EC4-MP1U

EtherCAT Slim
Pulse Output Module
User Manual

(Version 1.0)





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1 Product overview

1.1 Introduction

The EC4-MP1U is a slim pulse output module, which is designed to operate a pulse-type drive with pulse output. Configuration has to be done by the EtherCAT MDevice and the application program.

The EC4-MP1U has an integrated incremental encoder interface, 32 bit high frequency encoder counter counts the input signal of external incremental encoders. The encoder can for example be used for homing purposes and for consistency checks.

Three digital input channels are provided: A Left and right hardware limit switch and a home switch. The hardware limit switch which automatically stops the motor when activated, and all three digital inputs can be used for home position search.

The 26-pin HD D-Sub connector can be used to easily connect with various servo drivers and stepper drivers. ICP DAS also provides a variety of cables suitable for a range of brands of servo drivers, which further reduces the amount of wiring required between the drivers and the controller, making this an ideal solution for highly integrated machine automation applications.

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1.2 Technical Data

Features:

- On the fly processing: EtherCAT
- Maximum pulse frequency up to 4 MHz
- Differential encoder interface (A, B, Z),
- Maximum counting rate: 4 MHz
- Three DI channels: hardware limit input, home switch input
- Optically isolated I/O
- LED indicators for I/O, EtherCAT and motion status
- Internal memory for storing configuration data
- EtherCAT
  - EtherCAT conformance test tool verified
  - Supports Free-Run and Distributed Clock (DC) operation modes
  - Supports CoE and FoE
  - Supports Control modes: CPS、CSV、Hm and PP、PV
  - Support minimum communication cycle 0.5ms
- Suitable for controlling a variety of servo drivers and stepper drivers

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1.3 Hardware Specification

Pulse output	
Mode	Pulse /DIR、CW/CCW、A/B phase
Maximum pulse frequency	4 MHz
Encoder inputs	
Mode	Pulse/Dir、CW/CCW、A/B phase
Maximum encoder pulse frequency	1 MHz
Axis I/O	
Servo Interface Output	SVON、ERC、ALM_RST
Mechanical Switch Input	LL、RL、ORG、EMG
Servo Interface Input	ALM、RDY、INP
LED Indicators	
Diagnostic LED	Power, EtherCAT status, Digital IO
EtherCAT	
Cycle Time	0.5 ms
Distributed Clocks	Yes
Power	
Input voltage range	+24 V_{DC}
Power consumption	Maximum 4.5W
EMS Protection	
ESD (IEC 61000-4-2)	±4 KV Contact for each channel
EFT (IEC 61000-4-4)	Signal: 1 KV Class B; Power: 1 KV Class B
Mechanism	
Casing	Plastic
Dimensions [mm]	25 × 108 × 90 (W × L × D)
Installation	DIN-Rail or Wall Mounting
Environment	
Operating temperature	-25℃ ~ +75℃
Storage temperature	-30℃ ~ +80℃
Relative humidity	10 ~ 90%, No condensation

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2 Wiring

2.1 LED Definition

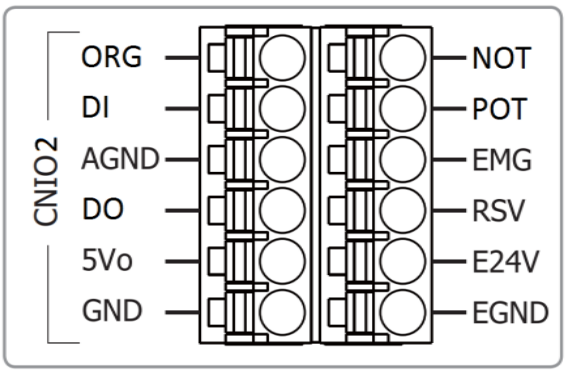
The ECAT-2092DS provides on the frontside of the connection cap several diagnostic LEDs.

Furthermore there are three LEDs to indicate the network status for EtherCAT. The exact meaning of the LED indication is specified in the following tables:

EtherCAT LED	Color	State	Description
PWR	green		Power indicator
RUN	green		This LED indicates the operation state of the EtherCAT SubDevice:
		Off	Device is in INIT state
		Flashing	Device is in PREOP state
		Single flash	Device is in SAFEOP state Outputs remain in safe state
		On	Device is in OP state
NOT	green		Negative direction hardware limit input
ORG	green		Home Switch input
POT	green		Positive direction hardware limit input
DI	green		Digital input
EMG	green		Emergency stop input

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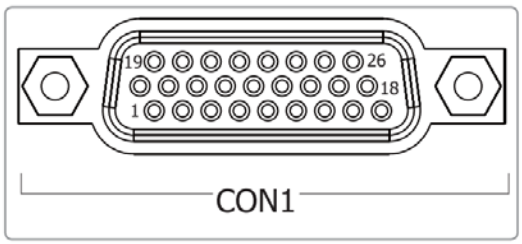
2.2 Connection Interfaces



CON2 (Dual row 6 pin removable terminal block): These connectors contain the input signal of mechanical switch (NOT, POT, ORG) and Emergency Stop input. Table below shows the detailed description of these signals.

No.	Name	Description	I/O Define	Name	Description	I/O Define
	CON2 (the upper one, left side)			CON2 (the upper one, right side)		
1	ORG	Home position	Input	NOT	Negative end limit	Input
2	DI	Digital input	Input	POT	Positive end limit	Input
3	AGND	Optional analog ground , no internal connection	Connect to CON1	EMG	Emergency stop	Input
4	DO	Digital output	Output	RSV	Reserved signal (no internal connection)	Connect to CON1
5	5Vo	Internal 5V power +derived from 24V supply (*See Note)	Output	E24V	External power 24V	Input
6	GND	Internal ground	Output	EGND	External ground	Input

*Note: The maximum output current of 5Vo is 200mA



CON1(Female HD D-Sub 26 pin): This connector contain the commonly used control singals and I/O signals to the servo driver. ICP DAS provide various cables for easily snap-on connection between different servo drivers and the MN-MP4U-DIN.

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No.	Name	Description	I/O Define
CON2 (the lower one)			
1	SRV_ON	Servo On	Output
2	INP	In Position	Input
3	ERC	Error Counter Clear	Output
4	RDY	Servo Ready	Input
5	P-	Forward rotation pulse train (differential)	Output
6	P+		Output
7	A-	Encoder A-phase pulse	Output
8	A+		Output
9	N.C.	No internal connection	N.C.
10	RESET	Alarm Reset	Output
11	ALARM	Servo Alarm	Input
12	E24V	External power 24V	Input
13	EGND	External ground	Input
14	N.C.	No internal connection	N.C.
15	AGND	Optional analog ground, no internal connection	Connect to CON2
16	B-	Encoder B-phase pulse	Input
17	B+		Input
18	N.C.	No internal connection	N.C.
19	EMG	Emergency stop	Input
20	RSV	Reserved signal, no internal connection	Connect to CON2
21	EGND	External ground	Input
22	EGND	External ground	Input
23	N-	Backward rotation pulse train (differential)	Output
24	N+		Output
25	Z-	Encoder Z-phase pulse	Input
26	Z+		Input

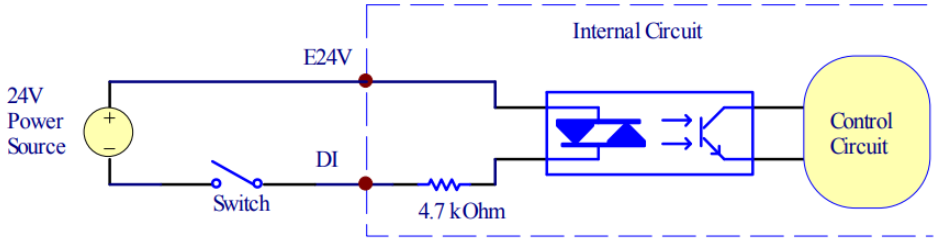
Note: Do not use signals marked as “N.C.”

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2.3 Digital Input Wiring

The digital input signals including INP, RDY, ALARM on CON1 and LL, RL, ORG, EMG on CON2. These signals are low speed 24V NPN photo-coupler input. Please refer to figure below for detailed connection information.

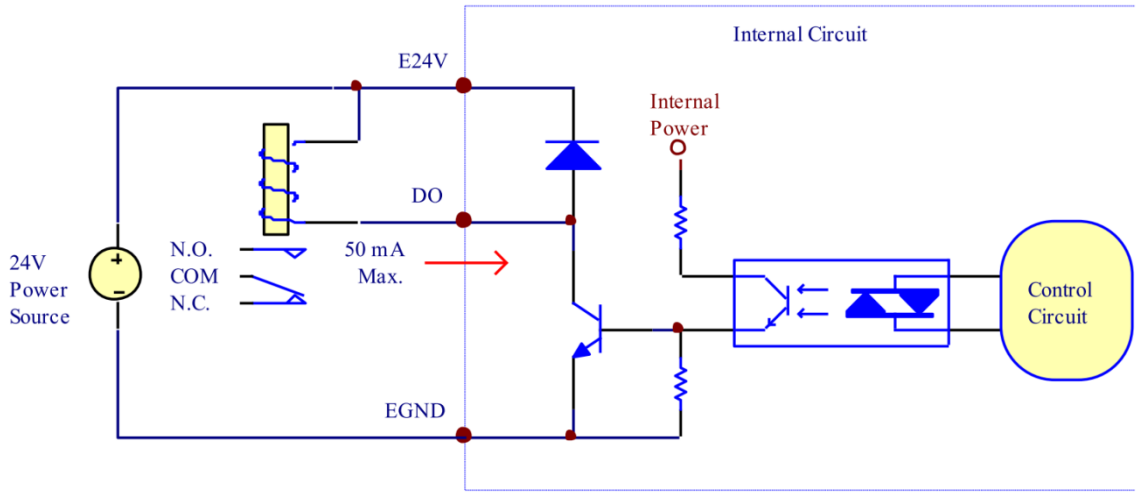
NPN Connection



2.4 Digital Output Wiring

The digital output signals including SRV_ON, RESET and ERC on CON1. These signals are open collector output of low speed photo-coupler with internal flywheel diode and the maximum output current of each is 50mA. Please refer to figure below for detailed connection information.

NPN Connection

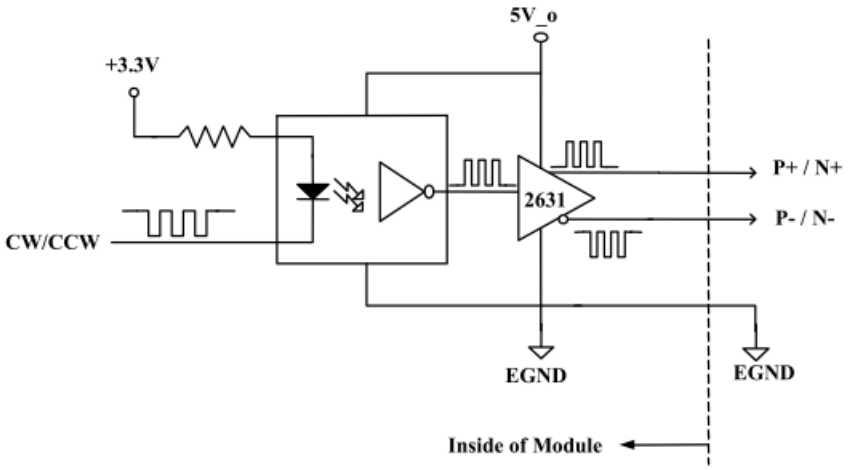


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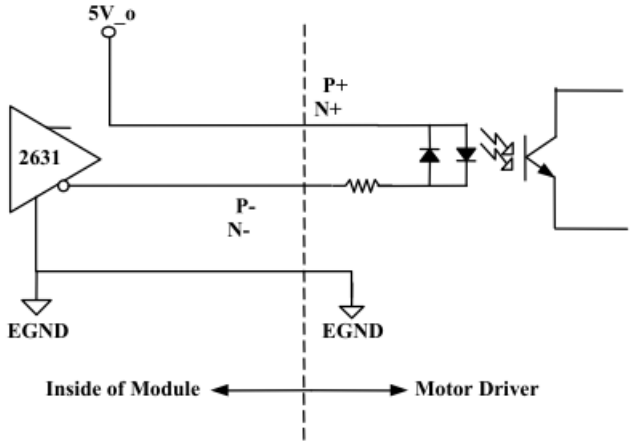
2.5 Pulse Output Wiring

The pulse output signals are located at pin #5, #6, #23 and #24 of CON1. These signals are differential line Driver output and the maximum output current of each pin is 20mA. The connection can be Differential Line Driver or Single Ended Current Sinking depending on external device.

1. Differential Line Driver connection:



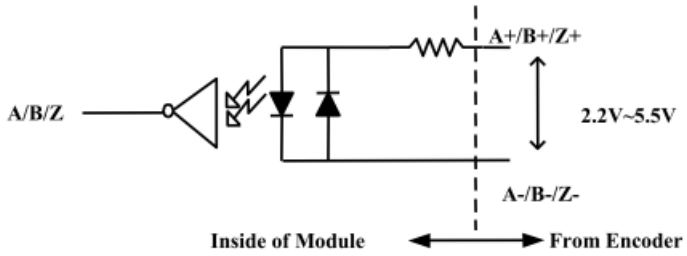
2. Single Ended Current Sinking connection:



2.6 Encoder Input Wiring

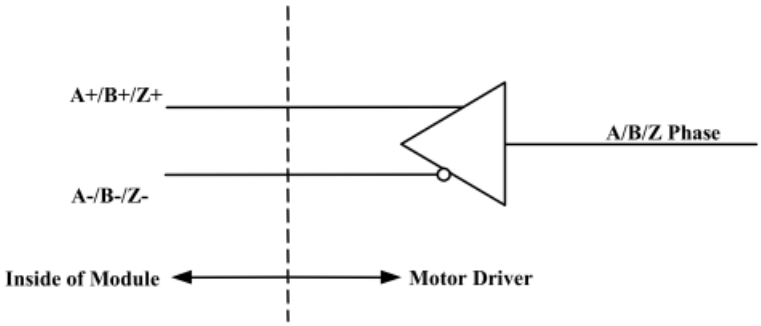
The encoder pulse input signals are located at pin #7, #8, #16, #17, #25 and #26 of CON1. These signals are high speed photo-coupler input with internal resistor of about 550 Ohms and the suggested input operating current is about 1.6~8mA. As a result, the suggested input voltage should be within 2.2V~5.5V.

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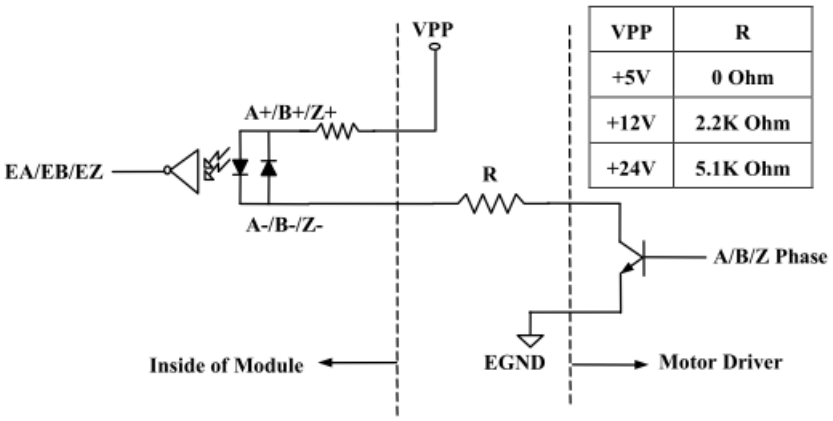


The connection can be Differential Line Driver or Open Collector depending on external device.

1. Differential Line Driver connection: Direct connection is possible



2. Open Collector: External resistor is required



VPP	R
+5V	0 Ohm
+12V	2.2K Ohm
+24V	5.1K Ohm

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2.7 Cable Wiring

Table below shows the internal I/O connection when using different cable to connect with respective servo driver:

CON1			Mitsubishi MELSERVO-J3/J4 CA26-MJ3-xx 50pin		Yaskawa Sigma-II/III/V CA26-YSV-xx 50pin	
Pin No.	Signal Name	Connected to	Pin No.	Signal Name	Pin No.	Signal Name
11	ALARM	Motion ASIC	48	ALM	31	ALM+
2	INPOS	Motion ASIC	24	INP	25	/COIN+
4	RDY	Motion ASIC	49	RD	29	/S-RDY+
10	RESET	Motion ASIC	19	RES	44	/ALMRST
3	ERC	Motion ASIC	41	CR / SP1	14	/CLR
1	SRV_ON	Motion ASIC	15	SON	40	/S-ON
21	EGND	EGND	43	LSP	42	P-OT
22	EGND	EGND	44	LSN	43	N-OT
19	EMG	CON2 and Motion ASIC	42	EMG	X	N.C.
12	E24V		20	DICOM	47	+ 24VIN
13	EGND		47	DOCOM	26	/COIN-
13	EGND		--	--	30	/S-RDY-
13	EGND		--	--	32	ALM-
15	AGND	CON2	3	LG	6	SG
			28	LG	10	SG
20	RSV	CON2	--	Reserved	--	Reserved
Note			--		To use the CLR (clear) function, SG signal on the servo driver should be connected to E-GND externally.	

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CON1			Panasonic MINAS A4/A5		Fuji FALDIC-W, ALPHA5 Smart	
			CA26-PA4-xx 50pin		CA26-FFW-xx 50pin	
Pin No.	Signal Name	Connected to	Pin No.	Signal Name	Pin No.	Signal Name
11	ALARM	Motion ASIC	37	ALM+	17	OUT3 (ALMb)
2	INPOS	Motion ASIC	39	COIN+ / AT-SPEED+	16	OUT2 (PSET)
4	RDY	Motion ASIC	35	S-RDY+	15	OUT1 (RDY)
10	RESET	Motion ASIC	31	A-CLR	3	CONT2 (RST)
3	ERC	Motion ASIC	30	CL	5	CONT4 (CR)*
1	SRV_ON	Motion ASIC	29	SRV-ON	2	CONT1 (RUN)
21	EGND	EGND	9	CCWL	X	N.C.
22	EGND	EGND	8	CWL	X	N.C.
19	EMG	CON2 and Motion ASIC	33	INH	4	CONT3 (EMG)*
12	E24V		7	COM+	1	P24
13	EGND		38	COIN- / AT-SPEED-	14	M24
13	EGND		34	S-RDY-	--	--
13	EGND		36	ALM-	--	--
13	EGND		41	COM-	--	--
15	AGND	CON2	13	GND	26	M5
			15	GND	13	M5
			17	GND	--	--
20	RSV	CON2	--	Reserved	--	Reserved
Note			For A4 servo driver, PrNo.40 should be set to “1” (the default value is “0”) For A5 servo driver, Pr0.05 should be set to “1” (the default value is “0”)		Please refer to the user’s manual of servo driver to modify the setting below: a. Set CONT4 as “7” (deviation clear) b. Set CONT3 as “5” (EMG)	

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CON1			Delta ASDA-A2		Delta ASDA-B2	
			CA26-DAA2-xx 50pin		CA26-DAB2-xx 50pin	
Pin No.	Signal Name	Connected to	Pin No.	Signal Name	Pin No.	Signal Name
11	ALARM	Motion ASIC	28	DO5+ (ALRM)	17	DO5+ (Alarm)
2	INPOS	Motion ASIC	1	DO4+ (TPOS) / (BRKR)	16	DO4+ (TPOS) / (BRKR)
4	RDY	Motion ASIC	7	DO1+ (SRDY)	15	DO1+ (SRDY)
10	RESET	Motion ASIC	33	DI5- (ARST)	3	DI5- (ARST)
3	ERC	Motion ASIC	10	DI2- (CCLR) / (TRQLM)	5	DI2- (CCLR) / (TRQLM)
1	SRV_ON	Motion ASIC	9	DI1- (SON)	2	DI1- (SON)
21	EGND	EGND	31	DI7- (CCWL)	X	DI7- (CCWL)
22	EGND	EGND	32	DI6- (CWL)	X	DI6- (CWL)
19	EMG	CON2 and Motion ASIC	30	DI8- (EMGS)	4	DI8- (EMGS)
12	E24V		11	COM+	1	COM+
13	EGND		6	DO1-	14	DO1-
13	EGND		26	DO4-	--	COM-
13	EGND		27	DO5-	--	DO4-
13	EGND		49	COM-	--	DO5-
15	AGND	CON2	44	GND	19	GND
			19	GND		
			12	GND		
20	RSV	CON2	--	Reserved	--	Reserved
Note			Digit D of P1-00 (source of pulse command) must be set as “1” (line driver)		Digit D of P1-00 (source of pulse command) must be set as “1” (line driver)	

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3 Basics Communication

3.1 EtherCAT Cabling

The cable length between two EtherCAT devices must not exceed 100 m.

Cables and connectors
For connecting EtherCAT devices only Ethernet connections (cables + plugs) that meet the requirements of at least category 5 (CAt5) according to EN 50173 or ISO/IEC 11801 should be used. EtherCAT uses 4 wires for signal transfer.
The pin assignment is compatible with the Ethernet standard (ISO/IEC 8802-3).

3.2 EtherCAT State Machine

The state of the EtherCAT MDevice and SubDevice is controlled via the EtherCAT State Machine (ESM). The state determines which functions are accessible or executable in the EtherCAT SubDevice. State changes are typically initiated by requests of the MDevice and acknowledged by the SubDevice after the successful initialization. In case of an internal error, the SubDevice automatically changes to a lower state.

Supports four states:

- Init (state after Reset)
- Pre-Operational
- Safe-Operational
- Operational

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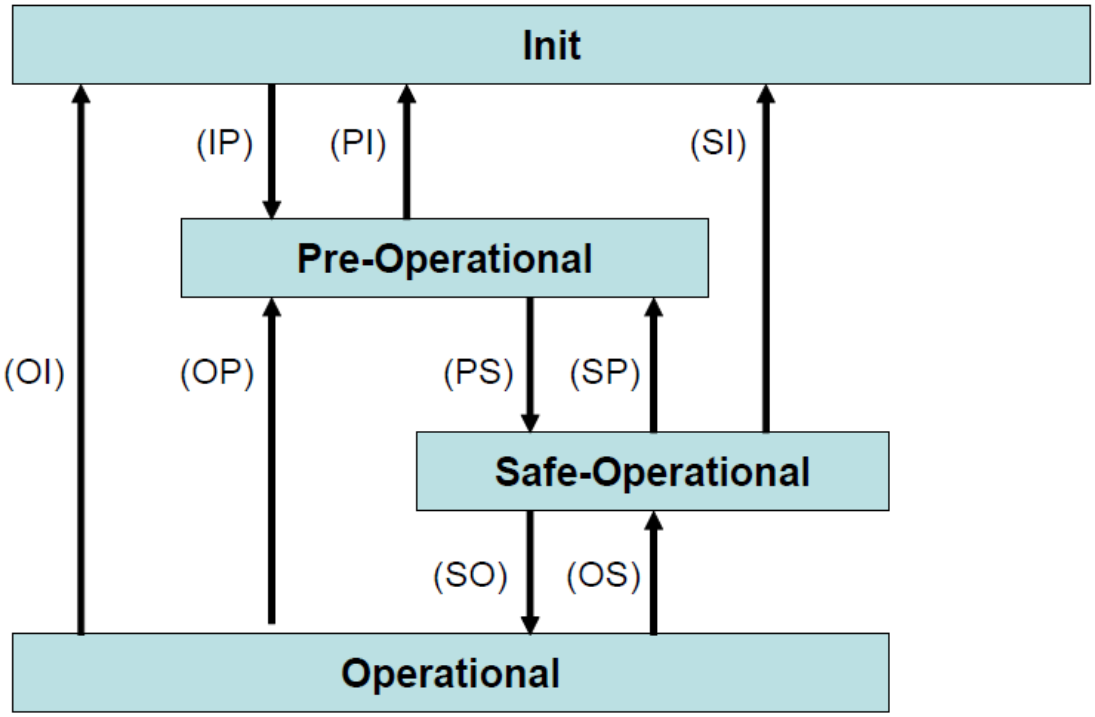


Figure 1: EtherCAT state machine

Init

After switch-on the EtherCAT SubDevice is in the initial state. Only ESC register communication is possible, but no mailbox or process data communication. The SubDevice initializes the service object data with default value or with values previously stored to the local memory. The EtherCAT MDevice assigns the station address and configures the sync manager channels 0 and 1 for acyclic mailbox communication.

Pre-Operational (Pre-Op)

In Pre-Op state acyclic mailbox communication is possible, but not process data communication. In this state the EtherCAT MDevice does the following configurations:

- Set the sync manager 2 and 3 for process data communication (from sync manager channel 2)
- The FMMU channels
- PDO mapping or the sync manager PDO assignment

Safe-Operational (Safe-Op)

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In Safe-Op state both mailbox and process data communication is enabled, but the SubDevice keeps its outputs in a safe state, while the input data are updated cyclically. The SubDevice will ignore the output data sent by the MDevice and just return the current input data (e.g. digital input, encoder value, etc.)

Outputs in Safe-Op state
The sync manager watchdog expires when the MDevice application does not provide new output process data within the configured watchdog time. In this case the SubDevice will automatically go from operational state to ERROR-SAFEOP state and set all the outputs in a safe state. Will stop the stepper motor and the motor current will be adjusted to 0.

Operational (Op)
Here both the process data object (PDO) and service data object (SDP) are fully enabled. MDevice sends cyclic output data and read input data. This module supports two types of Op modes: Free Run mode and Distributed Clock (DC) mode.

3.3 Synchronization Modes

ECAT-2092DS devices support two different modes

- Free Run: The MDevice cycle time and SubDevice cycle time is independent and not synchronized.
- Distributed Clock (DC): The MDevice cycle time and SubDevice cycle time are synchronized.

3.3.1 Free Run Mode

The SubDevice operates autonomously according to its cycle and is not synchronized with the EtherCAT cycle. The MDevice cycle time and the SubDevice cycle time are fully independent which means each SubDevice device reads/writes its own process data according to its local time, independent of the MDevice's cycle time.

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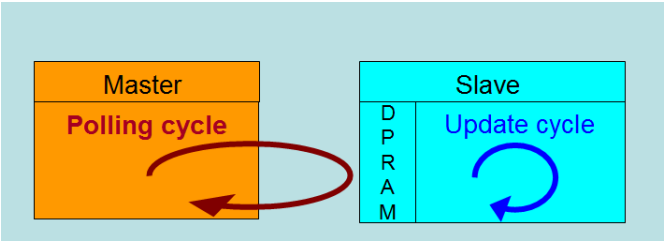


Figure 2: MDevice-SubDevice cycle in Free Run mode

The following diagram shows the process timing of the SubDevice in Free Run mode in detail:

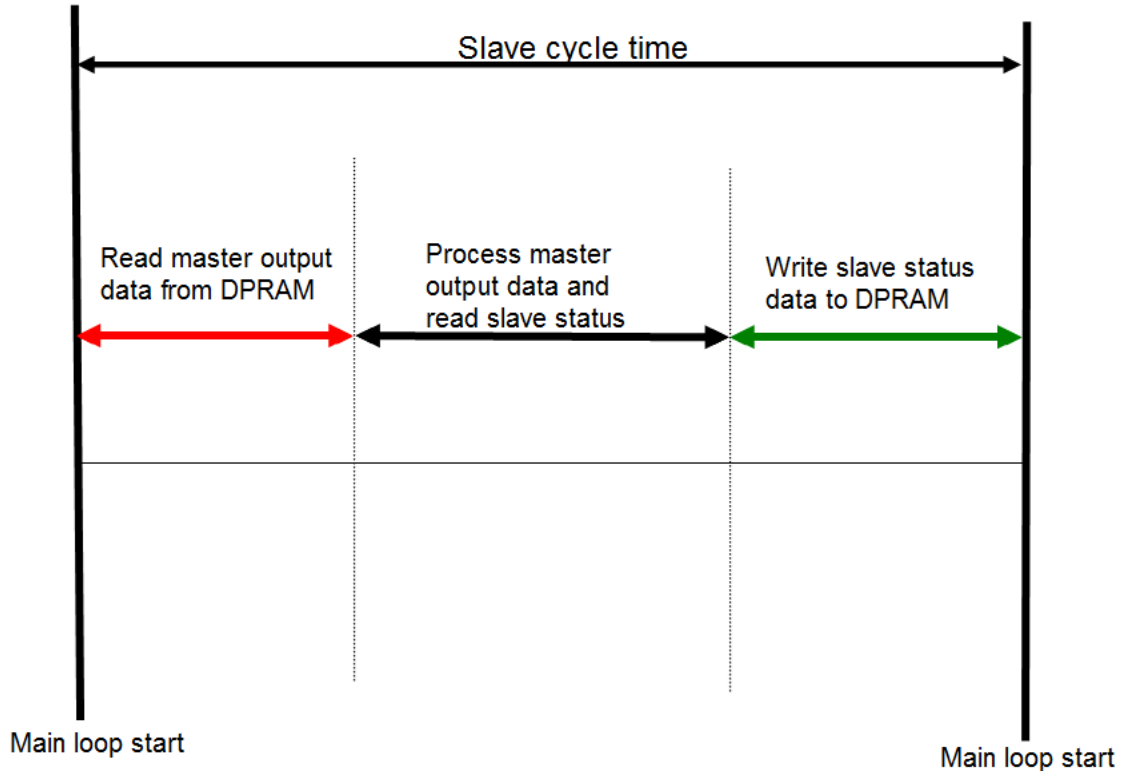


Figure 3: SubDevice processing sequence in Free-run mode

The SubDevice firmware checks in each cycle time the memory of the EtherCAT SubDevice chip (ESC) whether new output data has been received from the MDevice. Newly received data will be processed and the motion path will be calculated. In the next step motion and digital input status are being read from motion chip. In the final step the read status are being written to the DPRAM, so that the MDevice can retrieve the data ESC DPRAM in the next cycle time.

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3.3.2 Distributed Clocks (DC Mode)

DC clock synchronization enables all EtherCAT devices (MDevice and SubDevices) to share the same EtherCAT system time. The EtherCAT SubDevices in the network can be synchronized to each other. This enables the MDevice to simultaneously set the output (e.g. digital output, pulse output) or to synchronously read inputs (e.g. digital input, encoder counter) of different SubDevices in the EtherCAT network.

For system synchronization all SubDevices are synchronized to one reference clock. Normally the first EtherCAT SubDevice closest to the MDevice with Distributed Clocks capability becomes the clock base for the MDevice as well as for other DC SubDevices.

The EtherCAT SubDevice is synchronized with the SYNC0 or SYNC1 event of the distributed clock system. After the EtherCAT network has been set into DC communication mode by the MDevice, the ESC (EtherCAT SubDevice chip) of each SubDevice generates fixed time hardware interrupt which triggers the SubDevice firmware to process the PDO data received by the MDevice. The MDevice cycle time and the ESC hardware interrupt time interval are fully synchronized to the first SubDevice in the network that is used as a reference clock with the SYNC0 signal.

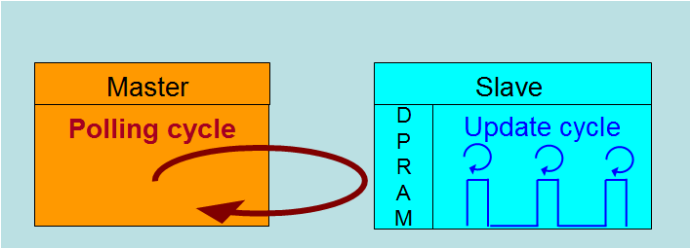


Figure 4: MDevice-SubDevice cycle in DC mode

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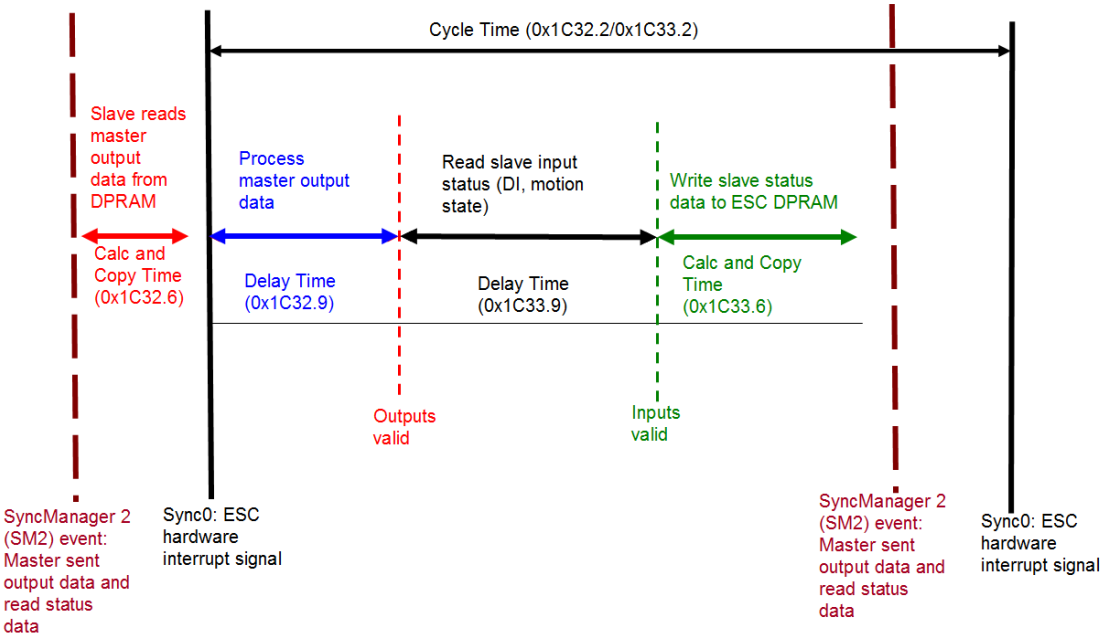


Figure 5: Internal SubDevice processing sequence in DC mode

Once the SubDevice receives process data (RxPDOs) from the MDevice the SM2 event is triggered which causes the firmware to read the data from the ESC memory. The ESC interrupts the firmware at fixed time interval to process the data received from the MDevice and write the status data to the ESC memory. Every time when the MDevice fails to sent process data within the DC cycle time the internal sync error counter is being increase by three counts. This error counter is being decreased by one count for every successful DC cycle. Once the error counter reached the maximum count (default 4) a sync error will be generated and the SubDevice goes into Safe OP mode (Sync Error 0x1C32:20 true TRUE). The maximum count value can be set by changing the default value of the "Sync Error Counter Limit" (0x10F1:02).

Index	Name	Flags	Value
10F1:0	Error Settings		> 2 <
10F1:01	Local Error Reaction	RW	0x00000001 (1)
10F1:02	Sync Error Counter Limit	RW	0x0004 (4)

Figure 6: Sync error counter limit object

The setting of the sync manager for the output and input data is available at the TwinCAT "CoE online" tab.

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Index	Name	Flags	Value
1C32:0	SM output parameter		> 32 <
1C32:01	Synchronization Type	RW	0x0002 (2)
1C32:02	Cycle Time	RO	0x00000000 (0)
1C32:04	Synchronization Types supported	RO	0x401F (16415)
1C32:05	Minimum Cycle Time	RO	0x001E8480 (2000000)
1C32:06	Calc and Copy Time	RO	0x0007A120 (500000)
1C32:08	Get Cycle Time	RW	0x0001 (1)
1C32:09	Delay Time	RO	0x000927C0 (600000)
1C32:0A	Sync0 Cycle Time	RW	0x005B8D80 (6000000)
1C32:0B	SM-Event Missed	RO	0x0000 (0)
1C32:0C	Cycle Time Too Small	RO	0x0000 (0)
1C32:20	Sync Error	RO	FALSE

Figure 7: SyncManager 2 parameters

SyncManager parameter description (time unit: nanosecond):

- Calc and Copy Time (0x1C32.6 / 0x1C33.6): Required time to copy the process data from the ESC to the local memory and calculate the output value.
- Delay Time (0x1C32.9 / 0x1C33.9): Delay from receiving the trigger to set the output or latch the input.
- Cycle Time (0x1C32.2 / 0x1C33.2): The current cycle time for the application. When using DC synchronization the value is read from register 0x9A0:0x9A3.
- 0x1C32.5 / 0x1C33.5 (Min Cycle Time): Minimum cycle time for the application. It is the total execution time of all SubDevice application related operations.

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4 CoE Communication Area (1000h ~ 1FFFh)

4.1 Device information

Index	sub-index	Name	Range	Data Type	Access	EEPROM	PDO	default
1000h	00h	Device type	0 - 4294967295	U32	ro	N	N	20192h
		Device type of the EtherCAT SubDevice						
1001h	00h	Error register	0 - 255	U8	ro	N	N	00h
1008h	00h	Manufacturer device name		VS	ro	N	N	EC4-MP1U
		Device name of the EtherCAT SubDevice						
1009h		Manufacturer hardware version		VS	ro	N	N	1.0.0
		Hardware version of the EtherCAT SubDevice						
100Ah		Manufacturer software version		VS	ro	N	N	1.0.0
		Software version of the EtherCAT SubDevice						
1018h	--	Identify object						
	00h	Number of entries	0 - 255	U8	ro	N	N	4
	01h	Vendor ID	0 - 4294967295	U32	ro	N	N	00494350h
		Vendor ID of the EtherCAT SubDevice						
	02h	Product code	0 - 4294967295	U32	ro	N	N	40F10001h
		Product code of the EtherCAT SubDevice						
	03h	Revision number	0 - 4294967295	U32	ro	N	N	00000001h
		Revision number of the EtherCAT SubDevice						
	04h	Serial number	0 - 4294967295	U32	ro	N	N	00000000h
		Serial number of the EtherCAT SubDevice						
10F1h	00h	Error settings						
	01h	Local error reaction	0 -	U32	rw	N	N	00000001h

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			4294967295					
	02h	Sync error counter limit	0 - 65535	U16	rw	N	N	0004h
		For DC mode only: The Sync Error Counter is incremented with every missing Sync Management Event by three and decremented by one if an event is received. If the Sync Error Counter exceeds this limit the system changes into the SAFEOP state with the "Synchronization Lost" error. The Sync Error Counter is reset when the error was acknowledged.						

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4.2 PDO(Process Data Object)Mapping

4.2.1 PDO Assign Object(1C12h ~ 1C13h)

Index	sub-index	Name	Range	Data Type	Access	EEPROM	PDO	default
1C12h	--	Sync manager channel 2						
	00h	Number of assigned PDOs	0 -1	U8	rw	N	N	1
	01h	PDO mapping object of assigned RxPDO 1	1600h	U16	rw	N	N	1600h
1C13h	--	Sync manager channel 3						
	00h	Number of assigned PDOs	0 -1	U8	rw	N	N	1
	01h	PDO mapping object of assigned TxPDO 1	1A00h	U16	rw	N	N	1A00h

4.2.2 PDO Mapping Object(1600h ~ 1630h、1A00~1A30h)

Index	sub-index	Name	Range	Data Type	Access	EEPROM	PDO	default
1600h	--	Receive PDO mapping 1						
	00h	Number of entries	0 - 16	U8	rw	N	N	4
	01h	1st receive PDO mapped	0 - 4294967295	U32	rw	N	N	60400010h
	02h	2nd receive PDO mapped	0 - 4294967295	U32	rw	N	N	60600008h
	03h	3rd receive PDO mapped	0 - 4294967295	U32	rw	N	N	607A0020h
	04h	4th receive PDO mapped	0 - 4294967295	U32	rw	N	N	600FF0020h

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	05h	5th receive PDO mapped	0 - 4294967295	U32	rw	N	N	00000000h
		. . .						
	0Fh	15th receive PDO mapped	0 - 4294967295	U32	rw	N	N	00000000h
1A00h	--	Transmit PDO mapping 1						
	00h	Number of entries	0 - 16	U8	rw	N	N	7
	01h	1st transmit PDO mapped	0 - 4294967295	U32	rw	N	N	60410010h
	02h	2nd transmit PDO mapped	0 - 4294967295	U32	rw	N	N	603F0010h
	03h	3rd transmit PDO mapped	0 - 4294967295	U32	rw	N	N	60610008h
	04h	4th transmit PDO mapped	0 - 4294967295	U32	rw	N	N	60640020h
	05h	5th transmit PDO mapped	0 - 4294967295	U32	rw	N	N	606c0020h
	06h	6th transmit PDO mapped	0 - 4294967295	U32	rw	N	N	60FD0020h
	07h	7th transmit PDO mapped	0 - 4294967295	U32	rw	N	N	00000018h
	08h	8th transmit PDO mapped	0 - 4294967295	U32	rw	N	N	00000000h
		. . .						
	0Fh	15th transmit PDO mapped	0 - 4294967295	U32	rw	N	N	00000000h

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4.3 Sync manager 2/3 sychronization(1C32h、1C33h)

Index	sub-index	Name	Range	Data Type	Access	EEPROM	PDO	default
1C32h	--	Sync manager 2 synchronization						
	00h	Number of sub-objects	0 - 255	U8	ro	N	N	20h
	01h	Synchronization Type	0 - 65535	U16	rw	N	N	0000h
	02h	Cycle Time	0 - 4294967295	U32	ro	N	N	0000h
	04h	Synchronization Types supported	0 – 65535	U16	ro	N	N	001Fh
	05h	Minimum Cycle Time	0 - 4294967295	U32	ro	N	N	0007A120h
	06h	Calc and Copy Time	0 - 4294967295	U32	ro	N	N	00009C40h
	08h	Get Cycle Time	0 - 65535	U16	ro	N	N	0000h
	09h	Delay time	0 - 4294967295	U32	ro	N	N	00002710h
	0Ah	Sync0 Cycle Time	0 - 4294967295	U32	ro	N	N	00000000h
	0Bh	SM-Event Missed	0 - 65535	U16	ro	N	N	0000h
	0Ch	Cycle Time Too small	0 - 65535	U16	ro	N	N	0000h
	20h	Sync Error	0 - 1	BOOL	ro	N	N	FALSE

Index	sub-index	Name	Range	Data Type	Access	EEPROM	PDO	default
1C33h	--	Sync manager 3 synchronization						
	00h	Number of sub-objects	0 - 255	U8	ro	N	N	20h
	01h	Synchronization Type	0 - 65535	U16	rw	N	N	0000h

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	02h	Cycle Time	0 - 4294967295	U32	ro	N	N	0000h
	04h	Synchronization Types supported	0 – 65535	U16	ro	N	N	001Fh
	05h	Minimum Cycle Time	0 - 4294967295	U32	ro	N	N	0007A120h
	06h	Calc and Copy Time	0 - 4294967295	U32	ro	N	N	00009C40h
	08h	Get Cycle Time	0 - 65535	U16	ro	N	N	0000h
	09h	Delay time	0 - 4294967295	U32	ro	N	N	00002710h
	0Ah	Sync0 Cycle Time	0 - 4294967295	U32	ro	N	N	00000000h
	0Bh	SM-Event Missed	0 - 65535	U16	ro	N	N	0000h
	0Ch	Cycle Time Too small	0 - 65535	U16	ro	N	N	0000h
	20h	Sync Error	0 - 1	BOOL	ro	N	N	FALSE

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5 Drive parameter Area (2000h ~ 5FFFh)

Index	sub-index	Name	Range	Data Type	Access	EEPROM	PDO	default
2000h	--	EMG Change Polarity	0 - 1	U16	rw	Y	N	0001h
2001h	--	ORG Change Polarity	0 - 1	U16	rw	Y	N	0001h
2002h	--	NOT Change Polarity	0 - 1	U16	rw	Y	N	0001h
2003h	--	POT Change Polarity	0 - 1	U16	rw	Y	N	0001h
2004h	--	EZ Change Polarity	0 - 1	U16	rw	Y	N	0001h
2005h	--	ALM Change Polarity	0 - 1	U16	rw	Y	N	0001h
2006h	--	INP Change Polarity	0 - 1	U16	rw	Y	N	0001h
2007h	--	RDY Change Polarity	0 - 1	U16	rw	Y	N	0001h
2008h	--	SVON Change Polarity	0 - 1	U16	rw	Y	N	0001h
2009h	--	DI0 Change Polarity	0 - 1	U16	rw	Y	N	0001h
200Ah	--	DO0 Change Polarity	0 - 1	U16	rw	Y	N	0001h
200Dh	--	ERC PulseWidth	0 – 65535	U16	rw	Y	N	0000h
		If the ERC pulse width is set to greater than 0, an ERC signal of the specified pulse width will be output upon completion of a homing operation						
3003h	--	Encoder PPR	0 - 4294967295	U32	rw	Y	N	00000000h
		pulse per revolution of the encoder						
3004h	--	Encoder Mode	0 - 127	U16	rw	Y	N	0004

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Bit	7	6	5	4	3	2	1	0
Function	-	EZ_INV	EB_INV	EA_INV	-	PULSE_MODE		

PULSE_MODE (R/W):
0: OUT/DIR pulse
1: CW/CCW pulse
2: 1 x AB phase pulse, the minimum pulse width is 80ns
3: 2 x AB phase pulse, the minimum pulse width is 80ns
4: 4 x AB phase pulse, the minimum pulse width is 160ns

EA_INV: Write '1' to invert A signal (default: '0')
EB_INV: Write '1' to invert B signal (default: '0')
EZ_INV: Write '1' to invert C signal (default: '0')

3006h	--	Motor PPR	200 - 51200	U16	rw	Y	N	C800h
	pulse per revolution of the motor: 200(Full step). 400. 800. 1600. 3200. 6400. 12800. 25600. 51200							
300Ch	--	Motor Interface	0 - 31	U16	rw	Y	N	00000000h

Bit	4	3	2	1	0
Function	P_INV	N_INV	SWP	FRMTx	

FRMTx (R/W): Pulse output format
"00": Pulse/Direction (Default)
"01": CW/CCW
"10": EA/EB

P_INV (R/W): Write '1' to invert P+ P- signal (default: '0')
N_INV (R/W): Write '1' to invert N+ N- signal (default: '0')
SWP (R/W): Write '1' to swap P signal and N signal (P signal will be sent via N pin while N signal will be sent via P pin)

3010h	--	Profile Jerk	0 - 4294967295	U32	rw	Y	N	0003E800h
3011h	--	Motor Direction	0 - 1	U16	rw	Y	N	00h
4002h	00h	Moving Average	0 - 10	U8	rw	N	N	5h
		CSP position command moving average filter, valid in interpolation mode, unit: ms						
4003h	00h	Motion Mode	0 - 1	U8	rw	N	N	0h

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		0: interpolation mode 1: high speed mode(It is suitable for high-speed and short-distance commands, and the command execution time should be less than 500ms)						
5000h	--	Store parameters						
	00h	Number of entries		U8	rw	N	N	3
	01h	Save all Parameters	0 - 4294967295	U32	rw	N	N	00000000h
	02h	Load Factory	0 - 1	U32	rw	Y	N	00000001h
	03h	Save counter	0 - 4294967295	U32	ro	Y	N	00000000h
	To enable EEPROM, please set Load Factory to 0, And set Save all Parameters from 0 to 1 to save the parameters, If the archive fails, the EEPROM Error(0x5001:01) is 1, Please reset Save all Parameters from 0 to 1, If the save is successful, Save counter + 1 To restore to the default value, please set Load Factory to 1, And set Save all Parameters from 0 to 1 to restore to the default value, If the archive fails, the EEPROM Error is 1 If the save is successful, Save counter + 1 All parameters will be restored to preset values after power on again							
5001h	--	Store Status						
	00h	Number of entries		U8	rw	N	N	2
	01h	EEPROM Error	0 - 1	U32	ro	N	N	00000000h
	02h	Load EEPROM	0 - 1	U32	rw	Y	N	00000000h
	If the EEPROM Error is 1 after power-on, it means that the EEPROM reading failed. Please set Load EEPROM from 0 to 1, if successful, EEPROM Error is 0. If the EEPROM Error is still 1, it means that a problem occurred during the last archive, but it was not processed. Please re-archive							

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6 Drive Profile Area (6000h ~ 6FFFh)

6.1 Object List

Index	sub-index	Name	Range	Data Type	Access	EEPROM	PDO	default
603Fh	00h	ErrorCode	0 - 65535	U16	ro	N	Y	0000h
6040h	00h	Controlword	0 - 65535	U16	rw	N	Y	0000h
6041h	00h	Statusword	0 - 65535	U16	ro	N	Y	0000h
605Ah	00h	Quick Stop Option Code	1 - 3 5 - 7	U16	rw	Y	N	0002h
605Bh	00h	Shutdown Option Code	1	U16	rw	Y	N	0001h
605Ch	00h	Disable Operation Option Code	1	U16	rw	Y	N	0001h
605Dh	00h	Halt Option Code	1 - 3	U16	rw	Y	N	0002h
605Eh	00h	Fault Reaction Option Code	1 - 2	U16	rw	Y	N	0002h
6060h	00h	Modes Of Operation	-128 - 127	I8	rw	N	Y	09h
6061h	00h	Modes Of Operation Display	-128 - 127	I8	ro	N	Y	00h
6062h	00h	Position Demand Value	-2147483648 - 2147483647	I32	ro	N	N	00000000h
6063h	00h	Position actual internal value	-2147483648 - 2147483647	I32	ro	N	N	00000000h
6064h	00h	Position Actual Value	-2147483648 - 2147483647	I32	ro	N	Y	00000000h
6065h	00h	Following error	0 -	U32	rw	N	Y	00000000h

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		window	4294967295					
6066h	00h	Following Error Time Out	0 - 65535	U16	rw	N	Y	00h
6067h	00h	Position Window	0 - 4294967295	U32	rw	N	Y	FFFFFFFFh
6068h	00h	Position Window Time	0 - 65535	U16	rw	N	Y	00h
606Bh	00h	Velocity Demand Value	-2147483648 - 2147483647	I32	ro	N	Y	00000000h
606Ch	00h	Velocity Actual Value	-2147483648 - 2147483647	I32	ro	N	Y	00000000h
606Dh	00h	Velocity Window	0 - 65535	U16	rw	N	Y	00h
606Eh	00h	Velocity Window Time	0 - 65535	U16	rw	N	Y	00h
607Ah	00h	Target Position	-2147483648 - 2147483647	I32	ro	N	Y	00000000h
607Ch	00h	Home Offset	-2147483648 - 2147483647	I32	rw	N	N	00000000h
607Dh		Software Position Limit					N	
	00h	Number of entries	2	U8	ro	N	N	2
	01h	Min position limit	-2147483648 - 2147483647	I32	rw	Y	N	00000000h
	02h	Max position limit	-2147483648 - 2147483647	I32	rw	Y	N	00000000h
607Fh	00h	Max. Profile Velocity	0 - 4294967295	U32	rw	Y	N	7FFFFFFFh
6081h	00h	Profile Velocity	0 - 4294967295	U32	rw	Y	N	0000C350h

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6083h	00h	Profile Acceleration	0 - 4294967295	U32	rw	Y	N	0000C350h
6084h	00h	Profile Deceleration	0 - 4294967295	U32	rw	Y	N	0000C350h
6085h	00h	Quick Stop Deceleration	0 - 4294967295	U32	rw	Y	N	0007A120h
6086h	00h	Motion profile type	0-3	I16	rw	Y	N	0000h
6098h	00h	Homing method	-128 - 127	I8	rw	Y	N	00h
6099h		Homing Speeds					N	
	00h	Number of entries	2	U16	ro	N	N	2
	01h	Speed during search for switch	0 - 4294967295	U32	rw	Y	N	0000C350h
	02h	Speed during search for zero	0 - 4294967295	U32	rw	Y	N	000007D0h
609Ah	00h	Homing acceleration	0 - 4294967295	U32	rw	Y	N	0000C350h
60B0h	00h	Position Offset	-2147483648 - 2147483647	I32	rw	N	Y	00000000h
60B1h	00h	Velocity Offset	-2147483648 - 2147483647	I32	rw	N	Y	00000000h
60C5h	00h	Max Acceleration	0 - 4294967295	U32	rw	Y	N	7FFFFFFFh
60C6h	00h	Max Deceleration	0 - 4294967295	U32	rw	Y	N	7FFFFFFFh
60F4h	00h	Following Error	-2147483648 - 2147483647	I32	ro	N	Y	00000000h
60FDh	00h	Digital Inputs	0 - 4294967295	U32	ro	N	Y	00000000h
60FEh		Digital Outputs					N	
	00h	Number of entries	2	U8	ro	N	N	2
	01h	Physical Outputs	0 -	U32	rw	Y	N	00000000h

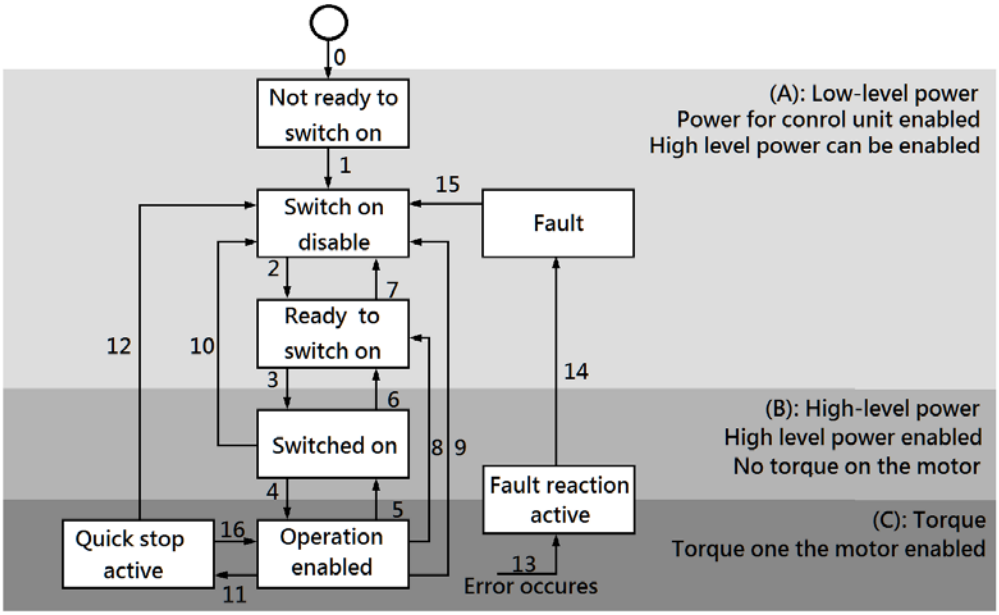
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<table>
<tr><td></td><td></td><td></td><td>4294967295</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>02h</td><td>Bit Mask</td><td>0 - 4294967295</td><td>U32</td><td>rw</td><td>Y</td><td>N</td><td>00000000h</td></tr>
<tr><td></td><td colspan="8">
<table>
<tr><td>Bit</td><td>231</td><td>30</td><td>29</td><td>28</td><td>27</td><td>26</td><td>25</td><td>24</td></tr>
<tr><td>Function</td><td colspan="8">(Not Supported)</td></tr>
<tr><td>Bit</td><td>23</td><td>22</td><td>21</td><td>20</td><td>19</td><td>18</td><td>17</td><td>16</td></tr>
<tr><td>Function</td><td colspan="8">(Not Supported)</td></tr>
<tr><td>Bit</td><td>15</td><td>14</td><td>13</td><td>12</td><td>11</td><td>10</td><td>9</td><td>8</td></tr>
<tr><td>Function</td><td colspan="8">(Not Supported)</td></tr>
<tr><td>Bit</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td>Function</td><td colspan="4">(Not Supported)</td><td>ALM RST</td><td>ERC</td><td>--</td><td>--</td></tr>
</table>
Physical Outputs: Control DO signal output.
Bit Mask: Control whether to enable DO signal output (0: Disable, 1: Enable).
When set to disable ALMRST output, ALMRST is automatically controlled by the module.
</td></tr>
<tr><td>60FFh</td><td>00h</td><td>Target Velocity</td><td>-2147483648 - 2147483647</td><td>I32</td><td>rw</td><td>N</td><td>Y</td><td>00000000h</td></tr>
<tr><td>6502h</td><td>00h</td><td>Supported Drive Modes</td><td>0 - 4294967295</td><td>U32</td><td>ro</td><td>Y</td><td>N</td><td>000001A5h</td></tr>
</table>

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6.2 PDS State Machine

According to the user command or abnormal detection, etc., the PDS state machine transition of the drive is defined as shown in the figure below



PDS Transition		Event(s)	Action(s)
0	Auto skip 0	Automatically changes after control power-on or after resetting application	The drive functions are self-diagnosed and initialized
1	Auto skip 1	Automatic transition after the completion of initialization	The communication is established
2	Shutdown	The Shutdown command is received	-
3	Switch on	The Switch on command is received	-
4	Enable operation	The Enable operation command is received	The drive functions are validated
5	Disable operation	The Disable operation command is received	The drive functions are disabled
6	Shutdown	The Shutdown command is received	-
7	Disable voltage	The Disable voltage command is received	-

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		The Quick stop command is received	
8	Shutdown	The Shutdown command is received	The drive functions are disabled
9	Disable voltage	The Disable voltage command is received	The drive functions are disabled
10	Disable voltage	The Disable voltage command is received The Quick stop command is received	-
11	Quick stop	The Quick stop command is received	The Quick stop function starts
12	Disable voltage	Quick stop function is completed and quick stop option code is 1, 2 or 3. After Quick stop function is completed, received Disable voltage command quick stop option code is 5, 6, or 7.	The drive functions are disabled
13	Error occurs	An error is detected	Performs the established Fault reaction function
14	Auto skip2	After completing the deceleration process due to an error detection, the state transitions automatically	The drive functions are disabled
15	Fault reset	After releasing factor error, The Fault reset command is received	Resets the Fault state when there is no Fault factor
16	Enable operation	When the Quick stop option code is 5, 6, or 7, the Enable operation command is received	The drive functions are validated

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6.3 Controlword(6040h)

Index	sub-index	Name	Range	Data Type	Access	EEPROM	PDO
6040h	00h	controlword	0-65535	U16	rw	N	Y
		Set a command to a servo driver including the PDS state transition.					

Bit	15 ~ 10	9	8	7	6 ~ 4	3	2	1	0
	r	oms	h	fr	oms	eo	qs	ev	so

r = reserve
oms = operation mode specific
(Different definitions according to modes of operation)
fr = fault reset
h = halt
eo = Enable operation
qs = quick stop
ev = enable voltage
so = switch on

Bit7, 3 ~ 0(fault reset / Enable operation / quick stop / enable voltage / switch on):

The following table indicates the PDS command.

Command	bits of the controlword					PDS State
	bit 7	bit 3	bit 2	bit 1	bit 0	
	fault reset	enable operation	quick stop	enable voltage	switch on	
Shutdown	0	-	1	1	0	2, 6, 8
Switch on	0	0	1	1	1	3
Switch on + Enable operation	0	1	1	1	1	3+4
Enable operation	0	1	1	1	1	4, 16
Disable voltage	0	-	-	0	-	7, 9, 10, 12
Quick stop	0	-	0	1	-	7, 10, 11
Disable operation	0	0	1	1	1	5
Fault reset	rising edge	-	-	-	-	15

Note: The bit logic of the quick stop command is valid at 0, please note that it is different from other bit logic

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The following shows the definition of oms bit under each control mode (modes of operation)

-: reserve

Op-mode	bit 9	bit 6	bit 5	bit 4
csp	-	-	-	-
csv	-	-	-	-
hm	-	-	-	start homing
pp		absolute/ relative	change set immediately	new set-point
pv	-	-	-	-

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6.4 Statuslword(6041h)

Index	sub-index	Name	Range	Data Type	Access	EEPROM	PDO	default
6041h	00h	Statusword	0-65535	U16	ro	N	Y	0
		Displays the servo driver state						

Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	r		oms		ila	oms	rm	r	w	sod	qs	ve	f	oe	so	rtso

r = reserve
oms = operation mode specific
(Different definitions according to modes of operation)
ila = internal limit active
rm = remote
w = warning
sod = switch on disabled
qs = quick stop
ve = voltage enabled
f = fault
oe = operation enabled
so = switched on
rtso = ready to switch on

Bit 6, 5, 3 – 0(switch on disabled/ quick stop/ fault/ operation enabled/ switched on/ ready to switch on): This bit enables to confirm the PDS state

Statusword	PDS State	
xxxx xxxx x0xx 0000 b	Not ready to switch on	Initialization non-completed
xxxx xxxx x1xx 0000 b	Switch on disabled	Initialization completed
xxxx xxxx x01x 0001 b	Ready to switch on	Main circuit power OFF
xxxx xxxx x01x 0011 b	Switched on	Servo-off/servo ready
xxxx xxxx 0x1x 0111 b	Operation enabled	Servo-on
xxxx xxxx x00x 0111 b	Quick stop active	Immediate stop
xxxx xxxx x0xx 1111 b	Fault reaction active	Error (alarm) discriminated
xxxx xxxx x0xx 1000 b	Fault	Error (alarm) state

Bit 5(quick stop):

If 0, it indicates PDS responds to quick stop request.

Quick stop enabled if the bit is '0'.

Please keep in mind that the bit performs reverse operation compared to other bits.

Bit 7(warning):

If 1, it is indicating a warning. The PDS state does not change during the warning, also, continues the motor operation.

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Bit 13, 12, and 10(operation mode specific):

Below table shows the behavior of the operation mode (Op-mode) specific bits.

Op-mode	bit 13	bit 12	bit 10
csp	-	drive follows command value	-
csv	-	drive follows command value	-
hm	homing error	homing attained	target reached
pp	-	set-point acknowledge	target reached
pv	-	-	target reached

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6.5 Operation mode Setting

6.5.1 Supported drive modes(6502h)

This driver can confirm the supported control modes (Modes of operation) according to 6502h.

Index	sub-index	Name	Range	Data Type	Access	EEPROM	PDO	default
6502h	00h	Supported drive modes	0-4294967295	U32	ro	N	N	0x1A5

bit	Modes of operation		
0	Profile position mode	pp	Yes
1	Velocity mode	vl	No
2	Profile velocity mode	pv	Yes
3	Torque profile mode	tq	No
5	Homing mode	hm	Yes
6	Interpolated position mode	ip	No
7	Cyclic synchronous position mode	csp	Yes
8	Cyclic synchronous velocity mode	csv	Yes
9	Cyclic synchronous torque mode	cst	No

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6.5.2 Modes of operation (6060h)

The operation mode is set by 6060h (Modes of operation)

Index	sub-index	Name	Range	Data Type	Access	EEPROM	PDO	default
6060h	00h	Modes of operation	-128 - 127	I8	rw	N	Y	0x00

bit	Modes of operation	
1	Profile position mode	pp
3	Profile velocity mode	pv
6	Homing mode	hm
8	Cyclic synchronous position mode	csp
9	Cyclic synchronous velocity mode	csv

- Because 6060h (Modes of operation) is default=0 (No mode change/no mode assigned), please set the control mode value before the PDS state transitions to Operation enabled.

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6.5.3 Modes of operation display (6061h)

The 6061h (Modes of operation display) enables to confirm the internal operation mode of this servo driver.

After setting 6060h (Modes of operation), monitor this object to confirm that the system operation is set as expected

Index	sub-index	Name	Range	Data Type	Access	EEPROM	PDO	default
6061h	00h	Modes of operation	-128 - 127	I8	ro	N	Y	0x00
		Displays the operation mode at present.						

bit	Modes of operation	
1	Profile position mode	pp
3	Profile velocity mode	pv
6	Homing mode	hm
8	Cyclic synchronous position mode	csp
9	Cyclic synchronous velocity mode	csv

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6.5.4 Caution for Changing Operation mode

- The operation mode can be switched by changing the value of 6060h (Modes of operation).
- The 6061h (Modes of operation display) enables to confirm the operation mode of the servo driver at present.
- About 2 ms is required from the time when the operation mode is changed until the completion of the change.
- When changing the operation mode, make sure that the motor is stopped.
- If the control mode is changed during a motor operation (including during an origin return operation and deceleration stop), the operation cannot be guaranteed.

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6.6 Position Control Function

6.6.1 Software position limit (Software position limit:607Dh)

Index	sub-index	Name	Range	Data Type	Access	EEPROM	PDO	default
0x607D		Software Position Limit						
	00h	Number of entries	2	U8	ro	N	N	2
	01h	Min position limit	-2147483648 - 2147483647	I32	rw	Y	N	00000000h
	02h	Max position limit	-2147483648 - 2147483647	I32	rw	Y	N	00000000h

The following conditions are invalidation of the software limit function

607Dh-01h >= 607Dh-02h

Example) 607Dh-01h = 0

607Dh-02h = 0

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6.6.2 Profile Position Mode(pp mode)

In this mode, specify the target position, target speed, acceleration and deceleration, etc., and the driver will drive the motor to move after generating instructions internally in accordance with the motion parameters.

If user want to enable S-curve acceleration/deceleration motion, you need to set the object (Motion ProfileType: 6086h) to 3, and set the jerk (Axes Profile Jerk: 3010h) to control the smoothness of the curve, the smaller the acceleration the smoother the curve. In addition, the acceleration curve and deceleration curve are symmetrical in the S-curve motion mode, so you only need to set the acceleration value (Profile acceleration: 6083h), and there is no need to set the deceleration value (Profile decceleration: 6084h).

If you need to enable the S-curve motion stop function, you need to set different objects according to the stop command. The quick stop command must set the object (Quick stop option code: 605A) to 1, the Halt stop command must set the object (Halt Option Code: 6060) to 1.The motor will decelerate and stop according to the value of 6083h (Profile acceleration).

Note that in Motion S-curve mode, the module will automatically change to Linear mode and will not resume Motion S-curve mode until the motor reaches the target position if any of the following conditions occur.
1. An interrupt or stop command is given during acceleration.
2. Give non-reverse interrupt commands during equal speed or S-curve deceleration (interrupt commands in Motion S-curve mode only support reverse commands).
3. Give an interrupt command or cancel the halt command during motor deceleration after a linear halt command

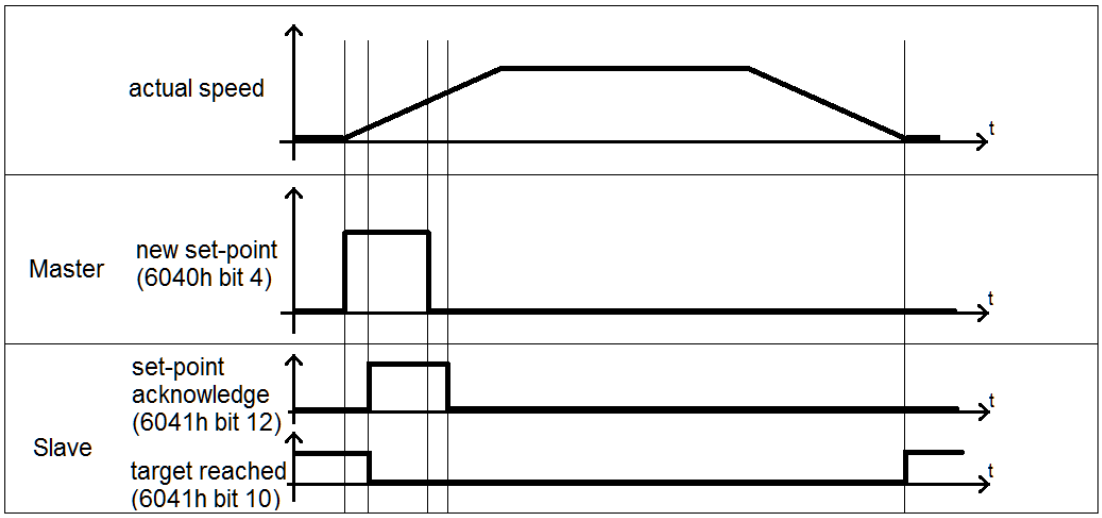
If user change the values of acceleration or jerk when reverse interrupt command in the S-curve motion mode, the motor will decelerate to stop according to the last set value, and then apply the new set value to do the motion control.

In addition, it is not possible to switch the motion mode during the motion period (including the Halt period), and it is necessary to wait until the motion is completed before switching the mode.

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Steps

1. Set the operation mode (Mode of operation: 6060h) to Profile position mode (pp mode) Value = 0x01, and confirm (Mode of operations Display: 6061h) = 0x01.
2. Change (Controlword: 6040h) from the value 0x06 → 0x07 → 0x0F to make the control system Servo On state.
3. Change the target position (Target Position: 607Ah).
4. Change the target velocity (Profile velocity: 6081h), this object is restricted by the setting value of (Max profile velocity: 607Fh).
5. Change acceleration (Profile acceleration: 6083h), this object is limited by the setting value of (Max acceleration: 60C5h).
6. Change the deceleration (Profile decceleration: 6084h), this object is limited by the setting value of (Max decceleration: 60C6h).
7. Set bit 4 (new set-point) of 6040h to change from 0 to 1, and the motor starts to operate.
8. Confirm that bit 12 (set-point acknowledge) of 6041h is from 0 to 1.
9. Confirm that bit10 (target reached) of 6041h is 1, and the positioning is completed.



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Control word: 6040h (under pp mode)

Bit	15 ~ 10	9	8	7	6 ~ 4	3	2	1	0
	r	r	h	fr	oms	eo	qs	ev	so
r = reserve fr = fault reset h = halt					eo = Enable operation qs = quick stop ev = enable voltage so = switch on				

bit	Name	Value	Definition
4	new set-point	0 -> 1	Start moving
5	change set immediately	0	After the current positioning action is completed, start the next positioning action
		1	Interrupt the current positioning action and immediately start the next positioning action
6	absolute/ relative	0	(Target position: 607A) is treated as an absolute position
		1	(Target position: 607A) is treated as a relative position

The difference according to the combined action of bit5 and bit4 is as follows

bit 5	bit 4	Definition
change set immediately	new set-point	
0	0 -> 1	The next positioning action is executed after the current positioning action is completed
1	0 -> 1	The next positioning action will be executed immediately

Status word: 6041h (under pp mode)

Bit	15~13	12	11	10	9	8	7	6	5	4	3	2	1	0
	r	set-point acknowledge	ila	target reached	rm	r	w	sod	qs	ve	f	oe	so	rtso

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r = reserve	w = warning
ila = internal limit active	sod = switch on disabled
rm = remote	qs = quick stop
	ve = voltage enabled
	f = fault
	oe = operation enabled
	so = switched on
	rtso = ready to switch on

bit	Name	Value	Definition
10	target reached	0	Command not completed
		1	When halt = 0: positioning is complete When halt = 1: the axis stops (speed is 0)
12	set-point acknowledge	0	new-setpoint is 0, and the buffer is empty
		1	new-setpoint is 1, or the buffer is not empty

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6.6.3 Cyclic Synchronous Position Mode(csp mode)

It is a position control mode to operate by creating a command position in the host controller (MDevice) and updating (transmitting) the command position in an interpolation cycle.

Step 1: Read (Position Actual Value: 6064h) and write to (Target position: 607Ah).

Step 2: Set (Mode of operation: 6060h) to Cyclic synchronous position mode (csp mode) value = 0x08, and check (Mode of operations Display: 6061h) = 0x08.

Step 3: Change (Controlword: 6040h) from the value 0x06 → 0x07 → 0x0F to make the control system Servo On state, and the drive starts to move according to (Target position: 607Ah).

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Control word: 6040h (under csp mode)

Bit	15 ~ 10	9	8	7	6 ~ 4	3	2	1	0
	r	r	h	fr	r	eo	qs	ev	so

r = reserve	eo = Enable operation
fr = fault reset	qs = quick stop
h = halt	ev = enable voltage
	so = switch on

Status word: 6041h (under csp mode)

Bit	15~13	12	11	10	9	8	7	6	5	4	3	2	1	0
	r	driver follows command value	ila	r	rm	r	w	sod	qs	ve	f	oe	so	rtso

r = reserve	w = warning
fe = following error	sod = switch on disabled
ila = internal limit active	qs = quick stop
rm = remote	ve = voltage enabled
	f = fault
	oe = operation enabled
	so = switched on
	rtso = ready to switch on

bit	Name	Value	Definition
12	driver follows command value	0	Operation is not performed according to the target position
		1	Operation is performed according to the target position

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6.6.4 Homing Mode(hm mode)

Specify the action speed, acceleration and homing method, the drive generates a position command and executes homing.

Step 1: Set (Mode of operation: 6060h) to the Homing mode (hm mode) Value = 0x06, and check (Mode of operations Display: 6061h) = 0x06

Step 2: Set (Home offset: 607Ch), the default is 0

Step 3: Set (Homing method: 6098h)

Step 4: Set (Homing speeds: 6099h Sub-1)

Step 5: Set (Homing speeds: 6099h Sub-2)

Step 6: Set (Homing acceleration: 609Ah)

Step 7: Change (Controlword: 6040h) from the value 0x06 → 0x07 → 0x0F to make the control system Servo On state

Step 8: Set (Controlword: 6040h)to 0x1F and start homing

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Control word: 6040h (under hm mode)

Bit	15 ~ 10	9	8	7	6 ~ 5	4	3	2	1	0
	r	r	h	fr	r	start homing	eo	qs	ev	so
r = reserve fr = fault reset h = halt					eo = Enable operation qs = quick stop ev = enable voltage so = switch on					

bit	Name	Value	Definition
4	start homing	0 -> 1	Start homing

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Status word: 6041h (under hm mode)

Bit	15~14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	r	homing error	homing attained	ila	target reached	rm	r	w	sod	qs	ve	f	oe	so	rtso

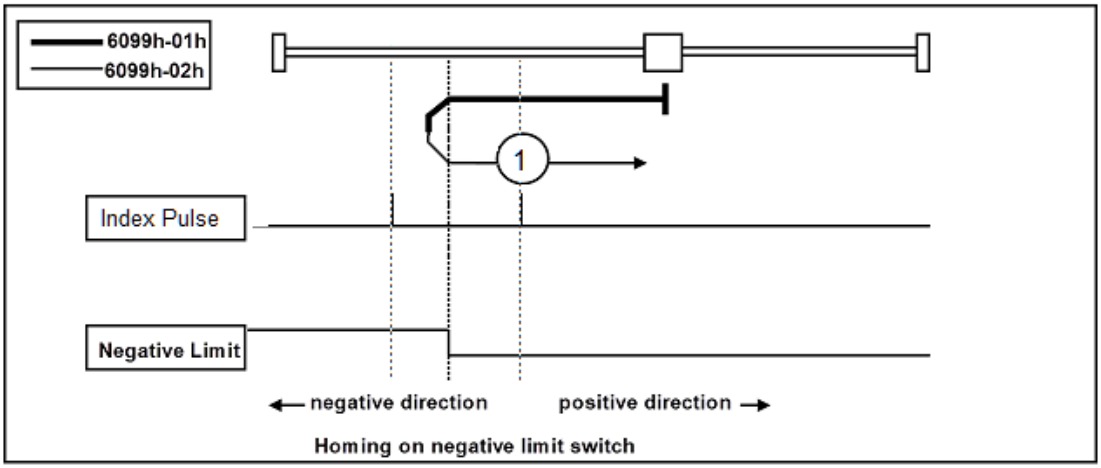
r = reserve
ila = internal limit active
rm = remote
w = warning
sod = switch on disabled
qs = quick stop
ve = voltage enabled
f = fault
oe = operation enabled
so = switched on
rtso = ready to switch on

bit	Name	Value	Definition
10	target reached	0	In operation
		1	Stopped state
12	homing attained	0	The homing operation is incomplete
		1	The homing operation complete to be performed successfully
13	homing error	0	A homing error does not occur (normal)
		1	A homing error occurs (The homing operation is not performed successfully)

bit 13	bit 12	bit 10	Definition
0	0	0	Homing
0	0	1	The homing operation is suspended or not started
0	1	0	The homing operation is completed, but the operation does not arrive at the target position
0	1	1	The homing operation is completed successfully
1	0	0	The homing error is detected but still working
1	0	1	The homing error is detected and stopped

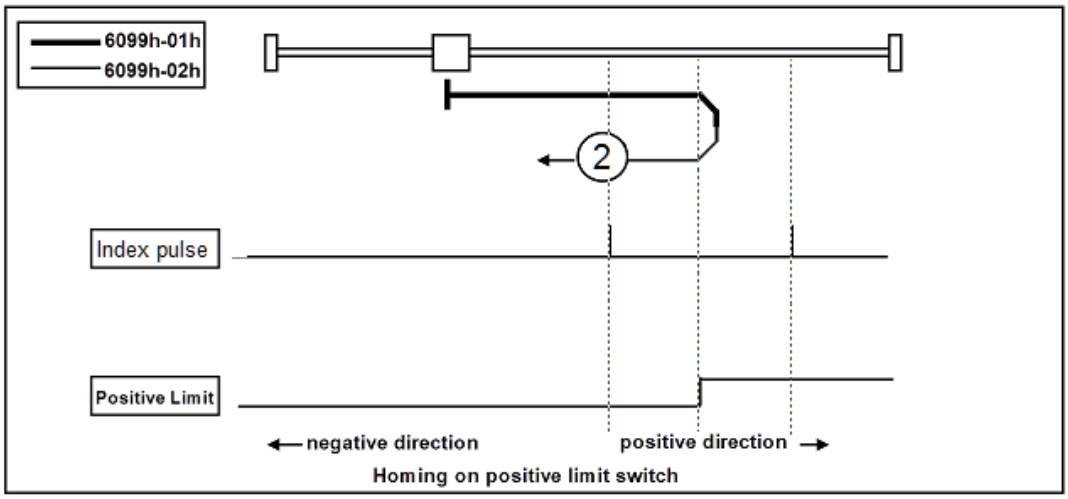
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- Method 1
  - If LL switch is not activated at the beginning of the action, the initial action direction is the negative direction.
  - If the LL switch has been activated at the beginning of the action, the initial action direction is the positive direction.
  - The home detection position is the first Index pulse detection position in the positive direction after the status change of LL.



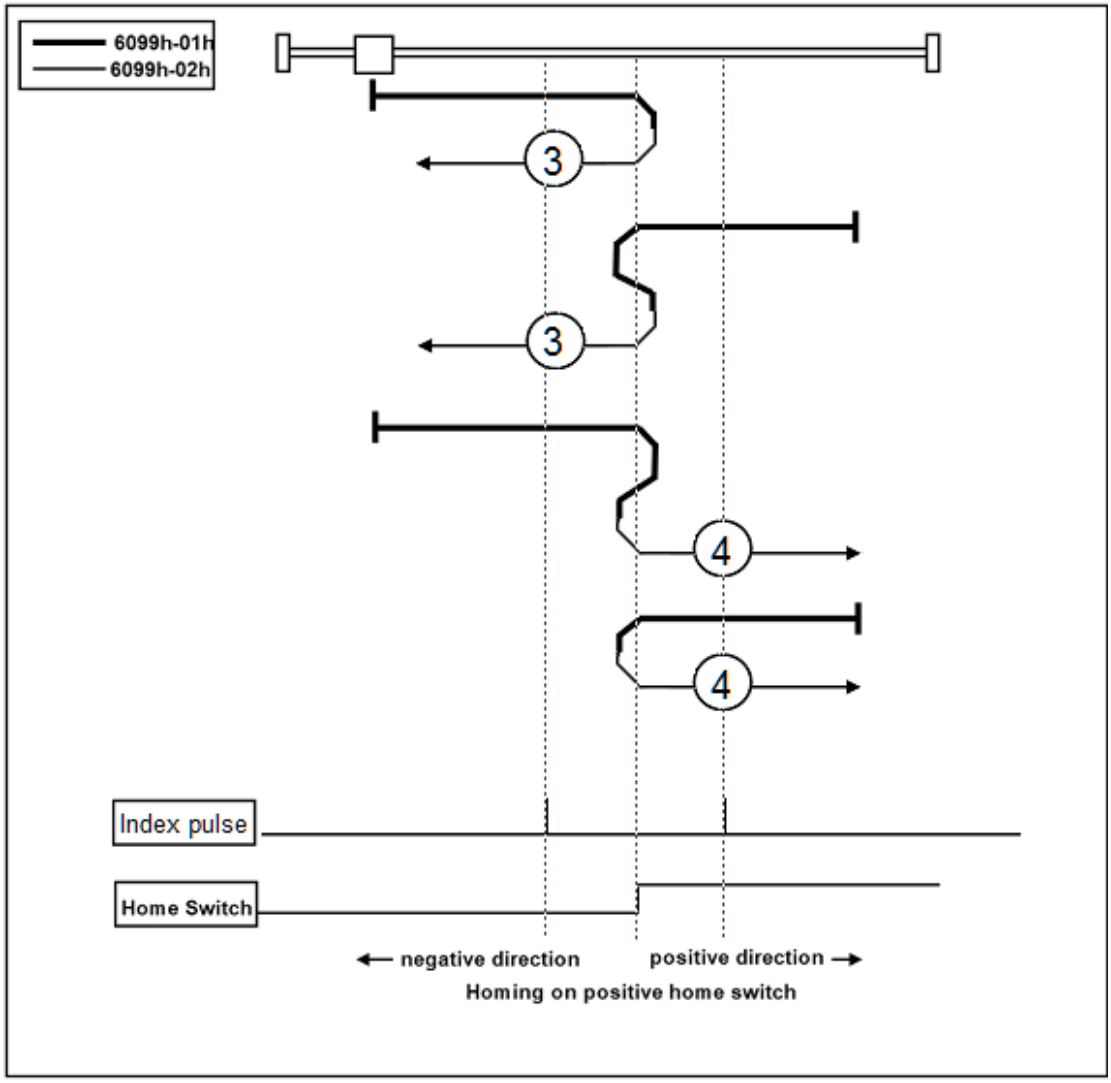
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- Method 2
  - If RL switch is not activated at the beginning of the action, the initial action direction is the positive direction.
  - If the RL switch has been activated at the beginning of the action, the initial action direction is the negative direction.
  - The home detection position is the first Index pulse detection position in the negative direction after the status change of RL.



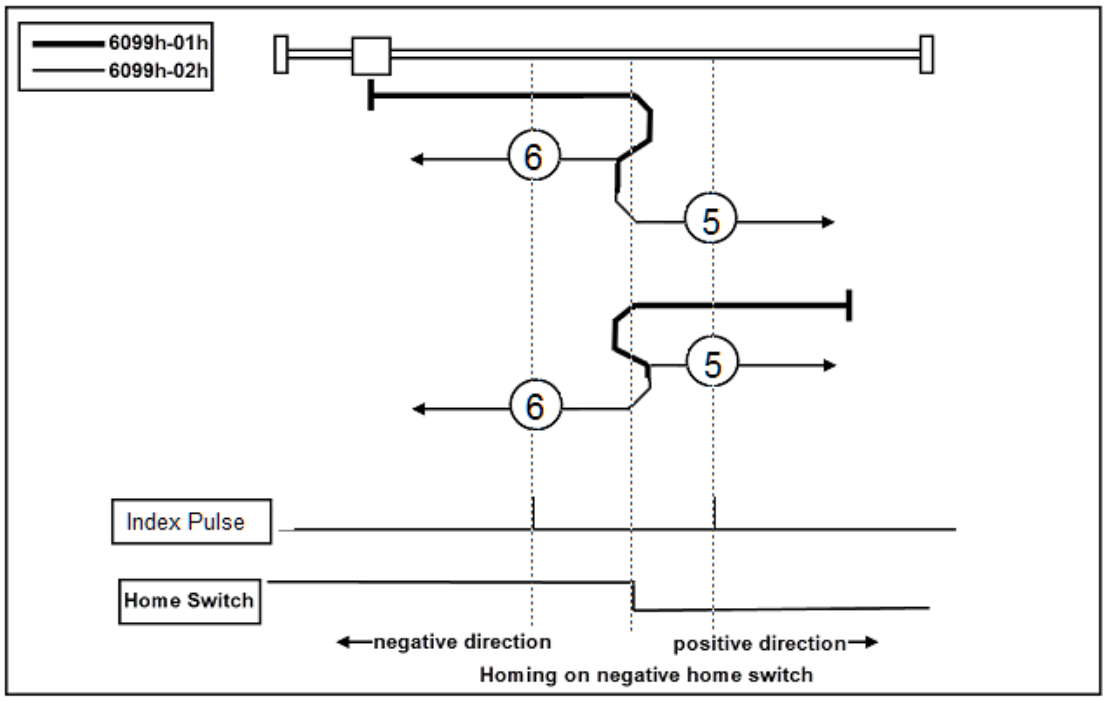
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- Method 3、4
  - If Home switch is not activated at the beginning of the action, the initial action direction is the positive direction.
  - If the Home switch has been activated at the beginning of the action, the initial action direction is the negative direction.
  - The home detection position is the first Index pulse detection position in the positive or negative direction after the status change of ORG.



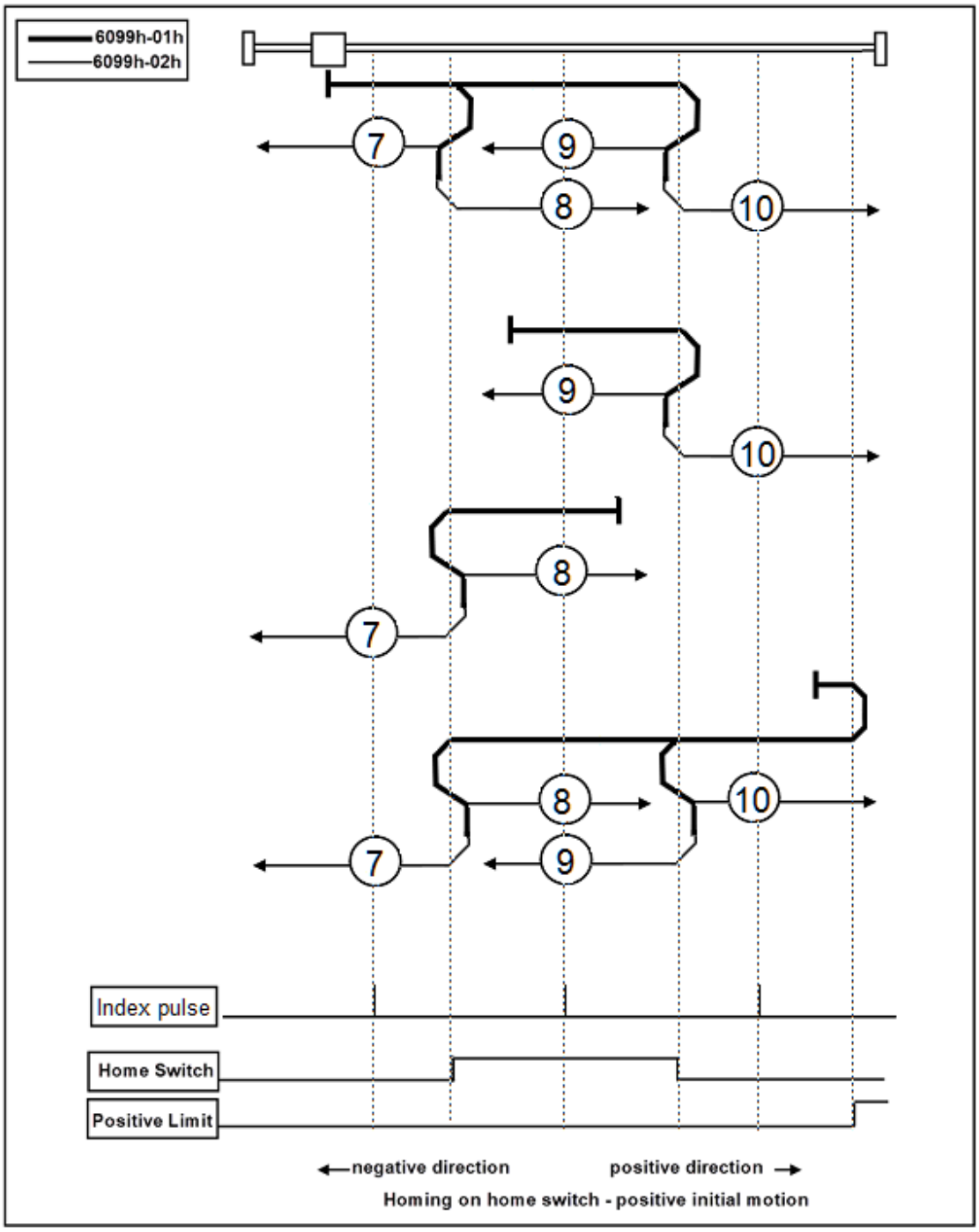
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- Method 5、6
  - If Home switch is not activated at the beginning of the action, the initial action direction is the negative direction.
  - If the Home switch has been activated at the beginning of the action, the initial action direction is the positive direction.
  - The home detection position is the first Index pulse detection position in the positive or negative direction after the status change of ORG.



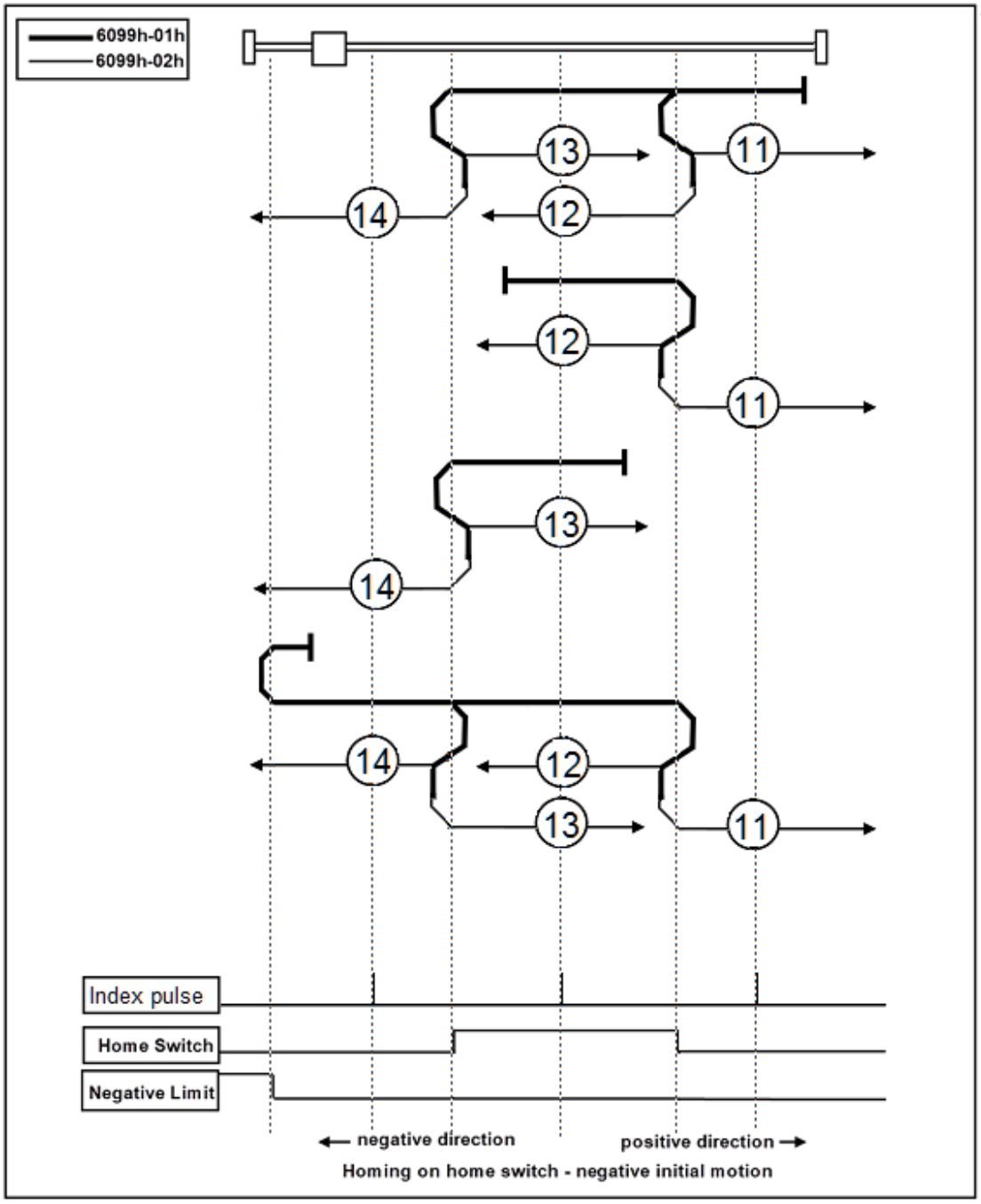
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- Method7、8、9、10
  - If Home switch of Method 7 and 8 is activated at the beginning of the action, the initial action direction is the negative direction.
  - If Home switch of Method 9 and 10 is activated at the beginning of the action, the initial action direction is the positive direction.
  - The home detection position is the first Index pulse detection position in the positive or negative direction after the status change of ORG.



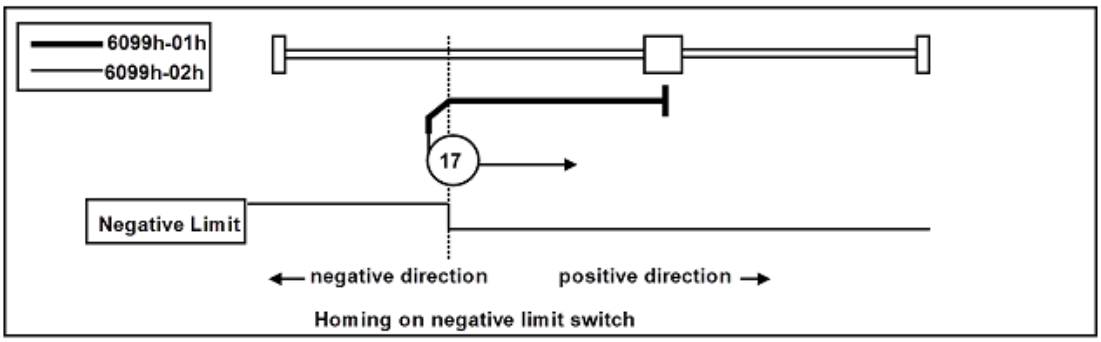
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- Method11、12、13、14
  - If Home switch of Method 13 and 14 is activated at the beginning of the action, the initial action direction is the negative direction.
  - If Home switch of Method 11 and 12 is activated at the beginning of the action, the initial action direction is the positive direction.
  - The home detection position is the first Index pulse detection position in the positive or negative direction after the status change of ORG.



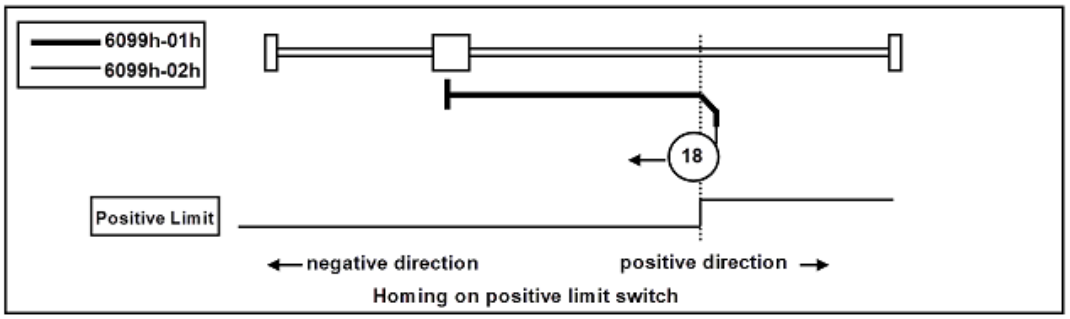
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- Method 17
  - If LL switch is not activated at the beginning of the action, the initial action direction is the negative direction.
  - If the LL switch has been activated at the beginning of the action, the initial action direction is the positive direction.
  - The home detection position is the position when the status of LL changes.



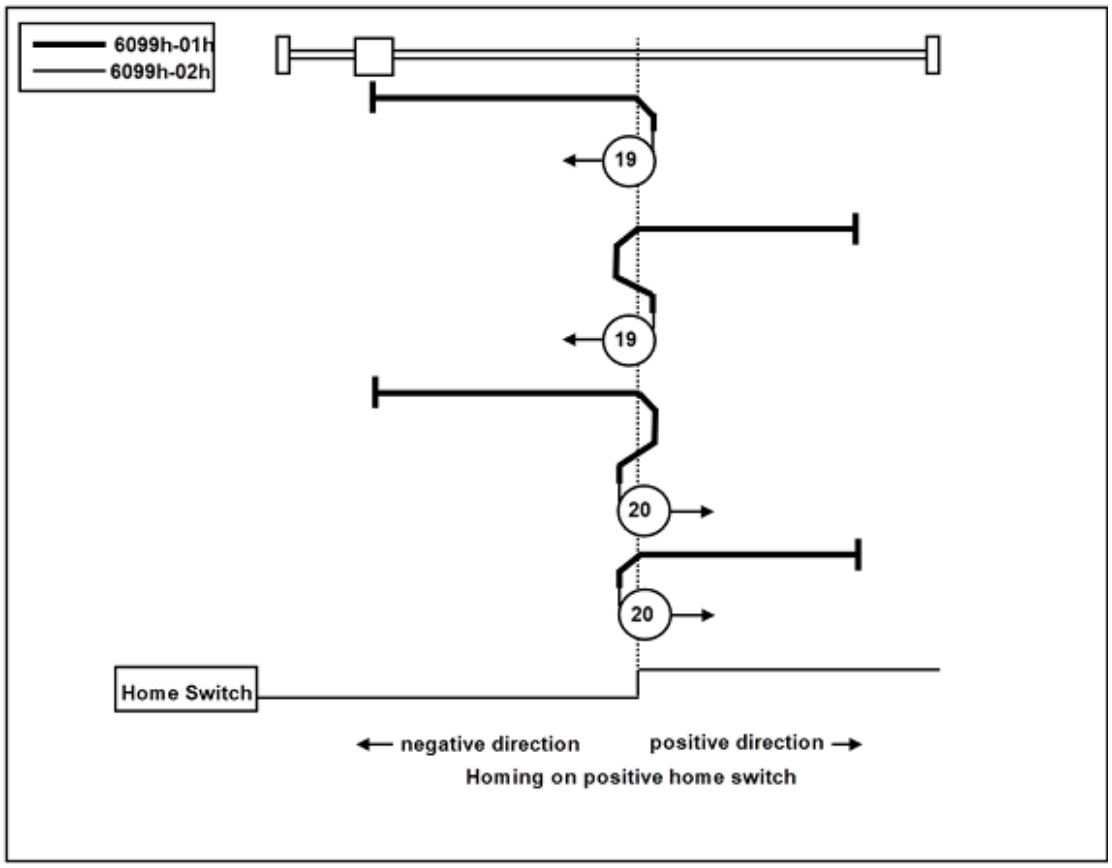
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- Method 18
  - If RL switch is not activated at the beginning of the action, the initial action direction is the positive direction.
  - If the RL switch has been activated at the beginning of the action, the initial action direction is the negative direction.
  - The home detection position is the position when the status of RL changes.



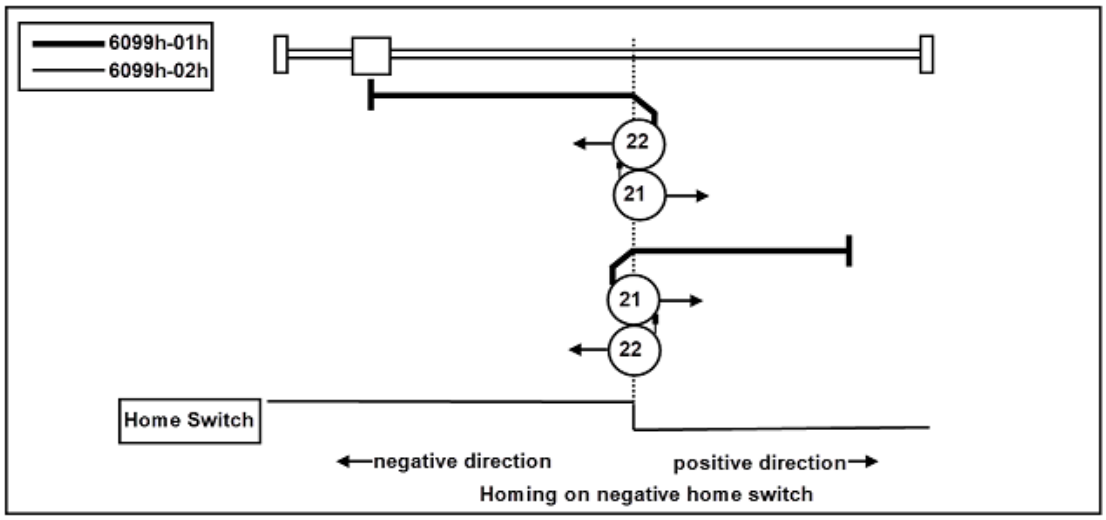
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- Method 19、20
  - If Home switch is not activated at the beginning of the action, the initial action direction is the positive direction.
  - If the Home switch has been activated at the beginning of the action, the initial action direction is the negative direction.
  - The home detection position is the position when the status of ORG changes.



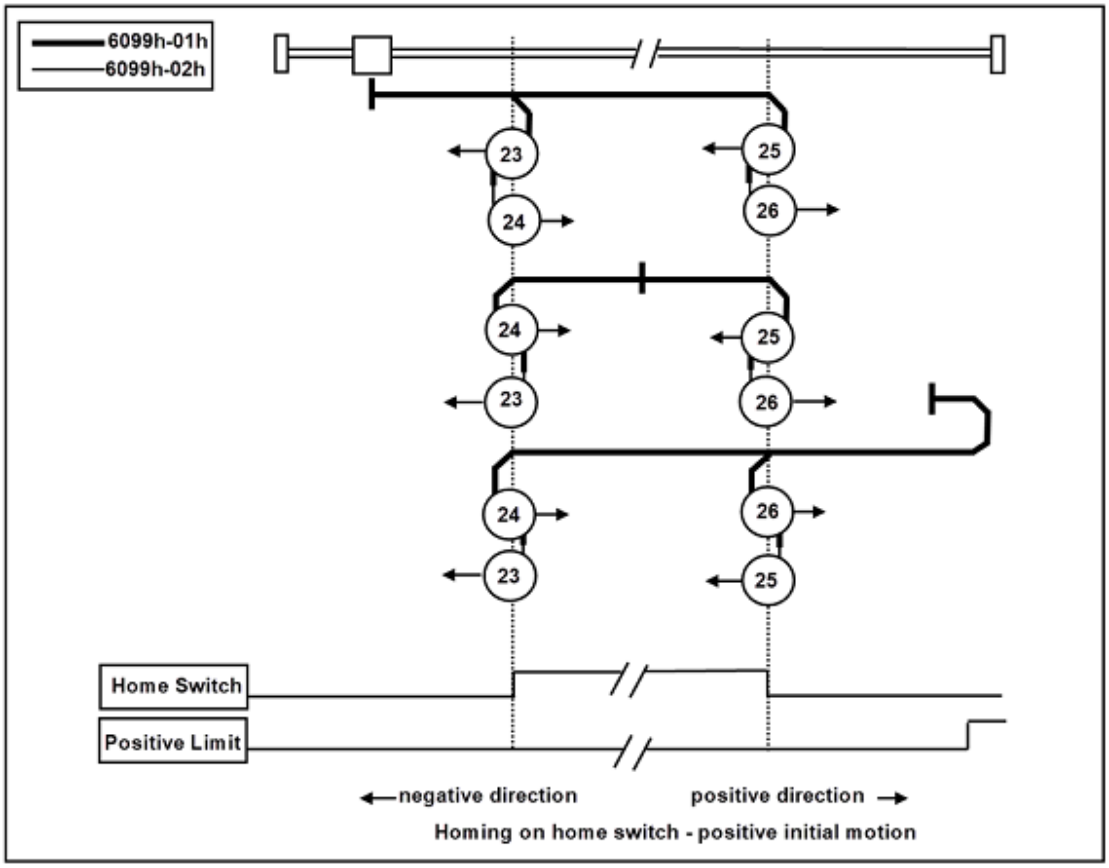
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- Method 21、22
  - If Home switch is not activated at the beginning of the action, the initial action direction is the negative direction.
  - If the Home switch has been activated at the beginning of the action, the initial action direction is the positive direction.
  - The home detection position is the position when the status of ORG changes.



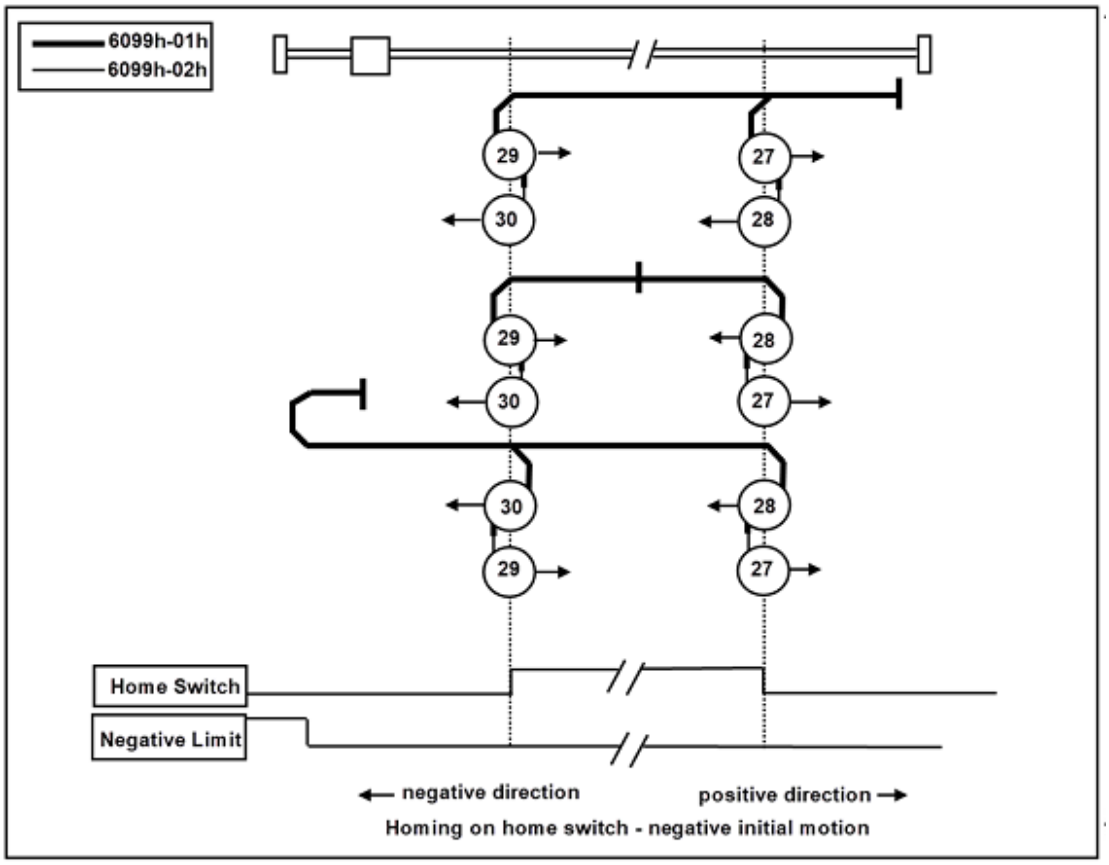
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- Method23、24、25、26
  - If Home switch of Method 23 and 24 is activated at the beginning of the action, the initial action direction is the negative direction.
  - If Home switch of Method 25 and 26 is activated at the beginning of the action, the initial action direction is the positive direction.
  - The home detection position is the position when the status of ORG changes.



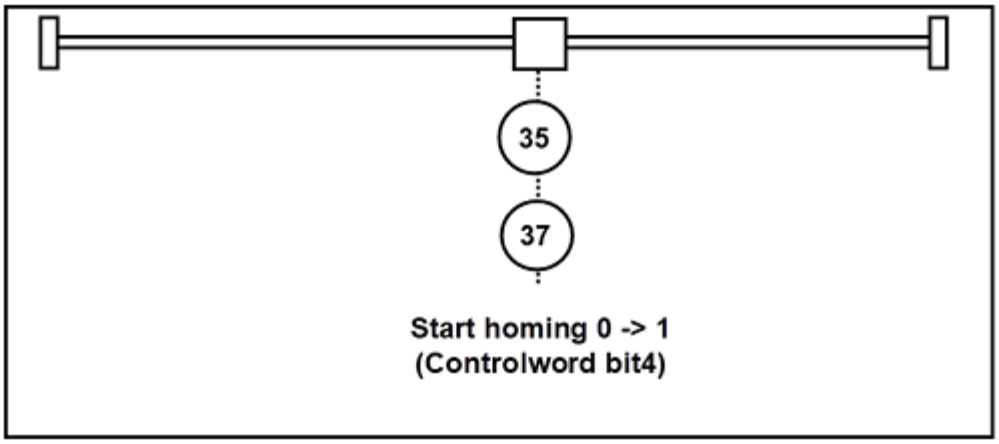
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- Method27、28、29、30
  - If Home switch of Method 29 and30 is activated at the beginning of the action, the initial action direction is the negative direction.
  - If Home switch of Method 27 and 28 is activated at the beginning of the action, the initial action direction is the positive direction.
  - The home detection position is the position when the status of ORG changes.



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- Method35、37
  - The home detection position is the current position.



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6.7 Velocity Control Function

6.7.1 Profile Velocity Mode (pv mode)

In this mode, specify the target speed, acceleration and deceleration, etc., and the driver will generate commands internally according to the motion parameters to drive the motor.

If user want to enable S-curve acceleration/deceleration mode, user need to set the object (Motion ProfileType: 6086h) to 3, and set the object (Axes Sigmoid Ramp Time: 3012h) to control the time of acceleration/deceleration time, the bigger the value, the smoother the curve.

Step 1: Set (Target velocity: 60FFh) to 0.

Step 2: Set (Mode of operation: 6060h) to Cyclic synchronous position mode (csv mode) value = 0x09, and check (Mode of operations Display: 6061h) = 0x09.

Step 3: Change (Controlword: 6040h) from the value 0x06 → 0x07 → 0x0F to make the control system Servo On state, and the drive starts to move according to the (target velocity: 60FFh).

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Control word: 6040h (under pv mode)

Bit	15 ~ 10	9	8	7	6 ~ 4	3	2	1	0
	r	r	h	fr	r	eo	qs	ev	so

r = reserve
fr = fault reset
h = halt
eo = Enable operation
qs = quick stop
ev = enable voltage
so = switch on

Status word: 6041h (under pv mode)

Bit	15~12	11	10	9	8	7	6	5	4	3	2	1	0
	r	ila	r	rm	r	w	sod	qs	ve	f	oe	so	rtso

r = reserve
ila = internal limit active
rm = remote
w = warning
sod = switch on disabled
qs = quick stop
ve = voltage enabled
f = fault
oe = operation enabled
so = switched on
rtso = ready to switch on

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6.7.2 Cyclic Synchronous Velocity Mode(csv mode)

It is a velocity control mode to operate by creating a command velocity in the host controller (MDevice) and updating (transmitting) the command velocity in an interpolation cycle.

Step 1: Set (Target velocity: 60FFh) to 0.

Step 2: Set (Mode of operation: 6060h) to Cyclic synchronous position mode (csv mode) value = 0x09, and check (Mode of operations Display: 6061h) = 0x09.

Step 3: Change (Controlword: 6040h) from the value 0x06 → 0x07 → 0x0F to make the control system Servo On state, and the drive starts to move according to the (target velocity: 60FFh).

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Control word: 6040h (under csv mode)

Bit	15 ~ 10	9	8	7	6 ~ 4	3	2	1	0
	r	r	h	fr	r	eo	qs	ev	so

r = reserve	eo = Enable operation
fr = fault reset	qs = quick stop
h = halt	ev = enable voltage
	so = switch on

Status word: 6041h (under csv mode)

Bit	15~13	12	11	10	9	8	7	6	5	4	3	2	1	0
	r	driver follows command value	ila	r	rm	r	w	sod	qs	ve	f	oe	so	rtso

r = reserve	w = warning
fe = following error	sod = switch on disabled
ila = internal limit active	qs = quick stop
rm = remote	ve = voltage enabled
	f = fault
	oe = operation enabled
	so = switched on
	rtso = ready to switch on

bit	Name	Value	Definition
12	driver follows command value	0	Operation is not performed according to the target velocity
		1	Operation is performed according to the target velocity

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7 Alarm List

Alarm	Description
0x7500	EtherCAT Communication error
0xFF01	ALARM (emergency stop)
0xFF02	EMG (emergency stop)
0xFF03	Changing (mode of operation: 6060h) during the running of the motor
0xFF04	EEPROM failed
0xFF08	Motor stall error

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