Homing Mode 17: Absolute Mode - Calculate and save offset

In this mode the drive will first execute an absolute homing and then calculate and store a value for FB1.OFFSET, so that the current position becomes the position specified by the user through HOME.P. The value of FB1.OFFSET is automatically saved in non-volatile memory, so that the drive does not have to be re-homed after power cycle when using an absolute feedback device.

This mode can apply to the following feedback devices:

- Single-turn and multi-turn absolute encoders (i.e. BISS, EnDat, Hiperface , Hiperface DSL)

- Kollmorgen SFD (used as a single turn feedback device)

- Resolver (used as a single turn feedback device)

This mode does not apply to non-absolute feedback types such as:

- Incremental encoder

- Sine encoder

This document demonstrates homing mode 17 using SFD as a single turn feedback device.

A new keyword (parameter) was added to the HOME group of parameters called HOME.MOVEREQUIRED which stores if a new homing needs to be executed or not. This depends on the feedback type and if homing mode 17 was successfully executed on absolute encoders.

This parameter stores the information once homing mode 17 is executed successfully.

HOME.MOVEREQUIRED=0   (homing not required)

HOME.MOVEREQUIRED=1   (homing required)

Description

HOME.MOVEREQUIRED indicates if a homing move has to be executed. It is always set to 0 (no move required) when using a multi-turn feedback and to 1 (move required) when using an incremental feedback. Using an absolute single-turn feedback it is set to 1 by default but changes to 0 if a homing procedure in mode 17 was successfully executed.

If, during power up of the drive, HOME.MOVEREQUIRED is 0, bits one and two of the motion status word are automatically set, allowing operation without requiring an additional homing routine to be executed.

Feedback Type	HOME.MOVEREQUIRED (default or on power up prior to Homing Mode 17 successful execution)	HOME.MOVEREQUIRED after Homing Mode 17 successful execution
Single Turn Absolute Encoder	1	0
Multiturn Absolute Encoder	0	0
Resolver	1	0
Incremental Encoder (Homing Mode 17 does not apply)	1	1
Sine Encoder (Homing Mode 17 does not apply)	1	1

Note with a multiturn encoder the HOME.MOVEREQUIRED is 0 whether Homing Mode 17 is used or not. The Home Found and Done bits on the Home screen in Workbench (or in the DRIVE.MOTIONSTAT status keyword) will always be set on powerup using a multiturn encoder. The nuance is whether the FB1.OFFSET has been calculated and stored or not.

The following is a typical setup for the Homing routine for an absolute feedback device.

- HOME.P

  The "Position" setting on the home screen can be set to zero or another value that is included in the calculation of the offset used for the taught position. For example, if the value is zero then when the Homing Mode 17 is successfully executed, the feedback position will be set to zero (and the offset is stored in non-volatile memory automatically). If the value is set for 90 degrees (for example), when the Homing is run then the feedback position will be set to 90 degrees (and the offset is stored in non-volatile memory automatically).

- Auto Homing

  Since the objective is to not have to home on power up every time, the Auto Homing listbox is selected to be Disabled.

Basic Setup for demonstration:

This application note used position units of Degrees and velocity RPM and acceleration RPM/s.

This is user preference so the drive can be setup for counts, degrees, etc. (whatever makes sense).

For this demonstration SFD was used which is a single turn absolute feedback type therefore Modulo was set to be enabled on the Modulo screen and the range was set from 0.000 deg to 360.000 deg so the feedback position will always be somewhere between 0 and 360 degrees even after multiple revs (rollover). Note if the position units in the Units screen are set to something else (i.e. counts 16 bit, etc.) then the units on the Modulo screen will reflect that. Note: The use of modulo not a requirement to set the FB1.OFFSET but it may applicable for some applications (direct drive rotary table for example). What this means is using Homing Mode 17 to set the FB1.OFFSET will set the position or origin accordingly but only within one revolution of the motor for a single turn absolute feedback type. On power up, a command to the trained position (i.e. zero) will result in the motor moving 1 revolution or less to the trained position regardless of the use of modulo or not. However, in this demonstration, the setup treats the motor like a direct drive on a rotary table where the desire is to always be somewhere between 0 and 1 revolution of the motor (i.e. 0 and 360 degrees) and that the reported feedback position prior and after power cycle are to be the same.

Depending on the application, the "Direction for Absolute Motion Task" can be set as desired.

This will determine the direction and path an absolute motion task takes when triggered.

For example "Positive" was chosen and if on power up the feedback position is 160 degrees. When a motion task that is setup for an absolute position of zero, it takes the positive direction from 160 degrees to 0,360 degrees. Which selection for "Direction for absolute motion task" is up to the user.

Next motion task 0 was created so an absolute move of zero could be commanded.

To setup the home, mode 17 was selected and the Position parameter was left at the default value of 0.000 in the Position parameter, and Auto Homing set to 0-Disabled.

For the demonstration 3 digital inputs were set : one to trigger the home ("teach"), one to Jog, and one to start Motion Task 0. Set the jog speed as desired.

The changes were saved to NV memory using Save To Device in the toolbar.
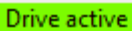
Running The Test

Drive Enabled and using the watch window to monitor position feedback:

Next the motor was jogged using the digital input until the mark on the motor shaft was roughly in the up position and then the jog input was turned off.

Note the mechanical degrees on the dial indicator on the Feedback 1 screen. At this point, the mechanical degrees and the position feedback are in agreement.

Next the digital input to start the home was triggered to "teach" the new zero position. On trigger notice in the watch window, the position feedback will be either zero or 360 degrees since the position feedback is now positioned at the modulo rollover point.

Feedback 1 (X10)

The primary position feedback fitted to your motor.

Feedback Selection: `-1 - Auto Identify` ⓘ This is disabled because drive is active.

Feedback Identified: `SFD3 (Smart Feedback Device Gen3)`

If you rotate the motor shaft you should see the dial move.

43.763°

Motor Autoset: `1 - On`

Position Feedback: `0.003` deg

Drive Direction: `0`

Position Feedback Poles: `2`

Goto Wake and Shake

Observe on the Home screen, the Found and Done bits are set. This means the drive has been homed and in this mode, the offset has been calculated and stored to non-volatile memory. Now a motion task can be triggered at any time including on power up.

Home

This page is used to issue a homing command. The home command is used to zero the drives position.

Select the type of homing motion you wish to use:

`17 - Absolute mode - Calculate and save offset`

Reference Point

User Position = Home position
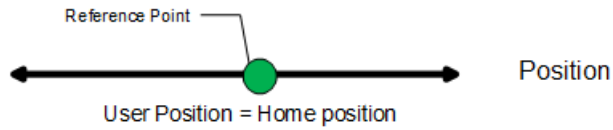
Position

Settings

Position: 0.000 deg

Goto Drive Motion Status

Controls

Found: ⬤

Done: ⬤

Active: ○ ▷ Start

Error: ○

Position Feedback: 0.006 deg

Auto Homing: 0 - Disabled

To demonstrate what is going on in the background:

Terminal

A command line interface to the device. Type a command and press return.

```
-->HOME.MOVEREQUIRED
0
-->FB1.OFFSET
-43.765 [deg]
-->
```

Note again on the Feedback 1 screen the mechanical dial indicator is still at the 43.763 degree mark but the position feedback has been "zeroed".

Feedback 1 (X10)

The primary position feedback fitted to your motor.

Feedback Selection:	-1 - Auto Identify	This is disabled because drive is active.
Feedback Identified:	SFD3 (Smart Feedback Device Gen3)	

If you rotate the motor shaft you should see the dial move.

43.763°

Motor Autoset:	1 - On	
Position Feedback:	0.003	deg
Drive Direction:	0	
Position Feedback Poles:	2	

Goto Wake and Shake

Next the motor was jogged with the digital input again for as long as desired, even multiple revolutions, and then the input was turned off so the motor stopped so the dial indicator would be somewhere else than the zero position and 43.763 degree point.

Feedback 1 (X10)

The primary position feedback fitted to your motor.

Feedback Selection:	-1 - Auto Identify	This is disabled because drive is active.
Feedback Identified:	SFD3 (Smart Feedback Device Gen3)	

If you rotate the motor shaft you should see the dial move.

239.850°
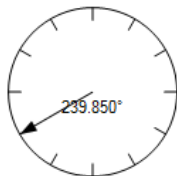
Motor Autoset:	1 - On	
Position Feedback:	196.081	deg
Drive Direction:	0	
Position Feedback Poles:	2	

Goto Wake and Shake

Now to "orient" to the taught position:

Trigger the input to start the motion task (0 in this case):

Revisiting the Feedback 1 screen, the motor has now moved back to the 43.763 degree mechanical position which is the "taught zero" position.

Next jog the motor out of the zero position again.

Then power the drive down.

Reconnect with Workbench and observe the current position (note <u>no</u> Homing is triggered or necessary as the drive remembers the taught and current position now).

On power up the current position was:

Now to orient the motor to the taught position, all that is required is to start the motion task using the digital input. On trigger of the input, the motor moves to the taught position (zero).
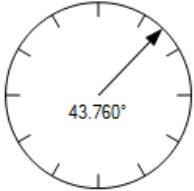
Feedback 1 (X10)

The primary position feedback fitted to your motor.

Feedback Selection: -1 - Auto Identify   ⓘ This is disabled because drive is active.

Feedback Identified: SFD (Smart Feedback Device)

If you rotate the motor shaft you should see the dial move.

33.400°

Motor Autoset: 1 - On

Position Feedback: 359.998 deg
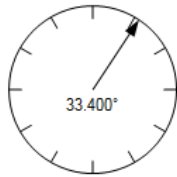
Drive Direction: 0

Position Feedback Poles: 2

Goto Wake and Shake

Additional Note On Multi-turn Encoders:

It is important to understand there is an intrinsic zero and rollover point for the multiturn counts and the feedback device. For example, in the AKM Selection Guide an AKM5 with either BISS (AB) or EnDat (DB) has 2048 cycles per rev. Note 2 states there are 4096 turns of absolute positioning.

Feedback Summary for AKM Servomotor with AKD Servo Drive

Feedback Device/ (Motor designation)	Plug & Play, Motor ID[3]	AKM Models	Device Resolution Cycles or Lines/rev	Resolution after AKD Interpolation[4]: counts (arc-min)	Accuracy: Arc-min (±)
Comcoder (1-)	N	AKM1-8	1024	4096 (5.27)	5.27
Comcoder (2-)	N	AKM1-8	2048	8192 (2.64)	2.64
Resolver (R-)	N	AKM1	1	65536 (0.330)	15
		AKM2-8			8
SFD (C-)	Y	AKM1	16,777,216 (0.00129 arc-min)	N/A	16
		AKM2-8			9
Endat 2.1[1] (DA)	Y	AKM2-4	512	134,217,728 (0.000161)	1.0
		AKM5-8	2048		0.333
Endat 2.1Multi-turn[1,2] (DB)	Y	AKM2-4	512	134,217,728 (0.000161)	1.0
		AKM5-8	2048		0.333
BiSS[1] (AA)	Y	AKM2-8	2048	134,217,728 (0.000161)	0.60
BiSS Multi-turn[1,2] (AB)	Y	AKM2-8	2048	134,217,728 (0.000161)	0.60
Inductive enc.[1] (LA)	Y	AKM2,3	16	1,048,576 (0.0206)	8
		AKM4-7	32	2,097,152 (0.0103)	4.66
Inductive enc. Multi-turn[1,2](LB)	Y	AKM2,3	16	1,048,576 (0.0206)	8
		AKM4-7	32	2,097,152 (0.0103)	4.66

Note 1: Not available for AKM1.
Note 2: Provides 4096 turns of absolute positioning.
Note 3: These feedback devices include electronic motor nameplate data allowing plug-and-play commissioning, eliminating the need for drive parameter set-up and servo loop tuning in most applications.
Note 4: AKD interpolation for sinusoidal feedback devices is 2^{16}, however the resulting usable resolution for positioning may be much less for very high resolution systems.

To graphically demonstrate this, there is an intrinsic zero of the multi-turn feedback device. For the DB and AB encoders rotating more than 2048 turns in either the positive or negative direction will cause the encoder position to rollover.
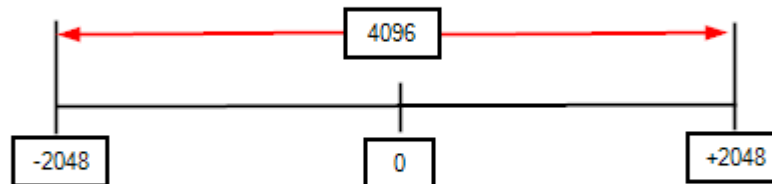
The 4096 turns in the AKM Selection Guide is based on starting at the -2048 turns or negative rollover point and move 4096 turns in the positive direction to the +2048 turn rollover point. Conversely You could move from the +2048 turn rollover point and move 4096 turns in the negative direction.

Basically the rollover point is +/-2048 turns in either direction from zero.

There is also a parameter in the AKD called FB1.EXTENDEDMULTITURN which was added so if enabled (set to 1 and saved to NV memory) the drive could keep track of turns beyond the rollover point and the absolute position would be retained on power cycle.

FB1.EXTENDEDMULTITURN

General Information	
Type	R/W
Description	Enables saving of the extended multiturn position.
Units	N/A
Range	0 to 1
Default Value	0
Data Type	Integer
Start Version	M_01-013-08-000

Description

This parameter allows additional multiturn information to be stored in non-volatile memory and restored on power up.

Extended Multiturn

If using a multiturn feedback where the machine period is not an integer divisor of the encoder period, the full turn count must be saved so that the exact position can be recovered after a power cycle. The machine period is the number of units required by the machine to complete one operational cycle. The encoder period is the maximum amount of travel measurable by the encoder. The encoder period is calculated using the following formula:

$$\text{encoder period} = 2^{(\text{number of encoder turn bits})} (\text{units for one turn of an end system}) (\text{gear ratio})$$

In some applications, a multiturn feedback is not enough to ensure that the position is known after a power cycle. These applications are those where:

$$\text{Machine period} \neq \text{encoder period} * N$$

In these cases, it is necessary to track and store the number of turn bits beyond the bits stored in the feedback. These bits can be stored by setting FB1.EXTENDEDMULTITURN = 1. The supported feedback types include all multiturn encoders: BiSS, EnDAT, Hiperface and Tamagawa (the algorithm requires 12 multiturn bits). If FB1.EXTENDEDMULTITURN is set to 1 on an invalid feedback type then an error will be reported.

A Note On Setting the Origin on an Absolute Feedback using Fieldbuses:

EtherCAT, CANopen, Modbus TCP, and Profinet all have homing methods. How the homing method is triggered depends on the fieldbus protocol. In some cases the drive has to be put into a homing mode and then triggered to start the homing. In other cases it can be done like Modbus TCP writing to the Modbus register for the HOME.MOVE parameter or like in the case of Ethernet IP using an AOI (add on instruction) to start the home. Homing Mode 17 is generally a set it and forget it operation where you run it only once. Sometimes when maintenance is done on the machine (i.e. a belt brakes, a gearhead or motor is replaced, etc. or anything that causes the original mechanical alignment and electrical offset to no longer be accurate) it will be required to recalibrate by executing Homing Mode 17 again. Often it is desirable to do this without using a PC and Workbench software hence the ability to run Homing Mode 17 from a password protected HMI screen etc. is desireable.