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Incremental Encoder Output on Main Spindle Drive Controllers KDA 3.2, RAC 2.2, RAC 3.1 with IGS Option

Applications

DOK-ENCODR-KDA+RAC*IGS-ANW1-EN-P

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Indramat

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KDA 3.2, RAC 3.1 and RAC 2.2

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The purpose of this document This document is supplementary to the documentation on digital intelligent INDRAMAT AC Main Drives

Supplementary documentation:

- High-resolution main spindle position encoder for KDA and RAC Main Spindle Drive Controllers; Applications; doc no. 9.552.247.4
- Incremental encoder output of the high-resolution main spindle position encoder via the "HGV Box"; Applications; doc no. 9.568.010.4

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1. Summary

Applications

The "IGS option" is used to generate either a rotor or spindle position in an INDRAMAT main spindle drive controller via an incremental-encoder compatible interface. This position can then, in turn, be used by a conventional NC control unit for position control, C-axis operation and thread cutting.

The positions can be alternatively tapped off at either the high-resolution rotor position calibration on the motor or the auxiliary calibration of the spindle position. (See second application note.)

Spindle outlets

High-resolution encoders with large spindle outlets are available to detect main spindle position. These can easily be mounted directly to the main spindle. (See also "High-Resolution Main Spindle Position Encoder", doc. no. 9.552.247.4-00/06.90).

High-definition

The high-definition evaluation of the spindle position or the rotor position encoder signals is performed in the KDAs and RACs with a resolution of 1/2 000 000 to 1/4 000 000 revolutions within the entire speed range. (It is not technically possible for the NC control unit to directly evaluate the encoder signal.)

The "IGS" taps the incremental encoder signals off of the high-resolution position calibration.

2. Application guidelines

IGS Applications The following figures depict typical applications of the "IGS-option" (IGS = Inkrementalgeber-Schnittelle = incremental encoder interface) as used in conventional NC control units with ± 10 V velocity command values and incremental encoder interface for psoition detection.

2.1. Spindle position calibration for C-axis operation, spindle positioning and thread cutting

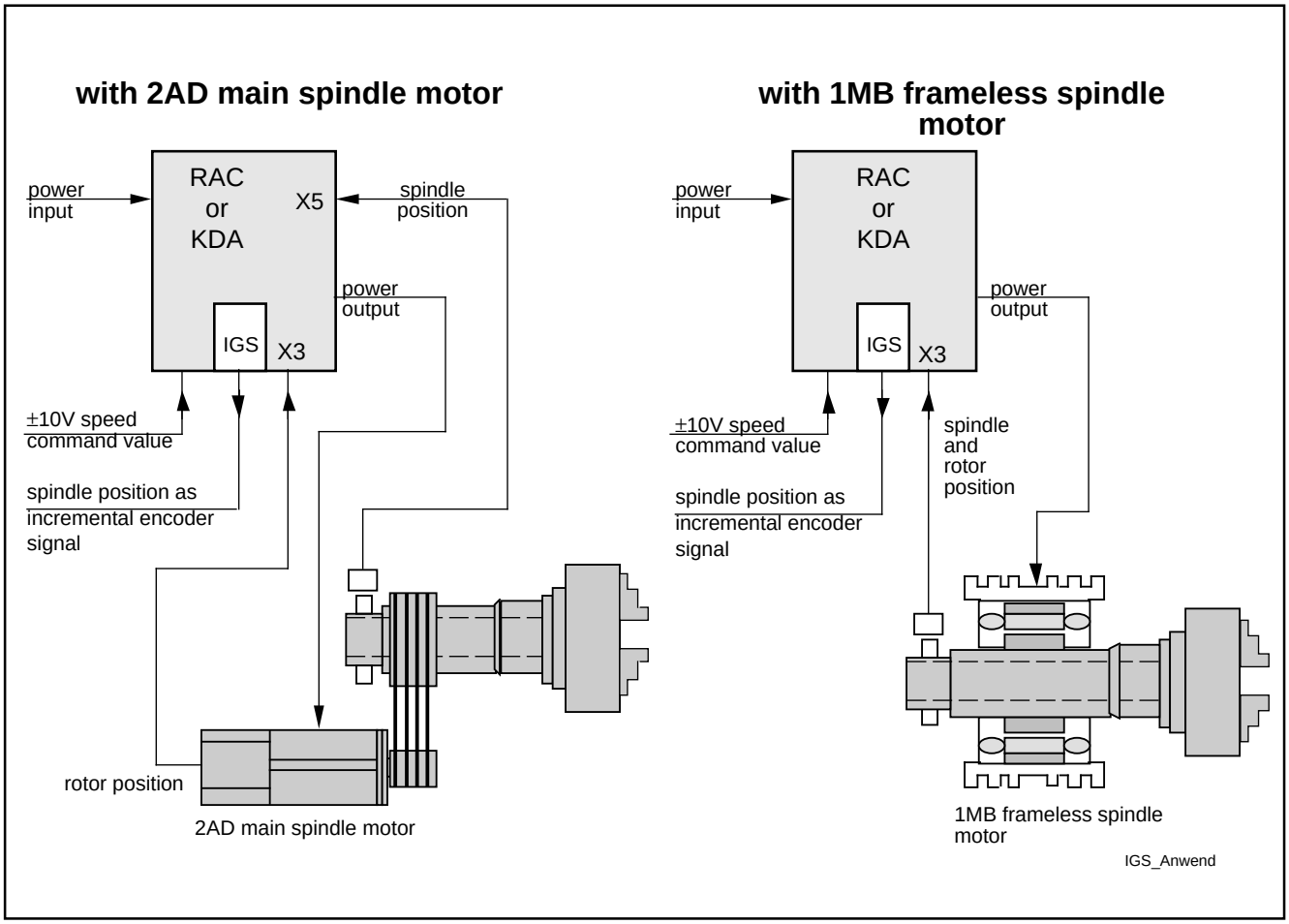

Figure 1: Principle of application with 2AD main and 1MB frameless spindle motor

Generally with toothed belt drives, either two incremental encoders have been used to detect spindle positions with varying definitions, or an expensive double incremental encoder. In this case, a limit switch was needed for homing to signal the zero impulse.

IGS option

The IGS option makes all signals equally available:

- 90,000 cycles per revolution (with fourfold evaluation = 360,000 increments per revolution) for C-axis operation up to a spindle speed of 150 rpm.
- can be switched to 1,024 cycles per revolution (with fourfold evaluation = 4,096 increments per revolution) for spindle positioning and thread cutting
- the reference switch signal indicating the zero impulse makes the "IGS option" with programmable switching points available.

2.2. Supplying fine and coarse incremental encoder signals simultaneously

HGV box

If the incremental encoder signals for C-axis operation and for normal operations are simultaneously applied to the NC control unit, then the incremental encoder signal can, for example, be generated with the use of an HGV box at 1,024 cycles per revolution. (See doc. no. 9.568.010.4)

As depicted in the Figure 2 below, the HGV box can be switched into the connecting cable of the high-resolution encoder.

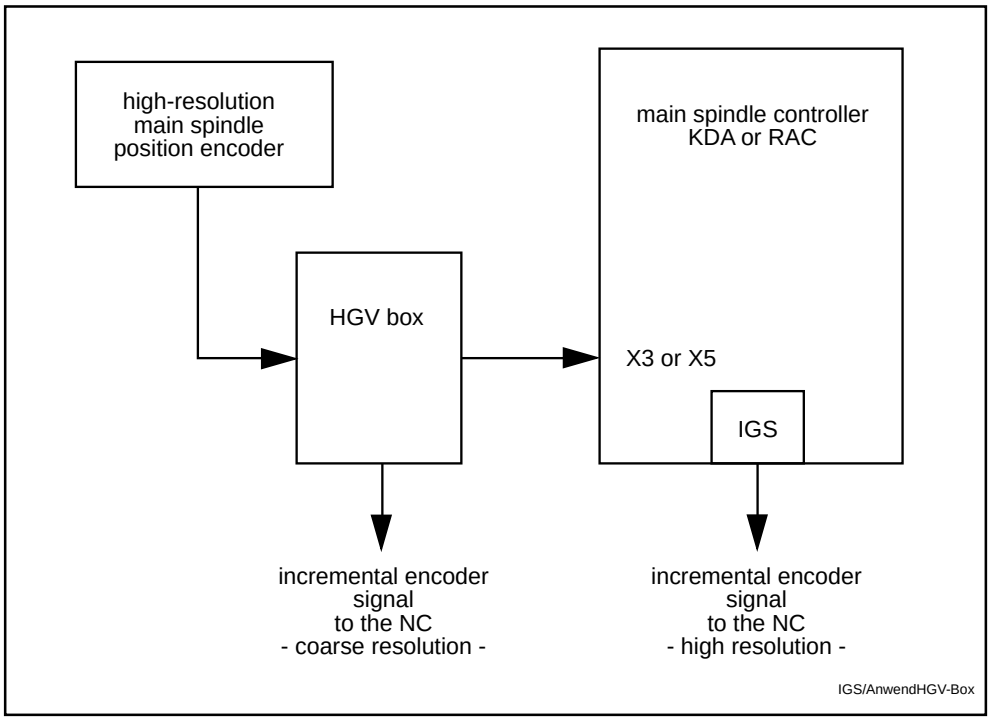

Figure 2: Principle of application of the "HGV box" for simultaneous provision of incremental encoder signals with fine and coarse definition

2.3. Using the AC Main Spindle Drive as a Servo Drive with Indirect Position Calibration

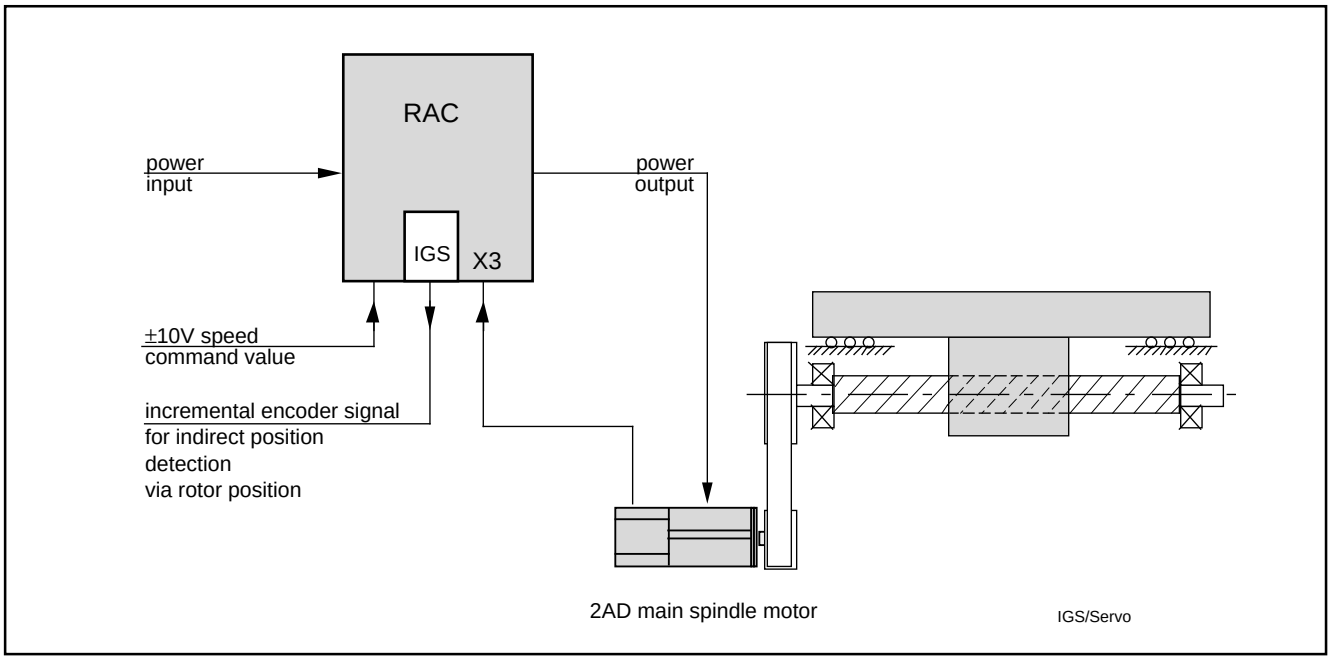

Figure 1: Principle of application for AC main spindle drives as servo drives for high performance with indirect position measurement by detecting the incremental encoder signals from the "IGS option"

3. Technical Guidelines on the "IGS-Option"

3.1. Control Voltage Power Supply

Optocouplers are used to isolate the output signals of the "IGS-option" from the drive. As usual with incremental encoders, the NC control unit is the power source of the line driver.

3.2. IncrementalEncoder Signal Definition

The incremental encoder signals of the IGS option can be switched:

- 90,000 cycles per revolution (with fourfold evaluation = 360,000 increments per revolution) with up to 150 rpm are available for C-axis operation
- A second resolution can be programmed using parameter PQRS 24 (IGSLINES) to any value between 1 and 16,383 cycles per revolution (with fourfold evaluation 0 4 to 65,532 increments per revolution)

3.3. Switching the Incremental Resolution

- a signal (+24V) at input EXT POS = 90,000 cycles per revolution
- no signal (0V) at input EXT POS = programmed definition

3.4. Maxiumum Speeds

The maxiumum output frequency of the incremental encoder compatible signals equals 230,000 cycles per second.

This equals the following maximum measuring speeds:

- 150 rpm for a definition with 90,000 cycles per revolution
- 13.8 million rpm divided by the definition programmed (e.g., 13,475 rpm at 1,024 cycles of programmed resolution)

Note:

If the aforementioned maximum RPMs are exceeded, it is possible that impulses will be missing without warning!

It must be noted that the maximum RPM is dependent on the cycle number selected. A double number of cycles means one-half permissible maximum RPM.

3.5. Apparent Signal Delay

As a result of the conversion time needed, there is a time delay of 970 µs of the incremental encoder compatible position signals to the actual position.

As of software version RIGS2V02, RIG32V02 and KIGS2V02 (4/91), the standard value of 16 will be programmed into parameter PWRS 25, IGSFUNCT. This will compensate the required conversion time of 970 µs in the software, meaning that there will no longer be a delay between the reaching of the position and the issuing of the relevant incremental encoder signal.

By subtracting the 16 from the programmed value of the aprameter PWRS 25, the incremental encoder signal will come with a time delay of 970 µs in comparison to the actual position.

3.6. Absolute Position Accuracy

The absolute position accuracy depends on the size of the measuring wheel of the high-resolution encoder and the precision with which this was mounted (excentricity).

Variables that affect the absolute position accuracy	measuring wheel 256-5	measuring wheel 256-5
typical position definition with the main spindle drives RAC and KDA	$\left(\frac{1}{2{,}000{,}000}\right)$ rev.	$\left(\frac{1}{4{,}000{,}000}\right)$ rev.
absolute position measuring accuracy dependent on the the measuring system	≤ 0.02 degrees	≤ 0.01 degrees
additional position error with an excentric mounting of the measuing wheel	approx. 0.01 degrees per 0.01 mm of excentricity	approx. 0.005 degrees per 0.01 mm of excentricity

Figure 4: Absolute position accuracy of the high-resolution main spindle

Use of the measuring wheel size 256-5

- 2AD motors, size 2AD 100, 132, 160 and 180
- 1MB frameless spindle motor of the size 1MB 240
- high-resolution main spindle position encoder, see doc. no. 9.552247.4

Use of the measuring wheel size 512-5

- 1MB frameless spindle motor size 1MB 310 and 410
- high-resolution main spindle position encoder, see doc. no. 9.552.247.4

3.7. Homing Switch Signal

A potential free contact is available for homing. It simulates the homing switch when operating at 90,000 cycles per revolution.

- 24V and 0.25 A can be applied to this contact
- the contact is open when no voltage is being applied from the drive
- the switching points can be programmed with the use of parameters PWRS 22 IGSREF and PQRS 23 IGSOPEN

3.8. Zero Impulse

The IGS option offers a zero impulse with a width of 1/4 cycle (= 90°) always within the range (signal A and signal B) = 1.

The position of the zero impulse can be shifted up to 360° with the use of parameter A07 (OFFSET).

3.9. Signal Behavior With Off-Load Drive

Caution!

- **incremental encoder signals A, B and 0 are not defined when drive is off load**
- **the IGS option does not supply correct signals until 0.5 seconds after the supply voltage is switched on. Only then does the output X2.15, SPINDLE CONTROL, switch to 1.**

3.10. Performance with Drive Errors

The IGS option continues to run correctly even in the presence of drive errors if the errors are not in the position encoder or the detector.

Ouput X2.15, SPINDLE CONTROL monitors the functioning of the interface. If all is in order, then the output goes to 1 (= 24 volts).

3.11. Performance in Parameter Mode

The interface continues to operate normally in parameter mode as of software versions

KIGS 2V0.1 for the KDA 3.2
RIGS 2V0.1 for the RAC 2.2
RIG3 2V0.1 for the RAC 3.1

4. Order Guidelines

4.1. Order codes for Drive with IGS Option

The IGS option is integrated during manufacture. Later mounting of this option is not possible.

The following alpha-codes in type code fields 6, 7 and 8 of the type codes for the KDA or RAC drive controllers should be used to order this option. (Also see the supplementary documentation outlined on page 1.)

Alpha-code	Drive controller version
- A 0 I -	= application as per Figures 1 and 3
	with "IGS option"
	without additional position interface for detection of spindle position
	with analogue command value input
- A P I -	= application as per Figures 1
	with "IGS option"
	without additional position interface for detection of spindle position
	with analogue command value input

4.2. Programming Module for Drives with IGS Option

A drive with IGS option requires a programming module with the following type codes:

- KDA 3.2 with IGS = programming module AS 33/ ...
- RAC 2.2 with IGS = programming module AS53/ ...
- RAC 3.1 with IGS = programming module AS63/ ...

For a complete list of programming module type codes see "AC Main Spindle Drives with 2AD Motors", selection lists, doc. no. 9.567.013.4.

5. Parametrization

PQRS 22 IGSREF
Defines the angle with which the contact of the homing switch signal opens (see 3.8). The angle counts in a clockwise direction starting with the zero impulse. Angular degrees are used for parametrization.

PQRS 23 IGSOPEN
Defines the angle with which the contact of the homing switch signal opens (see 3.8). Angular degrees are used for parametrization.

PQRS 24 IGSLINES
Defines the cycle number of the incremental encoder signal with programmable resolution (see 3.2).

PQRS 25 IGSFUNCT
Additional functions can be activated herewith. The sum of the selection numeric codes ( ) must be entered.

IGSFUNCT = (1): even with EXT POS = 1 the cycle number programmed in PQRS 24 is generated (see 3.4).

IGSFUNCT = (2): the contact for the homing switch signal is active even with the programmable resolution.

IGSFUNCT = (4): rotational direction of IGS output signals is reversed.

IGSFUNCT = (8): reserved

IGSFUNCT = (16): software compensation for the conversion time of 970 µs is active.

A 07 OFFSET
This parameter can be used to shift the position of the zero impulse in terms of the phsical position of the zero impulse at the encoder.
Angular degrees are used in the parametrization.

A 11 ENCODER 2
If an additional high-resolution encoder is used to detect main spindle position, then the numeric code of the encoder type must be set here:

- numeric code = 3 for measuring wheel size 256
- numeric code = 4 for measuring wheel size 512

Additional settings in the function parameters

- A 05 FUNCTION1 = (8): ignores the additional spindle position interface (HR12) in drives with alpha code API (see 4.1).

6. IGS Faults Messages

NO IGS — no IGS1 incremental encoder interface has been installed at X12.
---> equip with IGS

NO 12MHZ — This error message appears if a programming module for the IGS option is plugged into a module that is not equipped for the IGS option (incorrect CDR2).
---> use AS .1/... type programming module

NO 8MHZ — This error message appears if an incorret programming module has been plugged into a drive controller that is equipped for the IGS option (see 4.2).
---> use AS . 3/... type programming module

ENCODER2 — Malfunction of the additional high-resolution spindle position encoder.
---> check spindle position encoder and the connection to the drive

NO INPUT — Incorrect speed command value card has been inserted. With the IGS option, only ± 10 volts is possible (ADW3 command value card).
---> install ADW3 command value card

7. Electrical Characteristic Values

Technical Data of the Incremental Encoder Output of the "IGS-Option"

Designation		Einheit	min	type	max
operating voltage		V	4.75	5.0	5.25
operating current		mA			200
signal level at40 mA	U_{HIGH}	V	1.8		
	U_{LOW}	V			0.5
output current		mA			40
output frequency		kHz			250
rise and fall time		ns			100
reference point delay t1		ns	0	0	30
time t2		µs	1		

Incremental encoder output signal (line driver DS 8830)

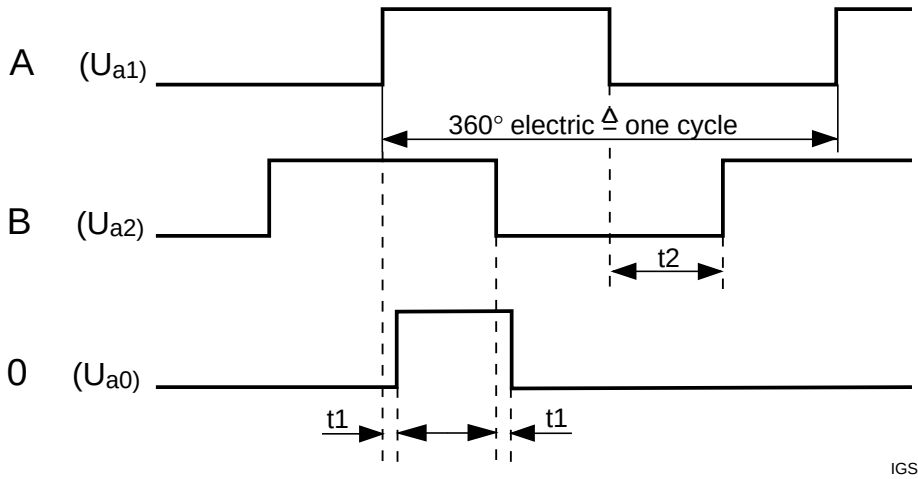

Figure 5: Electrical characteristic values of the incremental encoder output of the "IGS option" with main spindle drive controllers

8. Connector assignment

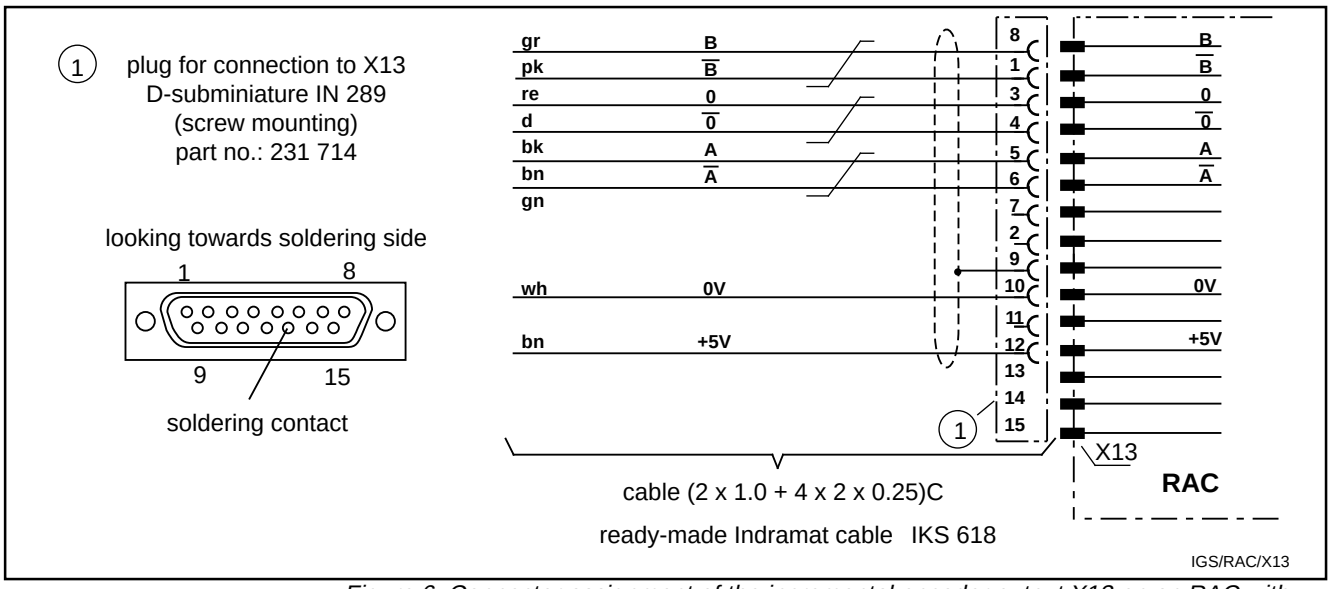

Figure 6: Connector assignment of the incremental encoder output X13 on an RAC with "IGS option", screw fixing

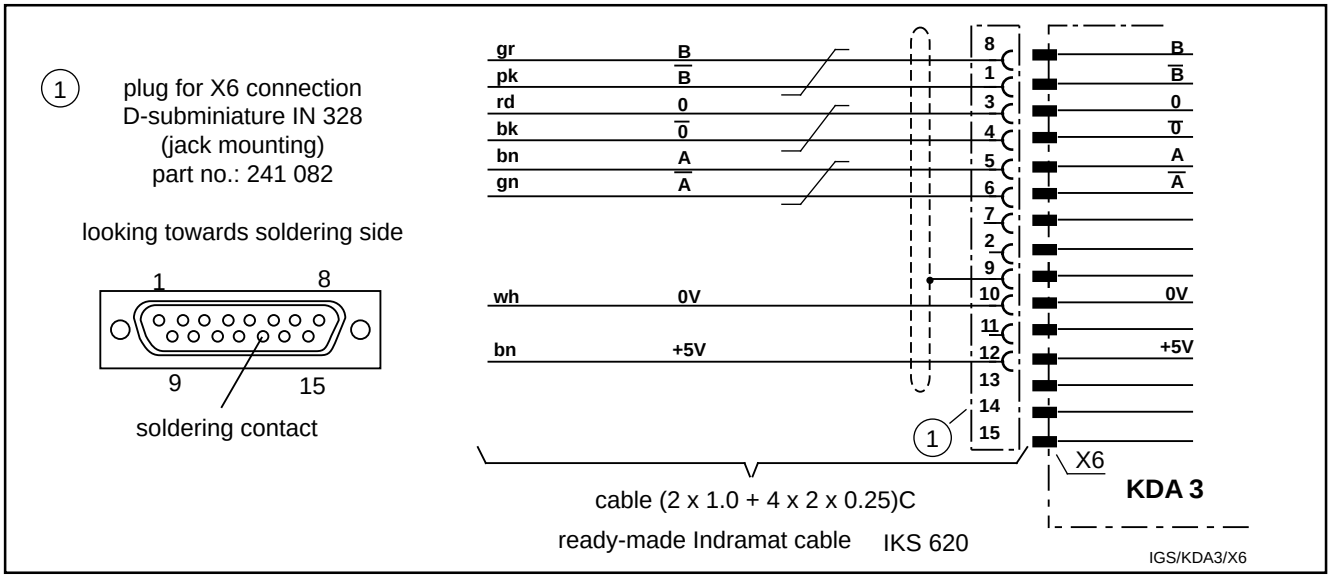

Figure 7: Connector assignment of the incremental encoder output X6 on a KDA3 with "IGS option", latchet fixing

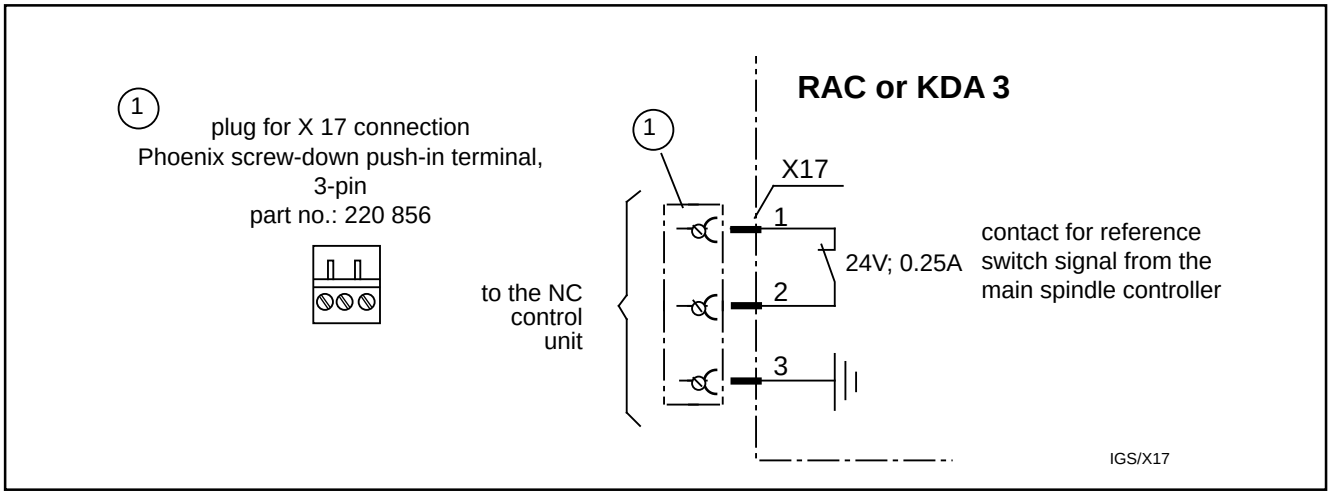

Figure 8: Connector assignment for the homing switch signal contact X17 on a KDA and RAC with "IGS option"

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