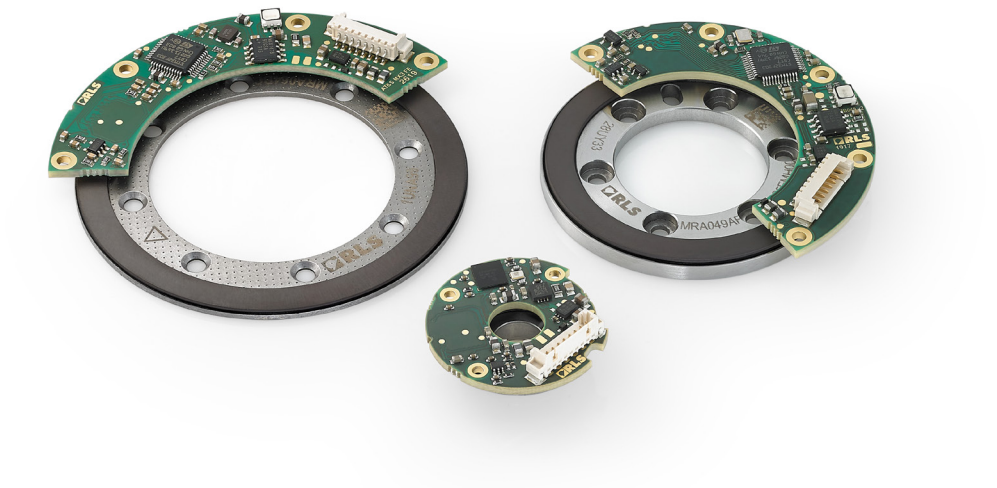
Application note
MBD08_02
Issue 2, 6th July 2020

Programming AksIM-2 encoders with EncoLink communication protocol

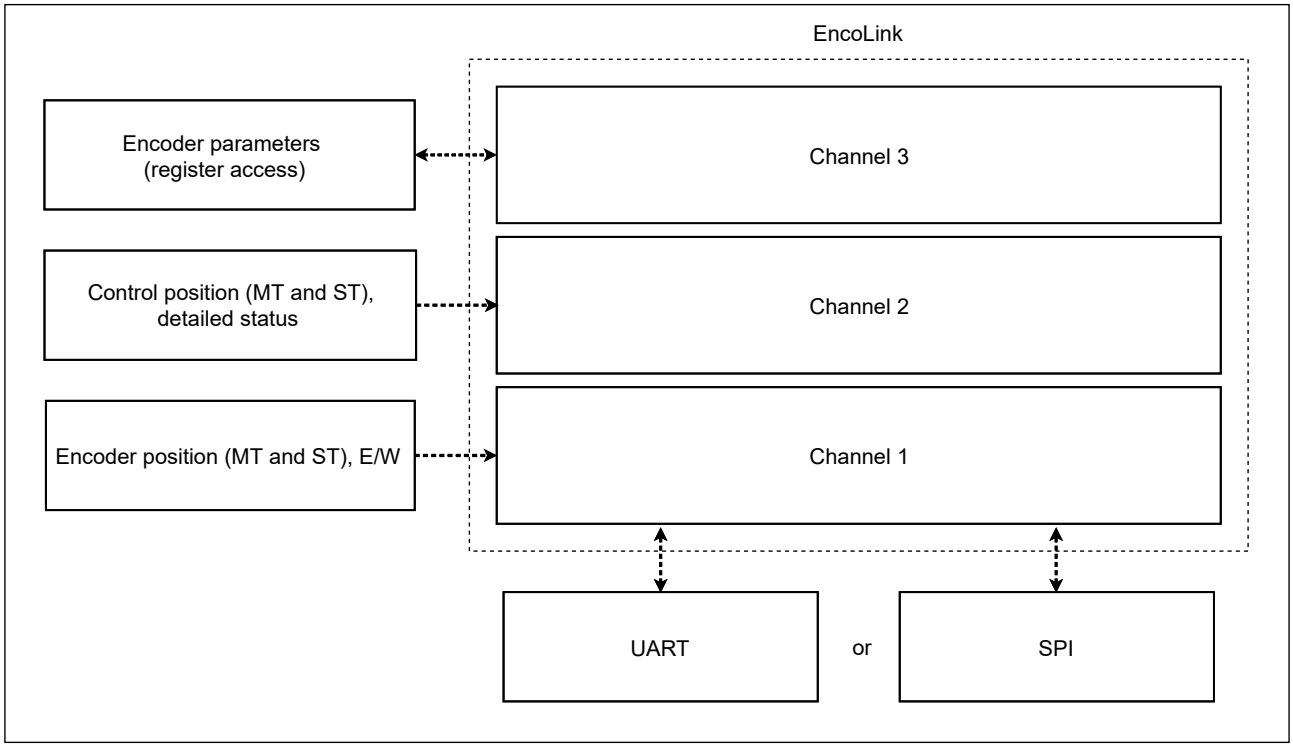


A RENISHAW associate company

AksIM-2 application note

General description

EncoLink is a communication protocol which can be implemented on different physical channels, UART and SPI. It is a multi-layer communication protocol which provides position, CRC and error/warning bits in the first channel, control position and detailed status in the second channel and register access in the third channel. User can read all data simultaneously, the first channel with highest and the third channel with lowest bandwidth.



User can opt for either of two options:

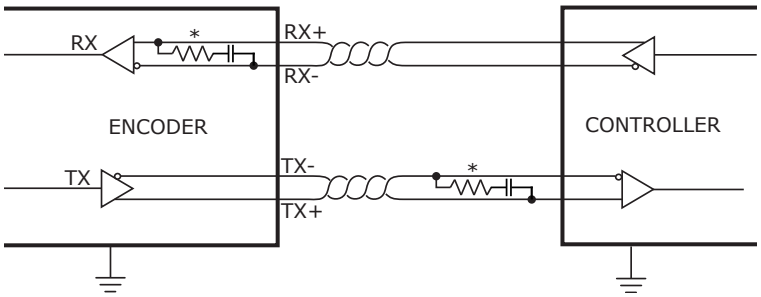
1. **Channel 1 only.** Functionality is the same as on AksIM-1. Only encoder position is available with general Error and Warning bits. On SPI MOSI line can be tied to GND (unused) and on UART empty request (0x00, 0x00) is sent.
2. **Full 3-channel access.** RLS provides pre-compiled libraries (without NDA) or source code of EncoLink Master libraries (with NDA). There is no need for the end-user to write his own code to implement full encoder functionality.

Hardware layer

Asynchronous serial communication interface (UART)

Asynchronous serial communication is supported by a universal asynchronous receiver/transmitter commonly known as UART. It comprises two unidirectional communications channels, forming a full-duplex bidirectional data link. Every channel consists of a two wire differential twisted-pair connection conforming to the RS422 signalling standard.

Electrical connection



Line signals	
RX+	RX data in +
RX–	RX data in –
TX+	TX data out +
TX–	TX data out –

* The RX and TX signals are 5 V RS422 compatible differential pairs. RX signal is terminated with RC (100 Ω, 1 nF) inside the encoder.

Communication parameters

Character length	8 bits
Parity	None
Stop bits	1
Flow control	None
Bit order	LSB first (standard)

Communication interface variant in the part number:

Communication interface variant	L
Baud rate [kbps]	1000

Encoder position data structure (Channel 1)

Transmitted data (2 bytes): Command 0x00, Data 0x00
Received data: see table below

For multiturn	
b55 : b40	Multiturn counter (if specified in part number) – Left aligned, MSB first.
b39 : b18	Encoder position + zero padding bits – Left aligned, MSB first.
b17	Error – If low, the position data is not valid.
b16	Warning - If low, the position data is valid, but some operating conditions are close to limits.
b15 : b8	Inverted CRC, 0x97 polynom
b7 : b0	Data for channel 2, not used

For singleturn	
b39 : b18	Encoder position + zero padding bits – Left aligned, MSB first.
b17	Error – If low, the position data is not valid.
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CRC calculation example is in application note document CRCD01, available for download from www.rls.si/aksim-2.

Encoder programming

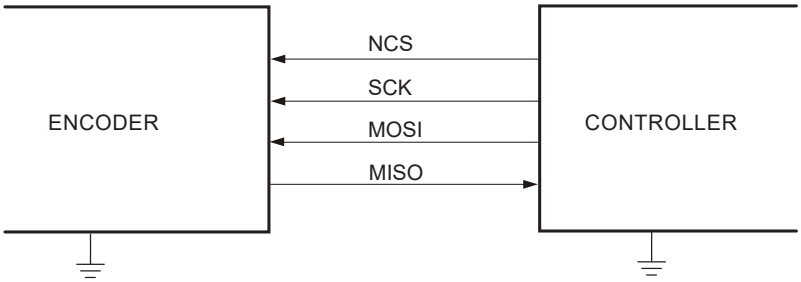
Encoder supports setting zero position, changing default baud rate, running self-calibration function, automatic transmission of selected data packet at programmable frame rate.
Additional functions are available over Channels 2 and 3 with use of EncoLink libraries.

SPI - Serial peripheral interface (slave mode)

The Serial Peripheral Interface (SPI) bus is a four wire bidirectional synchronous serial communication interface, typically used for short distance communication. It operates in full duplex mode, where master (controller) selects the slave with NCS line, generates clock signal on SCK line, sends command over MOSI line and receives data over MISO line.

Electrical connection

All data signals are 3.3 V LVTTL. Inputs are 5 V tolerant. Maximum current sourced or sunk from signal lines should not exceed 20 mA. Single-ended signals should be as short as possible, especially if high frequencies are used.
Signal termination: 100 ohm resistors are added in series with all SPI signals.

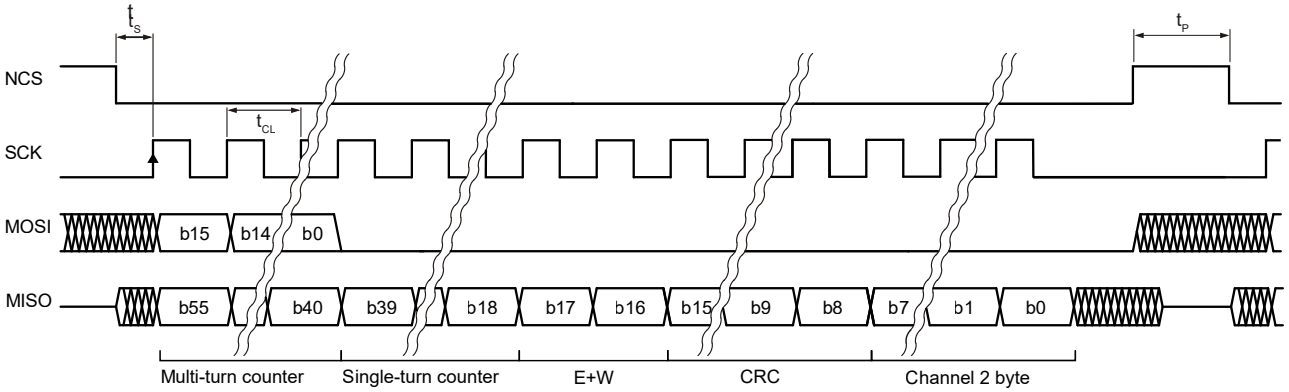


Signal	Description
NCS	Active low. NCS line is used for synchronisation between master and slave devices. During communication it must be held low. Idle is high. When NCS is high, MISO line is in high-Z mode. This allows connection of multiple slaves in paralell, sharing all lines except NCS.
SCK	Serial clock. Shifts out the data on rising edge.
MOSI	Master output → Slave input. Command from the controller to encoder.
MISO	Master input ← Slave output. Data is output on rising edge on SCK after NCS low. When NCS is high, MISO line is in high-Z mode.

Pinout

Pin	SPI
1	+5 V
2	GND
3	
4	
5	SCK
6	NCS
7	MISO
8	MOSI

SPI timing diagram



Controller starts the communication by setting the NCS signal low. The last available position data is latched at the same time. A delay of t_S is required for the encoder to prepare the data which is shifted to MISO output on rising edges of clock signal SCK. The command is received on 8 consecutive rising edges of SCK. Position and General Status (active low) data are sent out regardless of the received command. The following Requested data length as well as the content depends on the command. The last eight bits contain CRC (inverted) of the complete data packet.

Communication parameters

Parameter	Symbol	Min	Typ	Max
Clock period	t_{CL}	250 ns		
Clock frequency	f_{CL}			4 MHz
Time after NCS low to first SCK rising edge	t_S	5 µs		
Pause time	t_P	5 µs		

Encoder position data structure (Channel 1)

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Encoder programming

Encoder supports setting zero position and running self-calibration function.
Additional functions are available over Channels 2 and 3 with use of EncoLink libraries (Contact RLS).

Head office

RLS merilna tehnika d.o.o.
Poslovna cona Žeje pri Komendi
Pod vrbami 2
SI-1218 Komenda
Slovenia

T +386 1 5272100
F +386 1 5272129
E mail@rls.si
www.rls.si

Document issues

Issue	Date	Page	Corrections made
1	30. 4. 2020	-	New document
2	6. 7. 2020	2, 4, 6	Channels 0, 1 and 2 replaced with Channel 1, 2 and 3
		5	SPI timing diagram amended