Installation instructions

Absolute Shaft Encoders Type RA 58-S/M, RA 59-S

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Item No. **2 540 120**, Edition: 3050799hu

Introduction

These installation instructions are provided for the connection and starting procedure of your shaft encoder.
You will get further information from our Shaft Encoders Catalogue or on request.

This sign marks paragraphs particularly to be observed to assure proper use and to avoid risks.

Safety and Operating Instructions

- The absolute shaft encoders of the type RA 58/59 model series are quality products manufactured in accordance with established electrical engineering standards.
  The units have been delivered from the factory in perfect conformance to safety regulations. To maintain this condition and to ensure trouble-free operation, please observe the technical specifications of this document.
- **Installation and mounting may only be performed by an electrotechnical expert!**
- The units may only be operated within the limits specified by the technical data.
- **Maximum operating voltages must not be exceeded!**
  The units are designed complying with DIN EN 61010-part 1, protection class III. To prevent dangerous structure-borne currents, the equipment has to be run on safety extra-low voltage (SELV) and must be in an area of equipotential bonding. Use an external fuse for protection (see Electrical data).
- Fields of application: industrial processes and controls.
  Overvoltage at the connecting terminals must be limited to overvoltage class-II values.
- Please avoid shocks to the housing – especially to the encoder shaft – and axial or radial overload to the encoder shaft.
- Maximum accuracy and durability of our shaft encoders is only granted with suitable couplings.
- The high-quality EMC-specifications are only valid together with standard-type cables and plugs. When using screened cables, the screen must broadly be connected with ground on both ends. Also the voltage supply lines should be screened completely. If this is not possible, the corresponding filter measures are to be taken.
- Installation environment and wiring have a significant impact on the encoder's EMC: Thus the installer must secure EMC of the whole facility (device).
- In electrostatically threatened areas please take care for neat ESD-protection of plug and connecting cable during installation work.

Mechanical data

Shaft diameter	RA 58: 6 mm (synchro flange), 10 mm (clamping fl.) RA59: 9.52 / 10 mm (square flange)
Max. shaft load	∅ 6 mm - axial 60 N (13 lbs), radial 110 N (24 lbs) ∅ 9.52/10 - axial 107 N (24 lbs), radial 160 N (35 lbs)
Speed	10000 rpm (short term), 6000 rpm (continuous duty)
Torque	≤ 0.5 Ncm (IP64), ≤ 1 Ncm (IP 67)
Moment of inertia	Synchro flange approx. 14 gcm²
	Clamping flange, square flange approx. 20 gcm²
Protection class housing/bearing	IP 65/64[4] (IP 67 for singleturn on request)
General design	acc. to DIN EN 61010 part 1, protection class III,
	contamination level 2, overvoltage class II
Operating temperature	-25 ... +85 °C (SSI, Parallel)
	–10 ... +60°C (INTERBUS)
Storage temperature	–25 ... +85°C
Vibration performance (IEC 68-2-6)	100 m/s² (10 ... 500 Hz)
Shock resistance (IEC 68-2-27)	1000 m/s² (6 ms)
Connection	cable axial/radial, connector axial/radial,
	connector 2-fold radial[3], bus terminal box[3]
Housing	RA58: aluminium; RA59: stainless steel
Flange	RA58: S=Synchro flange[1], K=Clamping flange[2]
	RA59: Q=square flange 63.5 x 63.5
Weight	RA58: approx. 300 g (single-turn), 350 g (multi-turn)
	RA59: approx. 620 g (single-turn)
Bearing life	1 x 10^{10} revolutions (typ.) at 35% of full rated shaft load
	1 x 10^{9} revolutions (typ.) at 75% of full rated shaft load
	1 x 10^{8} revolutions (typ.) at 100% of full rated shaft load

[1] Fixing with M4 screws [2] Fixing with M3 or M4 screws [3] only with InterBus
[4] there must be no standing water present at the shaft input or bearings

Electrical data parallel

Resolution	360 increments (9 bit)[1]
	512 increments (9 bit)
	720 increments (10 bit)[2]
	1024 increments (10 bit)
	4096 increments (12 bit)
	8192 increments (13 bit)
	16384 increments (14 bit)
	4096 increments/16 turns (16 bit)[4]
	4096 increments/256 turns (20 bit)[4]
	4096 increments/4096 turns (24 bit)[4]
Linearity	± ½ LSB (± 1 LSB for 13 and 14 bit)
Type of code	Gray, Gray Excess, Binary
Sequence of code values	switchable by $\overline{\text{Direction}}$ input
Supply voltage (SELV)	5 VDC±10 %, 10...30 VDC[3]
Max. current consumption	600 mA (9 ... 14 bit), 900 mA (16 ... 24 bit)
Recommended external fuse	T 0.8 A (9 ... 14 bit), T 1.2 A (16 ... 24 bit)
Code switching frequency	max. 100 kHz
Inputs[5]	$\overline{\text{Direction}}$, $\overline{\text{Latch}}$, $\overline{\text{Tristate}}$
Output load	30 mA, short circuit proof
Alarm output	Open collector, NPN (for U_B = 5VDC max. 5mA,
	24 V; for U_B = 10...30 VDC: max. 5 mA, 32 V)
Max. cable length	100 m

[1] with offset 76 (range of values 76 ... 435) [2] with offset 152 (range of values 152 ... 871)
[3] Reverse battery protection [4] Not with RA59
[5] Operating delay time typically 10 ms for push-pull control. When controlling with PNP-Open Collector, an external pull-down resistor (1 kΩ) is needed.

Connection diagrams for parallel interface

Parallel interface with PVC-cable (single-turn, 13-14 Bit)

Colour	13 Bit	14 Bit
grey/pink	N.C.	S0 (LSB)
brown/yellow	S0 (LSB)	S1
brown/grey	S1	S2
red/blue	S2	S3
violet	S3	S4
white/brown	S4	S5
white/green	S5	S6
white/yellow	S6	S7
white/grey	S7	S8
white/pink	S8	S9
white/blue	S9	S10
white/red	S10	S11
white/black	S11	S12
brown/green	S12 (MSB)	S13 (MSB)
yellow[1]	$\overline{\text{Tristate}}$ S0...S12	$\overline{\text{Tristate}}$ S0...S13
pink[2]	$\overline{\text{Latch}}$ (binary only)	$\overline{\text{Latch}}$ (binary only)
green[3]	$\overline{\text{Direction}}$	$\overline{\text{Direction}}$
black	0 V	0 V
red	5/10...30 VDC	5/10...30 VDC
brown	$\overline{\text{Alarm}}$	$\overline{\text{Alarm}}$

[1] $\overline{\text{Tristate}}$: + U_B or unattached = Outputs active
0 V = Outputs at high impedance (Tristate mode)
[2] $\overline{\text{Latch}}$: + U_B or unattached = Encoder data continuously changing at output
0 V = Encoder data stored and constant at output
[3] $\overline{\text{Direction}}$: + U_B or unattached = Ascending code values when turning cw
0 V = Descending code values when turning cw

N.C. = Not Connected
LSB = Least Significant Bit
MSB = Most Significant Bit
S0, S1, ... = Data bits for resolution per turn

Item No. 2 540 120, 3050799hu

Absolute Shaft Encoders Type RA 58-S/M, RA 59

Connection diagrams for parallel interface

Parallel interface with PVC-cable (single-turn, 9-12 bit)

Colour	9 bit/360 increments	10 bit/720 increments	12 bit
brown/grey	N.C.	N.C.	S0 (LSB)
red/blue	N.C.	N.C.	S1
violet	N.C.	S0 (LSB)	S2
white/brown	S0 (LSB)	S1	S3
white/green	S1	S2	S4
white/yellow	S2	S3	S5
white/grey	S3	S4	S6
white/pink	S4	S5	S7
white/blue	S5	S6	S8
white/red	S6	S7	S9
white/black	S7	S8	S10
brown/green	S8 (MSB)	S9 (MSB)	S11 (MSB)
yellow[1)]	$\overline{\text{Tristate}}$ D0...D8	$\overline{\text{Tristate}}$ D0...D9	$\overline{\text{Tristate}}$ D0...D11
pink[2)]	$\overline{\text{Latch}}$ (binary only)	$\overline{\text{Latch}}$ (binary only)	$\overline{\text{Latch}}$ (binary only)
green[3)]	$\overline{\text{Direction}}$	$\overline{\text{Direction}}$	$\overline{\text{Direction}}$
black	0 V	0 V	0 V
red	5/10...30 VDC	5/10...30 VDC	5/10...30 VDC
brown	$\overline{\text{Alarm}}$	$\overline{\text{Alarm}}$	$\overline{\text{Alarm}}$

Parallel interface with connector, 17 poles (CONIN), 9-12 bit

Pin	9 bit/360 increments	10 bit/720 increments	12 bit
1	S0 (LSB)	S0 (LSB)	S0 (LSB)
2	S1	S1	S1
3	S2	S2	S2
4	S3	S3	S3
5	S4	S4	S4
6	S5	S5	S5
7	S6	S6	S6
8	S7	S7	S7
9	S8 (MSB)	S8	S8
10	N.C.	S9 (MSB)	S9
11	N.C.	N.C.	S10
12[1)]	$\overline{\text{Tristate}}$ S0...S8	$\overline{\text{Tristate}}$ S0...S9	S11 (MSB)
13[2)]	$\overline{\text{Latch}}$ (binary only)	$\overline{\text{Latch}}$ (binary only)	$\overline{\text{Latch}}$ (binary only)
14[3)]	$\overline{\text{Direction}}$	$\overline{\text{Direction}}$	$\overline{\text{Direction}}$
15	0 V	0 V	0 V
16	5/10...30 VDC	5/10...30 VDC	5/10...30 VDC
17	$\overline{\text{Alarm}}$	$\overline{\text{Alarm}}$	$\overline{\text{Alarm}}$

Parallel interface with TPE-cable (multi-turn)

Cable	37-pole Sub-D-connector	
Colour	Pin	Assignment
brown	2	S0
green	21	S1
yellow	3	S2
grey	22	S3
pink	4	S4
violet	23	S5
grey/pink	5	S6
red/blue	24	S7
white/green	6	S8
brown/green	25	S9
white/yellow	7	S10
yellow/brown	26	S11
white/grey	8	M0
grey/brown	27	M1
white/pink	9	M2
pink/brown	28	M3
white/blue	14	M4*
brown/blue	33	M5*
white/red	15	M6*
brown/red	34	M7*
white/black	16	M8**
brown/black	35	M9**
grey/green	17	M10**
yellow/grey	36	M11**
pink/green	18	$\overline{\text{Alarm}}$
yellow/pink	10	$\overline{\text{Direction}}$[3)]
green/blue	30	$\overline{\text{Latch}}$[2)]
yellow/blue	12	Tristate[4)]
red	13	10...30 VDC
white	31	10...30 VDC
blue	1	0 V
black	20	0 V

* N.C. with resolution 16 bit

** N.C. with resolution 16 bit or 20 bit

Parallel interface with connector, 17 poles (CONIN), 13-14 bit

Pin	13 bit	14 bit
1	S12 (MSB)	S13 (MSB)
2	S11	S12
3	S10	S11
4	S9	S10
5	S8	S9
6	S7	S8
7	S6	S7
8	S5	S6
9	S4	S5
10	S3	S4
11	S2	S3
12	S1	S2
13	S0 (LSB)	S1
14[3)]	$\overline{\text{Direction}}$	S0 (LSB)
15	0 V	0 V
16	5/10...30 VDC	5/10...30 VDC
17[2)]	$\overline{\text{Latch}}$/$\overline{\text{Alarm}}$*	$\overline{\text{Latch}}$/$\overline{\text{Alarm}}$*

* Latch with Binary code, Alarm with Gray code

[1)] $\overline{\text{Tristate}}$: + U_B or unattached = Outputs active
0 V = Outputs at high impedance (Tristate mode)

[2)] $\overline{\text{Latch}}$: + U_B or unattached = Encoder data continuously changing at output
0 V = Encoder data stored and constant at output

[3)] $\overline{\text{Direction}}$: + U_B or unattached = Ascending code values when turning cw
0 V = Descending code values when turning cw

[4)] Tristate: + U_B = Outputs at high impedance (Tristate mode)
0 V or unattached = Outputs active

N.C. = Not Connected
LSB = Least Significant Bit
MSB = Most Significant Bit
S0, S1, ... = Data bits for resolution per turn
M0, M1 ... = Data bits for number of turns (multi-turn only)

Item No. 2 540 120, 3050799hu

Absolute Shaft Encoders Type RA 58-S/M, RA 59

Synchronous-serial transfer (SSI) for absolute shaft encoders

Encoder data are sent out synchronously with the clock rate fed in by the SSI partner.
The number of clocks is defined by encoder type (single-turn resp. multi-turn) and configured special bits.

On multiple transaction (the stored value is read out several times successively), a fixed clock rate per transaction must be kept (for single-turn 13 resp. 14 clocks, for multi-turn 25 resp. 26 clocks).

- When idle – the last clock brush dates back more than 30 µs –, data output is at logically "1".
- With the first falling edge of the clock pulse, encoder data and special bits are loaded into the shift registers of the encoder interface.
- With every rising edge, data bits are put out serially, starting with MSB.
- When data transfer is finished, the data output remains at logically "0" for about 20 µs.
  If, within these 20 µs, another clock brush arrives at the encoder interface, data that have just been transferred will be put out once again.
  This multiple transaction of identical data provides transmission-error recognition.
- On expiration of the 20 µs, the data output returns to idle state (logically "1").
  Current encoder data can then be read out once again.

Electrical data serial (SSI)

Resolution	360 increments (9 bit)[1]
	720 increments (10 bit)[2]
	1024 increments (10 bit)
	4096 increments (12 bit)
	8192 increments (13 bit)
	16384 increments (14 bit)
	4096 increments/4096 turns (24 bit)
	8192 increments/4096 turns (25 bit)
	16384 increments/4096 turns (26 bit)
Linearity	±½ LSB (± 1 LSB for 13, 14 and 25 bit)
Type of code	Gray, Gray Excess, Binary
Sequence of code values	switchable by $\overline{\text{Direction}}$ input
Supply voltage (SELV)	5 VDC±10 %, 10 ... 30 VDC[3]
Current consumption	max. 0.3 A (5 VDC), max. 0.2 A (10 ... 30 VDC)
Recommended external fuse	T 0.4 A (5 VDC); T 0.25 A (10 ... 30 VDC)
Baud rate	70 KB ... 1.5 MB
Inputs[4]	$\overline{\text{Direction}}$
Output	RS 485
Alarm output	Alarm bit
Parity bit	optional on request
Max. cable length	400 m[5]

[1] with offset 76 (range of values 76 ... 435)
[2] with offset 152 (range of values 152 ... 871)
[3] Reverse battery protection
[4] Operating delay time typically 10 ms for push-pull control. When controlling with PNP-Open Collector, an external pull-down resistor (1 kΩ) is needed.
[5] See table "Dependence of baud rate on cable length"

Data formats SSI

Data format for single-turn encoder[1]

Resolution	Data bits							
	T1	...	T9	T10	T11	T12	T13	T14
9 bit[2]	**S8**	**...**	**S0**	**S0**	**0**	**0**	**A**	**0**
10 bit[2]	**S9**	**...**	**S1**	**S0**	**0**	**0**	**A**	**0**
12 bit[2]	**S11**	**...**	**S3**	**S2**	**S1**	**S0**	**A**	**0**
13 bit	**S12**	**...**	**S4**	**S3**	**S2**	**S1**	**S0**	**0**
14 bit	**S13**	**...**	**S5**	**S4**	**S3**	**S2**	**S1**	**S0**

Data format for multi-turn encoder[1]

Resolution	Data bits										
	T1	T2	...	T12	T13	...	T21	T22	T23	T24	T25	T26
24 bit[2]	**M11**	**M10...**		**M0**	**S11**	**...**	**S3**	**S2**	**S1**	**S0**	**A**	**0**
25 bit	**M11**	**M10...**		**M0**	**S12**	**...**	**S4**	**S3**	**S2**	**S1**	**S0**	**0**
26 bit	**M11**	**M10...**		**M0**	**S13**	**...**	**S5**	**S4**	**S3**	**S2**	**S1**	**S0**

[1] S0, S1, ...: Data bits for resolution per turn
M0, M1, ...: Data bits for number of turns (multi-turn only)
A: alarm bit
[2] Options (parity bit, alarm bit and parity bit, zero bit) on request and only with resolution 9, 10, 12 and 24 bit possible

Alarm bit: set to "1" with overheating, undervoltage, disk breakage, and LED defect.
Parity bit (option): Even Parity (The parity bit complements the data bits with an even number of 1-bits).

Connection diagram

SSI-Interface

Cable	Connector	Signal
brown (0.5 mm²)	1	0 V (supply voltage)
pink	2	Data
yellow	3	Clock
	4	N.C.
blue	5	$\overline{\text{Direction}}$[1]
red	6	N.C.
violet	7	N.C.
white (0.5 mm²)	8	5/10 ... 30 VDC
	9	N.C.
grey	10	$\overline{\text{Data}}$
green	11	$\overline{\text{Clock}}$
black	12	0 V-Signal ground[2]

[1] $\overline{\text{Direction}}$: + U_B or unattached = Ascending code values when turning cw
0 V = Descending code values when turning cw
[2] connected to 0 V within the encoder.
Please use this output to set Direction to logically "0", if necessary.

Dependence of Baud rate on cable length

Cable length[1]	Baud rate
< 50 m	< 400 kBaud
< 100 m	< 300 kBaud
< 200 m	< 200 kBaud
< 400 m	< 100 kBaud

[1] for twisted pair data and clock lines

N.C. = Not Connected
LSB = Least Significant Bit
MSB = Most Significant Bit
S0, S1, ... = Data bits for resolution per turn
M0, M1 ... = Data bits for number of turns (multi-turn only)

Item No. 2 540 120, 3050799hu

Absolute Shaft Encoders Type RA 58-S/M, RA 59

INTERBUS/K2 (installation remote bus)

Concerning function and transmission procedure, the absolute shaft encoder RA 58 complies with the Class 2-profile defined by the ENCOM User group.
The interface is encoder-integrated and includes a potential-free power supply.
The Master (e.g. PLC-attachment assembly) is responsible for cyclic data transfer to RA 58. In each cycle two words are transferred from RA 58 to the Master. Out of these 32 bits, at most 24 bits are reserved for data. The remaining bits are "0".

Starting procedure

With connection type cable:

- Connect the encoder to an external T-manifold.
  By this T-manifold the encoder is connected to the bus system and to the power supply.
- If further devices follow in the same bus line, a bridge between RBST and GND signal output must be made, in the connecting plug for the continuing bus, on the external T-manifold.

With connection type connector 2-fold:

- Connect the incoming bus to the encoder input (IN) (see connection diagram).
- If further devices follow in the same bus line:
  Connect continuing bus to the encoder output (OUT) (see connection diagram). A bridge between RBST and GND signal output must be made in the mating connector for the encoder output!

⚠ **Maximum current: 4.5 A via pin 7 and 8!**
Recommended external fuse for the complete bus supply voltage: T 4.5 A

With connection type bus terminal:

- Release screws and pull bus terminal box off the encoder.
- Insert incoming bus cable through the middle screwed conduit entry and connect to the input terminals (index 1), according to marking.
- If no further devices follow in the same bus line:
  In the bus terminal box, plug jumper ST2.
- If further devices follow in the same bus line:
  Facing the opened bus terminal box, insert outgoing bus cable through the right-hand screwed conduit entry and connect to the output terminals (index 2), according to marking.

⚠ **Maximum current: 2 A via U_B and 0 V!**
Recommended external fuse for the complete bus supply voltage: T 2 A

- Only if external power supply (not via bus) desired:
  Facing the opened bus terminal box, insert external encoder supply voltage through the left-hand screwed conduit entry and connect to U_B and 0 V.
- Put bus terminal box on encoder and tighten screws.

Electrical data

Output	Interbus (ENCOM profile K2)
Resolution	1024 increments (10 bit) 4096 increments (12 bit) 4096 increments / 4096 turns (24 bit)[1]
Linearity	± ½ LSB
Type of code	Binary
Sequence of code values	ascending code values when turning cw
Supply voltage (SELV)	10 ... 30 V DC with reverse battery protection
Current consumption	max. 0.2 A
Recommended external fuse	T 0.25 A
Baud rate	500 KB
Output load	RS 485
Max. cable length	50 m

[1] Not with RA 59

Data output

	5 V differential signals (RS 485) ENCOM profile K2, 32 bit process data binary right-aligned, readable only, without control/status bit				
Data transmission format	Sµpi-address	0	1	2	3
(as per Phoenix)	Byte-No.	3	2	1	0
ID-Code	36H (= 54 decimal)				

Connection diagram

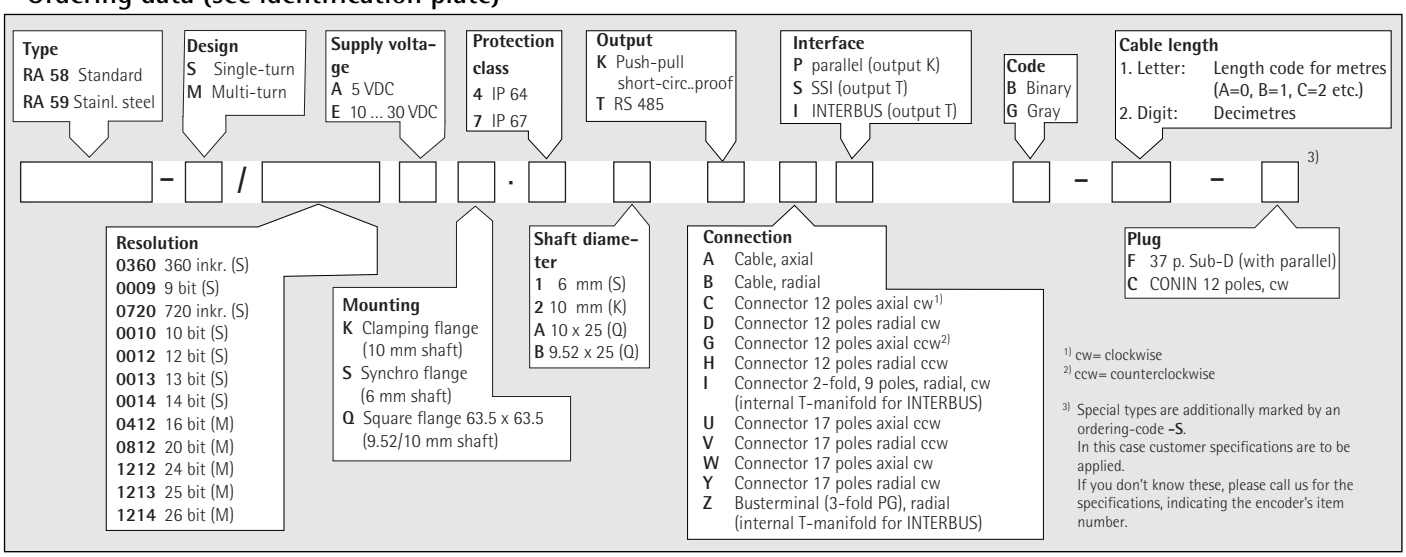
Interbus interface (ENCOM standard assignment)

Pin	Cable with plug (12 poles)	connector 2-fold (internal T-manifold) IN (9 poles, pins)	OUT (9 poles, socket)
1	D02	D01	D02
2	$\overline{D02}$	$\overline{D01}$	$\overline{D02}$
3	DI 2	DI 1	DI 2
4	$\overline{DI\ 2}$	$\overline{DI\ 1}$	$\overline{DI\ 2}$
5	D01	GND signal output[1]	GND signal output[1]
6	$\overline{D01}$	PE[2]	PE[2]
7	DI 1	10 ... 30 VDC	10 ... 30 VDC
8	$\overline{DI\ 1}$	0 V (supply voltage)	0 V (supply voltage)
9	$\overline{RBST}$	N.C.	$\overline{RBST}$
10	0 V (supply voltage)		
11	GND signal output[1]		
12	10 ... 30 VDC		

[1] Signal output; because of the potential separation, not identical with 0 V (supply voltage); used in the T-manifold in order to set the RBST input to logically "0".

[2] Functional earthing; connected to the encoder housing

Ordering data (see identification plate)



Item No. 2 540 120, 3050799hu