DINGS'
Precision Motion Specialist

VER 1.3

Technical Manual

DS-OL57-ICAO

Table of Contents

1. Product Introduction

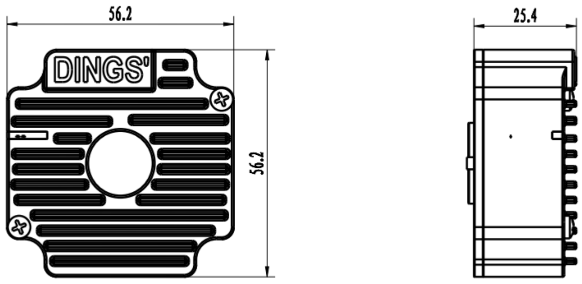
1.1 Features

- Input power : DC 24 - 48V
- Output rated current : 5.6A (max)
- CANopen communication control, supporting control modes PP, PV and HM
- Maximum frequency response of input signal : 1KHz (duty cycle 50%)
- 4 input signals : Optocoupler isolation, 5V signal drive, current limiting resistor required for exceeding 5V
- 1 general output

1.2 Technical Parameters

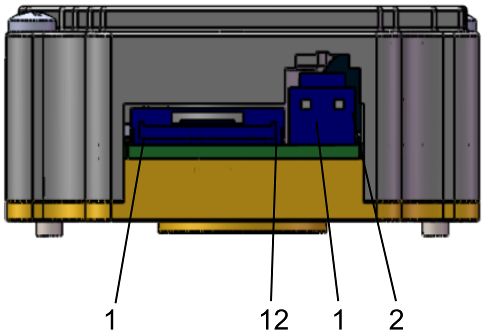
Drive model		**DS-OL57-ICAO**
Adapted motor		2-phase hybrid stepper motor
Power supply		DC 24V ~ 48V
Output current		5.6A (max)
Drive method		Full-bridge bipolar PWM drive
Input signal	**IN1 signal**	Optocoupler input voltage: H = 3.5 - 5V, L = 0 - 0.8V On current 5 ~ 8mA Signal power supply 12VDC series resistance R = 1 KΩ Signal power supply 24VDC series resistance R = 2.2 KΩ It can also be selected based on the input signal voltage, such as fixed 12V or 24V.
	IN2 signal	
	IN3 signal	
	IN4 signal	
Output signal		Photoelectric isolated output, withstand voltage up to 30VDC, maximum saturation current 10mA
Device initialization time		2s
Working Environment	**Precaution**	Avoid dust, oil mist and corrosive gases
	Humidity	< 85 % RH, Non-condensing
	Temperature	0°C - +40°C
	Cooling	Installation in a ventilated environment

1.3 Dimensional Drawing



Unit : mm

2. Schematic and Interface Definition



2.1 **Power Input** (as shown, arranged from left to right)

Pin	Name	Description
1	V+	24V – 48VDC
2	GND	Power supply ground

2.2 **Signal Input** (as shown, arranged from left to right)

Pin	Name	Description
1	485-A	485 communication (debugging port)
2	485-B	
3	IN1	General input port, 5V effective Max. input frequency 1KHz, signal definition configurable
4	IN2	
5	IN_COM	Single-ended input signal common Both positive and negative (5VDC) compatible
6	IN3	General input port, 5V effective Max. input frequency 1KHz, signal definition configurable
7	IN4	
8	OUT+	The maximum output current is 10mA, and the maximum withstand voltage is 30Vdc. The output function is configurable, but not configured by default
9	OUT-	
10	CAN-GND	CAN communication port
11	CANL	
12	CANH	

2.3 Indicator Function

This product has 2 red and green LEDs to indicate the light display status:

2.3.1 Status Indication :

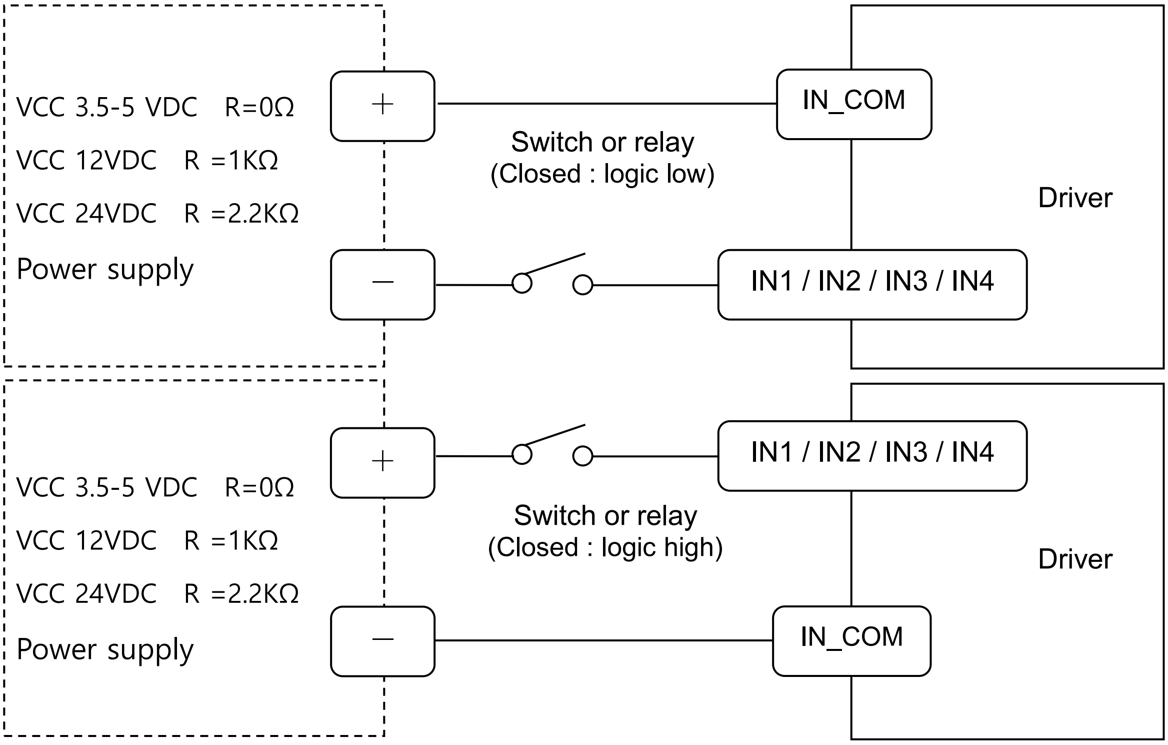
Status function	Green light	Description
Stopping	flicker	On, the motor is phase locked but the motor is not running
In operation	always on	Drive is running
Enable disconnect	flicker	Enable disconnect, motor can be free

2.3.2 Error Indication :

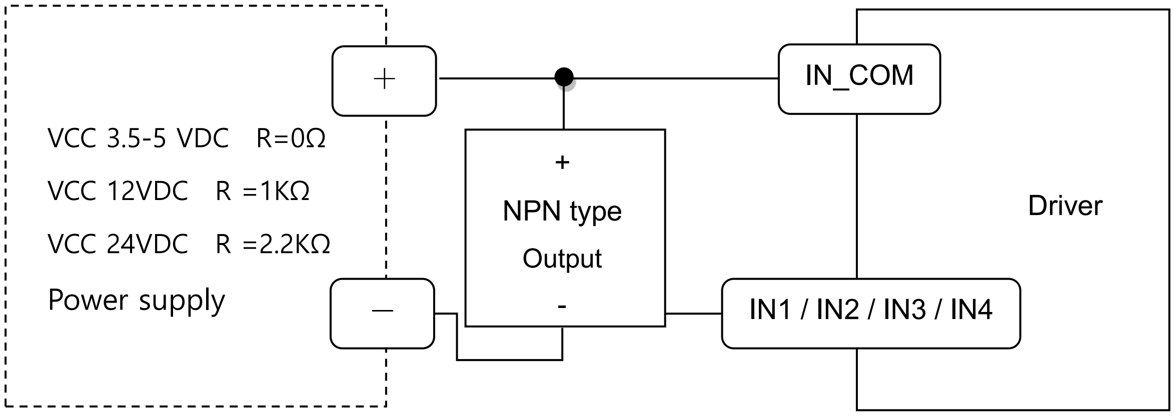
Alarm function	red light	Description
Motor overcurrent	1 green +1 red	Motor phase current overcurrent or drive failure
Motor phase loss	1 green +2 red	Motor is not connected
Overvoltage	1 green +3 red	Power input is greater than 52V
Undervoltage	1 green +4 red	Power input is less than 18V
Other alarms	1 green +5 red	

3. Typical Signal Connection

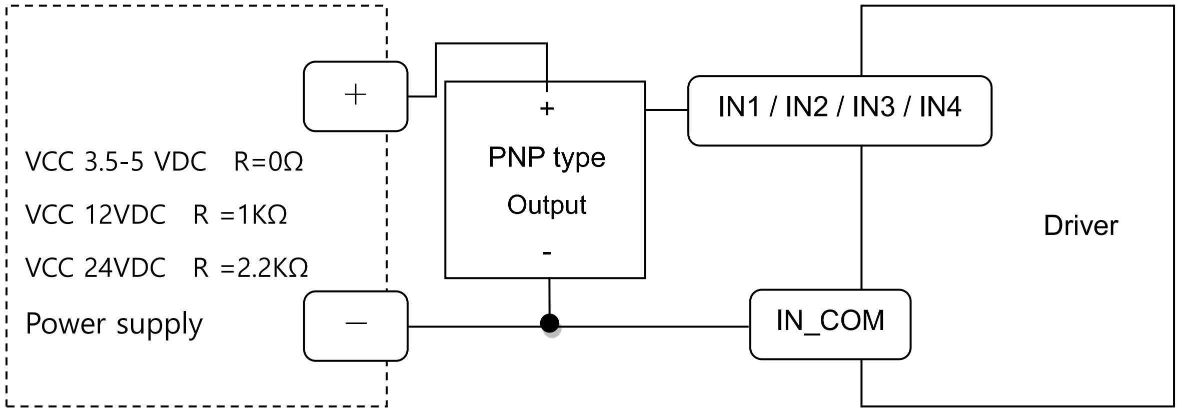
3.1 Input Signal of Switch or Relay Connection



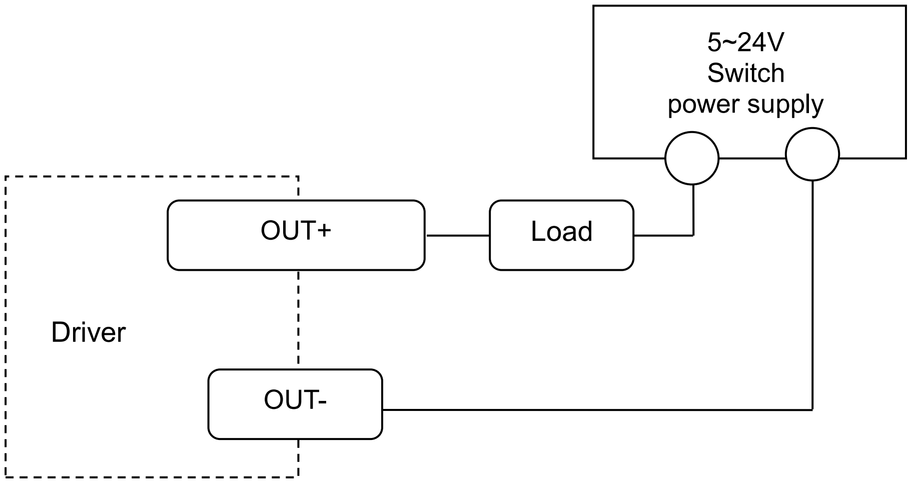
3.2 Connection of Input Signal and NPN Type Output



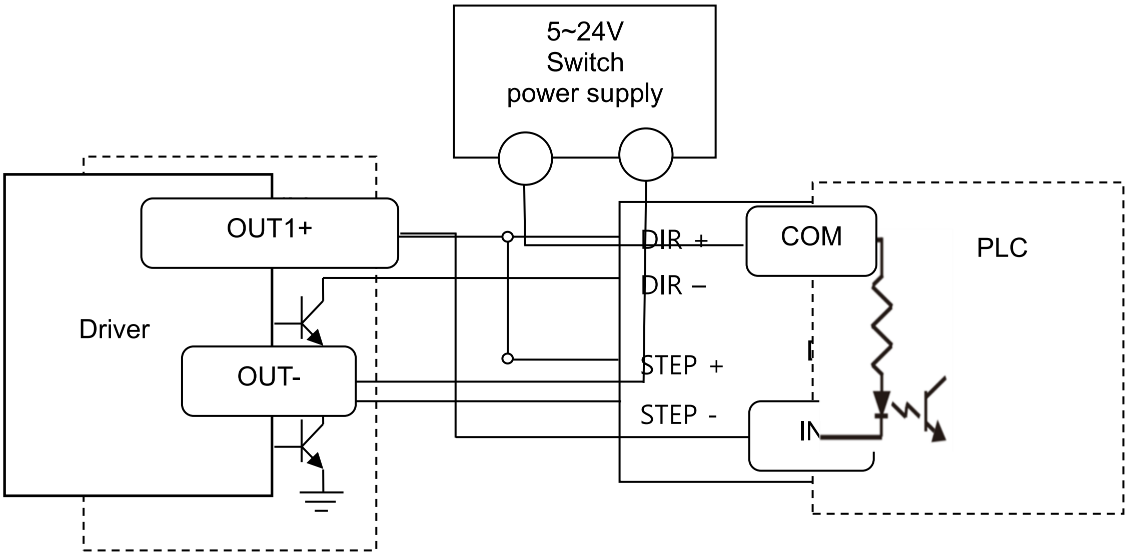
3.3 Connection of Input Signal and PNP Type Output



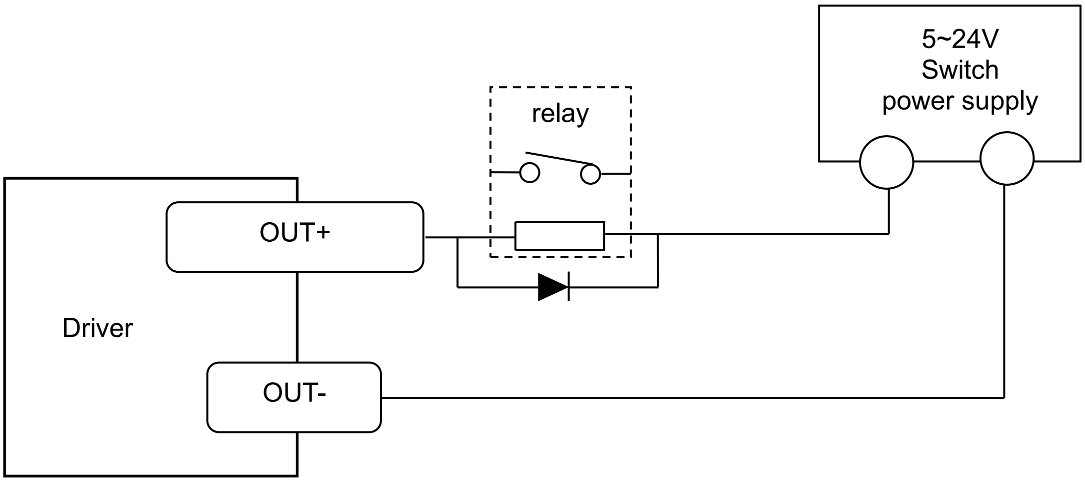
3.4 Connection Method for Current Output of Output Signal



3.5 Connection of Output Signal and PLC Type Input



3.6 Connection the Output Signal to the Relay



Caution **Do not connect the output terminal to a DC voltage above 30V, and the current flowing into the output terminal should not exceed 10mA.**

4. CANopen Communication

4.1 CANopen Communication Service

4.1.1 CANopen specification followed by the product :

- Comply with CAN 2.0A standard
- Comply with CANopen standard protocol DS 301 V4.02
- Comply with CANopen standard protocol DSP 402 V2.01

4.1.2 Services supported by CANopen drives :

- Support NMTSlave services
- Equipment monitoring: supports heartbeat messages and node protection
- Supporting PDO services: Each slave station can be configured with up to 4 TxPDOs and 4 RxPDOs
- PDO transmission type: supports event triggering, time triggering, synchronous cycle, and synchronous non cycle
- Supporting SDO services
- Support for Emergency Protocol

4.2 CANopen Communication Object Identifier

The communication object identifier (COB-ID) is used to specify the priority of the communication object and its identification.

The 11-bit CAN-ID contains the 4-bit function code part and the 7-bit Node ID(Node-ID) part, as shown in the figure below:

Functional code				ID of nodes						
10	9	8	7	6	5	4	3	2	1	0

The Node-ID range is 1 to 127(0 is not allowed).

Each communication object of CANopen has a default COB-ID, which can be read through SDO, and parts can be modified through SDO.right

As shown in the list below:

CANopen pre-defines a master/slave connection set of broadcast objects				
Object	**Functional code**	**Node address**	**COB-ID**	**Object Dictionary Index**
NMT network management	0000	0	0x000	-
Synchronization object	0001	0	0x080	1005H,1006H,1007H
Emergency	0001	1~127	0x081~0x0FF	1024H,1015H
TXPDO1 (send)	0011	1~127	0x181~0x1FF	1800H
RXPDO1 (receive)	0100	1~127	0x201~0x27F	1400H
TXPDO2 (send)	0101	1~127	0x281~0x2FF	1801H
RXPDO2 (receive)	0110	1~127	0x301~0x37F	1401H
TXPDO3 (send)	0111	1~127	0x381~0x3FF	1802H
RXPDO3 (receive)	1000	1~127	0x401~0x47F	1402H
TXPDO4 (send)	1001	1~127	0x481~0x4FF	1803H
RXPDO4 (receive)	1010	1~127	0x501~0x57F	1403H
TSDO(Server send)	1011	1~127	0x581~0x5FF	1200H
SRDO (send by customer)	1100	1~127	0x601~0x67F	1200H
NMT error control	1110	1~127	0x701~0x77F	1016H~1017H

Notes

1) PDO/SDO transmission/reception is relative to the slave CAN node.

2) NMT fault control includes Node protection, Heartbeat and boot-up protocols.

3) The ID address allocation table corresponds to a pre-defined set of master-slave connections, and because all peer IDs are different, there is actually only one master device (known) All connected node IDs can communicate with each connected slave node (up to 127) in a peer-to-peer manner. Two slave nodes connected together cannot communicate.

4.3 Object Dictionary (OD)

4.3.1 Object Dictionary Overview

An Object Dictionary is an ordered group of objects; Each object is addressed with a 16-bit index in order to allow access

A single element in the data structure defines an 8-bit sub-index. The structure of the object dictionary is shown in the following table:

Index	Object
0000H	Don't use
0001H——001FH	Standard data types such as Boolean (Bool), Integer16, etc
0020H——003FH	Complex data types such as PDO communication parameters (PDOCommpar)
0040H——005FH	The responsible data type specified by the manufacturer
0060H——007FH	Standard data types specified in the device subprotocol
0080H——009FH	A complex data type specified by a device subprotocol
00A0H——0FFFH	Reserved area
1000H——1FFFH	Communicate sub-protocol areas, such as device type, PDO number, etc
2000H——5FFFH	Manufacturer specific sub-protocol area
6000H——9FFFH	Standard device sub-protocol areas, such as the object dictionary area of DSP 402
A000H——FFFFH	Reserved area

The detailed definition of the object dictionary is described in Electronic Data Documents (EDS) and EDS can be obtained by contacting our technology.

The three main object dictionaries in EDS are described as follows:

(1) Communication object dictionaries, such as 1000H, 1400H, 1A00H and other object dictionaries
(2) Custom object dictionary of the manufacturer, such as 2000H-2130H
(3) CIA DSP402 section object dictionary.

4.3.2 Object Type

The CANopen object code corresponding to the "object" column in the above table is shown in the following table:

Object name	Object code	Note
NULL	0	No data
DOMAIN	2	Large amounts of data, such as executable code snippets
VAR	7	Variables, such as Boolean, are of unsigned 8-bit type
ARRAY	8	Arrays, lots of data of the same type
RECORD	9	Records can be a large number of different types of data

4.3.3 Access Properties

Property	Note
RW	Read/write
WO	Write-only
RO	Read-only
CONST	Constant, read-only

4.3.4 Communication Object Dictionary

The communication class object dictionary list is as follows:

Index	Object type	Name of name	Data type	Access properties
1000H	VAR	Device type	Unsigned 32 bits	RO
1001H	VAR	Error register	Unsigned 8 bits	RO
1003H	ARRAY	Predefined error area	Unsigned 32 bits	RO
1005H	VAR	The PDO synchronous ID	Unsigned 32 bits	RW
1006H	VAR	Communication cycle	Unsigned 32 bits	RW
1007H	VAR	PDO time window	Unsigned 32 bits	RW
1008H	DOMAIN	Device name	String	CONST
1009H	VAR	Hardware version	String	CONST
100AH	VAR	Software version	String	CONST
1014H	VAR	Emergency message	Unsigned 32 bits	RW
1017H	VAR	Producer heartbeat time	Unsigned 16 bits	RW
1018H	RECORD	Identifies objects	Unsigned 32 bits	RO
1200H	RECORD	Server SDO parameters	Server SDO parameters	RO
1400H	RECORD	Receive the PDO parameter	Receive the PDO parameter	RW
1402H	RECORD	Receive the PDO parameter	Receive the PDO parameter	RW
1403H	RECORD	Receive the PDO parameter	Receive the PDO parameter	RW
1600H	RECORD	Receive the PDO map	Receive the PDO map	RW
1602H	RECORD	Receive the PDO map	Receive the PDO map	RW
1603H	RECORD	Receive the PDO map	Receive the PDO map	RW
1800H	RECORD	Send the PDO parameter	Send the PDO parameter	RW
1802H	RECORD	Send the PDO	Send the PDO	RW
1803H	RECORD	Send the PDO parameter	Send the PDO parameter	RW
1A00H	RECORD	Send the PDO map	Send the PDO map	RW
1A02H	RECORD	Send the PDO map	Send the PDO map	RW
1A03H	RECORD	Send the PDO map	Send the PDO map	RW

4.4 Network Management (NMT)

NMT provides network management services. This service is implemented in a master-slave communication mode (so there is only one NMT master node).

Only NMT master node can transmit NMT module control message, all slave nodes must support NMT module control service, and NMT module control does not need reply. The message format is as follows:

NMT master node → NMT slave node

COB-ID	Byte 0	Byte 1
0x000	Command word	Node-ID

When Node-ID=0, all NMT slave nodes are addressed. The corresponding relationship between the value of the command word and the service is shown in the following table:

Command Word	NMT service
1 (01H)	Start remote node
2 (02H)	Stop remote node
128 (80H)	Enter the pre-operation state
129 (81H)	Nodes reset
130 (82H)	Communication is reset

4.5 NMT Error Control

NMT error control is mainly used to detect whether the device in the network is online and the state of the device, including node protection, lifetime protection and heartbeat.

Notes

1) Node protection and heartbeat cannot be used simultaneously;
2) Node protection. The heartbeat time should not be set too short to avoid increasing network load.

4.5.1 Node / Lifetime protection

Node protection is used to query the state of NMT slave machine periodically through remote frames. Lifetime protection is received from the station to monitor the slave station

Remote frame intervals are used to indirectly monitor the state of the master station, node protection follows the master-slave model, and each remote frame must be answered.

Objects related to node/lifetime protection include protection time 100Ch and life factor 100Dh.The value of 100Ch is the node protection distance under normal circumstances

The interval, in ms, the product of 100Ch and 100Dh determines the latest time for the host query. Under normal circumstances, node protection is possible.

Activate the lifetime protection when the nodes 100Ch and 100Dh are non-zero and are subject to a frame node protection request frame.

The master station sends the node to protect the remote frame every 100Ch, and the slave must reply, otherwise the line will be considered dropped from the station. Time from station 100Ch*100Dh

If no node protection remote frame is received, the master station is considered to be offline.

Through this service, the NMT master node can check the current state of each node. The master node sends remote frames in the following format:

NMT master node → NMT slave node

COB-ID
0x700+Node-ID

The format of NMT slave reply message is as follows:

NMT slave node → NMT master node

COB-ID	Byte 0
0x700+Node-ID	Bit 6:0state

The data portion includes a trigger bit (Bit7) that must be interchanged with either a "0" or a "1" in each node-protection reply. The trigger bit is set to "0" on the first node protection request. Bit 0 in position 6(BITS0 ~ 6) represents the node state and the corresponding relationship between its value and state is shown in the table below:

Value	State
0 (00H)	Initialize the
1 (01H)	Not connected
2 (02H)	The connection
3 (03H)	prepare
4 (04H)	stop
5 (05H)	operation
127 (7FH)	pre-operational

Notes

If node/lifetime protection is used, 100C is recommended to be greater than 10ms and 100D is recommended to be greater than

4.5.2 The Heartbeat

A node may be configured to produce periodic packets called heartbeats. The heartbeat model uses a producer-consumer model. CANopen device can send heartbeat packets according to the cycle set by the producer heartbeat interval object 1017h, in ms. Nodes with consumer heartbeat function in the network will be monitored according to the consumer time set by the object 1016h. Once the heartbeat of the producer of the corresponding node is not received within the range of consumer heartbeat time, the node will be considered to be disconnected (or there is a fault).

After the manufacturer's heartbeat interval was configured for 1017h, the node's heartbeat function was activated and heartbeat packets were generated. After configuring a valid sub-index of consumer heartbeat for 1016h, monitoring begins when a frame of heartbeat is received from the corresponding node.

The host sends heartbeat packets according to the producer's time. If the slave monitoring the host does not receive heartbeat packets within 1016h sub-index time, the host is considered to have dropped the station.1016h a sub-index time ≥ host producer time ×2, otherwise it is easy to misreport from the machine and consider the host to drop the station.

The slave shall send heartbeat packets every 1017h to monitor the slave's host (or other slave). If the slave fails to receive the heartbeat packets within the consumer's time, the slave shall be considered to have dropped the station.1017h×2≤ monitoring the consumer time of the slave's host machine (or other slave machine), otherwise it is easy to misreport the slave station.

The format of the heartbeat message is shown in the table. The data segment contains only one byte, and the others are consistent with the status of the node protection reply message in the table.

Heartbeat producer → consumer

COB-ID	Byte 0
0x700+Node-ID	state

The corresponding meaning of its value is shown in the following table:

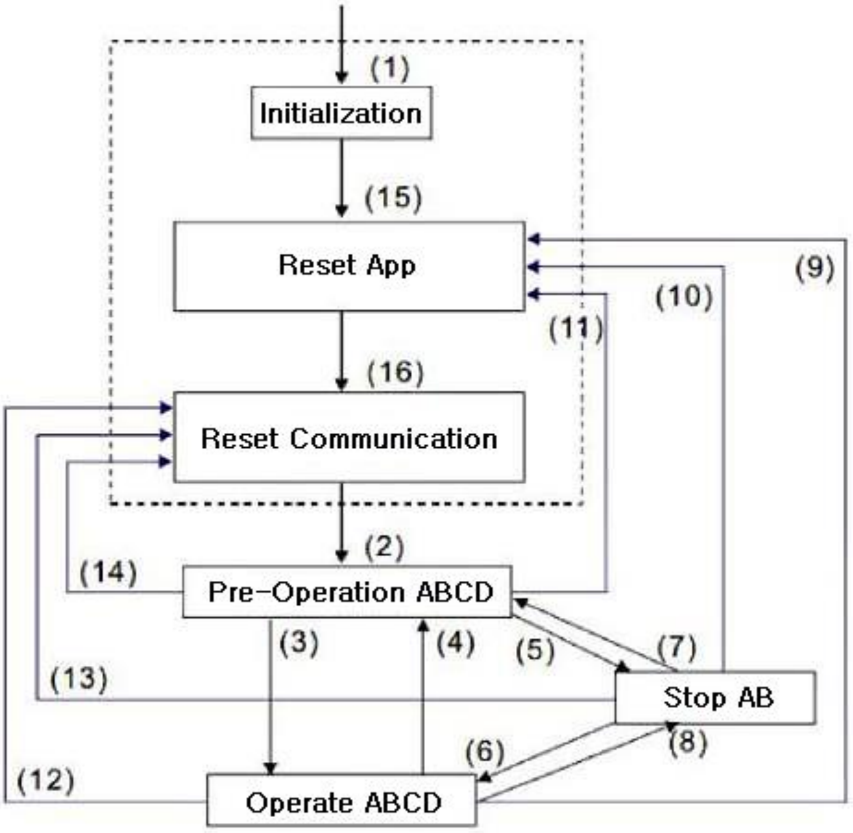
State value	Meaning
0 (00H)	Initialization
4 (04H)	Stop
5 (05H)	Operation
127 (7FH)	Pre-operation

ℹ Notes

The driver is the heartbeat producer. It is recommended that the duration of the heartbeat producer should not be less than 20ms.

4.5.3 Communication State Machine

The communication state machine of CANopen is shown in the following figure:



Description:

(1) After the power is turned on, it will automatically enter the initialization state A: NMT

(2) Automatically enter the pre-operation state B: Node Guard

(3) / (6) Start the remote node C: SDO

(4) / (7) Enter pre-operation state D: Emergency

(5) / (8) Stop remote node E: PDO

(9) / (10) / (11) Reset the node F: Boot-up

(12) / (13) / (14) Reset the communication

(15) Automatically enter the reset application state

(16) Automatically enter the reset communication state

Device initialization (the general term for initialization, reset application and reset communication in the figure) is completed and then enters the pre-operation state. Devices in this state can be passed SDOs (such as using configuration tools) set parameters and assign IDs. The node then goes directly into the operational state.

4.6 Service Data Object (SDO)

SDO is used to access a device's object dictionary. A visitor is called a client, and the object dictionary is accessed and provides the requested service

A CANopen device is referred to as a server. The client's CAN message and the server's reply CAN message always contain 8 bytes of data (although not all data bytes are necessarily meaningful). A customer's request must have an answer from the server.

Its basic structure is as follows:

Client → server/server → Client

Byte 0	Byte 1:2	Byte 3	Byte 4:7
SDO command word	An object	Object sub-index	data

Ex example

Use the SDO message to write the value 0x20F0 to an object dictionary with an index of ID 2 of 1801H and a sub-index of 3.

COB-ID	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
Client → server								
602	2B	01	18	03	F0	20	00	00
server → Client								
582	60	01	18	03	00	00	00	00

Use the following SDO message to read the data of an object whose index is 1801H and whose sub-index is 3 in the object dictionary.

COB-ID	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
Client → server								
602	40	01	18	03	00	00	00	00
server → Client								
582	4B	01	18	03	F0	20	00	00

The SDO client or server aborts SDO transmission by sending a message in the following format:

Client → server/server → Client

Bit	7	6	5	4	3	2	1	0
	1	0	0	-	-	-	-	-

In the SDO abort message, bytes 0 and 1 represent the object index, and bytes 2 represent the sub-index. Bytes 4 to 7 contain 32-bit abort codes, which describe the cause of the abort.

4.7 Process Data Object (PDO)

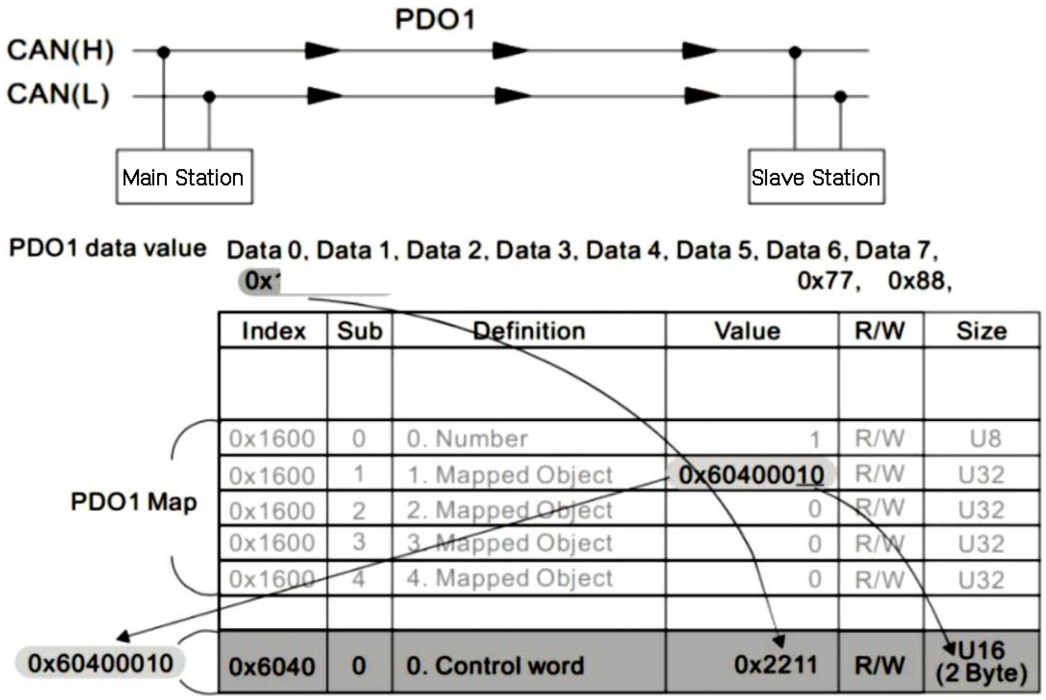
4.7.1 PDO transmission framework and features

The Process Data Object (PDO) is used to transmit data in real time and is the main data transmission mode in CANopen. PDO adopts the producer/consumer mode. The length of PDO can be less than 8 bytes, and the transmission speed is relatively fast. PDO data transmission can be one-to-one or one-to-many. Each PDO information includes sending PDO(TxPDO) and receiving PDO(RxPDO) information, and the transmission mode is defined in the PDO communication parameter index.

All PDO transfers must be mapped to the corresponding index area through the object dictionary image. Take the 1600H and 1A00H objects defined in DSP 402 as examples:

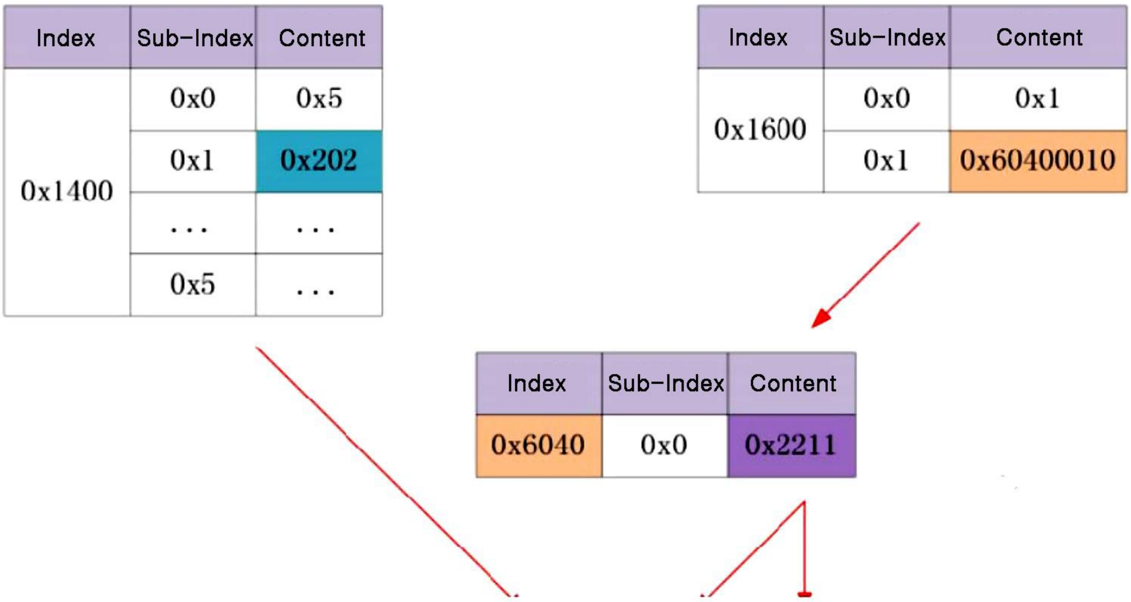
Notes **The value of the object dictionary in the figure is only needed for example, and does not have practical significance.**

The master station sends messages to the slave station PDO



Index	Sub	Definition	Value	R/W	Size
0x1600	0	0. Number	1	R/W	U8
0x1600	1	1. Mapped Object	0x60400010	R/W	U32
0x1600	2	2. Mapped Object	0	R/W	U32
0x1600	3	3. Mapped Object	0	R/W	U32
0x1600	4	4. Mapped Object	0	R/W	U32
0x6040	0	0. Control word	0x2211	R/W	U16 (2 Byte)

The following figure describes in detail the relationship between PDO parameters (1400H) and PDO mapping (1600H) and the transmission process of PDO data (take Node 2 as an example). The direction of the arrow shown in the figure indicates the direction of data processing of the master station.

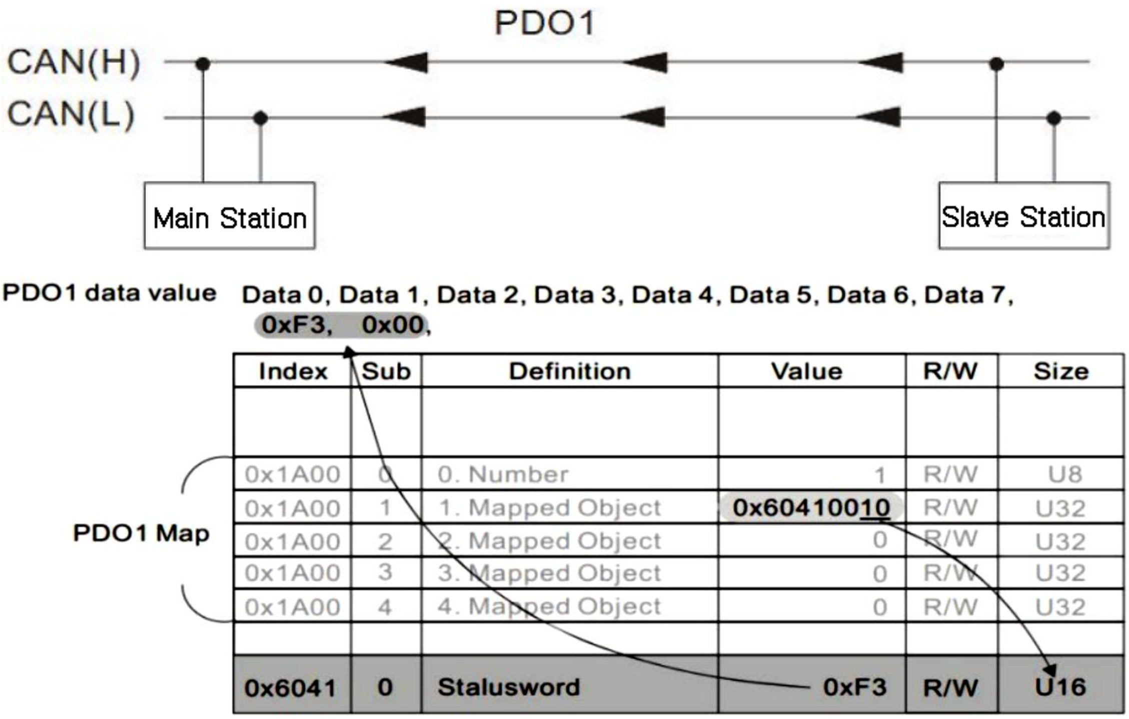


Index	Sub-Index	Content
0x1400	0x0	0x5
	0x1	0x202
	...	...
	0x5	...

Index	Sub-Index	Content
0x1600	0x0	0x1
	0x1	0x60400010

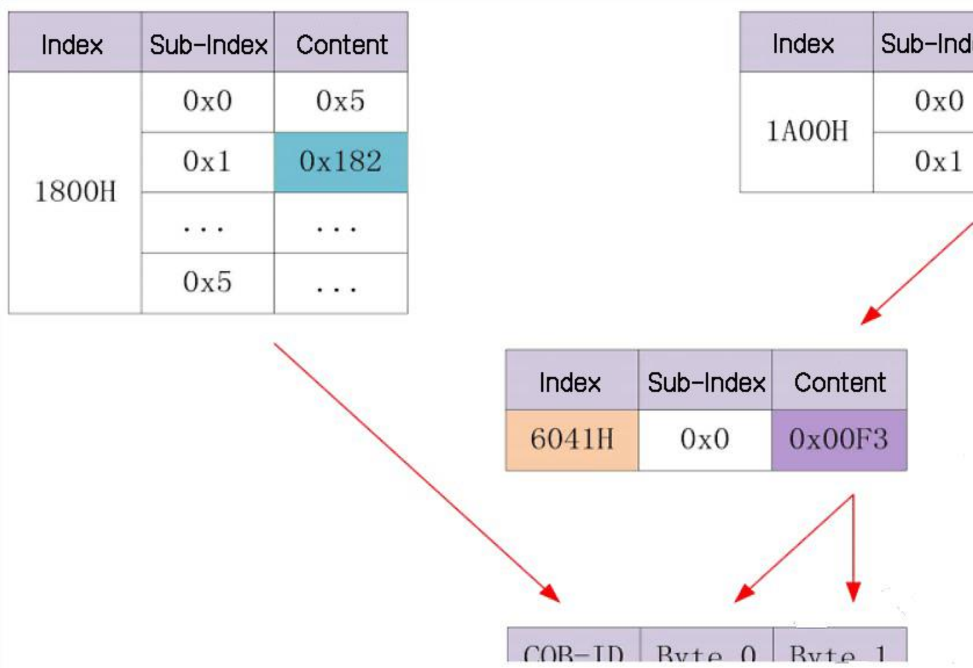
Index	Sub-Index	Content
0x6040	0x0	0x2211

The master station receives the information returned from the station



Index	Sub	Definition	Value	R/W	Size
0x1A00	0	0. Number	1	R/W	U8
0x1A00	1	1. Mapped Object	0x60410010	R/W	U32
0x1A00	2	2. Mapped Object	0	R/W	U32
0x1A00	3	3. Mapped Object	0	R/W	U32
0x1A00	4	4. Mapped Object	0	R/W	U32
0x6041	0	Stalusword	0xF3	R/W	U16

The following figure describes in detail the relationship between PDO parameters (1800H) and PDO mapping (1A00H) and the transmission process of PDO data (take Node 2 as an example). The direction of the arrow shown in the figure indicates the direction of slave station data processing.



Index	Sub-Index	Content
1800H	0x0	0x5
	0x1	0x182
	...	...
	0x5	...

Index	Sub-Index	Content
1A00H	0x0	0x1
	0x1	0x60410010

Index	Sub-Index	Content
6041H	0x0	0x00F3

COB-ID	Byte 0	Byte 1

In this product, CANopen communication only supports point-to-point PDO transmission.

4.7.2 PDO Object

According to the difference of receiving and sending, note that PDO is divided into TPDO and RPDO for slave stations. Four TPDO and four RPDO are used. The list of related objects is as follows:

Object	Function code	COB-ID	Communication object	Mapping object
TXPDO1 (send)	0011	0x181~0x1FF	1800H	1A00H
RXPDO1 (receive)	0100	0x201~0x27F	1400H	1600H
TXPDO2 (send)	0101	0x281~0x2FF	1801H	1A01H
RXPDO2 (receive)	0110	0x301~0x37F	1401H	1601H
TXPDO3 (send)	0111	0x381~0x3FF	1802H	1A02H
RXPDO3 (receive)	1000	0x401~0x47F	1402H	1602H
TXPDO4 (send)	1001	0x481~0x4FF	1803H	1A03H
RXPDO4 (receive)	1010	0x501~0x57F	1403H	1603H

4.7.3 PDO communication parameters

(1) CAN identifier of PDO

The CAN identifier of PDO, namely the COB-ID of PDO, contains the control bit and identification data to determine the bus priority of the PDO. The COB-ID is located on the sub-index 01 of the communication parameter (RPDO: 1400h~1403h, TPDO: 1800h~1803h), and the highest bit determines whether the PDO is valid.

The drive only supports point-to-point PDO transmission, so the COB-ID low by 7 bits must be the station address of the node.

(2) Transmission type of PDO

The transmission type of PDO is located on the sub-index 02 of the communication parameter (RPDO: 1400h~1403h, TPDO: 1800h~1803h)

Asynchronous transmission : transmission triggered by events, including data change trigger, periodic event timer trigger
Synchronous transmission : The connection between synchronous frames in a network.
Communication parameters (RPDO: 1400h~1403h, TPDO: 1800h~1803h) sub-index 02 Different values represent different transmission types, defined
The method that triggers TPDO to transmit or process the received RPDO is shown in the table.

Communication type value	Synchronous		Asynchronous
	Cyclic	Acyclic	
0		√	
1~240	√		
241~254	Reservations		
254, 255			√

Description:

1) When the TRANSMISSION type of TPDO is 0, if the data of the mapped object changes and a synchronous frame is received, the TPDO is sent.

2) When the transmission type of TPDO is 1~240, the corresponding number of synchronous frames are received and the TPDO is sent.

3) When the transport type of TPDO is 254 or 255, the TPDO is sent when the mapping data changes or the event timer arrives.

4) When the transmission type of RPDO is 0~240, update the latest data of the RPDO to the application as long as a synchronous frame is received; When the RPDO transport type is 254 or 255, the received data is updated directly to the application.

(3) No time

The forbidden time is set for TPDO, which is stored on the sub-index 03 of the communication parameter (1800h~1803h) to prevent the CAN network from being continuously occupied by PDO with lower priority. The unit of this parameter is 100US. After setting the value, the transmission interval of the same TPDO shall not be less than the time corresponding to this parameter.

For example, if TPDO2 has a forbidden time of 300, the transmission interval of TPDO will not be less than 30ms.

Suggestion: When frequently changing objects (such as feedback position, feedback speed, etc.) are configured to TPDO, and the transmission type of the TPDO is asynchronous, it is recommended to set a certain time of prohibition.

(4) Event timer

An event timer is defined for TPDO with an asynchronous transport (of type 254 or 255) on a sub-index 05 of the communication parameter (1800h~1803h).An event timer can also be thought of as a trigger event, which also triggers the corresponding TPDO transport. If other events, such as data changes, occur during the timer cycle, TPDO also fires, and the event counter is reset immediately.

(5) Configuration suggestions for PDO properties

1) Synchronous or asynchronous: Synchronous transmission means that the data corresponding to PDO is updated when the synchronous frame is generated on the bus. Its characteristic is that the data update cycle is stable, but it cannot keep synchronous with the data changes in real time. Asynchronous data update is immediately once the index according to the change, the transmission way of quick response but for frequent changes of data (location) according to the facts, etc., have larger data load on the bus easily, so often configuration a ban on time parameter (after the data is not successful, interval is a time to send again, rather than repeatedly uninterrupted send) in order to reduce the network load.

   Therefore, it is recommended to use synchronous PDO for the parameters with low real-time requirements in the network, and asynchronous PDO for the parameters with high real-time requirements, but pay attention to the configuration of the forbidden time, so as to protect the network load from impact.

2) Setting of synchronization cycle: It is recommended to calculate according to empirical formula (default baud rate of 1M) :

   Synchronization period (ms) =[PDO total /9] /(40%) +2

   Suppose a CANopen network has 12 axes, each with one send and one receive PDO. So the total number of PDOs is 12*2=24.Transport every millisecond bus capacity situations about 9 PDO, considering bus load margin, assuming that the bus load is 40% (relatively reasonable load factor), the time needed for 24 PDO transmission for: (40%) = 6.67/24/9 (ms), SDO, considering the network synchronization time frame, the heartbeat message, such as emergency message overhead, add 2 milliseconds, recommended configuration synchronization cycle is 8.67 milliseconds.
   The above empirical formula also applies to setting the disable time of asynchronous PDO.

4.7.4 PDO mapping parameters

The PDO mapping parameter contains a pointer to the process data corresponding to PDO that PDO needs to send or receive, including the index, sub-index, and length of the mapped object. Each PDO data can be up to 8 bytes long and can map one or more objects simultaneously. Where sub-index 0 records the number of objects in the specific mapping of the PDO, and sub-index 1~8 is the mapping content. The mapping parameter content is defined as follows.

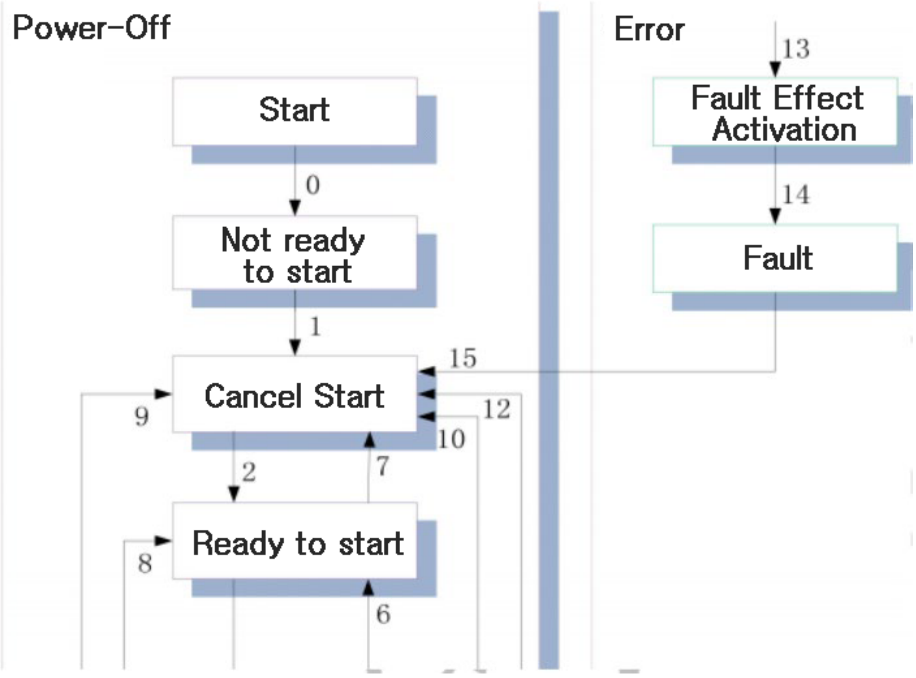
Position	31	… …	16	15	… …	8	7	… …	0
Definition	Index			Sub-index			Object length		

Index and sub-index jointly determine the position of the object in the object dictionary. The length of the object indicates the specific bit length of the object, which is expressed in hexadecimal, namely:

The object length	bit length
08h	8-bit
10h	16-bit
20h	32-bit

4.8 Synchronization Object (SYNC)

A synchronization object (SYNC) is a special mechanism that controls the harmony and synchronization between multiple nodes' sends and receives for PDO synchronization transfers. The configuration process of synchronization generator is as follows:



Drive synchronization cycles of less than 2ms are not recommended.

4.8.1 Sync generator

A driver is both a synchronization consumer and a synchronization producer. The synchronization related objects that are supported are the synchronization object COB-ID (1005h) and the synchronization cycle (1006h).

The secondary level of the synchronization object COB-ID determines whether the synchronization generator is activated.

4.8.2 Transmission framework for sync objects

Similar to the transmission of PDO, the transmission of the synchronous object follows the producer-consumer model, in which the synchronous producer issues the synchronous frame, and all other nodes in the CAN network CAN receive the synchronous frame as the consumer without feedback. Only one active sync generator is allowed in the same CAN network.

The transmission of synchronous PDO is closely related to synchronous frames.

- For synchronous RPDO, as long as the PDO is received, the received PDO is updated to the application at the next SYNC.
- For synchronous TPDO, it can be divided into synchronous cycle and synchronous non-cycle, as shown in the following table:

Type		Note
Synchronous TPDO	Synchronous acyclic	The PDO transport type is 0, the PDO mapped object content changes and is sent at the next SYNC.
	Synchronous cycle	The TRANSMISSION type of PDO is 1~240, and the TPDO needs to be sent whenever the SYNC specified by the transmission type is reached, regardless of whether the data has changed

4.9 Emergency Object Service (EMCY)

When an error occurs in the CANopen node, the node will send a frame of emergency message according to the standardization mechanism.

The emergency message follows the producer-consumer model. After a node failure is sent, other nodes in the CAN network CAN choose to handle the failure.

Drivers act as emergency message producers only and do not process emergency messages from other nodes.

An object associated with an emergency message	Description
Error register (1001h)	Reflect the general error status of the node, each bit is classified according to the corresponding error
Scheduled at error field (1003h)	Save the most recent error

The emergency instruction message is triggered by a fatal error in the device and is sent to other devices with the highest priority by the relevant application device. Suitable for interrupt type error warning signals.

An emergency message consists of 8 bytes. The format is as follows:

Sending end → receiving end

COB-ID	Byte 0:1	Byte 2	Byte 3:7
0x080+Node-ID	Emergency error code	Error register (1001h)	Manufacturer designated area

Supported Emergency Error Codes

Recent errors are stored in the "Booked in error Field" object dictionary (index 1003H); Users can read this information through SDO; But if the drive fails, these error messages are not saved. The current error type is stored in the object dictionary error register (index 1001H).

The device can map internal errors to this status byte and can quickly see the current error type.

The following table defines the error register bits

Position	Error type
0	General error
1	Current
2	Voltage
3	The temperature
4	Communication
5	Error specified in device Protocol (402)
6	Keep
7	Vendor designation error

5. Parameter Description and Setting

5.1 DO Parameter List

The bus closed loop stepping driver is a standard EtherCAT slave station device that follows the EtherCAT standard protocol to communicate with the standard master station that supports the protocol.

The PC software interacts with the driver using MODBUS protocol, and the PC software can modify/read all the driver parameters, alarm information and control the pilot run of the driver.

5.1.1 Configuration Parameters

Object dictionary	Name	Property	Word	Range	Default	Unit	Remarks
2064	Integrated current	RO	1	0~65535	--	0.1%A	
2065	Bus voltage	RO	1	0~65535	--	1%V	
206C	Error code	RO	1	0~65535	--		
206D	Running state	RO	1	0~65535	--		
206E	Hardware version	RO	1	0~65535	--		
206F	Software version	RO	1	0~65535	--		
207E	Actual location	RO	1	0~65535	--		
20C8	Current loop Kp	RW	1	50~30000	800		
20C9	Running direction	RW	1	0~3	0		Select motor running direction and set encoder direction: Bit1 =0: do not change the direction of encoder; Bit1 =1: Change the direction of encoder; Bit0 =0: do not change the running direction, bit0=1: Change the running direction.
20CE	Control command	RW	1	0~5	0		
20D5	Idle current	RW	1	10~120	50		Stop current is the percentage of running current.
20D7	Current loop Ki	RW	1	50~30000	800		
20DE	Kp max. value of current ring	RW	1	50~30000	800		
20E0	Filter coefficients	RW	1	0~500	50		The smaller the value, the smoother the motor operation, but the higher the delay.
20E1	Max. current ratio	RW	1	1000~2000	1000		

20E4	Max. value of current loop Ki	RW	1	50~30000	800		
20F1	Current Settings	RW	1	0~6500	1000	0.1%A	
20F2	Resolution setting	RW	2	0~4294967296	10000	PPR	
20F5	Idle current time	RW	1	0~65535	200	ms	The delay time (ms) after the motor stops running and enters the semi-current state.
2127	Automatic detection parameter	RW	1	0~1	1000		In open loop mode Whether the motor parameters are automatically detected and updated 0: Manual setting 1: Automatic detection
2190+1	IN1 function selection	RW	1	0~23	0		
2190+2	IN2 function selection	RW	1	0~23	0		
2190+3	IN3 function selection	RW	1	0~23	0		
2190+4	IN4 function selection	RW	1	0~23	0		
2190+5	IN5 function selection	RW	1	0~23	0		
2190+6	IN6 function selection	RW	1	0~23	0		
2190+7	IN7 function selection	RW	1	0~23	0		
2190+8	IN8 function selection	RW	1	0~23	0		
21A4+1	OUT1 function selection	RW	1	100~109	101		
21A4+2	OUT2 function selection	RW	1	100~109	100		
21A4+3	OUT3 function selection	RW	1	100~109	100		
21A4+4	OUT4 function selection	RW	1	100~109	100		
21A4+5	OUT5 function selection	RW	1	100~109	100		
21AD	Input port logic	RW	1	0~65535	RW		
21AE	Output port logic	RW	1	0~256	RW		

5.1.2 Motion Parameters

Object dictionary	Name	Property	Word	Range	Default	Unit	Remarks
603F	Error register	R	1	0~65535	0	--	
6040	Control word	R/W	1	0~65535	0	--	
6041	Status word	R	1	0~65535	0	--	
605A	Quick stop	R/W	1	0~65535	0	--	
6060	Operating mode	R/W	1	0-255	1	--	1-pp,3-pv,6-Home,8-CSP
6061	Operation mode display	R	1	0-255	0	--	
6064	Actual position	R	2	-2147483647~ 2147483647	0	pulse	
606C	Actual speed	R	2	-2147483647~ 2147483647	0	0.01 rps	
607A	Target location	R/W	2	-2147483647~ 2147483647	0	pulse	pp mode 1 target location instruction
607D+1	Negative soft limit	R/W	2	-2000000000 ~2000000000	-2000000000	pulse	
607D+2	Forward soft limit	R/W	2	-2000000000 ~2000000000	2000000000	pulse	
6080	Max. speed limit	R/W	2	-2147483647~ 2147483647	3000	0.01 rps	
6081	Trapezoidal velocity	R/W	2	-2147483647~ 2147483647	50000	0.01 rps	pp mode 1 maximum speed
6083	Acceleration	R/W	2	-2147483647~ 2147483647	4000	rps^2	pp, pv, mode 1,3 acceleration
6084	Deceleration	R/W	2	-2147483647~ 2147483647	4000	rps^2	pp, pv mode 1,3 deceleration
6085	Emergency stop deceleration	R/W	2	-2147483647~ 2147483647	40000000	rps^2	Emergency stop deceleration (PP, PV, Home)
6098	Origin method	R/W	1	0~ 100	21	--	
6099	Origin velocity	R/W	2	-2147483647~ 2147483647	50000	rps	
609A	Zero acceleration and deceleration	R/W	2	-2147483647~ 2147483647	25000	rps^2	
607C	Origin offset	R/W	2	-2147483647~ 2147483647	0	pulse	
60FD	Input IO status	R	2	0~ 4294967296	0	--	Enter the IO function logic state

6. Common Function

6.1 Control Word and Operation Mode

The closed-loop stepper driver of this product will conduct trajectory planning according to the motion parameters sent by the master station after receiving the motion start command of the master station. In asynchronous motion mode, the motion between each motor shaft is asynchronous. The asynchronous motion mode of this product includes protocol position mode (PP), protocol velocity mode (PV) and origin mode (HM).

Regardless of the control mode, the data interaction between EtherCAT bus master and slave station is implemented by object dictionary. There are two data transmission modes, PDO and SDO. According to the control needs, data transmission is divided into three levels according to the real-time requirements and importance of data transmission: > is required and > is recommended. "Must" means that in this mode, the corresponding object dictionary must be configured for PDO transport. "Suggestion" means that in this mode, the corresponding object dictionary is suggested to be configured as PDO transmission mode to ensure real-time data, so as to obtain better control requirements. If control requirements are not high, data transmission can also be done through SDO communication. "Yes" means that in this mode, the corresponding object dictionary is generally transmitted through SDO communication, and does not have to be configured as PDO. The object dictionaries associated with each control schema are shown in the table below.

Dictionary of objects associated with each control mode

Control mode	Index + Subindex	Name	Data Type	Access Type	Unit	PDO Configuration	SDO Communications
PP mode (1)	607A-00h	Target location	I32	RW	P	advice	can
	6081-00h	Max. speed	U32	RW	P	can	can
PV mode (3) PP mode (1) share	60FF-00h	Target speed	I32	RW	P	advice	can
	6040-00h	Control word	U16	RW	—	advice	can
	6083-00h	Acceleration	I32	RW	P/S^2	can	can
	6084-00h	Deceleration	U32	RW	P/S^2	can	can
HOME Mode (6)	6040-00h	Control word	U16	RW	—	advice	can
	6098-00h	Back to zero method	I8	RW	—	can	can
	6099-01h	Origin fast	U32	RW	P/S	can	can
	6099-02h	Origin slow	U32	RW	P/S	can	can
	609A-00h	Origin acceleration	U32	RW	P/S^2	can	can
	607C-00h	Origin offset	U32	RW	P	can	can

PP, PV and HOME mode shared	6041-00h	Status word	U16	RO	—	advice	can
	6064-00h	Actual location	I32	RO	P	advice	can
	606C-00h	Actual speed	I32	RO	P/S	can	can
All modes share	60FD-00h	Digital input	U32	RO	—	advice	can
	603F-00h	Latest error code	U16	RO	P	advice	can
Other correlation parameters	6060-00h	Operation mode	I8	RW	—	can	can
	60B0-00h	Position offset	I32	RW	—	can	can
	6082-00h	Takeoff speed	U32	RW	P/S	can	can
	6085-00h	Emergency stop deceleration	U32	RW	P/S^2	can	can
	6061-00h	Operation mode display	I8	RO	—	can	can

No matter which control mode is adopted to realize the drive control of the actuator, it is inseparable from the reading and writing of two object dictionaries, control word 6040h, state word and 6041h. The master and slave stations use these two object dictionaries as the media to realize the instruction issuing and state monitoring. The following highlights the definitions of the individual bits of the two object dictionaries.

The control word (6040h) is defined in the following table. In the left half of the table, bit4~6 and Bit8 are described. Their meanings depend on the operation mode, and they mainly control the operation, execution or stop of each mode.

The right half of the table describes bit0~3 and Bit7, which manage the state transitions of the 402 state machine to meet complex and diverse control requirements. The definition of the status word (6041h) is shown in the bit definition table of the status word (6041h).

Bit0 ~ Bit7 mainly shows the 402 state machine transition state, while Bit8 ~ Bit15 mainly shows the motion execution or stop state under each control mode.

The typical transition of the enabling state is as follows:

Initial (00 h) – Power on (06 h) – Start (07h) -- enabled (0 fh) -- execution runs or suspend (depending on the operating mode, combining bit4 ~ 6 and bit8 Issue relevant control instructions).

The state transition that triggers the operation control under each control mode is shown in the state transition table of each control mode.

Control word (6040h) bit definition

Mode/ bit	15~9	8	6	5	4	7	3	2	1	0	Typical value	Action result
A total of	-	suspend	Depending on mode of operation			Error reset	Allow operation	Quick stop	Voltage Output	Start		
PP mode 1	-	Deceleration stop	Absolute/ Relative	Immediate trigger	New location points	0	0	1	1	1	07h	Start
PV mode 3	-	Deceleration stop	Invalid	Invalid	Invalid	0	0(x)	0	1	0(x)	02h	Quick stop
HM mode 6	-	Deceleration stop	Invalid	Invalid	Start movement	0	1	1	1	1	0fh	Enable
Nothing						1	0(x)	0(x)	0(x)	0(x)	80h	Correct mistake
Nothing						0	0	0	0	0	0	Initial

Additional notes for other bits:

Bit 2 quick stop trigger logic is valid for 0, note that it is distinguished from other triggered logic.

Bit 7 error reset trigger logic is valid along the rising edge.

Bit 5 immediately triggers the trigger logic that is valid along the rising edge

Status word (6041 h) bit definition

Mode / Low 8	7	6	5	4	3	2	1	0
Shared	Reserved	Not started	Quick stop	Power on	Error	Allow operation	Start	Ready to start
Mode / high 8	**15**	**14**	**13**	**12**	**10**	**8**	**11**	**9**
Shared	Depending on mode of operation						Limit effective	Remote
PP mode 1	Trigger response	Parameter 0	Invalid	New location point response	Location arrival	Abnormal stop	Hardware limits Bit valid Position	Below PreOP 0
PV mode 3	Invalid	Parameter 0	Invalid	Speed 0	Speed arrival	Quick stop		
HM mode 6	Trigger response	Parameter 0	Origin error	Origin completed	Location arrival	Abnormal stop		

Additional notes for other bits:

When the drive is powered on, bit 4 will be set.

Bit 5 quickly stops activation and is only valid under logic 0, contrary to the logic of the other bits.

Bit 9 remote, display the state of communication state machine, 0 when ProOP is below, then the command of control word (6040h) cannot be executed.

Bit 11 Limit, set only when the hardware limit is valid.

Bit 8 abnormal stop, generally effective in the hardware limit, deceleration stop and fast stop trigger state.

Bit 12 follows the master station. Under CSP, if the driver does not enable or no longer follows the command of the master station, the position is 0.

State transition for each mode control operation

	Steps	0	1	2	3	4	5	6	7	8
Mode	Action	Preparatory work	Initial	Power on	Start	Enable	Start Running	Variance	Stop	Fault
PP mode 1	6040	Establish communication OP state and set motion parameters	00h	06h	07h	0fh	-	2fh→3fh	10fh	-
	6041		250h	231h	233h	8237h	1237h	1637h→ 1237h	1737h	1238h
PV mode 3	6040	Establish the all-OP state and set the motion parameters	00h	06h	07h	0fh	Enabled Running	Change speed Degree	10fh	-
	6041		250h	231h	233h	1637h	1637h	1637h	1737h	1638h
HM mode 6	6040	Establish the all-OP state and set the motion parameters	00h	06h	07h	0fh	1fh	Invalid	10fh	-
	6041		250h	231h	233h	8337h	237h	237h	737h	238h

Additional notes for other bits:

When PP mode changes position, the rise edge of BIT5 of control word needs to be given to start the new position movement.

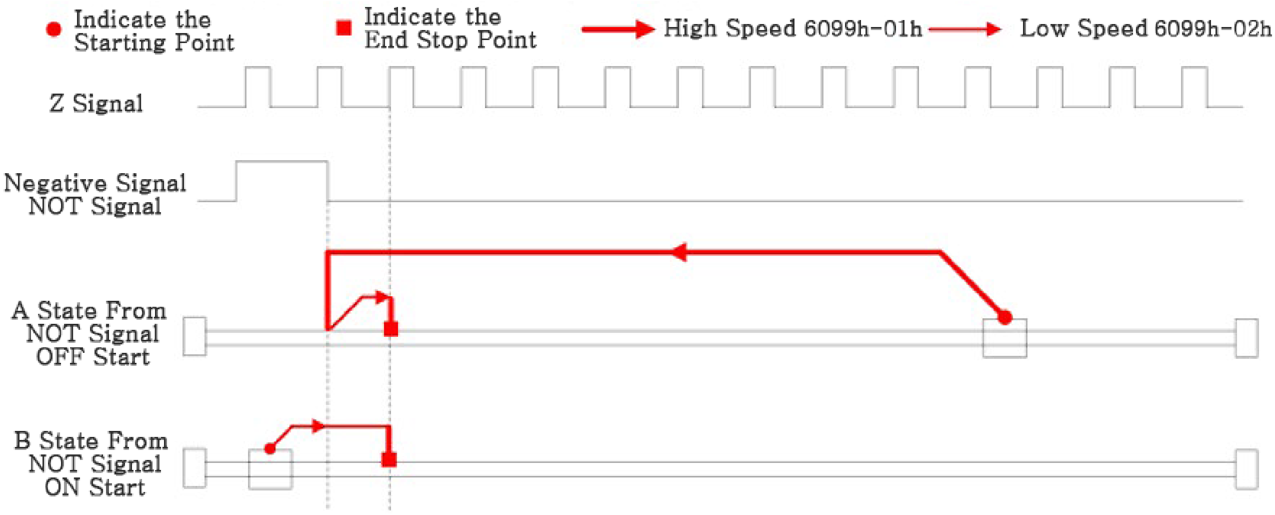
7. Appendix : Return to origin method

This drive product supports the return to the origin mode of Z signal from 1 to 14 and 17 to 34,35. The specific definition and return to the origin process are described below.

Method 1:

If the negative limit is invalid, the motor will move in the negative direction at high speed at the origin until the negative limit switch signal is effective. The motor will stop abruptly and start moving forward at low speed at the origin. The first one after leaving the negative limit switch will stop moving when the encoder Z signal is effective, as shown in Figure A below.
If the motor stops at the negative limit position when it starts moving at the origin, the motor will move forward at the low speed of the origin and stop the first time after leaving the negative limit switch when the encoder Z signal is in effect.

If the positive limit signal is effective during the movement, the status word (6041h) bit 13 will be effective, indicating that the origin motion is wrong, and the motor will stop immediately.


● Indicate the Starting Point
■ Indicate the End Stop Point
High Speed 6099h-01h
Low Speed 6099h-02h
Z Signal
Negative Signal NOT Signal
A State From NOT Signal OFF Start
B State From NOT Signal ON Start

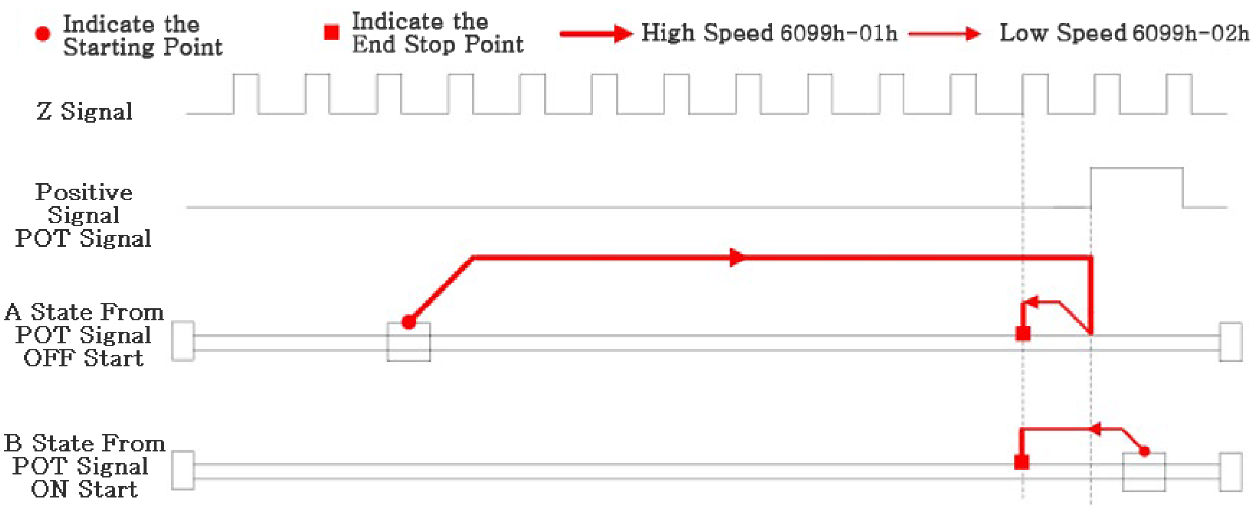
Method 1 Diagram

Method 2:

If the positive limit is invalid, the motor will move in the positive direction at high speed at the origin until the positive limit switch signal is effective. The motor will stop and move at low speed at the origin in the negative direction. When the first encoder Z signal after leaving the negative limit switch is effective, the motor will stop moving, as shown in Figure A below.

If the motor stops at the positive-limit position when it starts moving at the origin, it will move at the origin low speed negatively and stop when the first Z-signal after leaving the positive-limit switch is in effect.

If the negative limit signal is effective during the movement, the status word (6041h) bit 13 will be effective, indicating that the origin motion is wrong, and the motor will stop immediately.


● Indicate the Starting Point
■ Indicate the End Stop Point
High Speed 6099h-01h
Low Speed 6099h-02h
Z Signal
Positive Signal POT Signal
A State From POT Signal OFF Start
B State From POT Signal ON Start

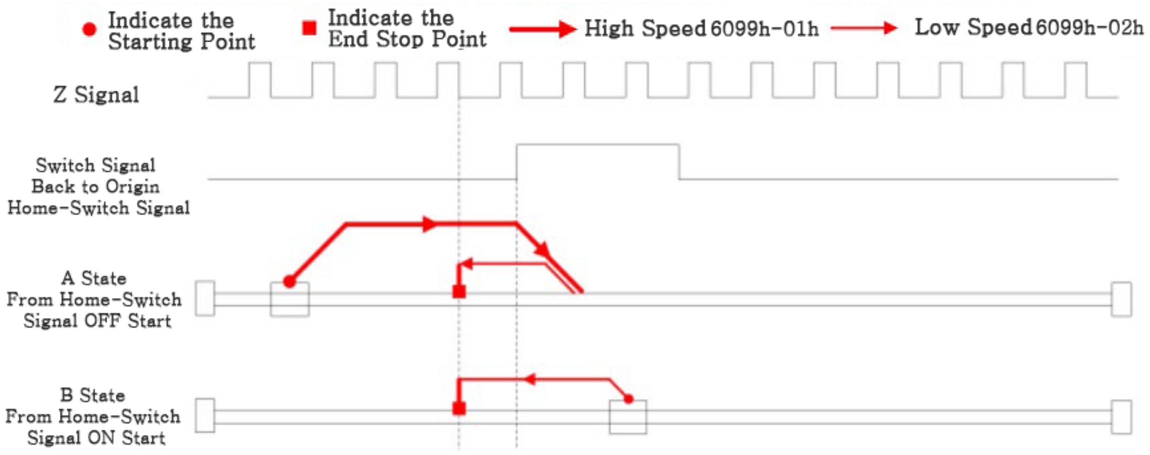
Method 2 Diagram

Method 3:

If the origin signal is invalid, the motor will move in A positive direction at A high speed at the origin until the origin signal is effective. The motor will stop and move at A low speed at the origin in A negative direction. When the first encoder Z signal after leaving the origin switch is effective, the motor will stop moving, as shown in FIG. A.

If the motor stops at the origin signal switch position when starting the origin motion, then the motor will move negatively at the origin low speed and stop when the first Z signal after leaving the origin switch is valid

If the limit signal is effective during the movement, the status word (6041h) bit 13 will be effective, indicating that the origin motion is wrong, and the motor will stop immediately.


● Indicate the Starting Point
■ Indicate the End Stop Point
High Speed 6099h-01h
Low Speed 6099h-02h
Z Signal
Switch Signal Back to Origin Home-Switch Signal
A State From Home-Switch Signal OFF Start
B State From Home-Switch Signal ON Start

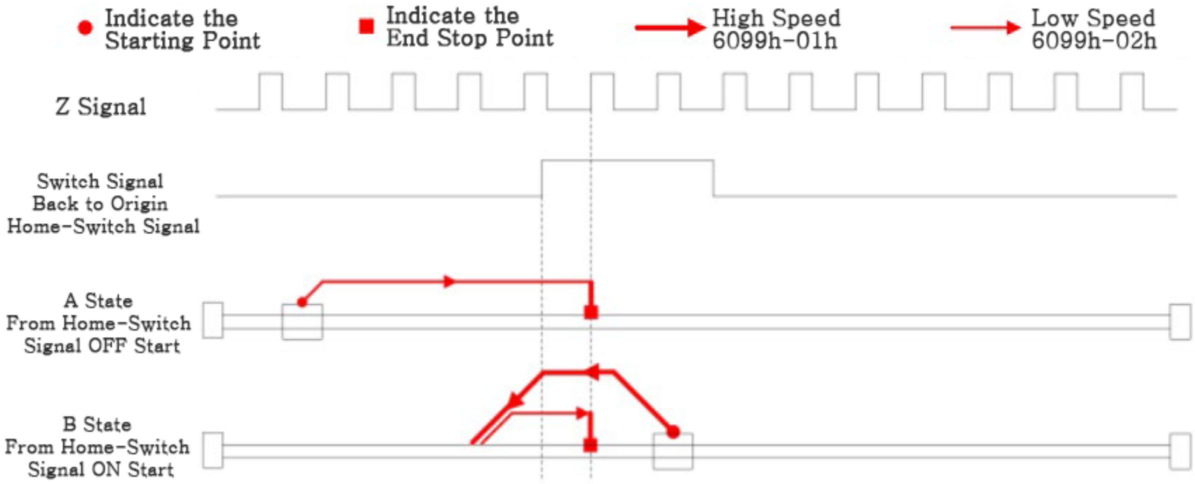
Method 3 Diagram

Method 4:

If the origin signal is invalid, the motor will move forward at low speed at the origin until the first encoder Z signal after the origin signal is valid stops, as shown in FIG. 7-4.

If the motor stops at the switch position of the origin signal when it starts to move at the origin, it will move at high speed at the origin in the negative direction until the origin signal is invalid and the motor slows down to stop and moves at low speed at the origin in the forward direction. It will stop moving when the first encoder Z signal after the origin signal is effective, as shown in Figure B.

If the limit signal is effective during the movement, the status word (6041h) bit 13 will be effective, indicating that the origin motion is wrong, and the motor will stop immediately.


● Indicate the Starting Point
■ Indicate the End Stop Point
High Speed 6099h-01h
Low Speed 6099h-02h
Z Signal
Switch Signal Back to Origin Home-Switch Signal
A State From Home-Switch Signal OFF Start
B State From Home-Switch Signal ON Start

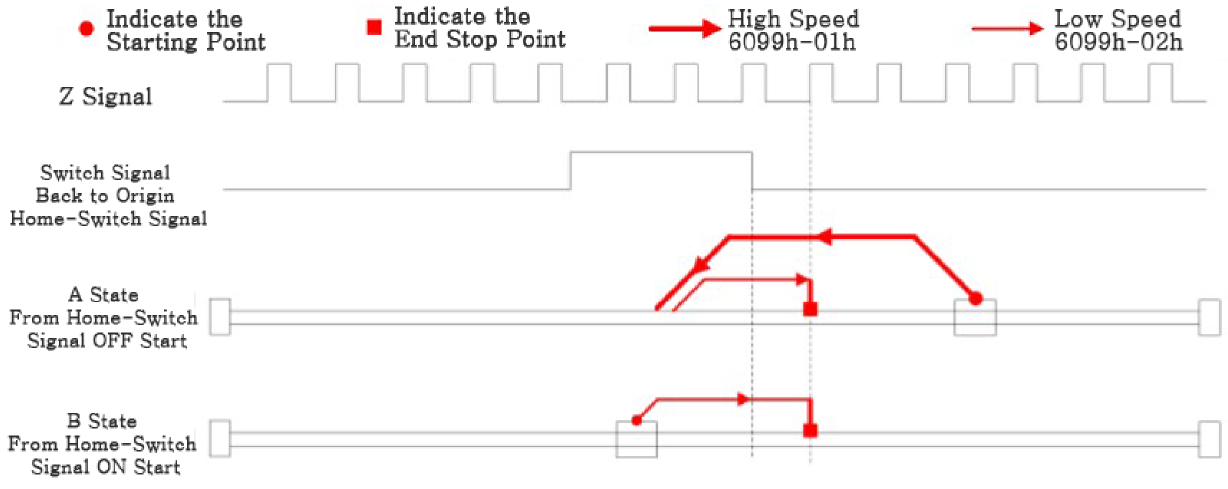
Method 4 Diagram

Method 5:

If the origin signal is invalid, the motor will move in A negative direction at A high speed at the origin until the origin signal is valid. After the motor slows down and stops, it will move at A low speed at the origin in A positive direction. When the first encoder Z signal after leaving the origin signal switch is valid, the motor will stop moving, as shown in Figure A.

If the motor stops at the origin signal switch position when it starts to move at the origin, it will move forward at the origin low speed and stop when the first Z signal after leaving the origin signal switch is effective, as shown in Figure B.

If the limit signal is effective during the movement, the status word (6041h) bit 13 will be effective, indicating that the origin motion is wrong, and the motor will stop immediately.


● Indicate the Starting Point
■ Indicate the End Stop Point
High Speed 6099h-01h
Low Speed 6099h-02h
Z Signal
Switch Signal Back to Origin Home-Switch Signal
A State From Home-Switch Signal OFF Start
B State From Home-Switch Signal ON Start

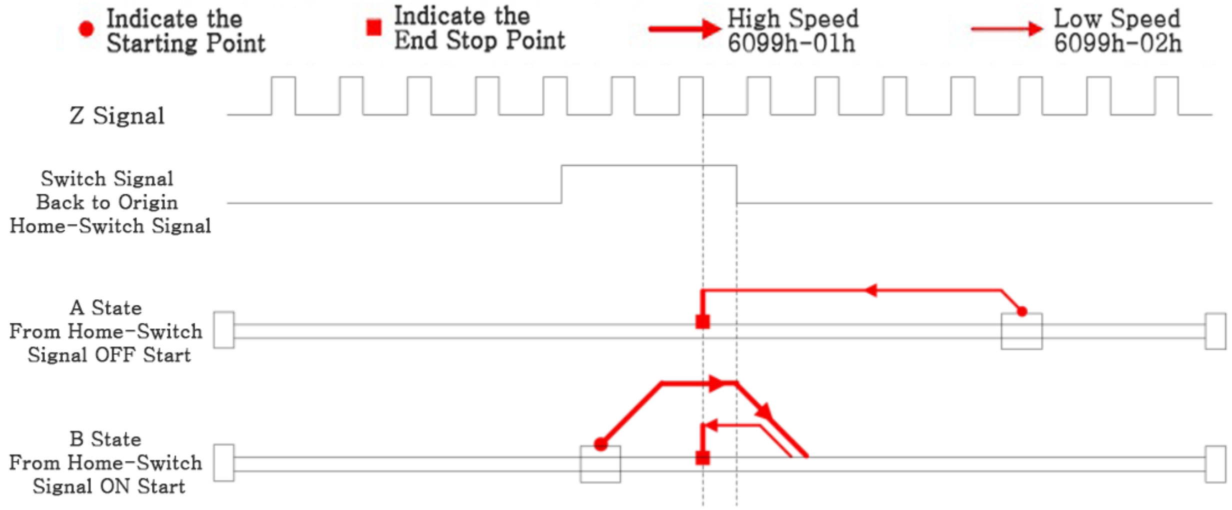
Method 5 Diagram

Methods 6:

If the origin signal is invalid, the motor will move in the negative direction at low speed at the origin until the first encoder Z signal with valid origin signal stops moving, as shown in Figure A.

If the motor stops at the origin signal switch position when it starts to move at the origin, it will move forward at a high speed at the origin, slow down and stop when it leaves the origin signal switch, and then move in the opposite direction at a low speed at the origin until it stops when the first Z signal with valid origin signal is valid, as shown in Figure B.

If the limit signal is effective during the movement, the status word (6041h) bit 13 will be effective, indicating that the origin motion is wrong, and the motor will stop immediately.


● Indicate the Starting Point
■ Indicate the End Stop Point
High Speed 6099h-01h
Low Speed 6099h-02h
Z Signal
Switch Signal Back to Origin Home-Switch Signal
A State From Home-Switch Signal OFF Start
B State From Home-Switch Signal ON Start

Method 6 Diagram

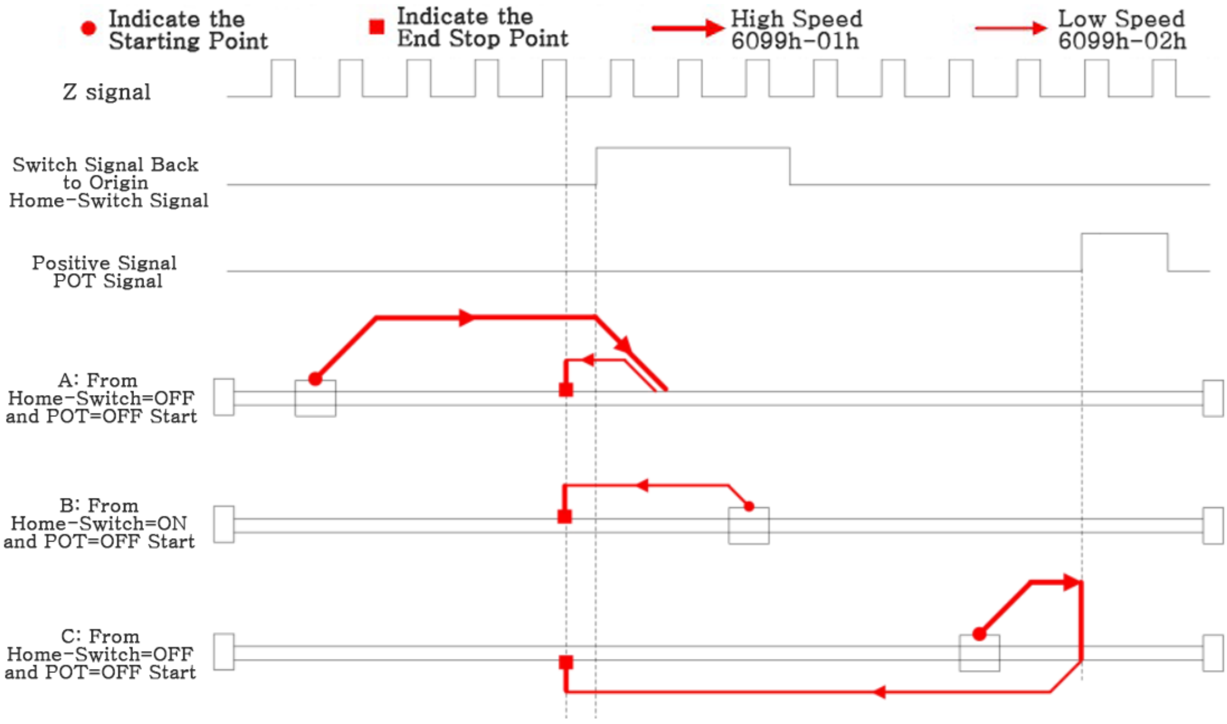
Methods 7:

If both the origin signal and the positive limit signal are invalid, the motor will move in the positive direction at high speed at the origin until the origin signal is effective, and then move in the negative direction at low speed at the origin, and stop when the first encoder Z signal leaving the origin signal switch is effective, as shown in FIG. A.

If the positive limit is invalid, the motor will stop at the origin signal switch position when it starts to move at the origin. The motor will move at the origin low speed negatively, and stop when the first Z signal leaving the origin signal switch is effective, as shown in Figure B.

If the origin signal and the signal is invalid is limit, the motor will be positive to origin of high-speed movement, until the limit is effectively stop signal, and then the negative direction to the origin low-speed movement, to continue movement in the origin signal is valid, until leave the origin signal switch Z first encoder signal effectively stop motion, as shown in figure C.

If the negative limit signal is effective during the movement, the status word (6041h) bit 13 will be effective, indicating that the origin motion is wrong, and the motor will stop immediately.


● Indicate the Starting Point
■ Indicate the End Stop Point
High Speed 6099h-01h
Low Speed 6099h-02h
Z signal
Switch Signal Back to Origin Home-Switch Signal
Positive Signal POT Signal
A: From Home-Switch=OFF and POT=OFF Start
B: From Home-Switch=ON and POT=OFF Start
C: From Home-Switch=OFF and POT=OFF Start

Method 7 Diagram

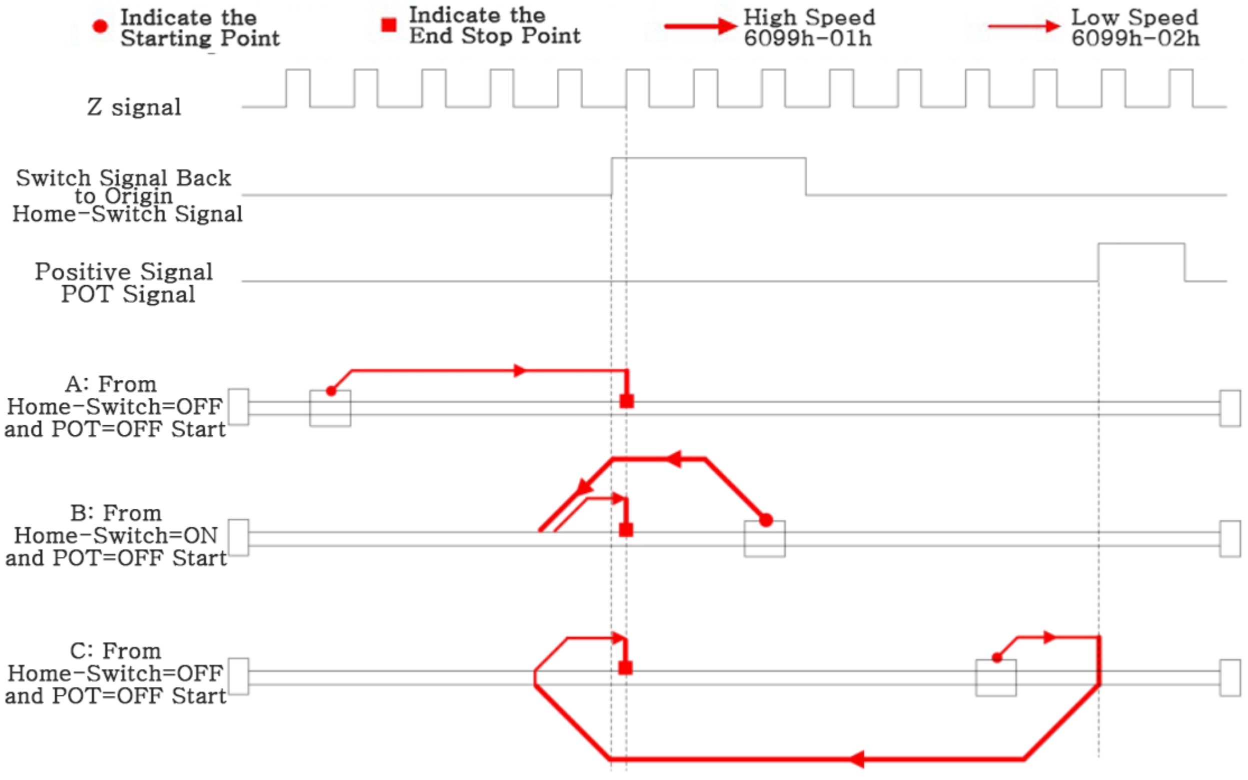
Methods 8:

If both the origin signal and the positive limit signal are invalid, the motor will move in the positive direction at low speed at the origin and stop moving when the first encoder Z signal with valid origin signal is valid, as shown in FIG. A.

If the positive limit is invalid, the motor will stop at the origin signal switch position when it starts to move at the origin, and move at a high speed at the origin in a negative direction. After leaving the origin signal switch, the motor will slow down and stop, and then move at a low speed in a positive direction, and stop when the first Z signal after the origin signal is effective, as shown in Figure B.

If the origin signal and the signal is invalid is limit, the motor will be positive in origin of low speed movement, until the limit is effectively stop signal, and then the negative direction to the origin high-speed movement, to continue movement in the origin signal is valid, until after leaving the origin signal switch to slow down to stop, and then to forward to origin of low-speed movement, and then at the origin signal Z effective after the first encoder signal effectively stop motion, as shown in figure C.

If the negative limit signal is effective during the movement, the status word (6041h) bit 13 will be effective, indicating that the origin motion is wrong, and the motor will stop immediately.


Indicate the Starting Point
Indicate the End Stop Point
High Speed 6099h-01h
Low Speed 6099h-02h
Z signal
Switch Signal Back to Origin Home-Switch Signal
Positive Signal POT Signal
A: From Home-Switch=OFF and POT=OFF Start
B: From Home-Switch=ON and POT=OFF Start
C: From Home-Switch=OFF and POT=OFF Start

Method 8 Diagram

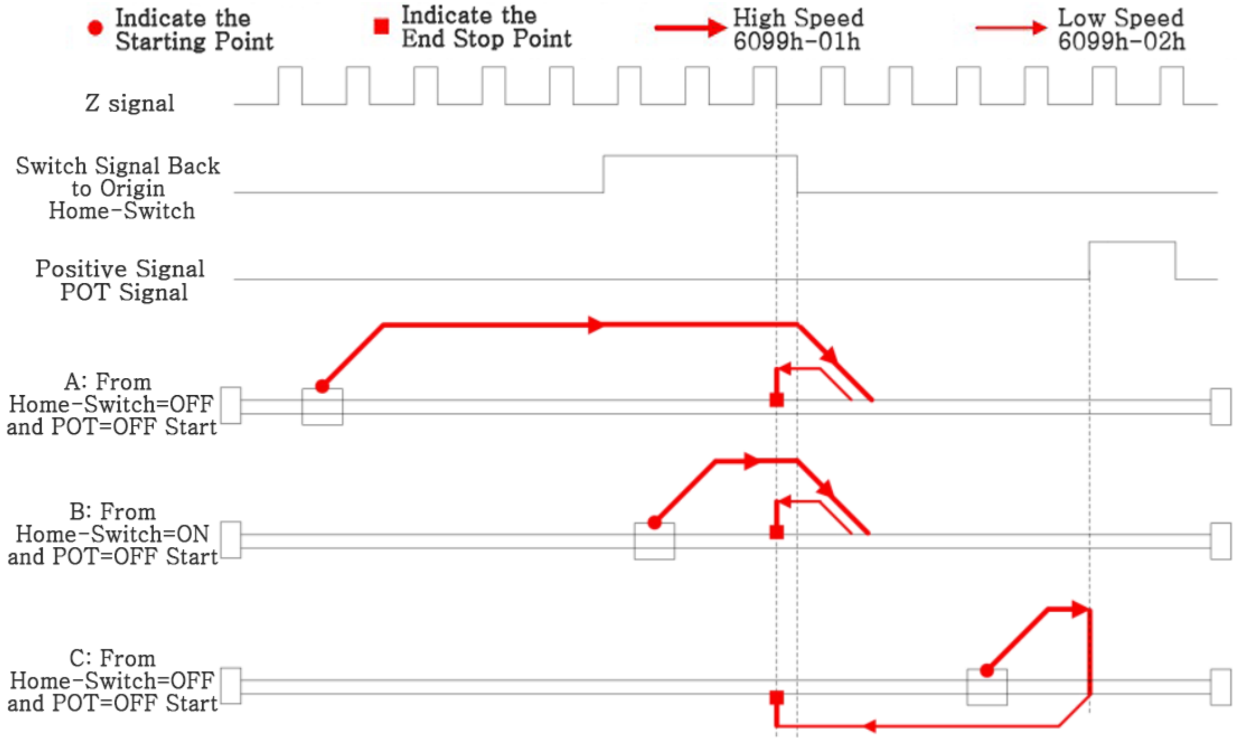
Methods 9:

If the origin signal and the signal is invalid is limit, the motor will toward the positive direction to origin of high-speed movement, the origin signal is valid to continue to exercise, slow stop when leaving the origin signal switch, then turn negative origin in slow motion, until the origin signal Z effective after the first encoder signal effectively stop motion, as shown in figure A.

If the positive limit is invalid, the motor will stop at the origin signal switch position when it starts to move at the origin. The motor will move at a high speed forward at the origin, slow down after leaving the origin signal switch, then move at a low speed at the origin in a negative direction, and stop when the first Z signal after the origin signal is valid, as shown in Figure B.

If both the origin signal and the positive limit signal are invalid, the motor will move at high speed towards the origin until the positive limit signal is effectively stopped, and then move at low speed towards the origin in the negative direction. It will stop moving when the first encoder Z signal after the origin signal is effective, as shown in FIG. C.

If the negative limit signal is effective during the movement, the status word (6041h) bit 13 will be effective, indicating that the origin motion is wrong, and the motor will stop immediately.


Indicate the Starting Point
Indicate the End Stop Point
High Speed 6099h-01h
Low Speed 6099h-02h
Z signal
Switch Signal Back to Origin Home-Switch
Positive Signal POT Signal
A: From Home-Switch=OFF and POT=OFF Start
B: From Home-Switch=ON and POT=OFF Start
C: From Home-Switch=OFF and POT=OFF Start

Method 9 Diagram

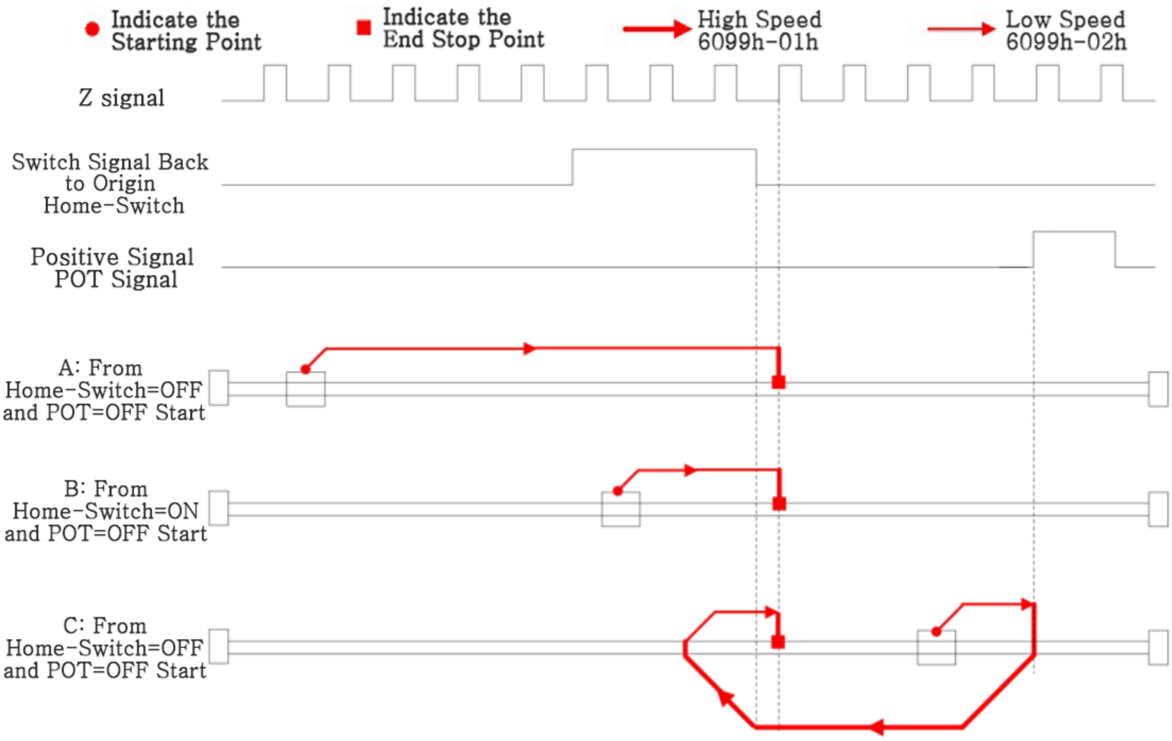
Methods 10:

If both the origin signal and the positive limit signal are invalid, the motor will move in the positive direction at the low speed of the origin. When the origin signal is valid, the motor will continue to move until the first encoder Z signal after the origin signal is invalid stops moving, as shown in Figure A.

If the positive limit is invalid, the motor will stop at the switch position of the origin signal when it starts to move at the origin. The motor will move forward at low speed at the origin and stop when the first Z signal after the origin signal is invalid, as shown in Figure B.

If the origin signal and the signal is invalid is limit, the motor will be positive in origin of low speed movement, until is limit signals effectively after abrupt stop, and then the negative direction to high speed movement, the origin at the origin signal effectively and stop slowing down, and then to forward to origin low-speed movement, until the origin signal is invalid after the first encoder signal Z effective stop motion, as shown in figure C.

If the negative limit signal is effective during the movement, the status word (6041h) bit 13 will be effective, indicating that the origin motion is wrong, and the motor will stop immediately.


● Indicate the Starting Point
■ Indicate the End Stop Point
High Speed 6099h-01h
Low Speed 6099h-02h
Z signal
Switch Signal Back to Origin Home-Switch
Positive Signal POT Signal
A: From Home-Switch=OFF and POT=OFF Start
B: From Home-Switch=ON and POT=OFF Start
C: From Home-Switch=OFF and POT=OFF Start

Method 10 Diagram

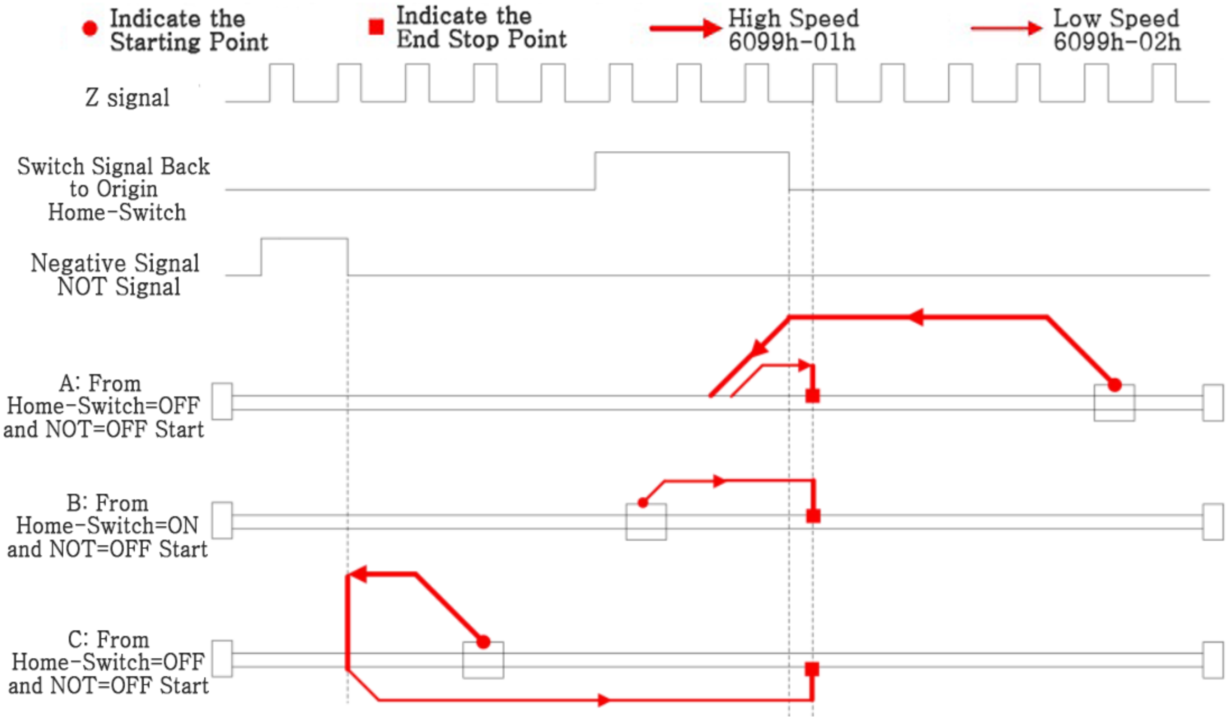
Methods 11

If both the origin signal and the negative limit signal are invalid, the motor will move at A high speed in the negative direction at the origin until the origin signal is effective, and then move at A low speed at the origin in the positive direction, and stop when the first encoder Z signal leaving the origin signal switch is effective, as shown in Figure A.

If the negative limit is invalid, the motor will stop at the origin signal switch position when it starts to move at the origin. The motor will move forward at the origin low speed and stop when the first Z signal leaving the origin signal switch is effective, as shown in Figure B.

If the origin signal and negative limit signal is invalid, the motor will toward the negative to the origin high-speed movement, until negative limit effectively stop signal, and then the positive direction to the origin, low-speed movement, to continue movement in the origin signal is valid, until leave the origin signal switch Z first encoder signal effectively stop motion, as shown in figure C.

If the positive limit signal is effective during the movement, the status word (6041h) bit 13 will be effective, indicating that the origin motion is wrong, and the motor will stop immediately.


● Indicate the Starting Point
■ Indicate the End Stop Point
High Speed 6099h-01h
Low Speed 6099h-02h
Z signal
Switch Signal Back to Origin Home-Switch
Negative Signal NOT Signal
A: From Home-Switch=OFF and NOT=OFF Start
B: From Home-Switch=ON and NOT=OFF Start
C: From Home-Switch=OFF and NOT=OFF Start

Method 11 Diagram

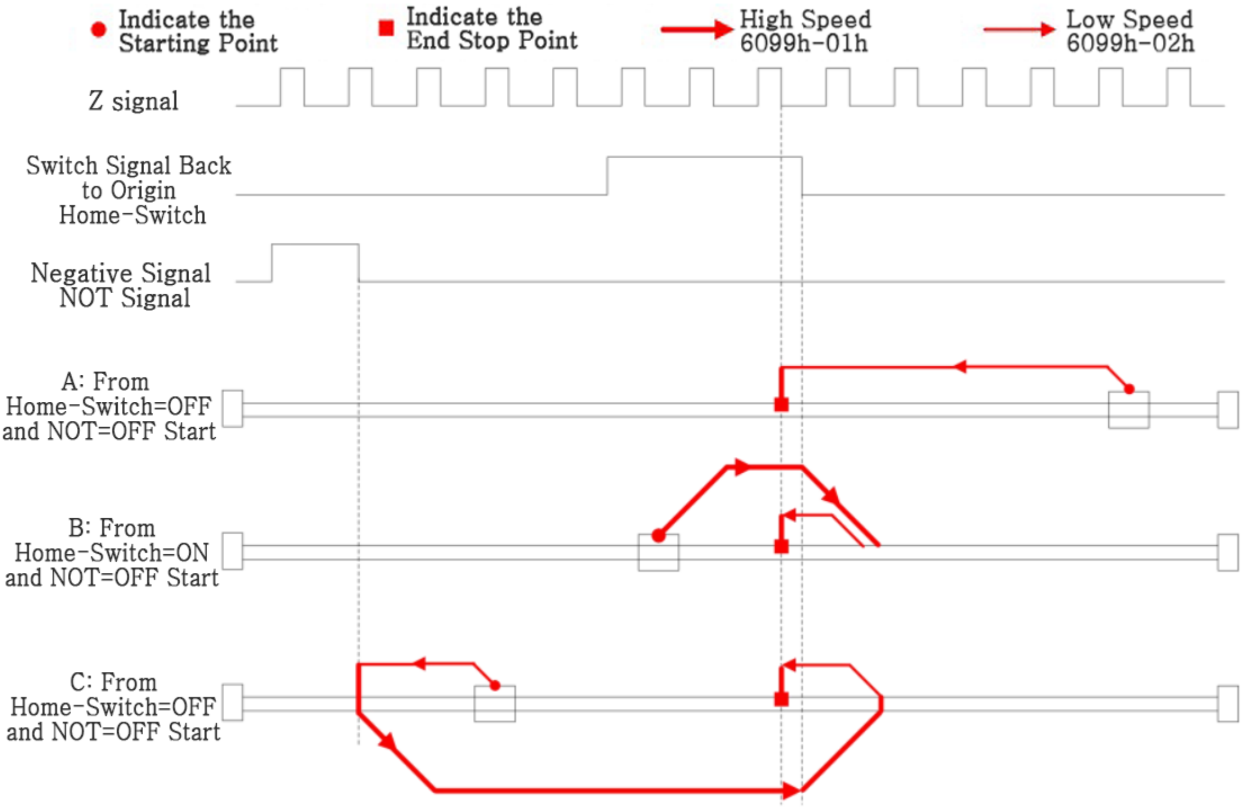
Methods 12:

If both the origin signal and the negative limit signal are invalid, the motor will move in the negative direction at low speed at the origin, and stop moving when the first encoder Z signal with valid origin signal is valid, as shown in FIG. A.

If the negative limit is invalid, the motor will stop at the origin signal switch position when it starts to move at the origin, and move at a high speed forward at the origin. After leaving the origin signal switch, the motor will slow down and stop, then move at a low speed at the origin negatively, and stop when the first Z signal after the origin signal is valid, as shown in Figure B.

If origin signals and negative limit are invalid, the motor will be toward the negative origin in slow motion, until negative limit effectively stop signal, and then the positive direction to the origin of high-speed movement, to continue movement in the origin signal is valid, until after leaving the origin signal switch to slow down to stop, then turn negative origin in slow motion, and then at the origin signal Z effective after the first encoder signal effectively stop motion, as shown in figure C.

If the positive limit signal is effective during the movement, the status word (6041h) bit 13 will be effective, indicating that the origin motion is wrong, and the motor will stop immediately.


Indicate the Starting Point
Indicate the End Stop Point
High Speed 6099h-01h
Low Speed 6099h-02h
Z signal
Switch Signal Back to Origin Home-Switch
Negative Signal NOT Signal
A: From Home-Switch=OFF and NOT=OFF Start
B: From Home-Switch=ON and NOT=OFF Start
C: From Home-Switch=OFF and NOT=OFF Start

Method 12 Diagram

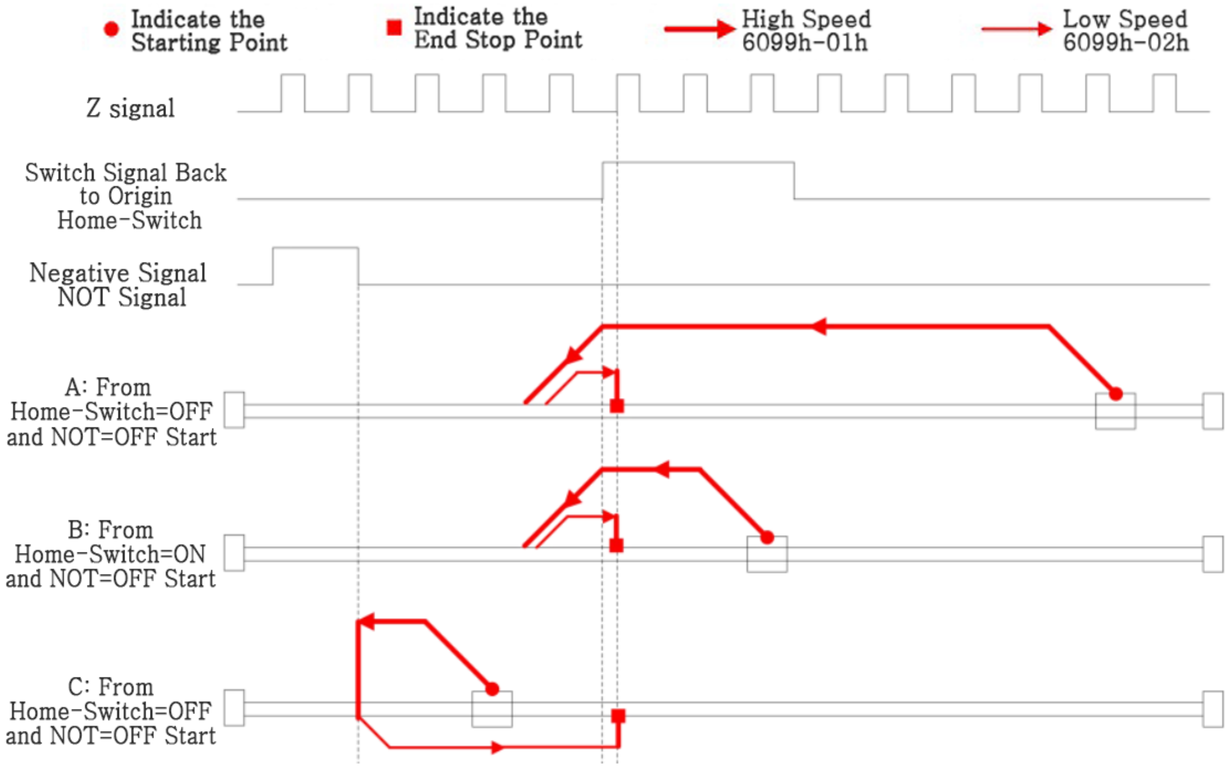
Methods 13:

If the origin signal and negative limit signal is invalid, the motor will be toward the negative direction of the origin in the high-speed movement, the origin signal is valid to continue movement, slowing down to stop when leaving the origin signal switch, and then to forward to origin low-speed movement, until the origin signal Z effective after the first encoder signal effectively stop moving, as shown in figure A.

If the negative limit is invalid, the motor will stop at the origin signal switch position when it starts to move at the origin, and will move at a high speed at the origin in a negative direction. After leaving the origin signal switch, the motor will slow down and stop, and then move at a low speed in a positive direction. It will stop when the first Z signal after the origin signal is effective, as shown in Figure B.

If both the origin signal and the negative limit signal are invalid, the motor will move at a high speed towards the negative limit signal until the negative limit signal is effectively stopped, then move at a low speed towards the positive direction, and stop when the first encoder Z signal after the origin signal is effective, as shown in FIG. C.

If the negative limit signal is effective during the movement, the status word (6041h) bit 13 will be effective, indicating that the origin motion is wrong, and the motor will stop immediately.


● Indicate the Starting Point
■ Indicate the End Stop Point
High Speed 6099h-01h
Low Speed 6099h-02h
Z signal
Switch Signal Back to Origin Home-Switch
Negative Signal NOT Signal
A: From Home-Switch=OFF and NOT=OFF Start
B: From Home-Switch=ON and NOT=OFF Start
C: From Home-Switch=OFF and NOT=OFF Start

Method 13 Diagram

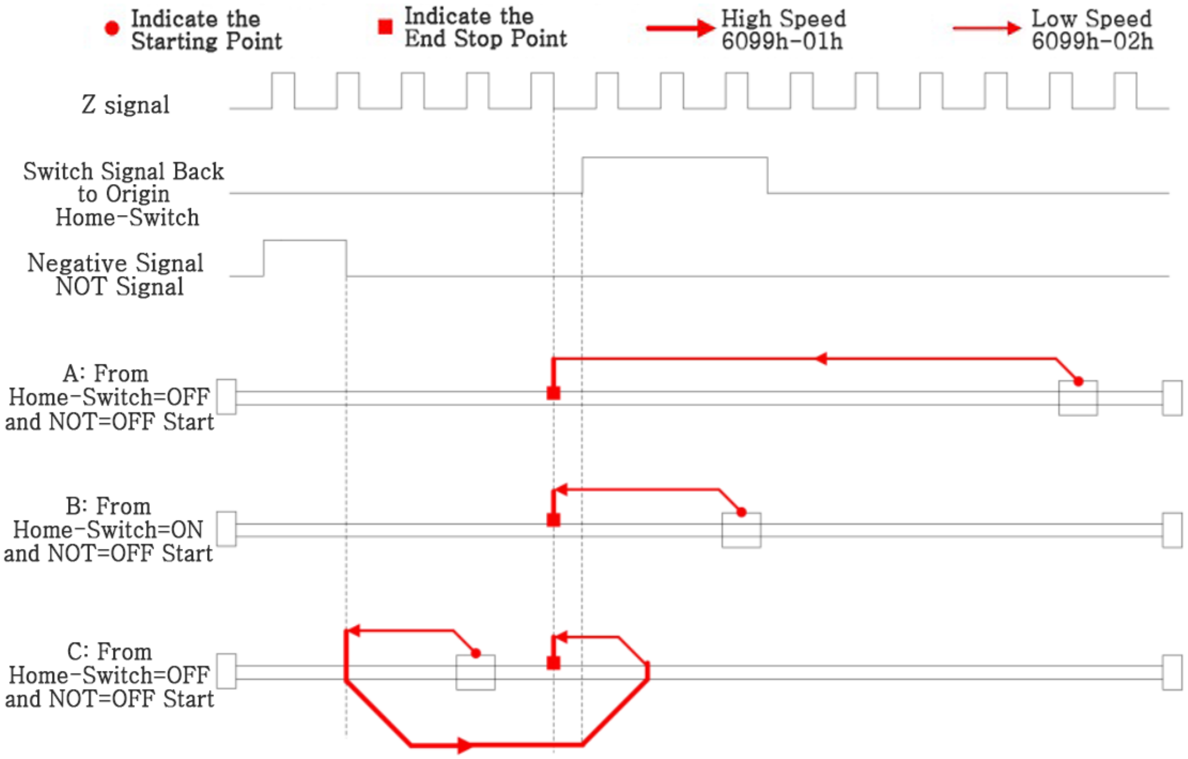
Methods 14:

If both the origin signal and the negative limit signal are invalid, the motor will move in the negative direction at the low speed of the origin. When the origin signal is valid, the motor will continue to move until the first encoder Z signal after the origin signal is invalid stops moving, as shown in Figure A.

If the negative limit is invalid, the motor will stop at the switch position of the origin signal when it starts to move at the origin. The motor will move at the low speed at the origin negatively, and stop when the first Z signal after the origin signal is invalid, as shown in Figure B.

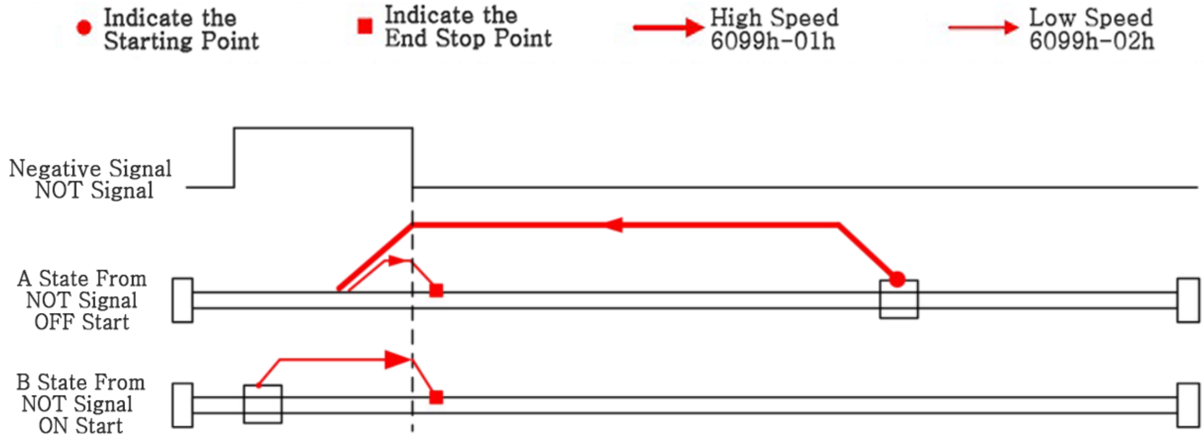
If the origin signal and negative limit signal is invalid, the motor will be toward the negative origin in slow motion, until the stop after negative limit signals effectively, high speed movement, and then the positive direction to the origin at the origin signal effectively and stop slowing down, and then to negative origin in slow motion, Z until the origin signal is invalid after the first encoder signal effectively stop motion, as shown in figure C.

If the negative limit signal is effective during the movement, the status word (6041h) bit 13 will be effective, indicating that the origin motion is wrong, and the motor will stop immediately.


● Indicate the Starting Point
■ Indicate the End Stop Point
High Speed 6099h-01h
Low Speed 6099h-02h
Z signal
Switch Signal Back to Origin Home-Switch
Negative Signal NOT Signal
A: From Home-Switch=OFF and NOT=OFF Start
B: From Home-Switch=ON and NOT=OFF Start
C: From Home-Switch=OFF and NOT=OFF Start

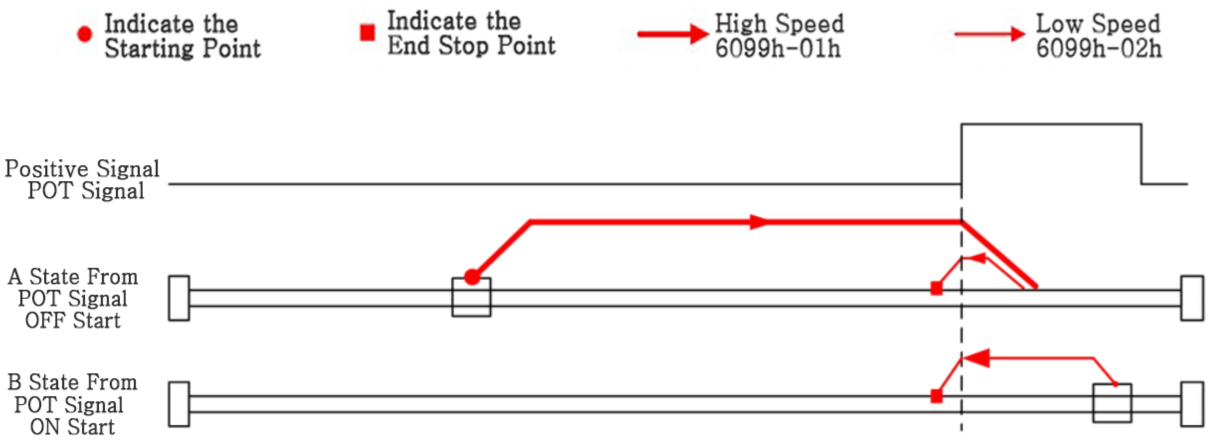
Method 14 Diagram

Methods 15:


● Indicate the Starting Point
■ Indicate the End Stop Point
High Speed 6099h-01h
Low Speed 6099h-02h
Negative Signal NOT Signal
A State From NOT Signal OFF Start
B State From NOT Signal ON Start

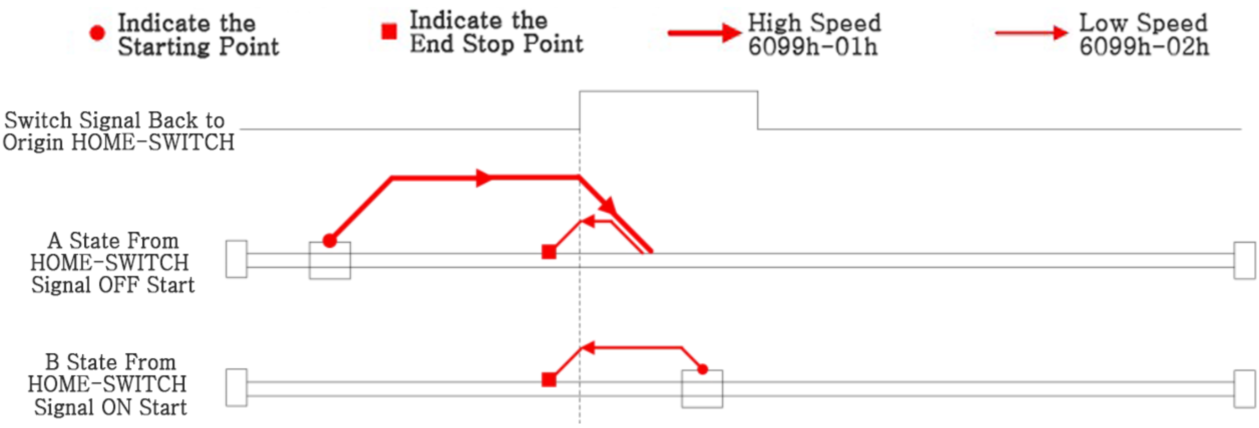
Method 15 Diagram

Method 16:


● Indicate the Starting Point
■ Indicate the End Stop Point
High Speed 6099h-01h
Low Speed 6099h-02h
Positive Signal POT Signal
A State From POT Signal OFF Start
B State From POT Signal ON Start

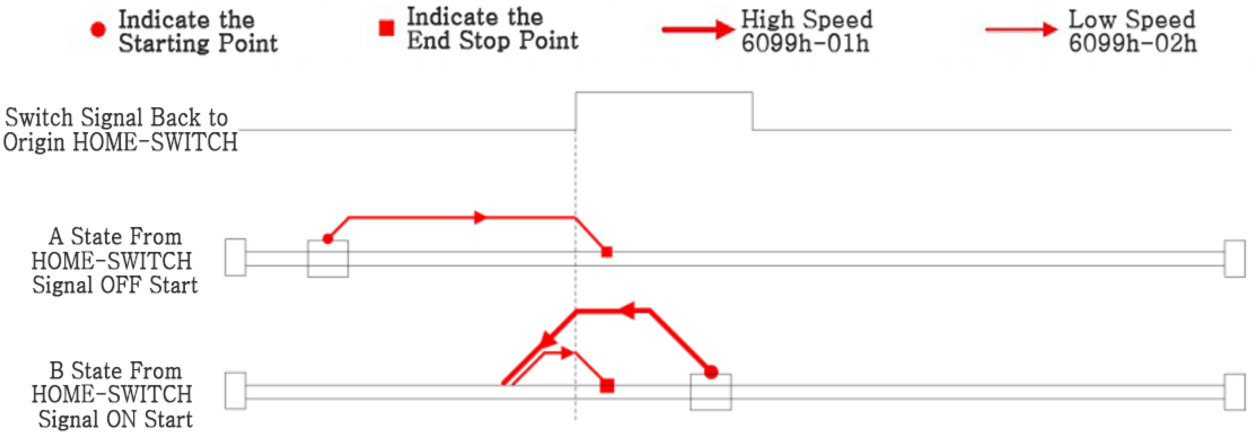
Method 16 Diagram

Method 17:


● Indicate the Starting Point
■ Indicate the End Stop Point
High Speed 6099h-01h
Low Speed 6099h-02h
Switch Signal Back to Origin HOME-SWITCH
A State From HOME-SWITCH Signal OFF Start
B State From HOME-SWITCH Signal ON Start

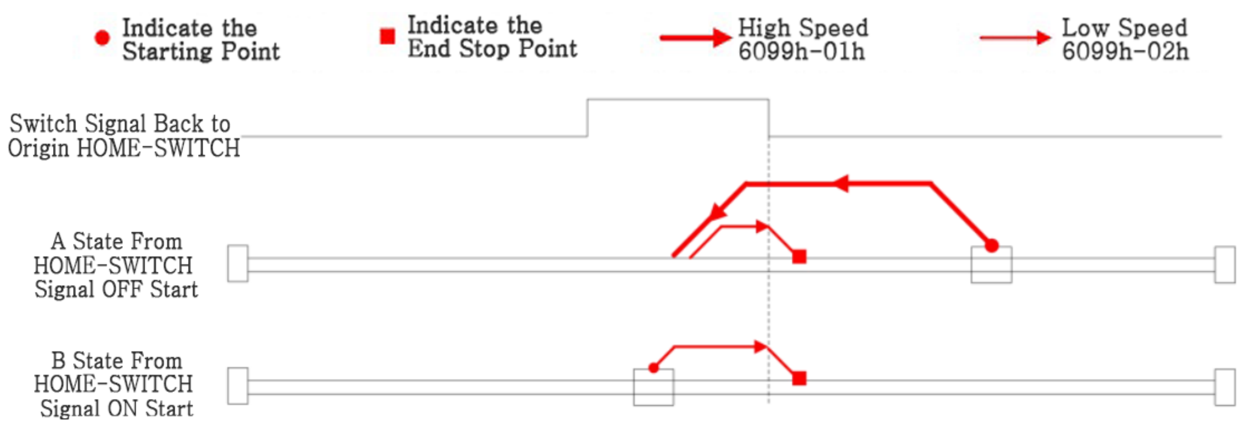
Method 17 Diagram

Method 18:


● Indicate the Starting Point
■ Indicate the End Stop Point
High Speed 6099h-01h
Low Speed 6099h-02h
Switch Signal Back to Origin HOME-SWITCH
A State From HOME-SWITCH Signal OFF Start
B State From HOME-SWITCH Signal ON Start

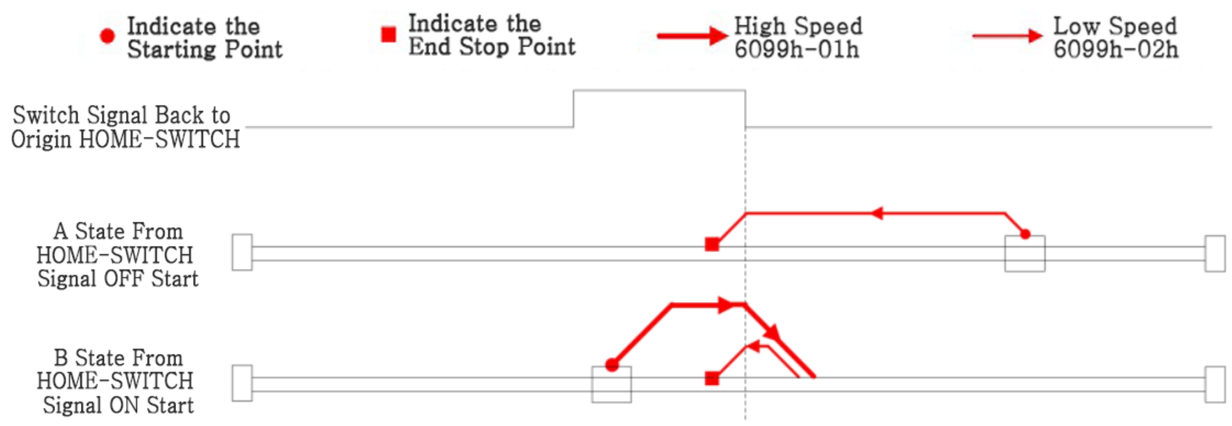
Method 18 Diagram

Method 19:


● Indicate the Starting Point
■ Indicate the End Stop Point
High Speed 6099h-01h
Low Speed 6099h-02h
Switch Signal Back to Origin HOME-SWITCH
A State From HOME-SWITCH Signal OFF Start
B State From HOME-SWITCH Signal ON Start

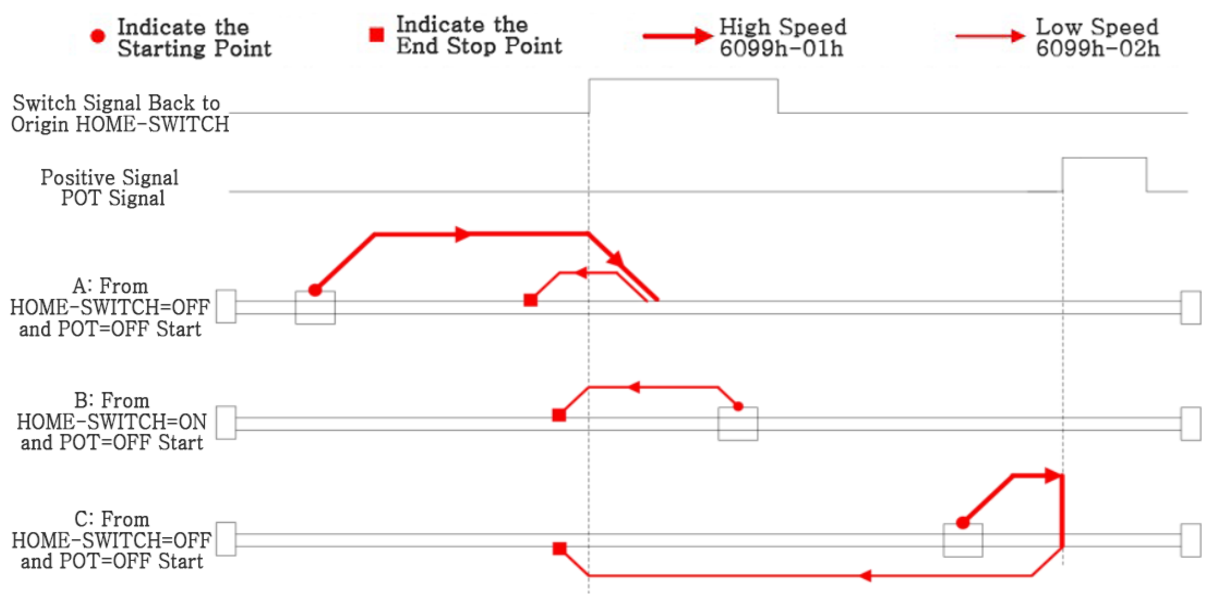
Method 19 Diagram

Method 20:


● Indicate the Starting Point
■ Indicate the End Stop Point
High Speed 6099h-01h
Low Speed 6099h-02h
Switch Signal Back to Origin HOME-SWITCH
A State From HOME-SWITCH Signal OFF Start
B State From HOME-SWITCH Signal ON Start

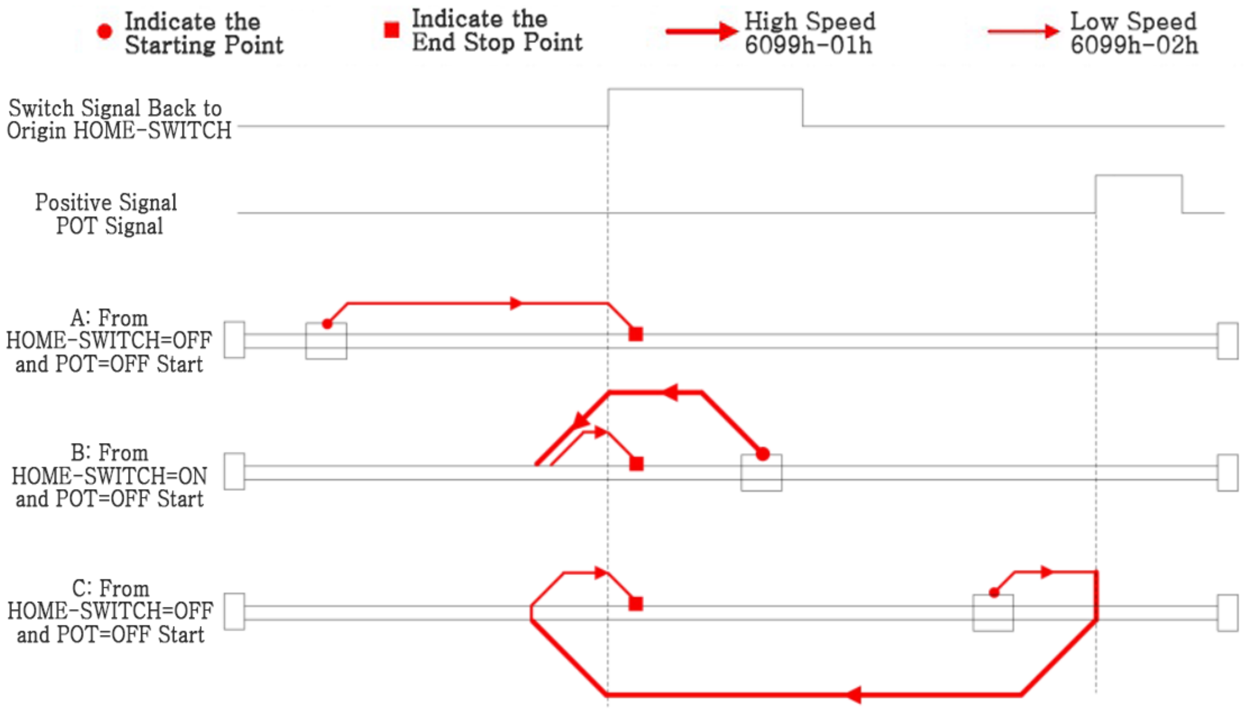
Method 20 Diagram

Method 21:


● Indicate the Starting Point
■ Indicate the End Stop Point
High Speed 6099h-01h
Low Speed 6099h-02h
Switch Signal Back to Origin HOME-SWITCH
Positive Signal POT Signal
A: From HOME-SWITCH=OFF and POT=OFF Start
B: From HOME-SWITCH=ON and POT=OFF Start
C: From HOME-SWITCH=OFF and POT=OFF Start

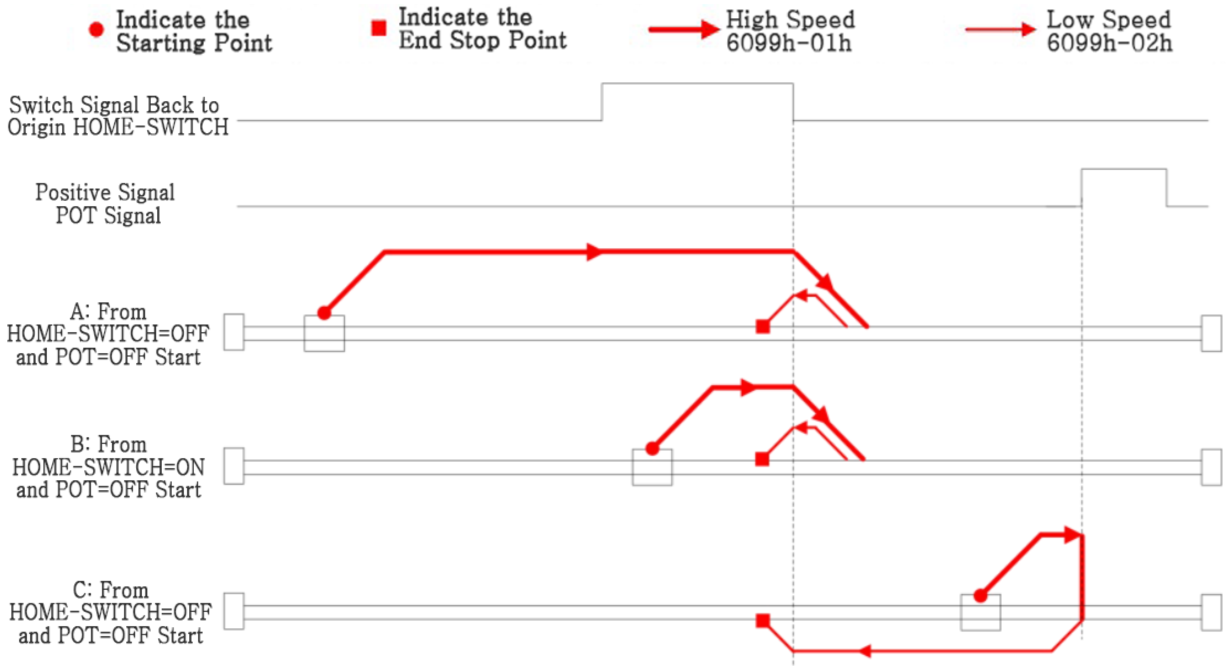
Method 21 Diagram

Method 22:


● Indicate the Starting Point
■ Indicate the End Stop Point
High Speed 6099h-01h
Low Speed 6099h-02h
Switch Signal Back to Origin HOME-SWITCH
Positive Signal POT Signal
A: From HOME-SWITCH=OFF and POT=OFF Start
B: From HOME-SWITCH=ON and POT=OFF Start
C: From HOME-SWITCH=OFF and POT=OFF Start

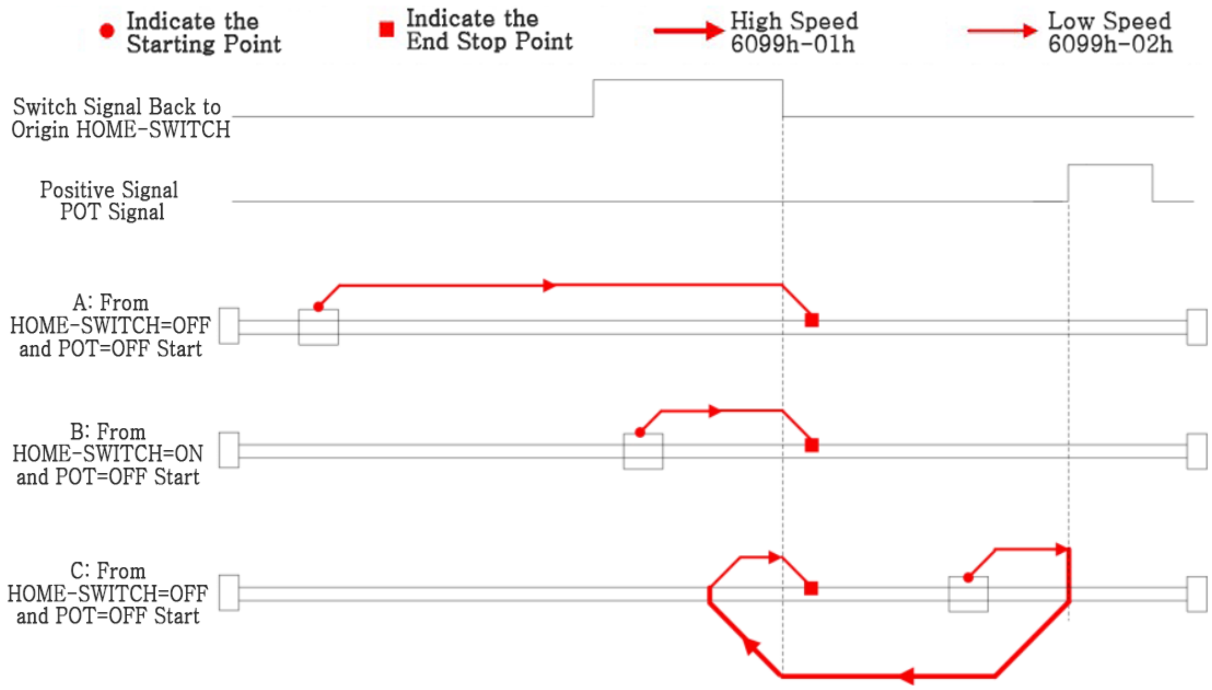
Method 22 Diagram

Method 23:


● Indicate the Starting Point
■ Indicate the End Stop Point
High Speed 6099h-01h
Low Speed 6099h-02h
Switch Signal Back to Origin HOME-SWITCH
Positive Signal POT Signal
A: From HOME-SWITCH=OFF and POT=OFF Start
B: From HOME-SWITCH=ON and POT=OFF Start
C: From HOME-SWITCH=OFF and POT=OFF Start

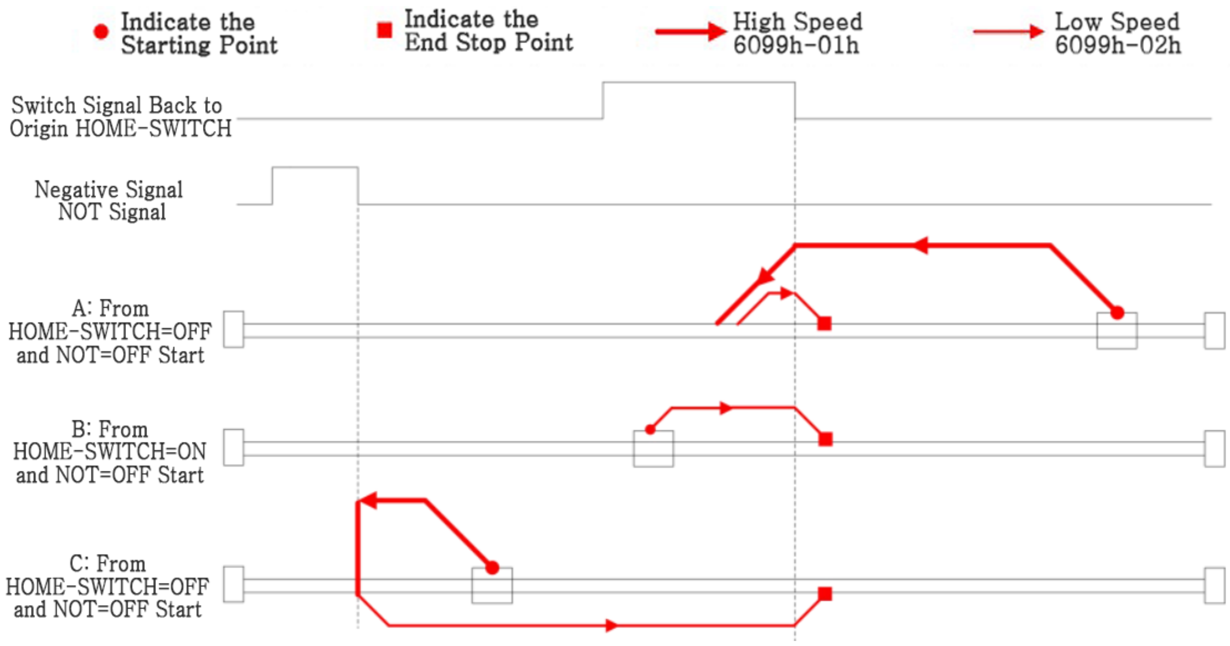
Method 23 Diagram

Method 24:


● Indicate the Starting Point
■ Indicate the End Stop Point
High Speed 6099h-01h
Low Speed 6099h-02h
Switch Signal Back to Origin HOME-SWITCH
Positive Signal POT Signal
A: From HOME-SWITCH=OFF and POT=OFF Start
B: From HOME-SWITCH=ON and POT=OFF Start
C: From HOME-SWITCH=OFF and POT=OFF Start

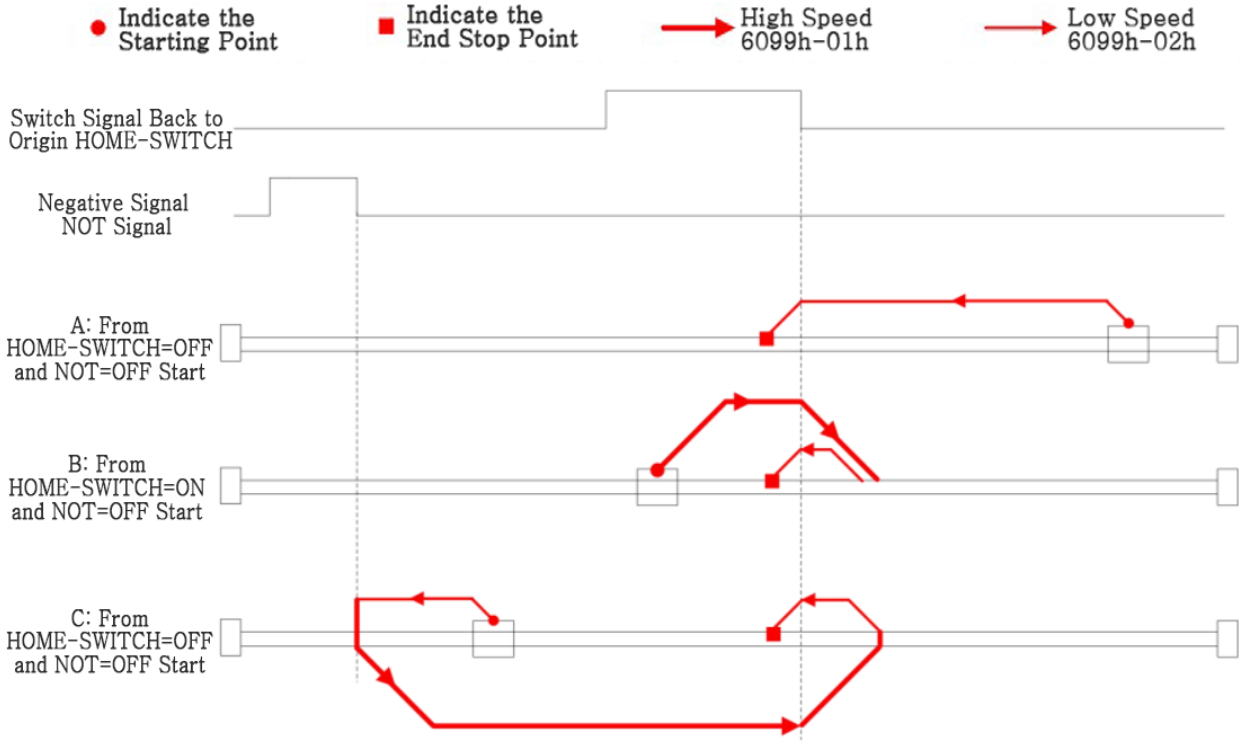
Method 24 Diagram

Method 25:


● Indicate the Starting Point
■ Indicate the End Stop Point
High Speed 6099h-01h
Low Speed 6099h-02h
Switch Signal Back to Origin HOME-SWITCH
Negative Signal NOT Signal
A: From HOME-SWITCH=OFF and NOT=OFF Start
B: From HOME-SWITCH=ON and NOT=OFF Start
C: From HOME-SWITCH=OFF and NOT=OFF Start

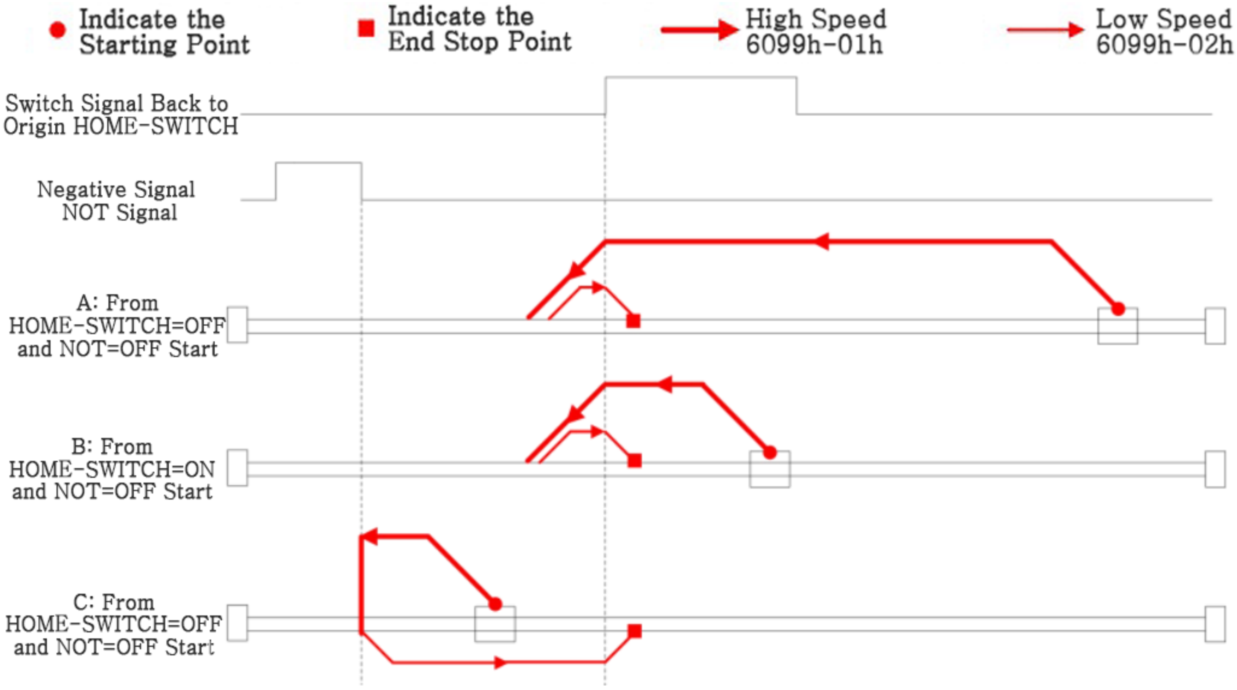
Method 25 Diagram

Method 26:


● Indicate the Starting Point
■ Indicate the End Stop Point
High Speed 6099h-01h
Low Speed 6099h-02h
Switch Signal Back to Origin HOME-SWITCH
Negative Signal NOT Signal
A: From HOME-SWITCH=OFF and NOT=OFF Start
B: From HOME-SWITCH=ON and NOT=OFF Start
C: From HOME-SWITCH=OFF and NOT=OFF Start

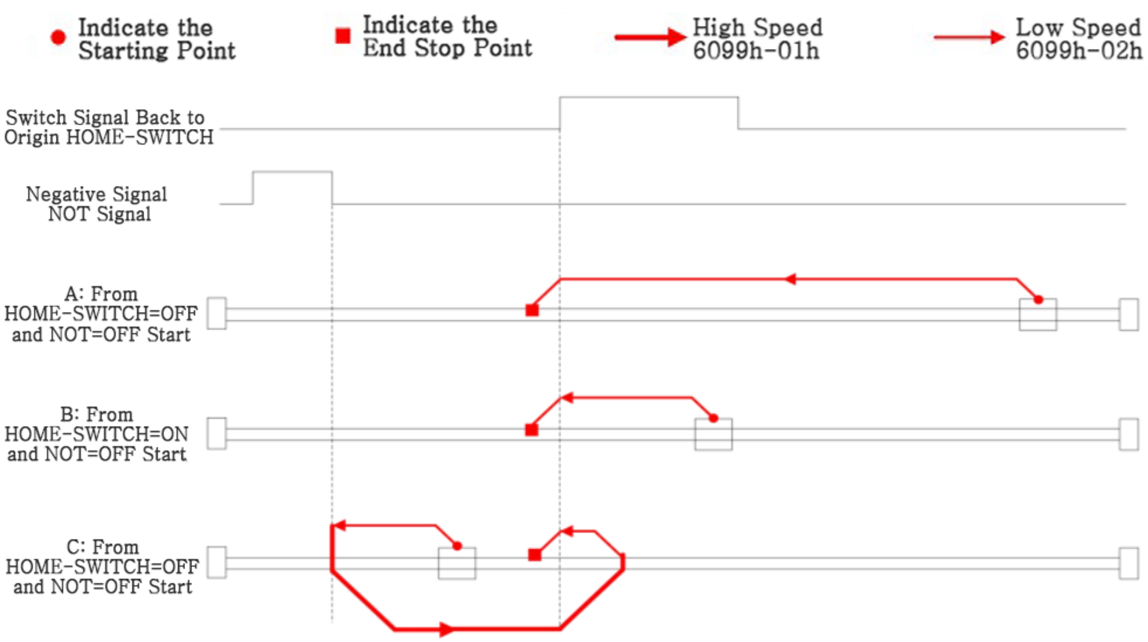
Method 26 Diagram

Method 27:


● Indicate the Starting Point
■ Indicate the End Stop Point
High Speed 6099h-01h
Low Speed 6099h-02h
Switch Signal Back to Origin HOME-SWITCH
Negative Signal NOT Signal
A: From HOME-SWITCH=OFF and NOT=OFF Start
B: From HOME-SWITCH=ON and NOT=OFF Start
C: From HOME-SWITCH=OFF and NOT=OFF Start

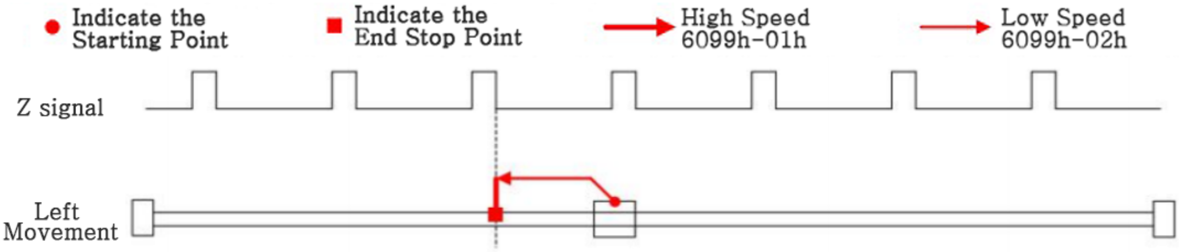
Method 27 Diagram

Method 28:


● Indicate the Starting Point
■ Indicate the End Stop Point
High Speed 6099h-01h
Low Speed 6099h-02h
Switch Signal Back to Origin HOME-SWITCH
Negative Signal NOT Signal
A: From HOME-SWITCH=OFF and NOT=OFF Start
B: From HOME-SWITCH=ON and NOT=OFF Start
C: From HOME-SWITCH=OFF and NOT=OFF Start

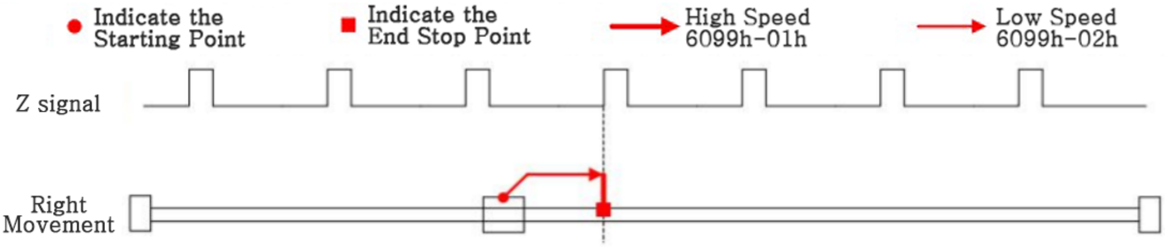
Method 28 Diagram

Method 29:



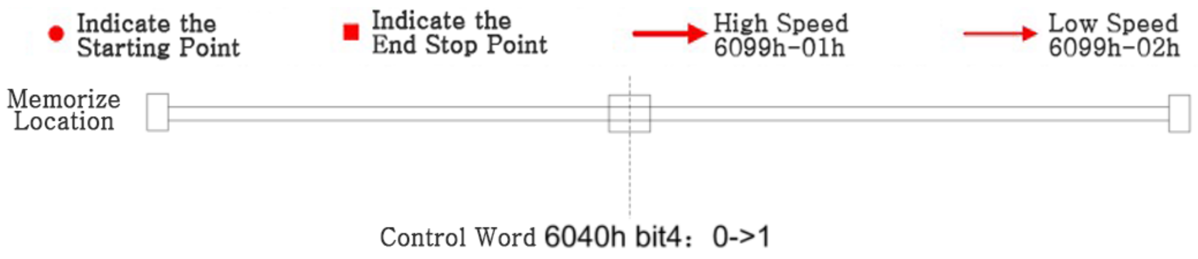
Method 29 Diagram

Method 30:



Method 30 Diagram

Method 31:


● Indicate the Starting Point
■ Indicate the End Stop Point
High Speed 6099h-01h
Low Speed 6099h-02h
Memorize Location
Control Word 6040h bit4：0->1

Method 31 Diagram

8. Appendix Ⅰ

Alarm code

Function	Alarm code	Alarm/Warning (Hexadecimal/Decimal)	Explain
Motor overcurrent	Alarm	AH (10)	Motor phase current overcurrent or driver failure
Motor phase loss	Alarm	BH (12)	The motor is not connected
Spare	Alarm	CH (13)	Reserved by the manufacturer
Undervoltage	Alarm	DH (14)	Power input less than 18V
Overvoltage	Alarm	EH (15)	Power input greater than 60V
Overheating	Alarm	FH (16)	The temperature of the driver heat sink reaches above 85 ℃
MOS transistor driver voltage fault	Alarm	10H (17)	MOS transistor driver voltage fault
Spare	Alarm	11H (18)	Reserved by the manufacturer
Spare	Alarm	12H (19)	Reserved by the manufacturer
Spare	Alarm	13H (20)	Reserved by the manufacturer
EEPROM data write exception	Alarm	14H (21)	EEPROM data write exception
EEPROM data reading error	Warning	100H (256)	EEPROM data reading error
Bus voltage instability	Warning	200H (512)	Bus voltage instability
Emergency stop	Warning	400H (1024)	Emergency stop
Positive limit	Warning	800H (2048)	On the positive limit or beyond the positive soft limit
Negative limit	Warning	1000H (4096)	On negative limit or beyond negative soft limit
Failed to return to origin	Warning	2000H (8192)	Failed to return to origin

※ Note : Multiple warnings can exist simultaneously

※ Example: Both positive and negative limits are sensed simultaneously, with alarm code 1800H (6144)

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