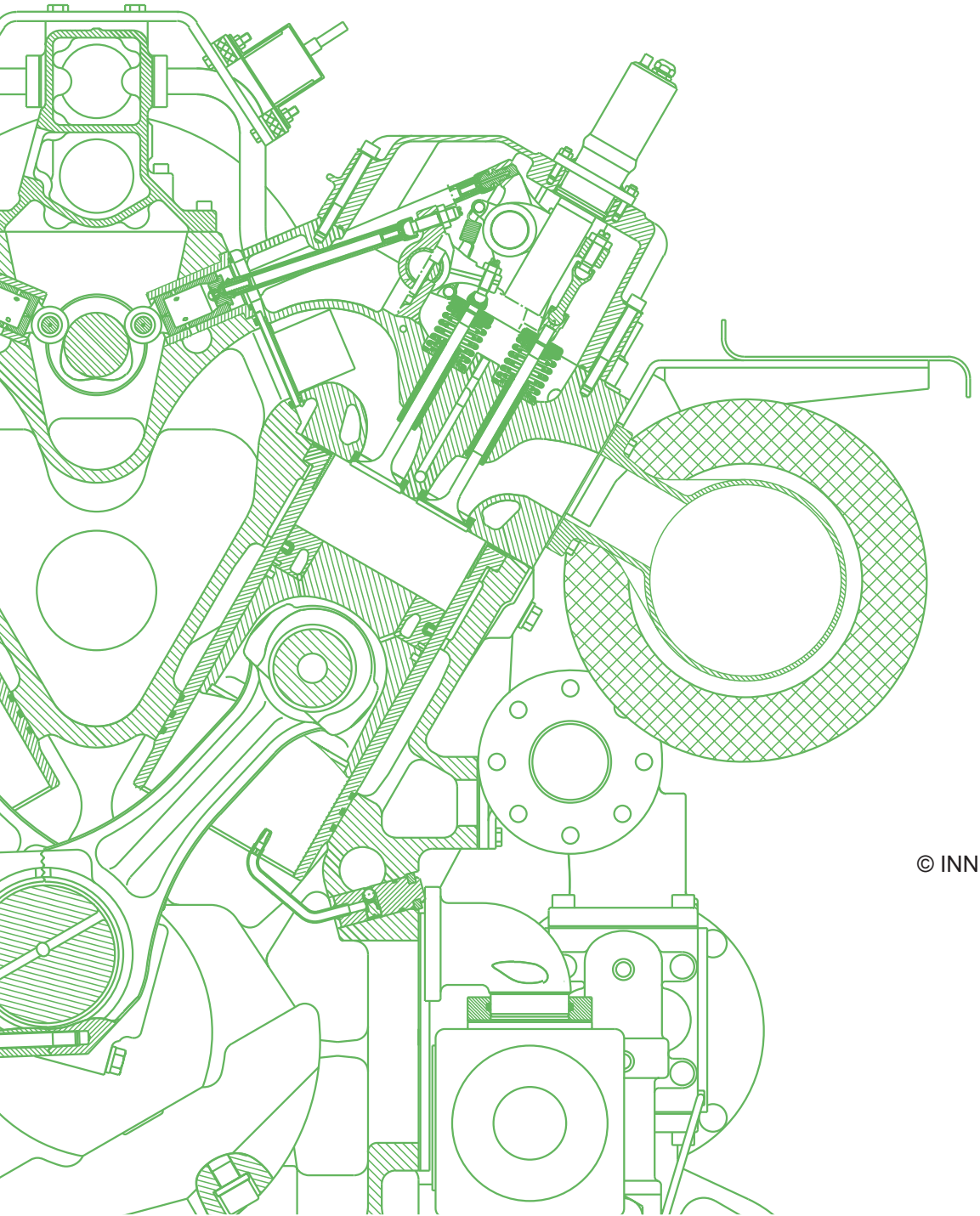
JENBACHER

TA 1504-0369

Technical Instruction

Redundant Knock-Monitoring System



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EN

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The target recipients of this document are:

Service Partners, commissioning partners, subsidiaries/branches, Jenbach location

1 Area of application

This Technical Instruction (TA) applies to the following Jenbacher Gas Engines:

- Type 9 engines

2 Purpose

This Technical Instruction (TA) describes the system layout, operation, troubleshooting and connections / wiring of the redundant knock-monitoring system.

3 Safety information

⚠ WARNING

Personal injury

Failure to use personal protective equipment and comply with safety instructions or employee protection information may lead to personal injury.

- ➢ Wear the relevant personal protective equipment (PPE).
- ➢ Observe the safety instructions as per TA 2300-0005.
- ➢ Observe the employee protection information as per TA 2300-0001.

⚠ WARNING

Danger of burns

Hot surfaces

- Do not start maintenance work until the plant has cooled down.
- Use a contact thermometer to check the temperature.
- Wear the appropriate personal protective equipment.

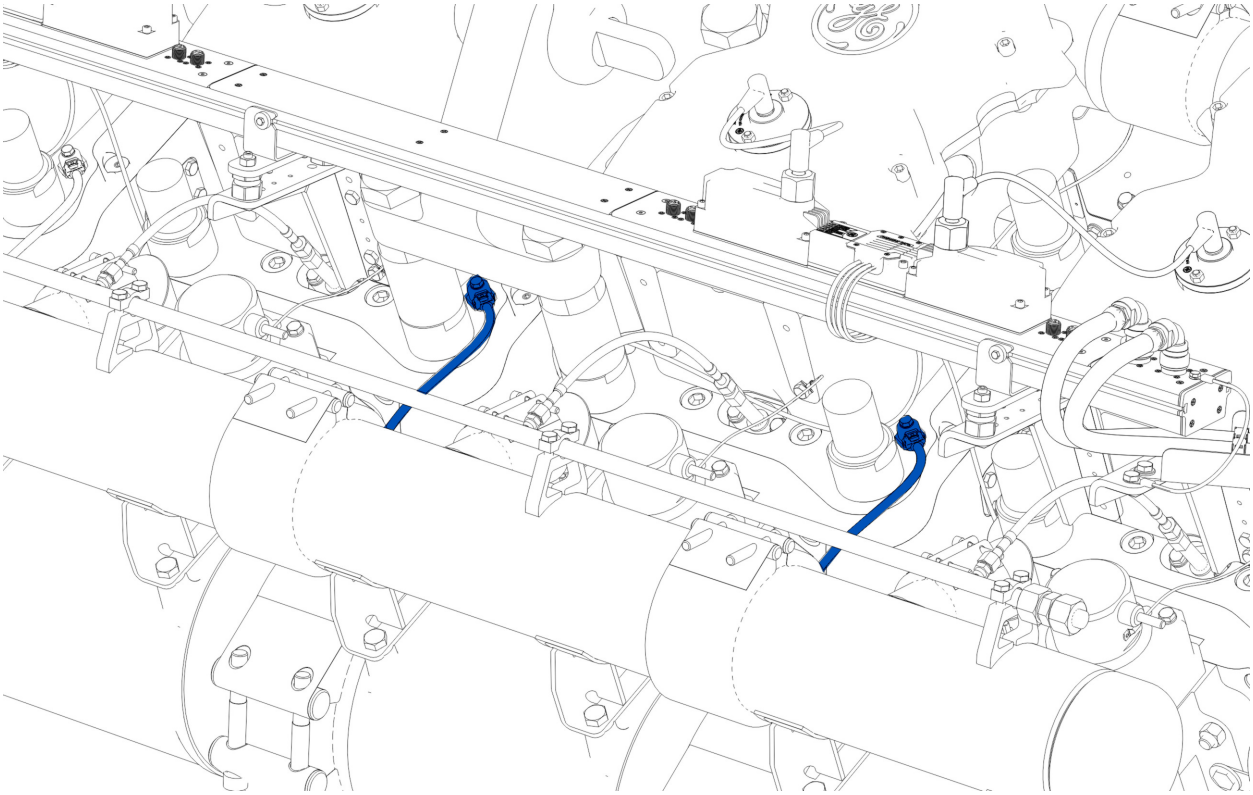
⚠ WARNING

Danger from unauthorised restarting

Serious injuries such as cutting, crushing, severing or shearing of body parts due to unintentional contact with rotating or moving machine parts.

- Shut down the engine as described in TA 1100-0105.
- Secure the engine against unauthorised restarting in accordance with TA 2300-0010.

4 Additional information



General view of redundant knock-monitoring system

Relevant documents:

TA 1100-0105 – Engine shut-down

TA 1502-0071 – SAFI (Sensor Actuator Function Interface)

TA 2300-0001 – Employee protection

TA 2300-0005 – Safety instruction

TA 2300-0010 – Guidelines for using the LOTO kit

WA 8069 M9 – Redundant knock system

5 Description

The Redundant Knock-monitoring System – RKS, for short – is a substitute, or backup system for knock monitoring.

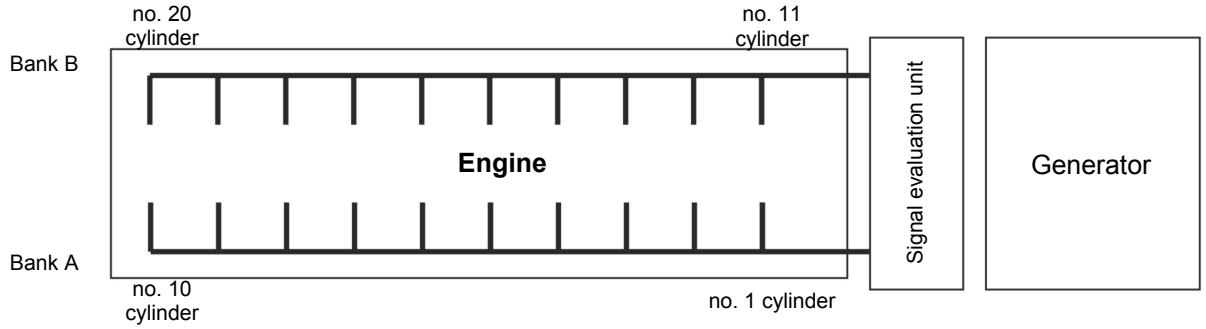
In the event of a cylinder pressure-sensor failure, the knock monitoring for this cylinder is switched over to a conventional knock sensor in the RKS.

The engine can thus continue to operate even with a failed cylinder pressure sensor and does not shut down.

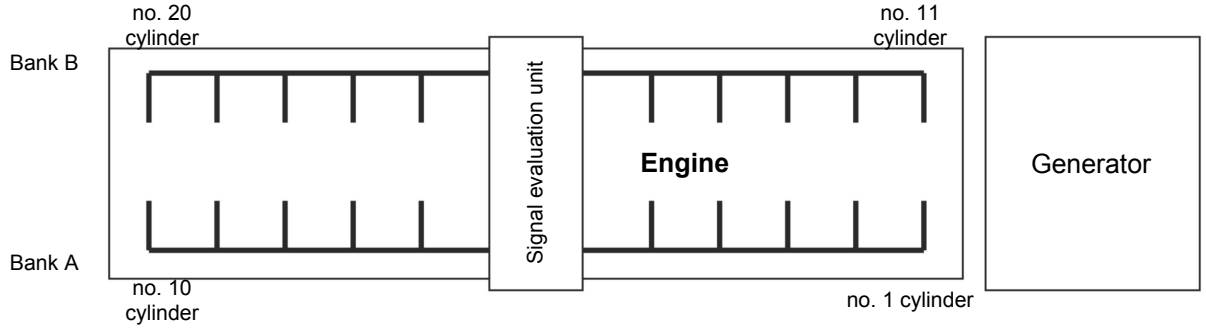
6 System layout

For RKS knock monitoring, the engine is equipped with 20 additional conventional knock sensors.

These are connected via a cable harness to the respective RKS signal evaluation units on Bank A and Bank B.

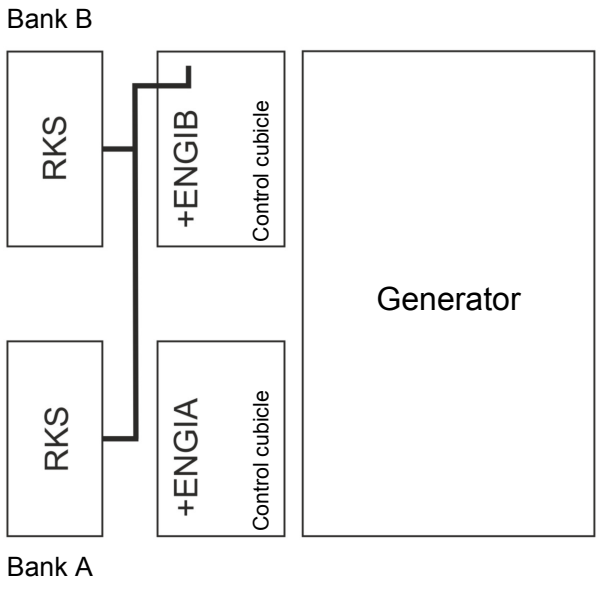


Knock sensor cable harness through product range 2019



Knock sensor cable harness from product range 2019

The RKS signal evaluation units are connected to the DIA.NE in the +EngiB control cabinet and supplied with 24 V.



Attention: The RKS signal processing units for Bank A and Bank B have different part numbers:

9023835	RKS Steuergerät Bank A / RKS box for Bank A
9024683	RKS Steuergerät Bank B / RKS box for Bank B

The boxes (i.e. the 'control units') for Bank A / Bank B differ in the cylinder arrangement and, via the crank angle, in the knock window for each cylinder.

It is imperative that the correct part numbers are allocated / fitted to their respective banks, otherwise correct function is not guaranteed.

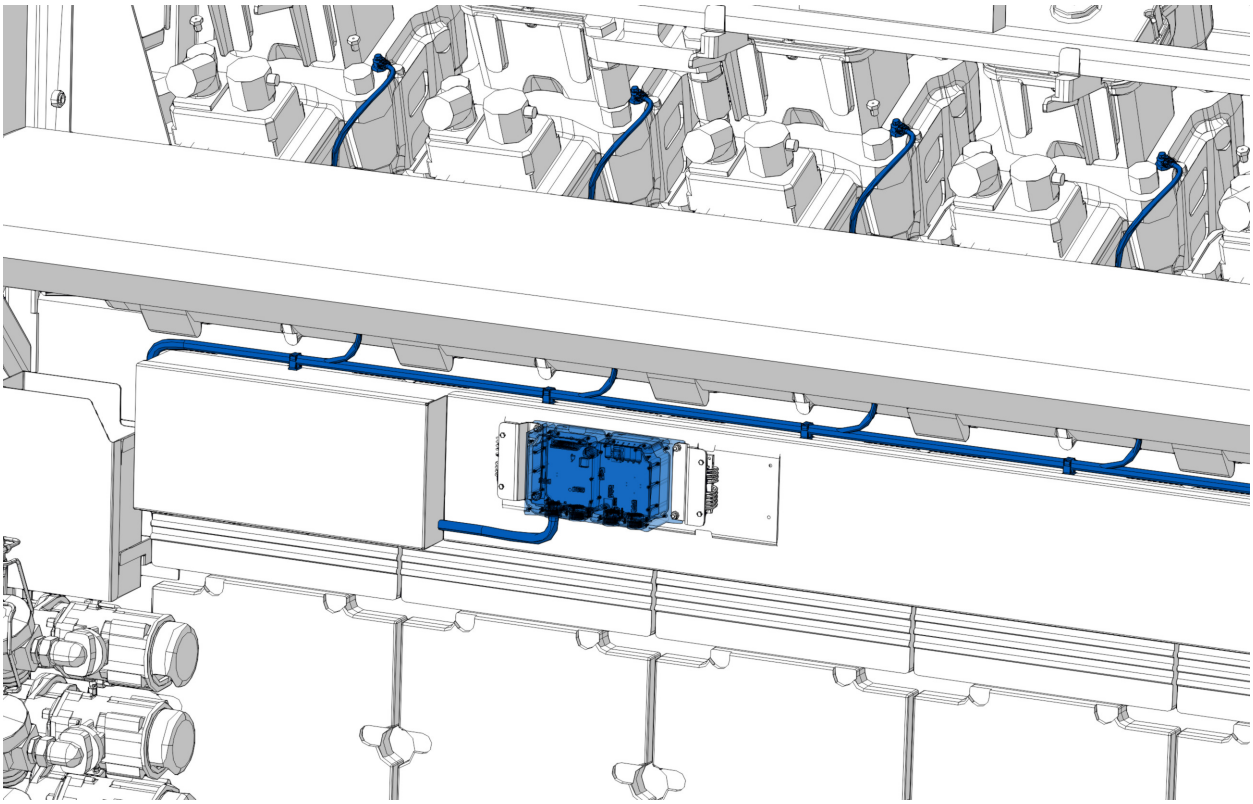
The RKS-to-DIA.NE wiring harnesses also have a different pin coding at their connectors. If, for example, you try to connect a Bank B RKS unit to the connectors of a Bank A wiring harness, an appropriate warning will be output on the DIA.NE:

Alarm number	Bank A: **2438**, Bank B: **2439**
Alarm text ENG	RKS unit Bank A(B) not ready for operation
Alarm text DEU	RKS Unit Bank A(B) nicht betriebsbereit

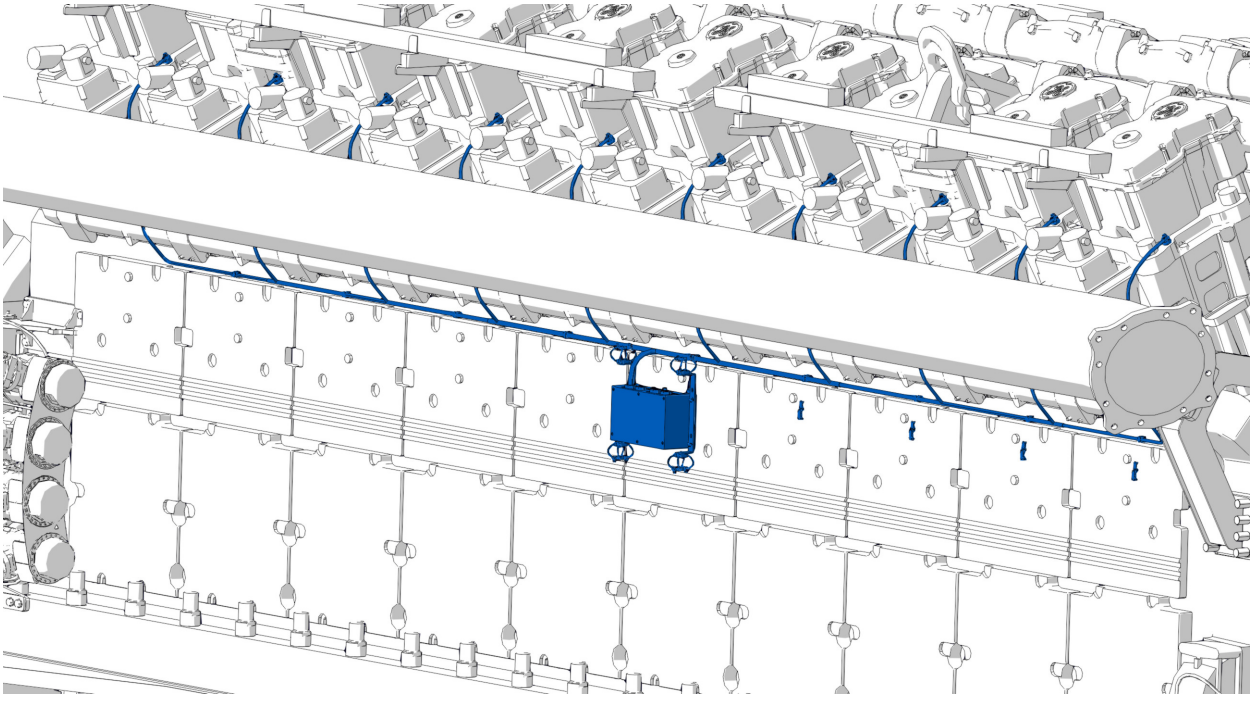
The RKS status page on the DIA.NE, see the status displays "operating", will also show an error (displayed individually for Bank A / B).

This means that, for all cylinders in the bank concerned, there is no longer any redundancy. This in turn means that, in the event of an additional fault in the measuring signal for cylinder pressure in this bank, the engine will shut down.

The knock-sensor wiring harness is secured on the cable tray for the bearing monitoring system. The RKS signal evaluation units are located on a console above the cables of the bearing monitoring system and are each provided with a cover.



Knock sensor cable harness through product range 2019



Knock sensor cable harness from product range 2019

Cable harness part numbers from product range 2019:

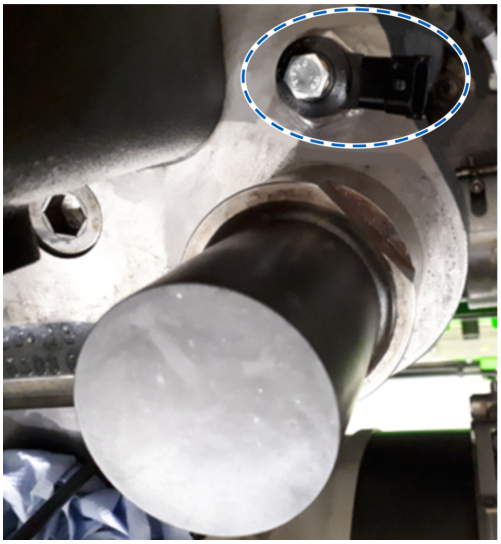
1244104	Harness Bank A / new design from 2019
1244107	Harness Bank B / new design from 2019
1244108	Cable harness Bank A ECU to DIA.NE / design from 2019
1244109	Cable harness Bank B ECU to DIA.NE / design from 2019

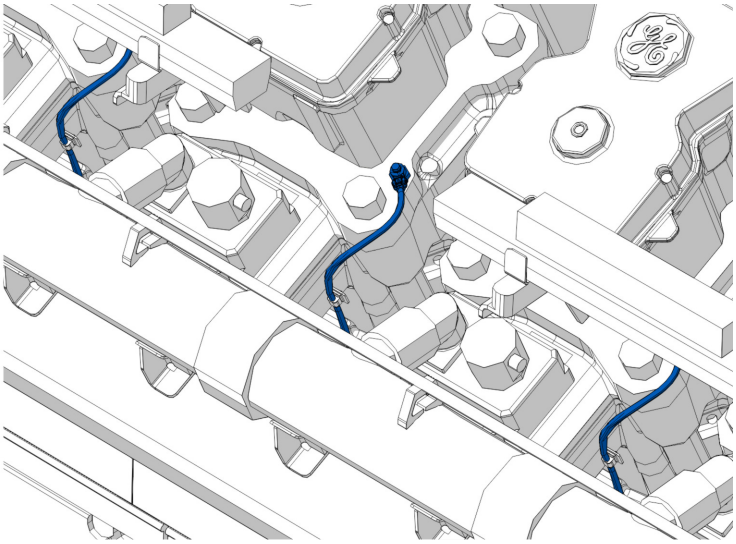
RKS signal evaluation unit

Using an M8 screw, the knock sensors are screwed onto an M20 cylinder-head adapter screw. This is screwed onto the cylinder head as shown below.

- The tightening torque for the M20 adapter screw for supporting the knock sensor is 100 Nm.
- The tightening torque for the M8 screw for fitting the knock sensor is 20 Nm.
- During assembly, the contact surface of the knock sensor on the adapter screw, and the contact surface of the adapter screw on the cylinder head must be checked to ensure there is no dirt or corrosion.

- If necessary, clean the contact surfaces.





Mounting of knock sensors

Please also refer to the Maintenance Instruction W 8069 M9.

W 8069 M9 – Redundant knock system

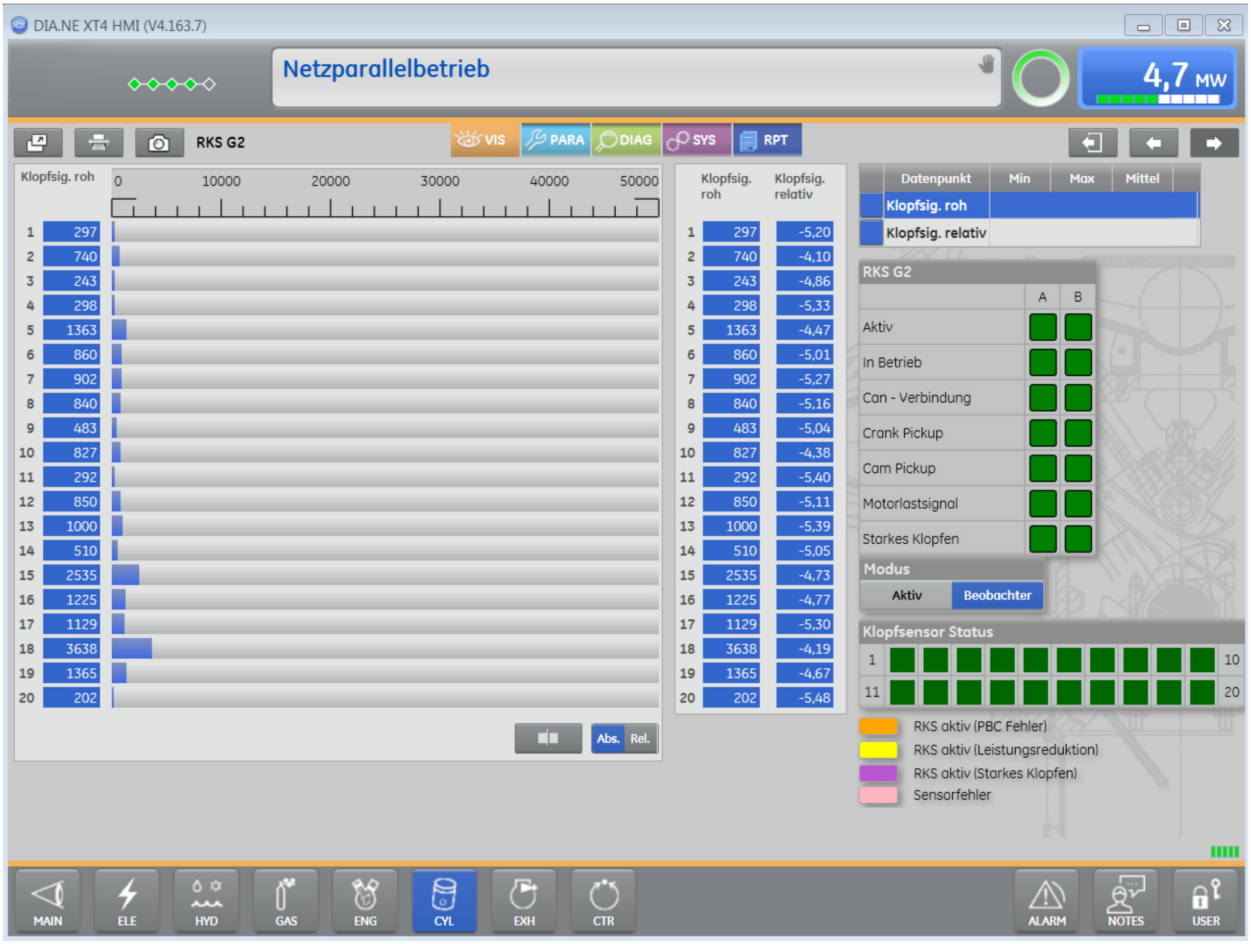
Module for the RKS system (design before Q2 2018 - design variant RKS at generator, not after Q2 2018 RKS in engine centre):

– **Part no. 9026889**

7 Operation

The system works essentially independently: no further user operating inputs are required.

The RKS page on the DIA.NE gives a status overview of the RKS:



The only user input is the possibility of switching the system to either the passive "Observer" mode or the "Active" mode.

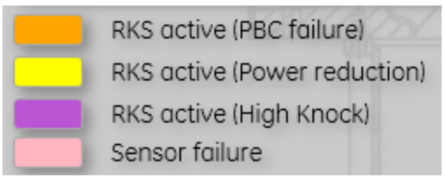
Switching to Observer mode gives the following properties:

- The system is purely passive.
- There is no redundancy.
- No controller intervention.
- Engine behaviour is as if RKS did not exist.
- Engine shuts down in the event of a fault in the measuring signal for cylinder pressure.
- However, values measured by the RKS knock sensors are displayed and stored in the trend.

Switching to Active mode gives the following properties:

- RKS is ready for knock control.
- When knocking occurs, the knock integrator can be filled by the cylinder pressure sensor and/ or by the RKS knock sensor.
- In the event of a fault in the measuring signal for cylinder pressure, the knock monitoring / knock control for the respective cylinder is taken over by RKS.
- In the event of a fault in the measuring signal for cylinder pressure, the engine can thus continue to be operated; the engine does not shut down.
- A measuring signal fault from an RKS knock sensor does not result in an engine stop, but for this cylinder there is then no more redundancy for the cylinder pressure sensor.
- If, in addition to a measuring signal fault from a RKS knock sensor, a fault in the measuring signal for cylinder pressure occurs on the same cylinder, the engine then shuts down.
- Likewise, the thermocouple and the cylinder pressure sensor of the same cylinder must not be in a failure condition at the same time. The thermocouple is required here in addition for monitoring the combustion. Thus, on a cylinder with a failed thermocouple there is no RKS redundancy, so a fault in the measuring signal for cylinder pressure will therefore result in a shutdown.

In the section "Knock Sensor Status", the colour for each cylinder indicates the current status of the RKS for that cylinder:



The first three colours under "RKS active" indicate that the cylinder pressure sensor on the respective cylinder has failed and the RKS has taken over engine control for that cylinder. The three colours represent the three different types of controller intervention.

The first three points "RKS active" mean that the cylinder pressure sensor for the cylinder concerned has failed and RKS has taken over the knock monitoring for this cylinder.

- Orange "PBC failure" means RKS is in normal control mode for this cylinder. In this mode the ignition timing is set 2° towards late.
- Yellow "Power reduction" means that RKS has initiated a power reduction for this cylinder.
- Purple "High Knock" means that RKS has detected heavy knocking in this cylinder and made a control intervention.

The last point in pink, "Sensor Failure", indicates that only the RKS knock sensor for the cylinder in question has a measuring signal error.

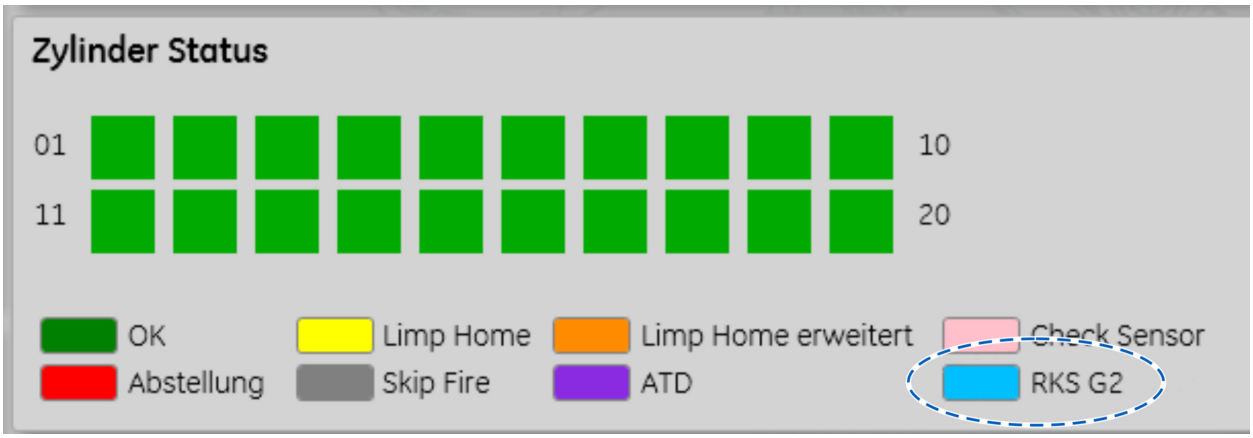
- In this case there is no longer any redundancy for the cylinder pressure sensor.
- The engine does not shut down in this situation, however.
- However, if the cylinder pressure sensor on the same cylinder were to fail, the engine will shut down.

Meaning of Raw Knock and Delta Knock:

The RKS evaluates the raw values from the knocking signals with a special weighting function.

The results of the weighting function are the "Delta Knock" values, which enable more sensitive knock detection than the raw values. In the actively controlled RKS mode, the "Delta Knock" values are used for knock control.

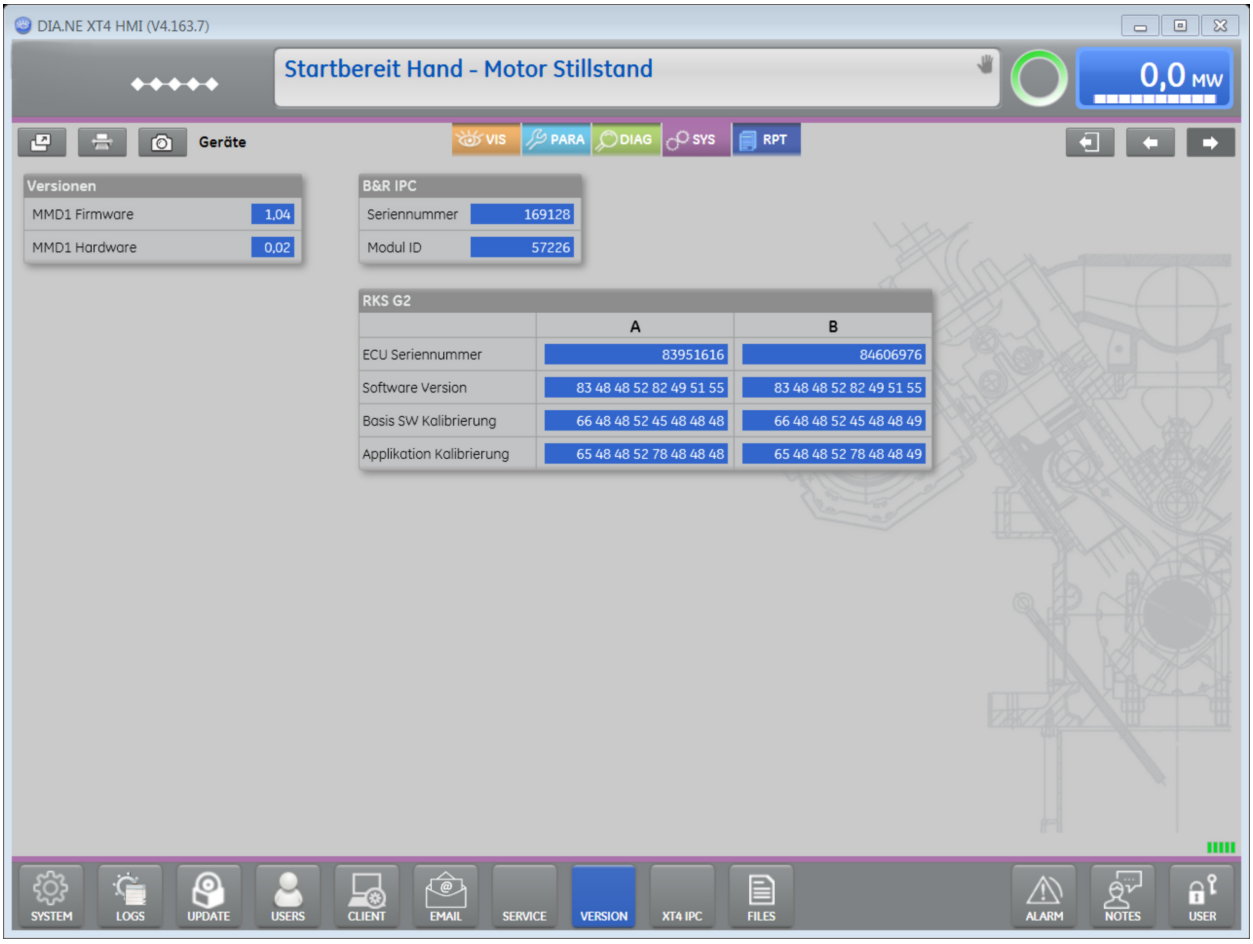
On the Statistics page under Cylinder Status, a cylinder is marked in light blue if RKS control has become active for that cylinder.



Under System → Version, you can also read the following RKS version numbers for Bank A and Bank B:

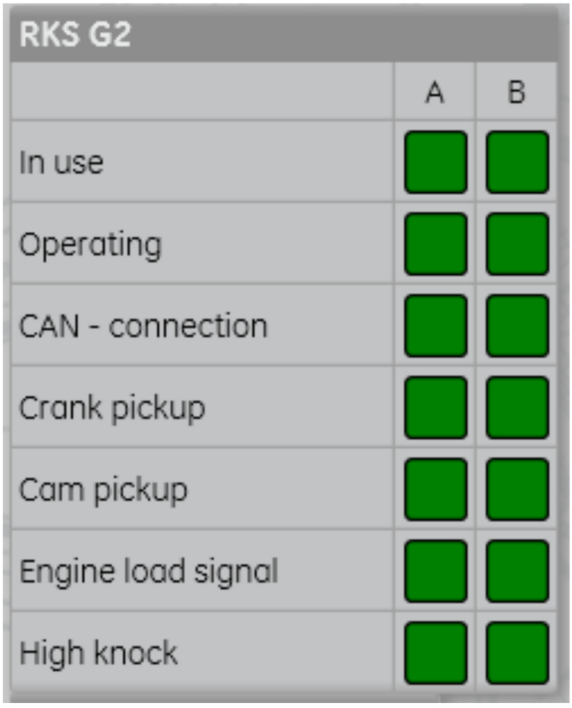
- ECU serial number
- Software version
- Base SW calibration

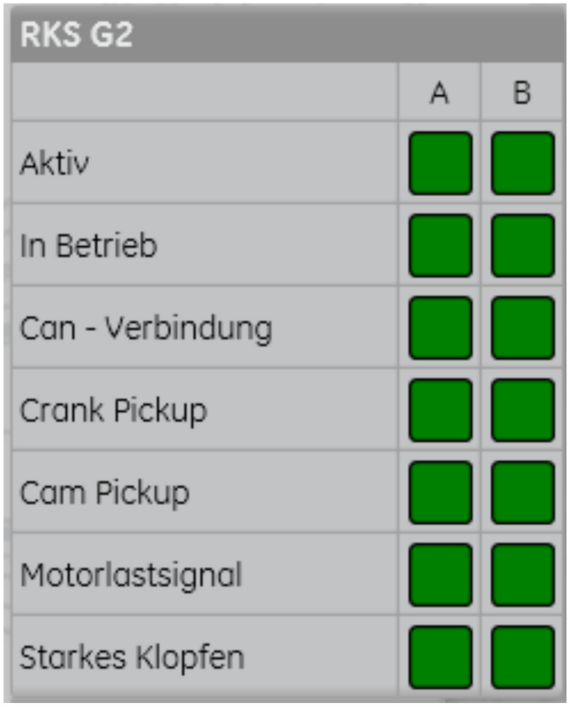
- Application calibration



8 Troubleshooting

The status display can provide diagnostic information during troubleshooting.





Meaning of In Use / Aktiv:

Displays a green signal when the engine is running and valid knock values are being sent from the RKS.

This signal is greyed out when the engine is at a standstill. This is not a fault.

If the signal remains grey even during engine operation, this means that the RKS is not sending knock values.

This can have several causes, and the appropriate corrective suggestions for each case are listed:

The crank angle reference is missing → check the signal connection from the trigger- and cam-/reset-signals to the RKS (terminals in control cabinet are correct, wiring harness is not damaged, plug is correctly connected to RKS unit and not damaged, bridge at terminals in control cabinet is correctly set).

If applicable, further fault signals are displayed, which indicate the cause of the disturbance in the knock signal transmission.

Engine load signal missing → check the signal connection of the engine load signal to the RKS boxes (terminals in control cabinet are correct, wiring harness is not damaged, plug is correctly connected to RKS boxes and not damaged).

Meaning of Operating / In Betrieb:

Displays a green signal when the DIA.NE is receiving a digital 'Ready' signal from the RKS.

Possible causes in the event of a fault:

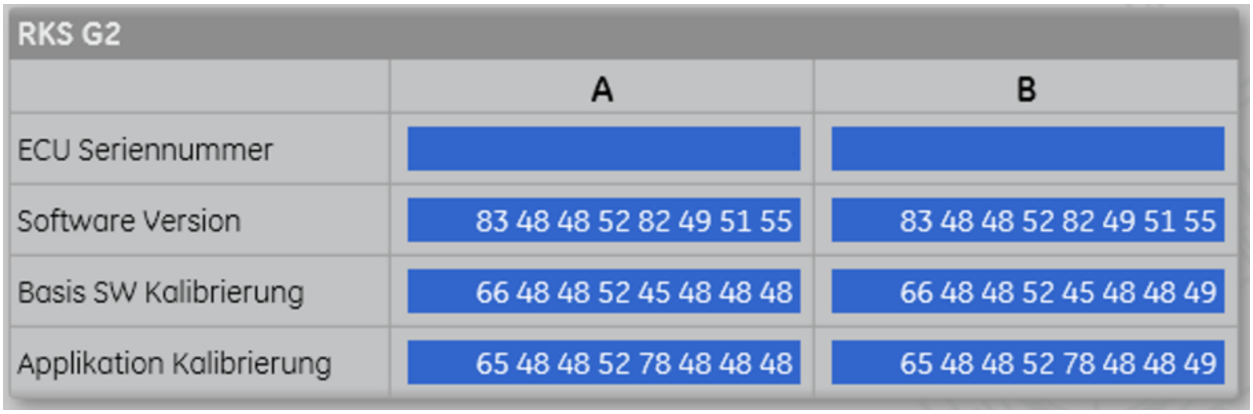
- There is a Bank A RKS unit fitted on Bank B or vice versa, there is a Bank B RKS unit fitted on Bank A.

Corrective measures:

– Check the allocation of part number to bank:

9023835	RKS Steuergerät Bank A / RKS box for Bank A
9024683	RKS Steuergerät Bank B / RKS box for Bank B

Check the base SW calibration and the application calibration. For this purpose, the following values should be available for Bank A / Bank B:



RKS G2	A	B
ECU Seriennummer		
Software Version	83 48 48 52 82 49 51 55	83 48 48 52 82 49 51 55
Basis SW Kalibrierung	66 48 48 52 45 48 48 48	66 48 48 52 45 48 48 49
Applikation Kalibrierung	65 48 48 52 78 48 48 48	65 48 48 52 78 48 48 49

– If necessary, remove the incorrectly installed RKS unit and install the correct RKS unit.

Important: the pin assignment of the RKS boxes on Bank A and Bank B is different to prevent accidental swapping of the boxes. The wiring harnesses also have a different pin coding at the connectors. If, for example, a RKS programmed for Bank B were fitted on the A side and connected to the wiring harness for Bank A, the DIA.NE would accordingly report a fault in the Operating / In Betrieb signal.

The background to this is that the cylinder arrangement and the crank angle-based knock windows on the two banks are completely different. This means that correct functionality can only be guaranteed when the RKS box programmed for a specific bank is fitted on that particular bank.

Other causes of faults, and their corrective measure:

- There is no signal connection to the DIA.NE → check the wiring in the control cabinet and at the terminals. Check wiring harness and connector: no damage, no bent pins in the connector?

9 CAN connection

When the CAN connection has a red status, it means that: The DIA.NE is not receiving any messages from the RKS box via the CAN bus. Corrective measures are:

- Check the CAN bus signal connection from the RKS box to the DIA.NE (terminals in control cabinet correct, wiring harness not damaged, plug correctly connected to RKS unit and not damaged). See also the Pin-to-Pin pin assignment tables.
- Check that the RKS boxes have a power supply. Check the LED on the front of the enclosure – it should be lit green.

- Check that the correct CAN bus is connected:
  - The RKS box has 2 different CAN bus connections.
  - The main CAN bus is responsible for the RKS-to-DIA.NE data connection and sends, among other things, the knock values to the DIA.NE. It is located in connector A on pin T (= CAN high, yellow) and pin U (= CAN low, green).
  - There is an additional CAN bus for maintenance and diagnostics. This CAN bus is only connected to the terminal in the control cabinet and is not used in normal engine operation. This CAN bus does not transmit any knock values and should therefore not be connected to the DIA.NE. This CAN bus is only used by the Development Department, e.g. for firmware updates or extended diagnostics. It is located in connector A on pin S (= CAN high, yellow) and pin R (= CAN low, green).
  - See also the Pin-to-Pin pin assignment tables.
  - **Caution:** the diagnostic CAN bus also sends the serial number, SW version, etc., i.e. at standstill it may initially look as if the correct CAN bus is connected. During engine operation, however, a malfunction will occur, because no knock values are transmitted via the maintenance and diagnostics CAN bus.

10 Meaning of Crank- / Cam-Pickup

For the crank angle reference / cycle reference, the RKS box needs the digital crank- and cam-pickup signals that, in parallel with SAFI/MORIS, are taken from the SPA24 digital outputs.

If the signals are present during normal engine operation, this is indicated by a green status display.

If there is a signal failure during engine operation, a red status display will appear.

Possible causes in the event of a fault, and corrective measures:

- If SAFI also reports a pickup alarm, the pickup sensor's signal chain is broken and must be checked.
- If the engine is running normally (no pickup alarm from SAFI) and the RKS reports a crank- or cam-pickup signal fault, then the signal chain between SPA24 and the RKS box is broken.
  - The individual terminal points in the control cabinet must be checked by multimeter continuity testing between SPA24 and RKS to determine at which terminal point the signal interruption exists and to then rectify the interruption.
  - Additional check of wiring harness and connector: no damage, no bent or damaged pins in the connector?

11 Meaning of Engine Load Signal

To provide their functionality, the RKS boxes need the prevailing power output of the engine. This power signal is supplied by the DIA.NE as an mA signal to the two RKS boxes.

If the power signal is present during normal engine operation, this is indicated by a green status display.

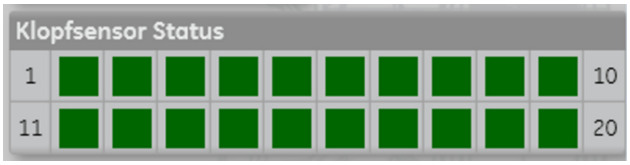
If there is a signal failure during engine operation, a red status display will appear.

Possible causes in the event of a fault:

- The mA analogue signal output module of the DIA.NE is not providing an mA load signal → check with multimeter.
- The signal path for the mA signal between the DIA.NE and the RKS is interrupted.
  - Check with a multimeter / Check the individual terminal points in the control cabinet.
  - Additional check of wiring harness and connector: no damage, no bent or damaged pins in the connector?

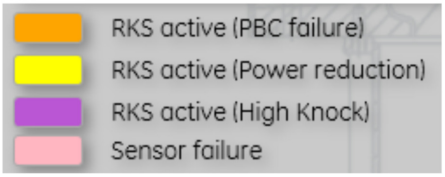
12 Signal fault with cylinder pressure sensor or RKS knock sensor

In the knock sensor status overview you can see at which cylinder a pressure sensor or a RKS knock sensor has failed.



A cylinder pressure sensor failure is represented by one of the colours shown below from the category "RKS active".

A RKS knock sensor failure is represented by the colour shown below for "Sensor failure".



Corrective measures:

For a measuring signal fault regarding the cylinder pressure sensor, please follow the corresponding TA 1502-0071.

TA 1502-0071 – SAFI (Sensor Actuator Function Interface)

For a measuring signal fault regarding the RKS knock sensor, the following points must be checked:

- The knock sensor is correctly fitted and screwed onto the adapter screw on the cylinder head with the correct tightening torque (20 Nm)?
- The sensor is properly connected; the sensor plug is correctly engaged?
- The pins in the sensor connector have not been pushed out?
- The wiring harness/the cable to the sensor is not visibly damaged?
- The intrinsic impedance of the sensor is >1 MΩ

- The signal connection between the pin on the round connector on the RKS box and the knock sensor connector is not interrupted? (See also the Pin-to-Pin pin assignment tables).
- The pin on the round connector on the RKS box is not bent / damaged?

Service tools:

Part number	Designation
1245393	Replacement connector set for knock sensor (10 pieces)
1245460	Pin release tool for knock-sensor connector
1230824	Crimp tool set for knock-sensor connectors

13 Replacing the RKS box

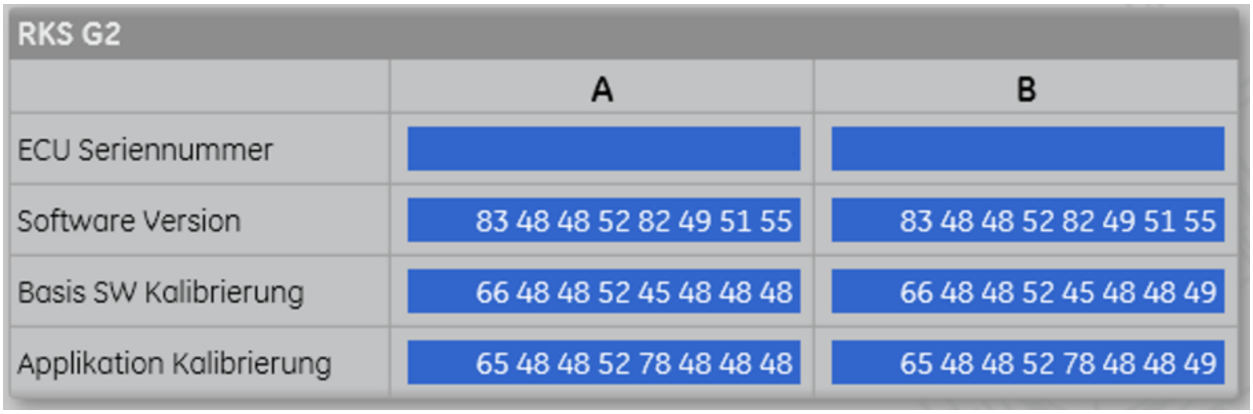
If it has not been possible to solve the problem through the points mentioned above, and problems on the software side can be excluded, then the RKS box can be replaced. It is essential to ensure that the RKS box is set up correctly for the bank in question (correct P/N with associated bank-specific software installed).

- Check the allocation of part number to bank:

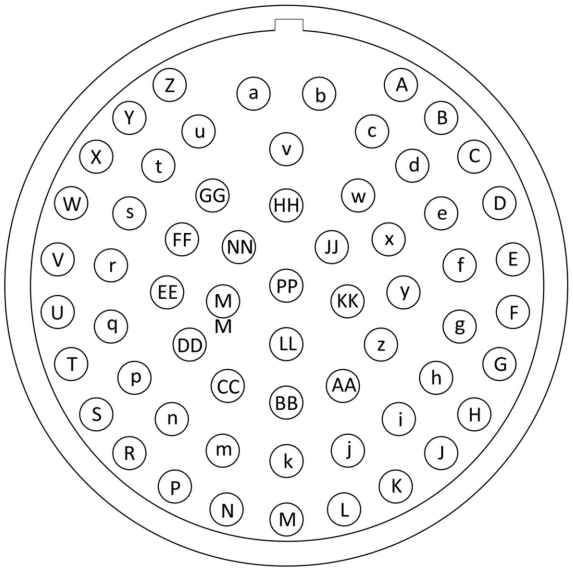
9023835	RKS Steuergerät Bank A / RKS box for Bank A
9024683	RKS Steuergerät Bank B / RKS box for Bank B

Check the **base SW calibration** and the **application calibration**.

For this purpose, the following values should be available for Bank A / Bank B:



14 Pin assignment for connectors / wiring harnesses



Pin assignment – mapping for ITT Cannon Connector Series KSPE08E24-61

Pin assignment for RKS knock sensor wiring harness, Bank A:

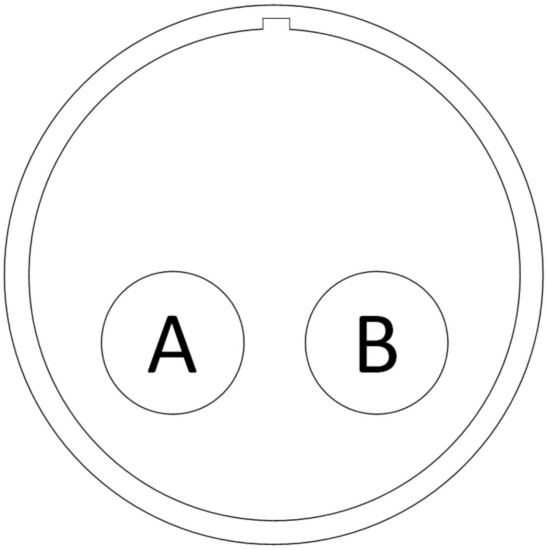
Connector		Cable		Connector		Signal
Type	Pin	Type	No. / Color	Type	Pin	Description
KPSE08F24-61SYF0	c	Individual 2 wire shielded knock harness cables Bank A	White	BOSCH 1 928 403 874	1	Knock Sensor Cyl 1 +
	n/c		(shield)		n/c	shield
	C		Brown		2	Knock Sensor Cyl 1 -
	d		White		1	Knock Sensor Cyl 7 +
	n/c		(shield)		n/c	shield
	D		Brown		2	Knock Sensor Cyl 7 -
	e		White		1	Knock Sensor Cyl 3 +
	n/c		(shield)		n/c	shield
	E		Brown		2	Knock Sensor Cyl 3 -
	f		White		1	Knock Sensor Cyl 9 +
	n/c		(shield)		n/c	shield
	F		Brown		2	Knock Sensor Cyl 9 -
	g		White		1	Knock Sensor Cyl 5 +
	n/c		(shield)		n/c	shield
	G		Brown		2	Knock Sensor Cyl 5 -
	h		White		1	Knock Sensor Cyl 10 +
	n/c		(shield)		n/c	shield
	H		Brown		2	Knock Sensor Cyl 10 -
	j		White		1	Knock Sensor Cyl 4 +
	n/c		(shield)		n/c	shield
	J		Brown		2	Knock Sensor Cyl 4 -
	K		White		1	Knock Sensor Cyl 8 +
	n/c		(shield)		n/c	shield
	L		Brown		2	Knock Sensor Cyl 8 -
	M		White		1	Knock Sensor Cyl 2 +
	n/c		(shield)		n/c	shield
	N		Brown		2	Knock Sensor Cyl 2 -
	j		White		1	Knock Sensor Cyl 6 +
	n/c		(shield)		n/c	shield
	k		Brown		2	Knock Sensor Cyl 6 -

Pin assignment for RKS knock sensor wiring harness, Bank B:

Connector		Cable		Connector		Signal
Type	Pin	Type	No. / Color	Type	Pin	Description
KPSE08F24-61SYF0	c	Individual 2 wire shielded knock harness cables Bank B	White	BOSCH 1 928 403 874	1	Knock Sensor Cyl 17 +
	n/c		(shield)		n/c	shield
	C		Brown		2	Knock Sensor Cyl 17 -
	d		White		1	Knock Sensor Cyl 13 +
	n/c		(shield)		n/c	shield
	D		Brown		2	Knock Sensor Cyl 13 -
	e		White		1	Knock Sensor Cyl 19 +
	n/c		(shield)		n/c	shield
	E		Brown		2	Knock Sensor Cyl 19 -
	f		White		1	Knock Sensor Cyl 15 +
	n/c		(shield)		n/c	shield
	F		Brown		2	Knock Sensor Cyl 15 -
	g		White		1	Knock Sensor Cyl 20 +
	n/c		(shield)		n/c	shield
	G		Brown		2	Knock Sensor Cyl 20 -
	h		White		1	Knock Sensor Cyl 14 +
	n/c		(shield)		n/c	shield
	H		Brown		2	Knock Sensor Cyl 14 -
	i		White		1	Knock Sensor Cyl 18 +
	n/c		(shield)		n/c	shield
	J		Brown		2	Knock Sensor Cyl 18 -
	K		White		1	Knock Sensor Cyl 12 +
	n/c		(shield)		n/c	shield
	L		Brown		2	Knock Sensor Cyl 12 -
	M		White		1	Knock Sensor Cyl 16 +
	n/c		(shield)		n/c	shield
	N		Brown		2	Knock Sensor Cyl 16 -
	j		White		1	Knock Sensor Cyl 11 +
	n/c		(shield)		n/c	shield
	k		Brown		2	Knock Sensor Cyl 11 -

Plug connector for knock monitoring, RKS-ECU to DIA.NE:

Table of Connectors for knock monitoring RKS ECU to DIANE harness		
Connector No.	**Type**	**Location**
1	CAN-bus & I/Os connector **ITT Cannon KPSE08E24-61S** or compatible connectors	Bank A/B RKS knock monitoring ECU – Socket: ECU-A
2	Analog signal connector **ITT Cannon KPSE08E24-61SW** or compatible connectors	Bank A/B RKS knock monitoring ECU – Socket: ECU-C
3	RKS ECU power supply connector **Amphenol PT06A10-2S** or compatible connectors	Bank A/B RKS knock monitoring ECU – Socket: ECU-F



Pin assignment for Amphenol connector PT06A10-25

Note the different pin position for Bank A / Bank B!

Pin assignment for RKS-ECU to DIA.NE wiring harness Bank A to connector KPSE08E24-61S

Connector		Cable		Cable ends on terminal	Signal	CAN-Bus termination resistor
Type	Pin	Type	No. / Color		Description	
KPSE08E24-61S	V	Individual shielded cables and two CAN bus cables	1	SPA24-J7-1	Trigger (T)	
	X		2	SPA24-J7-3	Cam/Reset (C/R)	
	G		3	SPA24-J7-2	Ground (G)	
	S		Yellow		CAN gateway + (cal tool)	120 Ohm resistor between Pin S and Pin R on connector
	n/c				CAN gateway shield	
	R		Green		CAN gateway – (cal tool)	
	T		Yellow		CAN 2 bus +	120 Ohm resistor between Pin T and Pin U on connector
	n/c				CAN 2 bus shield	
	U		Green		CAN 2 bus -	
	EE		1		+24V or System Enable signal	
	a		2		Knock Indication (+)	
	H		3		Digital (-)	
	PP		4		**Active Restriction (+)**	

Pin assignment for RKS-ECU to DIA.NE wiring harness Bank B to connector KPSE08E24-61S

Connector		Cable		Cable ends on terminal	Signal	CAN-Bus termination resistor
Type	Pin	Type	No. / Color		Description	
KPSE08E24-61S	V	Individual shielded cables and two CAN bus cables	1	SPA24-J8-1	Trigger (T)	
	X		2	SPA24-J8-3	Cam/Reset (C/R)	
	G		3	SPA24-J8-2	Ground (G)	
	S		Yellow		CAN gateway + (cal tool)	120 Ohm resistor between Pin S and Pin R on connector
	n/c				CAN gateway shield	
	R		Green		CAN gateway – (cal tool)	
	T		Yellow		CAN 2 bus +	120 Ohm resistor between Pin T and Pin U on connector
	n/c				CAN 2 bus shield	
	U		Green		CAN 2 bus -	
	EE		1		+24V or System Enable signal	
	a		2		Knock Indication (+)	
	H		3		Digital (-)	
	v		4		**Active Restriction (+)**	

Pin assignment for RKS-ECU to DIA.NE wiring harness Bank A/B to connector KPSE08E24-61SW

Connector		Cable		Cable ends on terminal	Signal
Type	Pin	Type	No. / Color		Description
KPSE08E24-61SW	D	Shielded signal cable	1		Load Signal (+)
	e		2		Load Signal (-)
	J		1		Analog Information #1 (+)
	H		2		Analog Information #1 (-)
	F		3		Analog Information #2 (+)
	E		4		Analog Information #2 (-)

Pin assignment for RKS-ECU to DIA.NE wiring harness Bank A/B to connector PT06A10-25

Connector		Cable		Cable ends on terminal	Signal
Type	Pin	Type	No. / Color		Description
PT06A10-2S	A	+24V power supply cable	1	+24V supply	ECU power +24V
	B		2	-24V supply	ECU power -24V

15 Revision code

Revision history

Index	Date	Description / Revision summary	Expert *Auditor*
3	31.10.2019	RKS Kabelbaum ab Produktprogramm 2019 ergänzt / RKS cable harness from product range 2019 added	**Neiteler N.** *Kopecek H.*
2	10.04.2019	GE durch INNIO ersetzt / GE replaced by INNIO	**Stojiljkovic T.** *Pichler R.*
1	31.01.2019	Erstausgabe / First issue	**Meintker N.** *Kopecek H.*