
TL-E
EtherCAT Bus Integrated Controller

User Manual

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Chapter I Product Introduction

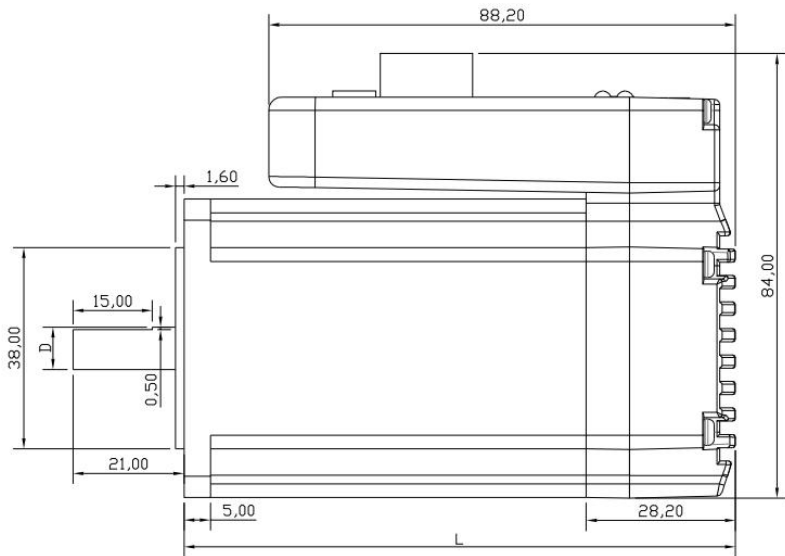
1.1 Communication Specifications

EtherCAT Communication Specifications	Physical Layer	100BASE-TX
	Communication Ports	RJ45 × 2 (Input: CN6A; Output: CN6B)
	Network Topology	Daisy Chain
	Transmission Speed	2 x 100 Mbps (Full Duplex)
	Data Frame Length	Maximum 1484 bytes
	Application Layer Protocol	CoE: CANopen over EtherCAT
	Synchronization Modes:	DC Synchronization Mode (SYNC0) Asynchronous Mode (Free Run)
	Communication Objects	SDO: Service Data Object (Non-cyclic) PDO: Process Data Object (Cyclic) EMCY: Emergency Object
	Application Layer Profile	CiA402 Drive Profile
	Supported Control Modes	Profile Position Mode (PP) Profile Velocity Mode (PV) Homing Mode (HM) Cycle Synchronized Position Mode (CSP)

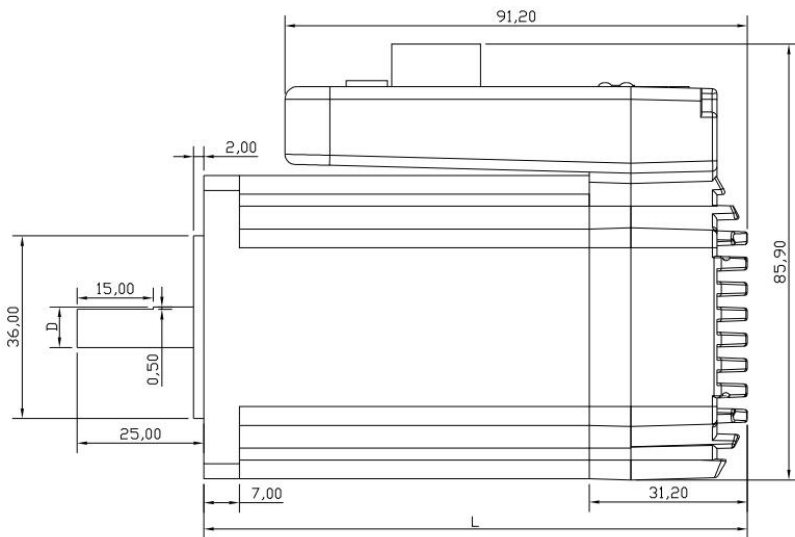
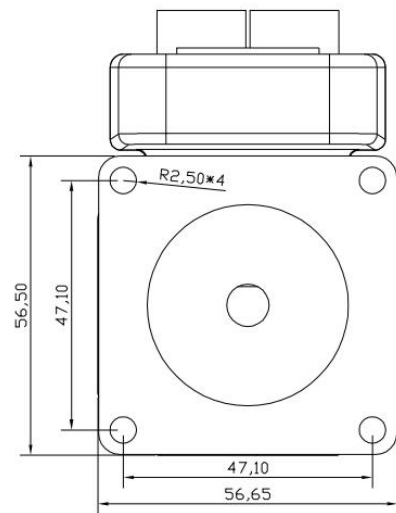
1.2 Product Specifications

Driver Models	TLC57-E	TLO57-E	TLC60-E	TLO60-E	TLC86-E	TLO86-E
Compatible Motor Sizes	57		60		86	
Power Supply Voltage	24~50V DC		24~50V DC		24~70V DC	
Maximum Output Current	4.0A		4.0A		6.0A	
DI Port Input Current	10 ~ 50mA					
DI Port Input Voltage	24V DC					
Encoder	1000 lines	None	1000 lines	None	1000 lines	None
Insulation Resistance	100MΩ					
Operating Environment	Temperature: 0°C ~ 45°C; Humidity: ≤90% RH, non-condensing Altitude: ≤1000m. Installation Conditions: Free from corrosive gases, flammable gases, oil mist, or dust. Vibration: Less than 0.5G (4.9m/s ²), 10–60 Hz (non-continuous operation).					
Storage Environment:	-20°C to 65°C (no frost), ≤90% RH, non-condensing					

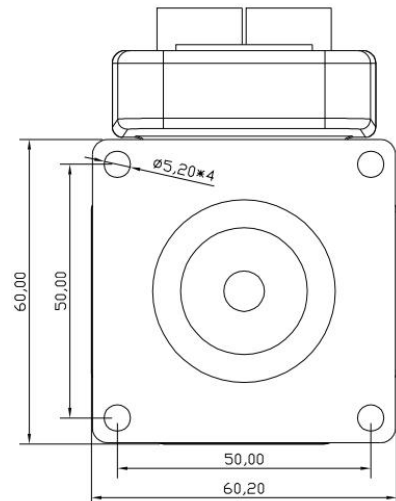
1.3 Installation Dimensions

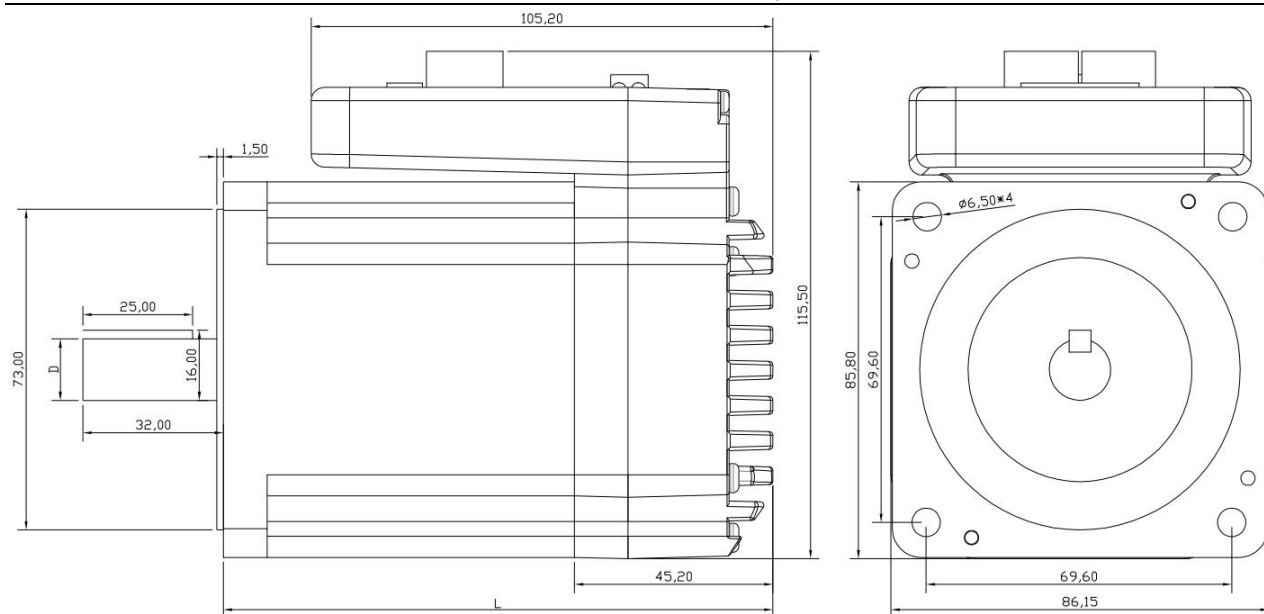


TLC57-E/TLO57-E



TLC60-E/TLO60-E



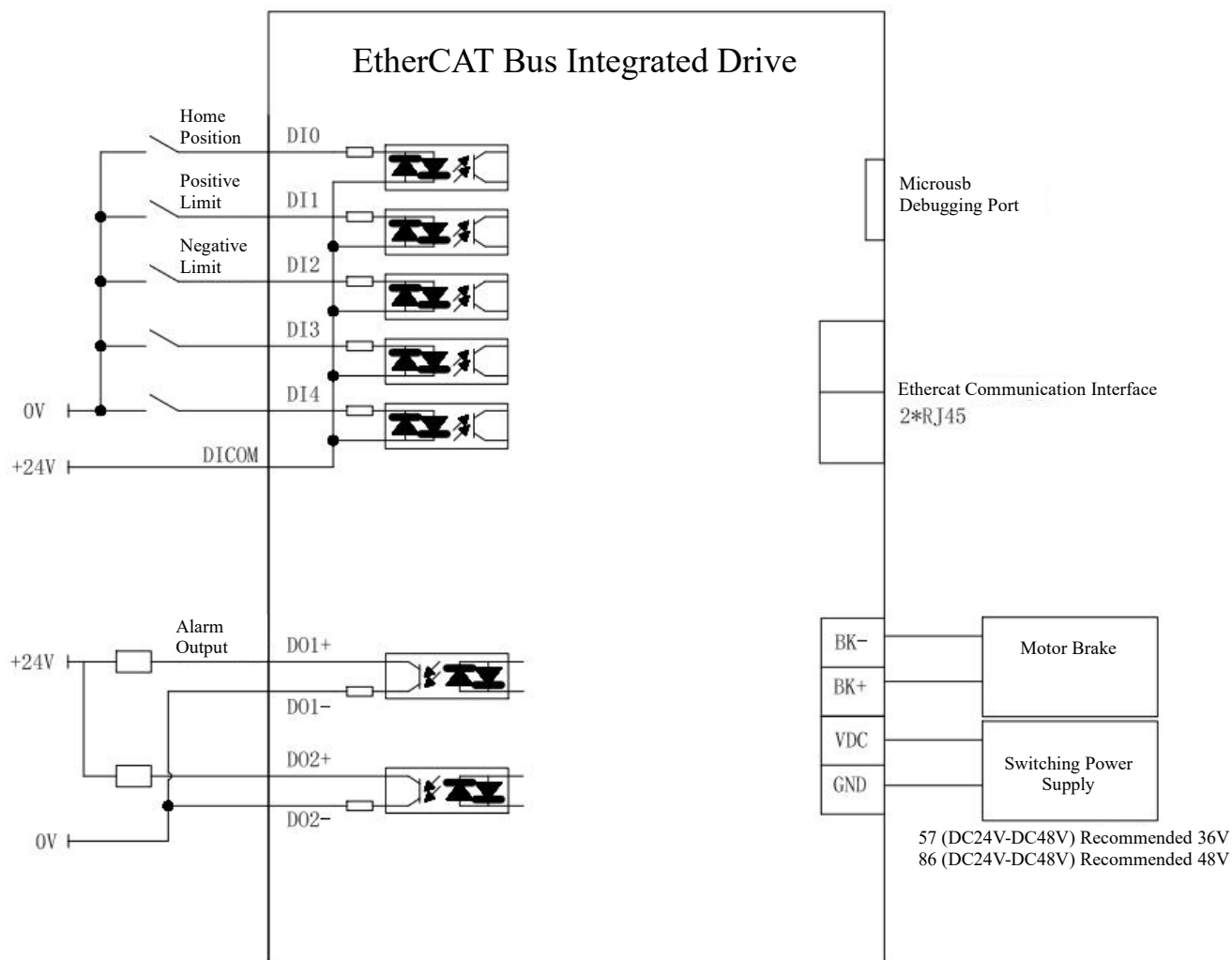


TLC86-E/TLO86-E

Model	D	Motor Length	Total Body Length (L)
TLC57-E/TLO57-E-1	φ6.35 or φ8	56	84.2
TLC57-E/TLO57-E-2	φ6.35 or φ8	82	110.2
TLC57-E/TLO57-E-3	φ6.35 or φ8	100	128.2
TLC60-E/TLO60-E-3	φ8	88	119.2
TLC60-E/ TLO60-E-3.5	φ8	100	131.2
TLC60-E/TLO60-E-4	φ8	112	143.2
TLC86-E/ TLO86-E-4.5	φ12.7 or φ14	80	125.2
TLC86-E/ TLO86-E-8.5	φ12.7 or φ14	114	159.2
TLC86-E/TLO86-E-10	φ12.7 or φ14	128	173.2
TLC86-E/TLO86-E-12	φ12.7 or φ14 or φ 15.8	150	195.2

Chapter 2: Wiring

2.1 EtherCAT Bus Driver Wiring Diagram



- Note:**
1. The functions of the DI/DO ports can be freely configured via the host software. The functions shown in the diagram are the default definitions;
 2. The DI0 to DI4 input ports can be connected using either a common anode or common cathode method. The diagram shows the common anode configuration;
 3. The brake output signal (BK) can directly control the motor brake coil without the need for an intermediate relay;

2.2 Port and DIP Switch Function Descriptions

2.2.1 Power Terminals

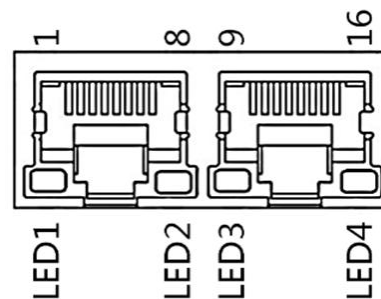
Terminal Name	Description	
VDC	DC Power Negative Terminal	
	TL57/TL60	TL86
	24~50V	24~70V
GND	DC Power Negative Terminal	
BK+	Motor Brake Control Output (+)	
BK-		

2.2.2 DI/DO Port

Pin No.	Signal	Description
1	DI1	Single-ended input signal, 12~24V active, configurable signal function
2	DI2	
3	DI3	
4	DI4	
5	DI5	
6	DICOM	Common terminal for single-ended input signals, supports both common anode and common cathode configurations.
7	DO1+	Differential output signal DO1, maximum current 100mA
8	DO1-	
9	DO2+	Differential output signal DO2, maximum current 100mA
10	DO2-	

2.2.5 EtherCAT Bus Ports

Pin No.	Signal	Description
1,9	TX+	EtherCAT Data Transmission Positive Terminal
2,10	TX-	EtherCAT Data Transmission Negative Terminal
3,11	RX+	EtherCAT Data Reception Positive Terminal
4,12	-	-
5,13	-	-
6,14	RX-	EtherCAT Data Reception Negative Terminal
7,15	-	-
8,16	-	-
PE	PE	Shield Ground
LED1	LA/OUT	Link/Activity OUT Status Indicator
LED2	ERR	Communication Error Status Indicator
LED3	LA/IN	Link/Activity IN Status Indicator
LED4	RUN	Communication Running Status Indicator



EtherCAT Port Diagram

EtherCAT Bus Port Indicator Light Descriptions

Name	Color	Status	Description
RUN	Orange	Off	Initialization State
		Blinking	Pre-operational State
		Single Blink	Safe-operational State
		On	Operational State
ERR	Orange	Off	No Error
		Slow Blink	Communication Setting Error
		Single Blink	Synchronization or Communication Data Error

		Double Blink	Watchdog Timeout Request
L/A IN	Green	Off	No Physical Layer Link Established
		On	Physical Layer Link Established
		Blinking	Data Exchange Occurring on Physical Layer Link
L/A OUT	Green	Off	No Physical Layer Link Established
		On	Physical Layer Link Established
		Blinking	Data Exchange Occurring on Physical Layer Link

2.2.7 MicroUSB Debug Port

This series of EtherCAT bus drives can be configured using the Lichuan Drive upper-level software via this USB port to set drive parameters.

1. First, connect the drive to the computer using an Android USB cable. The computer will automatically install the driver. If installation fails, you can use the Drive Wizard to assist with the installation.
2. After the driver is successfully installed, the port number can be viewed in the Device Manager.
3. Open the debugging software, select the EtherCAT model, and click "OK."



4. Select the port number, then click "Open Port."



5. Once the connection is successful, you can read and modify parameters through the software. After modifying, write the parameters to save them to the drive.

Chapter 3: Parameter Descriptions

3.1 Communication Parameters Table

Object Dictionary	Sub-index	Name	Attributes	Type	Range	Default Value	Unit	Description
1000h	00	Device Type	R	UINT	0~32767	0x40192	-	CIA Standard
1001h	00	Error Register	R	USINT	0~255	0	-	CIA Specified Error Register
1008h	00	Device Name	R	UINT	0~32767	ECAT-DR	-	Device Name
1009h	00	Hardware Version	R	UINT	0~32767	V1.0	-	Hardware Version
100Ah	00	Software Version	R	UINT	0~32767	V1.0	-	Software Version
1018h	00	Sub-index Count	R	UINT	0~32767	4	-	None
	01	Manufacturer ID	R	UINT	0~32767	0xA79	-	None
	02	Product Code	R	UINT	0~32767	0x1000	-	None
	03	Revision Number	R	UINT	0~32767	0x1	-	None
	04	Serial Number	R	UINT	0~32767	0x1	-	None
1600h	00	Sub-index Count	R/W	UINT	0~32767	12	-	None
	01~12	RxPDO Mapping Object Group 1	R/W	UDINT	0~0xFFFFFFFF	-	-	Default RxPDO Mapping Group 1
1601h	00	Sub-index Count	R/W	UINT	0~32767	12	-	None
	01~12	RxPDO Mapping Object Group 2	R/W	UDINT	0~0xFFFFFFFF	-	-	Default RxPDO Mapping Group 2
1A00h	00	Sub-index Count	R/W	UINT	0~32767	12	-	None
	01~12	TxPDO Mapping Object Group 1	R/W	UDINT	0~0xFFFFFFFF	-	-	Default TxPDO Mapping Group 1
1A01h	00	Sub-index Count	R/W	UINT	0~32767	12	-	None
	01~12	TxPDO Mapping Object Group 2	R/W	UDINT	0~0xFFFFFFFF	-	-	Default TxPDO Mapping Group 2
1C12	00~02	RxPDO Assignment	R/W	UINT	0~32767	-	-	None
1C13	00~02	TxPDO Assignment	R/W	UINT	0~32767	-	-	None
1C32	00~0A	RxPDO Management Parameters	R	UINT	0~32767	-	-	None
1C33	00~0A	TxPDO Management Parameters	R	UINT	0~32767	-	-	None

3.2 Basic Parameters Table

Object Dictionary	Sub-index	Name	Attributes	Type	Range	Default Value	Unit	Description
2000h	00	Drive ID Number	R	UINT	0~65535	0x40192	-	Manufacturer Set Drive ID

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2001h	00	Drive Software Version	R	UINT	0~65535	0	-	Drive Software Version
2100h	00	Input IO Status	R	UINT	0~65535	0	-	Input Terminal Hardware Signal Status 0: No Signal; 1: Signal Present; Bit0: I1 Signal; Bit1: I2 Signal; Bit2: I3 Signal; Bit3: I4 Signal; Bit4: I5 Signal;
2101h	00	Output IO Status	R	UINT	0~65535	0	-	Output Terminal Hardware Status, 0: Output Active; 1: Output Inactive; Bit0: O1 Signal; Bit1: O2 Signal;
2200h	00	Manufacturer Parameter Reset Command	R/W	UINT	0~1	0	-	Write 0→1 to trigger factory parameter reset; detected by internal drive edge detection
2201h	00	Manufacturer Parameter Save Command	R/W	UINT	0~1	0	-	Write 0→1 to trigger factory parameter save; detected by internal drive edge detection
2300h	00	Drive Default Direction	R/W	UINT	0~1	0	-	Drive Default Direction, 0: Default; 1: Reverse;
2301h	00	Drive Operating Mode	R/W	UINT	1~2	0	-	1: Open-loop; 2: Closed-loop; Valid only for closed-loop series products;
2302h	00	Subdivision Setting	R/W	UINT	400~51200	10000	pulse	Number of pulses per motor revolution
2303h	00	Peak Current	R/W	UINT	0~6000	5000	mA	Peak current, specific to drive model: 57: 5000mA 86: 6000mA
2304h	00	Base Holding Current Percentage	R/W	UINT	0~100	40	%	Base current during motor operation, as a product of this percentage and the value set in 2303h;
2305h	00	Closed-loop Holding Current Percentage	R/W	UINT	0~100	100	%	Rated current during motor operation in closed-loop mode, as a product of this percentage and the value set in 2303h;
2306h	00	Open-loop Holding Current	R/W	UINT	0~100	100	%	Rated current during motor operation in

		Percentage						open-loop mode, as a product of this percentage and the value set in 2303h
2307h	00	Lock Shaft Current Percentage	R/W	UINT	0~100	40	%	Current during motor lock state, as a product of this percentage and the value set in 2303h;
2308h	00	Lock Shaft Time	R/W	UINT	0~2000	200	ms	Time to enter lock shaft state;
2309h	00	Target Pulse Count	R/W	UINT	0~1000	5	pulse	Allowable error value for motor positioning;
230Ah	00	Target Delay Time	R/W	UINT	0~1000	200	ms	Delay time to eliminate vibration after motor positioning;
230Bh	00	Command Filter Coefficient	R/W	UINT	0~1024	5	-	Smoothing filter coefficient for commands; the smaller the coefficient, the stronger the filtering effect;
230Ch	00	Encoder Resolution	R/W	UINT	4000~10000	4000	pulse	Encoder resolution, default to 4x frequency;
230Dh	00	Position Deviation Value	R/W	UINT	0~65535	4000	pulse	Position deviation value;
2400h	00	Limit Alarm	R/W	UINT	0~1	0	-	Limit handling in CSP mode: 0: No action; 1: Stop and alarm;
2401h	00	Homing Offset Reset	R/W	UINT	0~1	0	-	When using the internal drive homing function (home mode) and 607C is non-zero: 0: Do not reset offset; 1: Reset offset;
2402h	00	Limit Stop Setting	R/W	UINT	0~2	0	-	Handling method for limit events in PP/PV mode: 0: Stop; 1: Emergency stop; 2: No action
2403h	00	Brake Enable	R/W	UINT	0~1	0	-	Brake output enable 0: Disable; 1: Enable;
2404h	00	Brake Open Delay	R/W	UINT	1~65535	200	ms	Brake open delay time;
2405h	00	Brake Close Delay	R/W	UINT	1~65535	200	ms	Brake close delay time;
2600h	00	ESC Synchronization	R/W	UINT	1~65535	1	-	--

		Frame Alarm Threshold						
2700h	00	Current Loop Kp Gain Multiplier	R/W	UINT	1~65535	6144	-	--
2701h	00	Current Loop Kp Gain	R/W	UINT	1~65535	1024	-	--
2702h	00	Current Loop Ki Gain	R/W	UINT	1~65535	655	-	--
2703h	00	Current Loop Kc Gain	R/W	UINT	1~65535	71	-	--
2704h	00	LA Speed Kp1	R/W	UINT	1~65535	2560	-	--
2705h	00	LA Speed Kv1	R/W	UINT	1~65535	114	-	--
2706h	00	LA Speed Kp2	R/W	UINT	1~65535	2560	-	--
2707h	00	LA Speed Kv2	R/W	UINT	1~65535	1024	-	--
2708h	00	LA Position Loop Ki Gain	R/W	UINT	1~65535	0	-	--
2709h	00	LA Speed Feedforward Kvf Gain	R/W	UINT	1~65535	20	-	--

3.3 IO Function Configuration Table

Object Dictionary	Sub-index	Name	Attributes	Type	Range	Default Value	Unit	Description
2500h	00	Input Terminal Default Level	R/W	UINT	0~65535	0	-	Bit0: I1 Terminal; Bit1: I2 Terminal; Bit2: I3 Terminal; Bit3: I4 Terminal; Bit4: I5 Terminal; 0: Normally Open; 1: Normally Closed;
2501h	00	Output Terminal State	R/W	UINT	0~65535	0	-	Bit0: O1 Terminal; Bit1: O2 Terminal; 0: Normally Open; 1: Normally Closed;
2510h	00	I1 Function Setting	R/W	UINT	0~255	7	-	Input terminal function definition: 0: Undefined 1: Home; 2: Positive Limit; 3: Negative Limit; 4: Stop; 5: Emergency Stop;
2511h	00	I2 Function Setting	R/W	UINT	0~255	8	-	
2512h	00	I3 Function Setting	R/W	UINT	0~255	1	-	

2513h	00	I4 Function Setting	R/W	UINT	0~255	2	-	6: Release; 7: Probe 1; 8: Probe 2; 9: User-defined 1; 10: User-defined 2; 11: User-defined 3; 12: User-defined 4; 13: User-defined 5; 14: User-defined 6;
2514h	00	I5 Function Setting	R/W	UINT	0~255	3	-	
2520h	00	O1 Function Setting	R/W	UINT	0~255	0	-	Output terminal function definition: 0: Undefined 1: Alarm Signal; 2: In-position Signal; 3: Homing Complete; 9: User-defined 1; 10: User-defined 2; 11: User-defined 3;
2521h	00	O2 Function Setting	R/W	UINT	0~255	0	-	
2530h	00	I1 Terminal Filter Coefficient	R/W	UINT	0~65535	2	-	Terminal filter coefficient; the larger the value, the stronger the filtering effect
2531h	00	I2 Terminal Filter Coefficient	R/W	UINT	0~65535	2	-	Terminal filter coefficient; the larger the value, the stronger the filtering effect
2532h	00	I3 Terminal Filter Coefficient	R/W	UINT	0~65535	2	-	Terminal filter coefficient; the larger the value, the stronger the filtering effect
2533h	00	I4 Terminal Filter Coefficient	R/W	UINT	0~65535	2	-	Terminal filter coefficient; the larger the value, the stronger the filtering effect
2534h	00	I5 Terminal Filter Coefficient	R/W	UINT	0~65535	2	-	Terminal filter coefficient; the larger the value, the stronger the filtering effect

3.4 Motion Parameters

Object Dictionary	Sub-index	Name	Attributes	Type	Range	Default Value	Unit	Description
603Fh	00	Drive Fault Code	R	UINT	0~65535	0	-	Drive error conditions: 0x00h: No error; 0xFF01h: Overcurrent; 0xFF02h: Overvoltage;

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								0xFF03h: Undervoltage; 0xFF04h: Phase error; 0xFF05h: Position deviation
6040h	00	Control Word	R/W	UINT	0~65535	0	-	--
6041h	00	State Word	R	UINT	0~65535	0	-	--
605Dh	00	Halt Control Register	R/W	UINT	0~65535	0	-	Halt command control word action: 0: Stop; 1: Emergency stop;
6060h	00	Operating Mode Control Register	R/W	USINT	0~255	0	-	0: Undefined 1: PP Mode; 3: PV Mode; 6: Home Mode; 8: CSP Mode
6061h	00	Operating Mode Status Register	R	USINT	0~255	0	-	--
6064h	00	Actual Position	R	DINT	-2147483648 ~2147483647	0	pulse	Actual motor position
606Ch	00	Actual Speed	R	DINT	-2147483648 ~2147483647	0	Pulse/s	Actual motor speed
607Ah	00	Target Position	R/W	DINT	-2147483648 ~2147483647	0	pulse	Target position given by the master
607Ch	00	Homing Offset	R/W	DINT	-2147483648 ~2147483647	0	pulse	Homing offset in Home mode;
6081h	00	Position Mode Speed	R/W	UDINT	0~0xFFFFFFFF	0	Pulse/s	Running speed in PP mode
6083h	00	Acceleration	R/W	UDINT	0~0xFFFFFFFF	0	Pulse/s ²	Acceleration in PP/PV mode
6084h	00	Deceleration	R/W	UDINT	0~0xFFFFFFFF	0	Pulse/s ²	Deceleration in PP/PV mode
6098h	00	Homing Mode	R/W	USINT	0~255	0	-	Homing mode, the drive supports 17/18/24/29/35/37 37 six modes:
6099h	01	Homing Speed	R/W	DINT	-2147483648 ~2147483647	0	Pulse/s	Homing speed in Home mode
6099h	02	Homing Search Speed	R/W	DINT	-2147483648 ~2147483647	0	Pulse/s	Homing search speed in Home mode
609Ah	00	Homing Acceleration/Deceleration	R/W	UDINT	0~0xFFFFFFFF	0	Pulse/s ²	Acceleration/Deceleration in Home mode
60B8h	00	Probe Control	R/W	UINT	0~65535	0	-	Probe Control;
60B9h	00	Probe Status	R	UINT	0~65535	0	-	Probe Status;
60BAh	00	Probe Latch Position	R	DINT	-2147483648 ~2147483647	0	-	Probe 1 rising edge latch position
60BBh	00	Probe Latch Position	R	DINT	-2147483648 ~2147483647	0	-	Probe 1 falling edge latch position
60BCh	00	Probe Latch Position	R	DINT	-2147483648 ~2147483647	0	-	Probe 2 rising edge latch position
60BDh	00	Probe Latch	R	DINT	-2147483648	0	-	Probe 2 falling edge latch

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		Position			~2147483647			position
60D5h	00	Probe Latch Counter (Rising Edge)	R	UDINT	0~0xFFFFFFFF	0	-	Probe 1 rising edge latch position
60D6h	00	Probe Latch Counter (Rising Edge)	R	UDINT	0~0xFFFFFFFF	0	-	Probe 1 falling edge latch position
060D7h	00	Probe Latch Counter (Rising Edge)	R	UDINT	0~0xFFFFFFFF	0	-	Probe 2 rising edge latch position
60D8h	00	Probe Latch Counter (Rising Edge)	R	UDINT	0~0xFFFFFFFF	0	-	Probe 2 falling edge latch position
60F4h	00	Position Error	R	DINT	-2147483648 ~2147483647	0	-	Position Error
60FDh	00	Input IO Status	R	DINT	-2147483648 ~2147483647	0	-	Input signal mapping status: Bit0: Negative Limit Signal; Bit1: Positive Limit Signal; Bit2: Home Signal; Bit16: User-defined 1; Bit17: User-defined 2; Bit18: User-defined 3; Bit19: User-defined 4; Bit20: User-defined 5; Bit21: User-defined 6;
60FEh	01	Physical Output Enable	R/W	UDINT	0~0xFFFFFFFF	0	-	Output signal mapping status; when using this register, the corresponding output IO terminal must be set to a user-defined function: Bit16: User-defined 1; Bit17: User-defined 2; Bit18: User-defined 3;
60FEh	02	Physical Output Enable	R/W	UDINT	0~0xFFFFFFFF	0	-	Output signal mapping status; when using this register, the corresponding output IO terminal must be set to a user-defined function: Bit16: User-defined 1 Enable; Bit17: User-defined 2 Enable; Bit18: User-defined 3 Enable;
60FFh	00	Target Speed	R/W	DINT	-2147483648 ~2147483647	0	-	Running speed in PV mode
6502h	00	Supported Operating Modes	R	UDINT	0~0xFFFFFFFF	165	-	--

3.5 Debugging Software Parameters Table

Parameter No.	Register Address	Parameter Name	Parameter Description	Setting Range (Note: Other values are invalid)	Default Value
PA_001	0x0010	Motor Default Direction	0: Default; 1: Reverse;	0~1 (RW)	0
PA_002	0x0011	Drive Operating Mode	1: Open-loop Mode; 2: Closed-loop Mode;	0~2 (RW)	1
PA_003	0x0012	Subdivision Setting	Number of pulses per motor revolution;	400~51200 (RW)	10000
PA_004	0x0013	Maximum Effective Current	Unit: mA	0~5000 (RW)	
PA_005	0x0014	Base Current Percentage	Base current during operation, unit: %;	0~100 (RW)	
PA_006	0x0015	Maximum Current Percentage in Closed-loop Mode	Maximum current during closed-loop operation, unit: %;	0~150 (RW)	
PA_007	0x0016	Maximum Current Percentage in Open-loop Mode	Maximum current during open-loop operation, unit: %;	0~100 (RW)	
PA_008	0x0017	Lock Motor Current Percentage	Lock motor current, unit: %;	0~100 (RW)	
PA_009	0x0018	Lock Motor Time	Lock motor time, unit: ms;	0~5000 (RW)	
PA_010	0x0019	Positioning Error Range	Positioning Error Range	0~100 (RW)	
PA_011	0x001A	Positioning End Time	Positioning End Time	1~65535 (RW)	
PA_012	0x001B	Pulse Command Filter Coefficient	Pulse Command Filter Coefficient	1~65535 (RW)	512
PA_013	0x001C	Positioning Algorithm	0: Algorithm 0; 1: Algorithm 1;	0~1 (RW)	0
PA_014	0x001D	Encoder Resolution	Encoder Resolution	4000	4000
PA_015	0x001E	Position Deviation Alarm Threshold	Position Deviation Alarm Threshold	0~4000 (RW)	4000
PA_016	0x0020	CSP Mode Limit Alarm	0: No Alarm; 1: Alarm;	0~1 (RW)	0
PA_017	0x0021	607C Offset Reset	0: No Reset; 1: Reset;	0~1 (RW)	0
PA_018	0x0022	Limit Handling in PP/PV Mode	0: Stop; 1: Emergency stop;	0~1 (RW)	0
PA_019	0x0023	Brake Function Enable	0: Disabled; 1: Enabled;	0~1 (RW)	0
PA_020	0x0024	Brake Open Time	Unit: ms	1~1000 (RW)	200
PA_021	0x0025	Brake Close Time	Unit: ms	1~1000 (RW)	200

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PA_022	0x0026	ECAT Synchronization Frame Alarm Threshold	ECAT Synchronization Frame Alarm Threshold	1~20 (RW)	1
PA_023	Ethercat ID	ECAT Slave Node Number	ECAT Node Number	0~65535 (RW)	0
PA_024	0x0030	Input Terminal Default Level	Bit0: I1 Terminal; Bit1: I2 Terminal; Bit2: I3 Terminal; Bit3: I4 Terminal; Bit4: I5 Terminal; 0: Normally Open; 1: Normally Closed;	0~65535 (RW)	0
PA_025	0x0031	Output Terminal Default State	Bit0: O1 Terminal; Bit1: O2 Terminal; 0: Normally Open; 1: Normally Closed;	0~65535 (RW)	0
PA_026	0x0032	Input Terminal I1 Function Selection	0: Undefined 1: Home; 2: Positive Limit; 3: Negative Limit; 4: Stop; 5: Emergency Stop; 6: MF Signal; 7: Probe 1; 8: Probe 2; 9: User-defined 0; 10: User-defined 1; 11: User-defined 2; 12: User-defined 3; 13: User-defined 4; 14: User-defined 5;	0~14 (RW)	0
PA_027	0x0033	Input Terminal I2 Function Selection		0~14 (RW)	0
PA_028	0x0034	Input Terminal I3 Function Selection		0~14 (RW)	0
PA_029	0x0035	Input Terminal I4 Function Selection		0~14 (RW)	0
PA_030	0x0036	Input Terminal I5 Function Selection		0~14 (RW)	0
PA_031	0x003A	Input Terminal I1 Filter Time	Input Terminal I1 Filter Time	0~65535 (RW)	0
PA_032	0x003B	Input Terminal I2 Filter Time	Input Terminal I2 Filter Time	0~65535 (RW)	0
PA_033	0x003C	Input Terminal I3 Filter Time	Input Terminal I3 Filter Time	0~65535 (RW)	0
PA_034	0x003D	Input Terminal I4 Filter Time	Input Terminal I4 Filter Time	0~65535 (RW)	0
PA_035	0x003E	Input Terminal I5 Filter Time	Input Terminal I5 Filter Time	0~65535 (RW)	0
PA_036	0x0042	Output Terminal O1 Function Selection	0: Undefined 1: Alarm Signal; 2: In-position Signal; 3: Homing Complete Signal; 9: User-defined 0; 10: User-defined 1; 11: User-defined 2;	0~65535 (RW)	0
PA_037	0x0043	Output Terminal O2 Function Selection		0~65535 (RW)	0
PA_038	0x0050	Current Loop Kp Gain	Current Loop Kp Gain	0~65535	0

		Multiplier	Multiplier	(RW)	
PA_039	0x0051	Current Loop Kp Gain	Current Loop Kp Gain	0~65535 (RW)	0
PA_040	0x0052	Current Loop Ki Gain	Current Loop Ki Gain	0~65535 (RW)	0
PA_041	0x0053	Current Loop Kc Gain	Current Loop Kc Gain	0~65535 (RW)	0
PA_042	0x0054	LA Speed Kp1	LA Speed Kp1	0~65535 (RW)	0
PA_043	0x0055	LA Speed Kv1	LA Speed Kv1	0~65535 (RW)	0
PA_044	0x0056	LA Speed Kp2	LA Speed Kp2	0~65535 (RW)	0
PA_045	0x0057	LA Speed Kv2	LA Speed Kv2	0~65535 (RW)	0
PA_046	0x0058	LA Position Loop Ki Gain	LA Position Loop Ki Gain	0~65535 (RW)	0
PA_047	0x0059	LA Speed Feedforward Kvf Gain	LA Speed Feedforward Kvf Gain	0~65535 (RW)	0
PA_048	0x0060	Target Position High	High word of the target position, unit: pulses	0~65535 (RW)	0
PA_049	0x0061	Target Position Low	Low word of the target position, unit: pulses	0~65535 (RW)	0
PA_050	0x0062	Positioning Speed High	High word of the positioning speed, unit: pulses/s	0~65535 (RW)	0
PA_051	0x0063	Positioning Speed Low	Low word of the positioning speed, unit: pulses/s	0~65535 (RW)	0
PA_052	0x0064	Acceleration High	High word of the acceleration, unit: pulses/s ²	0~65535 (RW)	0
PA_053	0x0065	Acceleration Low	Low word of the acceleration, unit: pulses/s ²	0~65535 (RW)	0
PA_054	0x0066	Deceleration High	High word of the deceleration, unit: pulses/s ²	0~65535 (RW)	0
PA_055	0x0067	Deceleration Low	Low word of the deceleration, unit: pulses/s ²	0~65535 (RW)	0
PA_056	0x0068	JOG Speed High	High word of the JOG speed, unit: pulses/s	0~65535 (RW)	0
PA_057	0x0069	JOG Speed Low	Low word of the JOG speed, unit: pulses/s	0~65535 (RW)	0

3.6 IO Port Configuration

The IO parameters can be configured via the EtherCAT master or Lichuan upper computer software. After configuring the drive parameters, you need to save the parameters and restart the drive for the changes to take effect.

3.6.1 DI Port Function Description

DI Port	DI5	DI4	DI3	DI2	DI1
---------	-----	-----	-----	-----	-----

DI Function Setting Index	2514h	2513h	2512h	2511h	2510h
DI Filter Setting Index	2534h	2533h	2532h	2531h	2530h
DI Input State Setting 2500h	Bit4	Bit3	Bit2	Bit1	Bit0
DI Input State Setting 2100h	Bit4	Bit3	Bit2	Bit1	Bit0

1) The DI ports on the drive can be set to Normally Open (NO) or Normally Closed (NC) states via the bits Bit0~Bit5 in the index 2500h. For example, if Bit0 of 2500h is set to 1, DI1 will be in the normally closed input state.

2) The input filter time of the DI ports can be set through the indices 2530h~2535h. The larger the parameter setting, the slower the DI port response, and the stronger the anti-interference ability.

3) The input status of DI1~DI5 can be monitored through the index 2100h. If the corresponding bit is 1, it indicates an input; if it is 0, it indicates disconnection.

4) As shown in the second row of the table above, the functions of the DI ports can be set using the corresponding index numbers, and the current status of the functions can be monitored via 60FDh (which differs from the monitoring of the DI port status via 2100h). The function table is as follows:

Parameter Value	Function Description	DI Port Function Status Monitoring 60FDh
0	Undefined	
1	Home	Bit2 (This bit is 1 when the home signal is connected, and similarly for other functions below)
2	Positive Limit	Bit1
3	Negative Limit	Bit0
4	Stop	
5	Emergency Stop	
6	Enable	
7	Probe 1	Bit12
8	Probe 2	Bit13
9	User-defined 0	Bit16
10	User-defined 1	Bit17
11	User-defined 2	Bit18
12	User-defined 3	Bit19
13	User-defined 4	Bit20
14	User-defined 5	Bit21

3.6.2 DO Port Function Description

DO Port	DO2	DO1
DO Function Setting Index	2521h	2520h
DO Output State Setting 2501h	Bit1	Bit0
DO Port Status Monitoring 2101h	Bit1	Bit0

1) The DO ports on the drive can be set to Normally Open (NO) or Normally Closed (NC) states via the bits Bit0~Bit2 in the index 2501h. For example, if Bit0 of 2501h is set to 1, DO1 will be in the normally closed output state.

2) The output status of DO1~DO2 can be monitored through the index 2101h. If the corresponding bit is 1, it indicates an output; if it is 0, it indicates disconnection.

3) The functions of the DO ports can be set using the corresponding index numbers listed in the table above. The function table is as follows:

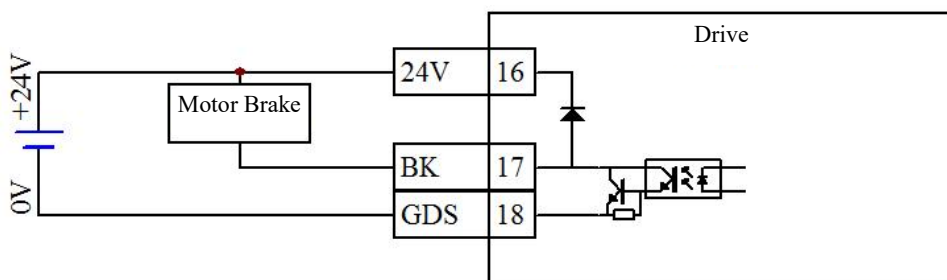
Parameter Value	Function Description
0	Undefined
1	Alarm Signal
2	In-position Signal
3	Homing Complete Signal
9	User-defined 1
10	User-defined 2
11	User-defined 3

4) When the DO port is configured as a user-defined output signal, the output port status can be set using indices 60FE+01h and 60FE+02h, as shown in the table below:

DO Port	Physical Output Enable 60FE-01h	Physical Output Enable 60FE-02h	Description
DO1	Bit16	Bit16	When both 60FE-01h and 60FE-02h are written with 0x10000 (i.e., Bit16 is 1), DO1 has an output
DO2	Bit17	Bit17	When both 60FE-01h and 60FE-02h are written with 0x20000 (i.e., Bit17 is 1), DO2 has an output

3.6.3 Brake Output Signal Description

This series of drives has a dedicated brake output signal port, with an output current of up to 500mA, which can directly drive the motor brake without the need for an intermediate relay. The wiring diagram is as follows:



Chapter 4: Common Functions

4.1 Control Word and Status Word Descriptions

4.1.1 Control Word 6040h

Data Bits \ Mode	CSP Mode	PP Mode	PV Mode	HM Mode
Bit0	Start			
Bit1	Power-on			
Bit2	Quick Stop			
Bit3	Enable Operation			
Bit4	N/A	0->1: Trigger new target position	N/A	0->1: Start homing; 1->0: Interrupt homing
Bit5	N/A	0: Update position after completion; 1: Immediate position update	N/A	N/A
Bit6	N/A	0: Absolute Position 1: Relative Position	N/A	N/A
Bit7	1: Error Reset			
Bit8	1: Deceleration Stop			
Bit9~Bit15	N/A			

4.1.2 Status Word 6041h

Data Bits \ Mode	CSP Mode	PP Mode	PV Mode	HM Mode	
Low Bit	Bit0	Ready to Start			
	Bit1	Start			
	Bit2	Enable Operation			
	Bit3	Error			
	Bit4	Power-on			
	Bit5	Quick Stop			
	Bit6	Not Ready			
High Bit	Bit9	Remote			
	Bit10	0	Halt=0, target position/speed not reached; Halt=1, axis decelerating	0	Halt=0, target position/speed not reached; Halt=1, axis decelerating
		1	Halt=0, target position/speed reached; Halt=1, axis speed is 0	1	Halt=0, home position not reached; Halt=1, axis speed is 0
	Bit12	0: Slave not following command; 1: Slave following command	0: Target position updatable; 1: Target position not updatable	0: Speed not 0; 1: Speed is 0	0: Homing not completed; 1: Homing completed
Bit13	N/A	N/A	N/A	Homing Error	

Note: In the table above, "Halt" refers to Bit8 of Control Word 6040h.

4.2 Operating Modes

The supported operating modes for this series of drives are:

Index	Sub-index	Name	Description
6060h	00	Operating Mode	0: Undefined 1: Profile Position Mode (PP); 3: Velocity Mode (PV); 6: Homing Mode (HOME); 8: Cyclic Synchronous Position Mode (CSP);

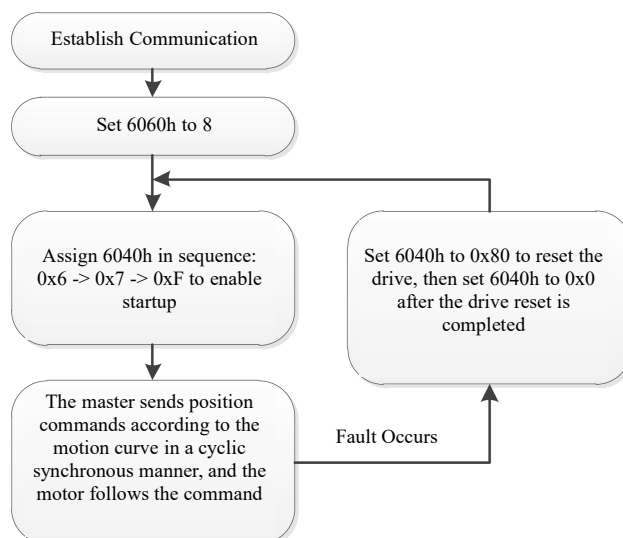
4.2.1 CSP Mode (Cyclic Synchronous Position Mode)

To use CSP mode, set 6060h to 8. When the Operating Mode Status object (6061h) reads as 8, CSP mode-related operations can be performed.

In CSP mode, the master station completes the position command planning and outputs the planned target position 607Ah. The target position is then sent to the drive in a cyclic synchronous manner. The drive receives the master station's planned command according to the synchronization cycle to achieve position and speed control. This mode is suitable for multi-axis synchronous motion control. The commonly used object dictionary in CSP mode is as follows:

Index	Sub-index	Name	Access Type	Data Type	Unit	Configuration Recommendation	
6040h	00h	Control Word	R/W	UINT	-	PDO	Must be configured
607Ah	00h	Target Position	R/W	DINT	Pulse	PDO	Must be configured
6041h	00h	State Word	R	UINT	-	PDO	Must be configured
6064h	00h	Actual Position	R	DINT	Pulse	PDO	Must be configured
603Fh	00h	Latest Error Code	R	UINT	-	PDO/SDO	Recommended
6060h	00h	Operating Mode Control	R/W	USINT	-	PDO/SDO	Configure if needed
6061h	00h	Operating Mode Status	R	USINT	-	PDO/SDO	Configure if needed
606Ch	00h	Actual Speed	R	DINT	Pulse/s	PDO/SDO	Configure if needed
60FDh	00h	Input IO Status	R	DINT	-	PDO/SDO	Configure if needed
60B8h	00h	Probe Control	R/W	UINT	-	PDO	Configure if needed
60B9h	00h	Probe Status	R	UINT	-	PDO	Configure if needed
60BAh	00h	Probe 1 Latch Position	R	DINT	Pulse	PDO	Configure if needed

CSP Mode Control Process



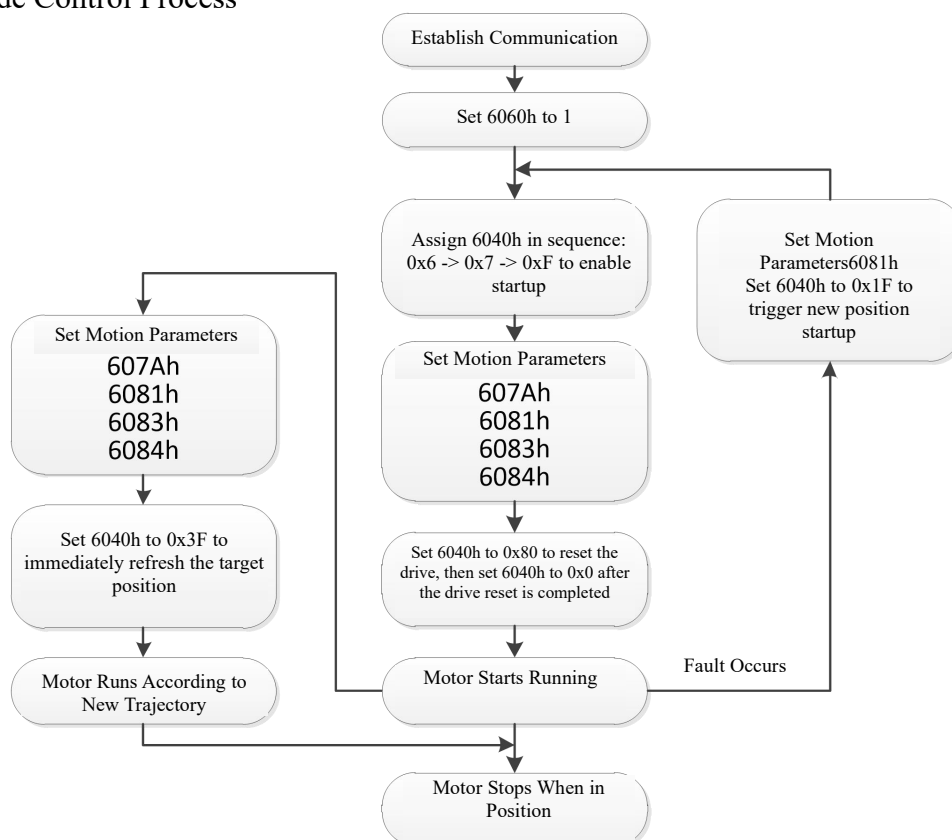
4.2.2 PP Mode (Profile Position Mode)

To use PP mode, set 6060h to 1. When the Operating Mode Status object 6061h reads as 1, PP mode operations can be performed.

This mode is primarily used for point-to-point positioning movements. In this mode, the controller provides the target position (607Ah), target speed (6081h), acceleration (6083h), and deceleration (6084h) parameters. The drive internally completes the trajectory planning based on the received motion parameters. The commonly used object dictionary in PP mode is as follows:

Index	Sub-index	Name	Access Type	Data Type	Unit	Configuration Recommendation	
6060h	00h	Operating Mode Control	R/W	USINT	-	PDO/SDO	Must be configured
6061h	00h	Operating Mode Status	R	USINT	-	PDO/SDO	Must be configured
6040h	00h	Control Word	R/W	UINT	-	PDO	Must be configured
607Ah	00h	Target Position	R/W	DINT	Pulse	PDO	Must be configured
6081h	00h	Position Mode Speed	R/W	UDINT	Pulse/s	PDO	Must be configured
6083h	00h	Acceleration	R/W	UDINT	Pulse/s ²	PDO/SDO	Must be configured
6084h	00h	Deceleration	R/W	UDINT	Pulse/s ²	PDO/SDO	Must be configured
6041h	00h	State Word	R	UINT	-	PDO	Must be configured
6064h	00h	Actual Position	R	DINT	Pulse	PDO	Must be configured
603Fh	00h	Latest Error Code	R	UINT	-	PDO/SDO	Recommended
606Ch	00h	Actual Speed	R	DINT	Pulse/s	PDO/SDO	Configure if needed
60FDh	00h	Input IO Status	R	DINT	-	PDO/SDO	Configure if needed
60B8h	00h	Probe Control	R/W	UINT	-	PDO	Configure if needed
60B9h	00h	Probe Status	R	UINT	-	PDO	Configure if needed
60BAh	00h	Probe 1 Latch Position	R	DINT	Pulse	PDO	Configure if needed

PP Mode Control Process



4.2.3 PV Mode (Velocity Mode)

To use PV mode, set 6060h to 3. When the Operating Mode Status object 6061h reads as 3, PV mode operations

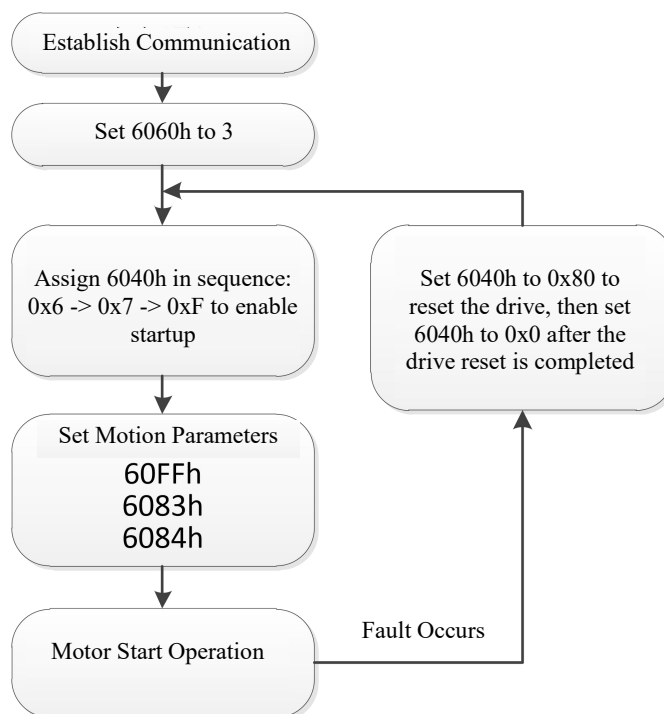
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can be performed.

In this mode, the controller sends the target speed (60FFh), acceleration time (6083h), and deceleration time (6084h) to the drive, which internally completes the speed curve planning. The commonly used object dictionary in PV mode is as follows:

Index	Sub-index	Name	Access Type	Data Type	Unit	Configuration Recommendation	
6060h	00h	Operating Mode Control	R/W	USINT	-	PDO/SDO	Must be configured
6061h	00h	Operating Mode Status	R	USINT	-	PDO/SDO	Must be configured
6040h	00h	Control Word	R/W	UINT	-	PDO	Must be configured
60FFh	00h	Target Speed	R/W	DINT	Pulse/s	PDO	Must be configured
6083h	00h	Acceleration	R/W	UDINT	Pulse/s ²	PDO/SDO	Must be configured
6084h	00h	Deceleration	R/W	UDINT	Pulse/s ²	PDO/SDO	Must be configured
6041h	00h	State Word	R	UINT	-	PDO	Must be configured
603Fh	00h	Latest Error Code	R	UINT	-	PDO/SDO	Recommended
606Ch	00h	Actual Speed	R	DINT	Pulse/s	PDO/SDO	Configure if needed
60FDh	00h	Input IO Status	R	DINT	-	PDO/SDO	Configure if needed
60B8h	00h	Probe Control	R/W	UINT	-	PDO	Configure if needed
60B9h	00h	Probe Status	R	UINT	-	PDO	Configure if needed
60BAh	00h	Probe 1 Latch Position	R	DINT	Pulse	PDO	Configure if needed

PV Mode Control Process



4.2.4 HOME Mode (Homing Mode)

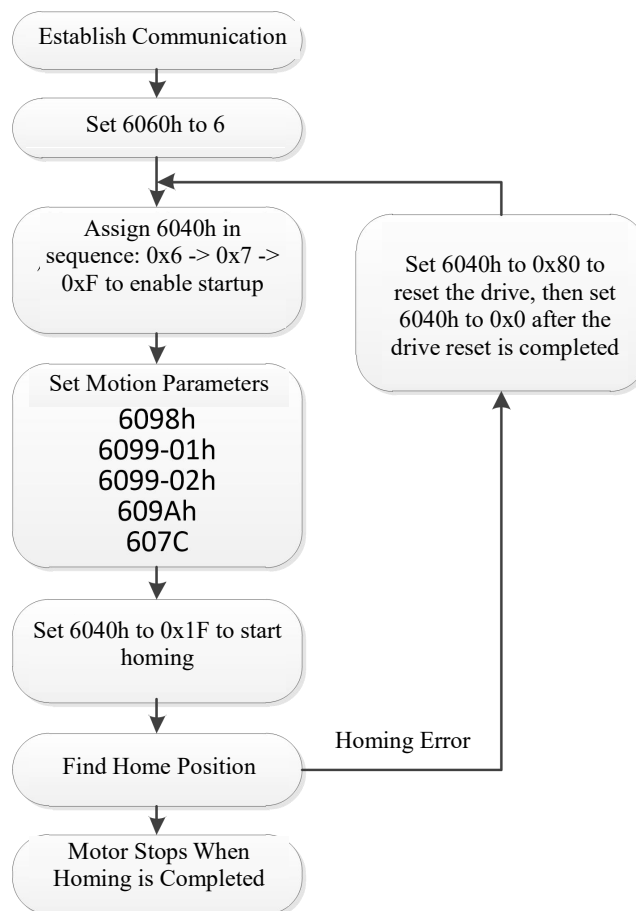
To use HOME mode, set 6060h to 6. When the Operating Mode Status object 6061h reads as 6, HOME mode operations can be performed.

In Homing mode, the home signal needs to be connected to the drive's input terminals. The controller will send the homing mode (6098h), homing high speed (6099h-01), homing creep speed (6099h-02), and homing acceleration/deceleration

(609Ah) parameters to the drive, which will internally locate and position the mechanical home. The drive currently supports six homing modes. The commonly used object dictionary in HOME mode is as follows:

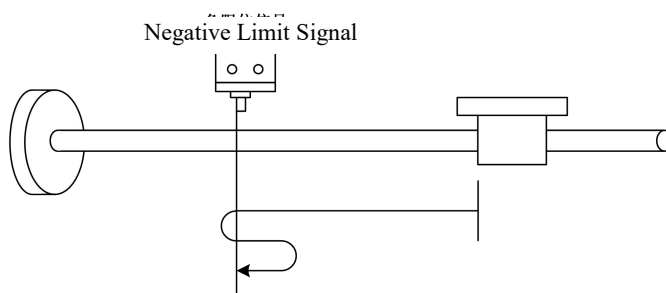
Index	Sub-index	Name	Access Type	Data Type	Unit	Configuration Recommendation	
6060h	00h	Operating Mode Control	R/W	USINT	-	PDO/SDO	Must be configured
6061h	00h	Operating Mode Status	R	USINT	-	PDO/SDO	Must be configured
6040h	00h	Control Word	R/W	UINT	-	PDO	Must be configured
6098h	00h	Homing Mode	R/W	USINT	-	PDO/SDO	Must be configured
6099h	01h	Homing High Speed	R/W	DINT	Pulse/s	PDO/SDO	Must be configured
6099h	02h	Homing Creep Speed	R/W	DINT	Pulse/s	PDO/SDO	Must be configured
607Ch	00h	Homing Offset	R/W	DINT	Pulse	PDO/SDO	Must be configured
609Ah	00h	Homing Acceleration/ Deceleration	R/W	UDINT	Pulse/s^2	PDO/SDO	Must be configured
6041h	00h	State Word	R	UINT	-	PDO	Must be configured
6064h	00h	Actual Position	R	DINT	Pulse	PDO	Recommended
603Fh	00h	Latest Error Code	R	UINT	-	PDO/SDO	Recommended
606Ch	00h	Actual Speed	R	DINT	Pulse/s	PDO/SDO	Configure if needed
60FDh	00h	Input IO Status	R	DINT	-	PDO/SDO	Configure if needed
60B8h	00h	Probe Control	R/W	UINT	-	PDO	Configure if needed
60B9h	00h	Probe Status	R	UINT	-	PDO	Configure if needed
60BAh	00h	Probe 1 Latch Position	R	DINT	Pulse	PDO	Configure if needed

HOME Mode Control Process

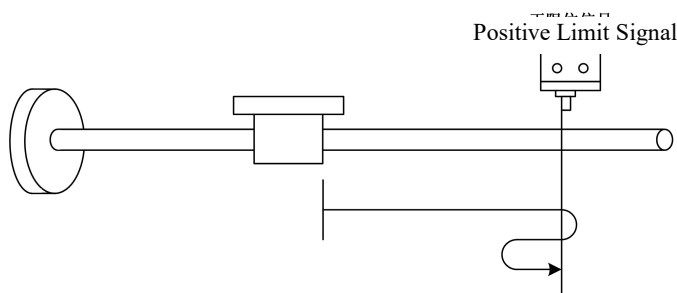


Homing Mode Descriptions:

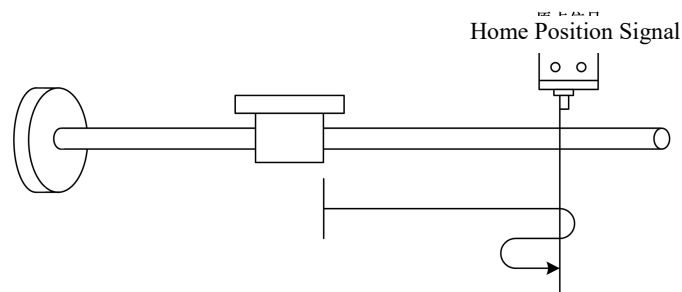
1. 6098h = 17: Searches for the negative limit signal in the reverse direction. Upon encountering the negative limit signal, the drive decelerates to a stop, then moves back a short distance. It then slowly reverses to find the negative limit signal again, stops when found, and the homing operation is complete.



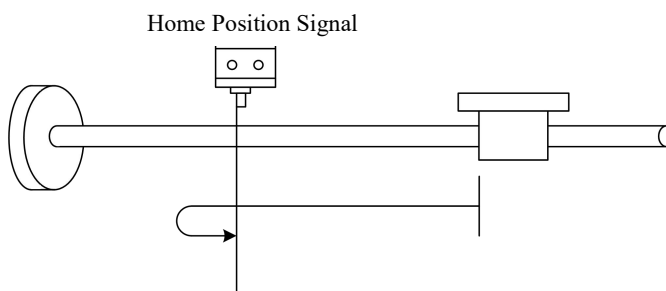
2. 6098h = 18: Searches for the positive limit signal in the forward direction. Upon encountering the positive limit signal, the drive decelerates to a stop, then moves back a short distance. It then slowly moves forward to find the positive limit signal again, stops when found, and the homing operation is complete.



3. 6098h = 24: Searches for the home position in the forward direction. Upon encountering the home position, the drive decelerates to a stop, then moves back a short distance. It then slowly moves forward to find the home position again, stops when found, and the homing operation is complete. If the positive limit is encountered during homing, the drive reverses to continue searching for the home position.



4. 6098h = 29: Searches for the home position in the reverse direction. Upon encountering the home position, the drive decelerates to a stop, then slowly moves forward to find the home position again, stops when found, and the homing operation is complete. If the negative limit is encountered during homing, the drive reverses to continue searching for the home position.



5. 6098h = 35 / 6098h = 37: The current position is set as the home position. When using these modes, the current position is taken as the home.

4.3 Position Capture Function

The position capture function is triggered by a dedicated probe signal (only DI1 and DI2 are high-speed input ports, with a response time of up to 5 microseconds). It stores the motor's current position into the corresponding register. This function is commonly used in high-speed measurement or packaging applications. This series of drives supports two probe functions that can be enabled simultaneously. The related object dictionary is as follows:

Index	Sub-index	Name	Access Type	Data Type	Unit
60B8h	00h	Probe Configuration	R/W	UINT	-
60B9h	00h	Probe Status	R	UINT	-
60BAh	00h	Probe 1 Rising Edge Latch Position	R	DINT	Pulse
60BBh	00h	Probe 1 Falling Edge Latch Position	R	DINT	Pulse
60BCh	00h	Probe 2 Rising Edge Latch Position	R	DINT	Pulse
60BDh	00h	Probe 2 Falling Edge Latch Position	R	DINT	Pulse
60D5h	00h	Probe 1 Rising Edge Latch Counter	R	UDINT	-
60D6h	00h	Probe 1 Falling Edge Latch Counter	R	UDINT	-
60D7h	00h	Probe 2 Rising Edge Latch Counter	R	UDINT	-
60D8h	00h	Probe 2 Falling Edge Latch Counter	R	UDINT	-

Before using the probe function, configure DO1 or DI2 as the probe function via the following registers.

Index	Sub-index	Name	Description	Configuration Value	Parameter Range
2310h	00	Terminal Function	Input Terminal DI1 Function Selection	7	0~65535
2311h	00	Terminal Function	Input Terminal DI2 Function Selection	8	0~65535

The probe function can be set using the Probe Configuration object dictionary, and the current working status of the probe can be checked using the Probe Status object dictionary. The specific configurations of the 60B8h and 60B9h object dictionaries are described below.

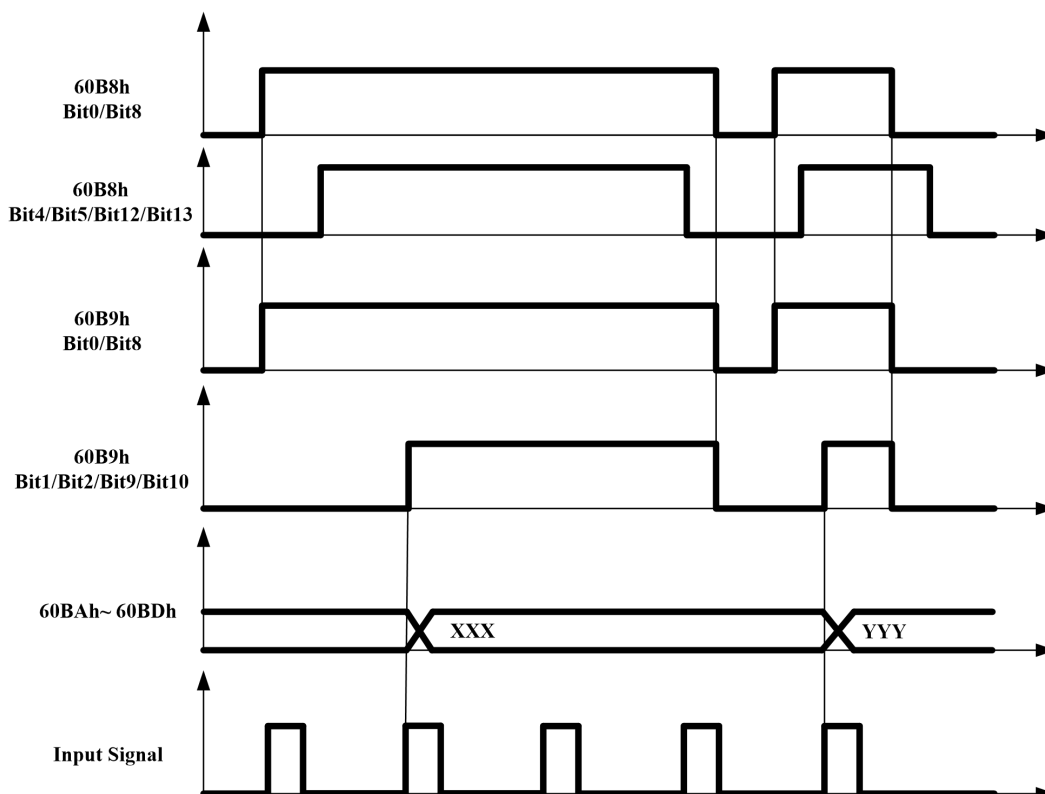
Index	Sub-index	Function Description	
60B8h	00h	Bit0	0 = Probe 1 Disabled; 1 = Probe 1 Enabled
		Bit1	0 = Probe 1 Single Mode; 1 = Probe 1 Continuous Mode
		Bit2 ~ Bit3	Reserved;
		Bit4	0 = Probe 1 Rising Edge Disabled; 1 = Probe 1 Rising Edge Enabled
		Bit5	0 = Probe 1 Falling Edge Disabled; 1 = Probe 1 Falling Edge Enabled
		Bit6 ~ Bit7	Reserved;
		Bit8	0 = Probe 2 Disabled; 1 = Probe 2 Enabled
		Bit9	0 = Probe 2 Single Mode; 1 = Probe 2 Continuous Mode
		Bit10 ~ Bit11	Reserved;
		Bit12	0 = Probe 2 Rising Edge Disabled; 1 = Probe 2 Rising Edge Enabled
		Bit13	0 = Probe 2 Falling Edge Disabled; 1 = Probe 2 Falling Edge Enabled
		Bit14 ~ Bit15	Reserved;
Index	Sub-index	Function Description	
60B9h	00h	Bit0	0 = Probe 1 Not Triggered; 1 = Probe 1 Active

	Bit1	0 = Probe 1 Rising Edge Capture Not Completed; 1 = Probe 1 Rising Edge Capture Completed
	Bit2	0 = Probe 1 Falling Edge Capture Not Completed; 1 = Probe 1 Falling Edge Capture Completed
	Bit3~Bit7	Reserved;
	Bit8	0 = Probe 1 Not Triggered; 1 = Probe 1 Active
	Bit9	0 = Probe 1 Rising Edge Capture Not Completed; 1 = Probe 1 Rising Edge Capture Completed
	Bit10	0 = Probe 1 Falling Edge Capture Not Completed; 1 = Probe 1 Falling Edge Capture Completed
	Bit11~Bit15	Reserved;

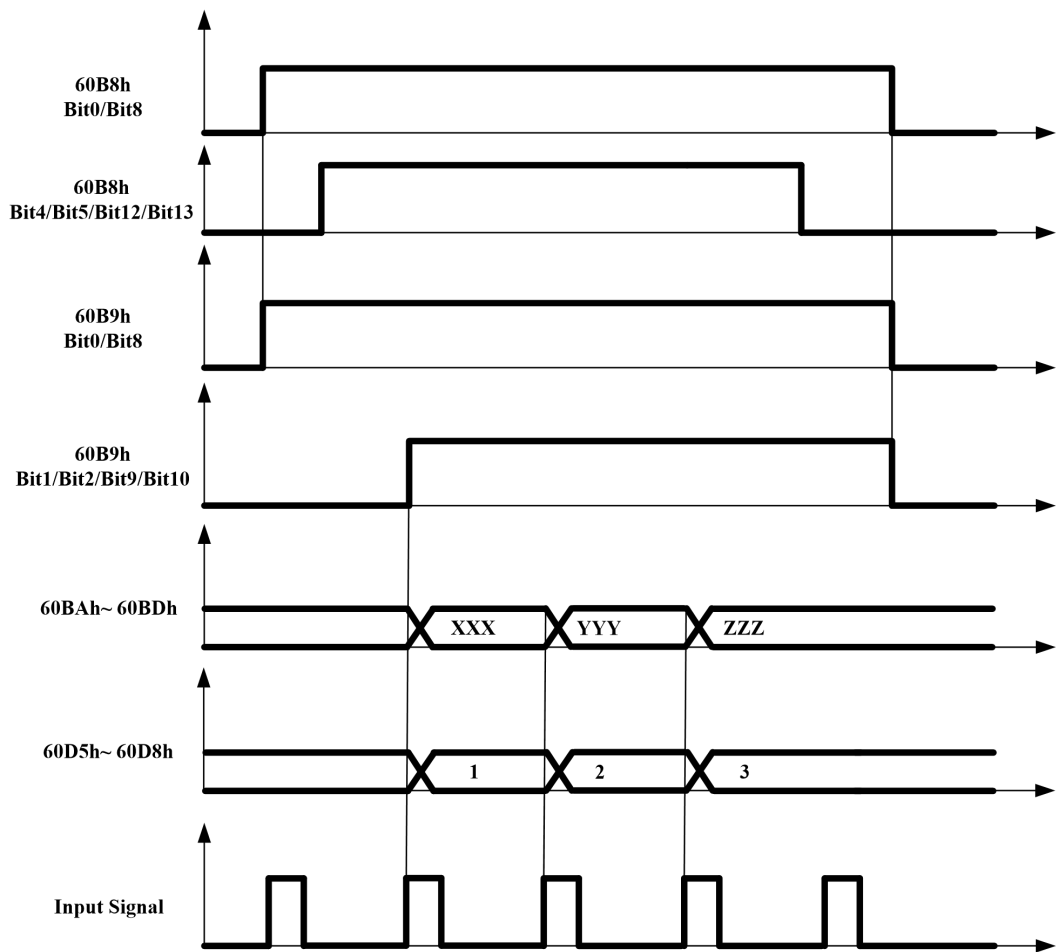
The probe operation mode has two options: single mode and continuous mode, controlled by Bit1/Bit9 of 60B8h. In single mode, the probe captures only one rising or falling edge signal and latches the current position information into the 60BAh~60BDh object dictionaries. In continuous mode, the probe captures each rising or falling edge signal, latches the current position information into the 60BAh~60BDh object dictionaries, and also latches the count of captured signals into the 60D5h~60D8h object dictionaries.

The probe function is initiated by controlling Bit0/Bit8 of 60B8h. The start command sequence is: first write "0", then write "1" to complete a command trigger. To restart the probe function, the start command sequence must be repeated. The following diagrams illustrate the probe operation in single mode and continuous mode.

Single Mode Probe Operation:



Continuous Mode Probe Operation:



The diagrams above only illustrate the rising edge triggered latching. The falling edge triggered latching operates similarly, with the only difference being that latching is completed at the falling edge.

Chapter 5: Alarm Handling

Alarms are categorized into drive alarms and communication alarms.

The following table lists the common drive alarms:

Fault Code	Fault Information	Fault Cause	Solution
E1	Overcurrent	<ol style="list-style-type: none"> 1. Motor power lines are connected incorrectly or short-circuited. 2. The mainboard is damaged. 3. Internal circuit fault in the drive. 	<ol style="list-style-type: none"> 1. Check motor wiring. 2. Measure the resistance between motor phases A and B, and check if either phase is conducting with the motor casing. 3. Drive fault, return for repair.
E2	Overvoltage	<ol style="list-style-type: none"> 1. Supply voltage is too high. 2. Internal circuit fault in the drive. 	<ol style="list-style-type: none"> 1. Check the power supply, replace if necessary. 2. Drive fault, return for repair.
E3	Undervoltage	<ol style="list-style-type: none"> 1. Supply voltage is too low. 2. Internal circuit fault in the drive. 	<ol style="list-style-type: none"> 1. Check the power supply, replace if necessary. 2. Drive fault, return for repair.
E5	Excessive Deviation	<ol style="list-style-type: none"> 1. Motor power line is disconnected or has poor connection. 2. Motor encoder line is disconnected or has poor connection. 3. Position deviation limit (230Dh) is set too low. 4. Motor speed is too high. 5. Load is too heavy or is stuck. 	<ol style="list-style-type: none"> 1. Check for disconnections or poor connections in motor power lines. 2. Check for disconnections or poor connections in motor encoder lines. 3. Increase the position deviation limit (230Dh). 4. Reduce motor speed. 5. Check for mechanical obstructions or test the motor in unloaded condition to see if the alarm persists.

Communication alarms are indicated by the LED display as follows:

Name	Color	Status	Description
ERR	Orange	Off	No Error
		Slow Blink	Communication Setting Error
		Single Blink	Synchronization or Communication Data Error
		Double Blink	Watchdog Timeout Request