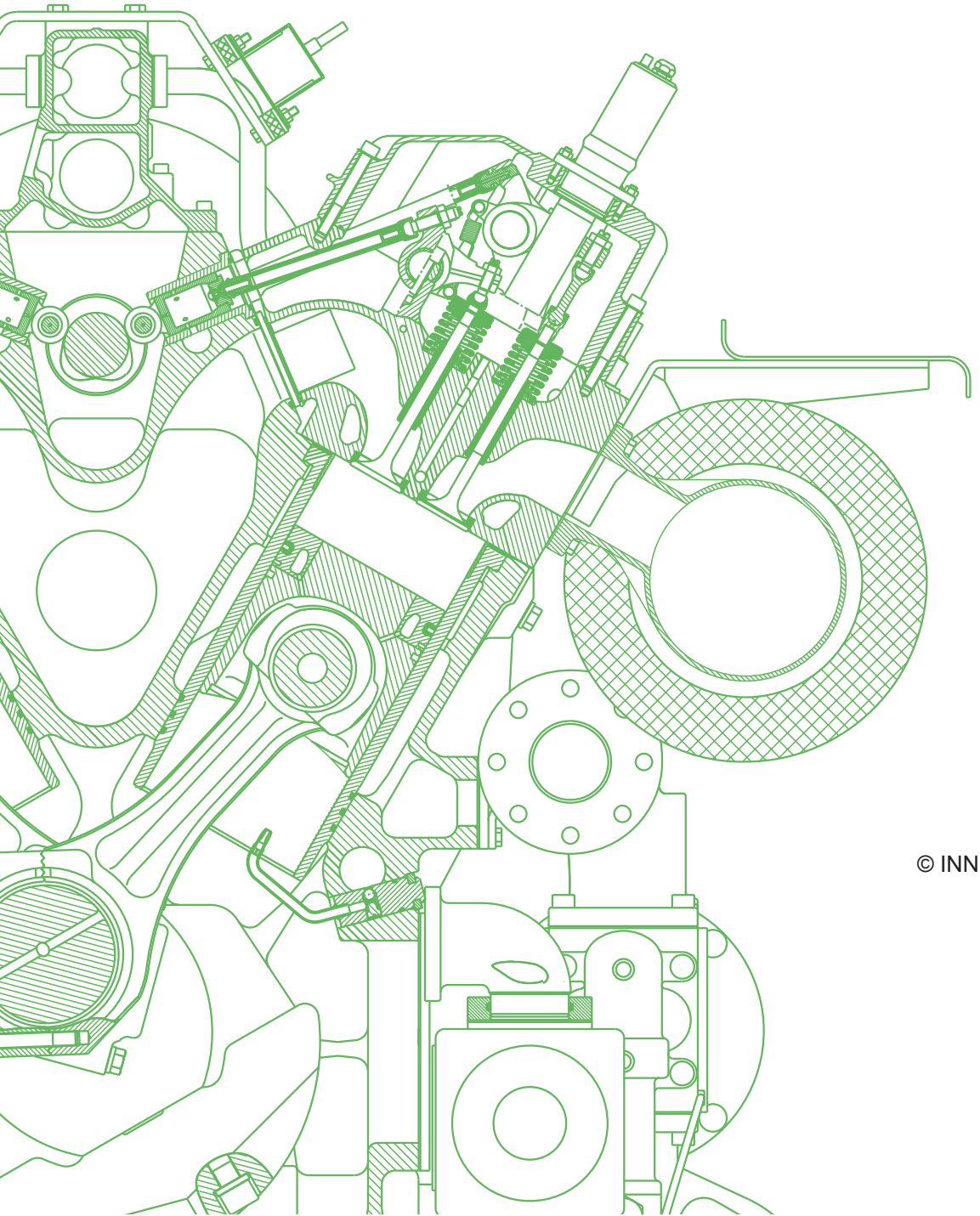
JENBACHER

TA 1502-0071

Technical Instruction

SAFI (Sensor Actuator Function Interface)



Achenseestr. 1-3
A-6200 Jenbach, Austria
www.innio.com

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1 Safety information

⚠ ATTENTION

Please observe the safety and hazard signs in the safety instructions (TA 2300-0005) and wear the appropriate personal protective equipment.

2 Description of the concept

SAFI is fitted between two cylinders and performs a variety of measuring and monitoring functions depending on hardware design and software configuration and controls and monitors the ignition system for both cylinders. SAFI stands for **S**ensor **A**ctor **F**unction **I**nterface SAFI is a further development of the KLS98, with a substantially increased range of functions.

The following functionalities are included in SAFI:

- KLS**:** knock detection and valve-noise control limit
- PBC: combustion analysis (knocking, misfires, etc.) by measuring the combustion pressure curve
- Port injection: controlling and monitoring the cylinder-specific injection into the inlet manifold Port Injection
- Ignition: activation and control of the MORIS ignition system
- Ignition voltage measurement: ignition voltage requirement of the spark plugs
- Exhaust-gas temperature measurement
- Speed measurement

2.1 Parts/design

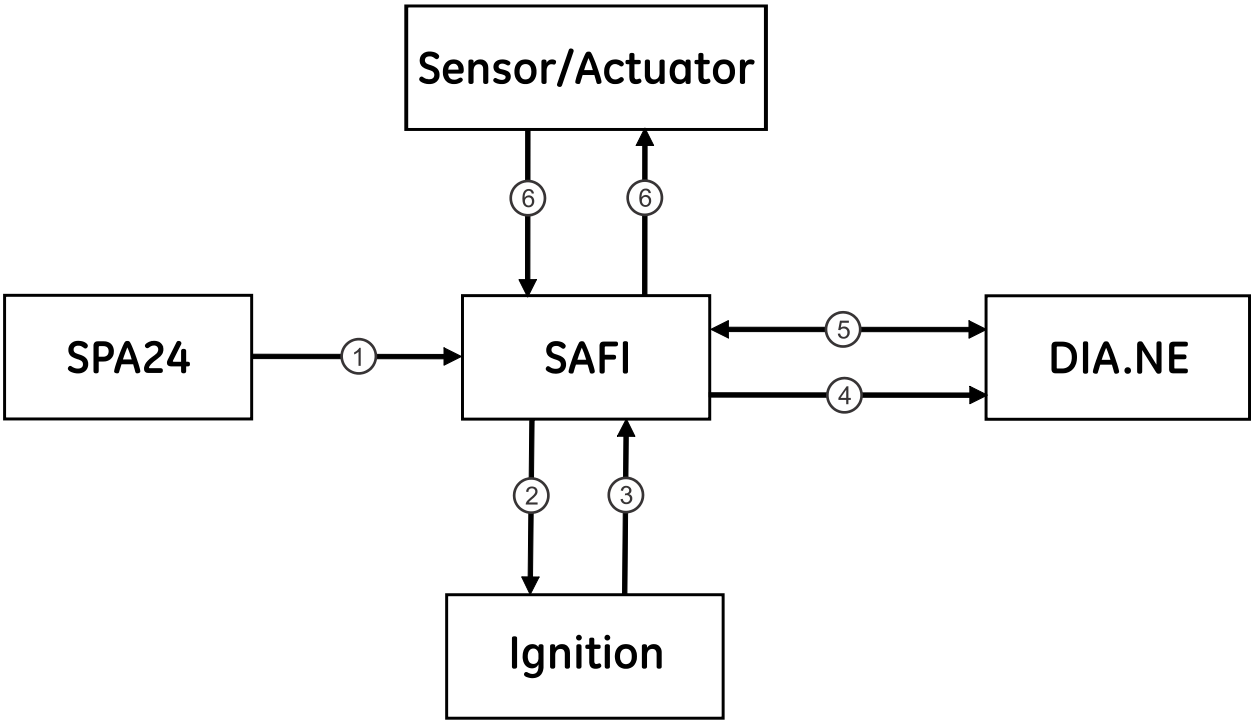
The designation SAFI is used in general in this document for the first-generation SAFI, and SAFI 2 for the further development. Where a description refers exclusively to the first-generation SAFI or to SAFI 2, this will be stated in the description.

	SAFI (1st generation)	**SAFI2**
SAFI with KLS function	411880 1200176	652092
SAI with DMR function	665426 435624	652439 652438
Thermocouple		

2.2 Basic function

SAFI boots up when the power supply is connected, after which all the parameters in SAFI are deleted and must be sent by the engine control system. The individual functions can only be activated via the CAN bus.

SAFI has a digital output that sends signals to indicate that the ignition is operating and therefore ignition signals are being emitted. If the CAN communication fails during operation, it is possible to deduce the operation of the ignition system from the level of this output and respond accordingly.



Sensors	Sensors
Ignition	Ignition
①	Pick-up signals
②	Ignition control system
③	Ignition feedback Power supply Cylinder coding
④	MORIS Safety circuit
⑤	CAN
⑥	Analogue signals

3 Technical data

3.1 Protection class

When fitted, SAFI achieves protection class IP54.

3.2 Ambient conditions

Temperature limits	Storage	-25 ... + 70 °C
	Operation	-25 ... + 85 °C
Rel. humidity	Storage	90 %, no dew
	Operation	85 %, no dew
Air pressure	up to 2,000 m above sea level	

3.3 Mechanical data

3.3.1 vibrations

SAFI must be protected from engine vibration when fitted. The supports designed for MORIS should be used. SAFI is designed for vibration loads to an effective value of max. 20 mm/s at 10-300 Hz.

3.3.2 Chemical requirements

SAFI has been developed to meet the specific INNIO Jenbacher GmbH & Co OG requirements for chemical resistance to the antifreeze (glycol) in the engine cooling water, sulphurous acid, engine oil and UV radiation.

In general, the following limit levels for atmospheric pollution apply:

- Sulphur dioxide (SO2) 0.030 ppm
- Hydrogen sulphide (H2S) 0.010 ppm
- Nitrous oxide gases (NOx) 0.030 ppm
- Chlorine (C12) 0.010 ppm
- Hydrogen fluoride (HF) 0.010 ppm
- Ammonia (NH2) 0.500 ppm
- Ozone (O3) 0.005 ppm

If pollution levels are higher, they must be approved separately by INNIO Jenbacher GmbH & Co OG.

3.4 Electrical data

Power supply

SAFI is powered by a battery with a nominal voltage of 24 V. The battery voltage may fluctuate in a range from 15 V to 32 V ± 10% residual ripple.

Power consumption

The maximum power consumption of a first-generation SAFI is 175 mA.

The maximum power consumption of a SAFI2 is 130 mA.

3.5 Exhaust-gas temperature measurement

The exhaust gas temperature of each cylinder is measured by SAFI using type K NiCrNi thermocouples, for which SAFI is provided with cold junction compensation. The measurement accuracy corresponds to Class 2 for type K thermocouples as specified in EN 60584-2.

Temperature range	Tolerance
0 °C to 333 °C	±2.5 K
333 °C to 900 °C	± 0.75%

Brief additional deviations of ± 5 K will occur in the event of rapid changes in SAFI's ambient temperature.

3.6 High-voltage measurement

High-voltage is measured over the entire range from 0 kV to 50 kV to an accuracy of ± 1 kV.

3.7 First-generation SAFI connections and displays

①	LEDs	③	Knock sensors
②	Exhaust gas thermocouples		

Terminal designation

Sub D connector plug

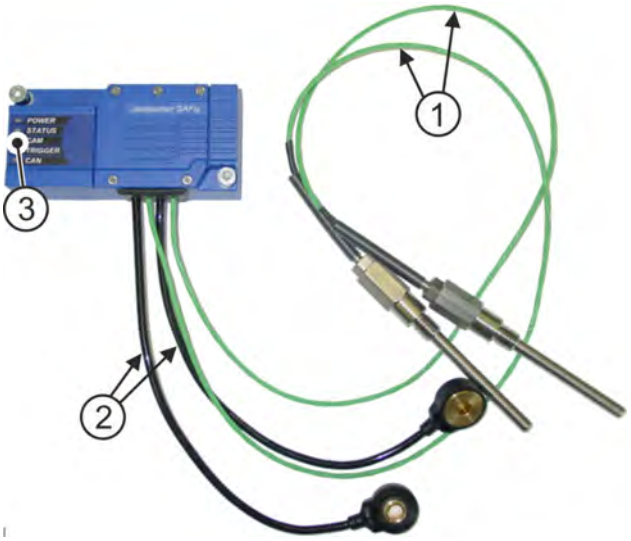
PIN	Designation	Meaning
1	HV 2	High-voltage measurement signal from right ignition coil
2	HV 1	High-voltage measurement signal from left ignition coil
3	POWER	Ignition current setpoint for left and right ignition end stage

PIN	Designation	Meaning
4	IP 1	Trigger signal for the left ignition end stage
5	CODE 4	Third bit of SAFI coding for position sensing
6	CODE 1	First bit of SAFI code for position sensing
7	CODE 2	Second bit of SAFI code for position sensing
8	CAN low	CAN low
9	CAN high	CAN high
10	OFF	Emergency shutdown
11	CAM	Signal from the camshaft pickup
12	GND	Ground
13	+24 V	Power supply for SAFI
14	GND	Ground
15	GND	Ground
16	IP2	Trigger signal for the right ignition end stage
17	RM1	Feedback from the left ignition output stage
18	GND	Ground
19	CODE 8	Fourth bit of SAFI code for position sensing
20	RM2	Feedback from the right ignition output stage
21	CAN-GND	CAN-GND
22	n.c.	Unallocated
23	TRIGGER	Signal from ring gear
24	GND	Ground
25	n.c.	Unallocated

Exhaust gas thermocouples

Number	Designation	Meaning
1	+	+ thermocouple connection
2	GND	Connection for shielding
3	-	- connection for thermocouple

3.8 Connections and displays from SAFI 2



①	Exhaust gas thermocouples	③	LEADs
②	Knock sensors		

3.8.1 Terminal designation

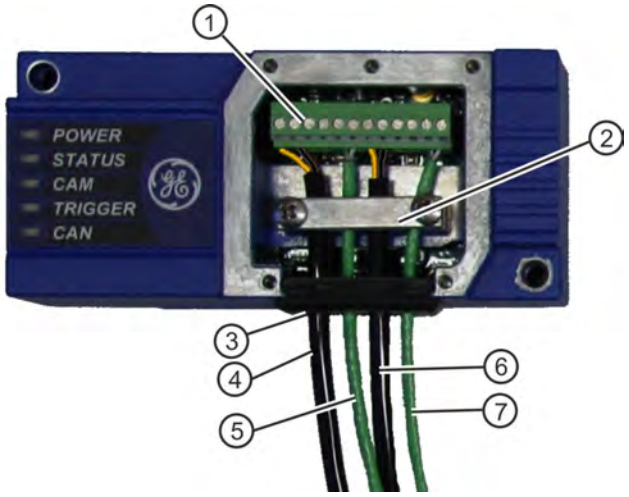
Sub D connector plug

PIN	Designation	Meaning
1	HS R	High-voltage measurement signal from right ignition coil
2	HS L	High-voltage measurement signal from left ignition coil
3	POWER	Ignition current setpoint for left and right ignition end stage
4	ZZP L (IP L)	Trigger signal for the left ignition end stage
5	CODE 4	Third bit of SAFI coding for position sensing
6	CODE 1	First bit of SAFI code for position sensing
7	CODE 2	Second bit of SAFI code for position sensing
8	CAN low	CAN low
9	CAN high	CAN high
10	SC	Emergency shutdown
11	CAM	Signal from the camshaft pickup
12	GND	Ground
13	+24 V	Power supply for SAFI
14	PI R	Trigger signal for the right Port Injection driver output stage
15	PCI R	Trigger signal for the right prechamber gas valve driver output stage
16	ZZP R (IP R)	Trigger signal for the right ignition end stage
17	RM1	Feedback from the left ignition output stage
18	PCI L	Trigger signal for the left prechamber gas valve driver output stage
19	CODE 8	Fourth bit of SAFI code for position sensing
20	RM2	Feedback from the right ignition output stage
21	CAN-GND	CAN-GND
22	PI RM R	Feedback for the right Port Injection and prechamber gas valve driver output stage
23	TRIGGER	Signal from ring gear
24	PI RM L	Feedback for the left Port Injection and prechamber gas valve driver output stage
25	PI L	Trigger signal for the left Port Injection driver output stage

Exhaust gas thermocouples, knock sensors and cylinder pressure sensors

On the SAFI2 the exhaust gas thermocouples, knock sensors and cylinder pressure sensors are connected directly inside the housing. To do this, undo the 5 connection screws and remove the cover to reveal the connector.

To connect the sensors, remove the 12-pole connector block from the socket with pointed pliers. Push the connector, with the sensors connected to it, into the socket and fit the strain reliever. Make sure that the gasket is correctly fitted to ensure the sealing effect.



①	Connector block for the sensors	⑤	Left cylinder exhaust gas thermocouple
②	Strain reliever	⑥	Right cylinder knock sensor
③	Gasket	⑦	Right cylinder exhaust gas thermocouple
④	Left cylinder knock sensor		

On the SAFI2 with the KLS function (part number 652092), connect the knock sensors, and on the SAFI2 with the DMR function (part number 652439), connect the connection cable for the pressure sensors.

Terminal designation for the SAFI2 with the KLS function

PIN	Designation	Colour	Meaning
1	Piezo / Pressure L+	Yellow	+ input to left cylinder knock sensor
2	Piezo / Pressure L -	black	- input to left cylinder knock sensor
3	+24V L		not used
4	GND		not used
5	TC L+	Green	+ input to left cylinder exhaust gas thermocouple
6	TC L-	White	- input to left cylinder exhaust gas thermocouple
7	Piezo / Pressure L+	Yellow	+ input to right cylinder knock sensor
8	Piezo / Pressure L -	black	- input to right cylinder knock sensor
9	+24V L		not used
10	GND		not used
11	TC L+	Green	+ input to right cylinder exhaust gas thermocouple
12	TC L-	White	- input to right cylinder exhaust gas thermocouple

Terminal designation for the SAFI2 with DMR function

PIN	Designation	Colour	Meaning
1	Piezo / Pressure L+	Blue	+ input to left cylinder pressure sensor
2	Piezo / Pressure L -	black	- input to left cylinder pressure sensor
3	+24V L	White	24 V power supply to left cylinder pressure sensor

PIN	Designation	Colour	Meaning
4	GND	-	Jumper to pin 2
5	TC L+	Green	+ input to left cylinder exhaust gas thermocouple
6	TC L-	White	- input to left cylinder exhaust gas thermocouple
7	Piezo / Pressure L+	Blue	+ input to right cylinder pressure sensor
8	Piezo / Pressure L -	black	- input to right cylinder pressure sensor
9	+24V L	White	24 V power supply to right cylinder pressure sensor
10	GND	-	not used
11	TC L+	Green	+ input to right cylinder exhaust gas thermocouple
12	TC L-	White	- input to right cylinder exhaust gas thermocouple

Shielding for the thermocouples and cylinder pressure sensors is not included in SAFI2, as the sensors themselves are already earthed.

3.8.2 Displays on the device

The device has five LED displays, of which the "STATUS" LED is in three colours.

Designation	Colour	Meaning
POWER	Green	Power supply
STATUS	Green	Ignition or ignition self-test / port injection or port injection self-test
	Red	Error
	Yellow	Booting up
CAM	Yellow	Synthetic camshaft/reset pulse
TRIGGER	Yellow	Trigger pulse
CAN	Yellow	CAN bus activity

3.9 Firmware

SAFI is operated using firmware version 7.xx. Firmware versions with the same figure before the decimal point are compatible, making it possible to operate an engine with different firmware versions of SAFI.

Reserved firmware numbers:

	Reserved firmware range	First version
SAFI (1st generation)	7.00 - 7.40	
SAFI DMR (2nd generation)	7.40 - 7.59	7.44
SAFI KLS (2nd generation)	7.60 – 7.99	7.64
SAFI1 DMR	7.53	
SAFI KLS filter version	1.00 - 1.99	1.01
SAFI DMR filter version	2.00 - 2.99	2.01

The numerals before the decimal point indicate the functional scope, the numerals after the decimal point indicate the firmware version.

Higher numerals after the decimal point represent improved versions without any increase in functionality.

If the code does not match the above-mentioned engine positions or if a firmware problem arises, on the first-generation SAFI the CAM and TRIGGER LEDs will flash alternately after the boot-up, and on SAFI2 the STATUS LED will light up red.

If firmware problems arise, download the firmware again or replace SAFI.

Firmware update

You can update the firmware via DIA.NE XT. The need for a firmware update and the exact procedure must be discussed with the Competence Centre in Jenbach.

4 Layout

The first-generation SAFI is supplied with one M6 x 30 and M6 x 35 hexagonal socket head screw and one gasket.

The SAFI2 is supplied with two M6 x 35 hexagonal socket head screws and one gasket.

The bolts must be tightened to 3.4 Nm.

①	Exhaust gas thermocouples	③	Gasket
②	Knock sensors		

4.1 Installation of the sensors

4.1.1 Knock sensors

Each of the two knock sensors is fastened by a mounting bolt (M8x25) to the adapter nut on the rear cylinder head bolts of the neighbouring cylinder heads, without crossing cables, using a tightening torque of 20 Nm. Ensure that the surface is even and clean. Filler rings are not permitted. Tighten the adapter nuts to the cylinder head bolts using a 60 Nm tightening torque.

4.1.2 Thermocouples

Tighten the thermocouple sleeves to a torque of 30 Nm. The exhaust gas thermocouples on the first-generation SAFI must be tightened by hand to the engine block to a torque of 15 Nm. Connect the thermocouple for the left cylinder to the left-hand connector and the thermocouple for the right cylinder to the right-hand connector.

The exhaust gas thermocouples are connected to the SAFI2 by the connector block and tightened on the engine block with a torque of 15 Nm.

4.2 Identifying the cylinder arrangement in the engine

The SAFIs boot up when the power supply is connected. During the boot-up SAFI detects the installation position on the engine by means of a code in the MORIS rail. This is visualised by the number of times the CAN LED flashes as shown in the table below. The STATUS LED flashes orange.

SAFI installed between	LED CAN flashes
Cylinders 1 and 2	once
Cylinders 3 and 4	twice
Cylinders 5 and 6	3 x
cylinders 7 and 18	4 x
Cylinders 9 and 10	5 x
Cylinders 11 and 12	6 x
Cylinders 13 and 14	7 x
Cylinders 15 and 16	8 x
Cylinders 17 and 18	9 x
Cylinders 19 and 20	10 x
Cylinders 21 and 22	11 x
Cylinders 23 and 24	12 x

If an engine position is duplicated in the event of an engine fault, the incorrect position will be highlighted on the DIA.NE system by the message "SAFI CAN communication error". The duplicate must be found by checking all the positions by connecting and disconnecting each individual device.

If the code does not match the above-mentioned engine positions or if a firmware problem arises, on the first-generation SAFI the CAM and TRIGGER LEDs will flash alternately after the boot-up, and on SAFI2 the STATUS LED will light up red.

5 Pickup signals

SAFI requires two digital signals to detect the engine running conditions. The three analogue pickup signals are converted to two digital signals by the SPA24.

NOTE

The settings for the pickup signals are documented in TA 1502-0072 – SPA24.

5.1 Camshafts/reset signal

The camshafts/reset signal is a synthetic signal generated by the SPA24 from the signal from the camshaft pickup and the reset signal from the crankshaft.

A significant factor for calculating the crankshaft position is the negative edge of this digital signal, which matches the crossover of the analogue reset signal. The position of this edge is set relative to the top dead centre of the first cylinder in the parameter manager and, as is usual in ignition systems, positive values indicate the range before the top dead centre and negative values the range after the top dead centre of the cylinder.

The negative edge of the input is indicated visually by the CAM LED on SAFI lighting up briefly.

Adjusting the reset position

INNIO Jenbacher GmbH & Co OG engines normally have a reset position in the range 45 – 95 °CA before top dead centre. The exact position of this signal must be communicated to SAFI via the parameter reset position in the SAFI parameter list. The possible adjustment range is from -360°CA to 360°CA.

When the engine is started for the first time or conversions are made that alter the position of the reset pickup, an ignition timing strobe must be used to compare the ignition point on the engine with the ignition point value on the engine control system. If the value displayed does not match the actual value on the flywheel, the engine must be shut down, the value for the reset signal corrected and the ignition point rechecked.

NOTE

The engine must not be switched to operation under load until the ignition point has been checked!

5.2 Flywheel signal (trigger signal)

SAFIs require between 50 and 500 impulses per rotation (trigger signal) to be able to calculate the speed and the exact angle position of the cylinders.

The positive edge of the input is visualised by the TRIGGER LED on SAFI lighting up briefly.

6 Implementation in the engine control system

Depending on the function, many shutdowns and warnings are assigned an operating notification containing information on the cylinder or SAFI. Once a shutdown has occurred or a warning has appeared, the assigned operational messages are entered one after the other in time intervals of a few seconds.

Only the operational message from the last cylinder is listed in the current alarm management system. The operating notifications from all the cylinders can be viewed in the alarm history.

6.1 Parameter manager

SAFI affects the following parameter lists:

SAFI:

- Function activation
- Reset position
- Ignition point monitoring

Exhaust gas:

- Activation of the monitoring system
- Limit values

Engine Data:

- SAFI activation

Ignition voltage measurement:

- Activation of the monitoring system
- Limit values

Anti-knock:

- Knock controller activation and setting
- Knock detection setting
- Valve noise detection setting
- Mechanical noise setting
- Individual cylinder enable
- General ignition point adjustment

Ignition

- Activation of the misfire control system
- Overspeed limit value
- Ignition point limit values
- MORIS energy setting
- MORIS output monitoring
- MORIS coil type
- MORIS power supply unit output

6.2 Alarm accompanying values

In all cylinder-specific error messages and warnings the cylinders concerned are displayed in an additional operating notification, which are designated as an alarm accompanying value.

The current alarm list displays the error message or warning and, in addition, an operational message. In the historic alarm list, all the cylinders concerned are each displayed in their own operational message. In the DIA.NE XT system the cylinder number appears beside the operational message and in the DIA.NE WIN system the cylinder number is displayed by double-clicking the relevant operational message.

7 Functions

7.1 General function

7.1.1 Description of general functions

Any functionalities which are required to operate and monitor SAFIs, irrespective of the assigned task, are described as general functions.

7.1.1.1 Pickup monitoring

SAFI generates the current position of the crankshaft and camshaft from the pickup signals to an accuracy of 0.1 °CA In order to avoid incorrect positions being detected by incorrect pickup signals, these signals are monitored

- for the presence of the trigger and the synthetic camshaft/reset signal
- to count the number of teeth between two synthetic camshafts/reset pulses
- to ascertain the time from one tooth to the next in order to detect missing teeth and interference signals.

To make troubleshooting easier when a pickup error occurs, the number of teeth detected between the last synthetic camshafts/reset pulse and the defective pickup pulse is displayed SAFI System screen. Make sure that the value displayed relates to the crankshaft which is rotated twice per engine cycle.

You can find the defective tooth by counting the teeth on the ring gear, starting with the reset.

Interference pulses from the ignition system can also cause the false detection of pickup signals as a result of faults in the high-voltage circuit. The crankshaft angle position relative to top dead centre of the first cylinder can be calculated using the formula below and the firing order of the engine concerned.

$$\text{(Number of teeth on failure x } \frac{360^\circ \text{ CA}}{\text{number of teeth on engine}} \text{ - Reset Position)}$$

7.1.1.2 Hardware monitoring

If the attached hardware does not support the selected function or the device has an internal malfunction, this error will be displayed.

7.1.1.3 CAN communication

All SAFIs must be communicating with the control system before the engine is started. Failure of CAN communication will generate an alarm message after 25 seconds and the engine will be shut down.

SAFI monitors the signals on the CAN bus. The warning "High CAN error rate" is available to identify CAN bus problems at an early stage. This message indicates an above-average number of defective protocols on the CAN bus.

NOTE

Although SAFI detects defective protocols, the cause of these defective protocols may also rest with other participants!

7.1.1.4 Software monitoring

The current software status of the individual devices is displayed on the System - SAFI screen.

An alarm message is generated if the software on at least one SAFI is not compatible with the software in the engine control system.

If SAFIs are connected to an engine with a different software version, this is indicated by a warning. Although different but compatible software versions can be run together on the engine, we recommend that you update to the same software version. Consult INNIO Jenbacher GmbH & Co OG to decide which software is to be updated.

7.1.1.5 Monitoring the temperature of the electronics

SAFI measures the internal temperature of the electronics which may exceed the temperature of the housing by up to 10 K. If the internal temperature exceeds 95°C, this means that the maximum permissible ambient temperature is exceeded and a warning is generated.

NOTE

If the maximum ambient temperature is exceeded, this will cause the SAFI to fail during prolonged operation, which is a situation that should therefore be avoided!

The current temperatures of the electronics of all the cylinders are displayed on the System – SAFI screen and recorded in a long-term trend.

7.1.1.6 Parameter monitoring

Irrespective of the functionality set, SAFI detects the presence of plausible parameters. A trip alarm is generated if parameters are not plausible or fall outside the value range, or if the parameters have not yet been transmitted.

If parameters on the SAFI parameter list are changed while the engine is running, the new value is not accepted in order to protect the engine. The user is alerted by the SAFI warning "Setting parameters during operation prohibited" to the fact that the change has not been effected. The new value will not become active until the next engine start-up.

7.1.2 Parameter setting

7.1.2.1 Engine data parameter list

SAFI

Use this parameter to activate the SAFI option. When you activate it, the SAFI parameter list and the System – System data – SAFI screen are displayed.

Default value: On

7.1.2.2 SAFI parameter list

Ignition

Choose the ignition option to activate SAFI as an ignition control system combined with an ignition output stage.

Default value: On

Ignition voltage

Choose the ignition voltage measurement option to activate SAFI as an ignition voltage measurement system and the SAFI ignition voltage parameter list is displayed.

Default value: On

Exhaust gas temperature

Choose the exhaust gas measurement option to activate SAFI as an instrument for measuring the exhaust gas temperature.

Default value: On

Knocking

Choose this option to activate **SAFI** as a knock detection system. This option requires SAFI to be used with knock sensors.

Default value: On

OCA

The OCA function (optical misfiring detection) is not enabled for SAFI.

Default value: Off

Reset position

Set this parameter on the engine as described in TA 1502-0072 – SPA24.

Default value: 50.0 °CA

J624 default value: 48.5 °CA

Check ignition point tolerance

Where this parameter has been activated, SAFI measures the difference in the ignition point between SAFI and the ignition system. As, in its current configuration, SAFI is controlling the ignition, this parameter is currently disabled.

Default value: Off

Ignition point tolerance

This parameter indicates the tolerance for the deviation of the ignition point of the ignition system from SAFI. As, in its current configuration, SAFI is controlling the ignition, this parameter is currently disabled.

Default value: 50.0 °CA

7.1.3 Displays

The SAFI screen in System visualises the system data for all SAFIs.

The system data consists of:

- Hardware version

The hardware version contains information on the version (numeral before the decimal point) and the type of hardware (numerals after the decimal point). The numeral before the decimal point is incremented on each redesign. The figure after the decimal point indicates the different SAFI versions equipped with the KLS or DMR functions.

The table below shows the allocation of the numerals after the decimal point to the component assembly.

Hardware version	Component assembly
x.064	SAFI with the KLS function and thermocouple sensors
x.192	SAFI with the DMR function and thermocouple sensors
x.080	SAFI with the KLS function, thermocouple sensors and PI control *)
x.208	SAFI with the DMR function, thermocouple sensors and PI control *)

*) PI control is required for the J920 engine

If the parameter setting activates a function that SAFI does not support, the alarm message "SAFI hardware error" is displayed.

- Firmware version
- Operating hours
- Serial number
- Production date
- Temperature of electronics
- Tooth error

To make troubleshooting easier when a pickup error occurs, the number of teeth detected between the last synthetic camshafts/reset pulse and the defective pickup pulse is displayed.

- Filter version

The filter version is the version of the filter implemented in the firmware for the Piezo sensors.

7.1.4 Trend display

The temperatures of the electronics are recorded in the SAFI long-term trend over 12 months with a resolution of 0.5 h.

7.1.5 Operational messages

Message number	Message	Description
B3270	SAFI hardware error at cylinder	Display of cylinder position of SAFI with hardware error
B3271	SAFI CAN communication failure at cylinder	Display of cylinder position of SAFI without CAN communication
B3272	SAFI wrong software at cylinder	Display of cylinder position of SAFI with incompatible software
B3273	SAFI parameter error at cylinder	Display of cylinder position of SAFI with parameter error
B3276	SAFI trigger pickup cylinder failure	Display of cylinder position of SAFI with trigger pickup failure

Message number	Message	Description
B3277	SAFI camshaft/reset pickup cylinder failure	Display of cylinder position of SAFI with camshaft/reset pickup failure
B3284	SAFI software versions not identical	Display of cylinder position of SAFI with different software version. At least two SAFIs are always displayed as the engine control system cannot decide which is the correct one.
B3291	SAFI setting parameters during operation prohibited Cylinder	Display of cylinder position of SAFI for which parameter setting is prohibited.
B3292	SAFI CAN error rate too high at cylinder	Display of cylinder position of SAFI with excessive CAN error rate
B3293	SAFI electronics temperature too high at cylinder	Display of the SAFI cylinder position with excessive electronics temperature

7.1.6 Warnings

Message number	Message	Description/Solution
W3531	SAFI CAN error rate too high	The message is displayed when an above-average number of error frames has been recorded on the CAN bus. Error frames are failed communication attempts which must be repeated, thereby increasing the utilisation of the CAN bus.
		As analysis of error rates is not included in each device in the CAN bus circuit, it is possible that the error frames are also being produced by another device. Error frames are caused by electromagnetic disturbances, defective cabling (e.g. cable too long, wrong cable, poor terminators, bypasses) or a faulty device. Detailed information on the CAN bus and troubleshooting can be obtained from TA 1531-0012 "CAN bus on the INNIO Jenbacher GmbH & Co OG engine".
W3533	SAFI software versions not identical	The software statuses of the individual SAFIs are not identical but they are compatible.
		Updating to identical software statuses is recommended. Consult INNIO Jenbacher node:180143985653961071008100 7 to decide which software is to be updated.
W3535	SAFI parameter setting during engine operation prohibited	If parameters on the SAFI parameter list are changed while the engine is running, the new value is not accepted in order to protect the engine. This warning alerts the user to the fact that the change has not been effected.
		The engine must be shut down. The changes will take effect the next time the engine is started.

Message number	Message	Description/Solution
W3539	SAFI electronic temperature too high	If the housing and therefore the ambient temperature exceeds 85 °C, this means that the maximum permissible ambient temperature is exceeded and this warning is generated. The internal temperatures of all SAFI devices are listed on the System – SAFI screen. On the SAFI 1 the warning is output at an electronics temperature of 86 °C. On the SAFI 2, the warning is output at a temperature of 102 °C due to the higher temperature generated by the electronics. If the ambient temperature reaches 95 °C, the SAFI is switched off with a SAFI hardware error and the safety loop is opened.
		Where the temperature of the electronics in one SAFI is too high, check the area around the SAFI for any heat sources (leaky exhaust gas lines, turbocharger, etc.) and rectify the cause of the problem. Where electronics temperatures in the engine as a whole are found to be high or excessive, optimise the ventilation system or provide additional ventilation for SAFI.

7.1.7 Error messages

Message number	Message	Description/Solution
A3330	SAFI hardware error	The hardware is either incompatible with the parameters set for the engine control system or defective.
		Compare the parameters on the SAFI parameter list with the devices actually installed. If the parameters are OK, replace the device.
A3331	SAFI CAN communication failure	This error message is generated when there has been no communication with one or more SAFIs for more than 25 seconds.
		The cause may be a faulty device, faulty CAN bus cabling or a power failure to the SAFI. Detailed information on the CAN bus and troubleshooting can be obtained from TA 1531-0012 CAN bus on the INNIO Jenbacher node: 180143985653961071008100 7.
A3332	SAFI wrong software	The software versions in the engine control system and SAFI are not compatible.
		If the hardware is compatible (see Hardware error), compatibility can be restored by updating the SAFI software or the engine control software.
A3333	SAFI parameter error	A parameter error is generated if parameters are not plausible or outside the value range, or if the parameters have not yet been transmitted.
		Check all SAFI parameters.

Message number	Message	Description/Solution
A3336	SAFI trigger pickup failure	A problem with the trigger signal has been detected.
		Adjust the pickups as described in TA 1502-0072 – SPA24. A TRIGGER LED on each SAFI and SPA24 flashes when a pickup signal is detected. These displays are helpful for checking whether a signal has failed in the event of an error.
A3337	SAFI camshaft/reset pickup failure	A problem with the synthetic camshaft/reset signal has been detected.
		Adjust the pickups as described in TA 1502-0072 – SPA24. A CAM LED on each SAFI and SPA24 flashes when a pickup signal is detected. These displays are helpful for checking whether a signal has failed in the event of an error.

7.2 KLS function

7.2.1 Description of the function

The information on knock and valve noise generated by the Piezo sensors is described as the KLS function.

The KLS function is based on the proven principle of the KLS98 and the parameter names used are the same as for the KLS98. However, the limit levels may differ if there is a different frequency response in the input circuit.

The KLS function consists of the windowing of the engine cycle into different measurement ranges in which on the one hand combustion noise is evaluated for knock noise and on the other hand mechanical noise is evaluated for defects in the valve operating mechanism.

Differences from the KLS98

If a higher-quality digital signal processor is used, the valve noise will be higher with SAFI than with the KLS98. This is because SAFI has a more linear frequency curve than KLS98 and therefore displays the high frequencies of valve noise. This property is taken into account when determining the limit levels.

At lower frequencies of knock noise the differences are negligible, with the knock noise on SAFI corresponding to the knock noise measured on the KLS98.

7.2.2 Parameter setting

General knock parameters

All the parameters have been saved in the Antiknock – KLS98/SAFI parameter list.

KLS98 Reset pulse position

This position of the reset pulse is **only used with KLS98**, while the position of the reset pulse in the SAFI parameter list is set for SAFI.

Default value for type 4 engines: -123 °CA

Default value for type 6 engines: -144 °CA

Angle window at start of knock noise

This parameter indicates the beginning of the combustion analysis relative to the top dead centre of the cylinder concerned.

Default value: 0 °CA

Angle window width of knock noise

This parameter indicates the duration of the combustion analysis starting with the "Angle window at start of knock noise" parameter.

Default value for type 4 engines: 50 °CA

Default value for type 6 engines: 45 °CA

Angle window at start of valve noise

This parameter indicates the beginning of the valve noise analysis relative to the top dead centre of the cylinder concerned.

The parameter must be selected so that there is no overlap with the angle window for the knock noise relative to the combustion cycle.

Default value for type 4 engines: 70 °CA

Default value for type 6 engines: 60 °CA

Angle window width of valve noise

This parameter indicates the duration of the mechanical noise analysis starting with the "Angle window at start of valve noise" parameter.

The parameter must be selected so that there is no overlap with the angle window for the knock noise relative to the combustion cycle.

Default value for type 4 engines: 630 °CA

Default value for type 6 engines: 660 °CA

Angle window at start of mechanical noise

This parameter is provided to split the valve noise into separate systems for monitoring the inlet and exhaust valves. The function is not active.

Default value for type 4 engines: 80 °CA

Default value for type 6 engines: 50 °CA

Angle window width of mechanical noise

This parameter is provided to split the valve noise into separate systems for monitoring the inlet and exhaust valves. The function is not active.

Default value for type 4 engines: 620 °CA

Default value for type 6 engines: 660 °CA

Limit level for measurement signal failure

When the engine is running at half-load or more, all the measured values for valve noise must have exceeded this value, otherwise the measurement signal from SAFI will not be recorded correctly.

Default value for type 4 engines: 50 mV

Default value for type 6 engines: 30 mV

Filter function for knocking

This parameter is used to select the digital filter function for the knock signals.

Default value for type 4 engines: 1

Default value for type 6 engines: 4

Limit level for knocking

The parameter indicates the level from which combustion is considered knocking combustion. The engine control system optimises the engine control on the basis of this limit level, and generates a shutdown if there is danger of damage to the engine.

Default value for type 4 engines: 1,200 mV

Default value for type 6 engines: 500 mV

Limit level for valve noise

The limit level indicates the maximum permissible valve noise during operation. If this limit is exceeded, this means that there is a defect and the engine shuts down.

Default value for type 4 engines: 10,000 mV

Default value for type 6 engines: 8,000 mV

Limit level for mechanical noise

This limit level is provided to split the valve noise. This function is not active.

Default value: 8,000 mV

General ignition point adjustment

If general active ignition point adjustment is enabled, the entire engine has is set to the same ignition point. The cylinder with the latest ignition point determines the ignition point for the engine as a whole.

Default value: Off

Options for releasing cylinders 1-24

These parameters are used to set the release of each cylinder monitor individually. You can choose from the following settings:

- 0 – Piezo off: The KLS functions are deactivated.
- 1 – Piezo on: The KLS functions are activated.

Default value: 1 up to the number of cylinders on the engine / 0 for cylinders above the number of cylinders.

NOTE

If the Piezo function is disabled, the knock and valve noise monitor for this cylinder is inactive, although the measured values are displayed!

7.2.3 Displays

The values for combustion noise output measured by SAFI are displayed on the Engine controller – Antiknock – Knock noise screen and the knock intensities calculated by the engine control system from the measured values are displayed on the Engine controller – Antiknock – Knock intensity screen.

The measured values for mechanical noise generated by SAFI are displayed in the Details – Valve noise screen.

7.2.4 Trend display

In the "knocking intensities" and "knocking intensities at trips" trends, the knocking intensities are recorded in a short-term trend over 1 hour with a resolution of 1 second.

7.2.5 Operational message

Message number	Message	Description
B3279	Knock failure at cylinder	Display shows cylinder position of SAFI with knocking
B3281	Maximum valve noise at cylinder	Display shows cylinder position of SAFI with shutdown due to excessive valve noise
B3282	Knock sensor measurement signal failure at cylinder	Display shows cylinder position of SAFI with measurement signal failure

7.2.6 Warnings

Message number	Message	Description
W3541	Measurement signal failure Knock sensor	Once engine half load has been exceeded, a check is carried out to ascertain whether the measured values for valve noise have exceeded the value parameterised for measurement signal failure. This message is generated if the value is not exceeded within 3 seconds.
		The Piezo sensor has not been installed correctly or the device is defective (e.g. break in sensor cable).

7.2.7 Error messages

Message number	Message	Description
A3339	Knocking	The engine control system detects a dangerous condition for the engine due to knock noise or mechanical issues. A shut down prevents mechanical damage due to knocking combustion.
		This is a complex shut down and may be caused by mechanical damage, poor mixture composition, auto-ignition, misfires or ignition problems. **Whenever this trip occurs, the cause of the trip must be investigated and remedied first before the engine is restarted again. Please respect additional information in Appendix 1 of this document.**
A3341	Maximum valve noise	The limit level for valve noise has been exceeded. Usually, this shut down points to a mechanical problem in the cylinder head (valves, bearings, etc.).
		Whenever this trip occurs, the cause of the trip must be investigated and remedied first before the engine is restarted again. Please respect additional information in Appendix 1 of this document. If the root cause is not clear inspect all cylinders with a bore scope.
A3342	Measurement signal failure Knock sensor	Once engine half load has been exceeded, a check is carried out to ascertain whether the measured values for valve noise have exceeded the value parameterised for measurement signal failure. This message is generated if the value is not exceeded in more than 50% of the installed devices within 3 seconds.
		The Piezo sensor has not been installed correctly or the device is defective (e.g. break in sensor cable).

7.3 DMR function

7.3.1 Description of the function

The DMR function (pressure-based engine control system) is the term use to describe a control system based on information generated by cylinder pressure sensors from the pressure curve.

The basis of the DMR function is the evaluation of defined areas of the pressure curve during the ignition event. The algorithms implemented in the SAFI allow different evaluations to be carried out in parallel. The facilities offered by the DMR function are significantly greater than the KLS function, since the pressure curve is evaluated in each cycle and the control system can respond to variations in the pressure changes.

The DMR function currently consists of the following algorithms:

- Knocking
- maximum pressure
- auto-ignition
- Misfires
- sensor faults
- IMEP
- AI50%

Detailed information on the cylinder pressure sensors for DMR is included in the maintenance instructions IW 8058 A0.

7.3.2 Parameter setting

The DMR function is activated/deactivated in the Parameters - SAFI - DMR screen.

General DMR parameters

Start of the pressure window

The start of the window for evaluating the pressure curve is defined by a parameter.

Default value: 310 °CA

High-pressure window

The actual evaluation is performed using the values from the high-pressure window. This is fixed at a length of 100 °CA and contains 1000 values, which results in a resolution of 0.1 °CA

Limit level for knocking

General ignition point adjustment

If general active ignition point adjustment is enabled, the entire engine has is set to the same ignition point. The cylinder with the latest ignition point determines the ignition point for the engine as a whole.

Local ignition point adjustment

In different control methods of the DMR, the ignition point is controlled selectively for individual cylinders.

Detailed information on the parameterisation can be found in the TA - Pressure-based engine control.

7.3.3 Displays

The values for combustion noise measured by SAFI are displayed in the Engine Controller - Antiknock - Knock Noise screen.

The knock strengths calculated by SAFI from the measurements are displayed in the Engine Controller - Antiknock - Knock Noise screen.

The ignition points given by the engine control system are displayed in the Engine Controller - Antiknock - IP screen.

The mean effective pressures calculated by SAFI from the measurements are displayed in the Engine Controller - Antiknock - IMEP screen.

The peak pressures calculated by SAFI from the measurements are displayed in the Engine Controller - Antiknock - p-max screen.

7.3.4 Trend display

In the "knocking intensities" and "knocking intensities at trips" trends, the knocking intensities are recorded in a short-term trend over 1 hour with a resolution of 1 second.

In the "Pmax" trends, the peak pressures are recorded in a short-term trend over 1 hour with a resolution of 1 second.

A long-term trend over 1 month is also stored, with a resolution of 30 seconds.

In the "IMEP" trends, the peak pressures are recorded in a short-term trend over 1 hour with a resolution of 1 second.

A long-term trend over 1 month is also stored, with a resolution of 30 seconds.

In the "Knock integrator" trends, the data from the knock integrator are recorded in a short-term trend over 1 hour with a resolution of 1 second.

In the "AI_var" trends, the values at a defined conversion point are recorded in a short-term trend over 1 hour with a resolution of 1 second.

A long-term trend over 1 month is also stored, with a resolution of 30 seconds.

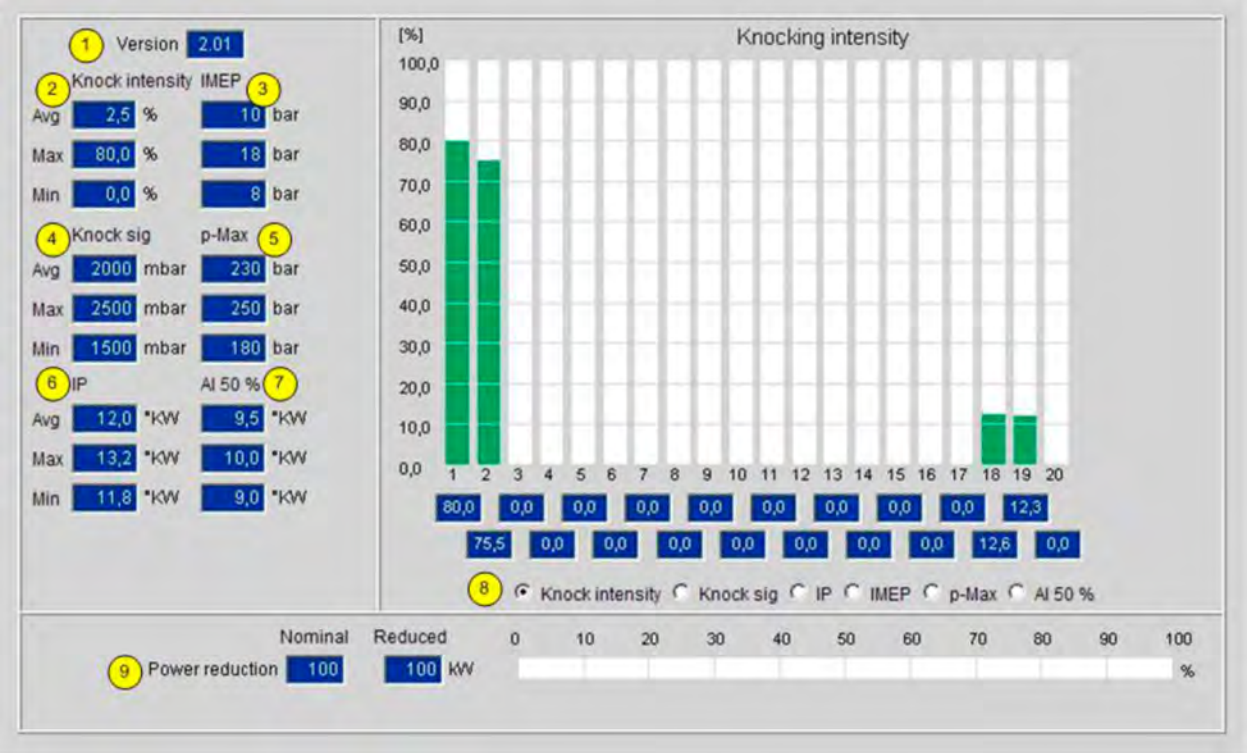
In the "PowerActUnfilt" trends, the active power is recorded in a short-term trend over 1 hour with a resolution of 1 second.

A long-term trend over 1 month is also stored, with a resolution of 30 seconds.

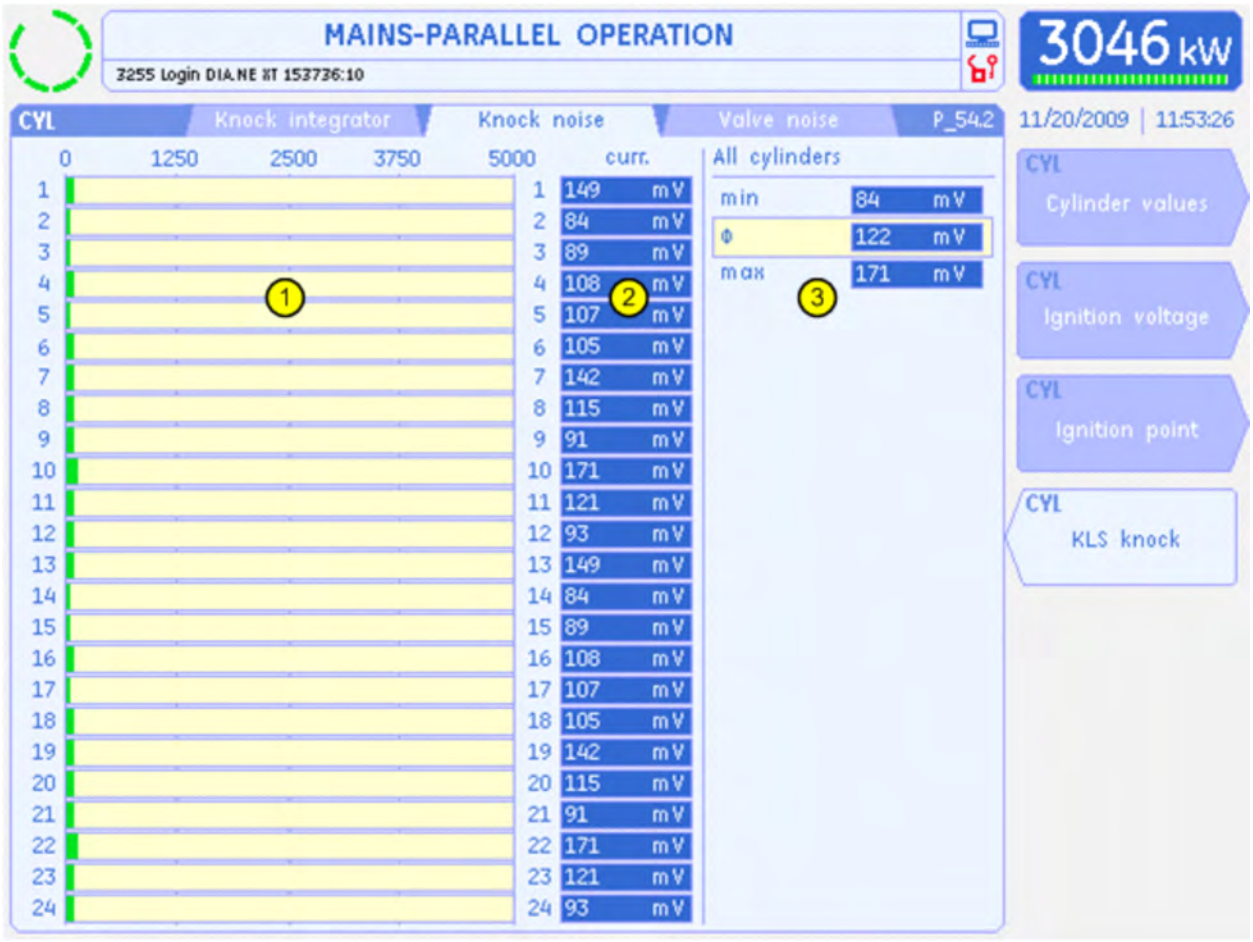
In the "PressBoostUnfilt" trends, the boost pressure is recorded in a short-term trend over 1 hour with a resolution of 1 second.

A long-term trend over 1 month is also stored, with a resolution of 30 seconds.

In the "IPCyl" trends, the controlled ignition point is recorded in a short-term trend over 1 hour with a resolution of 1 second.



Display in DIA.NE WIN



Display in DIA.NE XT3 / 3.2

7.3.5 Operational messages

Message number	Message	Description
B3279	Knock failure at cylinder	Display shows cylinder position of SAFI with knocking
B2802	Measuring signal failure cylinder pressure sensor	Display shows cylinder position of SAFI with measurement signal failure
B2151	DMR safety power reduction	Display of cylinder position with reduction in safety power
B2146	DMR power reduction	Display of cylinder position with power reduction
B2808	Maximum positive deviation from average peak cylinder pressure	Display of cylinder position with the maximum positive deviation from the average peak cylinder pressure
B2145	Ignition point reduction by DMR	Display of cylinder position with ignition point reduction due to a DMR measurement
B2825	Maximum cylinder peak pressure	Display of cylinder position with maximum peak pressure
B2826	Maximum cylinder peak pressure	Display of cylinder position with maximum peak pressure

7.3.6 Warnings

Message number	Message	Description
W2577	Measurement signal failure Knock sensor	Once engine half-load has been exceeded, a check is carried out to ascertain whether the measured values for peak pressure have exceeded the value parameterised for measurement signal failure. This message is generated if the value is not exceeded within 3 seconds.
		The cylinder pressure sensor has not been installed correctly or the device is defective (e.g. break in sensor cable)
W2588	Maximum cylinder peak pressure	Once engine half-load has been exceeded, a check is carried out to ascertain whether the measured values for the p-max signal have exceeded the value parameterised for measurement signal failure. This message is generated if the value does not drop back below the parameterised value within 3 seconds.

7.3.7 Error messages

Message number	Message	Description
A3339	Knocking	The engine control system detects a dangerous condition for the engine due to knock noise or mechanical issues. A shut down prevents mechanical damage due to knocking combustion.
		This is a complex shut down and may be caused by mechanical damage, poor mixture composition, auto-ignition, misfires or ignition problems. **Whenever this trip occurs, the cause of the trip must be investigated and remedied first before the engine is restarted again. Please respect additional information in Appendix 1 of this document.**
A2262	Maximum cylinder peak pressure	The engine control system detects that the parameterised maximum peak pressure has been exceeded and the engine is in a dangerous state. A shut down prevents mechanical damage due to incorrect combustion.
A2214	Measuring signal failure cylinder pressure sensor	SAFI detects a measuring signal failure and generates the operational and error messages described. If more than half the cylinders in question are affected by a measuring signal failure, the engine is shut down.
		The cylinder pressure sensor has not been installed correctly or the device is defective (e.g. break in sensor cable)
A2274	Maximum positive deviation from cylinder peak pressure	This check detects the maximum deviation between the peak pressure signals. If a threshold is exceeded, the engine is shut down for safety reasons.

7.4 Port Injection function

The Port Injection function consists of selective cylinder control of the gas quantity by means of solenoid valves. Activation and monitoring of these solenoid valves, also referred to as Port Injection valves, is implemented in SAFI2 and MORIS2.

MORIS2 and SAFI2 are further developments of the MORIS/SAFI system, expanded by the addition of an activation and monitoring function for selective cylinder gas metering (Port Injection).

In the first version only the selection of the Port Injection valve was implemented in the DIANE, and the electronic prechamber gas valve (PCI) and prechamber gas safety valve (PCS) were not supported.

A feedback signal corresponding to the actual current signal through the PI valve is evaluated by SAFI2 to diagnose the function of the PI valve.

7.4.1 Description of the function

The diagnosis is divided into three main areas:

Open Detection

The rise in the pull-in current is evaluated. It detects whether a valve is connected (there is a current flow), and whether the wiring is correct (no cable breakage or short-circuit).

Open Point Detection

Evaluation of the pull-in current curve shows whether and when the valve opens. Not activated in series usage.

Close Detection

Close Detection checks whether the valve has closed correctly after the normal opening sequences (gas injection event) but before the start of ignition. A brief current signal is sent to the valve, on the basis of which an incorrectly-open valve can be detected.

If an open valve is detected, the ignition pulse is suppressed by SAFI2 and the safety loop is opened, which triggers a priority 1 shutdown.

7.4.2 Parameter setting

7.4.2.1 Setting the valve control parameters

The valve parameters are grouped together in specific parameter packages for each valve

If valve type "1" is selected by the user, all values of the sub-variables are loaded under valve type 1, and if valve type "2" is selected, all the values of the sub-variables under valve type 2 are selected. The data structures of valve types "1" and "2" remain unchanged, and only the values change.

Contents:

Variable	Value (adjustable)
Name:	PI_config_file
Version	x.xx
Date	2011-06-23
Valve type	1-10

7.4.2.2 Setting the valve monitoring parameters

Valve closed detection

Activates/deactivates the Close Detection function

In SAFI2 Close Detection is activated by the variable "PI close detection"

Error rates for valve opening point detection

Open Point detection is deactivated if the variable "PI open point detection failure rate" is set to a value of 0.

Setting this variable to a parameter value between 1 and 10 gives different sensitivities.

Error rates for valve opened detection

The pull-in current detection, also known as open detection, is deactivated if the variable "PI open detection failure rate" is set to a value of 0.

Setting this variable to a parameter value between 1 and 10 gives different sensitivities.

7.4.3 Displays

The values for the opening point output measured by SAFI are displayed in the Engine Controller - Port Injection - Opening Point screen.

The values for the opening duration output measured by SAFI are displayed in the Engine Controller - Port Injection - Opening Duration screen.

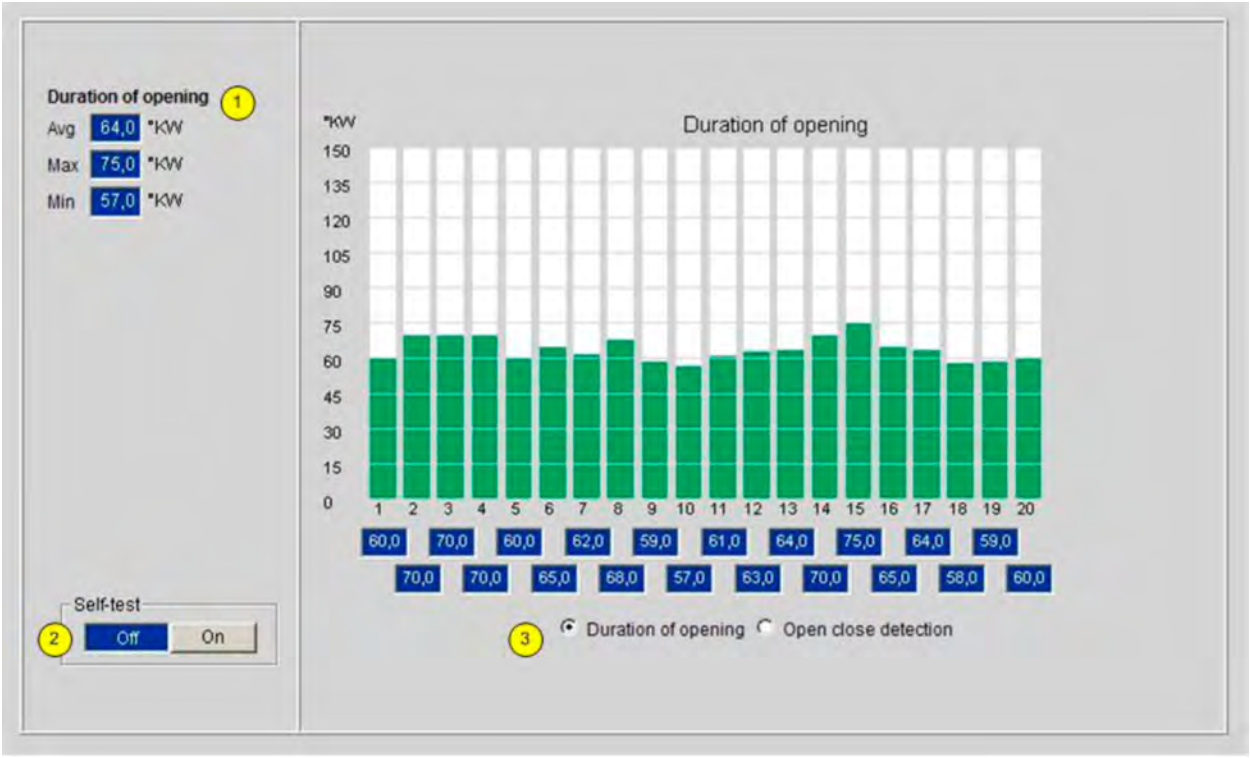
The values for the Close Detection gradient output measured by SAFI are displayed in the Engine Controller - Port Injection - Close Detection Slope screen.

A Close Detection signal is generated cyclically on all cylinders in the self-test to check whether the PI valves are closed. The measured values are shown in the Engine Controller - Port Injection - Close Detection Slope screen in bar and digital form. In the self-test, the average, maximum and minimum values are shown. The current values are average values from the last ten ignition events, and the maximum and minimum values are the highest/lowest values which have occurred.

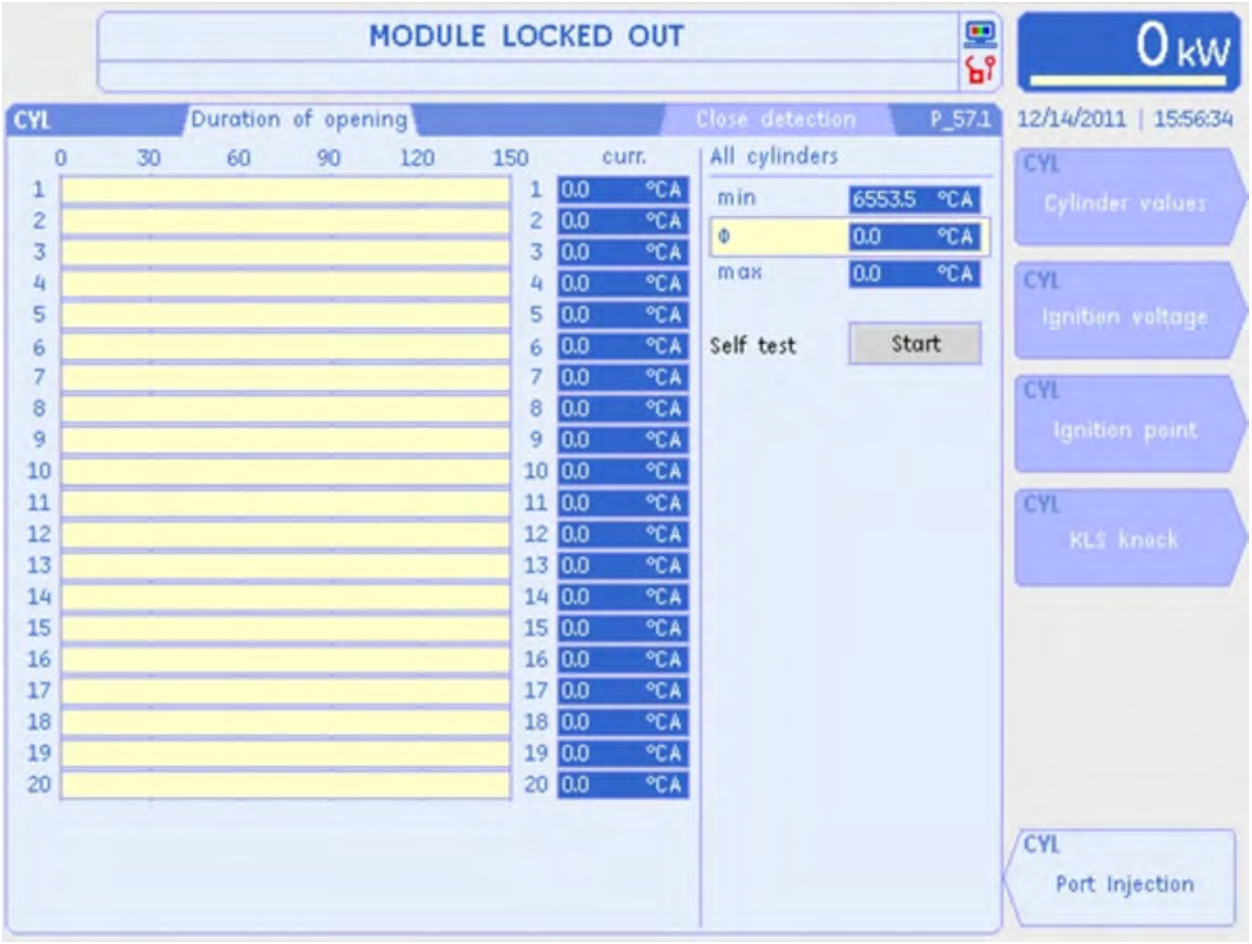
These displays are only visible if the function in question has been activated.

7.4.4 Trend display

No trend display is provided in the current version.



Display in DIA.NE WIN



Display in DIA.NE XT3

7.4.5 Operational messages

Message number	Message	Description
B2814	Maximum PI opening duration	Shows cylinder position of SAFI with maximum opening duration
B2815	Minimum PI opening duration	Shows cylinder position of SAFI with minimum opening duration
B2816	PI On	Shows activation of Port Injection valves
B2817	PI Off	Shows deactivation of Port Injection valves
B2818	PI opening detection failure	Shows cylinder position of SAFI with maximum opening duration
B2819	PI fault in opening point detection	Shows cylinder position of SAFI with faulty opening duration
B2820	PI valve failure when closing cylinder	Shows cylinder position of SAFI with maximum opening duration
B2823	PI deactivates cylinder	Shows cylinder position of SAFI with deactivated Port Injection

7.4.6 Warnings

Message number	Message	Description/Solution
W2585	PI opening detection failure	The warning is generated by the first opening detection failure. If the faults are detected consecutively equivalent to the set parameter "PI open detection failure rate", an alarm message is generated.

7.4.7 Error messages

Message number	Message	Description/Solution
A2254	PI opening detection failure	A Port Injection failure in opening detection is detected by SAFI2 if no current signal or an incorrect current signal to the Port Injection valve is measured.
		The main reason for this failure is a short circuit or cable breakage between the Port Injection driver and valve, or a valve which is not connected.
A2255	PI fault in opening point detection	If no valve opening or delayed opening is detected, this alarm message is generated and the engine is shut down.
A2256	PI valve closing failure	The PI valve remains open when de-energised, which allows an uncontrolled quantity of gas to be metered.
		SAFI2 suppresses the ignition pulses immediately after the failure and opens the "Ignition safety loop", which deactivates the power supply to the ignition and the PI valves.

7.5 Ignition function

7.5.1 Description of the function

The ignition functions are enabled when SAFI is operated in combination with MORIS ignition system. SAFI triggers the ignition, adjusts the ignition sparks in accordance with the set parameters and monitors the electrical ignition process.

A detailed description of the function can be found in TA 1502-0068.

7.5.2 Parameter setting

7.5.2.1 Ignition parameters

The following parameters have been saved in the **Ignition** parameter list.

Setting the ignition points

Ignition points are set for different modes of operation independently of the ignition system.

NOTE

The default values given here depend on the gas composition and application; changes in the ignition point may only be made by authorised personnel or after consultation with INNIO Jenbacher GmbH & Co OG!

Default values for type 4 engines:

IP without knock monitoring for gas types 1-4:	20 °CA
IP with knock monitoring for gas types 1-4, mains parallel mode:	24 °CA
IP with knock monitoring for gas types 1-4, island mode:	18 °CA
IP minimum gas types 1-4:	14 °CA

Default values for type 6 engines:

IP without knock monitoring for gas types 1-4:	18 °CA
IP with knock monitoring for gas types 1-4, mains parallel mode:	20 °CA
IP with knock monitoring for gas types 1-4, island mode:	18 °CA
IP minimum gas types 1-4:	14 °CA

Default values for type 9 engines:

IP without knock monitoring for gas types 1-4:	18 °CA
IP with knock monitoring for gas types 1-4, mains parallel mode:	20 °CA

IP with knock monitoring for gas types 1-4, island mode:	18 °CA
IP minimum gas types 1-4:	14 °CA

Earliest possible ignition point

The ignition point is limited to this value. SAFI will not accept an earlier ignition point.

Default value for type 4 engines: 27 °CA

Default value for type J612, J616, J620 engines ... 25 °CA

J624 default value: 27 °CA

Latest possible ignition point

The ignition point is limited to this value. SAFI will not accept a later ignition point.

Default value: 10 °CA

Overspeed

This parameter sets the speed for the overspeed trip which opens the safety contact and switching off the ignition.

Default value at rated speed of 1200 rpm: 1440 rpm

Default value at rated speed of 1500 rpm: 1800 rpm

Default value at rated speed of 1800 rpm: 2150 rpm

Misfire control

This parameter is used to enable the misfire control system to selectively shut down cylinders if the speed is too high.

Default value for type 4 engines: On

Default value for type 6 engines: Off

7.5.2.2 MORIS

The following parameters have been saved in the Ignition – MORIS parameter list.

Spark duration

You can set the duration of the ignition spark. Prolonging the spark duration has a positive effect on the misfire limit but also means an increased power requirement.

Type 4 engines with a default value of 500 mg/Nm³ NOX: 500 µs

Type 4 engines with a default value of 250 mg/Nm³ NOX: 700 µs

Default value for type 6 engines: 250 µs

Ignition current level

You can specify the maximum ignition current for the ignition spark. The ignition current level scales the set ignition current flow and indicates its maximum value. Increasing the ignition current has a positive effect on the misfire limit but also means an increased power requirement.

Default value: 40 %

Ignition current flow

This parameter is used to adjust the ignition current flows specified in TA 1502-0068 MORIS.

Default value for type 4 engines: 5

Default value for type 6 engines: 1

Coil type

As the electrical characteristics of the ignition coil affect the ignition control system, the set coil type must always match the installed coil type.

Default value: 1

Power unit output

This is the parameter for the total output of the 185 V **MPM** power units. The maximum permissible ignition output is calculated and limited on the basis of this parameter.

Default value for type 4 engines: 462 W

Default value for type 6 engines: 924 W

Minimum triggering level for varying the spark duration

This level indicates the number of tolerable misfires per ten engine cycles, above which a warning is generated. Monitoring is disabled when the parameter is set to 0.

Default value: 3

Spark duration tolerance

The spark duration tolerance indicates the extent to which the measured spark duration can deviate from the set spark duration.

Default value: 80%

7.5.3 Displays

You can switch between the ignition point and ignition voltage screens on the Details – Ignition screen and the ignition self-test can be activated when the mode selector switch is in the "Off" position.

Ignition output errors

Ignition output errors are displayed as digital values on the Details – Ignition screen, where a distinction is made between combustion time tolerance and ignition delay in order to improve diagnosis. The displayed value is a relative value which indicates the number of failed ignition attempts per ten ignition events.

Ignition point

The ignition points of all the cylinders and the global, minimum, maximum and average ignition point across the engine as a whole are displayed on the Details – Ignition point screen.

7.5.4 Trend display

No trends are recorded for MORIS.

7.5.5 Operational message

Message number	Message	Description
B3225	Ignition On	All the cylinders are firing

Message number	Message	Description
B3226	Ignition Off	At least one cylinder is not firing
B3294	Ignition power reduction active - cylinders	Display shows cylinder with power reduction
B3278	Ignition output error at cylinder	Display shows cylinder with output error
B3283	Ignition hardware error at cylinder	Display shows cylinder with hardware error

7.5.6 Warnings

Message number	Message	Description/Solution
W3545	Ignition output errors	This warning is generated when repeated combustion time deviations are measured.
		To carry out a diagnosis, check the "Combustion time tolerance" and "Minimum triggering level for combustion time deviation" parameters. The error rates for combustion time deviations are displayed on the Ignition – Output errors screen.
W3551	Ignition power reduction active	The ignition process had to be aborted before the set combustion time was reached as the power absorbed by the ignition system exceeded the maximum output of the MPM power supply.
		If the parameters set are OK, the problem may be caused by an excessive ignition voltage requirement. Check the air gaps of the spark plugs. The coil, ignition module or SAFI may have a hardware defect. If the installed MPM power unit is unable to provide the required output, install an additional unit.
W3552	Ignition power supply overloaded	The voltage level of the MPM power supply falls below 180 V at 185 V nominal for 2 seconds. This overloads the MPM, which results in a reduced service life.
		The power unit output parameter for MORIS must match the total of the outputs of all the power units. A detailed description of the original error can be found in TA MPM/MORIS.

Message number	Message	Description/Solution
W3544	Ignition hardware error	If SAFI does not receive any feedback from MORIS during the build-up of the ignition spark, the current ignition attempt is aborted and the warning is output. Ignition coil-related error rates have been parameterised.
		Check the setting of the ignition coil parameter. Check the hardware components, i.e. SAFI, MORIS, MPM, spark plug or spark plug sleeve. The error rates for hardware errors per ten combustion cycles are displayed on the Ignition – Output errors screen. Carry out the ignition self-test when troubleshooting to check the high-voltage supply from the coils. If the voltage is less than 40 kV at any cylinder, change the associated coil. If 3 or more cylinders are affected, the trip "A3433 Ignition hardware failure" is triggered.

7.5.7 Error messages

Message number	Message	Description/Solution
A3343	Ignition hardware error	If SAFI does not receive a response from MORIS during the build-up of the ignition spark, the current ignition attempt is aborted and the engine shut down. Ignition coil-related error rates have been parameterised.
		Check the setting of the ignition coil parameter. Check the hardware components, i.e. SAFI, MORIS, MPM, spark plug or spark plug sleeve. The error rates for hardware errors per ten combustion cycles are displayed on the Ignition – Output errors screen. Carry out the ignition self-test when troubleshooting to check the high-voltage supply from the coils. If the voltage is less than 40 kV at any cylinder, change the associated coil.
A3344	Ignition power supply failed	When the engine is running, this error message is displayed immediately after the failed response of the MPM power supply and the engine is shut down. The MPM power supplies are activated during start preparation. The error message is displayed if a successful activation has not been reported within 5 seconds.
		The power unit output parameter for MORIS must match the output of the power units. A detailed description of the original error can be found in TA 1502-0068 MPM.

Message number	Message	Description/Solution
A3345	Ignition fail-safe loop	Each SAFI reports the transmission of ignition signals via a contact. If a SAFI opens the contact while gas valves are open, the gas valves are closed immediately and this error message is displayed. Details of the event that triggered the opening of the SAFI contact are displayed in an additional message if there has been no CAN bus failure or cabling error.
		If no additional message is present, check the wiring, MORIS and SAFI for a hardware error by replacing the MORIS and SAFI modules to narrow down the fault to a single module.

7.6 Ignition voltage measurement function

7.6.1 Description of the function

If ignition coils with an active measurement output are available on the engine, it is possible to measure the SAFI ignition voltage and communicate this to the engine control system via the CAN bus.

In doing so, SAFI communicates the average value from 10 measurement cycles to the engine control system.

7.6.2 Displays

You can switch between the ignition point and ignition voltage screens on the Details ; Ignition screen.

The ignition voltages of all the cylinders are displayed in bar and digital form on the Ignition – Details screen while the engine is running and during the self-test. In the self-test it is possible to switch between the current and maximum values. The current values are average values from the last ten ignition events and the maximum value is the highest value which has occurred since you switched to the maximum value display.

7.6.3 Trend display

The measured values are recorded in the "Ignition voltages" long-term trend over 12 months with a resolution of 0.5 h.

7.6.4 Parameter setting

The following parameters have been saved in the Ignition voltage measurement parameter list.

Monitoring active from

The limit monitor starts when the average ignition voltage exceeds this limit level.

Default value for type 4 engines: 15 kV

Default value for type 6 engines: 12 kV

Monitoring the hysteresis

The limit monitor is deactivated as soon as the voltage falls below the "Monitoring active from" limit level minus this value.

Default value: 2 kV

Minimum ignition voltage monitoring active

Activates the monitor as soon as the voltage falls below the minimum ignition voltage.

Default value: On

Ignition voltage minimum

Indicates the lower limit level when monitoring the minimum ignition voltage.

Default value for type 4 engines: 12 kV

Default value for type J612, J616, J620 engines ... 6 kV

J624 default value: 8 kV

Ignition voltage minimum delay

The voltage must drop below the minimum limit level at least for this period so that a warning can be generated.

Default value: 30 s

Maximum ignition voltage monitor active

Activates monitoring as soon as the voltage exceeds the maximum ignition voltage.

Default value: On

Ignition voltage maximum

Indicates the upper limit level when monitoring the ignition voltage.

Default value for type 4 engines: 33 kV

Default value for type 6 engines: 35 kV

Ignition voltage maximum delay

The voltage must exceed the maximum limit level at least for this period so that a warning can be generated.

Default value: 10 s

Average ignition voltage monitoring active

Activates monitoring as soon as the voltage exceeds the average ignition voltage.

Default value: Off

Maximum average ignition voltage

Indicates the limit level for monitoring as soon as the voltage exceeds the average of all ignition voltages.

Default value: 30 kV

Average ignition voltage maximum delay

The voltage must exceed the maximum permissible average ignition voltage at least for this period so that a warning can be generated.

Default value: 30 s

Ignition voltage differential monitoring active

Activates the voltage differential monitoring from the highest to the lowest ignition voltage value.

Default value: On

J624 default value: Off

Ignition voltage differential

Indicates the limit level for the monitor as soon as the voltage exceeds the maximum ignition voltage differential.

Default value for type 6 engines: 10 kV

Default value for type 4 engines: 6 kV

J624 default value: 6 kV

Ignition voltage difference delay

The voltage must exceed the ignition voltage difference at least for this time so that a warning can be generated.

Default value: 30 s

Trigger voltage

This parameter is used for the MONIC only, is not enabled for SAFI and does not affect the function.

Default value: 5 kV

7.6.5 Operational message

Message number	Message	Description
B3286	Ignition coil offset error at cylinder	Display of cylinder position of SAFI with offset error
B3287	Ignition voltage too low at cylinder	Display shows cylinder position of SAFI with excessively low ignition voltage
B3288	Ignition voltage too high at cylinder	Display shows cylinder position of SAFI with excessive ignition voltage
B3289	Average ignition voltage too high at cylinder	Display shows cylinder position of SAFI with excessive average ignition voltage
B3290	Ignition voltage difference too high at cylinder	Display shows cylinder position of SAFI with excessive ignition voltage difference

7.6.6 Warnings

Message number	Message	Description/Solution
W3546	Ignition coil offset error	Every MORIS ignition coil produces an offset voltage of 2 V when connected to the power supply. This error message is generated if this offset voltage is not present. The
		Check for the presence of the offset voltage during start preparation.
		If this error affects one cylinder, the line connecting the ignition coil and SAFI may be damaged or the measuring device on the ignition coil may be defective. If the error affects all the cylinders, the power supply to the ignition coil has failed.
		To effect a diagnosis, measure the offset voltage on the relevant pin of the SAFI connector plug while the engine is at standstill. It can also be measured with SAFI disconnected.
W3547	Ignition voltage too low	The ignition voltage is too low, which means the ignition energy is too low, which in turn can cause misfires.
		The air gaps may be too small and must be checked.
		Check the ignition system by means of a self-test.
W3548	Ignition voltage too high	The ignition voltage is too high, which may result in damage to the high-voltage cables and the ignition coil. The ignition voltage could be so high that no flash-over occurs at the electrode, thereby causing misfires.
		The air gap may be too big and must be checked.
		An interruption in the high-voltage circuit between the ignition coil and the spark plug may also result in an excessive ignition voltage.

Message number	Message	Description/Solution
W3549	Average ignition voltage too high	The average value of all ignition voltages calculated in the engine control system is too high.
		Check the air gaps of the spark plugs.
W3550	Ignition voltage difference too high	The difference between the cylinders with the highest and lowest ignition voltage is too great.
		Check the air gaps.

7.6.7 Error messages

The ignition voltage measuring system does not generate trip-producing error messages.

7.7 Exhaust gas temperature measurement function

SAFI measures the exhaust gas temperature and transmits the measured values for each cylinder to the engine control system. The engine control system processes, displays and analyses the measured values.

7.8 Speed measurement function

7.8.1 Description of the function

SAFI calculates the speed from the ring gear pulses. From this, DIA.NE produces an average value which enters the engine controller as the engine speed. The speed is monitored for the set value in the Ignition parameter list. If the value is exceeded the fail-safe loop is opened, the ignition system disabled and an error message generated.

7.8.2 Displays

The current engine speed is available on a number of screens. The way the speed is displayed is not affected irrespective of whether the speed is determined by SAFI or another measuring device.

7.8.3 Operational message

Message number	Message	Description/Solution
B3275	SAFI overspeed trip at cylinder	Display shows cylinder position of SAFI with shutdown due to overspeed.

7.8.4 Warnings

The speed measurement system does not generate any warnings.

7.8.5 Error messages

Message number	Message	Description/Solution
A3335	SAFI shutdown due to overspeed	The engine speed exceeds the set value. At the same time as it is communicating the message, SAFI opens a hardware contact which triggers closure of the gas valves and with it the shutdown of the engine.

8 Appendix 1: Engine Restart after trip „Knocking Failure A3339“ as a result of mechanical causes

Whenever an engine is automatically tripped off by the module control system due to an alarm, the cause of the trip must be remedied first before the module is restarted again in accordance with TA 1100-0111 ("Faults" section).

Description of the facts

After a trip event it is not permitted simply to reset a failure and then restart the engine, as critical or wear-induced damage could possibly result in premature replacement of various components.

In single case events we have been informed of consequential damages on the engine due to restart after trip due to ‘Knocking failure A3339’.

In light of the above, we have issued this Service Bulletin to highlight the correct actions to be taken after engine shut down. This can be caused by either the engine control system detecting a dangerous condition for the engine due to the knocking noise or by poor mixture composition, auto-ignition, misfires or ignition problem. The former is considered more important and must be checked first rather than assuming the latter.

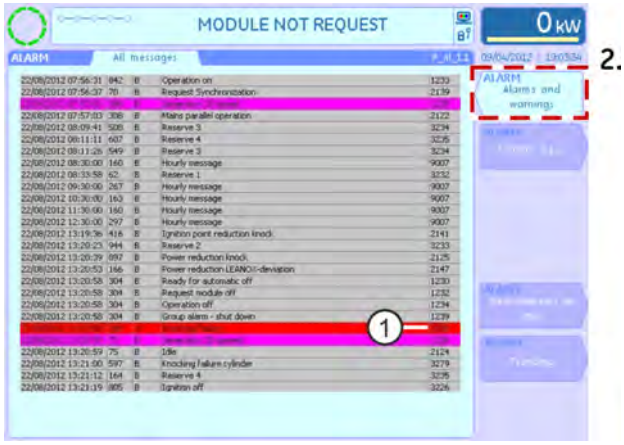
Required action

In case of engine shut down due to ’Knocking failure A3339’ all cylinder temperatures at trip must be checked.

Fig. 1: How to show the Alarm messages on the DIA.NE XT3

1. Press **‘ALARM‘**

Fig. 2: Alarm messages showing ’Knocking failure A3339’



2. Press **‘Alarms and warnings‘**

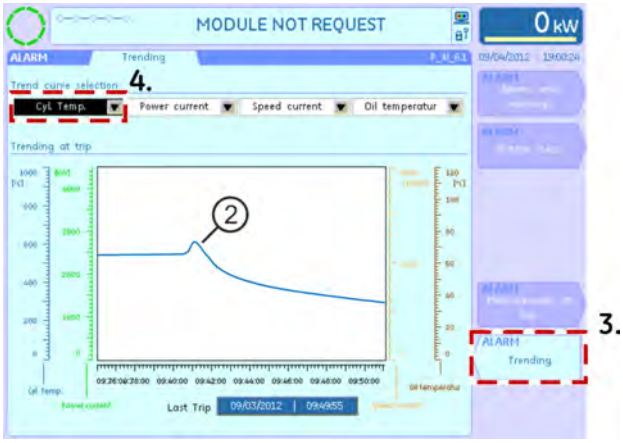
① Alarm messages showing ’Knocking failure A3339’

Check the cylinder temperature trending.

Fig. 3: Cylinder temperature trending

3. Press **'Trending '**
4. 'Cyl. Select **'Temp.'**

② Cylinder temperature at trip increased



Check all the cylinder temperatures at the trip and compare them with the average cylinder temperatures. If the difference at the trip between the temperature of one cylinder and the average temperature of all the cylinders is greater than 25°C, the engine may not be restarted. Inform the service staff member responsible for engine inspections and ascertain the cause of the trip.

The average cylinder temperature should be calculated as follows:

$$T_{Cyl.Av.} = (T_{Cyl.1} + T_{Cyl.2} + \ldots) / No._{Cyl.}$$

$T_{Cyl.Av.}$ …average cylinder temperature at trip
$T_{Cyl.1}$ …temperature of cylinder 1 at trip
$T_{Cyl.2}$ …temperature of cylinder 2 at trip
$No._{Cyl.}$ Total number of cylinders (12, 16, 20 or 24)

Cylinder temperatures at trip (the numbers shown above are only for display purposes)

5. Press **'Measurements at trip '**

③ Check all cylinder temperatures at trip

Relevant documents

The relevant regulations are all part of the plant documentation given to every customer when receiving an engine. In addition, the latest versions of the Technical Instructions referred to here can be downloaded from the Jenbacher web portal (http://information.jenbacher.com) under the heading 'Technical Knowledge Base'.

- Technical Instruction TA 2300-0005 "Safety regulations"
- Technical Instruction TA 1100-0111, General conditions – Operation and maintenance
- Service Bulletin SB-077, Exhaust gas temperature deviations

9 Revision code

Revision history

Index	Date	Description / Revision summary	Expert *Auditor*
8	11.04.2019	GE durch INNIO ersetzt / GE replaced by INNIO	**Opoku** *Pichler R.*
7	02.07.2014	Allgemeine Überarbeitung / general revision	**Boxleitner** *Fröhlich M.*
6	14.01.2013	neuer Anhang/ new appendix	**Provin** *Fahringer*
5	21.09.2012	Formatierung geändert/ Format edited	**Janys** *Janys M.*
4	30.10.2012	Bild Farben Anschlussbelegung getauscht / Picture and colors connection wires changed	**Boxleitner** *Fröhlich M.*