Application note
MHAD02_02
Issue 2, 3rd March 2017

Using AksIM™ encoder in closed-loop applications

Abstract

AksIM encoders are frequently used in closed servo loops.
Absolute encoder is mostly used as a primary feedback device for positioning of the main shaft. Often also as a secondary feedback for velocity and commutation as direct-drive motors are gaining popularity.

This application note helps setting up the correct parameters on a controller for a feedback device using AksIM encoder as an absolute feedback encoder.

List of tested drives

AksIM encoders have been tested and operation is confirmed on the following drive controllers.

Manufacturer	Type	Available communication interfaces for absolute encoders	Chapter
Elmo	Gold DC-Whistle Gold Cello	BiSS, SSI (option »E« in Elmo part number)	BiSS, SSI

AksIM™ application note

Drives and settings

1. Elmo Gold DC-Whistle or Cello

Specifications of the drive can be found here: DC-Whistle, Cello.

Electrical connection of the SSI or BiSS encoder to DC-Whistle drive is made using the Port A (J1) connector. See “Chapter 6. Wiring” of the document “Installation Guide” (DC-Whistle document, Cello document).

Image from chapter 6.6.3. for DC-Whistle.

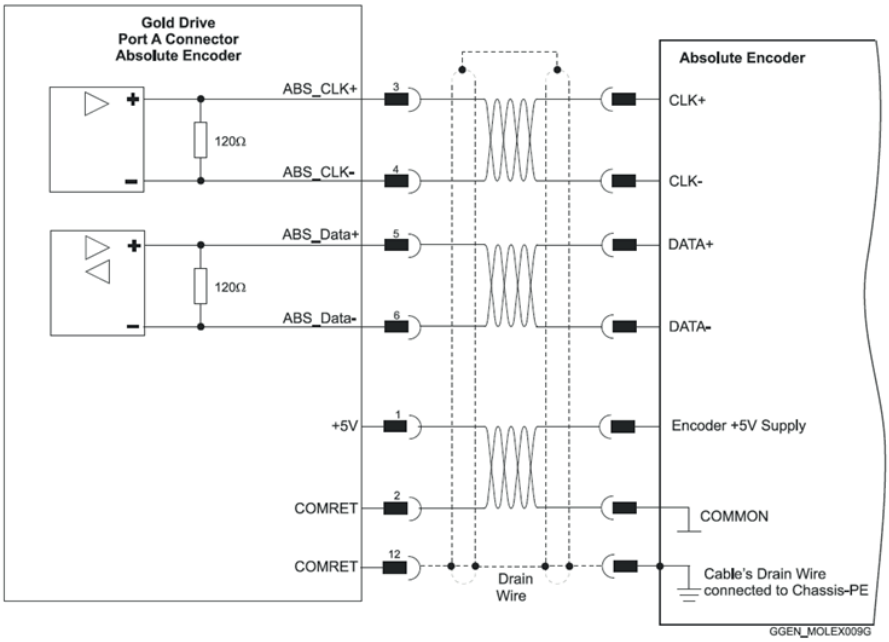


Figure 1

Image from chapter 6.6.3. for Cello.

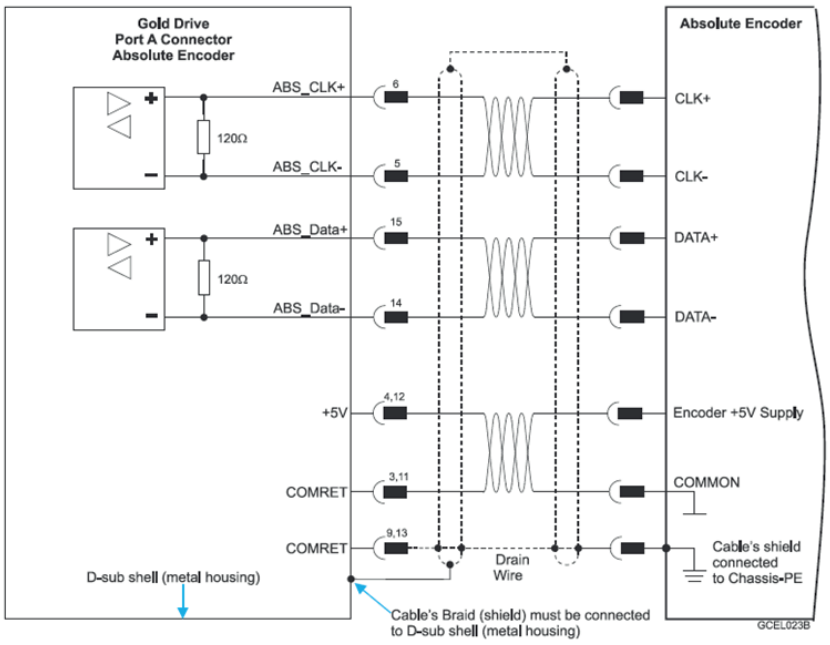


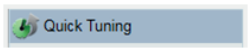
Figure 2

Power supply (+5 V) for the encoder is also derived from the Port A.
Drive supports RS422 signalling on encoder lines.
AksIM MHA readhead can be connected directly to the drive using a suitable connector.
When using AksIM MBA type of encoder (that does not have RS422 line driver integrated) make sure you add a suitable line driver in between. It can be purchased from RLS under part number ACC009. Accompanying FFC cable can be obtained under part number ACC006.

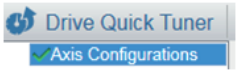
Elmo drive parameters are set up using the “Elmo Application Studio II” software (download).

1. Establish the communication between software and drive.
2. Go to:

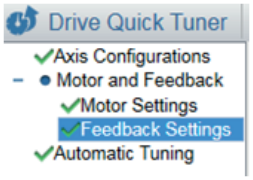
3. Go to:



4. Select:



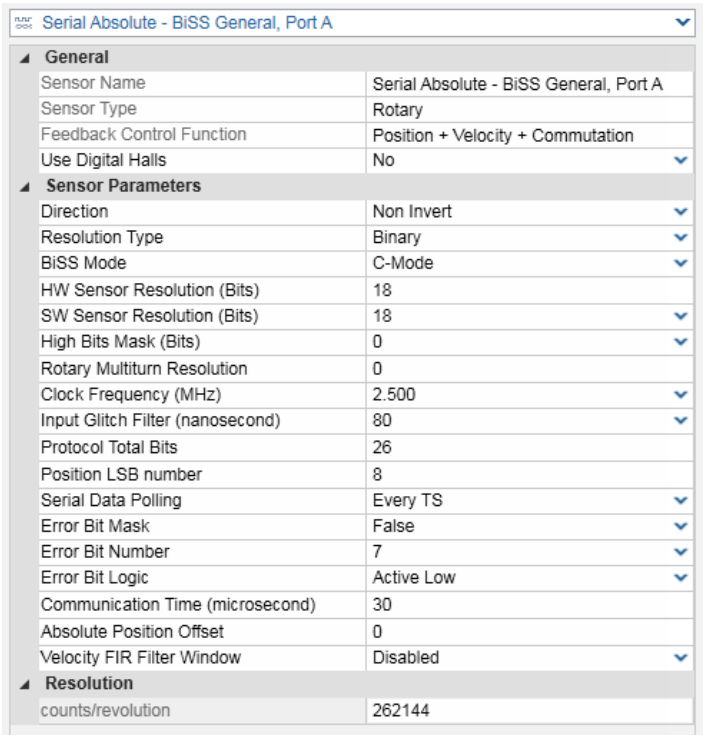
5. Enter mechanical configuration of your drive assembly.
6. Select:



7. Enter correct parameters for chosen encoder.

1.1 BiSS singleturn encoder (DCH and DDH output types)

Below are example settings for BiSS encoder with 18-bit binary resolution, Error bit, mounted as a single feedback device for a direct-drive motor:



Serial Absolute - BiSS General, Port A	
General	
Sensor Name	Serial Absolute - BiSS General, Port A
Sensor Type	Rotary
Feedback Control Function	Position + Velocity + Commutation
Use Digital Halls	No
Sensor Parameters	
Direction	Non Invert
Resolution Type	Binary
BiSS Mode	C-Mode
HW Sensor Resolution (Bits)	18
SW Sensor Resolution (Bits)	18
High Bits Mask (Bits)	0
Rotary Multiturn Resolution	0
Clock Frequency (MHz)	2.500
Input Glitch Filter (nanosecond)	80
Protocol Total Bits	26
Position LSB number	8
Serial Data Polling	Every TS
Error Bit Mask	False
Error Bit Number	7
Error Bit Logic	Active Low
Communication Time (microsecond)	30
Absolute Position Offset	0
Velocity FIR Filter Window	Disabled
Resolution	
counts/revolution	262144

Figure 3

Changing settings for different AksIM BiSS encoders:

Encoder resolution	HW sensor resolution	SW sensor resolution	Protocol total bits
16B	16	16	24
17B	17	17	25
18B	18	18	26
19B	19	19	27
20B	20	20	28

All other settings should be set as per Figure 3.

1.2 BiSS multiturn encoder (DCH and DDH output types)

Elmo drive supports position length of maximum 32-bits. If encoder used has 16 bit long multiturn counter and singleturn position data longer than 16 bits then user has to decide which part of the total data should be ignored to fit into 32 bits.

Full singleturn resolution is required
"High bits mask" parameter is adjusted so the MSB bits of the multiturn counter are ignored.

Encoder resolution	HW sensor resolution	SW sensor resolution	Rotary multiturn resolution	High bits mask	Protocol total bits	Position LSB number
16M	16	16	16	0	40	8
17M	17	17	16	1	41	8
18M	18	18	16	2	42	8
19M	19	19	16	3	43	8
20M	20	20	16	4	44	8

All other settings should be set as per Figure 3 on page 4.

Full multiturn resolution is required
Singleturn resolution is adjusted to 16 bits.

Encoder resolution	HW sensor resolution	SW sensor resolution	Rotary multiturn resolution	High bits mask	Protocol total bits	Position LSB number
16M	16	16	16	0	40	8
17M	16	16	16	0	41	9
18M	16	16	16	0	42	10
19M	16	16	16	0	43	11
20M	16	16	16	0	44	12

All other settings should be set as per Figure 3 on page 4.

1.3 SSI encoder (only SCH and SDH output types with low latency)

Below are example settings for SSI encoder with 18-bit binary resolution, mounted as a single feedback device for a direct-drive motor:

Serial Absolute - SSI, Port A	
General	
Sensor Name	Serial Absolute - SSI, Port A
Sensor Type	Rotary
Feedback Control Function	Position + Velocity + Commutation
Use Digital Halls	No
Sensor Parameters	
Direction	Non Invert
HW Sensor Resolution (Bits)	18
SW Sensor Resolution (Bits)	18
High Bits Mask (Bits)	0
Rotary Multiturn Resolution	0
Clock Frequency (MHz)	1.250
Input Glitch Filter (nanosecond)	120
Protocol Total Bits	22
Position LSB number	4
Sensor Data Presentation	Binary
First Clock Delay (microsecond)	8.0
Serial Data Polling	Every 2*TS
Error Bit Mask	False
Error Bit Number	1
Error Bit Logic	Active High
Communication Time (microsecond)	79
Absolute Position Offset	0
Velocity FIR Filter Window	Disabled
Resolution	
counts/revolution	262144

Figure 4

Settings for SSI encoder do not allow decimal and other custom resolutions, only binary.

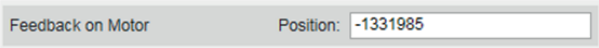
Changing settings for different AksIM SSI encoders:

Resolution	HW sensor resolution	SW sensor resolution	Position LSB number
16B	16	16	6
17B	17	17	5
18B	18	18	4
19B	19	19	3
20B	20	20	2

All other settings should be set as per Figure 4.

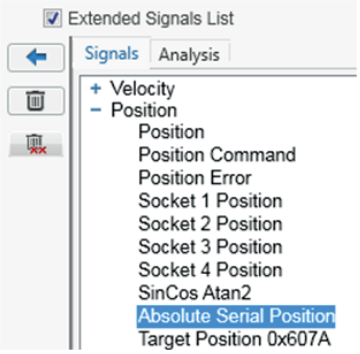
1.4 Operation validation

Correct operation of the encoder should be checked in the window above the settings:



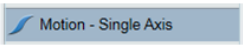
When moving the encoder this number should change.
Note this number does not represent the absolute position (readout from the encoder) but shows internal position calculated in the controller. It shows also negative numbers and counts multiple turns.

Reading the absolute value from the encoder can only be done in the Recorder window.
In Signal selection window tick “Extended Signals List” and add “Absolute Serial Position” to the chosen chart. Run the recorder to get the data.



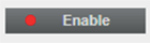
To verify correct operation of the CRC check (BiSS only) and Error bit motor must be enabled.

1. Go to:



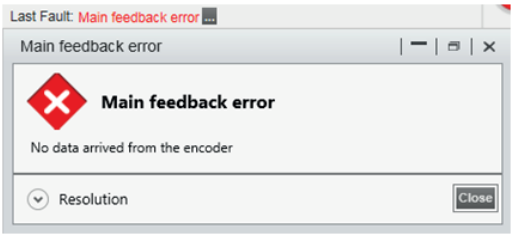
2. Select desired operation mode.

3. Click:

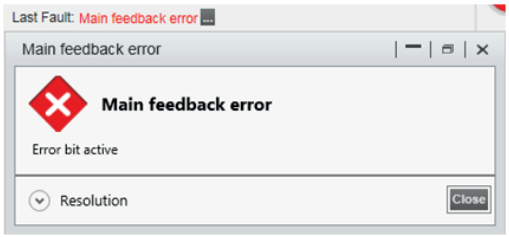


If none of the following errors show up, then encoder is wired and configured correctly.

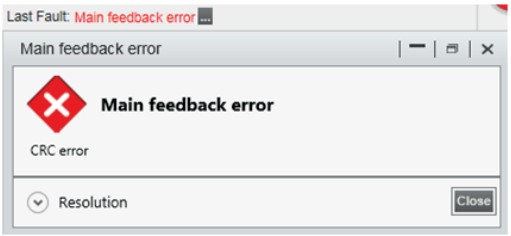
Encoder not connected:



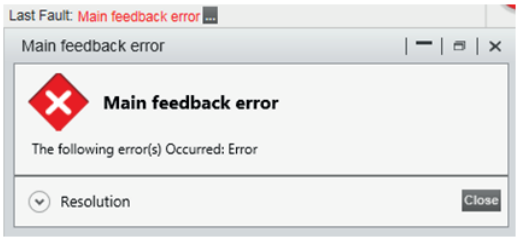
Error bit is active on BiSS encoder:



Fault on settings or wiring of BiSS encoder:



Error bit is active on SSI encoder:



Encoder-related errors can be read out on the terminal using commands “EE[1]”.
See EASII InLine Help for details on the “EE[N] – Extended Error”
Value returned from the “EE[1]” command can be one of these values:

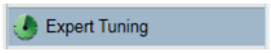
1024	No data received from the encoder
256	CRC Error
1	Encoder error

Communication status can be observed also on the AksIM encoder. When LED on the readhead stops blinking but glows continuously then communication is established. However this only shows that communication is in progress; it does not indicate that transmitted data is interpreted correctly by the drive.

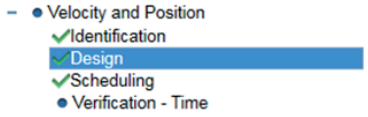
If the AksIM encoder has unstable position, reading the complete closed-loop system will be noisy.
To resolve this issue first check the correct distance between readheads and ring of the encoder. See AksIM datasheet for more information: MHA, MBA.

Second step is to enable Low-pass filter on velocity or position calculation – if Automatic tuning procedure has not enabled it already.

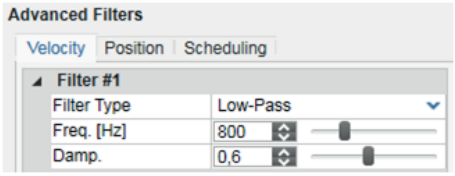
1. Go to:



2. Select:

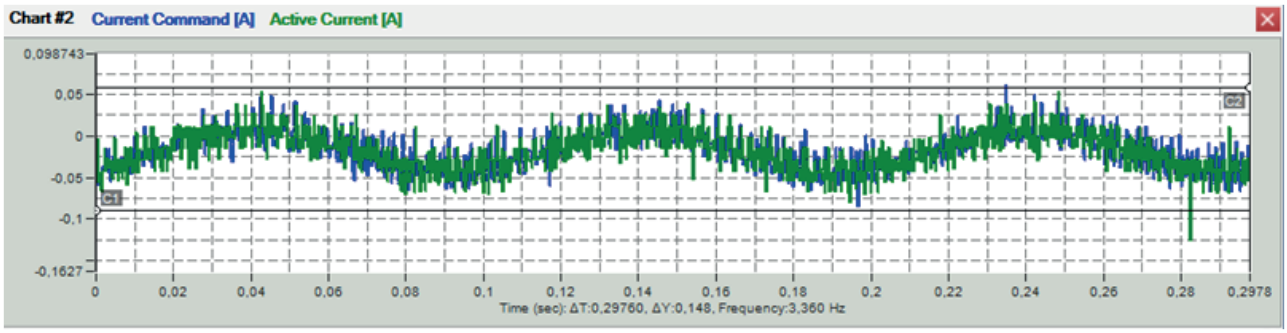


3. Choose correct filter settings to suit application requirements.



Setting the frequency limit too low can result in the system to become unresponsive and in worst case even unstable.

Verification of these settings can be done with tools available in Verification – Time window (for velocity testing) or under Motion - Single Axis, Drive Mode: Position [UM=5], go to Sine Reference tab, tick “Allow Sine Motion”, select Sine wave type, enable motor, enter small amplitude and frequency values and press Start. In Recorder verify how noisy “Current Command” and “Active Current” values are. Also listen to the motor in standstill, slow motion and fast motion.



Motor and brake influence

Magnetic brakes are installed in many of the motor assemblies. They can have leaking magnetic field when operated. Also motors with low shielding or strong permanent magnets can have leaking magnetic field.

Such external magnetic fields in excess of ±3 mT in the place of the readhead may cause AksIM encoder miscounting. In such case add ferromagnetic shielding between the motor or brake and encoder. Encoder should be mounted with the back of the ring facing the coils or magnets and readhead should be on the back side pointing away from the source of leaking magnetic field.
See AksIM datasheet for more information on this topic: MHA datasheet, MBA datasheet.

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Document issues

Issue	Date	Page	Corrections made
1	4. 4. 2016	-	New document
2	3. 3. 2017	4, 5	15B resolution removed, multiturn options added