AksIM-4™
BiSS C Register Access

The BiSS C interface implemented in AksIM supports bidirectional communication in register access mode. The readhead is user configurable. Implementation is compliant with BiSS C (also Standard Encoder Profile known as “BP3”), which is used to group linear and rotary encoders. Details on BiSS register access and BP3 can be found on the **BiSS website**.

User implementation: User can implement bidirectional BiSS in their own hardware according to the BiSS documentation provided by iC-Haus. As an alternative it is also possible to use the iC-Haus chip iC-MB4, which translates the high-level commands on the SPI bus into BiSS. The easiest way is to use the interface E201-9B from RLS including the corresponding software.

This document is organized in two parts:

- **Quick Start & Essential Registers**: the most commonly used registers and commands, for fast implementation.
- **Complete Register Map**: full register-level reference, including all memory banks (e.g. EDS), for advanced implementation.

Related products



AksIM-4™ off-axis absolute magnetic encoder



E201-9B USB interface

Quick start and essential registers

How to read and write registers

Registers are grouped into 64-byte banks, accessed by first selecting the bank via the Bank select register - see chapter Bank switching. All registers can be read directly; writable registers can also be written and, where needed, saved to non-volatile memory. The tables below cover the most commonly used registers and commands — for the complete register map and detailed access rules, see chapter **Complete register map**.

Bank switching

To switch to a different bank, write the desired bank number to the Bank select register (address 0x40) before reading or writing any register in that bank. This ensures subsequent register accesses (0x00–0x3F) refer to the correct bank.

Identification

Bank	Address	Data type	Access	Default value	Description
2	0x00–0x0F	16 x U8	R	*	RLS serial number (ASCII characters)
	0x14–0x27	20 x U8	R	*	RLS part number (ASCII characters)
	0x28–0x29	U16	R	4	FW major version
	0x2A–0x2B	U16	R	*	FW minor version

* Most values of parameters depend on actual part.

Installation (air gap)

Bank	Address	Data type	Access	Default value	Description
Direct access	0x50–0x53	U32	R	**	Signal level
2	0x3A–0x3B	S16	R	*	Ride height K value [x10]
	0x3C–0x3D	S16	R	*	Ride height N value

* Most values of parameters depend on actual part.
** Parameter value changes during operation.

The signal level information can be used to calculate the ride height (distance between rubber on the ring and sensor on the readhead). For more information refer to chapter **Signal level**.

Eccentricity calibration

Command	Command [hex]	Typ. execution time [ms]	Description
'A'	0x41	Set with parameter	Self-calibration start

Bank	Address	Data type	Access	Default value	Description
4	0x00–0x03	U32	R	0	Self-calibration status

Setting custom position offset

Bank	Address	Data type	Access	Value in effect	Default value	Min / max	Description
3	0x00–0x03	U32	RW	Immediate	0	0...RESOL.	Position offset *

* Max allowed value is determined from encoder resolution.

Command	Command [hex]	Typ. execution time [ms]	Description
'c'	0x63	70	Save current configuration to non-volatile memory

Multiturn preset

Bank	Address	Data type	Access	Value in effect	Default value	Min / max	Description
3	0x14–0x17	U32	RW	Immediate	0	0...65535	Multiturn counter preset *

* Multiturn parameters are set to READ access if encoder has no multiturn support.

Command	Command [hex]	Typ. execution time [ms]	Description
‘m’	0x6D	1	Apply multiturn counter from “multiturn counter preset” parameter value

Basic diagnostics

Bank	Address	Data type	Access	Default value	Description
Direct access	0x4A–0x4D	U32	R	0	Encoder detailed status (see chapter »**Encoder operating parameters**«)
	0x4E–0x4F	S16	R	*	Sensor temperature in °C
	0x50–0x53	U32	R	*	Signal level
	0x54–0x57	S32	R	*	Measured velocity in 0.1 RPM
	0x58–0x5B	U32	R	0	Persistent detailed status
	0x5E–0x5F	S16	R	*	Board temperature in °C

* Parameter value changes during operation.

Complete register map

BiSS EDS banks

Bank	Address	Symbol	Description	Data type	Unit	Value
1	0x00	EDS_VER	EDS version	U8	–	1
	0x01	EDS_LEN	EDS length	U8	Banks	2
	0x02	USR_STA	Bank address USER start	U8	–	255
	0x03	USR_END	Bank address USER end	U8	–	1
	0x04	TMA	Min. permitted clock period	U8	1 ns	200*
	0x05	TO_MIN	Min. BiSS timeout	U8	250 ns	50
	0x06	TO_MAX	Max. BiSS timeout	U8	250 ns	64
	0x07	TOS_MIN	Min. BiSS timeout_S	U8	25 ns	0
	0x08	TOS_MAX	Max. BiSS timeout_S	U8	25 ns	0
	0x09	TCLK_MIN	Min. sampling period adaptive timeout	U8	25 ns	0
	0x0A	TCLK_MAX	Max. sampling period adaptive timeout	U8	25 ns	0
	0x0B	TCYC	Min. cycle time	U8	250 ns	**table A**
	0x0C	TBUSY_S	Max. Processing time SCD	U8	250 ns	0
	0x0D	BUSY_S	Max. Processing time SCD in clocks	U8	TMA	15
	0x0E–0x0F	PON_DLY	Max. »power on delay« until control communication is available	U16	1 ms	250
	0x10	DC_NUM	Number of channels in this device	U8	–	1
	0x11	SL_NUM	Area of validity for this EDS (number of slave addresses)	U8	–	1
	0x12	SL_OFF	Memory location for this EDS (slave ID within this device)	U8	–	0
	0x13		Reserved	U8		0
	0x14	BANK1	Bank address for content description of data channel 1 (Profile EDS)	U8	–	0
	0x15	DLEN1	Data length for data channel 1	U8	Bit	**table A**
	0x16	FORMAT1	Data format for data channel 1	U8	Bit	2
	0x17	CPOLY1	CRC polynomial (8:1) for data channel 1	U8	–	0x21
	0x18–0x33		Reserved	U8		0
	0x34	BC_OFF	Bus coupler control location for this device (slave ID within this device)	U8	–	0
	0x35–0x3E		Reserved	U8		/
	0x3F	CHKSUM	Checksum (sum of all bytes within this bank)	U8	–	xx

All parameters from EDS banks are read-only.

*According to BiSS EDS (Common part) specification Rev A2, value of this register is out of permitted range (due to an error in specification document), yet correct according to encoder specification.

Bank	Address	Symbol	Description	Data type	Unit	Value
0	0x00	BP_VER	BiSS profile 3 version	U8	–	1
	0x01	BP_LEN	Length of this profile	U8	Banks	1
	0x02–0x03	BP_ID	Profile identification BP3 (content also available in addresses 0x42 and 0x43)	U16	–	**table B**
	0x04	PROFILE_FB1	Feedback bit 1 (nError = 1)	U8	–	1
	0x05	PROFILE_FB2	Feedback bit 2 (nWarning = 2)	U8	–	2
	0x06	PROFILE_PON_PDL	Max. “power on delay” until position data is available	U8	1 ms	250
	0x07		Reserved	U8		0
	0x08	PROFILE_EN_TYP	Encoder type (rotary = 0)	U8	–	0
	0x09	PROFILE_POS_NUM	Position value (1 position)	U8	–	1
	0x0A	PROFILE_MT_LEN	Data length MULTITURN	U8	Bit	**table B**
	0x0B	PROFILE_MT_FMT	Data format MULTITURN	U8	–	**table B**
	0x0C	PROFILE_CO_LEN	Data length COARSE	U8	Bit	0
	0x0D	PROFILE_CO_FMT	Data format COARSE	U8	–	0
	0x0E	PROFILE_FI_LEN	Data length FINE	U8	Bit	**table B**
	0x0F	PROFILE_FI_FMT	Data format FINE	U8	–	0
	0x10–0x13	PROFILE_MT_CNT	Number of distinguishable revolutions	U32	Count	**table B**
	0x14–0x17	PROFILE_SIP_CNT	Number of signal periods per revolution	U32	PPR	1
	0x18–0x1B	PROFILE_SIP_RES	Resolution factor per signal period (LSB of interpolation)	U32	Count	**table B**
	0x1C–0x1F	PROFILE_CPOLY	CRC polynomial (32:1 of 0x43)	U32	–	0x21
	0x20–0x23	PROFILE_CSTART	CRC start value	U32	–	0
	0x24–0x25	PROFILE_ABS_ACU	Absolute accuracy	U16	LSB/2	1 (Note A)
	0x26–0x27	PROFILE_REL_ACU	Repeat accuracy	U16	LSB/2	1 (Note A)
	0x28–0x29	PROFILE_SPD_ACU	Angular speed depending accuracy	U16	LSB/2	1 (Note A)
	0x2A–0x2B	PROFILE_HYST	Hysteresis	U16	LSB/2	1
	0x2C–0x2D	PROFILE_SPD_MAX	Max. revolution speed	U16	1/min	(Note B)
	0x2E–0x2F	PROFILE_ACC_MAX	Max. angular acceleration	U16	$1/min^2$	65534 (Note A)
	0x30–0x31	PROFILE_TMP_MIN	Min. operating temperature	U16	K	233 (Note B)
	0x32–0x33	PROFILE_TMP_MAX	Max. operating temperature	U16	K	378 (Note B)
	0x34–0x35	PROFILE_VLT_MIN	Min. operating voltage	U16	mV	4500
	0x36–0x37	PROFILE_VLT_MAX	Max. operating voltage	U16	mV	5500
	0x38–0x39	PROFILE_CUR_MAX	Max. current consumption	U16	mA	160
	0x3A–0x3E		Reserved	U8		0
	0x3F	CHKSUM	Checksum (sum of all bytes within this bank)	U8	–	xx

All parameters from EDS banks are read-only.
Note A: Register value set to minimum/maximum value according to BiSS EDS (Common part) specification Rev A2. Value may be defined in product datasheet.
Note B: Parameter value depends on actual part number.

Encoder identification bank

Bank	Address	Data type	Access	Default value	Description
2	0x00–0x0F	16 x U8	R	*	RLS serial number (ASCII characters)
	0x10–0x13	U8	R	/	Reserved
	0x14–0x27	20 x U8	R	*	RLS part number (ASCII characters)
	0x28–0x29	U16	R	4	FW major version
	0x2A–0x2B	U16	R	*	FW minor version
	0x2C–0x2D	U16	R	*	FW hotfix version
	0x2E–0x31	U32	R	*	FW build version
	0x32–0x35	4 x U8	R	*	FW version short hash
	0x36–0x39	U32	R	*	Production parameters version
	0x3A–0x3B	S16	R	*	Ride height K value [x10]
	0x3C–0x3D	S16	R	*	Ride height N value
	0x3E	U8	R	0	Reserved
	0x3F	U8	R	xx	Checksum (sum of all bytes within this bank)

* Most values of parameters in identification bank depend on actual part.

Encoder configuration bank

Bank	Address	Data type	Access	Value in effect	Default value	Min / max	Description
3	0x00–0x03	U32	RW	Immediate	0	0...RESOL.	Position offset *
	0x04–0x07	U32	RW	Power-on	200	0...240	Position filter value
	0x08–0x0B	U8	R	0	0		Reserved
	0x0C–0x0F	U32	RW	Power-on	190	0...240	Velocity filter value
	0x10–0x13	U8	R	0			Reserved
	0x14–0x17	U32	RW	Immediate	0	0...65535	Multiturn counter preset **
	0x18	U8	RW	Power-on	90	2...90	Multiturn error arc length [deg] **
	0x19–0x3D	U8	R	/			Reserved
	0x3E	U8	RW	Immediate (+ ‘c’ command)	0x5A	0...255	Write protect lock
	0x3F	U8	R	xx			Checksum (sum of all bytes within this bank)

* Max allowed value is determined from encoder resolution.

** Multiturn parameters are set to READ access if encoder has no multiturn support.

Self-calibration bank

Bank	Address	Data type	Access	Default value	Min / max	Description
4	0x00–0x03	U32	R	0		Self-calibration status
	0x04–0x05	U16	RW	360	180...360	Partial arc length [deg]*
	0x06–0x07	U16	R	0		Ring eccentricity shift from rotation axis centre [µm]
	0x08–0x09	U16	R	0		Ring eccentricity angle (phase) [deg]
	0x0A–0x0B	U16	R	0		Readhead radial shift (positive towards centre of axis) [µm]
	0x0C	U8	RW	10	1...40	Calibration timeout [s]
	0x0D	U8	R	0		Reserved
	0x0E–0x0F	U16	R	0		Average height value (optional)
	0x10–0x11	U16	R	0		Ring eccentricity shift from rotation axis centre [mdeg/10] (optional)
	0x12–0x13	U16	R	0		Ring eccentricity angle (phase) [0...511] (optional)
	0x14–0x3E	U8	R	0		Reserved
	0x3F	U8	R	xx		Checksum (sum of all bytes within this bank)

* If partial arc is not supported, this register is read-only.

Some of writable parameters values are taken into account immediately after value gets changed by writing to this register. For these registers it is not needed to save configuraton to non-volatile memory if setting will only be needed in current power cycle.

Error map banks

Bank	Address	Data type	Access	Description
8	0x00–0x3F	S16	R	Error Map [0 – 31]
9	0x00–0x3F	S16	R	Error Map [32 – 63]
10	0x00–0x3F	S16	R	Error Map [64 – 95]
11	0x00–0x3F	S16	R	Error Map [96 – 127]
12	0x00–0x3F	S16	R	Error Map [128 – 159]
13	0x00–0x3F	S16	R	Error Map [160 – 191]
14	0x00–0x3F	S16	R	Error Map [192 – 223]
15	0x00–0x3F	S16	R	Error Map [224 – 255]
16	0x00–0x3F	S16	R	Error Map [256 – 287]
17	0x00–0x3F	S16	R	Error Map [288 – 319]
18	0x00–0x3F	S16	R	Error Map [320 – 351]
19	0x00–0x3F	S16	R	Error Map [352 – 383]
20	0x00–0x3F	S16	R	Error Map [384 – 415]
21	0x00–0x3F	S16	R	Error Map [416 – 447]
22	0x00–0x3F	S16	R	Error Map [448– 479]
23	0x00–0x3F	S16	R	Error Map [480 – 511]
24	0x00–0x0F	U8	R	Checksums of banks 8-23 on addresses 0-15

Values in the error map are absolute position correction values for each 1/512 sector of the absolute position. The correction value at index 0 is applied to internal absolute position 0, index 1 corresponds to 1/512 of a rotation, and so on. Correction is applied to the internal position, which has higher resolution than the position read out via communication; the internal resolution depends on ring size. The correction value is subtracted from the current internal position. Corrections within a given sector are applied using the interpolated value of the two adjacent correction values.

Direct access registers

Address	Data type	Access	Default value	Description
0x40	U8	RW	0	Bank select
0x41	U8	R	1	EDS bank
0x42–0x43	U16	R	*	Profile ID (**table B** – BP_ID)
0x44–0x47	U32	R	*	Serial number (encoded)
0x48	U8	RW	255	Key register
0x49	U8	RW	255	Command register
0x4A–0x4D	U32	R	0	Encoder detailed status (refer to chapter »**Encoder operating parameters**«)
0x4E–0x4F	S16	R	**	Sensor temperature in °C
0x50–0x53	U32	R	**	Signal level
0x54–0x57	S32	R	**	Measured velocity in 0.1 RPM
0x58–0x5B	U32	R	0	Persistent detailed status
0x5C	U8	R	0	Parameter access status register – **table C**
0x5D	U8	R	0	Reserved
0x5E–0x5F	S16	R	**	Board temperature in °C
0x60–0x63	U8	R	0	Reserved
0x64–0x65	S16	R	**	Min. distance of decoding point from decoding warning threshold
0x66–0x67	S16	RW	**	Min. distance of decoding point from decoding warning threshold - persistent
0x68–0x6B	U32	R	**	Diagnostic data: Number of power cycles (max = 8,388,607 or 33K writes to flash)
0x6C–0x6F	U32	R	**	Diagnostic data: Time of operation in minutes (max = 16,777,215 or ~32 years)
0x70	S8	R	**	Diagnostic data: Min. measured temperature in °C (limit = –127 °C)
0x71	U8	R	0	Reserved
0x72–0x73	S16	R	**	Diagnostic data: Max. measured temperature in °C (limit = 255 °C)
0x74–0x77	U32	R	Same as in Identification bank	Major FW version
0x78–0x7D	U8	R	*	Device ID
0x7E–0x7F	U16	R	0x5253	Manufacturer ID

* Parameter value depends on actual part.
** Parameter value changes during operation.

Table A: EDS parameters

Resolution	DLEN	TCYC	Resolution	DLEN	TCYC
17 bit ST	19	90	20 bit MT	38	105
17 bit MT	35	102	21 bit ST	23	93
18 bit ST	20	90	21 bit MT	39	106
18 bit MT	36	103	22 bit ST	24	94
19 bit ST	21	91	22 bit MT	40	106
19 bit MT	37	104	23 bit ST	25	94
20 bit ST	22	92	23 bit MT	41	107

Table B: Encoder type parameters

Encoder type	BP_ID	MT_LEN	MT_FMT	FI_LEN	MT_CNT	SIP_RES
17 bit ST	0x6213	0	0	17	0	131072
17 bit MT	0x6223	16	1	17	65536	131072
18 bit ST	0x6214	0	0	18	0	262144
18 bit MT	0x6224	16	1	18	65536	262144
19 bit ST	0x6215	0	0	19	0	524288
19 bit MT	0x6225	16	1	19	65536	524288
20 bit ST	0x6216	0	0	20	0	1048576
20 bit MT	0x6226	16	1	20	65536	1048576
21 bit ST	0x6217	0	0	21	0	2097152
21 bit MT	0x6227	16	1	21	65536	2097152
22 bit ST	0x6218	0	0	22	0	4194304
22 bit MT	0x6228	16	1	22	65536	4194304
23 bit ST	0x6219	0	0	23	0	8388608
23 bit MT	0x6229	16	1	23	65536	8388608

Table C: Parameter access status register

Bit	Description
0	Write access denied
1	Value out of range
2–5	Reserved
6	Command fetched and executed
7	Write lock active

Bits are persistent - they get cleared on register read, except ‘Write lock active’, which can not be cleared.

Read access

All registers in AksIM memory are readable. Read access also supports sequential reading. It is possible to read up to 64 bytes forward from initialized read address. For detailed description on sequential read access refer to documentation provided by iC-Haus.

Write access

All registers can be write-protected if write access is locked by the user, except of Bank select register. Sequential write access is available in all banks. For detailed description on sequential write access refer to documentation provided by iC-Haus.

Encoder operating parameters

Address	Data Type	Access	Description
0x4A–0x4D	U32	R	Encoder status
0x58–0x5B	U32	R	Persistent encoder status
0x4E–0x4F	S16	R	Sensor temperature in °C
0x50–0x53	U32	R	Signal level
0x54–0x57	S32	R	Rotational speed in 0.1 rpm
0x00–0x03	U32	R	Self-calibration status (bank 4)

Encoder status

Detailed status bits represent current operational state of the encoder. For more information refer to MCD06 in “Detailed status bits” chapter at **RLS Media center**.

Persistent encoder status

This is similar to “Encoder status”, but with the added functionality that all detailed statuses are accumulated. Any error or warning that appears in Detailed Status during operation of encoder is copied into Persistent detailed status. Even if the value in Detailed Status has very short duration, the past statuses can be read from this Persistent register. It keeps the value as long as the power is present. Clearing is possible either by a power cycle or by writing the command ‘b’ to the Command register.

Sensor temperature

Temperature of the sensor in °C. This value is typically 10 °C to 15 °C higher than ambient. Tolerance of the readout is ±5 °C.

Signal level

The signal level information can be used to calculate the ride height (distance between rubber on the ring and sensor on the readhead).

The value is proportional to the distance between the sensor and the ring. To calculate the real distance, use the following formula:

$$\text{Ride height} = K \times \text{Ln}(\text{SignalLevel}) + N$$

Ln stands for natural logarithm.
Calculated ride height has tolerance of ±20 µm.
K and N are selected depending on the encoder size.
K value read from register needs to be divided by 10 when used in equation.

Rotational speed

Encoder rotational speed in 0.1 rpm.

Self-calibration status

Refer to chapter **Self-calibration.**

AksIM-4 programming

Position offset (encoder zero position), multiturn counter (optional) and register write protection can be programmed to the AksIM readhead. Additional to this, the readhead can be self-calibrated or reset to the factory defaults.
Values written into registers take effect immediately, with some exceptions - see “value in effect” column in registers description tables.

Command execution

To execute a command use the following sequence:
Write value 0xCD to Key register at address 0x48
Write command byte to Command register at address 0x49

Write to key and command register must be performed as a writing sequence — do not use BiSS sequential write (auto-incrementing burst write) to write both bytes in a single transaction, as this will not work correctly. No other register access should take place in between, otherwise command will not be executed. Any other register access after correct key is entered invalidates key value and the command write procedure has to be repeated.

After each command is fetched by encoder, communication is disabled during command execution.
Communication is enabled only after command has executed which can last up to 100 ms.
During this time encoder will not respond to communication requests.

The controller can check whether the command executed in the “Parameter access status register” – see **table C.**

Supported commands

Command	Command [hex]	Typ. execution time [ms]	Description
'A'	0x41	Set with parameter	Self-calibration start
'b'	0x62	1	Persistent detailed status reset
'c'	0x63	70	Save current configuration to non-volatile memory
‘m’	0x6D	1	Apply multiturn counter from “multiturn counter preset” parameter value
'r'	0x72	70	Configuration reset to factory defaults

Position offset (encoder zero position)

Position offset is subtracted from the raw encoder position. The position offset is mapped to registers 0x00–0x03 of bank 3 in big-endian format. To set a new position offset, write the corresponding bytes in counts to these registers. The values can then be read back to verify that the write operation was successful. If the absolute applied position offset is greater than the actual encoder resolution, the value will not be updated.

After changing the zero position by a larger amount, an acceleration error might appear. After setting a new position offset, verify or adjust the multiturn counter value (if present).

To store new value into non-volatile memory use the following sequence:
KEY: write value 0xCD to address 0x48
Command for saving programmed data to a non-volatile memory: write value 0x63 to address 0x49.

Saving the parameters in the non-volatile memory takes 70 ms. During this time, the encoder position is not calculated. With the multiturn counter option, the counter is only valid if the rotational speed does not exceed ±300 rpm during the saving process.

Multiturn counter

Multiturn counter preset is only available for the multiturn variants of the AksIM encoders.
First, the new multiturn counter value must be written to register 0x14 – 0x17, bank 3. Programming a multiturn counter greater than 65535 (unsigned) is discarded. At this point, the new multiturn counter is not yet active. To apply it, the user must execute the command to preset the multiturn counter:
KEY: write value 0xCD to address 0x48
Command: write value 0x6D to address 0x49

Self-calibration

Self-calibration of AksIM is suitable after mounting the readhead. It improves the accuracy of the encoder, which depends on the mounting precision. It can be triggered by sending the KEY (0xCD) to the Key register (address 0x48) and afterwards sending the Self-calibration start command (0x41) to the Command register (address 0x49). No communication via the BiSS interface is possible during the process; the encoder does not respond to incoming clock cycles. The completion of the process is indicated by the LED flashing rapidly for 3 seconds. If the self-calibration was successful, the LED flashes green, otherwise it flashes red. The BiSS interface is then active again. The status of self-calibration can be read from a register 0x00 in bank 4. It consists of a two-bit counter. The counter is incremented at the end of each self-calibration. Status bits indicate success or reasons for failure.

Prior to the self-calibration process, the status should be read from register 0x00 - 0x03 in bank 4. The controller must remember the current self-calibration counter (bits 1:0). After sending the self-calibration command, LED must be observed for completion. If the LED is not visible, the readhead should be polled via the BiSS interface until communication with the readhead is re-established, or wait 10 seconds, which is the default timeout for completion. The self-calibration status register should then be read out again. When the self-calibration counter has increased by 1 (compared to the previously read value), the self-calibration function has been completed. Additional data from the self-calibration is available in bank 4 and includes the measurement of the ring eccentricity and the placement of the readhead.

Speed and direction of rotation during self-calibration are not important and may be inconsistent. The only requirement is that the shaft makes at least one complete revolution within 10 seconds of the command being sent. If the default setting of 10 seconds is not sufficient, this period can be extended to up to 40 seconds using register 0x0C, bank 4. If the mechanics do not allow 360° rotation, the length of the calibration arc can be reduced to at least 180° and written into the register 0x04 – 0x05, bank 4. The new arc length must be set before the self-calibration function is executed. The performance of the self-calibration procedure is optimal at 360° rotation and is reduced if the arc length is reduced.

Address	Type	Range	Units	Description / usage
INPUT				
0x04–0x05, bank 4	U16	180 – 360	degrees	Partial arc length
0x0C, bank 4	U8	1 – 40	s	Calibration timeout
0x48	U8	0xCD	-	Key
0x49	U8	0x41	-	Command
OUTPUT, bank 4				
0x06–0x07	U16	0 – 400	µm	Ring eccentricity shift from rotation axis centre
0x08–0x09	U16	0 – 360	degrees	Ring eccentricity angle (phase)
0x0A–0x0B	S16	–1000 – 1000	µm	Readhead radial shift (positive value – readhead is mounted towards the center of the axis)
0x00–0x03	U32		bit	Status - see table on the next page

Self-calibration status register:

Bit	Meaning
b21	Error - Parameters could not be saved to non-volatile memory (system fault).
b20	Indication - Error map table is not default (self-calibration was successfully performed). Comparison is executed at power-up and at every command “Save current configuration to non-volatile memory”.
b19–b16	Reserved
b15	Error - Radial displacement is very high.
b14	Indication - Eccentricity is already low (no correction is needed).
b13	Error - Eccentricity is very high.
b12	Error - Numerical error during data processing.
b11–b10	Reserved
b9	Error - Encoder is in error state while calibration is started - aborted.
b8	Timeout - Encoder did not complete full revolution (or partial arc) in preset time.
b7	Reserved
b6	Error
b5	Ring positioning is already perfect - correction was not performed.
b4	Confirmation - Self calibration successfully completed.
b3–b2	Reserved
b1:b0	Counter is incremented at the end of self-calibration procedure.

When self-calibration is completed without error, the new parameters are automatically stored in non-volatile memory and no further command is required. All numeric results from the calibration are stored in the volatile memory and are cleared on the power cycle. To verify if encoder was already calibrated, read the Self-calibration status register and verify that bit b20 is set.

Dynamic filtering

The AksIM-4 encoder uses dynamic low-pass filters to reduce noise in the calculated position value.
The default values are suitable for most applications. However, in some extreme cases, fine tuning is required to achieve optimum performance. For example, in precise applications with low speed and acceleration, the filtering can be increased to increase the resolution.
In contrast, fast and dynamic applications may require a reduction in filtering to reduce delay and increase the bandwidth.

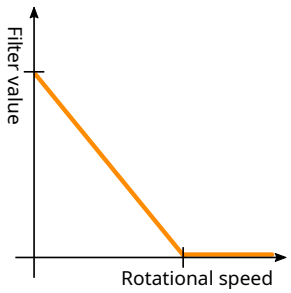
Filter settings

Settings are present in bank 3 - Encoder configuration bank.

Address	Name	Default	Range	Description
0x04–0x07	Position filter value	200	0 – 240	Maximum value of Position Filter when encoder is standstill. 0 = filter disabled
0x0C–0x0F	Velocity filter value	190	0 – 240	Value of Velocity Filter. 0 = filter disabled

Position filter

Encoder position value, from every internal encoder cycle, is passed through the low-pass filter. This gives smoother position value and increased resolution when encoder speed is low or decelerating.
Increased Value parameter increases filter strength and reduces cut-off frequency. This value is used when encoder is standstill. With increasing rotational speed, filter is linearly reduced. When rotational speed is equal or bigger than Speed parameter, filter is turned off.



Velocity filter

Internally calculated velocity (rotational speed) is passed through the low-pass filter. This gives smoother position value on communication interface. Increased Value parameter increases filter strength and reduces cut-off frequency. Filter is constant and not dependent on the rotational speed.

Changing filter values may cause encoder or closed control loop to become unstable. Use with caution and evaluate all possible situations before keeping the new values.

Saving configuration parameters

Sending a programming command byte ‘c’ triggers the procedure to save all configuration parameters of the encoder in the non-volatile memory. These parameters also include the position offset.

KEY: write value 0xCD to address 0x48
Command for saving programmed data to a non-volatile memory: write value 0x63 to address 0x49

Saving the parameters in the non-volatile memory takes 70 ms. During this time, the encoder position is not calculated. With the multiturn counter option, the counter is only valid if the rotational speed does not exceed ±300 rpm during the saving process.

Reset to factory defaults

Resetting to the factory defaults will set all programmed parameters to the default values. This includes the zero position, the calibration results and others.

KEY: write value 0xCD to address 0x48
Command for resetting readhead to the factory defaults: write value 0x72 to address 0x49.

Saving the parameters in the non-volatile memory takes 70 ms. During this time, the encoder position is not calculated. With the multiturn counter option, the counter is only valid if the rotational speed does not exceed ±300 rpm during the saving process.

After locking the write access, the encoder cannot be reset to the factory defaults.

Write protection

Write protection can be used to lock the write access of any writable register in AksIM memory map, except of Bank select register. It is mapped to the register 0x3E of bank 3. Its default value is 0x5A. To lock the write access, user should write any value other than 0x5A. After that, the write access of any register, except of Bank select, will be refused.
All registers will behave as a non writable registers.

KEY: write value 0xCD to address 0x48
Command for saving programmed data to a non-volatile memory: write value 0x63 to address 0x49

Saving the parameters in the non-volatile memory takes 70 ms. During this time, the encoder position is not calculated. With the multiturn counter option, the counter is only valid if the rotational speed does not exceed ±300 rpm during the saving process.

After locking the write access, the readhead cannot be programmed anymore. All registers are still readable.

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Document issues

Issue	Date	Page	Description
1	2. 9. 2026	-	New document

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