EtherCAT Homing Method

Application Note

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Revision History

Version	Description	Date
1.0	Initial Release	17 September 2025

Contact Information

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Warranty

This product is warranted to be free of defects in material and workmanship and conforms to the specifications listed in this manual, for a period of 12 months from the shipment date from factory.

Contents

1 Introduction

1.1 General Information

This application note describes the various homing methods whereby the driver seeks the home position (datum, reference point or zero point). Various methods of achieving datum points include limit switches and/or home switch and/or using the hardware index from the encoder. The information below is an extract from “CiA402-2, CANopen device profile for drives and motion control, Part 2: Operation Modes and Application Data, Chapter 11”.

Chapter 2 of this application note describes the CiA402 Home methods and Chapter 3 of this application describes the TouchProbe Homing Method. Both methods are able to find the datum, reference point or zero point.

The CiA402 Home Method only applies for masters which explicitly change the Mode of Operation to “Homing Mode” (Mode 6), please refer to Chapter 2 of this application note. If the master is doing the homing sequence in “Cyclic Synchronous Position Mode” (Mode 8), please refer to Chapter 3 of this application note.

1.2 Functional Description (Applicable only to CiA402 Home Method)

Figure 1 shows the defined input objects as well as the output objects. The user may specify the motion profile and the method of homing. There is an additional object for home offset, which allows the user to display zero in the user’s coordinate system from the home position. Take note that the objects “Homing Speeds, Homing Acceleration and Home Offset” is scaled to the objects written in “Position Encoder Resolution ($608F_h$), Gear Ratio (6091_h) and Feed Constant (6092_h). If the scaling factor is adjusted on the master side and the scaling ratio for these 3 object is kept at 1 : 1 , the speed, acceleration and offset will be in terms of counts instead of user units.

There is no output data except for the bits in the statusword which indicates the status of the homing process and the demand value to the driver position control loops.

There are two homing speeds; typically, the faster speed is used to find the home switch and the slower speed is used to find the hardware index pulse.

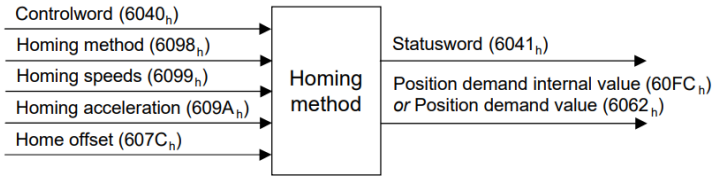


Figure 1 – Homing Mode Function

By selecting the desired homing method, the following behavior is determined: The homing signal (positive limit switch, negative limit switch, home switch), the direction of travel and the position of the index pulse.

The sections below will describe the use of controlword, statusword and also the various homing methods.

2 Use of Controlword and Statusword

2.1 Controlword

The homing mode uses some bits of the controlword for mode-specific purposes (generally transparent to the user as it is being packaged on the master upon calling the home function block).

Figure 2 shows the structure of the controlword. Table 1 defines the values for bit 4 and 8 of the controlword.

15 … 9	8	7	6	5	4	3 … 0
Refer to CiA402 documents	Halt	Refer to CiA402 documents	Reserved (0)		Homing operation start	Refer to CiA402 documents

Figure 2 – Controlword for homing mode

Table 1 – Definition of bit 4 and bit 8

Bit	Value	Definition
4	0	Do not start homing procedure
	1	Start or continue homing procedure
8	0	Enable bit 4
	1	Stop axis according to halt option code ($605D_h$)

2.2 Statusword

Figure 3 shows the structure of the status word. Table 2 defines the values for bit 10, bit 12 and bit 13. Bit 12 shall provide the actual homing status. Bit 12 may be used to observe whether homing is attained without executing the homing procedure.

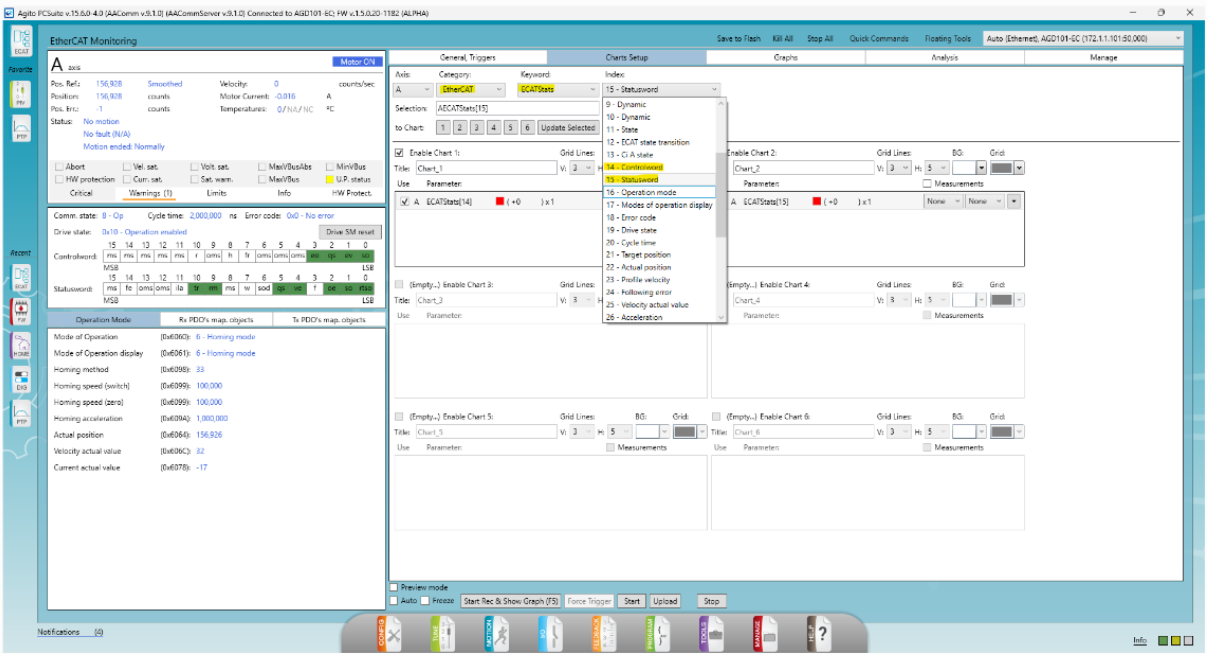
15 … 14	13	12	11	10	9 … 0
Refer to CiA402 documents	Homing error	Homing attained	Refer to CiA402 documents	Target reached	Refer to CiA402 documents

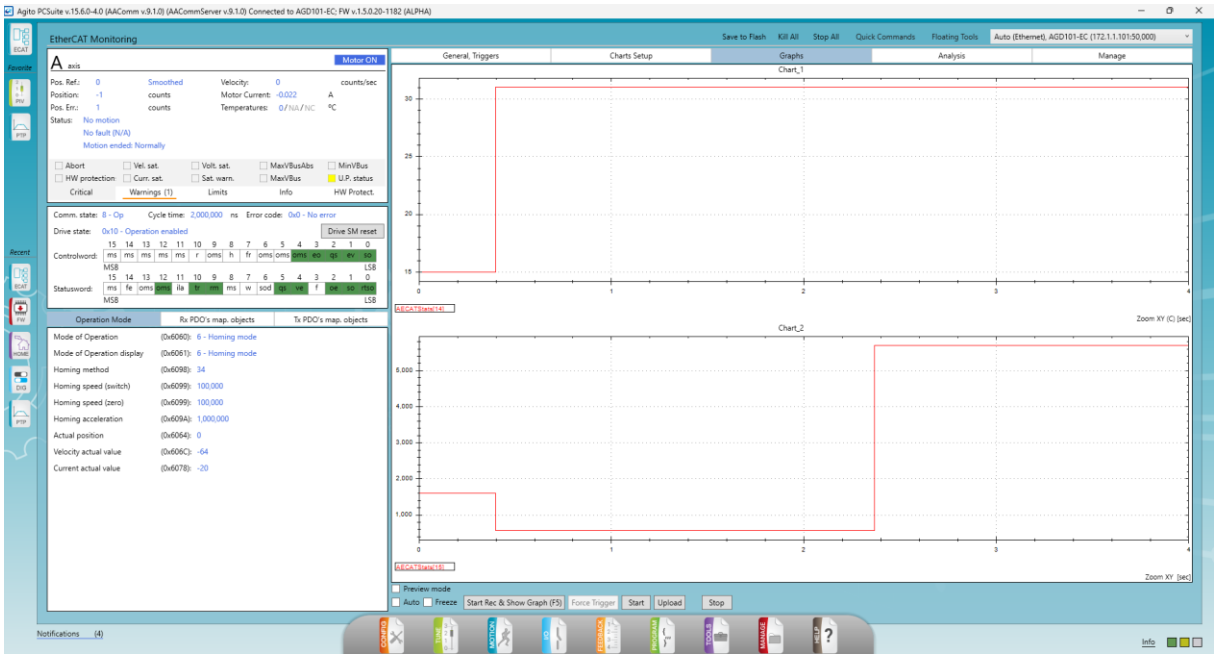
Figure 3 – Statusword for homing mode

Table 2 – Definition of bit 10, bit 12 and bit 13

Bit 13	Bit 12	Bit 10	Definition
0	0	0	Homing procedure is in progress
0	0	1	Homing procedure is interrupted or not started
0	1	0	Homing is attained, but target is not reached
0	1	1	Homing procedure is completed successfully
1	0	0	Homing error occurred; velocity is not 0
1	0	1	Homing error occurred; velocity is 0

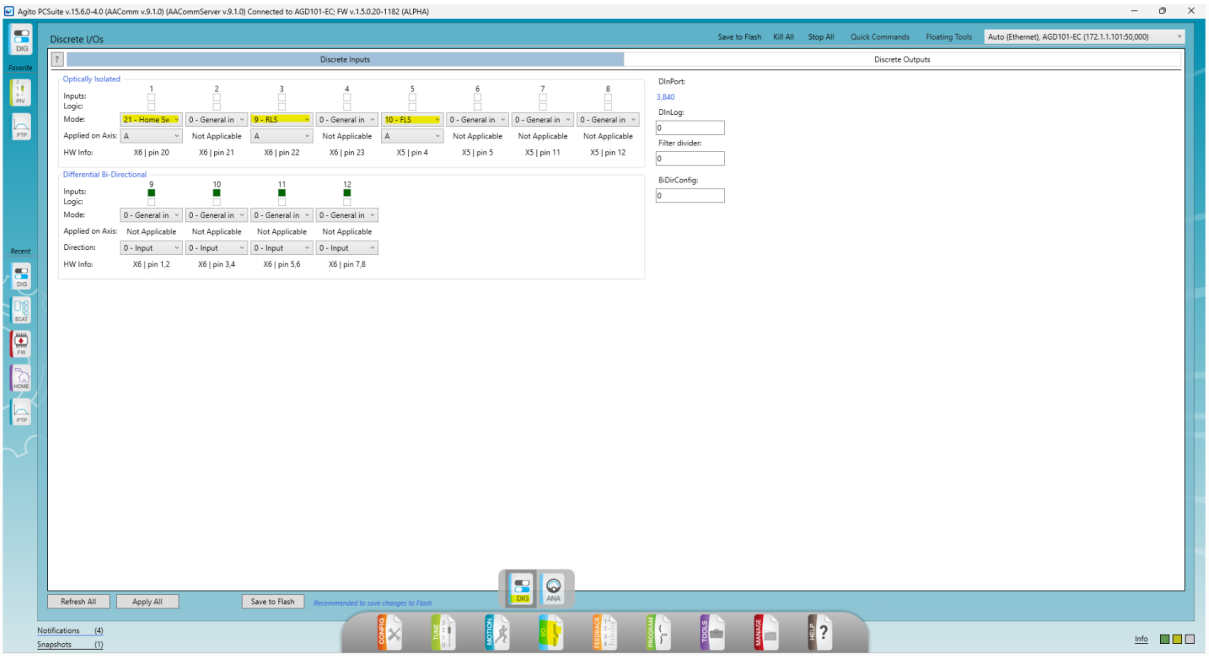
Users can also use our PCSuite UI to capture a graph to monitor the controlword and statusword.





2.3 CiA402 Homing Methods

The homing modes are working on logical values of the limit- and homing- switches (object $60FD_h$) or through manufacturer specific digital inputs (object 2460_h). Ensure that the various “mode” is set in the PCSuite as it is required to differentiate what digital inputs represents.



2.3.1 Method -4: Homing on hard stop by high error (Negative Direction)

Using this method as shown in Figure 4, User should set the object 0x2421 “Hard Stop Position Threshold” to the desired error threshold. The default threshold is given in 1000 counts. The initial direction of travel is in the negative direction and upon triggering the condition whereby the Position Error is higher than the threshold setpoint, it will set the current position as the home position.

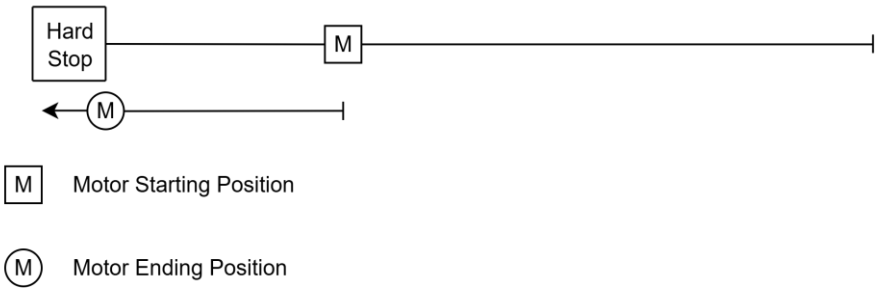


Figure 4 – Homing on hard stop by high error (Negative Direction)

2.3.2 Method -3: Homing on hard stop by high error (Positive Direction)

Using this method as shown in Figure 5, User should set the object 0x2421 “Hard Stop Position Threshold” to the desired error threshold. The default threshold is given in 1000 counts. The initial direction of travel is in the positive direction and upon triggering the condition whereby the Position Error is higher than the threshold setpoint, it will set the current position as the home position.

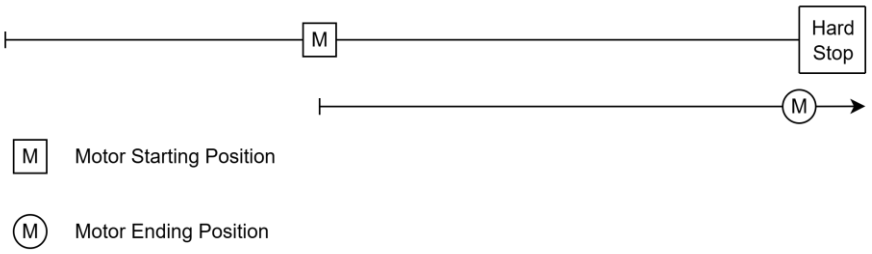


Figure 5 – Homing on hard stop by high error (Positive Direction)

2.3.3 Method -2: Homing on hard stop by high error to index pulse (Negative Direction)

Using this method as shown in Figure 6, User should set the object 0x2421 “Hard Stop Position Threshold” to the desired error threshold. The default threshold is given in 1000 counts. The initial direction of travel is in the negative direction and upon triggering the condition whereby the Position Error is higher than the threshold setpoint, it will reverse the direction of travel and search the index.

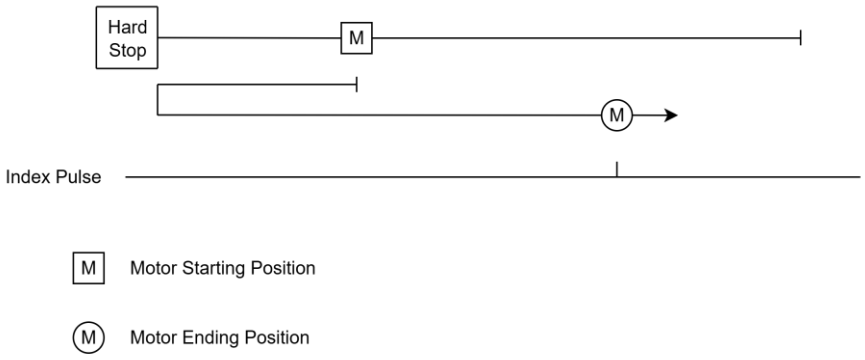


Figure 6 – Homing on hard stop by high error to index pulse (Negative Direction)

2.3.4 Method -1: Homing on hard stop by high error to index pulse (Positive Direction)

Using this method as shown in Figure 7, User should set the object 0x2421 “Hard Stop Position Threshold” to the desired error threshold. The default threshold is given in 1000 counts. The initial direction of travel is in the positive direction and upon triggering the condition whereby the Position Error is higher than the threshold setpoint, it will reverse the direction of travel and search the index.

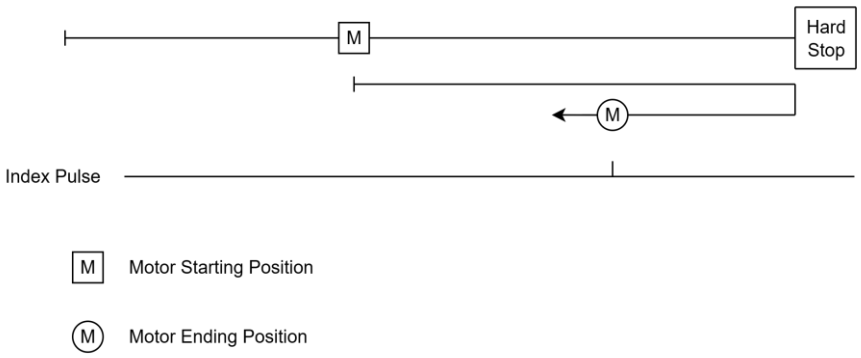


Figure 7 – Homing on hard stop by high error to index pulse (Positive Direction)

2.3.5 Method 0: Home using PCSuite homing steps

Using this method as shown in Figure 8, users can customize their desired homing steps inside the PCSuite software. For eg. Home To RLS -> Home To FLS -> Home to Index. This is not part of the pre-assign homing methods as defined in the CiA402 homing methods.

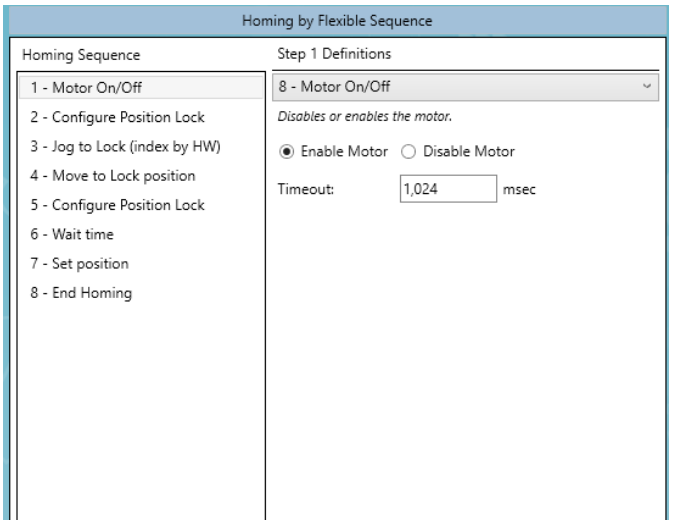


Figure 8 – Home using PCSuite homing steps

2.3.6 Method 1: Home on negative limit switch and index pulse

Using this method as shown in Figure 9, the initial direction of travel shall be in the negative direction. The home position shall be at the next index pulse in the positive direction when the negative limit switch becomes inactive.

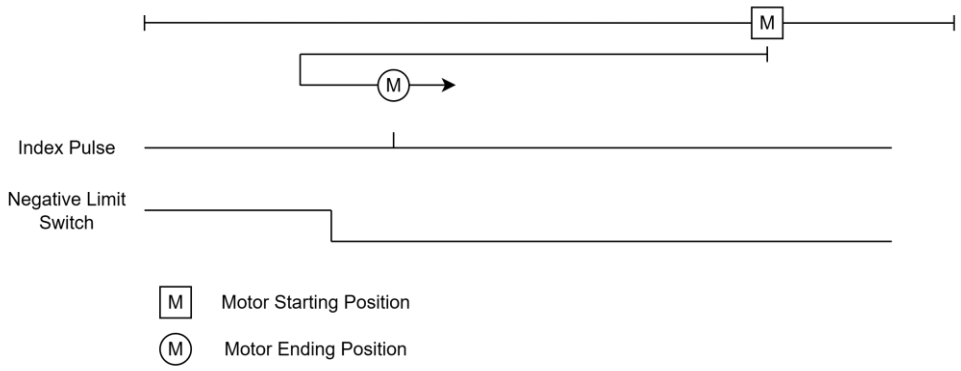


Figure 9 – Homing on negative limit switch and index pulse

2.3.7 Method 2: Home on positive limit switch and index pulse

Using this method as shown in Figure 10, the initial direction of movement shall be in the positive. The position of home shall be at the next index pulse in the negative direction when the positive limit switch becomes inactive.

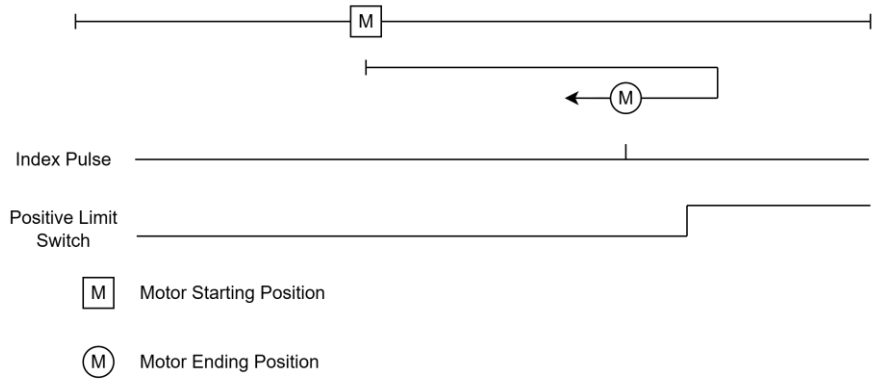


Figure 10 – Homing on positive limit switch and index pulse

2.3.8 Method 3: Home on positive home switch and index pulse

Using this method as shown in Figure 11, the initial direction of travel shall be dependent on the state of the home switch. The home position shall be at the next index pulse in the negative direction when the home switch becomes inactive.

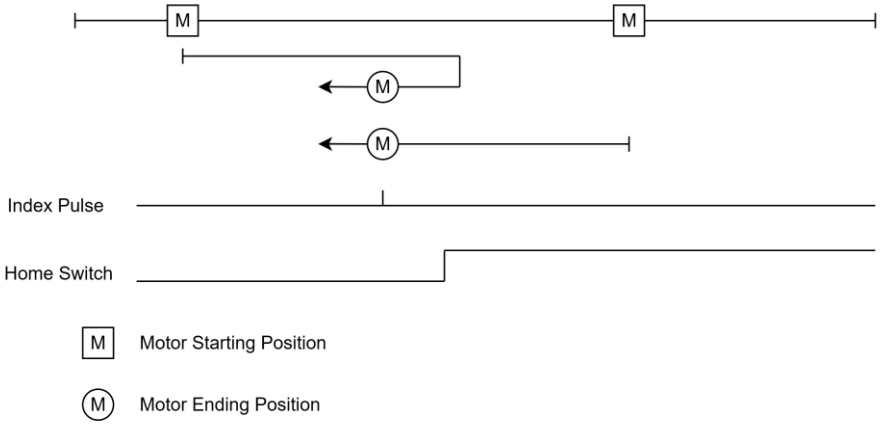


Figure 11 – Homing on positive home switch and left-side index pulse

2.3.9 Method 4: Home on positive home switch and index pulse

Using this method as shown in Figure 12, similar to Method 3 but the index pulse is in the positive direction when the home switch becomes active.

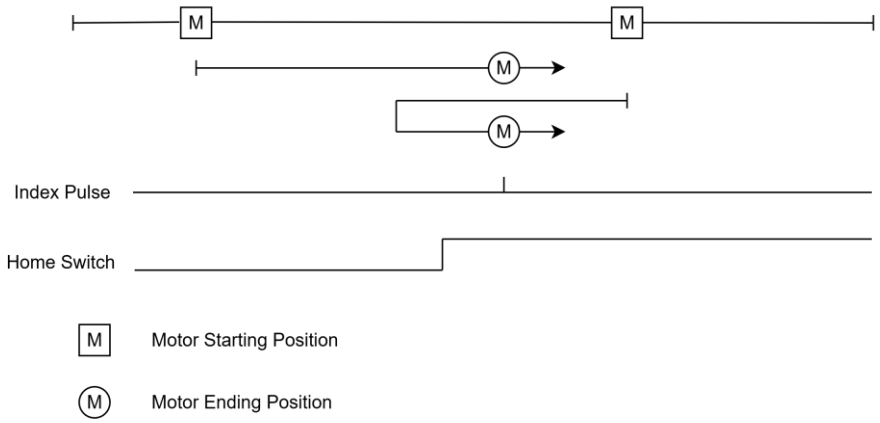


Figure 12 – Homing on positive home switch and right-side index pulse

2.3.10 Method 5: Home on negative home switch and index pulse

Using this method as shown in Figure 13, the initial direction of travel shall be dependent on the state of the home switch. The home position shall be at the next index pulse in the positive direction when the home switch becomes inactive.

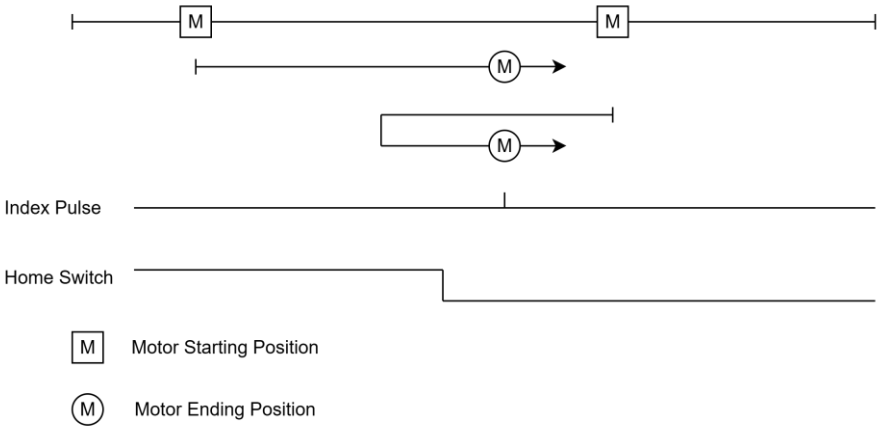


Figure 13 – Homing on negative home switch and right-side index pulse

2.3.11 Method 6: Home on negative home switch and index pulse

Using this method as shown in Figure 14, similar to Method 5 but the index pulse is in the negative direction when the home switch becomes active.

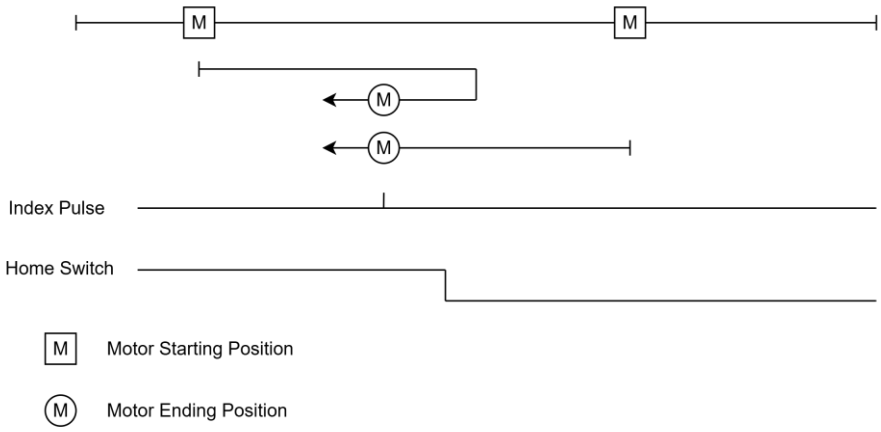


Figure 14 – Homing on negative home switch and left-side index pulse

2.3.12 Method 7 to 14: Home on home switch and index pulse

These methods use a home switch in conjunction with the hardware index pulse and takes into account when RLS/FLS was triggered. The initial direction of travel depends on the methods that the user chooses and whether the home switch is active during the activation of home function. Method 7 – 10 describes the various starting positions that the motor could start from and the initial direction of travel is in the positive direction. Method 11 – 14 shall be the inverse of Method 7 – 10.

2.3.12.1 Method 7

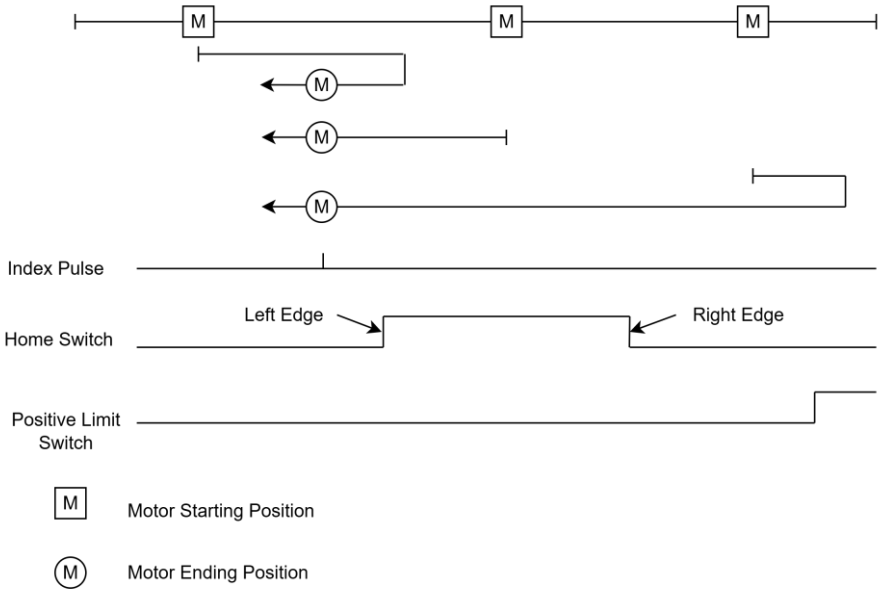


Figure 15 – Homing Method 7

2.3.12.2 Method 8

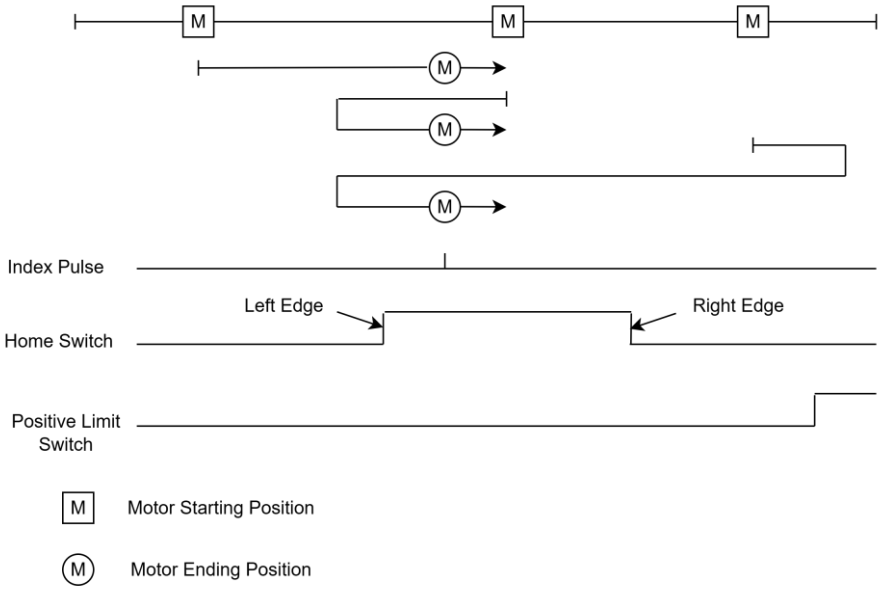


Figure 16 – Homing Method 8

2.3.12.3 Method 9

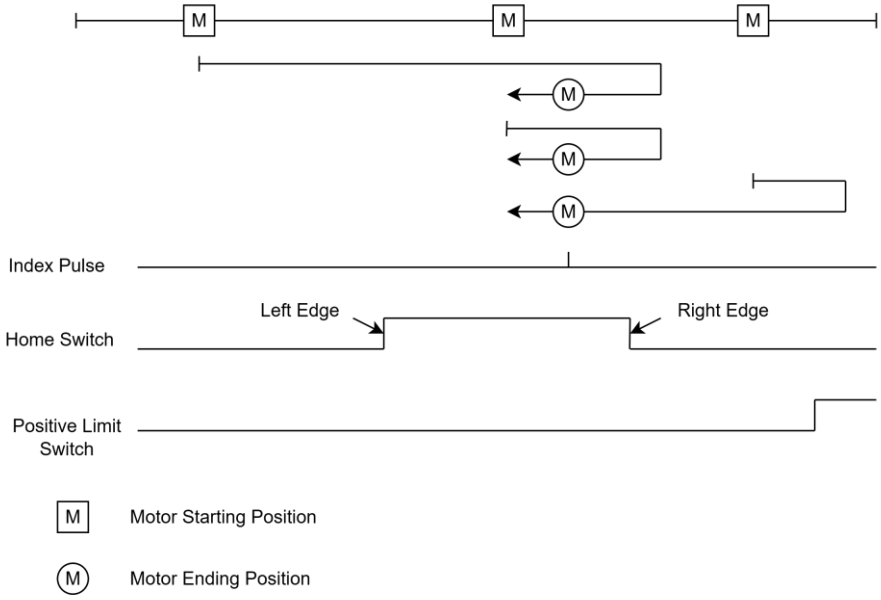


Figure 17 – Homing Method 9

2.3.12.4 Method 10

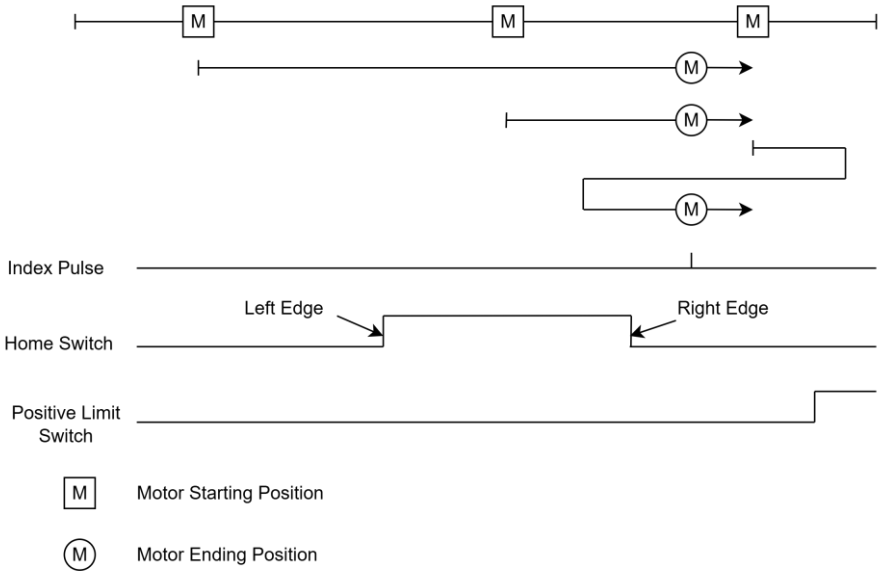


Figure 18 – Homing Method 10

2.3.12.5 Method 11

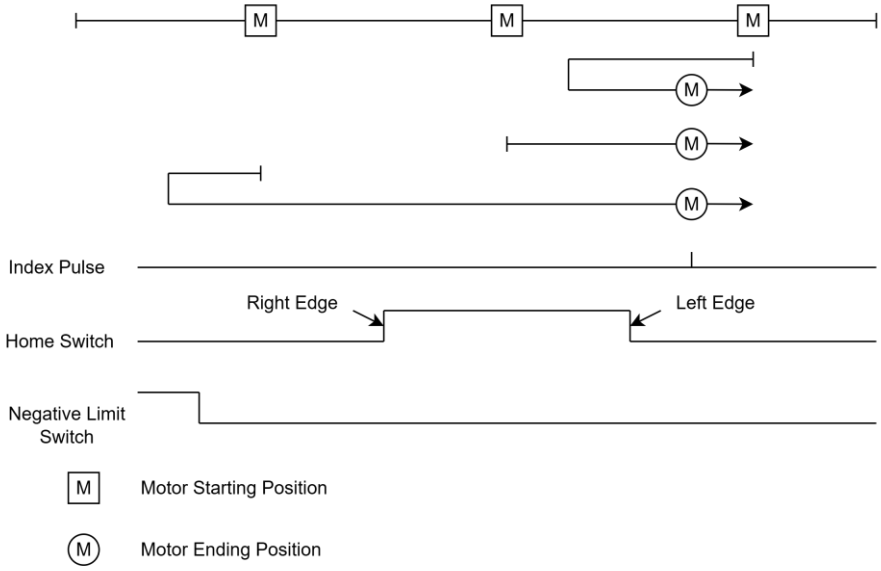


Figure 19 – Homing Method 11

2.3.12.6 Method 12

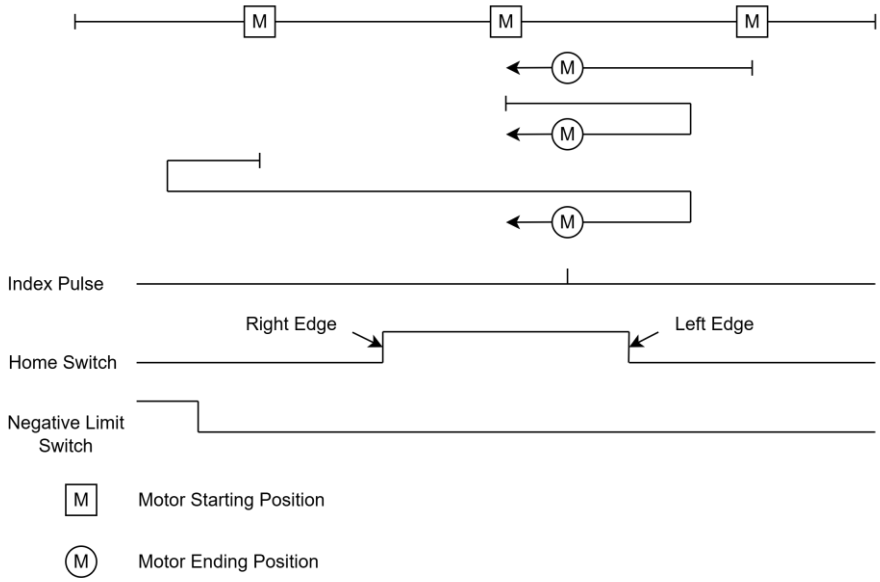


Figure 20 – Homing Method 12

2.3.12.7 Method 13

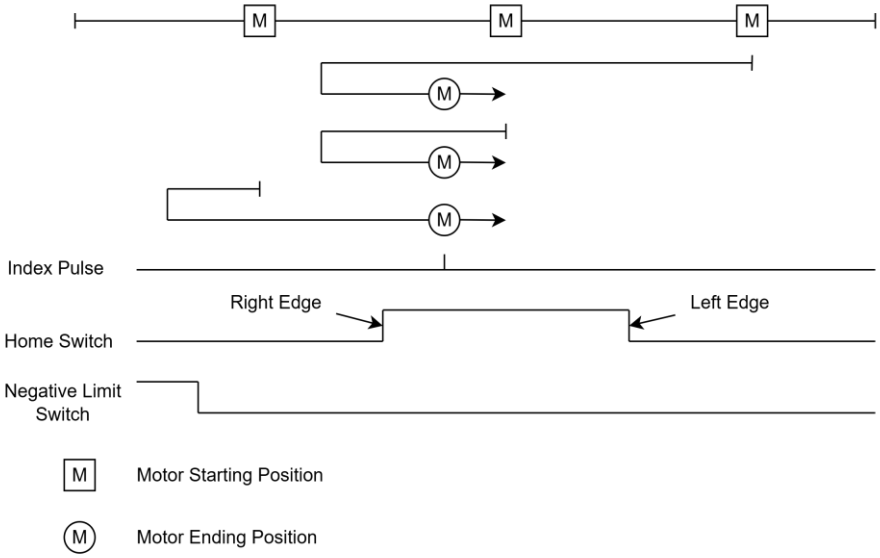


Figure 21 – Homing Method 13

2.3.12.8 Method 14

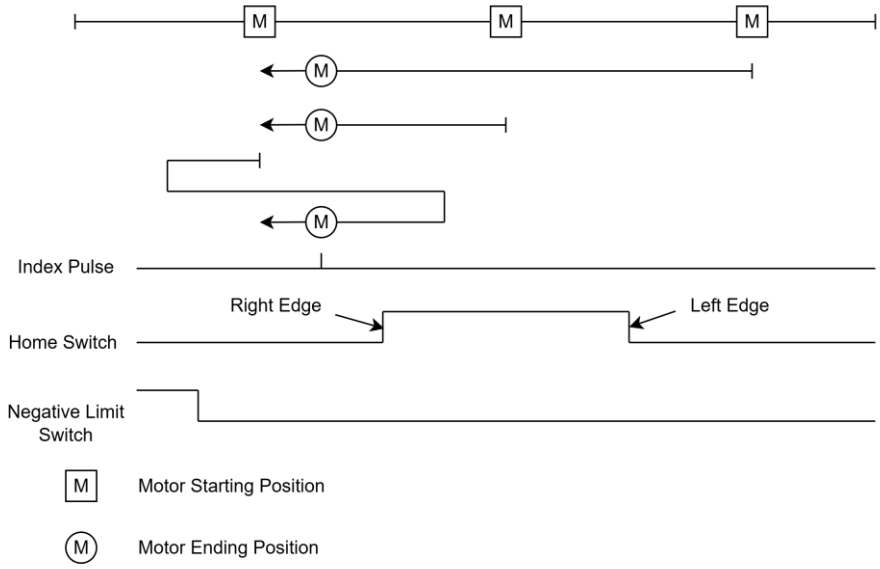


Figure 22 – Homing Method 14

2.3.13 Method 17: Home on negative limit Switch

Using this method as shown in Figure 23, the initial direction of travel shall be in the negative direction. The home position shall be at the point where the negative limit becomes active.

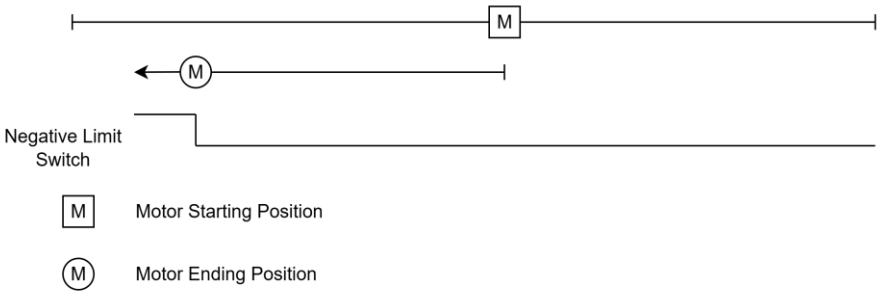


Figure 23 – Home on Negative Limit Switch

2.3.14 Method 18: Home on positive limit Switch

Using this method as shown in Figure 24, the initial direction of travel shall be in the positive direction. The home position shall be at the point where the positive limit becomes active.

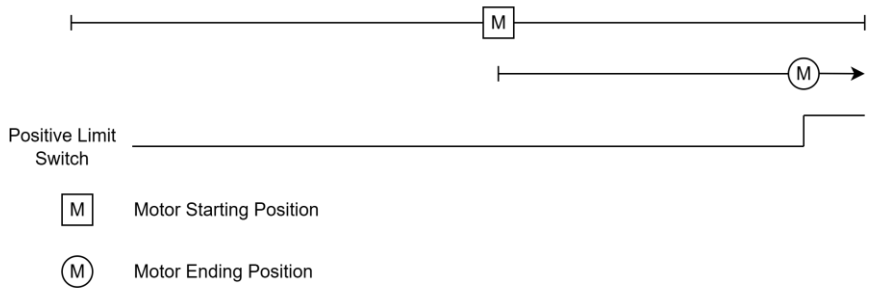


Figure 24 – Home on Positive Limit Switch

2.3.15 Method 19: Home on Falling Left Edge Home Switch (Positive Initial Direction)

Using this method as shown in Figure 25, the initial direction of travel shall be in the positive direction if the initial state of the home switch is inactive. The home position shall be at the point where the home switch becomes inactive.

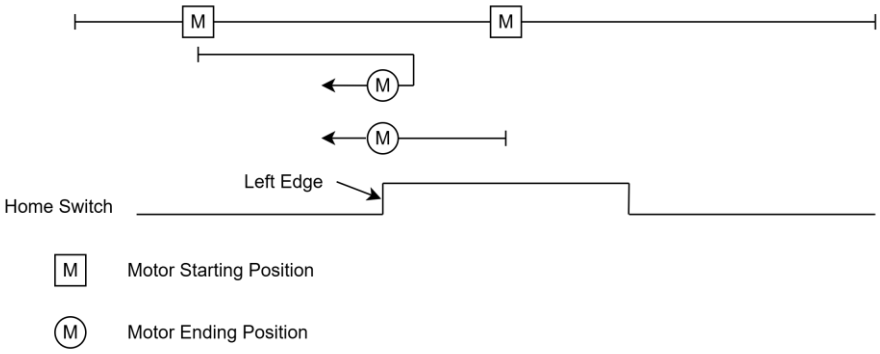


Figure 25 – Home on Falling Left Edge Home Switch (Positive Initial Direction)

2.3.16 Method 20: Home on Rising Left Edge Home Switch (Positive Initial Direction)

Using this method as shown in Figure 26, the initial direction of travel shall be in the positive direction if the initial state of the home switch is inactive. The home position shall be at the point where the home switch becomes active.

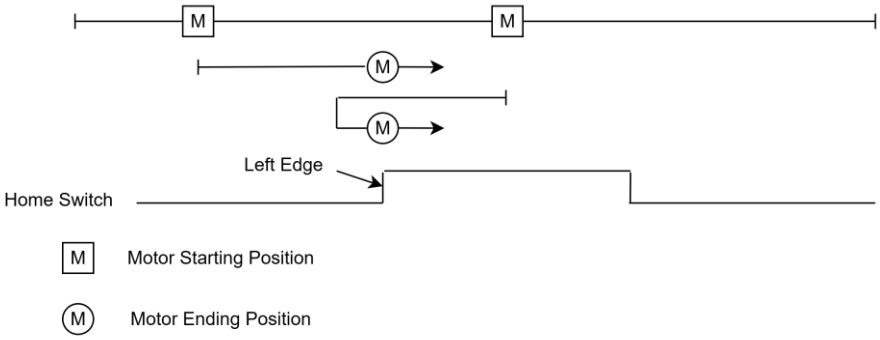


Figure 26 – Home on Rising Left Edge Home Switch (Positive Initial Direction)

2.3.17 Method 21: Home on Falling Left Edge Home Switch (Negative Initial Direction)

Using this method as shown in Figure 27, the initial direction of travel shall be in the negative direction if the initial state of the home switch is inactive. The home position shall be at the point where the home switch becomes inactive.

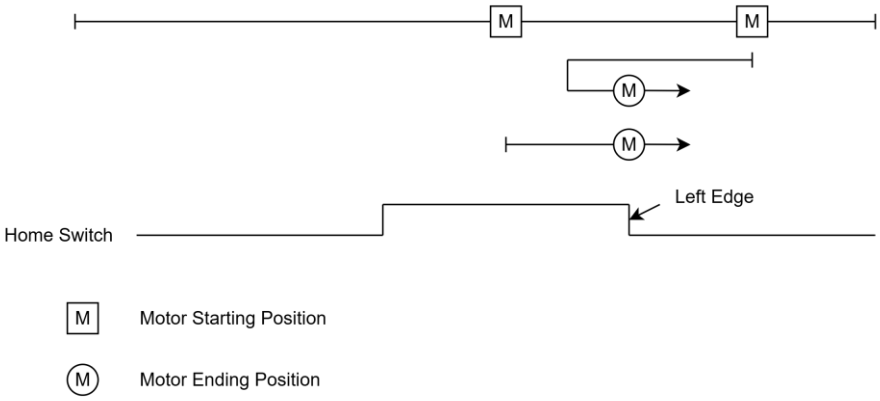


Figure 27 – Home on Falling Left Edge Home Switch (Negative Initial Direction)

2.3.18 Method 22: Home on Rising Left Edge Home Switch (Negative Initial Direction)

Using this method as shown in Figure 28, the initial direction of travel shall be in the negative direction if the initial state of the home switch is inactive. The home position shall be at the point where the home switch becomes active.

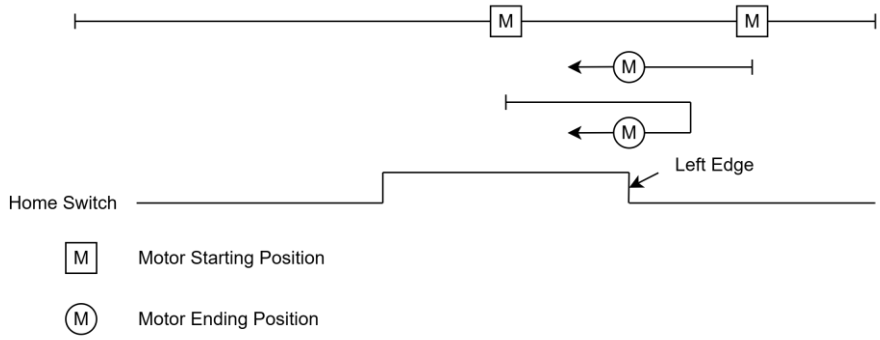


Figure 28 – Home on Rising Left Edge Home Switch (Negative Initial Direction)

2.3.19 Method 23 - 30: Home on home switch

Similar to Methods 7 -14 as described in 2.3.10. The home position will depend on the home edge (left/right) and whether it is on a falling or rising edge of the chosen edge instead of a hardware index pulse.

2.3.19.1 Method 23

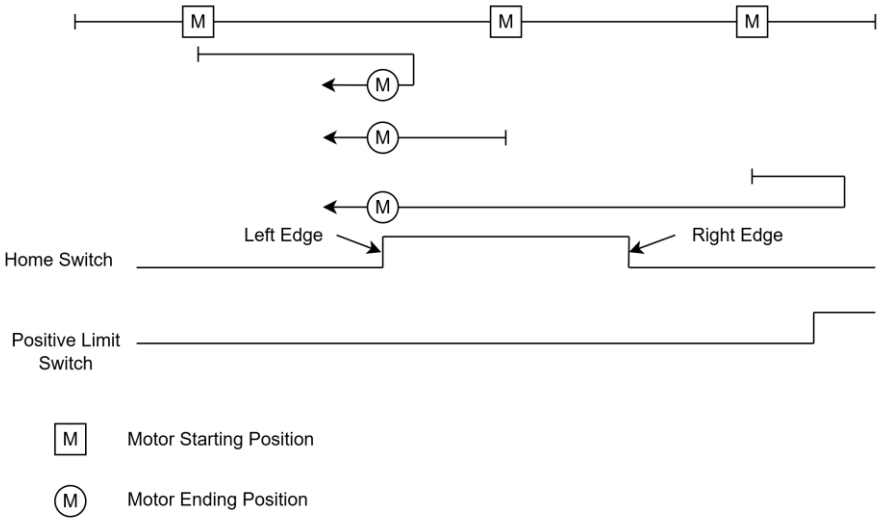


Figure 29 – Method 23

2.3.19.2 Method 24

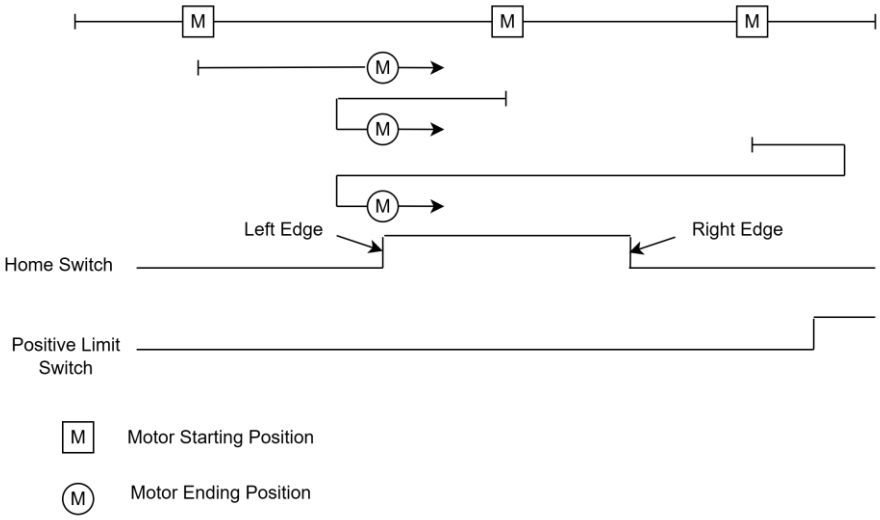


Figure 30 – Method 24

2.3.19.3 Method 25

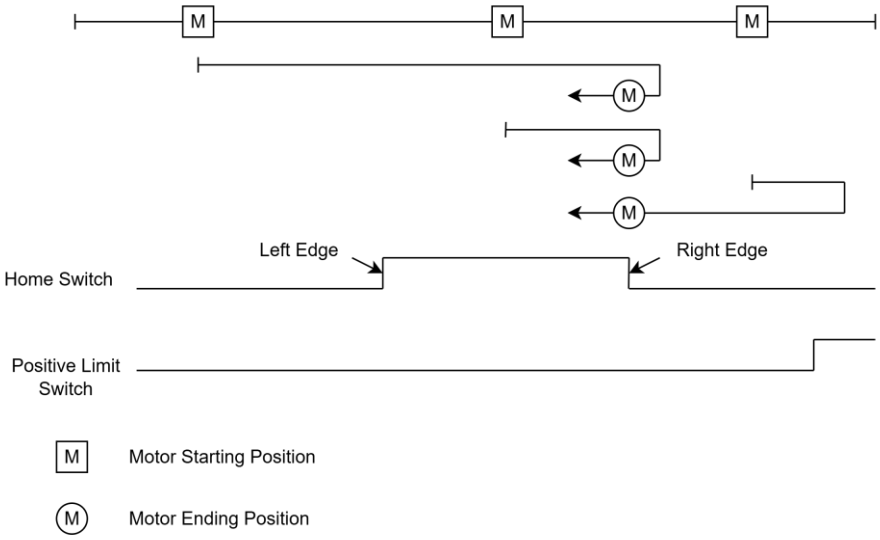


Figure 31 – Method 25

2.3.19.4 Method 26

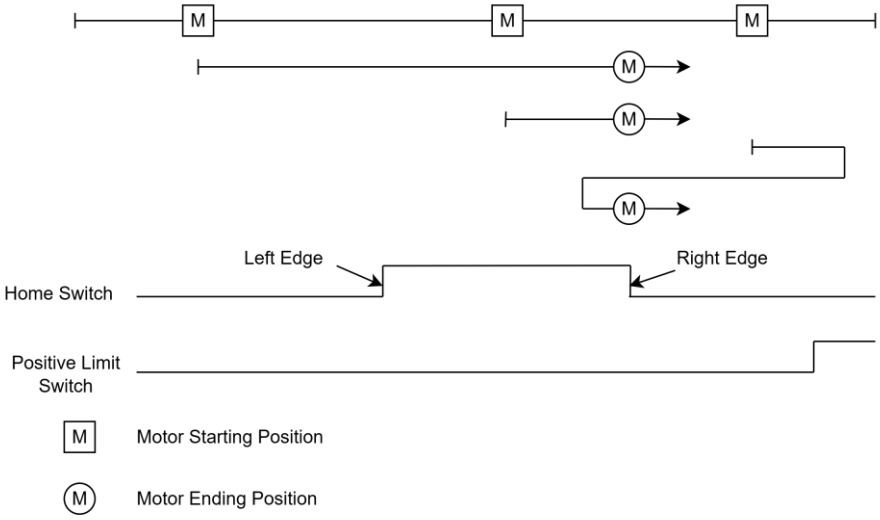


Figure 32 – Method 26

2.3.19.5 Method 27

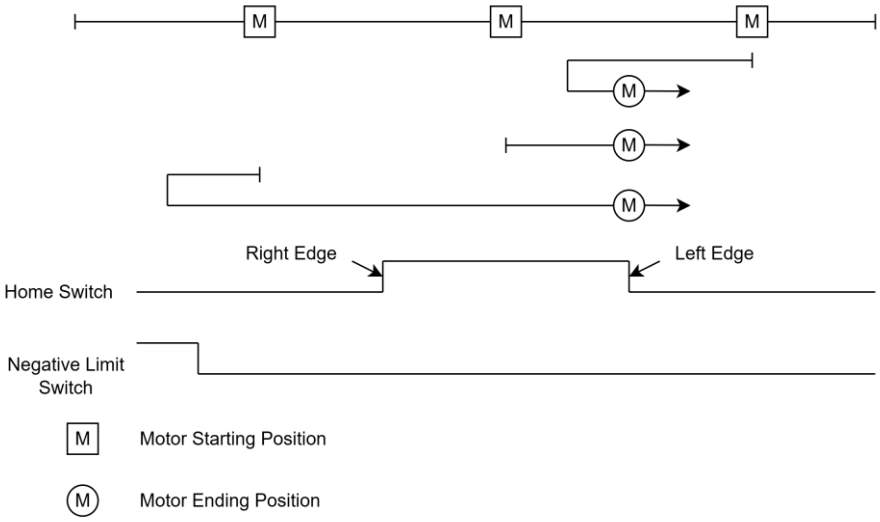


Figure 33 – Method 27

2.3.19.6 Method 28

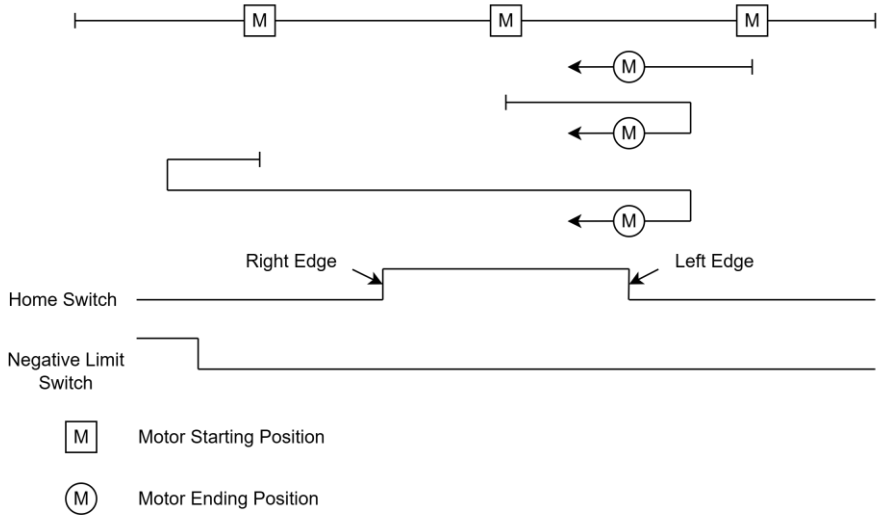


Figure 34 – Method 28

2.3.19.7 Method 29

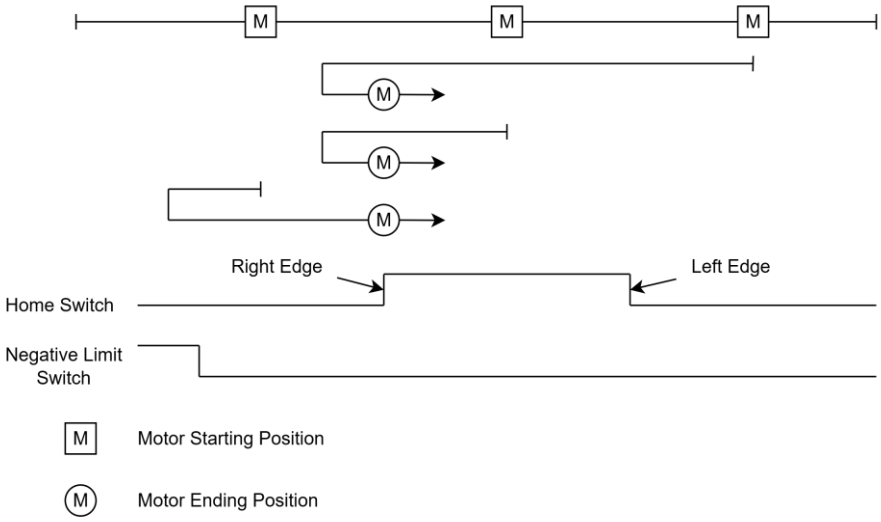


Figure 35 – Method 29

2.3.19.8 Method 30

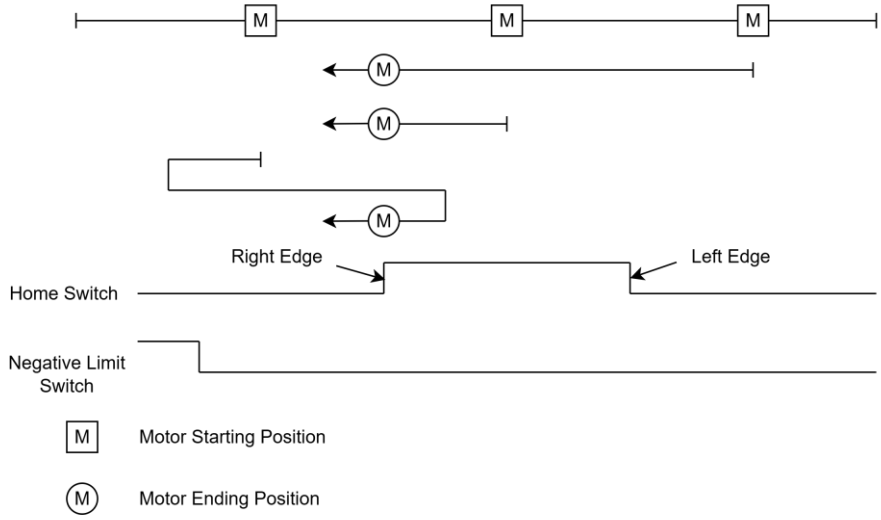


Figure 36 – Method 30

2.3.20 Method 33: Home on Negative Index

Using this method as shown in Figure 37, the motor moves in the negative direction until the next index is located.

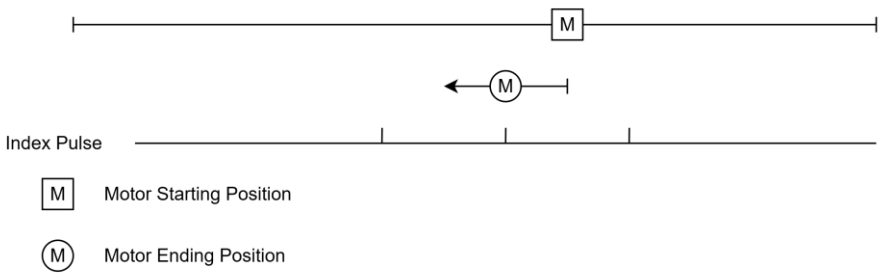


Figure 37– Method 33

2.3.21 Method 34: Home on Positive Index

Using this method as shown in Figure 38, the motor moves in the positive direction until the next index is located.

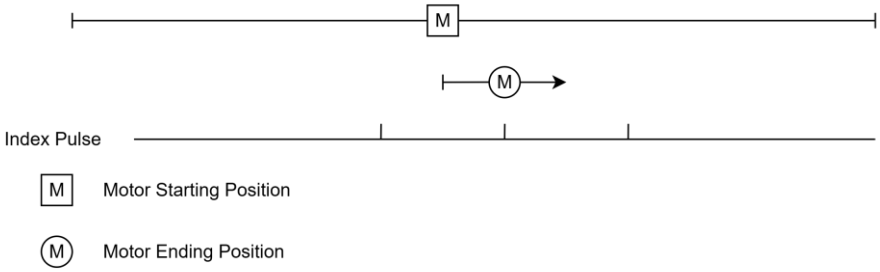


Figure 38– Method 34

2.3.22 Method 35: Home on Current Position

Using this method as shown in Figure 39, current position is selected as the new home “zero” position.

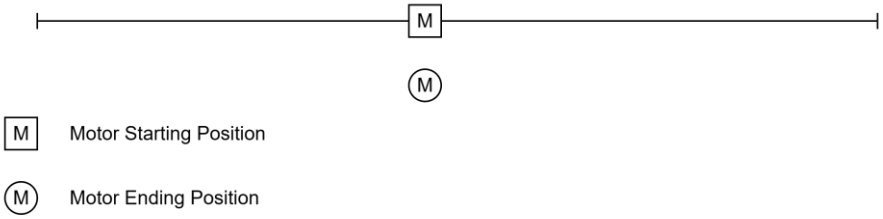


Figure 39– Method 35

3 Homing via Touch Probe Method

In the case whereby CiA402 Home methods are not available due to several reasons. (PLC only supports via Touch Probe Method or this is the preferred method of choice). The home function block which is integrated inside the PLC will be using the Touch Probe Method to search for the index of the motor. It is necessary to map the related EtherCAT objects when doing the set up / prompt by PLC (e.g. Omron). Section 3.2 shows an example of the Touch Probe Homing.

Related EtherCAT Objects that will be used in the method are as follows: (only Touch probe 1 and single event will be described. For more information on using Touch Probe 2 or continuous trigger, please refer to CiA402 Specification for more information)

60B8: Touch Probe Function

60B9: Touch Probe Status

60BA: Touch Probe 1 Positive Edge

60BB: Touch Probe 1 Negative Edge

60D0: Touch Probe Source

3.1 Description of related EtherCAT Objects

3.1.1 Object $60B8_h$: Touch Probe Function

Table 3 specifies the value definition of the object 60B8, usually the integrated home function block which uses this function will be enable the function with “Trigger First Event”, “Trigger with Zero Impulse signal or Position Encoder” and “Enable sampling at positive edge of touch probe 1”. Which is 21 or 15_h.

Bit	Value	Definition
0	0	Switch off touch probe 1
	1	Enable touch probe 1
1	0	Trigger first event
	1	Continuous Trigger
3, 2	00_b	Trigger with touch probe 1 input
	01_b	Trigger with zero impulse signal or position encoder
	10_b	Touch probe source as defined in object $60D0_h$, sub-index 01_h
	11_b	Reserved
4	0	Switch off sampling at positive edge of touch probe 1
	1	Enable sampling at positive edge of touch probe 1
5	0	Switch off sampling at negative edge of touch probe 1
	1	Enable sampling at negative edge of touch probe 1
6, 7	-	

Table 3 – Touch probe function values definition

3.1.2 Object $60B9_h$: Touch Probe Status

Table 4 specifies the value definition of the object 60B9.

Bit	Value	Definition
0	0	Touch probe 1 is switched off
	1	Touch probe 1 is enabled
	0	Touch probe 1 no positive edge value stored

1	1	Touch probe 1 positive edge position stored
2	0	Touch probe 1 no negative edge value stored
	1	Touch probe 1 negative edge position stored
3 to 5	0	Reserved
6, 7	-	User-defined (e.g. for testing)
NOTE: Bit 1 and bit 2 are set to 0_b when touch probe 1 is switched off (object $60B8_h$ bit 0 is 0_b)		

Table 4 – Touch probe status values definition

3.1.3 Object 60BA$_h$: Touch Probe 1 Positive Edge

This object stores the rising edge of the index position in counts. It should correspond to PCSuite keyword “LockVal” as the Lock Function is enabled and the lock source is the rising edge of the index.

3.1.4 Object 60BB$_h$: Touch Probe 1 Negative Edge

This object stores the falling edge of the index position in counts. It should correspond to PCSuite keyword “LockVal” as the Lock Function is enabled and the lock source is the falling edge of the index.

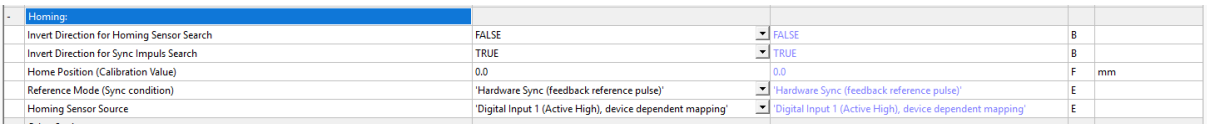
3.1.5 Object 60D0$_h$: Touch Probe Source

Table 5 specifies the value definition. As our current drive do not have a dedicated touch probe functionality, Value 1 – 4 is not in used. If users want to use Digital Input as the touch probe source, -1 to -16 (if 16 digital inputs are supported) can be set according to their desired source.

Value	Definition
-16 to -1	Digital Input 16 to Digital Input 1
0	Reserved
+1	Touch probe 1 input
+2	Touch probe 2 input
+3	Touch probe 3 input
+4	Touch probe 4 input
+5	Hardware zero impulse signal of position encoder
+6	Software zero impulse signal of position encoder
+7 to +32 767	Reserved

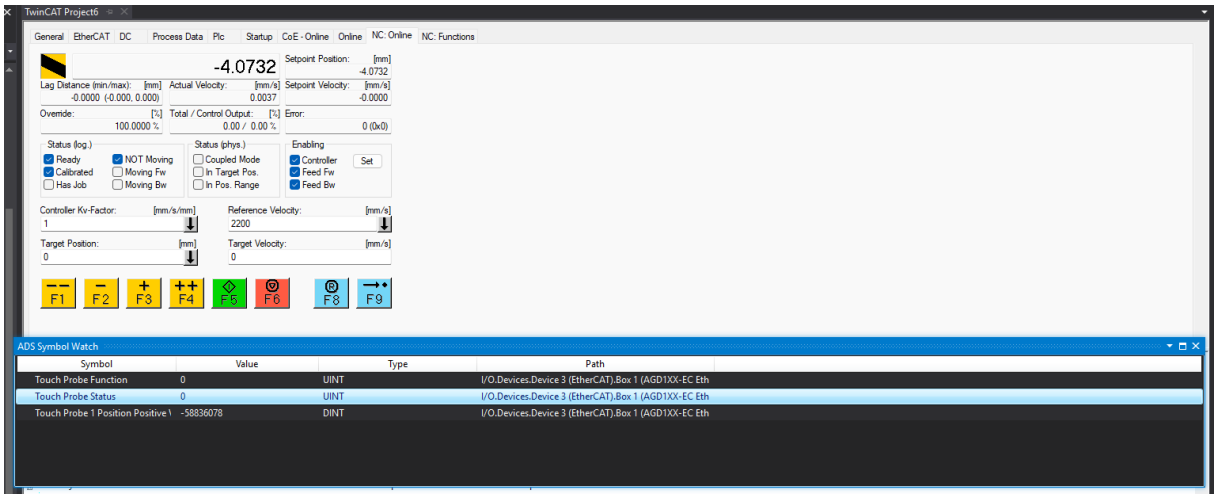
3.2 Touch Probe Homing Example (by Index Pulse)

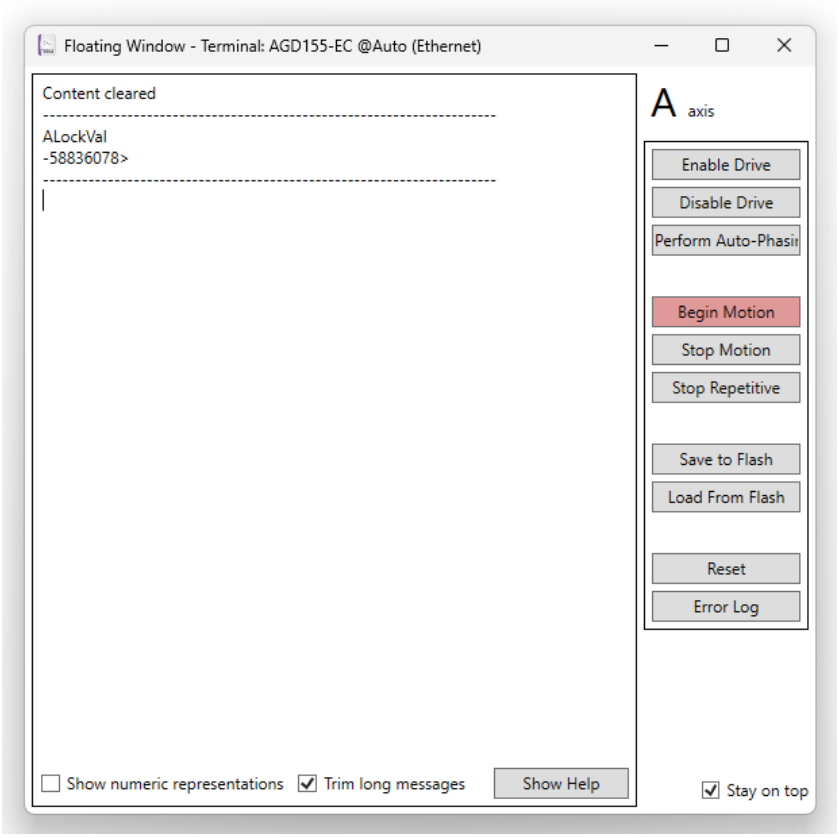
Different masters do their configuration differently. In TwinCAT, it is necessary to configure the Reference Mode (Sync condition) to hardware sync (feedback reference pulse) in order to find the index signal. Other reference mode examples will also be shown below to show the different configurations when the integrated home function is called from the PLC.



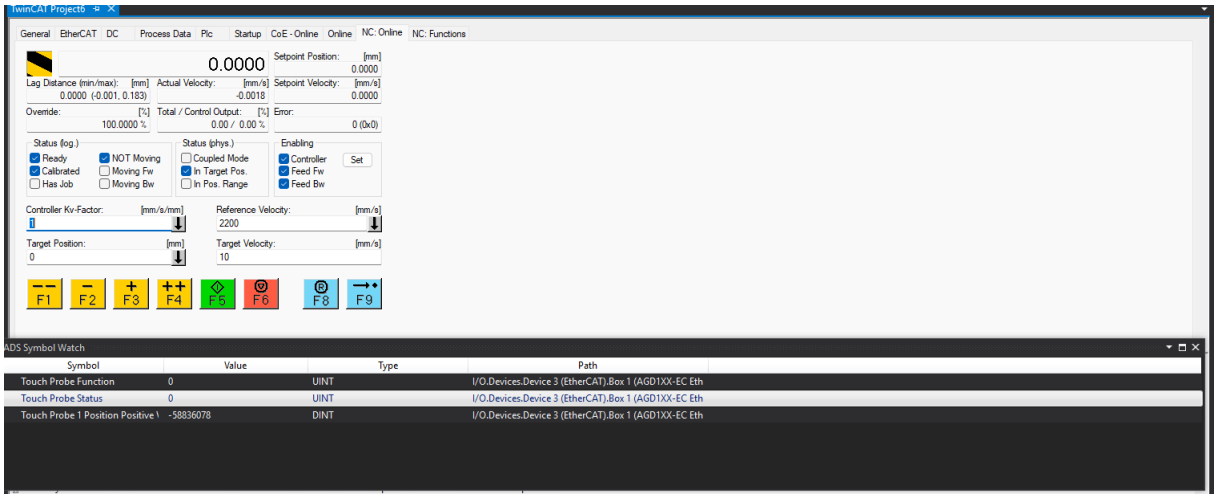
It can be seen that when I set the reference mode to “Hardware Sync” and called the home function, the “Touch Probe Function” will be toggled to 21_{10} or 15_h and it is searching for the index position.

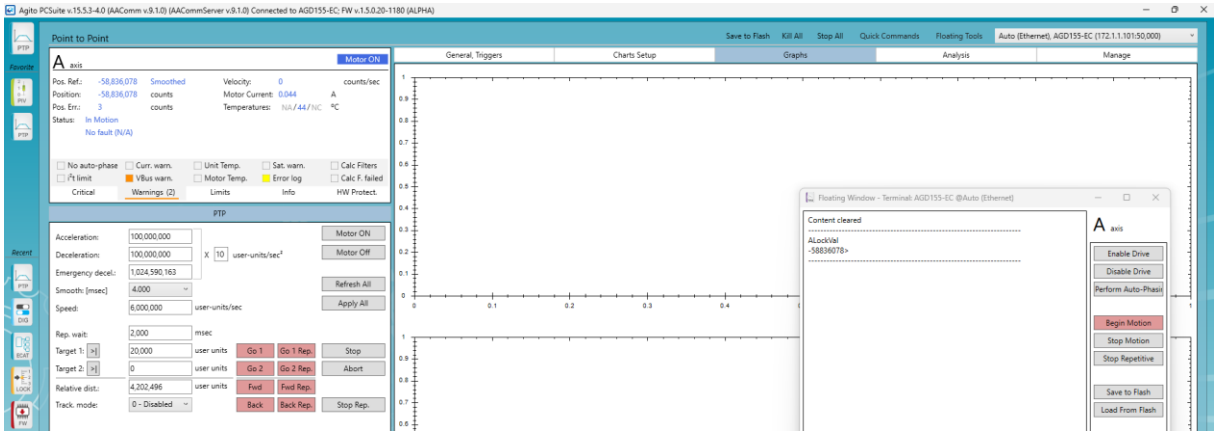
Once the index position is obtained, the current position reflects the delta at the point of time the profiler ramps down once the index position has been detected. Users will have to move the axis to zero position explicitly or integrate it as part of their program. It can be check from the PCSuite terminal “LockVal” that will reflect the index position which corresponds to “Touch Probe 1 Positive Value”.





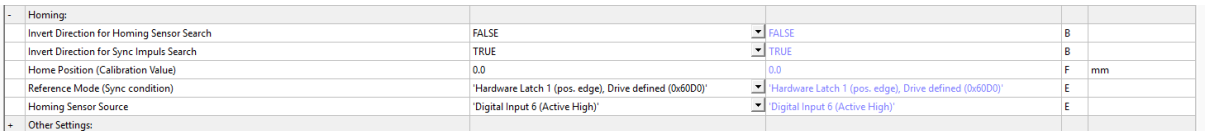
If we move to zero in the TwinCAT Software, it can be seen that the PosRef matches with the "LockVal" position and also "Touch Probe 1 Position Positive Value".



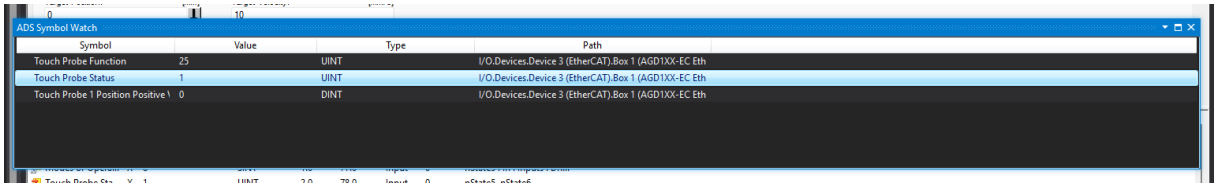


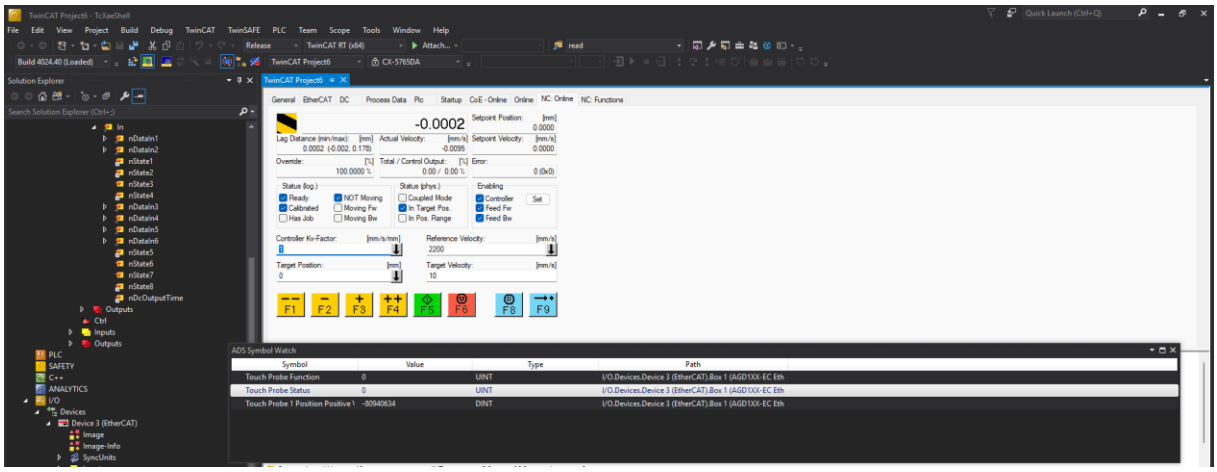
3.3 Touch Probe Homing Example (by Digital Input Touch Probe Source)

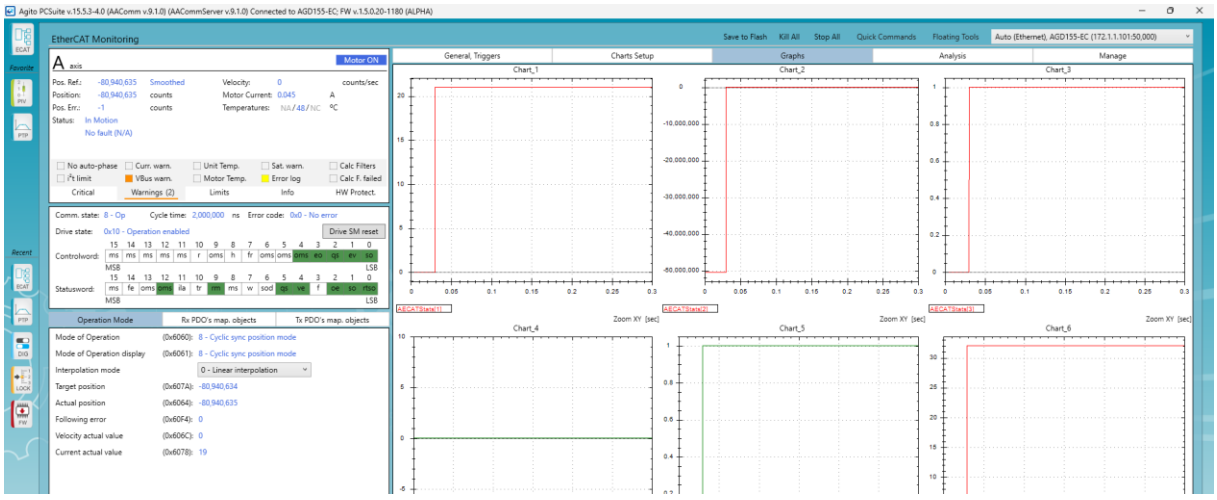
In the case of Reference Mode (Sync condition) "Hardware Latch 1", the source is from the defined object 0x60D0 and in this use case Digital Input 5 has been chosen to be the source.



It can be seen that for this Reference Mode (Sync condition) "Hardware Latch 1", the master will toggle the "Touch Probe Function" to 25_{10} or 19_h as it is expecting a continuous hardware latch from Digital Input 5. As soon as Digital Input 5 is triggered, the master will take that position as the datum position and also set it to 0. An explicit call to move to 0 is necessary in order to move the motor to the "Touch Probe 1 Positive Value 1" position.


ADS Symbol Watch
Symbol
Value
Type
Path
Touch Probe Function
25
UINT
I/O.Devices.Device 3 (EtherCAT).Box 1 (AGD1XX-EC Eth
Touch Probe Status
1
UINT
I/O.Devices.Device 3 (EtherCAT).Box 1 (AGD1XX-EC Eth
Touch Probe 1 Position Positive \
0
DINT
I/O.Devices.Device 3 (EtherCAT).Box 1 (AGD1XX-EC Eth


TwinCAT Project6
-0.0002
ADS Symbol Watch
Touch Probe Function
Touch Probe Status
Touch Probe 1 Position Positive \


EtherCAT Monitoring
Chart_1
Chart_2
Chart_3
Chart_4
Chart_5
Chart_6