Jenbacher DIA.NE XT Control

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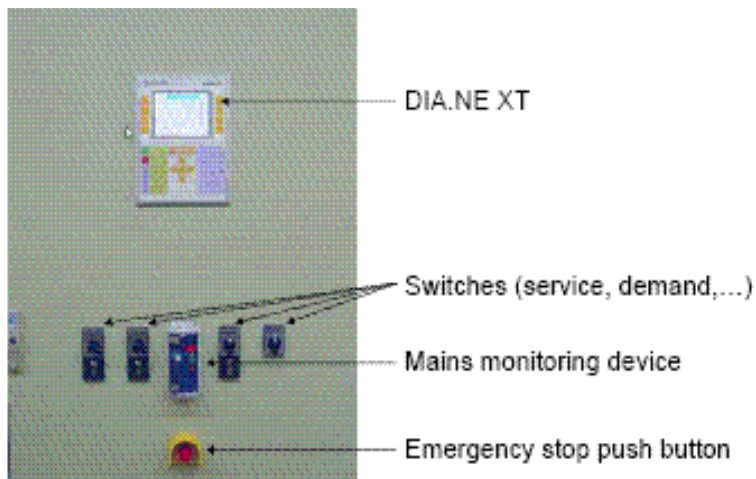
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1 Information on the DIA.NE XT User Manual

Options

Not all of the pages or display and entry fields listed in this documentation are necessarily available for your engines.

Depending on the number of engines, engine type, number of cylinders and module and control system configurations, the DIA.NE XT3 system will only display the screens that are relevant to your engines.

If you have any questions concerning the configuration of your modules, please contact our Sales or Service Department (www.gejenbacher.com).

Reference texts

[text]

The text in the screens is always in English. Where direct reference is made in a screen to a reference text, it will be placed within square brackets and shown in bold and italics.

2 DIA.NE XT3 is much more - a system description

DIA.NE XT3 is the new generation of engine management system used by GE Jenbacher in all of its engine types. It consists of a control unit, which includes a visualisation unit, in a single device.

The optional PC visualisation unit DIA.NE WIN provides a central and convenient means of operating the Jenbacher modules, as well as a customer-specific coupling to a higher-order control system.

One of the main goals when developing DIA.NE XT3 was the perfect combination of powerful and flexible control electronics on the one hand and a user-friendly operation concept on the other.

The innovative hardware concept is made up of state-of-the-art components and sets new standards in terms of power, functionality and reliability of operation.

The innovative graphical information display makes DIA.NE XT3 a particularly user-friendly human-machine interface, thereby making the plant much easier to handle for both the operator and the service and maintenance staff. Particular consideration has been given to customer specifications and requirements. For example, a specific expert view containing large amounts of information has been generated for customers who are interested in details. The customer view is ideal for those who require an interface reduced to the most important items.

A special detail of the new customer view consists of keys to the individual visualisation screens. This is a fast and uncomplicated way of finding out what the various symbols mean.

The new help system is another milestone on the way to achieving a customer-friendly approach. For example, online help facilities have been provided for the visualisation screens and for individual alarm entries.

The large 10.4" screen and a logical, simplified navigation system make DIA.NE XT3 an easy-to-operate human-machine interface.

3 Components and hardware

3.1 Components

DIA.NE XT3 comprises the following units:

① Engine control and display unit based on a panel controller

② Decentralised I/O module for module control

③ Decentralised I/O module on the engine

④ Decentralised engine control/monitoring components (CAN bus)

⑤ Connection to DIA.NE WIN visualisation unit on client PC (Ethernet)

⑥ Connection to higher-order control system (RS232 / RS485)
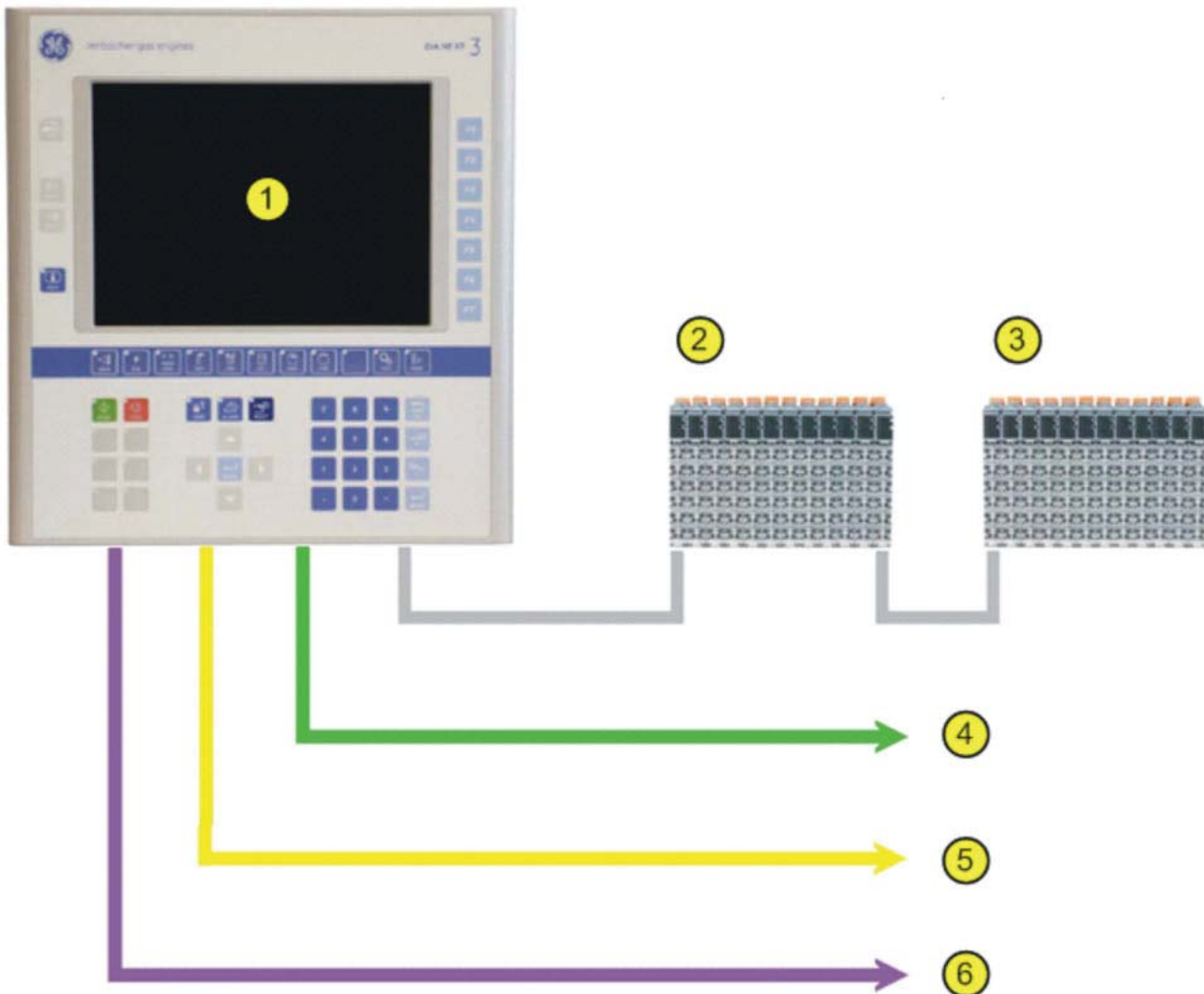
The individual components are connected via interference-free industrial bus media. All measurement data are communicated to the module itself by means of a decentralised I/O concept.

The consistent use of state-of-the-art technology therefore reduces the number of electrical connections to the module to an absolute minimum.

3.2 Hardware

General

All of the control functions and substantial parts of the engine monitoring and control units on the engine control system have been created using digital technology. The hardware used, known as a Power Panel, is a combination of a programmable logic controller and a graphical used interface.

At the heart of this panel is a powerful standard CPU. The advantage of this is that these microprocessors already provide a substantial bandwidth, which means that it will be possible to integrate ever more powerful compatible motherboards into the system in future.

A separate communication module is used to copy the data required to map the CPU process from the I/O modules. This copying process is performed in parallel with the actual computations in the CPU and does not add to its load.

To keep the amount of cabling running to the module to an absolute minimum, a decentralised I/O concept has been created for process connection. To this end, a module has been placed in the module interface cabinet to combine all the engine measurement signals and control commands. It is connected to the engine controller in the module control cabinet via a fast, interference-free bus connection.

A variety of modules are used at I/O level. The system allows the digital and analogue I/O modules to be flexibly adjusted as required.
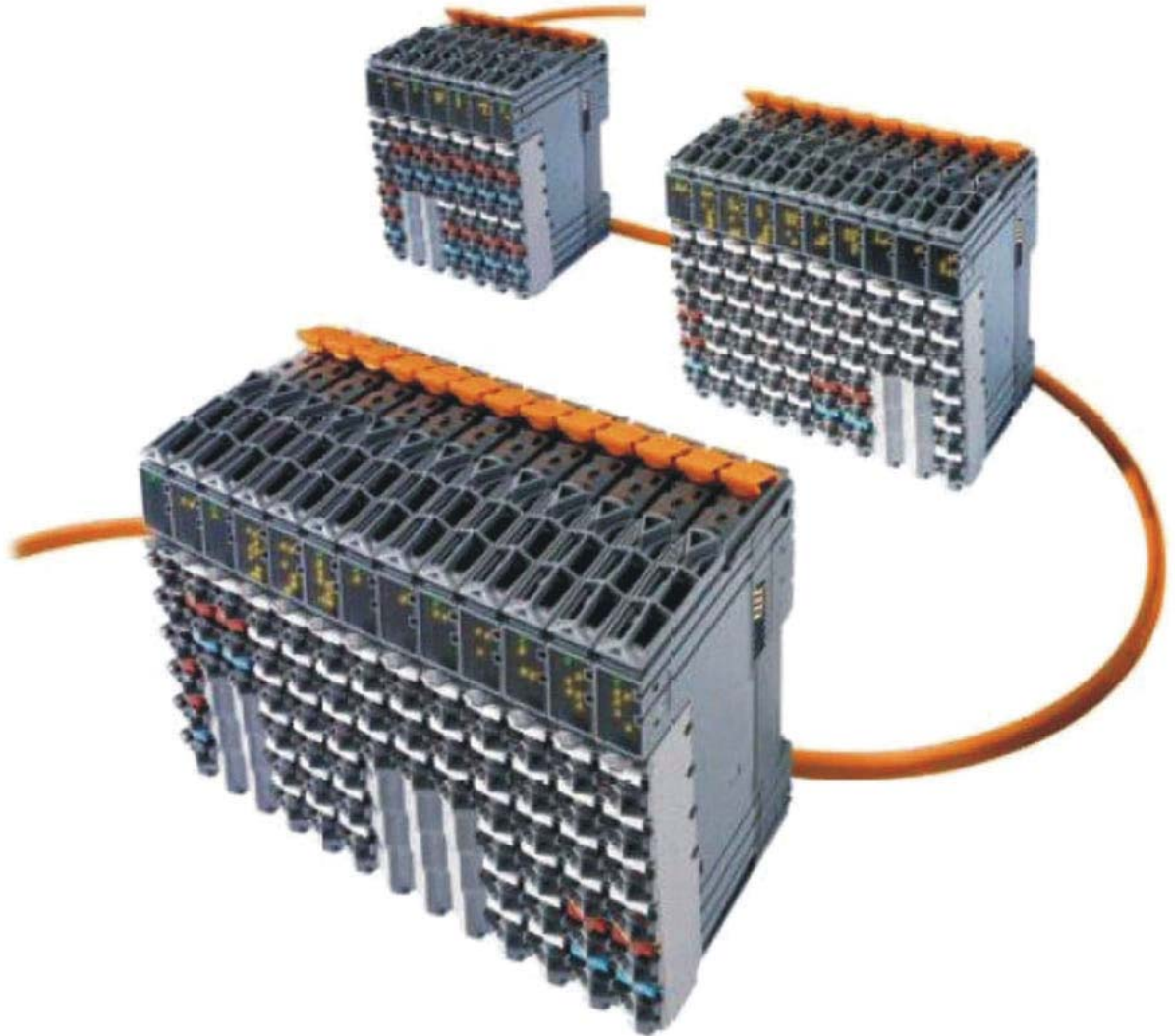
3.2.1   Power panel
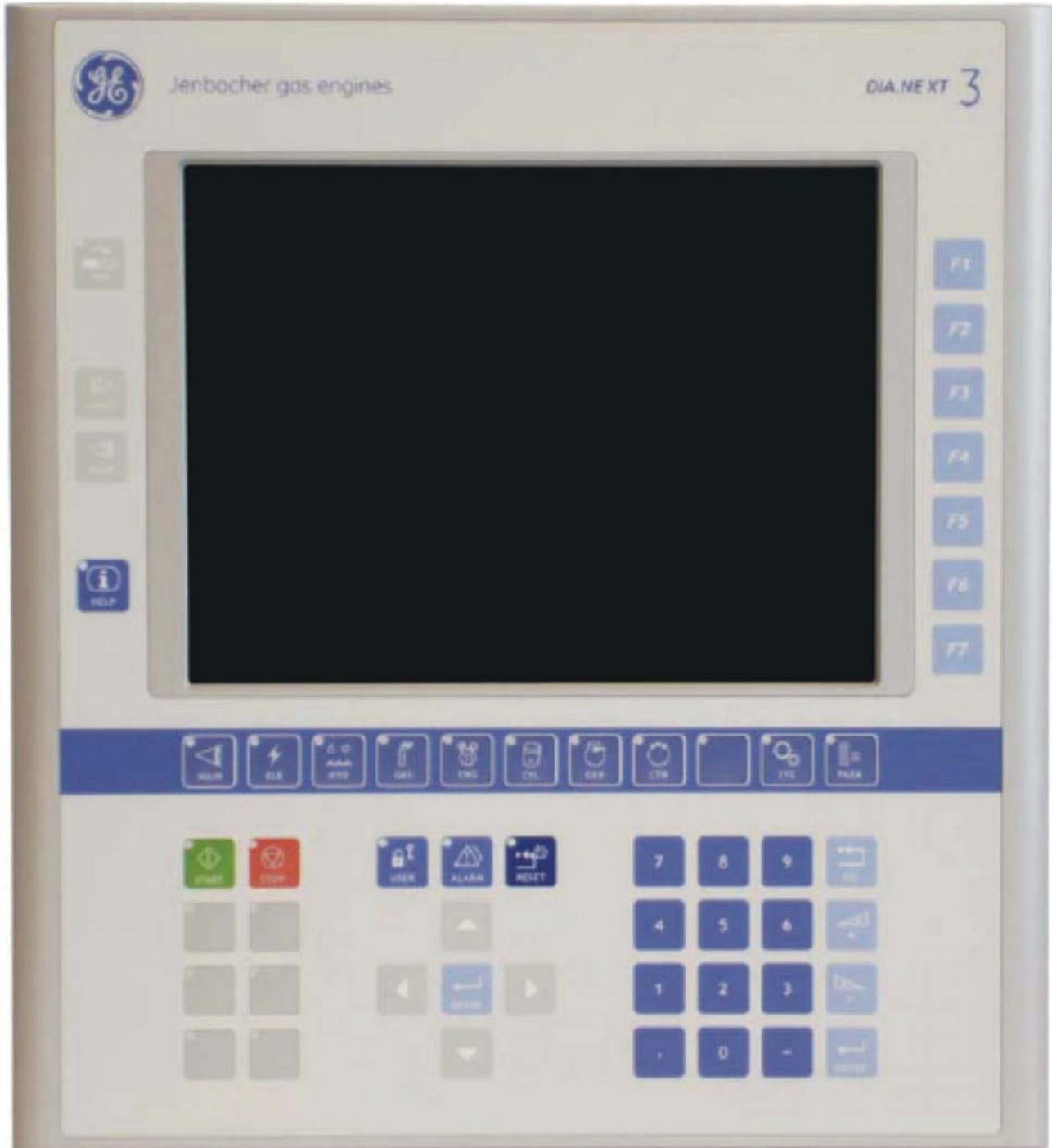
3.2.2 I/O bus connection

With 400 µs cycle time for a complete automation system, the I/O bus connection is the basis for very fast, cyclical and strictly deterministic data traffic.

3.2.3 I/O MODULES

The I/O hardware is a modular industrial automation system. The control philosophy is based on universal scalability and full compatibility. In this way it is possible to achieve response times of less than 10 ms. The I/O bus connection enables the system to be expanded without problems. Modular system design permits flexible configurations at a granularity of 1 - -32 channels per module and the direct connection of sensors and actuators.
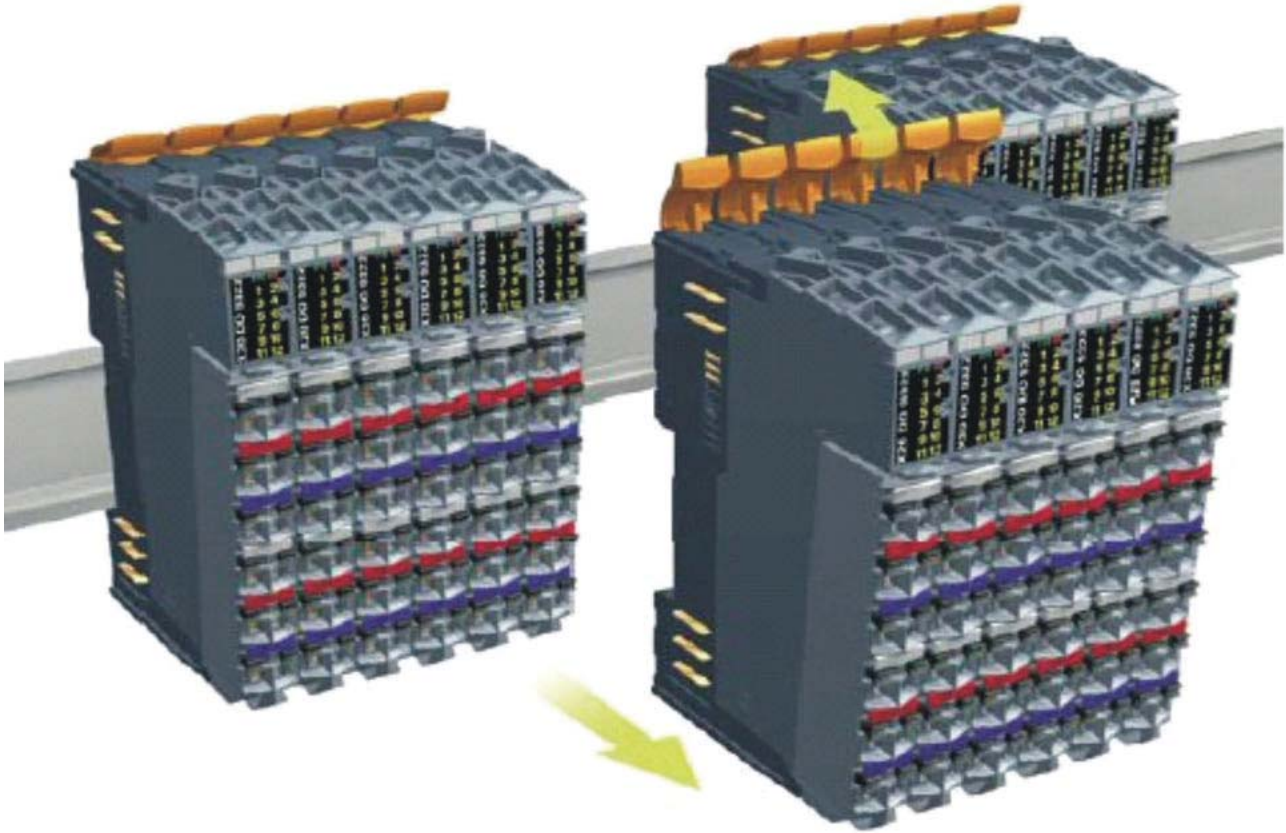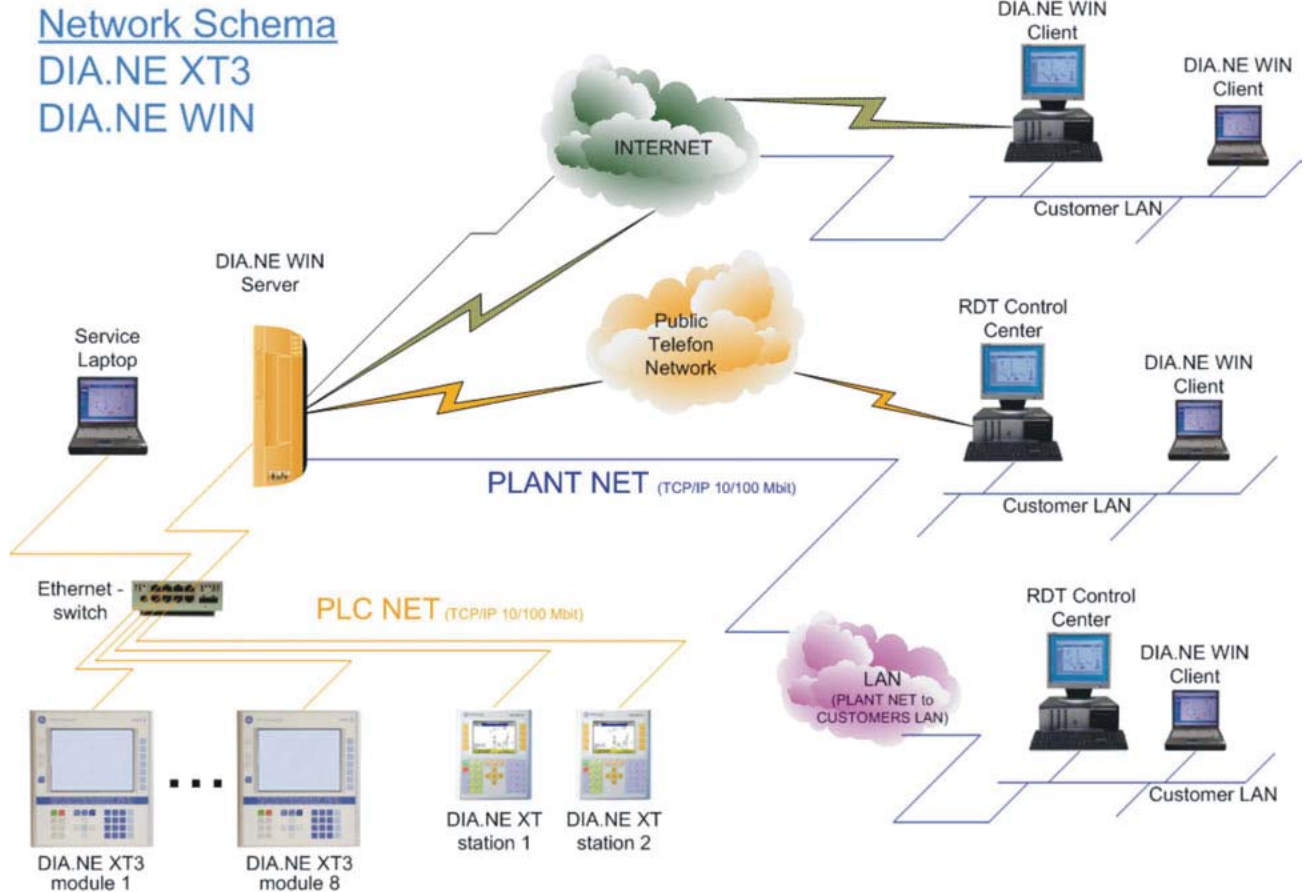
4 Interfaces

4.1 Interface with the DIA.NE WIN system

Network Schema
DIA.NE XT3
DIA.NE WIN

Control network [PLC NET]

The control network connects the engine and master controls to the DIA.NE WIN server. A second DIA.NE WIN server is used in multi-engine plants with more than 4 engines. All participants within a single network are arranged radially (Ethernet 10/100BaseT) with switches.

Plant network [PLANT NET]

In the case of multi-engine plants with more than 4 engines, the plant network interconnects the two DIA.NE WIN servers. Once again, a radially arranged Ethernet network (Ethernet 100BaseT) is used.

4.2 Interfaces with inputs and outputs

The interface with the inputs and outputs of the engine control system is provided by a proprietary protocol. This protocol ensures a high data rate and high reliability.
The individual modules communicate with each other along the common I/O bus backplane, whether they are along-

side each other on the top-hat rail, linked together in the same switchgear cabinet, or 100 m away in other switchgear cabinets.

4.3 Interface with the decentralised control components

Decentralised control components are activated via a CAN bus connection.

Devices can be connected for:

control → ignition, gas proportioning valve (optional)

monitoring → KLS 98, SAFI (optional)

measurement → MONIC (optional)

4.4 Interfaces with customer's higher-order control system

The DIA.NE XT3 system makes it possible to provide data for a higher-order control system belonging to the customer.

Several protocols are available. For example, serial protocols such as Modbus RTU (Slave) and Profibus DP (Slave) are possible options.

5 Visualisation system

5.1 General visualisation

The visualisation system increases the operational reliability and provides an ease of use which meets the highest expectations. The visualisation system handles all display and control functions. The use of a powerful processor ensures that the system operates safely.

The display contains a clear and functional summary of the measured values. All values are presented graphically. The system is operated using screen selection and function keys.

System messages and screen texts are all displayed in the language selected.

In addition to the usual process diagrams, the user is presented with tables showing the auxiliary equipment and the most important measured values.

5.2 Additional visualisation features

5.2.1 Parameter manager

An easy-to-use parameter manager is provided in DIA.NE XT3 to display, adjust and store all engine and plant parameters. To make the parameters easy to find, they have been structured into up to three levels.

5.2.2 Alarm management system

The DIA.NE XT3 alarm management provides the user with a powerful diagnostic tool. All error messages are displayed in plain text and are arranged in tabulated form. The sequence of events can be clearly seen from the time indication attached to the error messages. In addition, shutdown-related measured quantities are displayed in a trending diagram.

5.2.3 Online trends

A multi-colour trend overview makes it possible to observe closely the real-time chronological trends of the relevant measured values.

5.2.4 Access protection

When accessing the system, every user must log in using his own user name and user code. This enables user identification and the release of specific functionalities and allows the user interface to be adapted to the specific user group.

To protect against illegal access, the password entry is blocked for a specified period after three unsuccessful login attempts.

5.2.5 Activity recording

All user activities, e.g. login, logout, starting and stopping the module, etc. are recorded (activity logging).

5.2.6 Multiple language capability

The user interface is available in two languages and the user can switch between them. English is installed as the default language on each DIA.NE XT system.

Additionally, one of the following languages can be displayed on the DIA.NE XT3 system:

Bulgarian, Chinese, Czech, German, Danish, Spanish, Estonian, Finnish, French, Greek, Croatian, Hungarian, Lithuanian, Italian, Latvian, Dutch, Norwegian, Polish, Portuguese, Romanian, Russian, Swedish, Serbian, Slovak, Slovene, Turkish;

The pressure and temperature display values can be changed between "bar", "psi" and "Pa" and between "degrees Celsius" and "degrees Fahrenheit" respectively. All other units can be switched between the "ISO" and the "US" system.
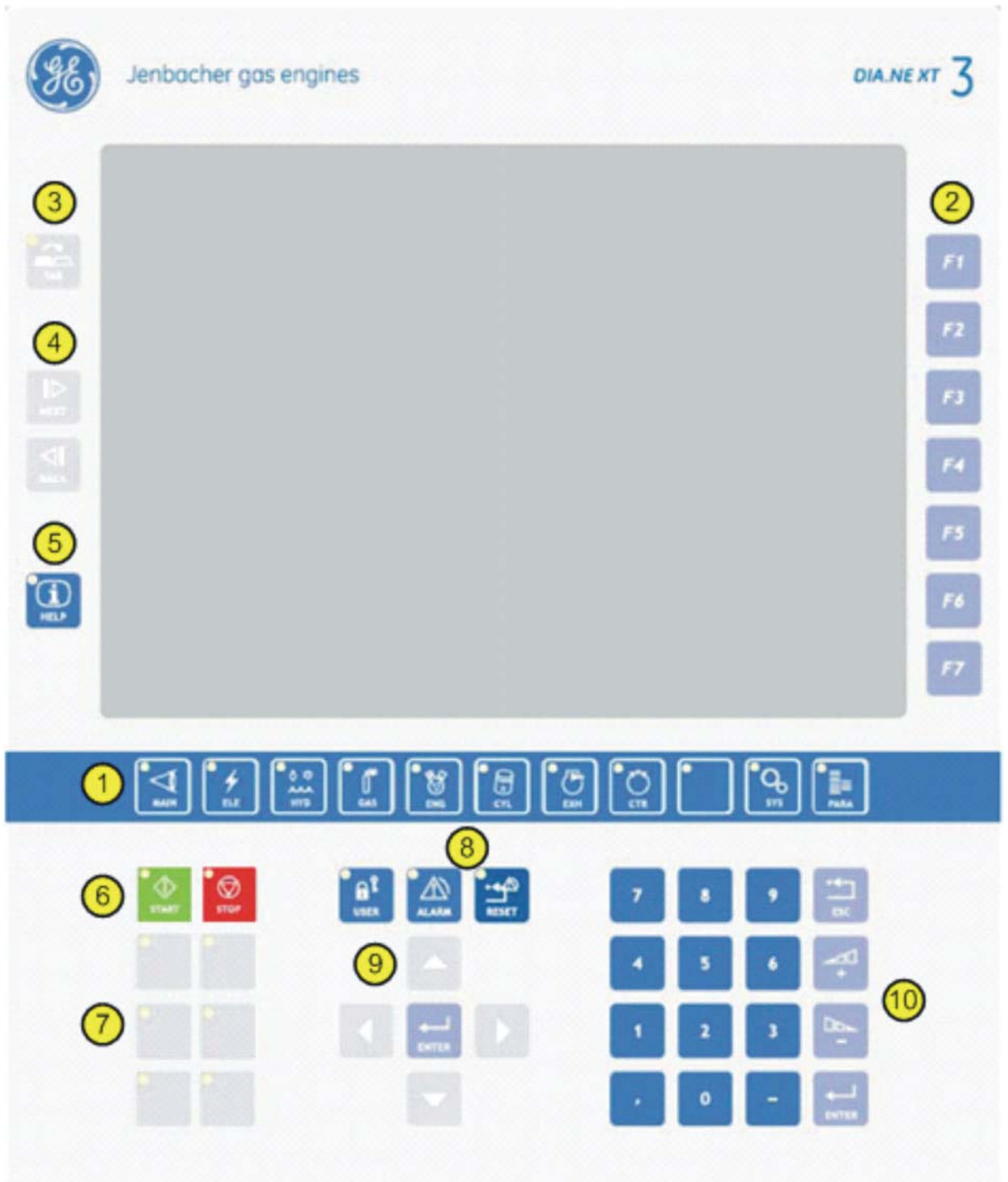
6 User interface

6.1 Operation and navigation

6.1.1 Arrangement of keys

The keyboard is divided into the following units:

① Screen selection keys

② Function keys

③ Tab key

④ Next screen/last screen

⑤ Help key

⑥ Engine start/stop

⑦ Control keys

⑧ Alarm management

⑨ Cursor keys

⑩ Numerical keys

6.1.2 Key functionalities

Screen selection keys

The screen selection keys are the highest level in the navigation system. Pressing one of the keys displays the category in the relevant first screen (**F1**). You can select from the following 12 categories:

Main screens for the customer

Electrical diagram

Lube oil/cooling water schematic

Gas details

Engine controller

Cylinder measured values

Exhaust gas measurement data

Plant controllers

Spare screens for customer applications

System displays

Parameter manager

User settings

Alarm management system

The blue indicator lights in the top left-hand corner of the screen selection keys informs the user of the category they have chosen to view.

Function keys

Function keys **F1** to **F7** are the second level of the navigation system.

Tab switching

The third and lowest navigation level is the tab switch key. By pressing the **TAB** key, you can alternate between up to three different visualisation screens. As well as the screen itself, the lighting of the white indicator light will tell you if other tabs are available.

Next screen/last screen

The **NEXT** and **BACK** screens allow you to navigate quickly between the current view and views you have previously visited. You may already be familiar with this function from various web browsers. By pressing the **BACK** key, you can browse back up to 10 views.

Help key

Whenever a help page is available for a page or an alarm entry, the indicator light on the **HELP** key lights up. Press this key to go to the appropriate help view.

Engine start/ stop

Press the **START** and **STOP** keys to start or stop the module in manual mode.

Function indicator light on **START** key

- Flashing: The module is in the start preparation phase. A manual or automatic start has been requested.
- Continuous light: The engine is running.

Function indicator light on **STOP** key

- Flashing: The module is in shutdown mode. Shutdown has been requested manually, automatically or due to a failure.

- Continuous light: The engine is not running and is not ready for operation.

Control keys

You can allocate up to 6 keys for additional control commands, such as manual synchronisation, horn off, etc. When a key has been allocated a function, this is shown by a labelling it.

Alarm management system

Press the **ALARM** key to go to the alarm management pages, as listed above.

The special feature of this key is the indicator light function. A flashing light means that an alarm has been triggered. This flashing becomes a constant light as soon as you switch to a page in the alarm management system. A fault can be displayed remotely if the screen saver has been activated.

Pressing the **RESET** key resets warnings and failures. Trips can only be reset when the operating mode selector is in OFF position.
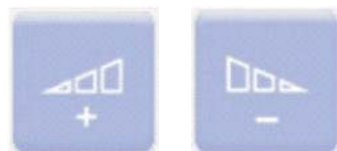
When the white indicator light lights up this generally means that a reset is possible.

Cursor keys

The cursor keys are only used to navigate between the individual entry fields.

Warning: do not use them to select an option from a drop-down menu. Use the plus or minus keys (**+/-**) to select from these menus.

Press the **ENTER** key to save entries and actuate pushbuttons.

Numerical keys

The numerical keys are used to enter numerical data.

The following keys are provided for entering negative (**-**) figures or figures with decimal places (**,**).

If you type in a figure incorrectly and you have not confirmed it by pressing **ENTER**, you can cancel the entry by pressing the **ESC** key.

The plus or minus keys (**+/-**) are active each time you enter figures. You can use them to change the last digit of the figure. Save the value by pressing the **ENTER** key.

These keys are use to select the desired option in drop-down menus.
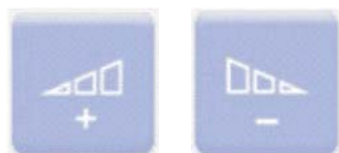
The **ENTER** key is used to complete entries and actuate software pushbuttons.

6.2 Representation

6.2.1 Customer and expert view

GE Jenbacher gas engines are highly efficient energy producers. A large number of measurements have to be carried out to optimise the engine control system and perfect the plant control system. The resulting quantity of displays is often irritating, as the values of interest to the plant operator are not explicitly displayed. Now, with the advent of the DIA.NE XT3, a new approach has been adopted which is intended to assist the customer to operate the engine.

The operator can decide how much data to visualise.

The full range of measured values is displayed in Expert View. In Customer View, displays are reduced to the essential. In addition, symbols and labels should make the screens easier to understand.

You can switch views in the **USER** screen group.

6.2.2 Display in Customer View

The screen is divided into the following sections:

- Status indication
- Date and time
- Navigation
- Screen content

Status indication

The status indication is made up of the following elements.

The engine status is displayed in the form of an animated circle. When this circle is "turning", the engine is running as well.
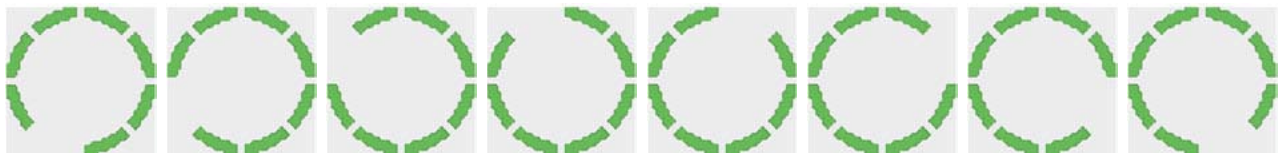
This circle only "stands still" when the engine is coasting down.

When a warning is imminent, the circle turns yellow and a warning triangle appears.

If a trip occurs, a red symbol will make you aware of it.

Information on the status of the engine run-up is provided by the progress indication. This indication allows you to see at a glance whether the engine is running at the pre-selected operating point or not.

◇—◇—◇—◇ Module has not been activated

◆—◇—◇—◇ Module has been activated

◆—◆—◇—◇ Engine start-up

◆—◆—◆—◇ Idle mode

◆—◆—◆—◆ Mains-parallel or isolated operation

◆—◆—◆—◆ LEANOX® control system enabled

◆—◆—◆—◆ The engine operates at 95% efficiency or more in relation to the nominal load of the current gas type.

The module status is shown in plain to the left of the status indication.

Netzparallelbetrieb

The monitor symbol shows whether a user is online via DIA.NE WIN.

A user is connected to the engine control system via DIA.NE WIN.

The icons below indicate whether a user has logged on to DIA.NE XT3.

No user has logged on.

A user has logged on.

The electrical power currently being produced is displayed as a numerical value and as a progress bar. The bar grows from left to right. When it reaches the right-hand side, the engine has reached the nominal power for the current gas type.

Because of the different modes, stated individually in the power reduction screen, a power reduction may be required. This operational status is indicated when the progress bar changes colour to orange.

Date and time

The current date and time are displayed below the power indicator.

Navigation

On the right-hand side, the labels on the function keys are displayed according to the currently selected main screen group. The international abbreviation of the main screen group is displayed on the left in the individual fields. The title of the subscreen appears in the centre below.

To switch to the relevant subscreen, press function keys **F1** to **F7**.

A change of colour and the direction of the arrow indicates the screen you are currently in.

The third navigation level consists of the tabs. One screen may contain up to three tabs.

The international abbreviation of the main screen group again appears on the left-hand side.

You will find the descriptions of the individual tabs in the centre of this screen label. The currently selected tab is the same colour as the background of the actual screen content. Press the **TAB** key to switch between the individual tabs.

The screen number is displayed at the right-hand side of this bar.
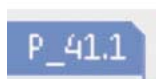
The first character denotes the main screen selection group. The second character shows the currently selected subscreen. The character behind the decimal point provides information on the tab currently displayed.

Screen content
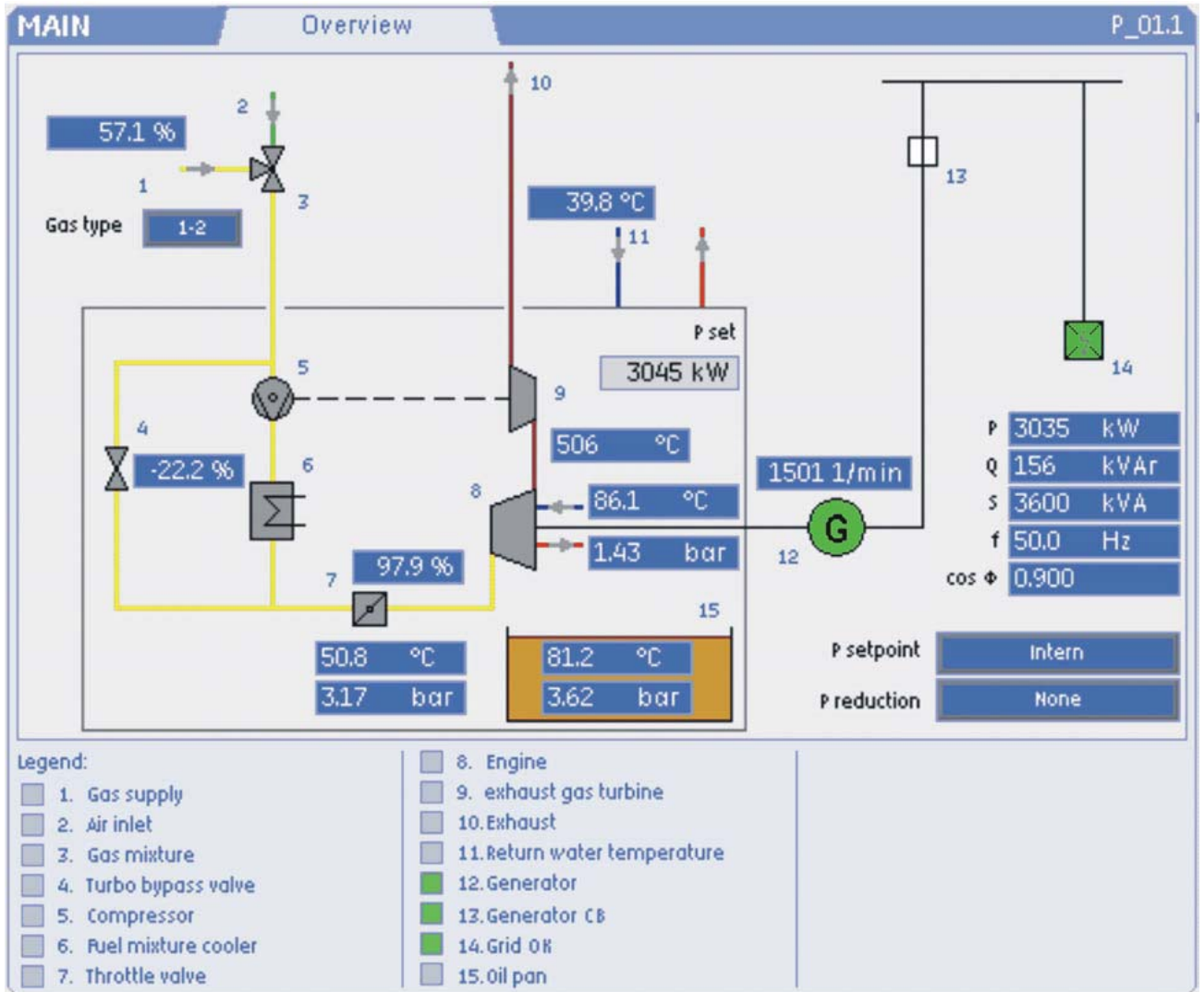
The screen content consists of inputs and outputs, graphics and animations. The individual elements are described in detail in the section on display elements.

The special feature of the customer view is that each graphic is provided with a key. A number in the screen refers to the corresponding entry in the key. There you can read the name of the corresponding part of the plant. A further simplification is a square symbol that indicates the status of the components.

6.2.3 Display in Expert View

The Expert View differs from the Customer View in the following respects:

- the status indication contains detailed information
- additional indications and inputs are displayed

- additional screens are displayed
- Keys are not displayed

Status indication

In expert mode, detailed text is displayed in the status indication. If a user has logged on at customer level or higher, the last message entered in the alarm management system is also displayed.

Additional indications and measured values

measured values which are only of secondary importance for operating the plant are only displayed in Expert View.

In the **ELE** overview screen, for example, the bus bar voltages are also displayed.

Additional screens

Screens containing detailed information which is likewise not of primary importance for operating the plant is only displayed in Expert View.

The Generator Details, Synchronization and Generator screens are additional displays in the **ELE** screen group.
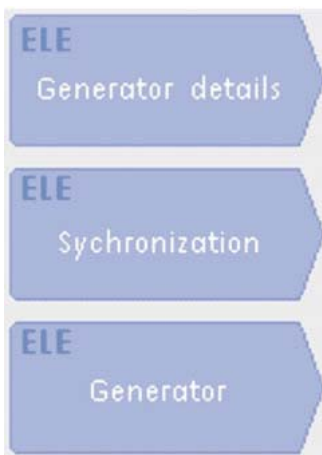
Keys

For reasons of space, no keys are displayed at all. The resulting blank areas are used to display additional information.

6.2.4 Display elements

Numerical entry

Numerical values are displayed as black figures on a blue background. In addition to the measured value, the unit appears on the right and on the left, where appropriate, an abbreviation of the measured quantity.

If an entry field has a grey background, this means that your current user authorisation level does not allow you to adjust the value.

Focused entry:

A white background around a numerical value or a text display shows that the field is an entry field. A change in the colour of the figures to white and the background to black means that the cursor has been focused on this position.

Text / numerical display

Text and numerical displays are shown as white characters on a blue background.

Text selection

A status/option can be selected using text selection. This is indicated by a downward arrow. Press the **ENTER** button to enter selection mode.

and then select the desired option using the "increase" and "decrease" buttons (**+/-**).
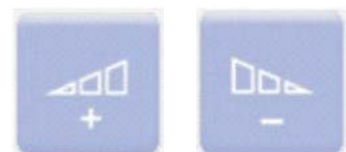
Press the "Enter" button to confirm the selection. To abort the selection process, press the **ESC** button or the cursor buttons.

Action buttons

Buttons which initiate an action have black lettering against a white background. When the button is focused, the print colour changes from black to white and the background changes from white to dark grey.

If the lettering on a button is greyed out, your current user authorisation level does not allow you to adjust the value.

Animated graphical symbol

The colour or shape of the symbol can change according to the operating condition. In general, the colour green indicates an active condition, and red a fault.

Key

A legend is shown if Customer View is selected and the screen display is a schematic diagram.

The link between the diagram and legend texts is provided by numbers in ascending order.

Legend:		
☐ 1. Gas supply	☐ 8. Engine	☐ 16. Mains CB
☐ 2. Air inlet	☐ 9. exhaust gas turbine	■ 17. Grid OK
☐ 3. Gas mixture	☐ 10. Catalyst	☐ 18. Oil pan
☐ 4. Turbo bypass valve	☐ 11. Exhaust	
☐ 5. Compressor	■ 12. Generator	
☐ 6. Fuel mixture cooler	☐ 13. Transformer	
☐ 7. Throttle valve	■ 14. Generator CB	
	☐ 15. Transformer	

The pilot lights next to the texts give a overview of the status of the various//different elements. The different colours LEDs have the following meanings:

☐ grey: There is no electrical response from the key item

☐ white: the element status is "off" or "open"

■ green: the element status is "on" or "closed"

■ red: a fault has been detected.

Trendings

Trending is provided on many screens as a support tool to optimise plant operation.

The trend curves cannot as a rule be edited, with the sole exception of the last shut-down trend. 4 curves out of 16 can be displayed.

The time axis can be varied in the User Settings screen (P_U_1.1).
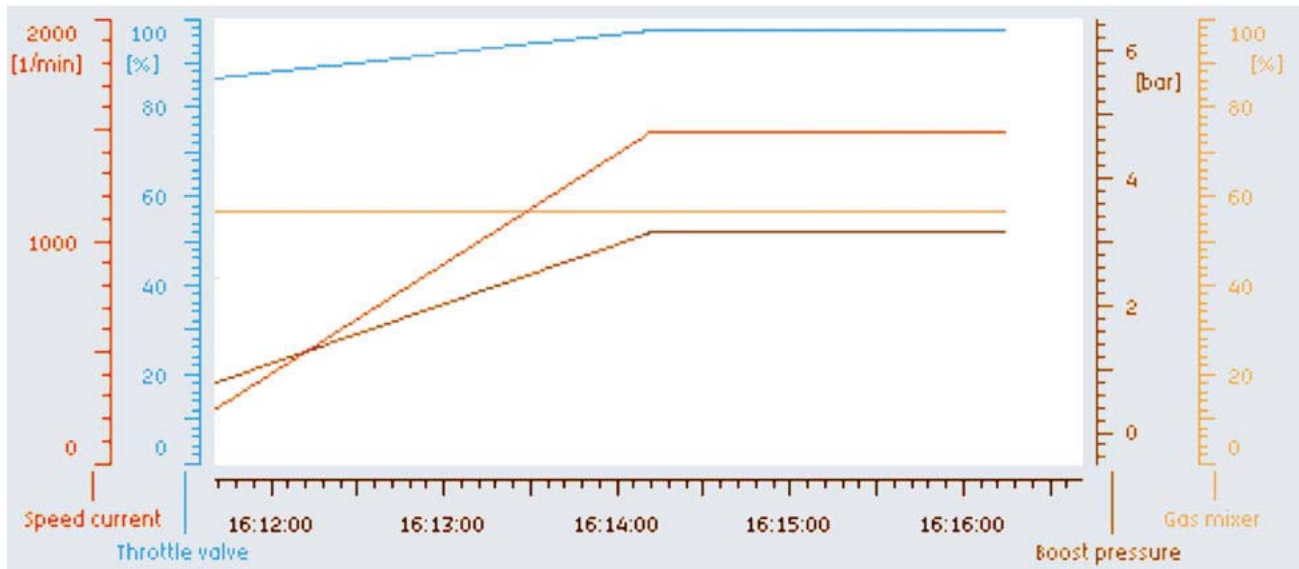
The scales are shown to left and right of the graph display area, in the same colour as the trend curve.

7 Visualisation screens

All the screens that can be viewed by customers are described individually below. The description is based on Expert View. Where Customer View not only contains a reduced number of indications but also deviates in terms of display, the differences will be listed.

If engine parts are not displayed during visualisation, this means that it is an option. Where additional indications relating to this documentation are available locally, it is a customer-specific add-on.

Note: The screenshots of the visualisation screens have been created using customer level (10).

7.1 MAIN Plant Overview

The **MAIN** screen group contains a summary of the most important information for the engine operator. Electrical and hydraulic measurement data are displayed, as well as a number of counters.

7.1.1 Overview (P_01.1)

The main overview screen is brought up by pressing the **MAIN** main screen selection button. This screen presents an overview of the most important engine measurements and settings, and gives information about the current operating and switching condition of the module.

① **Gas mixer / Gas proportioning valve**

The gas mixer and the gas proportioning valve are displayed here, depending on the engine type and the design of the installation.

Gas mixer:

The gas mixer opening amount is displayed as percentage (see the illustration above).

Gas proportioning valve:

The lambda value is displayed at the gas proportioning valve.

Display showing the gas type

The current gas type is shown for each mixer version as **Gas type**. The following displays are possible, depending on the plant design:

Gas type	Description
1	Gas type 1
2	Gas type 2
3	Gas type 3
4	Gas type 4
1_2	Gas quality = interpolation between the gas 1 and gas 2 parameter sets
1_2/3	Gas type 1_2 (gas train1) mixed with gas type 3 (gas train 2)
1/3	Gas type 1 (gas train 1) mixed with gas type 3 (gas train 2)

Further details of the gas mixer are displayed in the **Gas** screen group

② **Turbocharger bypass valve**

Display showing the turbocharger bypass position (optional).

③ **Waste heat boiler**

Display showing the tube plate temperature (optional). The inlet and outlet temperatures are displayed in the **EXH** screen group.

④ **Catalytic converter**

Display showing the catalytic converter temperature (optional). The inlet and outlet temperatures are displayed in the **EXH** screen group.

⑤ **Throttle valve**

Display showing the throttle valve position.

⑥ **Charge temperature and pressure**

Display showing the charge temperature and pressure. The display showing boost pressure upstream of the throttle valve (p2) is optional.

⑦ **Return temperature**

Display showing the return water temperature (optional).

⑧ **Inlet water temperature**

Display showing the supply water temperature (optional).

⑨ **Power set point**

It is necessary to have at least "Customer (10)" authorisation to adjust the power setpoint.

⑩ **Average exhaust gas temperature / Turbocharger inlet temperature**

Depending on the components on the engine, either the average exhaust gas temperature or the turbocharger inlet temperature is displayed.

⑪ **Engine cooling water**

Display showing the cooling water temperature and pressure. Details are displayed in the **HYD** screen group.

⑫ **Engine oil**

Display showing the engine oil temperature and pressure. Details are displayed in the **HYD** screen group.

⑬ **Speed**

Display showing the engine speed.

⑭ **Electrical diagram**

The arrangement of the generator breaker, mains breaker and transformer varies and is designed for each specific installation.

Status of generator and mains breakers:

Closed:

Open:

Mains status indication

In the event of mains failure, the mains status indication is white, otherwise it is green.

Mains OK:

Mains failure:

⑮ **Electrical measurement data**

Display showing electrical data for the generator. Details are displayed in the **ELE** screen group.

Abbreviation	Designation	Unit
P	Active power	[kilowatts]
Q	Reactive energy	Kilovolt amperes reactive
S	Apparent power	Kilovolt amperes
F	Frequency	Hertz
cos Φ	Power factor	[1]

⑯ **Power set value and power reduction**

The following types of power set values "P setpoint" are available:

Power set value	Description
Internal	The power set value is determined on the basis of the power setpoint set by the operator. The power setpoint can be set in the Overview, Engine Controller Overview, LEANOX Controller and Power Controller screens.
External - analog	The power set value is generated by an external analog signal (4-20-mA). See "Power / Scaling external power setpoint" parameter.
External - bus	The power set value is created by a higher-order control system connected to DIA.NE XT via an industrial bus connection.

The following types of power reduction "P reduction" are possible:

reducing the power	Description
None	No power reduction is in effect.
Knock	The Knocking intensity has exceeded the limit value for power reduction.
Misfiring	The number of Misfires has exceeded the limit value for power reduction.
External - analog	Power reduction due to an external analog signal. This signal can be used for a variety of applications (e.g. to control return water temperature). See "Power / Scaling external power limitation" parameter.
External - bus	The power reduction is caused by a higher-order control system connected to DIA.NE XT via an industrial bus connection.
Charge temperature	The charge temperature has exceeded the limit value for power reduction. The power rating is reduced linearly. See the "Power / Boost temperature reduction" parameter.
Maximum power	The pre-set power setpoint has exceeded the rated power related to the gas type and is limited to the latter. See "Power / Nominal values" parameter.
Minimum power	The pre-set power setpoint has fallen below the minimum permissible power setpoint and is limited to the latter. See "Power / Nominal values / Minimum power" parameter.
Exhaust gas temperature	If a cylinder temperature ("Exhaust temp. positive/negative deviation max.") deviates from the average value for more than 30 seconds, a power reduction is activated.
LEANOX	The LEANOX controller deviation limit value has been exceeded towards "lean". The power rating is reduced linearly. If the LEANOX controller deviation limit value is exceeded by than 20 percent towards "rich", the engine is switched off. See "LEANOX / Gas type x / Controller / Controller deviation limit" parameter
intake temperature	The intake temperature has exceeded the limit value for power reduction. The power rating is reduced linearly. See "Power / Intake air reduction" parameter.
CH4	If the CH4 content of the gas is decreasing, the power is reduced in accordance with an external signal (4-20mA). See "Special gas / CH4 content" parameter.
Gas pressure	If the gas pressure is decreasing, the power is reduced in accordance with an external signal (4-20mA). See "Special gas / Gas pressure" parameter.

reducing the power	Description
Suction pressure	If the suction pressure (compressor intake pressure, e.g. on a landfill site) is decreasing, the power is reduced in accordance with an external signal (4-20mA). See "Special gas / Suction pressure" parameter.
Turbocharger speed	If one of the two "switching point maximum speed" limits (exhaust gas/turbocharger A or B) is exceeded, the power is reduced accordingly depending on the parameter "Value for P reduction" (power/turbocharger speed reduction).
Undervoltage	If the generator voltage drops below the adjustable limit value of the nominal generator voltage, power reduction begins.
Overvoltage	If the generator voltage exceeds an adjustable limit value of the nominal generator voltage, power reduction begins.
Underfrequency	If the generator voltage drops below an adjustable limit value, power reduction begins.
Overfrequency	If the generator frequency exceeds an adjustable limit value of the nominal generator frequency, power reduction begins. The power reduction only ends when the deviation from the nominal frequency is very small again (hysteresis window).
G. winding temperature	If the generator winding temperature exceeds an adjustable limit value, power reduction begins.
Jacket water temperature	If the jacket water temperature rises, power is reduced. See "Power / Jacket water temperature reduction" parameter.
Oil temperature	If the oil temperature rises, power is reduced. See "Power / Oil temperature reduction" parameter.
Return water temperature	If the hot water return temperature rises, power is reduced. See "Power / Return water temperature reduction" parameter.
Pre-combustion chamber gas pressure	If the pressure in the prechamber gas train decreases, power is reduced. See "Power / Pressure pre-chamber gas train reduction" parameter.

The most effective power reduction is displayed. Further details are displayed in the "Power Reductions" screen.

In addition, a reactive power reduction can also take place. This is not displayed in this screen, however, but only as an operational notification in the alarm management:

Reactive energy reduction	Description
G. winding temperature	If the generator winding temperature exceeds an adjustable limit value, reactive power reduction begins.
Pole wheel angle	If the capacitive reactive energy exceeds a certain value calculated on the basis of the pole wheel angle, the reactive energy is limited.

7.1.2 Engine Startup Assistant (P_02.1)

The Engine Startup Assistant screen appears when you press the **MAIN** screen selection key, followed by **F2**. The main measured and actuating variables for starting the gas engine are listed on this screen. A trend analysis is also provide a better diagnosis of control processes.
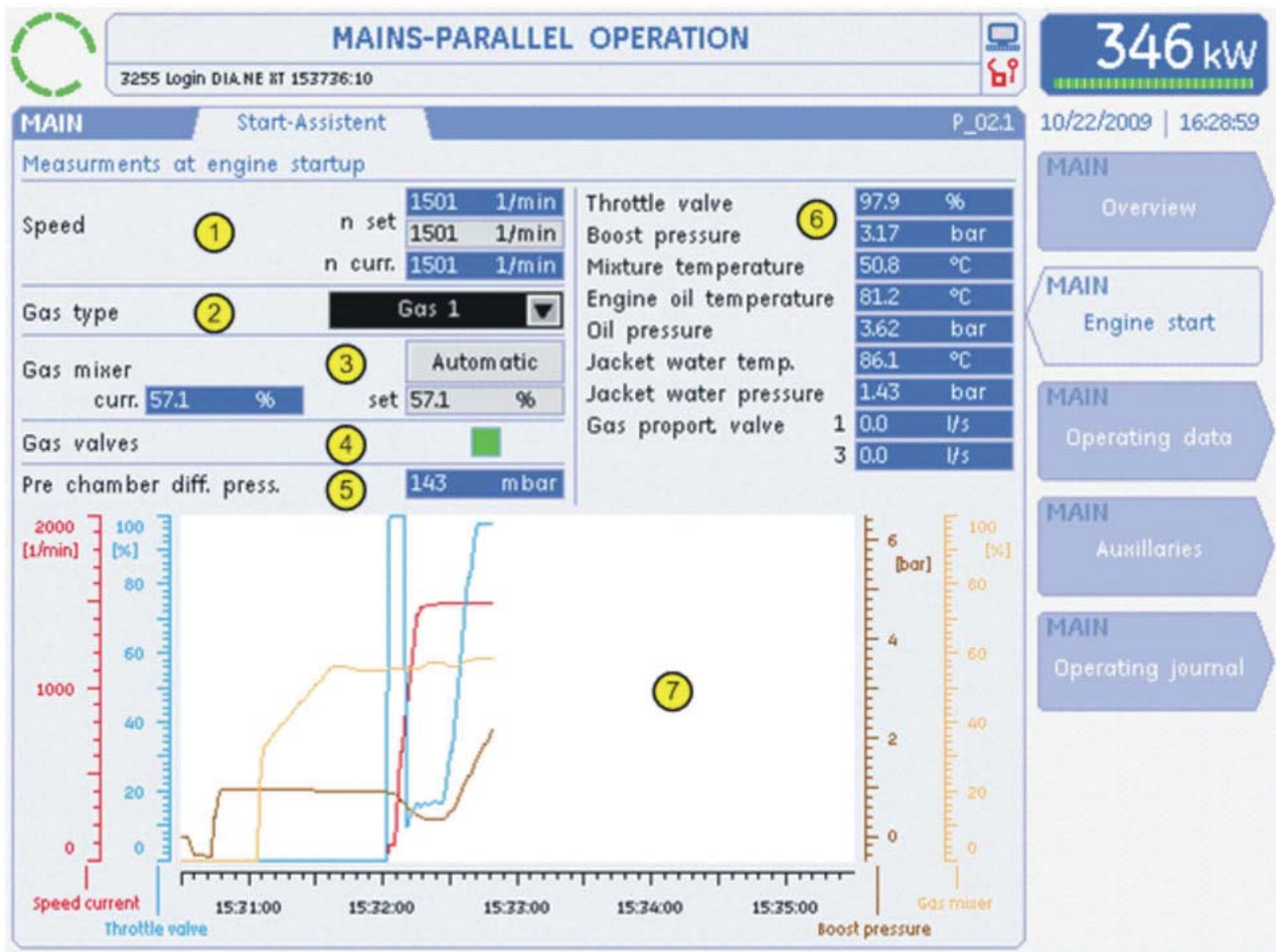
① **Speed data**

This indication displays the current setpoint value for the speed controller, the manual setpoint value and the measured actual value one below the other. The speed can only be adjusted in idle mode.

② **Setpoint value for gas type**

You can select the desired gas type from a text drop down menu.

③ **Gas mixing**

Either the setpoint values for gas mixers or gas proportioning valves are displayed here, depending on the engine configuration.

In addition, you can press the button to switch gas mixing to manual in order to adjust the setpoint value directly. If your authorisation level is "Customer (10)", you can already adjust the setpoint value in idle mode.

④ **Gas valve activation**

The "open" command for the gas valves is visualised by a green indicator light.

⑤ **Pre-combustion chamber gas differential pressure**

Optionally, the pre-combustion chamber gas differential pressure is displayed here. If the differential pressure is absent or too high, the engine is difficult or impossible to start.

⑥ Additional measured values

A series of additional measured values is displayed here, depending on the engine configuration. These measured values can be used to diagnose startup problems.

⑦ Trending

The trend analysis is intended to show changes in the engine control system in graphical form. The speed, throttle valve, boost pressure and gas mixing measurement data (% open or lambda) are displayed.

7.1.3 Operational Data (P_02.1)

The Operational Data screen appears when you press the **MAIN** screen selection key, followed by **F3**. It is used to visualise general module data such as counter readings and various measured values.

① Operating hour counter

Count of the number of hours for which the machine has been operating.

② Maintenance counter

A number of maintenance operations are required to keep the machine in good running order (e.g. oil change). Four separate maintenance counters are used to generate warnings as a reminder that a maintenance operation is due. The count is displayed in hours and is reduced by one hour after each hour of operation. The counter is reset once maintenance has been completed. If the maintenance interval is for example 1000 operating hours, the number 1000 is entered.

③ Start counter

Counter that counts the number of completed starts.

④ Reserve counter

The four reserve counters can be supplied to customers as an option, for totalling quantities specific to their plant. They are included in the application as ordered.

⑤ Active and reactive energy counter

The active energy counter is used to total the amount of active energy produced by the engine.

The reactive energy counter totals the amount of reactive energy. The generator always tries to calculate and set the optimum power factor (cos Phi).

7.1.4 Auxiliaries 1 (P_04.1)

The Auxiliaries screen appears when you press the **MAIN** screen selection key, followed by **F4**. It is used to visualise switching conditions and analogue measurement quantities of auxiliaries required for engine operation.

① **Auxiliary equipment description**

Depending on the configuration of the auxiliary equipment different screens can be shown here.

② **Auxiliary equipment status screen**

The condition of the individual auxiliaries is displayed here or shown as analogue values.

7.1.5 Auxiliaries 2 (P_04.2)

The Auxiliaries screen appears when you press the **MAIN** screen selection key, then **F4**, followed by the **TAB** key. It is used to visualise other switching conditions and analogue measurement quantities of auxiliaries required for engine operation.

① **Auxiliary equipment description**

Depending on the configuration of the auxiliary equipment different screens can be shown here.

② **Auxiliary equipment status screen**

The condition of the individual auxiliaries is displayed here or shown as analogue values.

7.1.6 Operational Logbook 1 (P_05.1)

The Operational Data screen appears when you press the **MAIN** screen selection key, followed by **F5**. The measurement data to be entered in the operational logbook are provided here in summarised form.

MAINS-PARALLEL OPERATION

3255 Login DIA.NE XT 153736:10

3045 kW

MAIN | Operating journal 1 | Operating journal 2 | P_05.1 | 10/22/2009 | 16:29:42

Electric power P	3046	kW
Electrical reactive power Q	156	kVAr
Electrical apparent power	3600	kVA
cos φ	0.900	
Current average Im	2428	A
Voltage average Um	400	V
Neutral current In	39	A
Excitation voltage Ue	35.1	V
Actice energy WP	0.0	MWh
Reactive energy WP	0.0	MVarh

Exhaust gas temperature cylinder no:

1	502 °C	13	499 °C
2	502 °C	14	499 °C
3	502 °C	15	499 °C
4	502 °C	16	499 °C
5	502 °C	17	499 °C
6	498 °C	18	499 °C
7	502 °C	19	499 °C
8	502 °C	20	499 °C
9	498 °C	21	499 °C
10	498 °C	22	500 °C
11	498 °C	23	500 °C
12	499 °C	24	500 °C

MAIN Overview

MAIN Engine start

MAIN Operating data

MAIN Auxiliaries

MAIN Operating journal

① **Description of record entry**

Depending on the engine configuration, various indications can be activated here which are to be copied to the operational logbook.

② **Measurement data displays**

The measurement data to be recorded can be read on the right of the plain text display.

7.1.7 Operational Logbook 2 (P_05.2)

The Operational Data screen appears when you press the **MAIN** screen selection key, then **F5**, followed by the **TAB** key. The data to be entered in the operational logbook are provided here in summarised form.

MAINS-PARALLEL OPERATION

3255 Login DIA.NE XT 153736:10

3046 kW

MAIN   Operating journal 1   Operating journal 2   P_05.2   10/22/2009 | 16:29:49

	①	②
Jacket water temperature	86.1	°C
Jacket water pressure	1.43	bar
Engine oil temperature	81.2	°C
Oil pressure	3.62	bar
Mixture temperature	50.9	°C
Boost pressure	3.17	bar
Fuel gas volume controller setting	57.1	%
Throttle valve	97.9	%
Compressor bypass position	22.6	%
Operation hours	556	h
Start counter	14	
Air temperature surrounding area	82.8	°C
Pre chamber differential pressure	143	mbar

MAIN Overview

MAIN Engine start

MAIN Operating data

MAIN Auxiliaries

MAIN Operating journal

① **Description of record entry**

Depending on the engine configuration, various indications can be activated here which are to be copied to the operational logbook.

② **Data displays**

The data to be recorded can be read on the right of the plain text display.

7.2 Electrical Diagram (ELE)

The **ELE** screen group contains a summary of information on the electrical system and in particular on the generator. Details of electrical data, synchronisation, the generator control system and temperature measuring points are displayed.

Note: Only the Overview (P_11.1) screen is displayed in Customer View.

7.2.1 Overview (P_11.1)

The Overview screen appears when you press the **ELE** screen selection key. This screen displays the main electrical measured quantities, as well as operating and switching conditions.

Note: Customer View does not show the indications for bus bar voltages ⑧ and ⑨.

① **Generator or engine indication**

Ten seconds after the starting speed is reached, the display changes colour from white to green.

② **Generator switch branch**

The switching condition of the generator switch is displayed:

open

closed

An optional transformer can also be displayed in the generator switch branch. This symbol is not animated (no colour change).

Transformer

③ **Mains branch**

Optionally, the switching condition of the mains switch is displayed:

⊟open

⊞closed

An optional transformer can also be displayed in the mains branch. This symbol is not animated (no colour change).

⊗Transformer

④ Bus bar status identification

If the voltage values of the bus bar are OK, a green mains symbol is displayed. In the event of a malfunction the symbol appears black and white.

☒ Bus bar voltage is O.K.

☒ Bus bar voltage error

⑤ Mains status indication

If the mains status is OK, a green mains symbol is displayed. In the event of a malfunction the symbol appears black and white.

☒ Mains voltage is O.K.

☒ Mains voltage error

⑥ **Entering speed and power setpoint**

Speed setpoint n

When the generator switch is open, the entry field is visible and the engine speed setpoint can

be altered. The engine speed setpoint value can be entered from User Level customer (10) upwards.

Power setpoint P

Here you can alter the power setpoint value, unless another type of power setting

has been installed. The power setpoint value can be entered from User Level customer (10) upwards.

⑦ **Electrical measurement**

Display showing electrical data for the generator.

Abbreviation	Description	Unit
Im	Current average value, 3 phases	[Ampere]
Um	Voltage average value, 3 phases	[Volt]
P	Effective power	[Kilowatts]
Q	Reactive power	[Kilo-Volt-Ampere-reactive]
S	Apparent power	[Kilo-Volt-Ampere]

Abbreviation	Description	Unit
f	Frequency	[Hertz]
cos Φ	Power factor	[1]

⑧ **Bus bar voltage interlinked**

Optionally, the three interlinked bus bar voltages L1-L2, L2-L3 and L3-L1 are displayed.

⑨ **Bus bar voltage per phase**

Optionally, the three bus bar voltages in phases L1, L2 and L3 are displayed in relation to the neutral conductor.

7.2.2 Generator Details 1 (P_12.1)

The Generator Details 1 screen appears when you press the **ELE** main screen selection key, followed by **F2**. The electrical data for the generator are displayed on this screen.

Note: This screen is only displayed in Customer View. Optionally, details of another measuring point can be shown on a second tab (P_12.2).

① **Animated switching condition diagram**

An explanation of the individual symbols can be seen in the Overview (P_11.1) screen.

② **Generator voltage interlinked**

Optionally, the three interlinked generator voltages L1-L2, L2-L3 and L3-L1 are displayed.

③ **Generator voltage per phase**

Optionally, the three generator voltages in phases L1, L2 and L3 are displayed in relation to the neutral conductor N.

④ **Dynamic pulsation amplitude of phase currents**

The maximum value of the current pulsation amplitude is displayed as a percentage so that the smooth running of the engine can be assessed while in mains-parallel operation. This peak-value memory has a decaying time constant and should ideally display the lowest possible value.

⑤ **Generator excitation voltage**

The generator excitation voltage is displayed in volts.

⑥ **Detailed electrical power indication**

The current electrical power is displayed in kilowatts. In addition, a special display field is used to display the maximum value for this measured quantity. The value is always reset when the generator switch is actuated.

⑦ **Detailed phase current indication**

The three current phase currents are displayed in amperes. In addition, special display fields are used to display the maximum values for the currents. The values are always reset when the generator switch is actuated.

⑧ **Detailed neutral conductor current indication**

The current neutral conductor current is displayed in amperes. In addition, a special display field is used to display the maximum value for the neutral conductor current. The value is always reset when the generator switch is actuated.

7.2.3   Synchronisation (P_13.1

The Synchronisation screen appears when you press the **ELE** screen selection key, followed by **F3**. A synchronoscope, with all the measured values required for synchronisation, is displayed on this screen.

Note: This screen is only displayed in Customer View. Optionally, details of another synchronisation can be shown on a second tab (P_13.2).
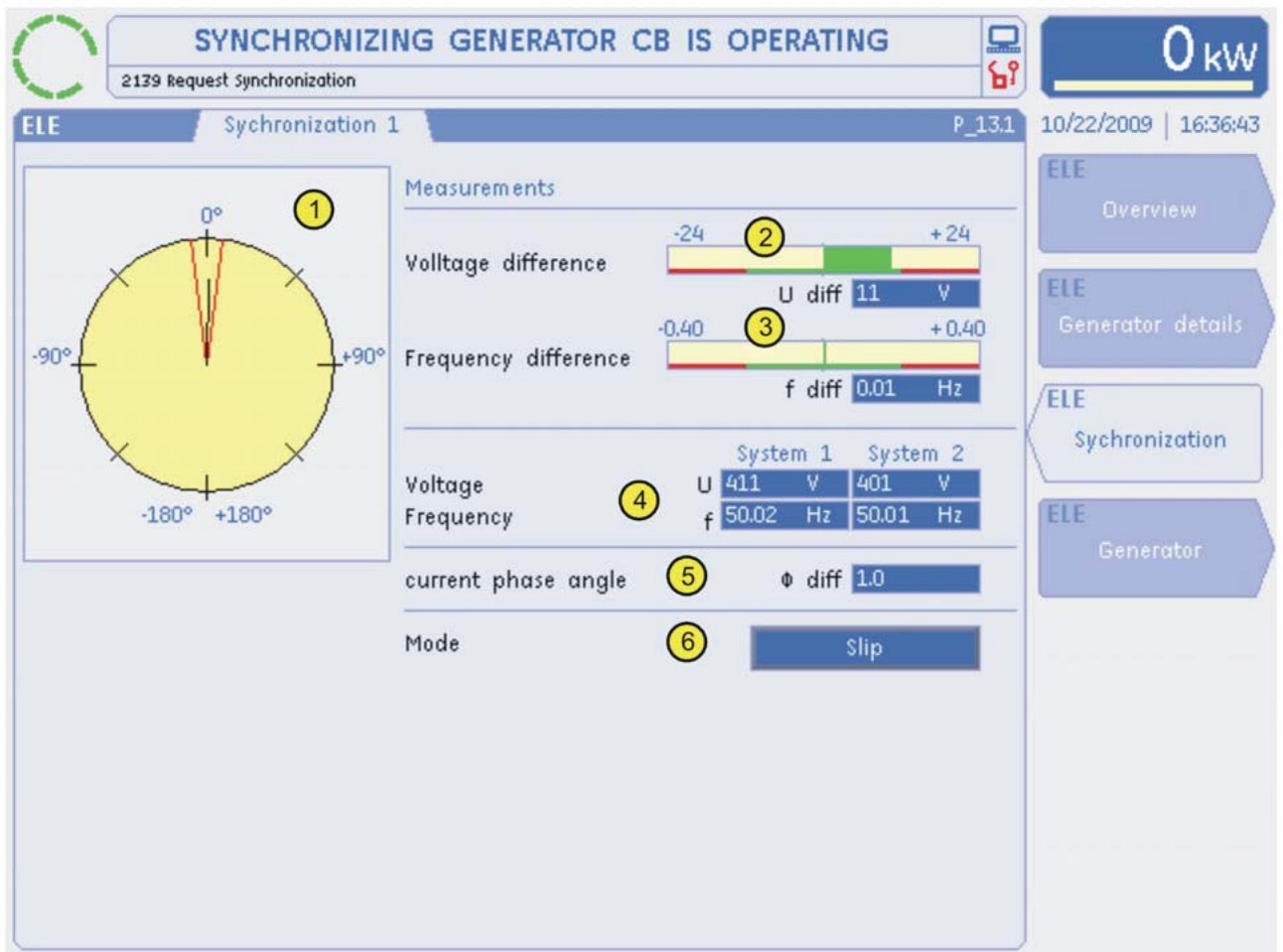
① Synchronoscope

The synchronoscope is used to display the changes in phase position during the synchronisation process. The position of the pointer corresponds to the numerical value of **Φ diff**. The value is displayed from -180 to +180 degrees.

The synchronoscope pointer indicates the current phase position. The lower the differential frequency the more slowly the pointer moves.

Permissible activation range
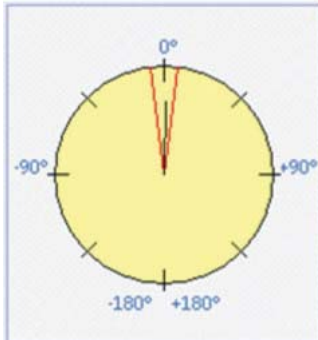
This activation condition is satisfied if the synchronisation pointer is within the permissible phase position.

Engine speed deviation
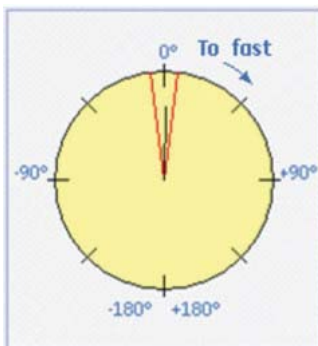
The messages **Too Fast** and **Too Slow** are shown as an additional aid.

The display appears as soon as the permissible differential frequency is exceeded.

Synchronisation completed
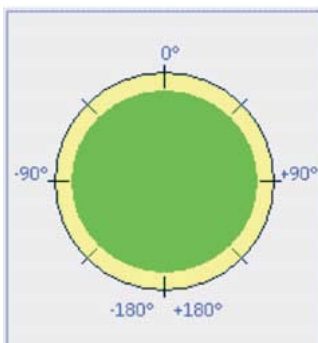
Synchronisation will be finished upon receipt of the power switches response. This status is displayed using a green disc. In this way, it is possible to check whether the control system is trying to close the switch.

Deviation from measured value in synchronised condition

Deviations may occur in the measured values because of errors in the measurement accuracy tolerance, despite the fact that the systems are electrically linked.

② **Voltage difference**

The current voltage difference **U diff** between the two networks to be synchronised (U diff = U System 1 - U System 2) is displayed.

③ **Frequency difference**

The current frequency difference **f diff** between the two networks to be synchronised (f diff = f System 1 - f System 2) is displayed.

④ **Comparing two electrical systems**

Electrical System 1

The entry **System 1** lists the current voltage and frequency of electrical system 1. System 1 is activated at the X4 terminals of the multi-measurement converter. The voltage closer to the generator is displayed here during the synchronisation procedure.

Examples:

The generator voltage is connected here during the synchronisation of the generator switch.

The bus bar voltage is connected here during the synchronisation of the mains switch.

Electrical System 2

The entry **System 2** lists the current voltage and frequency of electrical system 2. System 2 is activated at the X6 terminals of the multi-measurement converter. The voltage closer to the mains is displayed here during the synchronisation procedure.

Examples:

The bus bar or mains voltage is connected here during the synchronisation of the generator switch.

The mains voltage is connected here during the synchronisation of the mains switch.

⑤ **Phase angle**

The current phase angle between the networks to be synchronised **Φ diff** (-180° to +180°) is displayed.

⑥ **Synchronisation mode**

There are three ways in which synchronisation can be performed:

Inactive

No function has been selected or synchronisation has already been completed

Slip

The following applies to the generator and synchronisation voltage:

 50% < U < 125% of rated voltage UN
 80% < f < 110% of rated frequency fN

The generator voltage is adjusted to the synchronisation voltage in terms of amplitude and frequency. The switch command is designed and executed in advance to take account of the parameterised phase angle, a preset trans-

former connection circuit and the switch response time so that the main contacts of the power switch are closed at the point of synchronisation.

Synchronisation takes place subject to the following conditions:

- The "Select synchronisation" command is set in the software

- The parameterised limit for voltage difference has been maintained (dUmax)

- The parameterised limits for frequency difference have been maintained (dfmax and dfmin)

- The parameterised limit for the phase angle (including transformer connection circuit) has been maintained (dalpha)

If all the conditions have been satisfied, the activation output changes its condition from LOW to HIGH. When the parameterised pulse period has ended, it switches back from HIGH to LOW.

Synchro Check

In this operating mode the device can be used as a synchronisation control.

The "Close LS" relay remains attached as long as the following conditions are satisfied:

- The "Start synchro check" command is set in the software

- The parameterised limit for voltage difference has been maintained (dUmax)

- The parameterised limits for frequency difference have been maintained (dfmax and dfmin)

- The parameterised limit for phase angle has been maintained (phimax)

The activation output remains set so long as all the conditions are satisfied.

Dead bus

The activation command for the power switch is issued without synchronisation if the following conditions are satisfied:

- the "Start dead bus" command is set in the software

- The bus bar is dead (USS < 5% UN)

- The generator voltage and frequency can have any valid value.

If all the conditions have been satisfied, the activation output changes from LOW tot HIGH.

7.2.4 Generator (P_14.1)

The Generator screen appears when you press the main **ELE** screen selection key, followed by **F4**. Optionally, the operating diagram of the synchronous generator and, optionally, its bearing and winding temperatures are displayed.

Details of the function and setting of the generator controller can be found in Technical Instruction 1530-0182.
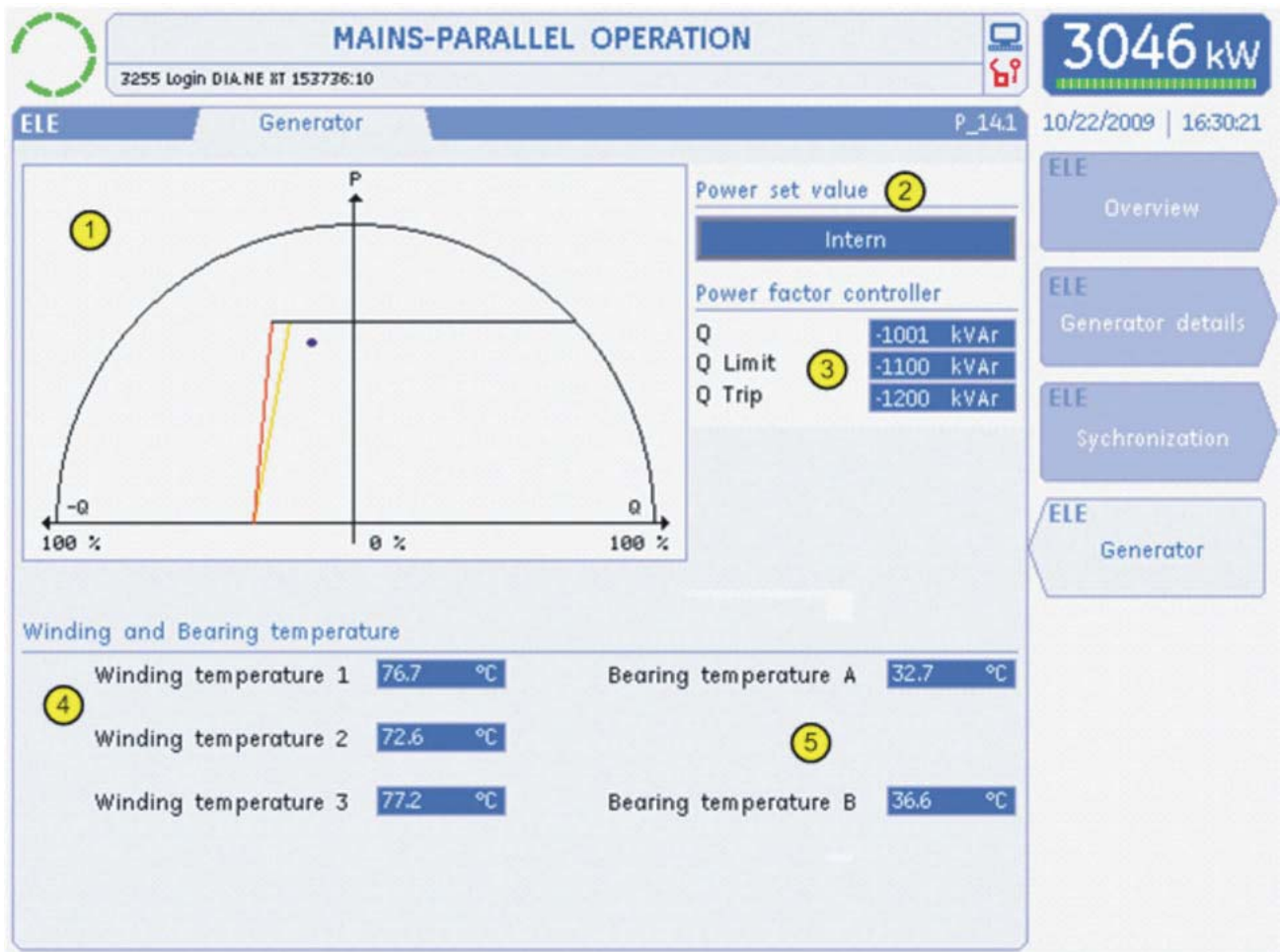
① Operating diagram of synchronous generator

The operating diagram of the synchronous generator shows the effective power and reactive energy. The blue dot indicates the operating point. The current reactive energy (Q), the maximum permissible reactive energy (Q LIMIT - orange line) and the exciter failure value (Q TRIP - red line)

Where the permissible reactive energy is reached and the generator control system is enabled, an operating notification is issued and the control system is limited to this value.

Where the maximum reactive energy (exciter failure value) has been reached, the engine shuts down due to exciter failure.

② Control type indication

The following control types are available for power factor control:

None	only operating diagram displayed
Internal	Setpoint value preset via parameter setting
External - analogue	Power factor setpoint preset via analogue signal
External - bus	Power factor setpoint value preset via bus

③ **Reactive energy indication**

The following information on reactive energy is displayed:

Q	current reactive energy
Q Limit	Limit level for warning and control limit
Q Trip	Limit level for shutdown due to exciter failure

④ **Generator winding temperature**

Optionally, generator winding temperatures can be displayed in degrees Celsius, degrees Fahrenheit or in Kelvin.

Depending on the generator type, either one or three measured values can be visualised.

⑤ **Generator bearing temperature**

Optionally, generator bearing temperatures can be displayed in degrees Celsius, degrees Fahrenheit or in Kelvin.

7.3 Hydraulic diagram (HYD)

The **HYD** screen group contains information on the hydraulic system. Pressure and temperature data for the oil and cooling water circuits are displayed.

7.3.1 Oil/Cooling Water screen (P_21.1)

The oil/cooling water screen is brought up by pressing the **HYD** main screen selection button. This screen shows the main hydraulic measured variables, together with the operational conditions in the cooling circuits.
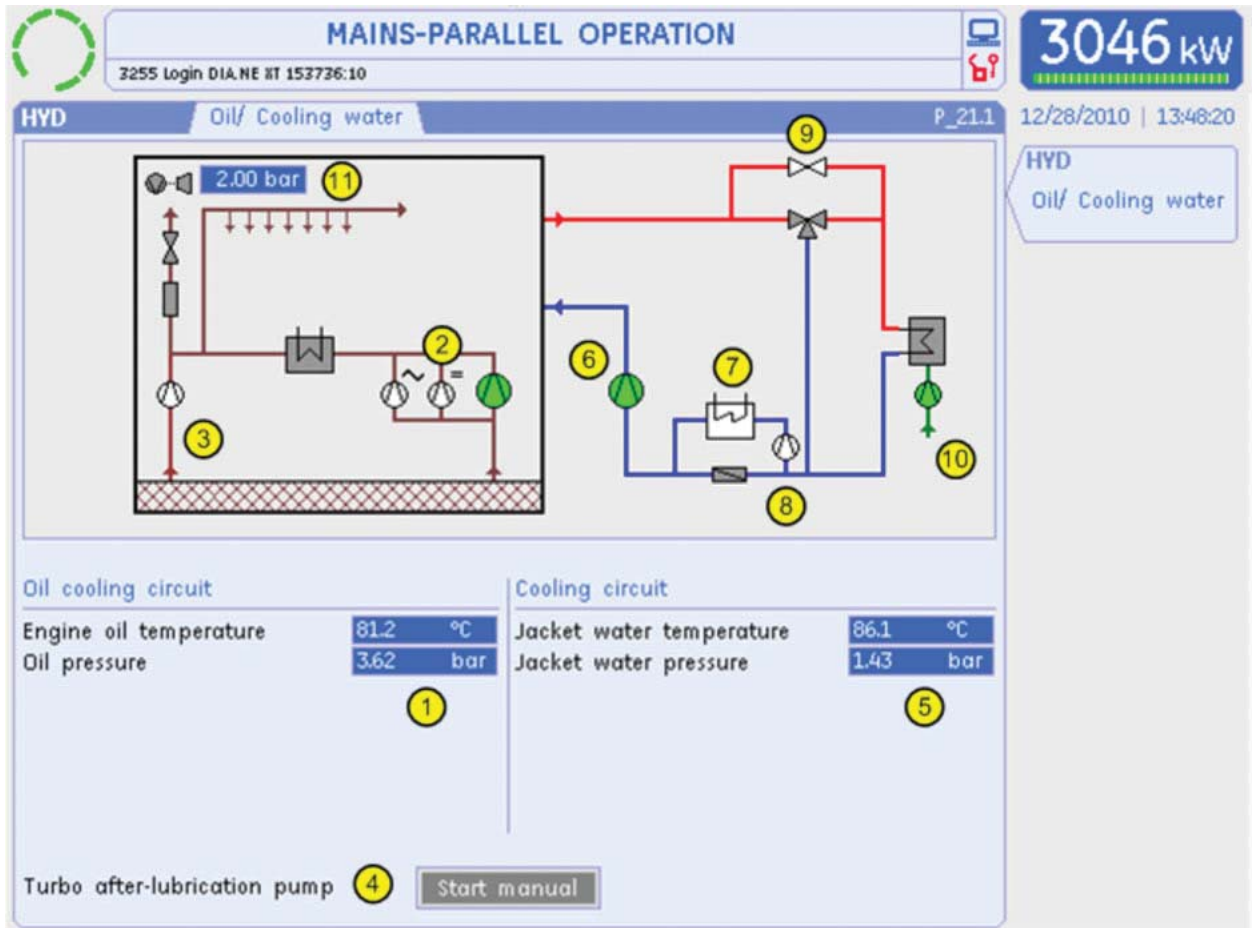
① **Oil circuit measured values**

The current oil temperature and pressure are displayed.

② **Oil pumps**

Various oil pumps may be installed, depending on the engine type.

⊘ Main oil pump

⊘ Pre-lubricating pump (24V)

⊘ Pre-lubricating pump (230V)

Whether a pump is in operation or not is indicated by a change of colour from white to green.

③ **Turbocharger oil pump**

The operating status of the turbocharger oil pump can be shown here as an option. If the pump is in operation, the colour changes to green.

④ **Turbocharger lubrication pump manual start**

If a turbocharger lubrication pump is fitted, it can be activated manually by pressing the start button.

⑤ Cooling water circuit measured values

The current cooling water temperature and pressure are displayed. Depending on the plant design, additional temperature measurements can be displayed here with plain language labelling.

⑥ Cooling water pump

This shows the operating status of the cooling water pump. If the pump is in operation, this is represented by a colour change to green.

⑦ Preheating

The preheating operating status is displayed as an option. If the heating is in operation, this is represented by a colour change to green.

⑧ Preheating pump

The preheating pump operating status is displayed as an option. If the pump is in operation, this is represented by a colour change to green.

⑨ Preheating from an external heating circuit

The preheating operating status is displayed as an option. If the heating is in operation, this is represented by a colour change to green.

⑩ (Emergency) cooling system

The cooling water pump operating status is displayed as an option. If the cooling is in operation, this is represented by a colour change to green.

⑪ Turbocharger oil pressure downstream of the control valve

The turbocharger oil pressure downstream of the control valve is displayed as an option.

7.4 Gas Supply (GAS)

The **GAS** screen group contains information on the gas supply to the engine. measured values and actuating variables for the gas volume and quality are displayed.

Note: Only the Gas Details (P_31.1) screen is displayed in Customer View.

7.4.1 Gas Details (P_31.1)

The Gas Details screen appears when you press the main **GAS** screen selection key. This screen displays the main information on the gas pressure control system(s) and the volume(s) of gas supplied.

Note: Customer View does not show the indications for mixture details ⑨.

① Gas type selection

You can select the desired gas type from a drop-down menu. Depending on the application, up to 4 gas types can be selected (**Gas 1, Gas 2, Gas 3 and Gas 4**). Optionally, a quality-dependant gas type, (**Gas 1-2**), or a mixed opera-tion using two gas pressure control systems (**Gas 1/3 and Gas 1-2/3**) can also be selected. The **Auto Gas** entry activates the automatic gas type switching system.

② Gas mixer setting

Mode of operation

Using the **Operation mode** screen button (automatic – manual), you can make the entry field for the setpoint value editable. The button is only available if the generator switch is deactivated. If the button has been activated (manu-al mode of operation) and the generator switch is activated, the automatic mode of operation is reactivated auto-matically. Moreover, switching is only possible if the user has logged in at a minimum of user level customer (10).

Entering setpoint values

At **Gas mixer rate set** you can enter the setpoint value for the gas mixer position as a percentage. The entry field is only visible while the generator switch is off and the setting has been switched to manual. In addition, the operator must at least have logged in as User Level Customer (10).

Current setpoint value

Gas mixer rate displays the current setpoint value to be used by the control unit.

③ **Gas quality indication**

If the gas type is subject to strong quality fluctuations (CH4 content, calorific value), it is possible to interpolate between two different parameter sets, depending on the measurement signal provided by the customer. The current interpolation factor (i.e. gas quality) is displayed as a percentage.

④ **Gas pressure control system leak test**

The gas pressure control system test is represented by the following 4 symbols:

 No leak test requested

 Leak test in progress

 Gas pressure control system OK

 Error during gas pressure control system test

⑤ **Gas valve**

The condition of the gas valve is represented by a colour change. If the valve is shown as green, the engine control system activates the "open" command.

⑥ **Gas mixer actual value signal**

The actual values for individual gas mixers are displayed as an opening percentage. Up to four gas mixers (1 - 4) can be installed on the engine, depending on the configuration.

⑦ **Intake air temperature**

The intake air temperature is displayed in degrees Celsius, Fahrenheit or Kelvin.

⑧ **Alternative indications with gas proportioning valve**

Depending on the engine configuration, gas proportioning valves can be installed instead of traditional gas mixers. The setpoint value for the mixture is set directly by entering a desired lambda value. The ratio indicates the current air volume as opposed to the minimum air volume required for full combustion.

Variant with one gas pressure control system:
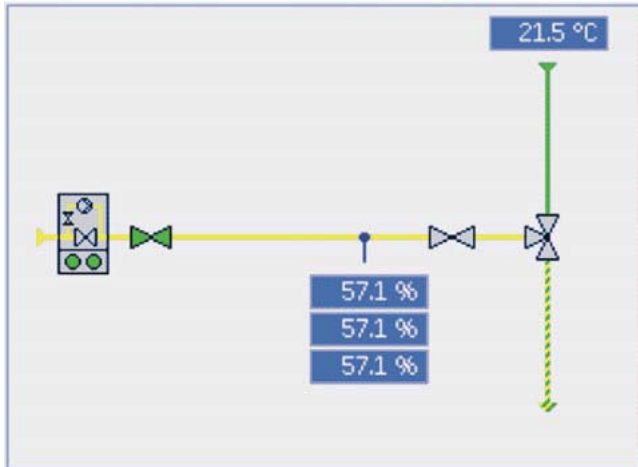
Up to three gas proportioning valves in parallel control the ratio of fuel gas to air in the mixture. The percentage indicated is the opening angle of the proportioning valve.

The gas proportioning valves are numbered consecutively from the top down. This arrangement is reflected in technical diagrams, distribution plans, alarm systems and parameter settings.

Variant with two gas pressure control systems:
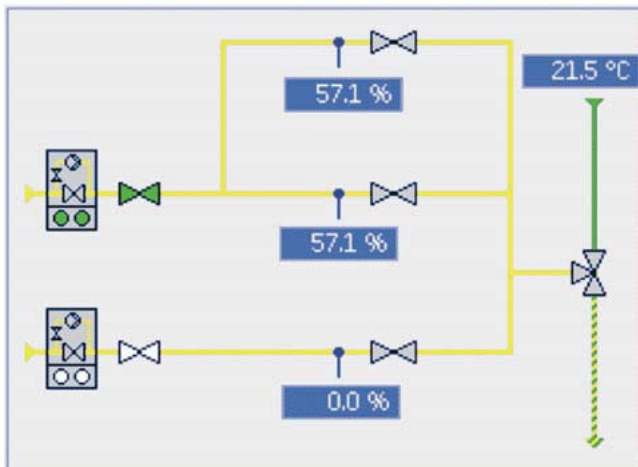
In this configuration, the gas pressure control system with the lower-quality gas in terms of calorific value (e.g. biogas) can be fitted with up to two gas proportioning valves and the system with the higher calorific value (e.g. natural gas) can be fitted with one valve. The percentage indicated is the opening angle of the proportioning valve.

The gas proportioning valves are numbered consecutively and the valve at the very top is number 3, the middle one number 1 and the bottom one number 2. This arrangement is reflected in technical diagrams, distribution plans, alarm systems and parameter settings.

⑨ **Details of gas proportioning valves**

The gas proportioning valve produces data which are only displayed in Expert Mode. Up to 3 columns can be displayed, depending on the engine configuration.

Gas proportioning valve					
0.000	λ	0.000	λ	0.000	λ
0.0	%	0.0	%	0.0	%
0.0	°C	0.0	°C	0.0	°C
0.0	l/s	0.0	l/s	0.0	l/s
0	mbar	0	mbar	0	mbar

The following values are displayed:

[λ]	Lambda factor
[%]	Gas proportioning valve opening angle
[°C], [°F], [K]	Fuel gas temperature
[l/s], [ft3/s]	Calculated flow rate
[bar], [psi], [kPa]	Fuel gas pressure

7.4.2 Special Gas (P_32.1)

The Special Gas screen appears when you press the main **GAS** screen selection key, followed by **F2**. Additionally, measured values for special gases are displayed on this screen.

Note: This screen is only displayed in Customer View and when at least one special gas measured value is to be displayed.

① **Animated switching condition diagram**

An explanation of the individual symbols can be seen in the Gas Details (P_31.1) screen.

② **Gas type selection**

You can select the desired gas type from a drop-down menu. Depending on the application, 4 gas types can be selected (**Gas 1, Gas 2, Gas 3 and Gas 4**). Optionally, a quality-dependant gas type, (**Gas 1-2**), or a mixed operation using two gas pressure control systems (**Gas 1/3 and Gas 1-2/3**) can also be selected. The **Auto Gas** entry activates the automatic gas type switching system.

③ **Gas mixer setting**

Mode of operation

Using the **Operation mode** screen button (automatic – manual), you can make the entry field for the setpoint value editable. The button is only available if the generator switch is deactivated. If the button has been activated (manual mode of operation) and the generator switch is activated, the automatic mode of operation is reactivated automatically. Moreover, switching is only possible if the user has logged in at User Level Customer

(10) or higher.

Entering setpoint values

At **Gas mixer rate set** you can enter the setpoint value for the gas mixer position as a percentage. The entry field is only visible while the generator switch is off and the setting has been switched to manual. In addition, the operator must at least have logged in as User Level Customer (10).

Current setpoint value

Gas mixer rate displays the current setpoint value to be used by the control unit.

④ **Gas quality indication**

If the gas type is subject to strong quality fluctuations (CH_4 content, calorific value), it is possible to interpolate between two different parameter sets, depending on the measurement signal provided by the customer. The current interpolation factor (i.e. gas quality) is displayed as a percentage.

⑤ **Indication of special gas data**

Optionally, the various measured values for special gases are displayed here.

7.4.3 Gas Mixture (P_33.1)

The Gas Mixture screen appears when you press the main **GAS** screen selection key, followed by **F3**. Additionally, setpoint values for the gas mixture are displayed on this screen.

Note: This screen is only displayed in Customer View and when at least one gas mixture is provided for this engine.

① **Animated switching condition diagram**

An explanation of the individual symbols can be seen in the Gas Details (P_31.1) screen.

② **Gas type selection**

You can select the desired gas type from a drop-down menu. Depending on the application, up to 4 gas types can be selected (**Gas 1, Gas 2, Gas 3 and Gas 4**). Optionally, a quality-dependant gas type, (**Gas 1-2**), or a mixed operation using two gas pressure control systems (**Gas 1/3 and Gas 1-2/3**) can also be selected. The **Auto Gas** entry activates the automatic gas type switching system.

③ **Gas mixer setting**

Mode of operation

Using the **Operation mode** screen button (automatic – manual), you can make the entry field for the setpoint value editable. The button is only available if the generator switch is deactivated. If the button has been activated (manual mode of operation) and the generator switch is activated, the automatic mode of operation is reactivated automatically. Moreover, switching is only possible if the user has logged in at User Level Customer

(10) or higher.

Entering setpoint values

At **Gas mixture rate set** you can enter the setpoint value for the gas mixer position as a percentage. The entry field is only visible while the generator switch is off and the setting has been switched to manual. In addition, the operator must at least have logged in as User Level Customer (10).

Current setpoint value

Gas mixture rate displays the current setpoint value to be used by the control unit.

④ **Current gas type indication**

The currently available gas types are shown here. A mixture of these gas types (e.g. the related parameter sets) produces the current, interpolated gas type.

⑤ **Current gas quality indication**

The ratio of gas quality interpolation between the Gas 1 parameters and Gas 2 parameters are displayed here.

⑥ **Current mixture ratio indication**

The mixture ratio for the gas change-over between gas type 1-2 and gas type 3 is shown here.

⑦ **Automatic / manual setting change-over**

Here you can set the gas quality or mixture ratio manually.

7.5 Engine controller (ENG)

The **ENG** screen group contains information on the active engine controller. The setpoint and actual values of individual controllers are displayed. Trend analyses assist in diagnosing control changes on the engine.

Note: Only the Engine Controller Overview (P_41.1) screen and the Ignition (P_46.1) screen are displayed in Customer View.

7.5.1 Engine Controller Overview (P_41.1)

The Engine Controller screen appears when you press the main **ENG** screen selection key. This screen displays an overview of the status, operating mode and control variables of all the engine controllers (LEANOX, power, speed and isolated-operation controller).

① Gas mixer / Gas proportioning valve

The gas mixer and the gas proportioning valve are displayed here, depending on the engine type and the design of the installation.

Gas mixer:

The gas mixer opening amount is displayed as percentage (see the illustration above).

Gas proportioning valve:

The lambda value is displayed at the gas proportioning valve.

Display showing the gas type

The current gas type is shown for each mixer version as **Gas type**. The following displays are possible, depending on the plant design:

Gas type	Description
1	Gas type 1
2	Gas type 2
3	Gas type 3
4	Gas type 4
1_2	Gas quality = interpolation between the gas 1 and gas 2 parameter sets
1_2/3	Gas type 1_2 (gas train1) mixed with gas type 3 (gas train 2)
1/3	Gas type 1 (gas train 1) mixed with gas type 3 (gas train 2)

Further details of the gas mixer are displayed in the **Gas** screen group

② **Turbocharger bypass valve**

Display showing the turbocharger bypass position (optional).

③ **Throttle valve**

Display showing the default throttle valve position.

④ **Boost pressure**

Display showing the boost pressure.

⑤ **Charge temperature**

Display showing the charge temperature.

⑥ **Speed**

Display showing the engine speed.

⑦ **Power output**

Display showing the electrical power produced by the generator.

⑧ **LEANOX controller**

If the controller is in operation, the pilot light changes from white ☐ to green ☐.

The controller mode (auto/manual) is displayed, as is the control deviation in mbar or mpsi.

⑨ **Power controller**

If the controller is in operation, the pilot light changes from white ☐ to green ☐.

⑩ **Speed controller**

If the controller is in operation, the pilot light changes from white ☐ to green ☐.

⑪ **Island operation controller**

If the controller is in operation, the pilot light changes from white ☐ to green ☐.

⑫ **Power set value and power reduction**

The following types of power set values "P setpoint" are available:

Power set value	Description
Internal	The power set value is determined on the basis of the power setpoint set by the operator. The power setpoint can be set in the Overview, Engine Controller Overview, LEANOX Controller and Power Controller screens.
External - analog	The power set value is generated by an external analog signal (4-20mA). See "Power / Scaling external power setpoint" parameter.
External - bus	The power set value is created by a higher-order control system connected to DIA.NE XT via an industrial bus connection.

The following types of power reduction "P reduction" are possible:

reducing the power	Description
None	No power reduction is in effect.
Knock	The Knocking intensity has exceeded the limit value for power reduction.
Misfiring	The number of Misfires has exceeded the limit value for power reduction.
External - analog	Power reduction due to an external analog signal. This signal can be used for a variety of applications (e.g. to control return water temperature). See "Power / Scaling external power limitation" parameter.
External - bus	The power reduction is caused by a higher-order control system connected to DIA.NE XT via an industrial bus connection.
Charge temperature	The charge temperature has exceeded the limit value for power reduction. The power rating is reduced linearly. See the "Power / Boost temperature reduction" parameter.
Maximum power	The pre-set power setpoint has exceeded the rated power related to the gas type and is limited to the latter. See "Power / Nominal values" parameter.
Minimum power	The pre-set power setpoint has fallen below the minimum permissible power setpoint and is limited to the latter. See "Power / Nominal values / Minimum power" parameter.
Exhaust gas temperature	If a cylinder temperature ("Exhaust temp. positive/negative deviation max.") deviates from the average value for more than 30 seconds, a power reduction is activated.
LEANOX	The LEANOX controller deviation limit value has been exceeded towards "lean". The power rating is reduced linearly. If the LEANOX controller deviation limit value is exceeded by than 20 percent towards "rich", the engine is switched off. See "LEANOX / Gas type x / Controller / Controller deviation limit" parameter

reducing the power	Description
intake temperature	The intake temperature has exceeded the limit value for power reduction. The power rating is reduced linearly. See "Power / Intake air reduction" parameter.
CH4	If the CH4 content of the gas is decreasing, the power is reduced in accordance with an external signal (4-20mA). See "Special gas / CH4 content" parameter.
Gas pressure	If the gas pressure is decreasing, the power is reduced in accordance with an external signal (4-20mA). See "Special gas / Gas pressure" parameter.
Suction pressure	If the suction pressure (compressor intake pressure, e.g. on a landfill site) is decreasing, the power is reduced in accordance with an external signal (4-20mA). See "Special gas / Suction pressure" parameter.
Turbocharger speed	If one of the two "switching point maximum speed" limits (exhaust gas/turbocharger A or B) is exceeded, the power is reduced accordingly depending on the parameter "Value for P reduction" (power/turbocharger speed reduction).
Undervoltage	If the generator voltage drops below an adjustable limit value of the nominal generator voltage, power reduction begins.
Overvoltage	If the generator voltage exceeds an adjustable limit value of the nominal generator voltage, power reduction begins.
Underfrequency	If the generator frequency drops below an adjustable limit value of the nominal generator frequency, power reduction begins.
Overfrequency	If the generator frequency exceeds an adjustable limit value of the nominal generator frequency, power reduction begins. The power reduction only ends when the deviation from the nominal frequency is very small again (hysteresis window).
G. winding temperature	If the generator winding temperature exceeds an adjustable limit value, power reduction begins.
Jacket water temperature	If the jacket water temperature rises, power is reduced. See "Power / Jacket water temperature reduction" parameter.
Oil temperature	If the oil temperature rises, power is reduced. See "Power / Oil temperature reduction" parameter.
Return water temperature	If the hot water return temperature rises, power is reduced. See "Power / Return water temperature reduction" parameter.
Pre-combustion chamber gas pressure	If the pressure in the pre-combustion chamber gas train decreases, power is reduced. See "Power / Pressure pre-chamber gas train reduction" parameter.

The most effective power reduction is displayed. Further details are displayed in the "Engine Controller Reductions" screen.

In addition, a reactive power reduction can also take place. This is not displayed in this screen, however, but only as an operational notification in the alarm management:

Reactive energy reduction	Description
G. winding temperature	If the generator winding temperature exceeds an adjustable limit value, reactive power reduction begins.
Pole wheel angle	If the capacitive reactive energy exceeds a certain value calculated on the basis of the pole wheel angle, the reactive energy is limited.

7.5.2 Power Reduction 1 (P_41.2)

The Power Reduction 1 screen appears when you press the main **ENG** screen selection key and then the **TAB** key. It shows the first part of an overview of the status of the power reductions envisaged for this engine.

Note: This screen is not displayed in Customer View.

① **Maximum power reduction**

The protective measure for the engine showing the maximum reduction is displayed here.

② **Reduction causes**

The names of the reduction causes relevant to the plant configuration are displayed here using a dynamic list.

An explanation of the individual reductions can be seen in the Engine Controller Overview (P_31.1) screen.

③ **Power reduction by cause**

The admissible load limit by cause is listed here in kW.

④ **Bar chart showing power reductions by cause**

This overview is meant to speed up the identification of power reduction.

⑤ **Highest reduction**

The longest bar limits the maximum power.

⑥ **Reduction**

All shorter bars do not affect the maximum power.

7.5.3 Power Reduction 2 (P_41.3)

The Power Reduction 2 screen appears when you press the main **ENG** screen selection key and then the **TAB** key twice. Further status indications are displayed as a continuation of the overview from the Power Reduction 1 screen.

Note: This screen is not displayed in Customer View.

① **Maximum power reduction**

The protective measure for the engine showing the maximum reduction is displayed here.

② **Reduction causes**

The names of the reduction causes relevant to the plant configuration are displayed here using a dynamic list.

An explanation of the individual reductions can be seen in the Engine Controller Overview (P_41.1) screen.

③ **Power reduction by cause**

The admissible load limit by cause is listed here in kW.

④ **Bar chart showing power reductions by cause**

This overview is meant to speed up the identification of power reduction.

7.5.4   LEANOX® Controller (P_42.1)

The LEANOX® controller screen is brought up by pressing the **ENG** main screen selection button followed by **F2**. This screen shows an overview of the most important control variables and a trending for emission control.

Note: This screen is only displayed in Customer View.
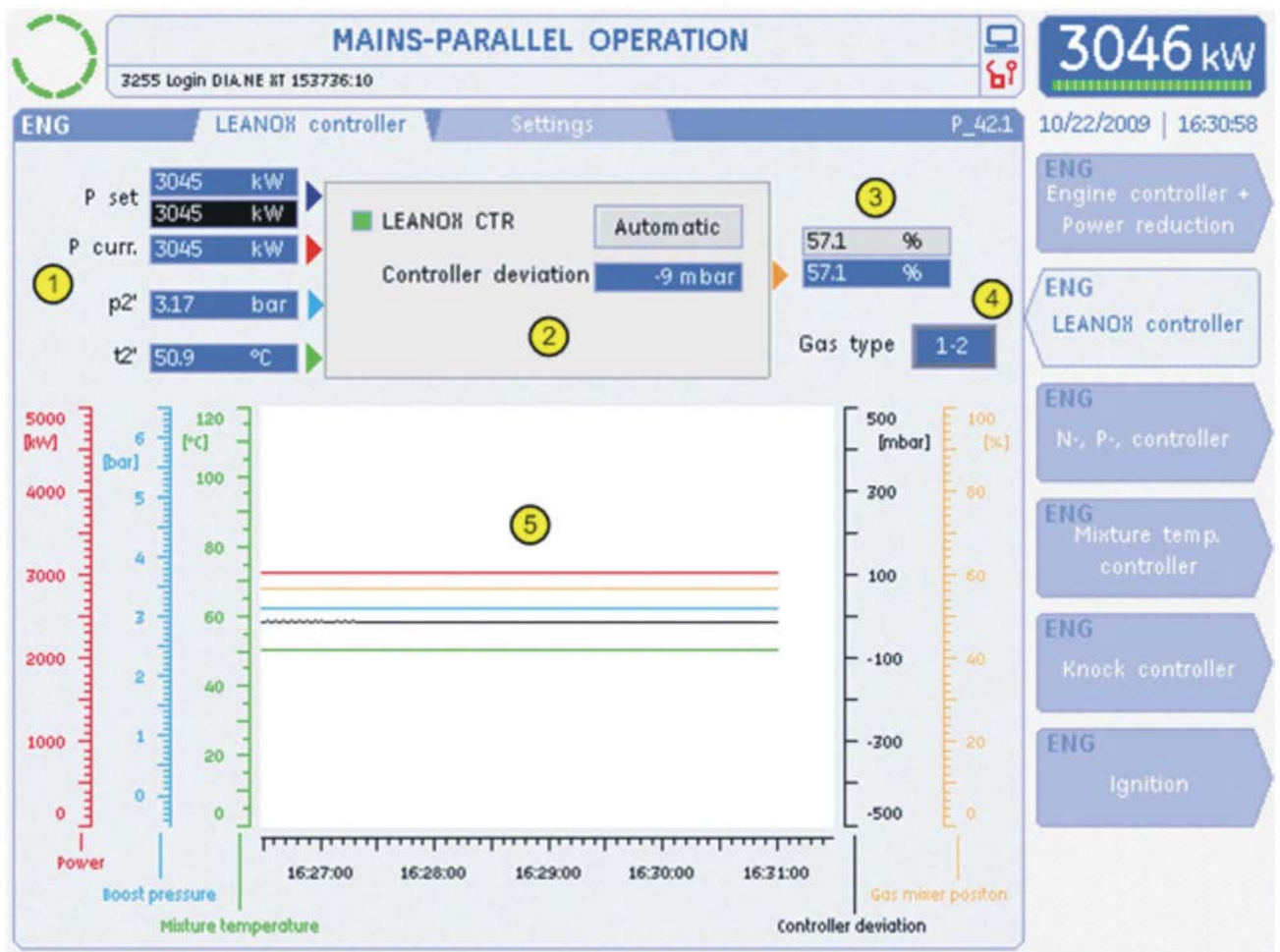
① **Controller input variables**

The following input variables are shown:

Abbreviation	Designation	Unit
P Set	Setpoint value	[kW]
P curr.	Actual power	[kW]
p2'	Boost pressure	[bar], [psi], [kPa]
t2'	Charge temperature	[°C], [°F], [K]

② **Leanox® controller**

If the controller is in operation, the pilot light changes from white ☐ to green ☐.

Click the **Automatic** button to toggle the operating mode of the LEANOX controller between "Automatic" and "Manual". To do so when the engine is at a standstill, you will need to have at least "Customer (10)" authorisation. The button is always enabled for higher authorisation levels.

The **Controller deviation** box shows the deviation in terms of boost pressure.

③ **Controller output**

The controller output is connected to the gas mixture actuator. Depending on the engine configuration, either a percentage value for the gas mixer or the excess air ratio (lambda) for the gas proportioning valve can be shown.

The enable for any change in the set point depends on the LEANOX controller mode. Adjustment is possible in manual mode.

④ **Gas type display**

The gas type currently being used is displayed. The individual gas types are set out in the engine controller overview screen (P_41.1).

⑤ **Online Trend**

The following controlled variables are displayed as a trend:

Abbreviation	Designation	Line colour	Unit
Power	Power	red	[kW]
Boost pressure	Current boost pressure	blue	[bar], [psi], [kPa]
Boost temperature	Charge temperature	green	[°C], [°F], [K]
Controller deviation	Controller deviation	black	[mbar], [mpsi], [Pa]
Gas mixer position	Gas mixer set point	orange	[% opening], [λ lambda]

7.5.5 LEANOX® Controller Settings (P_42.2)

The LEANOX® controller screen is brought up by pressing the **ENG** main screen selection button followed by **F2** and finally the **TAB** button. This screen shows the most important settings and measured variables for adjusting the LEANOX® controller including trending. Only trained customers are allowed to adjust the controller. Please ask for information about the comprehensive training available from GE Jenbacher.

Note: This screen is only displayed in Customer View.
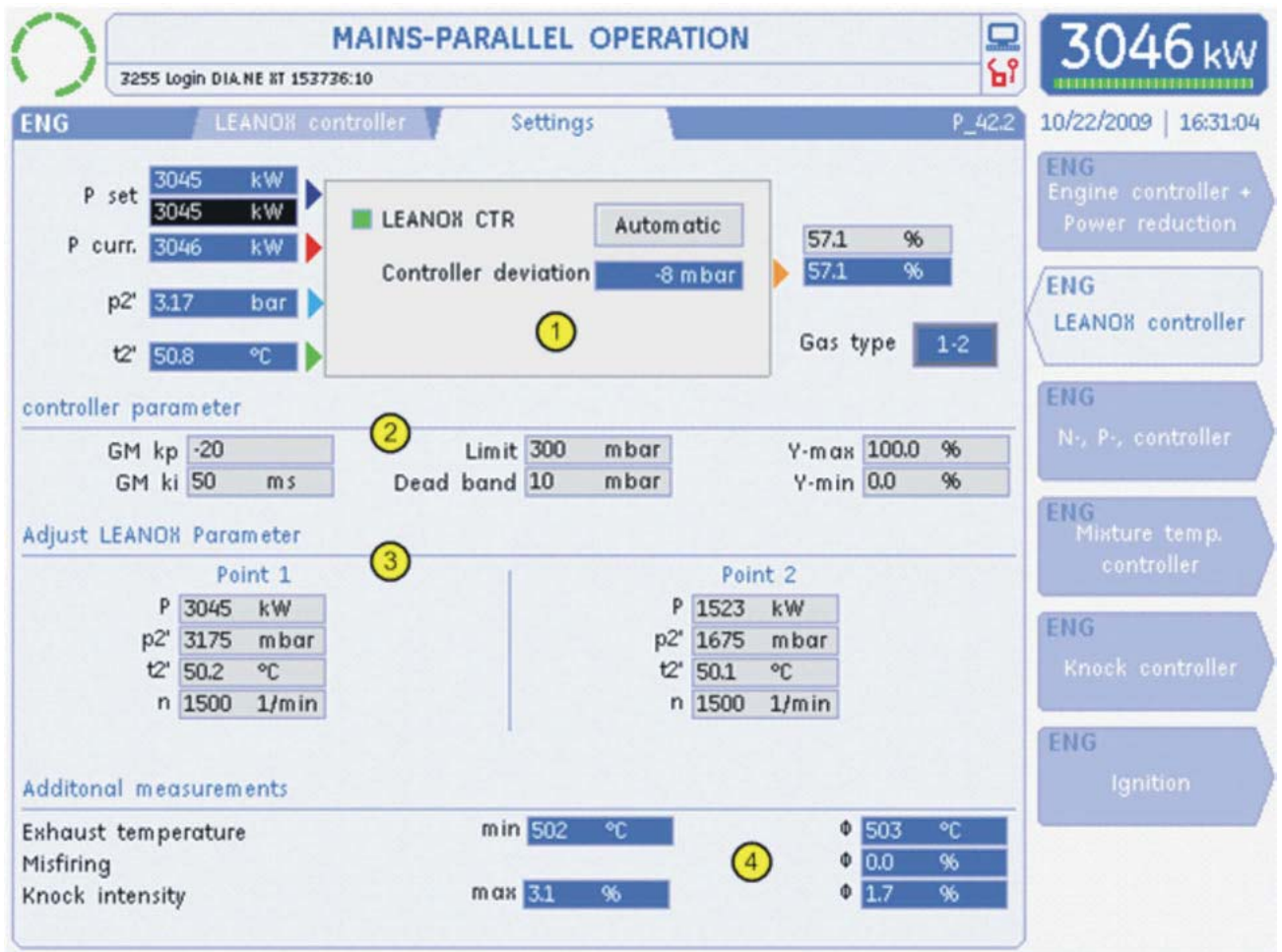
① **Controller representation**

The explanations of the individual symbols are identical to those in the LEANOX® controller (P_4.21). Only the bottom two-thirds of the screen is different.

② **Controller parameters**

The controller parameters can be edited above the "Advanced Customer" password level. The following settings are shown:

Abbreviation	Designation	Unit
GM kp	Proportional component of controller	[1]
GM ki	Integral component of controller	[ms]
Limit	Max. boost pressure deviation	[mbar], [mpsi], [Pa]
Dead zone	Controller dead zone	[mbar], [mpsi], [Pa]

Abbreviation	Designation	Unit
Y-max	Max. gas mixer set point	[% opening], [λ lambda]
Y-min	Max. gas mixer set point	[% opening], [λ lambda]

③ **LEANOX® Parameter setting**

The controller parameters can only be be edited by trained customers. The following settings are shown:

Abbreviation	Designation	Unit
P	Electrical power	[kW]
p2'	Boost pressure	[mbar], [mpsi], [Pa]
t2'	Charge temperature	[°C], [°F], [K]
n	speed	rpm

Two data points are displayed, which can be stored by advanced customers.

④ **Additional measured values**

A few additional measured values are shown here to assist in adjusting the controller.

Designation	Unit
Max and average Φ exhaust temperature	[°C], [°F], [K]
Misfire detection	[%]
Max and average Φ knock integrator	[%]

7.5.6 Speed, Power and Isolated Operation Controller (P_43.1)

The n, P, island controller screen is brought up by pressing the **ENG** main screen selection button followed by **F3**. This screen shows an overview of the main electrical control variables and a trend display for the speed and power output control.
Only trained customers are allowed to adjust the controller. Please ask for information about the comprehensive training available from GE Jenbacher.

Note: This screen is only displayed in Customer View.
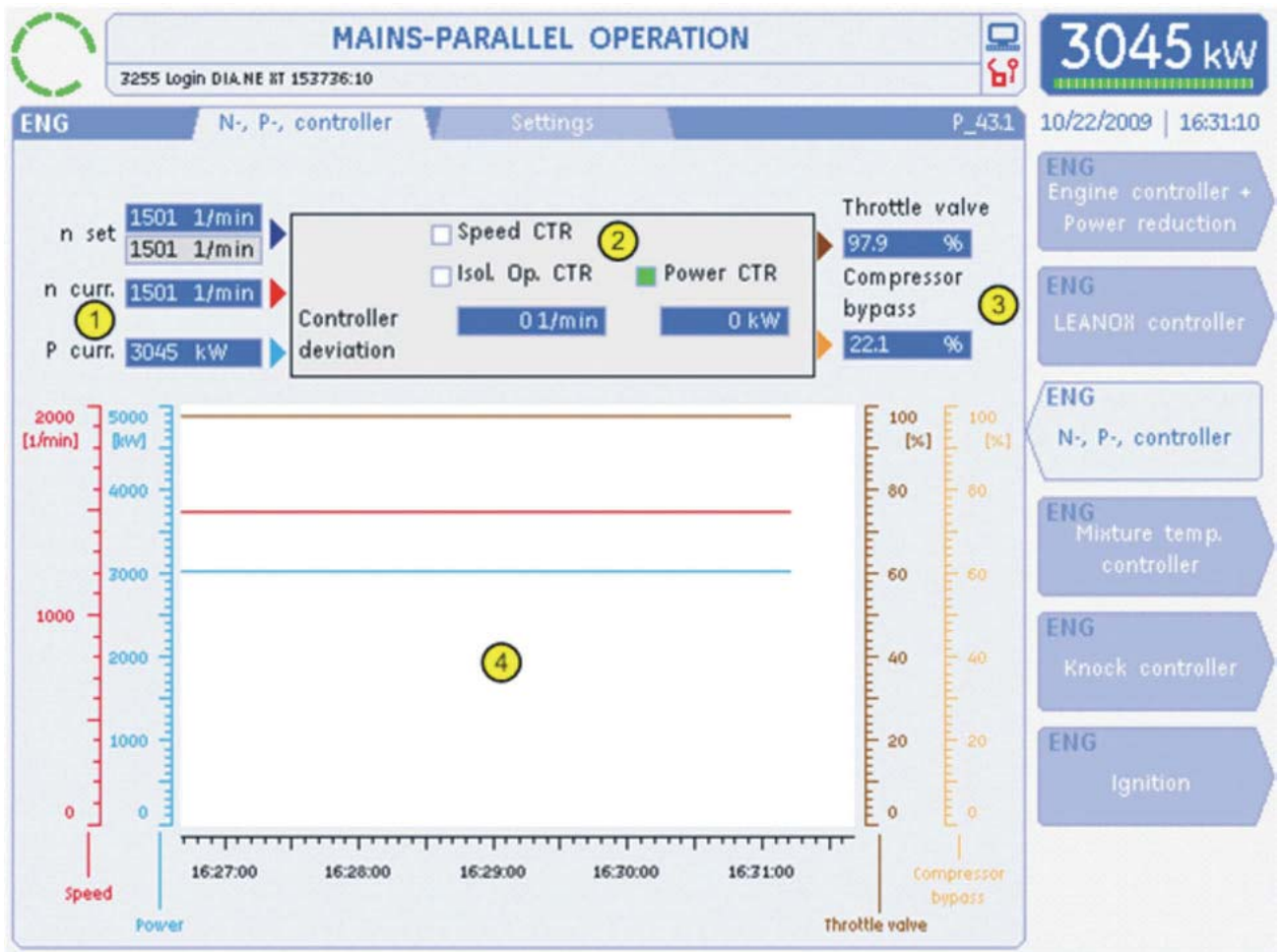
① **Controller input variables**

The following input variables are shown:

Abbreviation	Designation	Unit
n Set	Speed setpoint	[rpm]
n curr.	Actual speed	[rpm]
P curr.	Actual power	[kW]

② **Speed, power, island controllers**

A change of the associated pilot light from white ☐ to green ☐ indicates which of the three controllers is in operation.

In the event of a **controller deviation** the deviation for speed (rpm) and power 9kW) is shown.

③ **Controller output**

The controller output is connected to the throttle valve actuator and optionally to the turbocharger bypass valve.

④ **Online Trend**

The following controlled variables are displayed as a trend:

Abbreviation	Designation	Line colour	Unit
Speed	speed	red	[rpm]
Power	Power	blue	[kW]
Throttle valve	Throttle valve	brown	[% open]
Compressor bypass	Compressor bypass valve	orange	[% open]

7.5.7 Speed, Power and Isolated Operation Controller Settings (P_43.2)

The n, P, Isolated Operation Controller Settings screen appears when you press the main **ENG** screen selection key, then **F3** and finally the **TAB** key. The main controller variables and a trend analysis of speed and power control are summarised on this screen. Only customers who have received training are permitted to set the controllers. Please obtain information on GE Jenbacher's extensive range of training courses.

Note: This screen is only displayed in Customer View.

① **Controller display**

The explanation of the individual symbols is identical to the Speed, Power and Isolated Operation Controller (P_43.1) screen. Only the bottom two-thirds of the screen are different.

② **Speed controller parameters**

Only customers who have received training can edit the speed controller parameters. The following settings are displayed:

Abbreviation	Description	Unit
kp	Proportional component of controller	[1]
ki	Integral component of controller	[1]
kd	Differential component of controller	[1]
Y-max	Maximum actuating variable	[% opened]
Y-min	Minimum actuating variable	[% opened]

③ **Power controller parameters**

Only customers who have received training can edit the power controller parameters. The following settings are displayed for the throttle valve and, optionally, also for the compressor bypass valve.

Abbreviation	Description	Unit
kp	Proportional component of controller	[1]
ki	Integral component of controller	[1]
kd	Differential component of controller	[1]
Y-max	Maximum actuating variable	[% opened]
Y-min	Minimum actuating variable	[% opened]

④ **Isolated operation controller parameters**

Only customers who have received training can edit the isolated operation controller parameters. The following settings are displayed for the throttle valve and, optionally, also for the compressor bypass valve.

Abbreviation	Description	Unit
kp	Proportional component of controller	[1]
ki	Integral component of controller	[1]
kd	Differnetial component of controller	[1]

Abbreviation	Description	Unit
Y-max	Maximum actuating variable	[% opened]
Y-min	Minimum actuating variable	[% opened]

7.5.8 Charge temperature controller (P_44.2)

The charge temperature screen is brought up by pressing the ENG main screen selection button followed by F4 and finally the TAB button. This screen shows the main electrical control variables and a trending for the selected charge temperature controller.

Only trained customers are allowed to adjust the controller. Please ask for information about the comprehensive training available from GE Jenbacher.

Note: This screen is only an option and is only displayed in Customer View.
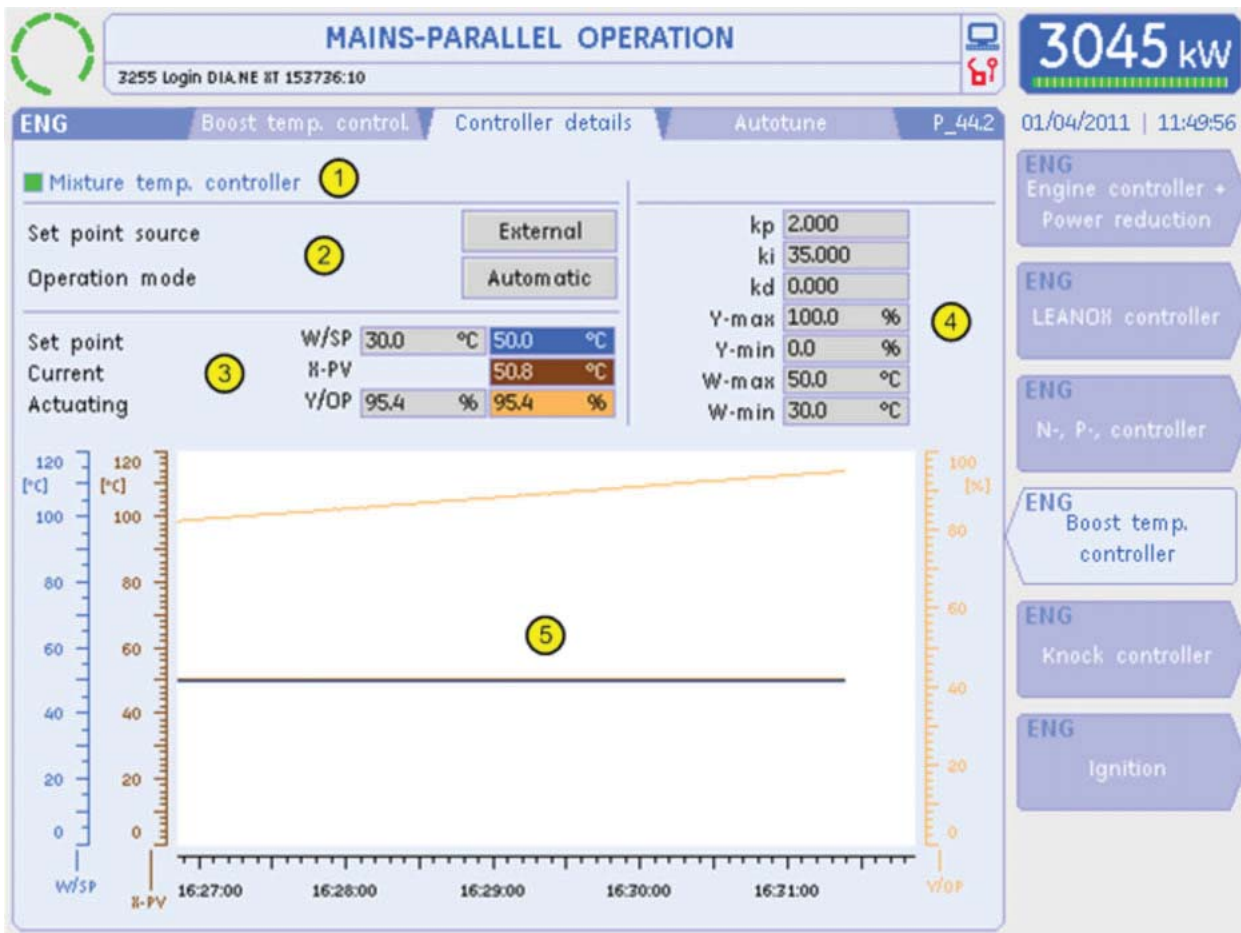
① **Controller information**

This is the name of the controller. If the controller is in operation, the pilot light changes from white ☐ to green ☐.

② **Controller mode**

The controller can be switched between using an internal and external set point with the **External** button, if this function is provided.

Click the **Automatic** button to switch the controller between "Automatic" and "Manual" modes. In manual mode, the actuating variable **[Y/OP]** can be changed by hand.

③ **Control variables**

The controller set point **W/SP**, the actual value **X-PV** and the actuating signal **Y/OP** can be read off or edited in this section, depending on access rights and operating mode.

④ **Controller parameters**

The controller parameters can only be be edited by trained customers. The following settings are shown:

Abbreviation	Designation	Unit
kp	Proportional component of controller	[1]
ki	Integral component of controller	[ms]
kd	Differential component of controller	[ms]
Y-max	Maximum actuating variable	[%]
Y-min	Minimum actuating variable	[%]
W-max	Maximum set point value	[°C], [°F], [K]
W-min	Minimum set point value	[°C], [°F], [K]

⑤ **Online Trend**

The following controlled variables are displayed as a trend:

Abbreviation	Designation	Line colour	Unit
W/SP	setpoint value	blue	[°C], [°F], [K]
x-PV	actual value	brown	[°C], [°F], [K]
Y/OP	Actuating variable	orange	[%]

7.5.9 Charge temperature controller autotune (P_44.3)

The charge temperature autotune screen is brought up by pressing the **ENG** main screen selection button followed by **F4** and finally the **TAB** button twice. This screen shows an overview of the information for initialising and using autotuning for the charge temperature controller.

Only trained customers are allowed to adjust the controller. Please ask for information about the comprehensive training available from GE Jenbacher.

Note: This screen is only an option and is only displayed in Customer View.

Note: Detailed information on the autotune controller can be found in TI 1000-0531.

The controller status is displayed in the plain text in the relevant language. The following texts can be displayed:

- Autotuning active
- Autotuning parameters calculated
- Invalid value for P component
- Invalid value for I component
- Invalid value for D component
- Y-MAX is less than or equal to Y-MIN
- Error in calculation of controller parameters
- Maximum tuning time has been exceeded
- Invalid value for change to control variable dy-MAX
- Controlled variable X has left the permissible range
- Difference between W and X is too small to start the tuning process

- Error in calculating the increase in the controlled variable
- Y-MAX or Y-MIN was changed during the tuning process

① **Control variables and parameters**

The explanations of the individual values are given in the charge temperature controller screen (P_44.2).

② **Tuning control**

Click the **[Start** button to start the tuning process.

Click the **Cancel** button to stop the tuning process or reject the calculated parameters.

Click **Accept** to accept the calculated parameters.

Enter a time limit for tuning in **Time-max**. If this value is exceeded, the tuning process is aborted and a note to that effect appears on the status display.

③ **Tuning Quality**

3 modes are available:

approx.:	1 vibration test over 3 periods
moderate :	2 vibration tests over 4 periods
fine :	3 vibration tests over 5 periods

④ **Autotuning parameters**

Calculated parameters:

The parameters which are used during or after the controller tuning process

are displayed here.

kp : Display of the calculated proportional component.

ki : Display of the calculated integral component.

kd : Display of the calculated differential component.

These parameters can be accepted for control purposes by pressing the **Accept** button.

Selecting the control mode:

The cross in the box $\boxed{X}$ next to the **ki** or **kd** parameters indicates whether control parameters should be sought during the autotuning process for the part of the controller selected in this way.

If this calculation for a component is not required, this can be deselected in the appropriate box.

7.5.10 Knock Controller (P_45.1)

The knock controller screen is brought up by pressing the **ENG** main screen selection button followed by **F5**. This screen shows the most important characteristics relating to knock control.
Note: This screen is only an option and is only displayed in Customer View.
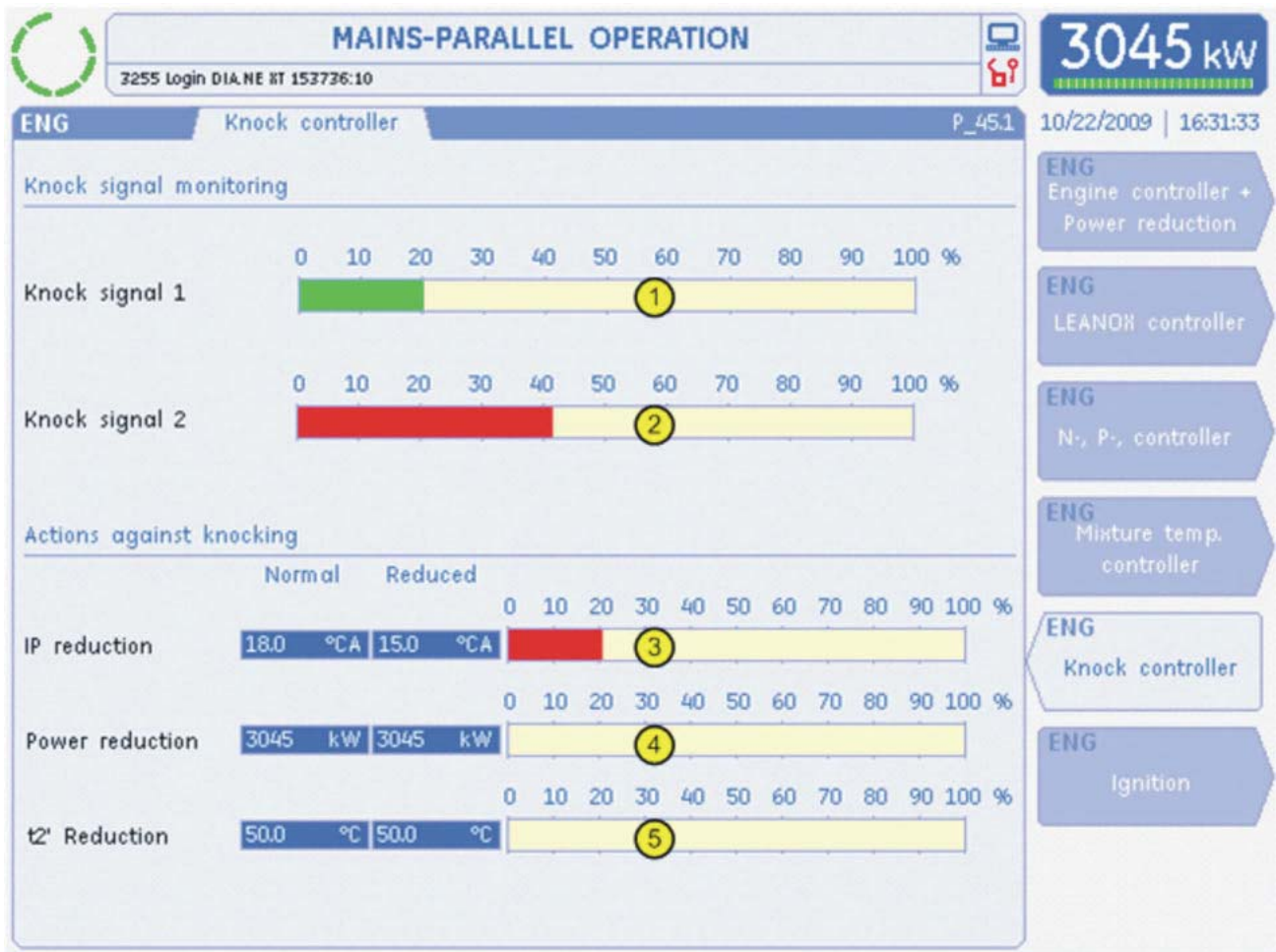
① **Bar display for knock sensor signal 1**

If the mA signal of a knock sensor **Knock signal 1**exceeds the preset control limit, the colour of the bar changes from green to red.

① **Bar display for knock sensor signal 2**

If the mA signal of a knock sensor **Knock signal 2**exceeds the preset control limit, the colour of the bar changes from green to red.

If SAFI or KLS98 has been installed on the engine as an option, the following optional screen content is brought up:
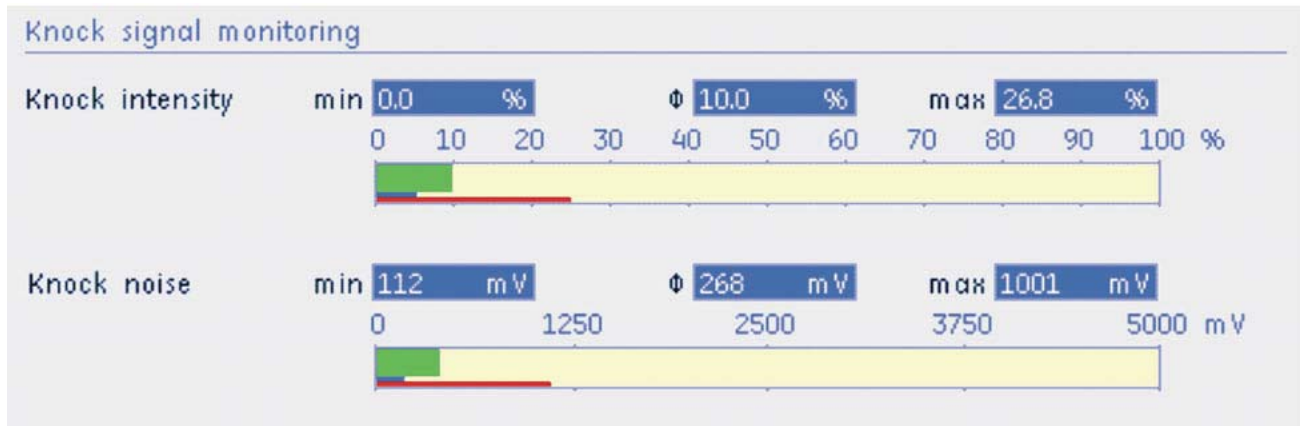
The minimum (**min**) and maximum (**max**) values for knocking intensity (**Knock intensity**) and knocking noise (**Knock noise**) for all cylinders are displayed.

In addition, the average value (**Φ**) for all the cylinders is displayed.

The permissible limit values for the individual variables are indicated by narrow red and blue bars under the broad bars for the measured values, where the red bar is the maximum permitted value and the blue bar is the minimum value.

If the measured value is within the permitted optimal zone the measured value bar is shown in green. If the value exceeds or drops below the permitted zone, the bar changes to red or blue as appropriate.

③ **Ignition point retardation**

Display showing the nominal ignition timing point **Nominal** and the ignition point as adjusted (retarded) to prevent knocking **Reduced**. The numerical display is given in crankshaft angle degrees.

100 percent of the corresponds to the maximum permissible adjustment.

④ **Power reduction**

Display showing the nominal power **Nominal** and the power as adjusted to prevent knocking **Reduced**. The numerical display is given in kilowatt.

100 percent of the corresponds to the maximum permissible adjustment.

⑤ **Charge temperature reduction**

Display showing the set charge temperature **Nominal** and the temperature as adjusted to prevent knocking **Reduced**. The temperatures are displayed in degrees Celsius, Fahrenheit or Kelvin.

100 percent of the corresponds to the maximum permissible adjustment.

7.5.11 Ignition (P_46.1)

The ignition screen is brought up by pressing the **ENG** main screen selection button followed by **F6**. This screen shows the most important characteristics relating to knock control.
Note: Only item ① is displayed in Customer View in this screen.
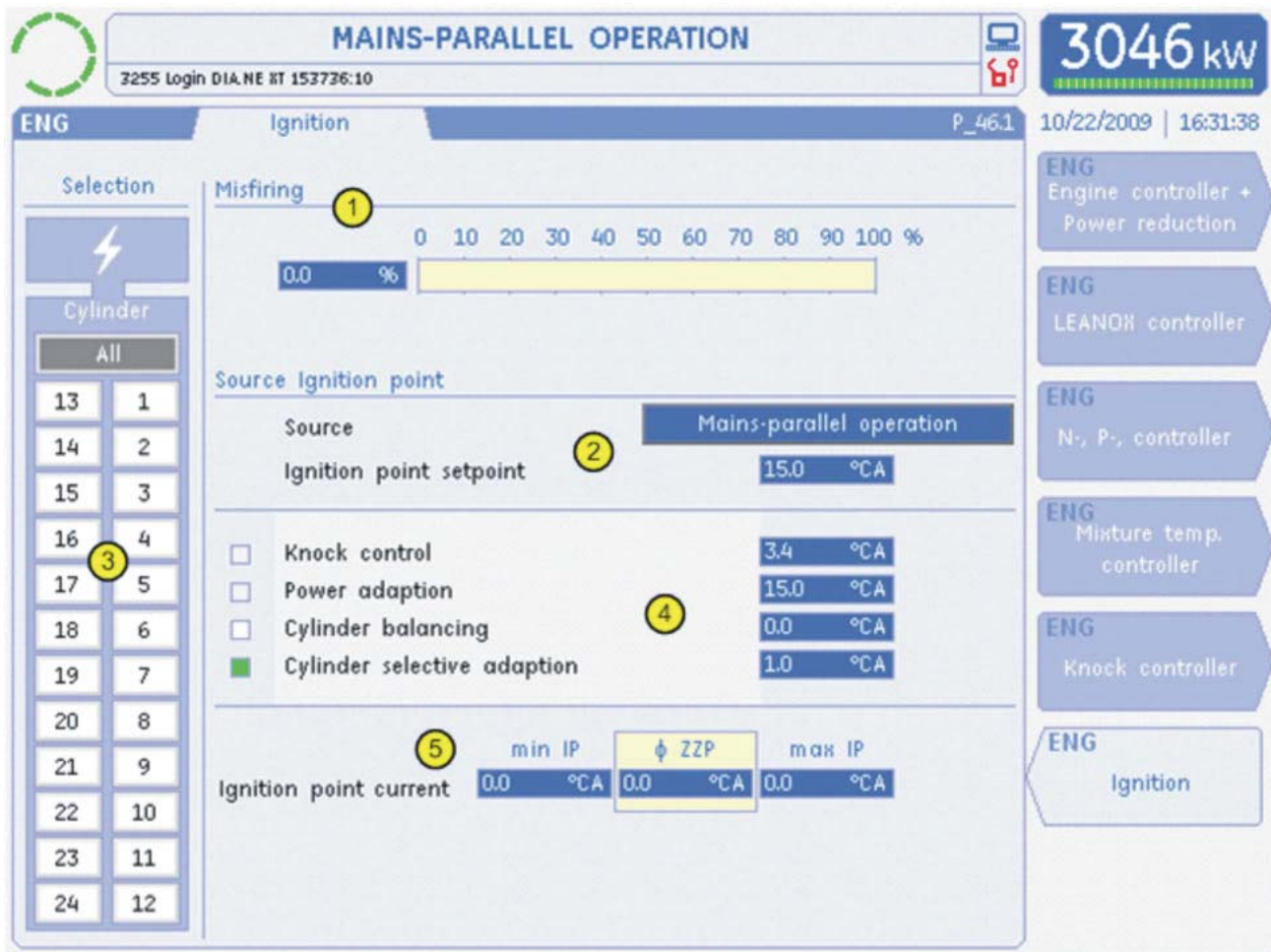
① **Misfiring detection**

The misfiring detection integrator is displayed here.

Power will be reduced if the engine misfires frequently. The misfire are counted by an integrator. This integrator will slowly be scaled down again during any period in which there is no misfiring.
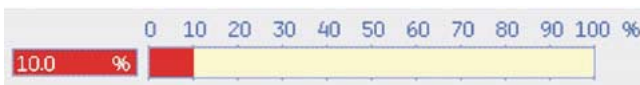
Power reduction is started when the integrator is at 50%. A power reduction to up to 50% is performed proportionally until the misfiring integrator reaches 100%.

② **Ignition point source**

Up to three sources for the ignition point are available.

- Starting the engine
- mains parallel operation
- island operation

The source actually user is displayed at **Source**.

The global set point, i.e. valid for all cylinders, is shown under **Ignition point setpoint**.

③ **Cylinder selection**

Either one specific cylinder or an overview of all cylinders (average) can be selected with this graphical selection tool. The selection is made using the cursor buttons.

④ **Ignition point adjustment**

The actual ignition point is composed from the following control interventions:

Knock control	knock control offset
Power adaptation	offset dependent the actual power
Cylinder balancing	offset for cylinder equalisation
Cylinder selective adaptation	offset for cylinder-selective operating point optimisation

A change of the associated pilot light from white ☐ to green ☐ indicates which of the controllers is in operation at any time.

Control interventions may need to be performed in parallel, indicated by more than one check box turning green (= active).

The displays are selected for the respective cylinders using the cylinder selection tool in Section ③. If all the cylinders are selected (**All**), the average for all the cylinders is displayed.

① **Current ignition point**

The current ignition point for one cylinder or the average is shown under the entry **Ignition point current**. Selection of the cylinders is described in Section ③.

In addition, the ignition points of the cylinders with the minimum (**min**) and maximum (**max**) values are shown.

7.5.12   2-stage pressure-charging (P_47.1)

The 2-stage pressure charging screen is brought up by pressing the ENG main screen selection button followed by F7. This screen shows the most important information about the 2-stage turbocharging.

Note: This screen is only displayed as an option.
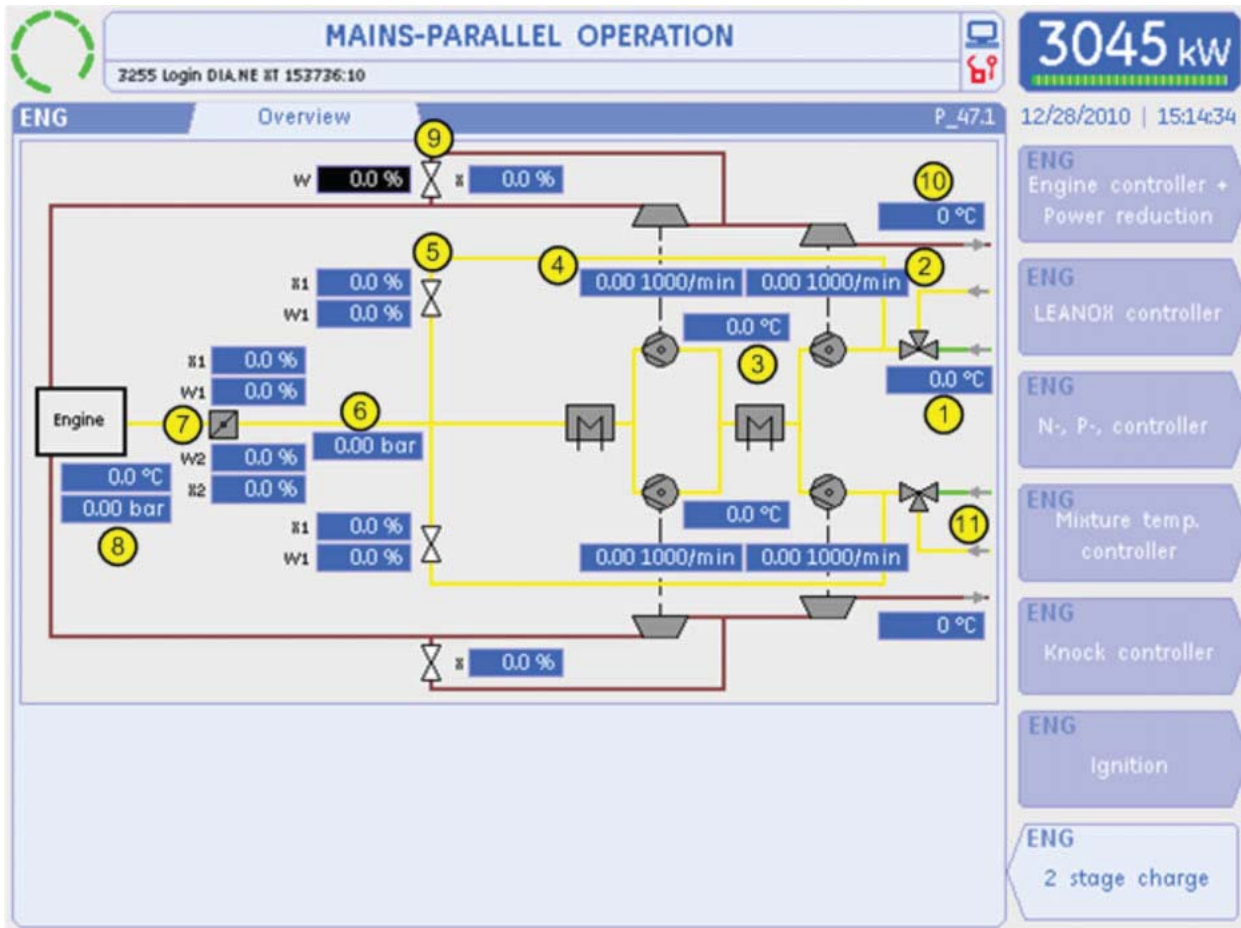
① Intake air temperature

This shows the temperature of the intake air.

② Turbocharger speed, bank A low pressure

This shows the speed of the low-pressure turbocharger for bank A.

③ Temperature upstream of exhaust gas turbocharger, high pressure

This shows the temperature upstream of the high pressure exhaust gas turbocharger.

② Turbocharger speed, bank A high pressure

This shows the speed of the high-pressure turbocharger for bank A.

⑤ Turbocharger valve position displays, bank A

X1	Valve 1 actual value
W1	Valve 1 set point
X2	Valve 2 actual value (optional)
X2	Valve 2 set point (optional)

⑥ Charge temperature and pressure upstream of throttle valve

This shows the charge temperature and pressure downstream of the throttle valve.

⑦ Throttle valve position displays

X1	Valve 1 actual value
W1	Valve 1 set point
X2	Valve 2 actual value (optional)
X2	Valve 2 set point (optional)

⑧ Charge temperature t2' and boost pressure p2' after the throttle valve

This shows the charge temperature t2' and boost pressure p2' downstream of the throttle valve.

⑨ Waste gate

The set point W and actual value X for the waste gate position can be shown here as an option.

⑩ Turbocharger outlet temperature, low pressure

The temperature downstream of the low-pressure turbocharger is shown here.

⑪ Measurement displays and inputs for bank B.

The measurement displays and inputs shown for cylinder bank A are available for bank b in the same way.

7.6 Cylinder information (CYL)

The **CYL** screen group contains information on the current status of the cylinders. Optionally, depending on the engine configuration, this allows you to view the ignition voltage, ignition point, knock detection and exhaust gas temperature.

Note: Only the Cylinder measured values (P_51.1) screen and, optionally depending on the engine configuration, the Ignition Voltage (P_52.1) screen, is displayed in Customer View.

7.6.1 Cylinder Measured Values (P_51.1)

The Cylinder Measured Values screen appears when you press the **CYL** screen selection key. It shows an overview of the status of the cylinder measured values.

Note: This screen is considerably reduced in Customer View and is therefore displayed extremely clearly (see below).
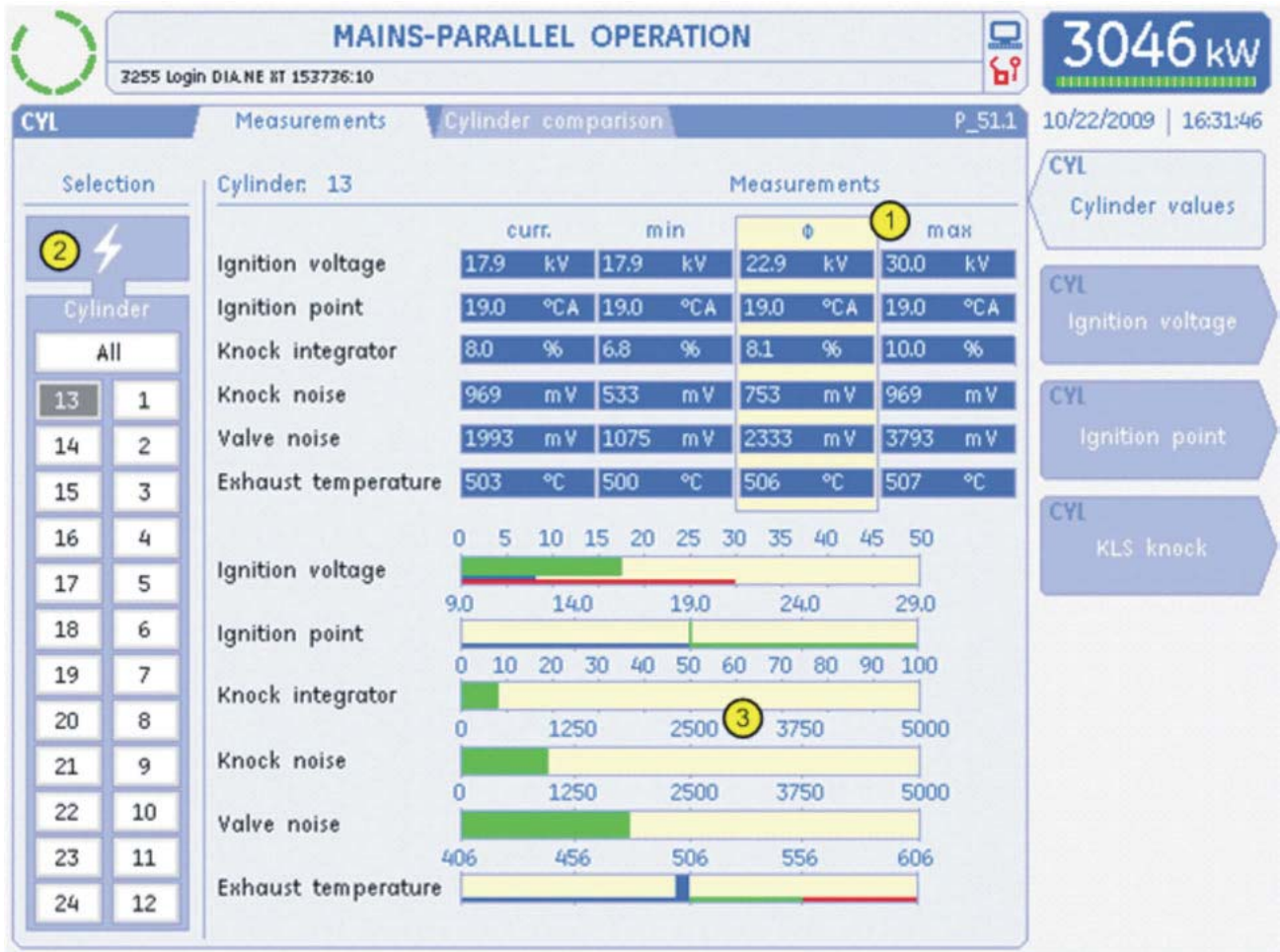
① **Numerical data display**

Optionally, the value of a cylinder selected as described in ② (**curr.**), the minimum value (**min**), the average (**Φ**) across all the cylinders and the maximum value (**max**) of all the cylinders are displayed for the following measured values

Reference text	Description	Unit
Ignition voltage	Ignition voltage	[kV]
Ignition point	Ignition point	[°Crankshaft angle]
Knock integrator	Knock integrator	[%]
Knock noise	Knock noise	[mV]
Valve noise	Valve noise	[mV]
Exhaust temperature	Exhaust gas temperature	[°C], [°F], [K]

② **Cylinder selection**

You can use this graphical selection aid to select either a specific cylinder or an overview of all the cylinders (average value). Use the cursor keys to make the selection.

If **All** is selected, only the maximum, minimum and average values will now be displayed.

③ **Graphical data display**

Optionally, in addition to the numerical display, the current measured values are displayed in a bar graph for the cylinders selected at ②.

The permissible limit values for individual variables are shown in narrow red and blue bars below the broad measured value bar. The red bar is the maximum permissible value and the blue bar is the minimum value.

When the measured value moves within the permissible, optimum range, the measured value bar is shown in green. If the values exceed or fall below this level, the bar changes to red or blue respectively.

Display in Customer View

CYL	Messwerte					P_51.1
Ampel	Zylinderüberwachung		Measurements			
			min	Φ	max	
🔴 ⚪ ⚪	Zündspannung		7.0 kV	22.9 kV	30.0 kV	
⚪ ⚪ 🟢	Zündzeitpunkt		19.0 °CA	19.0 °CA	19.0 °CA	
⚪ 🟡 ⚪	Klopfintegrator		6.8 %	8.1 %	10.0 %	
⚪ ⚪ 🟢	Klopfgeräusch		533 mV	753 mV	969 mV	
⚪ ⚪ 🟢	Ventilgeräusch		1075 mV	2333 mV	3793 mV	
⚪ ⚪ 🟢	Abgastemperatur		500 °C	506 °C	507 °C	

In Customer View, the information is reduced to the essential. The values for the individual cylinders are no longer displayed but the minimum, average and maximum values are shown.

"Traffic lights" are shown as a new display element. They provide an overview of the status of all the cylinders in the engine.

The following status displays may be generated:

Green → everything OK. Each cylinder is operating with the tolerance range

set for this measured value.

Yellow → warning. At least one cylinder is not operating with the tolerance range set for this measured value.

Red → shutdown. At least one cylinder is not operating with the tolerance range set for this measured value. This may result in an engine shutdown immediately or in the near future.

7.6.2 Cylinder Comparison (P_51.2)

The Cylinder Comparison screen appears when you press the main **CYL** screen selection key, followed by **TAB**. Depending on the engine configuration, up to 5 different measured values for each cylinder can be displayed in parallel.

Note: This screen is not displayed in Customer View.

① **Cylinder selection**

If there are 5 columns, one measured value available on the engine can be displayed for each cylinder. The setting is saved when you change screens.

The following measured values can be selected:

Reference text	Description	Unit
Exh. Temp.	Exhaust gas temperature	[°C], [°F], [K]
Ignition p.	Ignition point	[°Crankshaft angle]
High volt.	Ignition voltage	[kV]
Knock int.	Knock integrator	[%]
Knock signal	Knock noise	[mV]
Valve signal	Valve noise	[mV]

7.6.3 Ignition Voltage Measurement (P_52.1)

The Ignition Voltage Measurement screen appears when you press the main **CYL** screen selection key, followed by **F2**. It shows an overview of the measured values for ignition voltages.

Note: This screen is only displayed when the ignition voltage measurement option has been installed on the engine.

	MAINS-PARALLEL OPERATION		3046 kW
	3255 Login DIA.NE XT 153736:10		

CYL — Ignition voltage — P_52.1 — 11/20/2009 | 09:00:17

curr.		All cylinders		
1	18.7 kV	min	7.4	kV
2	18.8 kV	Φ	19.9	kV
3	18.9 kV	max	21.0	kV
4	21.0 kV			
5	19.1 kV			
6	19.2 kV			
7	19.3 kV			
8	19.4 kV			
9	7.4 kV			
10	19.6 kV			
11	19.7 kV			
12	19.8 kV			
13	19.9 kV			
14	20.0 kV			
15	20.1 kV			
16	20.2 kV			
17	20.3 kV			
18	20.4 kV			
19	20.5 kV			
20	18.8 kV			
21	20.7 kV			
22	20.8 kV			
23	18.7 kV			
24	21.0 kV			

Side panel: CYL Cylinder values · CYL Ignition voltage · CYL Ignition point · CYL KLS knock

① **Graphical display of the ignition voltage**

The ignition voltages of the individual cylinders are displayed in a bar graph.

The measured value bar is shown in green as long as it is within the tolerance range.

The tolerance range is visualised by means of two narrow bars in red and blue below the actual, broad measured value bar.

The blue narrow bar represents the minimum permissible ignition voltage. If one of the ignition voltages falls below this limit value, the colour of the bar will change from green to blue.

The red narrow bar represents the maximum permissible ignition voltage. If one of the ignition voltages exceeds this limit value, the colour of the bar will change from green to red.

② **Numerical display of the ignition voltage**

The ignition voltages of the individual cylinders are displayed numerically in Kilovolts.

③ **Minimum, maximum and average ignition voltage**

The maximum value (**max**) and the minimum value (**min**) of all the cylinders and the average (**Φ**) across all the cylinders are displayed here.

7.6.4 Ignition Point Display (P_53.1)

The ignition point screen is brought up by pressing the **CYL** main screen selection button followed by **F3**. It shows an overview of the current ignition point settings for the individual cylinders.

Note: This screen is only displayed in Expert View if an ignition system with selective ignition point adjustment is installed on the engine.
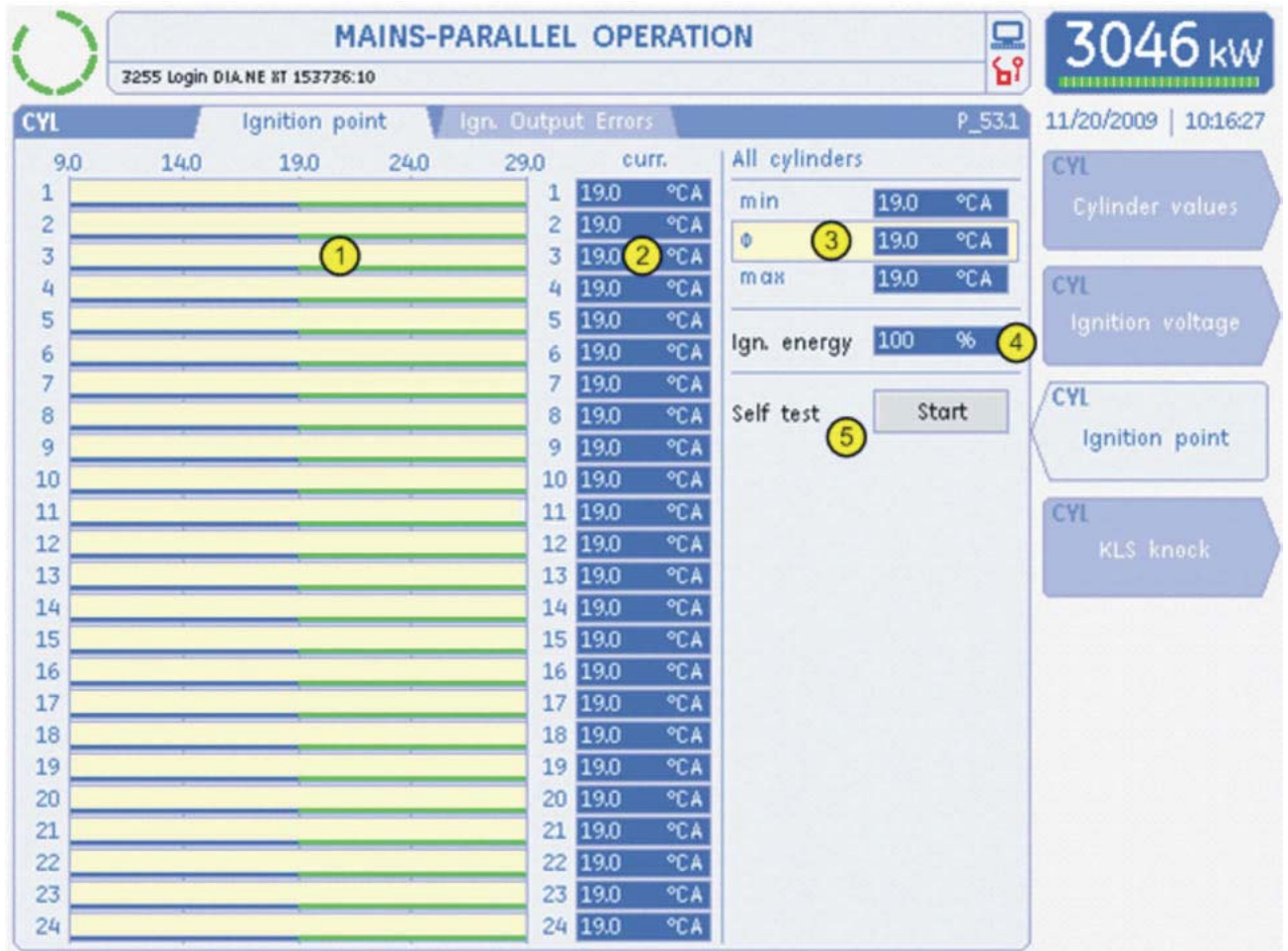
① **Graphical display of ignition points**

The ignition point settings for the individual cylinders are displayed as a bar chart.

The bars are shown in green if the measured value is within the tolerance range.

The tolerance range is shown as two narrow bars in red and blue under the broad bar for the measured value.

A narrow blue bar represents the minimum permissible ignition point, while the red bar represents the maximum permissible ignition point. Values above and below the tolerance cannot occur with this display.

The ignition points are displayed in crankshaft angle degrees before top dead centre.

The individual ignition points only vary if the individual knock control system has been activated by KLS/SAFI.

① **Numerical display of ignition points**

The ignition points are also displayed numerically in crankshaft angle degrees before top dead centre.

③ **Minimum, maximum and average ignition voltage**

The maximum (**max**) and minimum (**min**) values for all cylinders, and the average (**Φ**) for all cylinders, are shown here.

④ **Ignition energy**

The ignition energy shown is the energy supplied to the ignition coils. 100% equals the maximum ignition energy of the ignition system. This value is pre-set in the parameter management system.

This value is not displayed in the SAFI system.

⑤ **Ignition self-test**

This button is only enabled when the operation mode selector switch is in "OFF" position and the user has "Customer (10)" authorisation or higher.

Using the self-test function, you can test the ignition voltage supply of the ignition coils while the engine is at standstill. The self test is automatically de-activated after 10 minutes.

In order to avoid any misfires due to the self-test, a scavenging start is carried out. The test sequence is started by pressing the Start button.

Step 1: Warning that the engine will turn

Before any action is initiated on the set, a safety question is asked to make the user aware that the engine will turn when the OK button is pressed as confirmation.

This warning is intended to prevent any physical injury or damage to the engine.
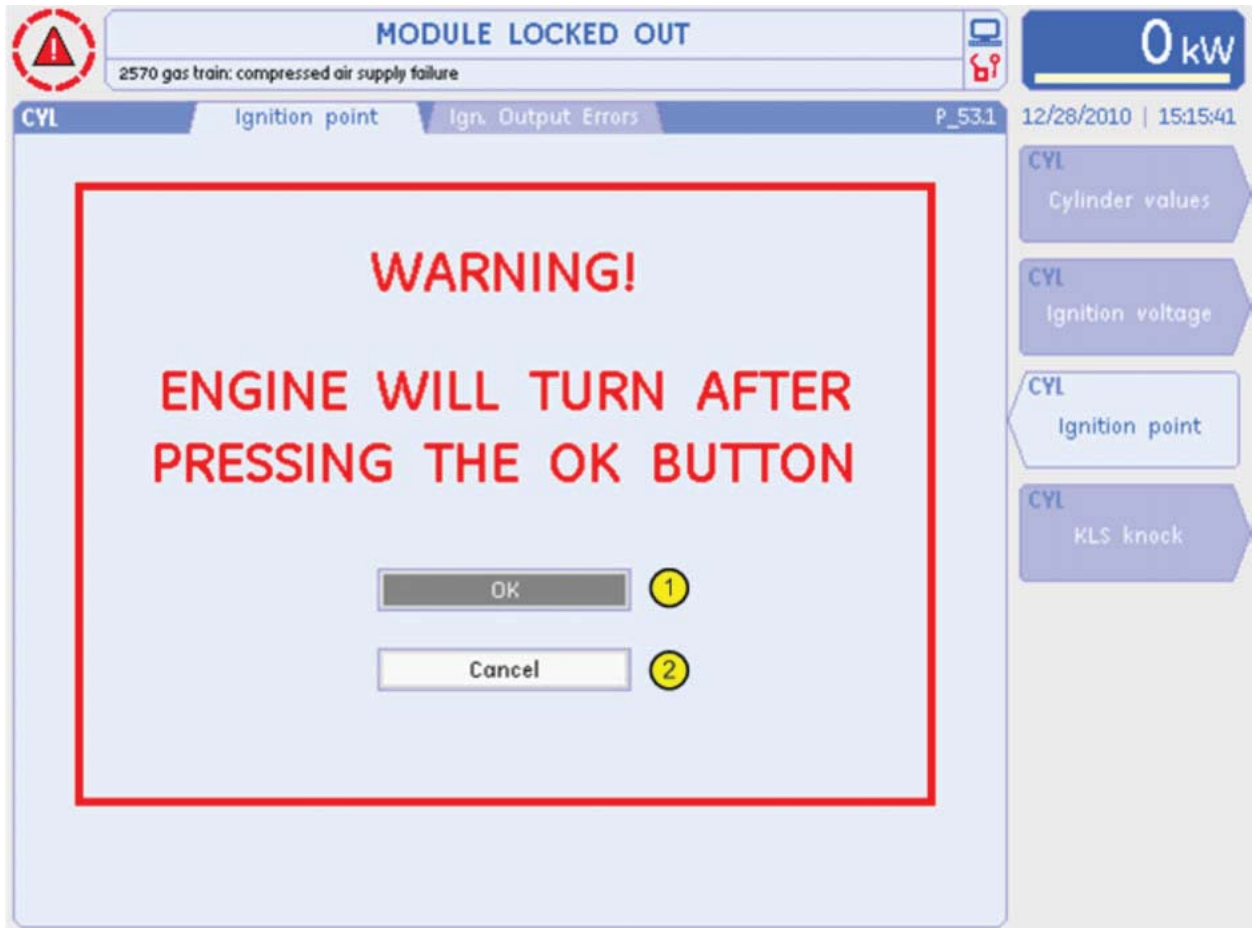
① **Activation button**

After confirmation of activation with the OK button, the self-test sequence is started.

② **Cancel button**

The entire preparatory sequence can be discontinued at any time with the Cancel button.

Step 2: Prelubrication

Depending on the engine type it may require prelubrication before being turned by the starter motor.

Step 3: Starting

The next step is to turn the engine for a short period to scavenge the intake and exhaust systems.

Step 4: Waiting time

Before the procedure is completed, a brief waiting time elapses so that the engine can coast down.

Step 5: Message that the self-test is active.

Once scavenging is completed the ignition system can be activated.

Step 6: Self-test active

The self-test is active for 10 minutes. It can be stopped prematurely at any time with the STOP button.

7.6.5   Ignition Output Error (P_53.2)

The Ignition Output Error screen appears when you press the main **CYL** screen selection key, then **F3**, followed by the **TAB** key. It shows an overview of the current ignition point settings for the individual cylinders, plus the ignition deviation errors and ignition duration errors.

Note: This screen is only displayed in Expert View when a SAFI ignition system has been installed on the engine.

MAINS-PARALLEL OPERATION

3255 Login DIA.NE XT 153736:10

3046 kW

| CYL | Ignition point | Ign. Output Errors | P_53.2 | 11/20/2009 | 10:16:27 |

CYL	curr.	Deviation	Duration
1	1 19.0 °CA	1 0	1 0
2	2 19.0 °CA	2 0	2 0
3	3 19.0 °CA	3 0	3 0
4	4 19.0 °CA	4 0	4 0
5	5 19.0 °CA	5 0	5 0
6	6 19.0 °CA	6 0	6 0
7	7 19.0 °CA	7 0	7 0
8	8 19.0 °CA	8 0	8 0
9	9 19.0 °CA	9 0	9 0
10	10 19.0 °CA	10 0	10 0
11	11 19.0 °CA	11 0	11 0
12	12 19.0 °CA	12 0	12 0
13	13 19.0 °CA	13 0	13 0
14	14 19.0 °CA	14 0	14 0
15	15 19.0 °CA	15 0	15 0
16	16 19.0 °CA	16 0	16 0
17	17 19.0 °CA	17 0	17 0
18	18 19.0 °CA	18 0	18 0
19	19 19.0 °CA	19 0	19 0
20	20 19.0 °CA	20 0	20 0
21	21 19.0 °CA	21 0	21 0
22	22 19.0 °CA	22 0	22 0
23	23 19.0 °CA	23 0	23 0
24	24 19.0 °CA	24 0	24 0

Bar graph scale: 9.0 14.0 19.0 24.0 29.0

Right-side buttons:
CYL Cylinder values
CYL Ignition voltage
CYL Ignition point
CYL KLS knock

① **Display of ignition points**

The ignition point settings of the individual cylinders are displayed in a bar graph and as a numerical value.

② **Ignition delay errors**

Display showing for each cylinder how often no ignition spark has been produced within the last ten engine cycles.

③ **Combustion time errors**

Display showing for each cylinder how often the permissible combustion-time tolerance has been exceeded and/or underrun within the last ten engine cycles.

7.6.6 Knock Integrator (P_54.1)

The knock Integrator screen is brought up by pressing the **CYL** main screen selection button followed by **F4**. It shows an overview of the current knock control integrator values for the individual cylinders.

Note: This screen is only displayed in Expert View if a cylinder-selective knock monitoring system (SAFI/KLS98) is installed on the engine.
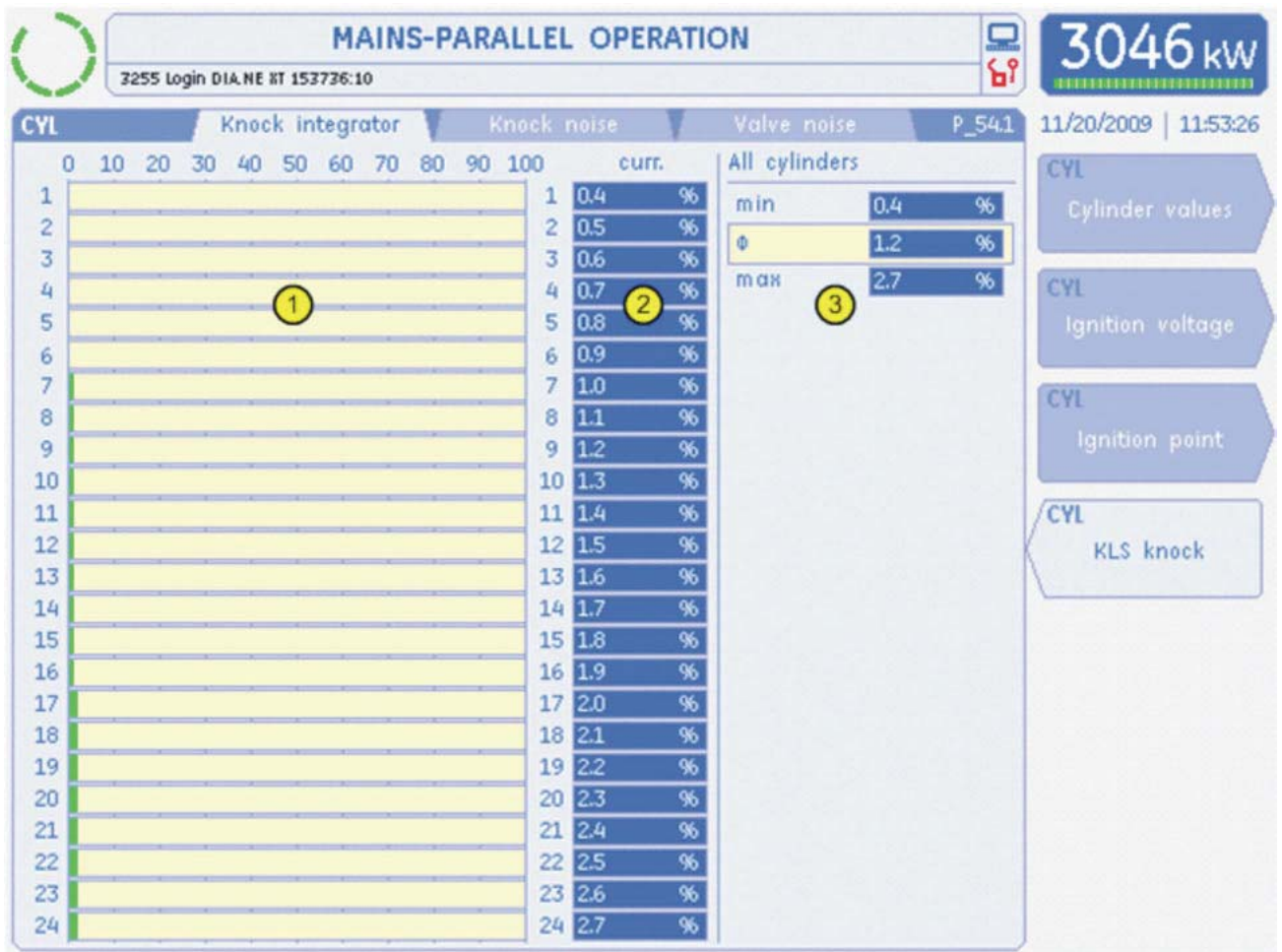
① **Graphical display of knock integrators**

The knock integrators are displayed as a percentage. Up to three knock prevention measures are set, depending on the individual percentage values. When a first threshold value is reached (e.g. 10%), the knock control system will retard the ignition point. When a second threshold value is reached (e.g .greater than 50%), the power will be reduced. If, despite the ignition point adjustment and the reduction in the engine power, a 100 percent knocking intensity value is reached, the engine will be shut down. In addition, the charge temperature will be lowered if the plant control system allows this.

① **Numerical display of knock integrators**

The knock integrators are also displayed numerically as a percentage.

③ **Minimum, maximum and average integrator values**

The maximum (**max**) and minimum (**min**) values for all cylinders, and the average (**Φ**) for all cylinders, are shown here.

7.6.7 Knock Noise (P_54.2)

The Knock Noise screen appears when you press the main **CYL** screen selection key, then **F4**, followed by the **TAB** key. It shows an overview of the current knock noise for the individual cylinders.

Note: This screen is only displayed in Expert View when a cylinder-selective knock monitoring system (SAFI/KLS98) has been installed on the engine.
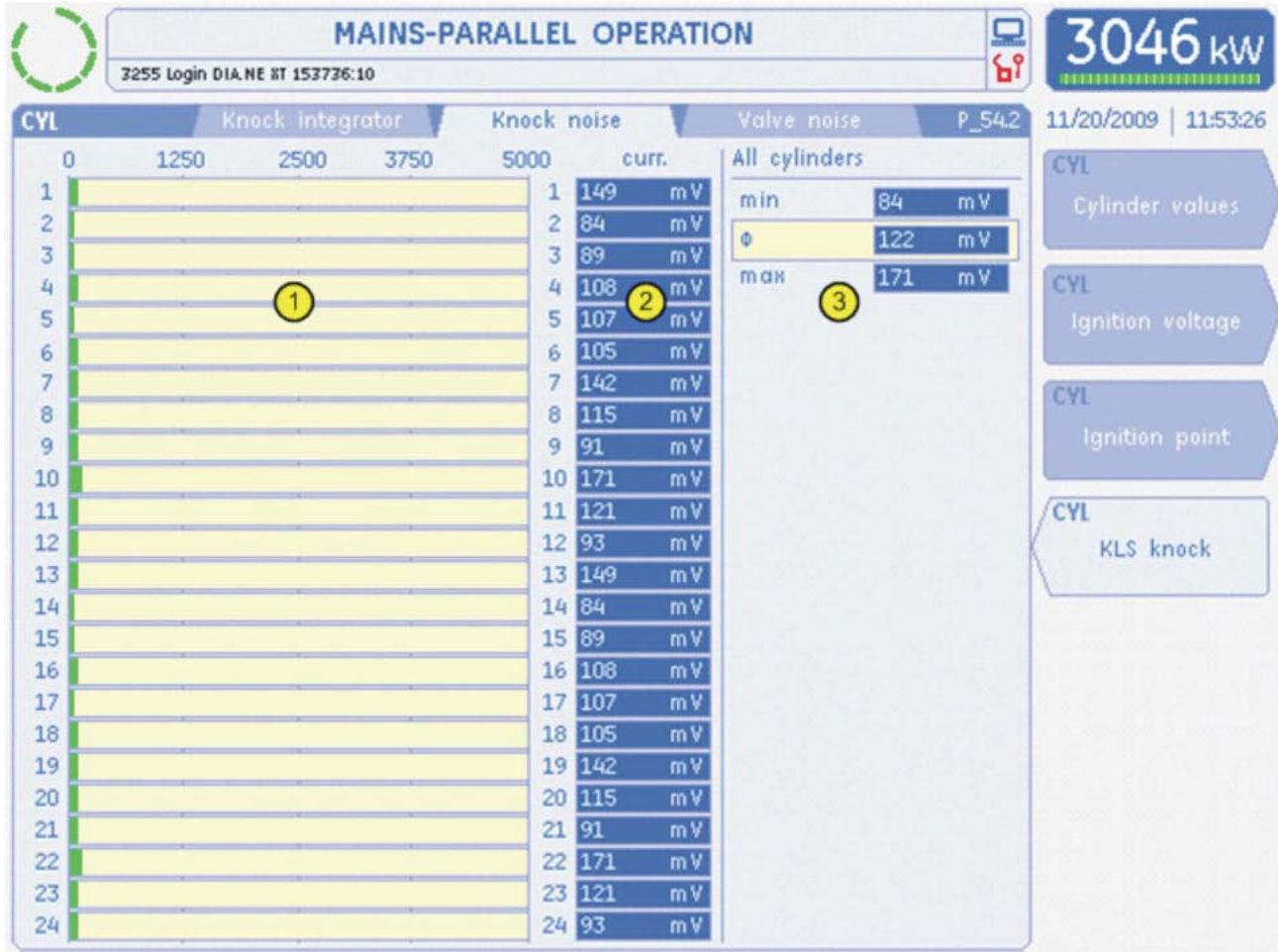
① **Graphical display of knock noise**

The knock noise is displayed as a percentage. The knock noise is used as a basis for increasing or reducing the knock integrator values.

② **Numerical display of the knock noise**

The knock noise is also displayed numerically in millivolts.

③ **Minimum, maximum and average knock noise**

The maximum value (**max**) and the minimum value (**min**) of all the cylinders and the average (**Φ**) across all the cylinders are displayed here.

7.6.8 Valve Noise (P_54.3)

The Valve Noise screen appears when you press the main **CYL** screen selection key, then **F4**, followed by **TAB** twice. It shows an overview of the current valve noise for the individual cylinders.

Note: This screen is only displayed in Expert View when a cylinder-selective knock monitoring system (SAFI/KLS98) has been installed on the engine.

① **Graphical display of valve noise**

The valve noise is displayed as mV. If a limit value (2000 mV) is exceeded, a trip warning (maximum valve noise) will be generated in the alarm management system. Possible causes could include excessive valve play, valve spring breakage, bearing damage, etc.

② **Numerical display of the knock noise**

The valve noise is also displayed numerically in millivolts.

③ **Minimum, maximum and average valve noise**

The maximum value (**max**) and the minimum value (**min**) of all the cylinders and the average (**Φ**) across all the cylinders are displayed here.

7.7 Exhaust system information (EXH)

The **EXH** screen group contains information on the current measured values for the exhaust system. Optionally, depending on the engine configuration, this allows you to view the exhaust gas collector temperatures, the exhaust gas temperatures per cylinder, turbo speeds and exhaust gas treatment systems (thermal reactor, CODINOX).

Note: Only the Exhaust System Overview (P_61.1) screen is displayed in Customer View.

7.7.1 Exhaust System Overview (P_61.1)

The Exhaust System Overview screen appears when you press the main **EXH** screen selection key. It shows an overview of the status of the exhaust system.

Note: This screen is considerably reduced in Customer View and is therefore displayed extremely clearly (see below).

The measuring points listed below may be displayed, depending on the engine configuration.

① **Cylinder selection**

You can use this graphical selection aid to select a specific cylinder. Use the cursor keys to make the selection.

② **Exhaust gas temperature at cylinder outlet**

The current value (**curr.**), the maximum value (**max**) and the minimum value (**min**) of all the cylinders and the average (**Φ**) across all the cylinders are displayed here.

③ **Display showing the catalytic converter temperatures**

The temperatures before, in and after the catalytic converter are displayed.

④ **Display showing turbo temperatures**

The temperatures before and after the turbocharger are visualised here.

⑤ **Pipe plate temperature**

The current pipe plate temperature is displayed here.

In addition, if you are authorised at user level "Customer" (10) or above, you can enter the limit values for **Warning** and **Trip**.

⑥ **Display showing temperatures at heat exchanger outlet**

Depending on the plant, the heat exchanger outlet temperatures can be displayed here.

⑦ **Status display for scavenging**

The status of the scavenging air valve and the scavenging air fan are shown here.

Display in Customer View
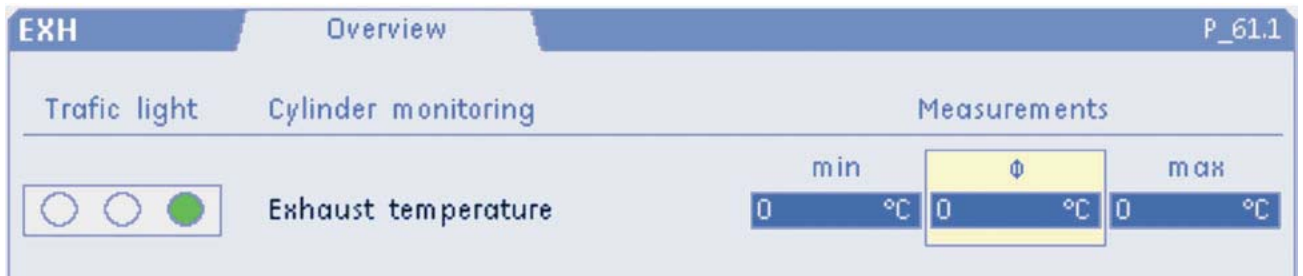
In Customer View, the information is reduced to the essential. The values for the individual cylinders are no longer displayed but the minimum, average and maximum values very probably will be.

"Traffic lights" are shown as a new display element. They provide an overview of the status of all the cylinders in the engine.

The following status displays may be generated:

Green → everything OK. Each cylinder is operating with the tolerance range

set for this measured value.

Yellow → warning. At least one cylinder is not operating with the tolerance range

set for this measured value.

Red → shutdown. At least one cylinder is not operating with the tolerance range

set for this measured value. This may result in an engine shutdown immediately or in the near future.

7.7.2 Exhaust Gas Temperature at Cylinder Outlet (P_54.1)

The Cylinder Temperature screen appears when you press the main **EXH** screen selection key, followed by **F2**. It shows an overview of the current exhaust gas temperature for the individual cylinders.

Note: This screen is only displayed in Expert View when a cylinder-selective exhaust gas measurement system has been installed on the engine.
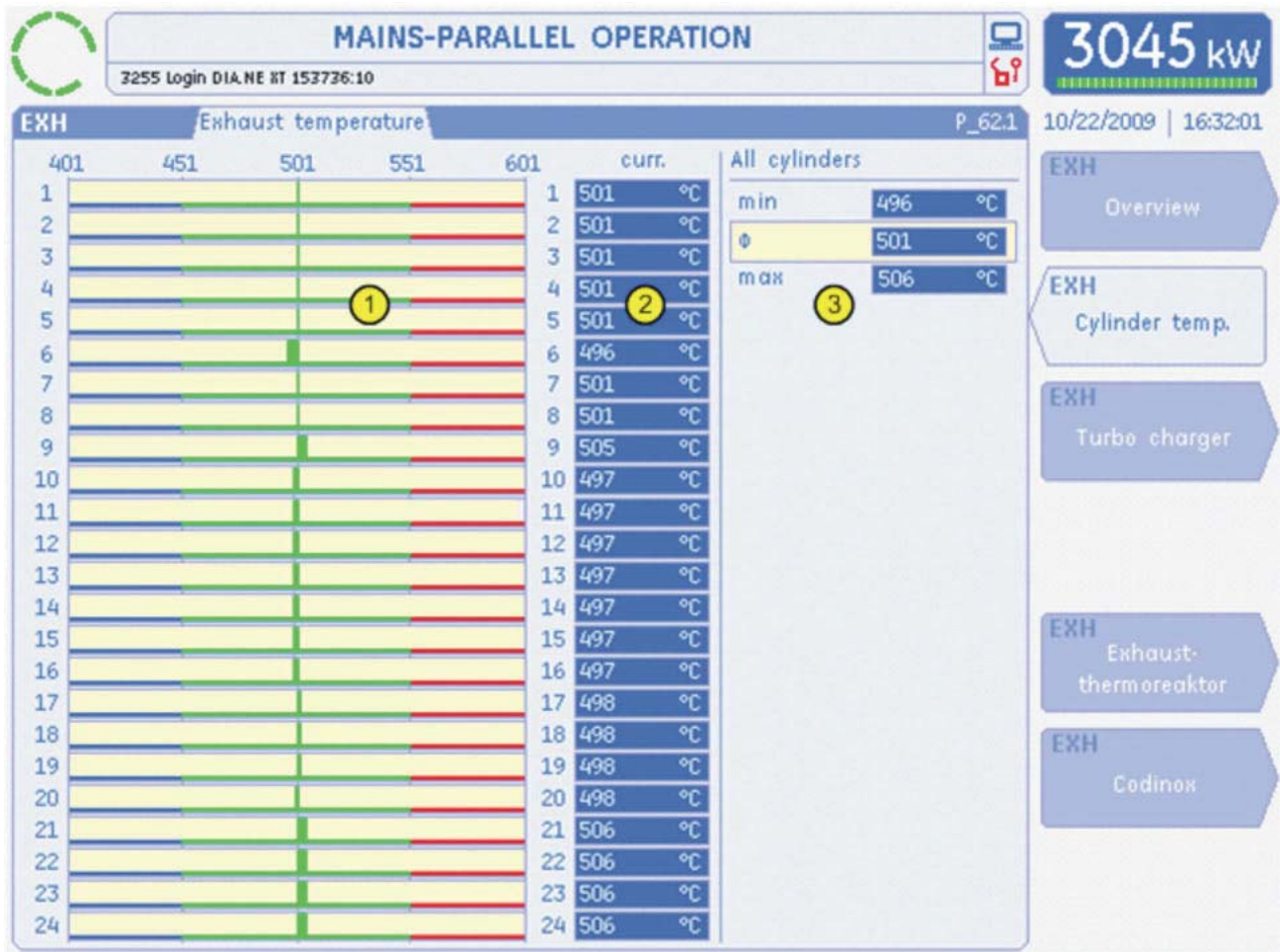
① **Graphical display of exhaust gas temperatures**

Optionally, the current measured values for the exhaust gas temperatures are displayed here in addition to the numerical display.

The permissible limit values for individual variables are shown in narrow red and blue bars below the broad measured value bar. The red bar is the maximum permissible value and the blue bar is the minimum value.

When the measured value moves within the permissible, optimum range, the measured value bar is shown in green. If the values exceed or fall below this level, the bar changes to red or blue respectively.

② **Numerical display of the exhaust gas temperatures**

You can choose to display the exhaust gas temperatures per cylinder in °C, °F or K.

③ **Minimum, maximum and average cylinder temperature**

The maximum value (**max**) and the minimum value (**min**) of all the cylinders and the average (**Φ**) across all the cylinders are displayed here.

7.7.3 Turbocharger (P_54.1)

The turbocharger screen is brought up by pressing the **EXH** main screen selection button followed by **F3**. It shows the turbocharger speeds.

Note: This screen is only displayed in Expert View if a turbocharger speed measurement system is installed on the engine.

① **Turbocharger diagram**

The turbocharger arrangement diagram is displayed here.

② **Turbocharger speed**

The speeds from the optional turbocharger speed sensors are displayed here in 1000 rpm. If two speeds are shown, then one turbocharger speed sensor is installed for each cylinder bank (A + B).

③ **Low-pressure turbocharger speed**

The speeds from the optional low-pressure turbocharger speed sensors are displayed here in 1000 rpm. If two speeds are shown, then one turbocharger speed sensor is installed for each cylinder bank (A + B).

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MRG3 – Generator protection with mains supervision, time overcurrent protection and earth current supervision

(September 2008)

Manual MRG3 (Revision New)

SEE MRG-3 SECTION IN SUBMITTAL
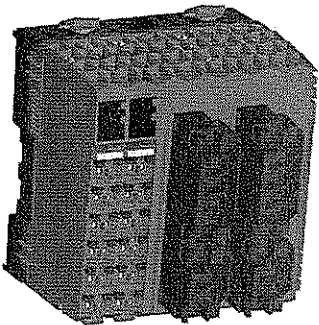
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Order data

Model number	Short description	Image
X20CM0985	X20 digital and analog mixed module, Multi-measurement transformer / synchronization module 5 x DO, 24 VDC, 0.5 A source; 1 relay 0.5 A 8 x AI ±480 V/120 V, 16-bit converter resolution 3 x AI ±5 A/1 A, 16-bit converter resolution	
X20TB12	X20 standard terminal 12x	
0TB3102-7011	Accessory 2-pin SCREW CLAMP (7.62) cod. A	
0TB3104-7011	Accessory 4-pin SCREW CLAMP (7.62) cod. A	
0TB3102-7012	Accessory 2-pin SCREW CLAMP (7.62) cod. B	
0TB3104-7012	Accessory 4-pin SCREW CLAMP (7.62) cod. B	

Technical data

Name	X20CM0985
General information	
Module type	X20 digital and analog mixed module
Ambient temperature during operation	
Vertical installation	55°C
Horizontal installation	50°C
Relative humidity	5 – 95%, non-condensing
Power consumption	
Bus	1.4 W
I/O internal	4 W
Digital outputs	
Number of outputs	5
Wiring	Source
Supply voltage	
Minimum	18 VDC
Nominal	24 VDC
Maximum	30 VDC
Maximum continuous current at nominal voltage	500 mA
Max. frequency	500 Hz
Short circuit protection	Yes
Overload protection	Yes
Readable	Yes
Open circuit recognition	No
Electrical isolation	Yes
Relay outputs	
Number of outputs	1
Relay contacts	Max. 230 VAC; 0.5 A
Capability of contacts to withstand surges	500 V

Measured variables

Analog input voltage (generator mains network)

Number of inputs	3
Digital converter resolution	16-bit
Value range / input signal	Configurable
Range1	± 120 VAC L1-L2 +10%
Range2	±480 VAC L1-L2 +10%
Output format	INT $8000 - $7FFF
Input resistance	~3 MΩ
Input filter	
Frequency limit	10 kHz
Attenuation	60 dB
Basic accuracy	0.5% (MBE)

Analog input current (generator mains network)

Number of inputs	3
Digital converter resolution	16-bit
Value range / input signal	Configurable
Range 1	±1A
Range 2	±5A
Thermal over-current	$15 \times I_{Nom}$ for 0.2 s
Monitored over-current	$4 \times I_{Nom}$
Output format	INT $8000 - $7FFF
Input filter	
Frequency limit	10 kHz
Attenuation	60 dB
Basic accuracy	0.5% (MBE)

Analog input voltage (bus bar)

Number of inputs	3
Digital converter resolution	16-bit
Value range / input signal	Configurable
Range1	± 120 VAC L1-L2 +10%
Range2	±480 VAC L1-L2 +10%
Output format	INT $8000 - $7FFF
Input resistance	~3 MΩ
Input filter	
Frequency limit	10 kHz
Attenuation	60 dB
Basic accuracy	0.5% (MBE)

Analog input voltage (synchronization mains network 1)

Number of inputs	1
Digital converter resolution	16-bit
Value range / input signal	Configurable
Range1	± 120 VAC L1-L2 +10%
Range2	±480 VAC L1-L2 +10%
Output format	INT $8000 - $7FFF
Input resistance	~3 MΩ
Input filter	
Frequency limit	10 kHz
Attenuation	60 dB
Basic accuracy	0.5% (MBE)

Analog input voltage (synchronization mains network 2)

Number of inputs	1
Digital converter resolution	16-bit
Value range / input signal	Configurable
Range1	± 120 VAC L1-L2 +10%
Range2	±480 VAC L1-L2 +10%
Output format	INT $8000 - $7FFF
Input resistance	~3 MΩ

Input filter	
Frequency limit	10 kHz
Attenuation	60 dB
Basic accuracy	0.5% (MBE)
Power supply	
Supply voltage	
Minimum	18 VDC
Rated	24 VDC
Maximum	30 VDC
Electrical isolation to PLC	No
Voltage monitoring	Error for voltages under 18 VDC

Environmental and general conditions	
Ambient temperature	
Operation	
Horizontal installation	0 - 55°C
Vertical installation	0 - 50°C
Storage	- 25 to + 70°C
Relative humidity	5 - 95%, non-condensing
Protection type	IP20
Standards	
Temperature	IEC 61131-2 / IEC 60068-2-x
Shock / tests carried out	IEC61131-2 / IEC60068-2-27
Vibration / tests carried out	IEC61131-2 / IEC60068-2-6
Emission / tests carried out	EN 50081-2 / EN 55022+A1
Immunity / tests carried out	IEC 61131-2 / IEC 61000-4-x

The device is provided with a CE mark. A UL label is in preparation.

Mechanical dimensions
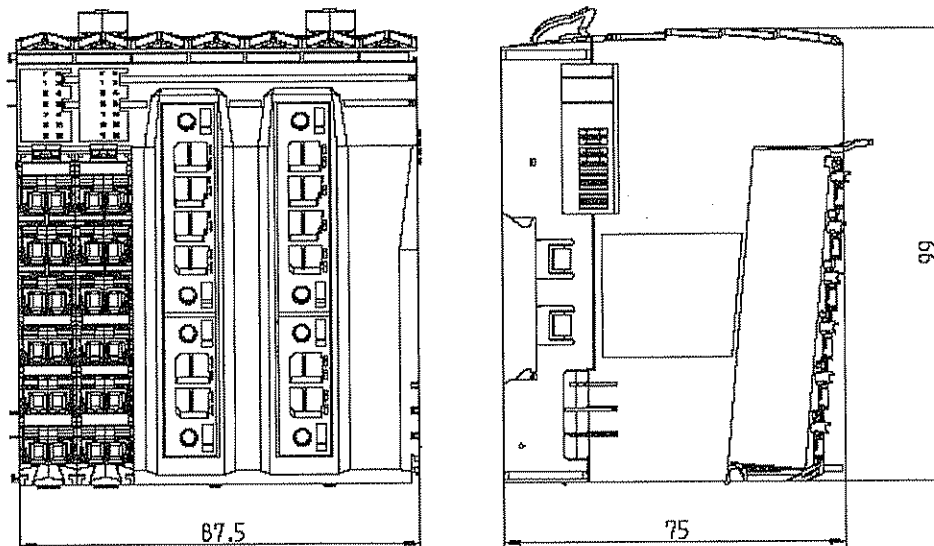
X20CM0985 module- Pin assignments

X1 – Digital outputs

Connection	Name	Image
11	DO1 normally closed contact	
21	DO1 normally open contact	
12	DO2	
22	DO1 COM	
13	DO3	
23	DO4	
14	DO5	
24	DO6	
15	+24 VDC	
25	+24 VDC	
16	GND	
26	GND	

- DO1: This digital output is designed as changeover switch. The monitoring relay allows chosen monitoring of: overvoltage and undervoltage, over-frequency and under-frequency, voltage asymmetry, current asymmetry, calculated neutral conductor current (maximum), short-circuit-current, thermal over-current and the limit value of the capacitive reactive power (exciter failure).

- DO2: Serves as counter output, using pulses for an external energy counter (kWh)

- DO3: The output is set when there is no current on the bus bar (below the lower limit of the defined parameter). The bus bar voltage is monitored in 3-phases.

- DO4: Serves as synchronization pulse. The power switch is activated by setting this output. The output is deactivated again after the output pulse and after the configured time has elapsed (exception: operating mode Synchro – Check)

- DO5, DO6: Digital outputs for other purposes of use

    Terminals X1 and X2 are each differently coded in order to avoid being plugged into the wrong module.
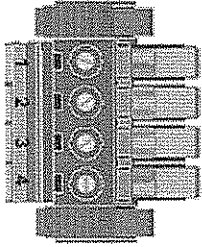
X2 – analog current inputs (generator mains network)

Connection	Name	Image
11	1A I1+ current L1	
12	1A I1- current L1	
21	5A I1+ current L1	
22	5A I1- current L1	
13	1A I2+ current L2	
14	1A I2- current L2	
23	5A I2+ current L2	
24	5A I2- current L2	
15	1A I3+ current L3	
16	1A I3- current L3	
25	5A I3+ current L3	
26	5A I3- current L3	

The X2 terminal measures the three phase currents of the generator mains network. It is possible to configure the measurement range for the current inputs between 1 A and 5 A.

X3 – analog voltage inputs (generator mains network)
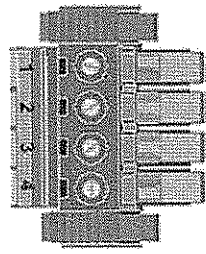
4-pin terminal
7.62 mm grid

Connection	Name	Image
1	GN - L1	
2	GN - L2	
3	GN - L3	
4	GN- N	

X3 and X5 terminals are each coded differently to avoid being plugged into the wrong module.
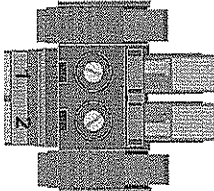
X5 – analog voltage inputs (bus bar)

4-pin terminal
7.62 mm grid

Connection	Name	Image
1	SS - L1	
2	SS - L2	
3	SS - L3	
4	SS - N	

X4 – analog voltage inputs (synchronization mains network 1)
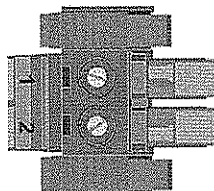
2-pin terminal
7.62 mm grid

Connection	Name	Image
1	Sync-mains1 - L1	
2	Sync-mains1 - L2	

X4 and X6 terminals are each coded differently to avoid being plugged into the wrong module.

X6 – analog voltage inputs (synchronization mains network 2)

2-pin terminal
7.62 mm grid

Connection	Name	Image
1	Sync-mains2 - L1	
2	Sync-mains2 - L2	

The voltage inputs X4 and X6 are used to determine the external line voltages for the synchronization between two different mains networks.
The X3 and X5 terminals are used to measure and monitor the external line voltages, phase voltages of the generator mains network and the bus bar.

Synchronizing - functions

Synchronizing with slip

The following applies to synchronization mains network 1 and synchronization mains network 2:
50% < U < 125% of the nominal voltage UN
80% < f < 110% of the nominal frequency fN
The generator voltage is adjusted to the synchronization voltage in amplitude and frequency. Taking into account the configured phase angle (dalpha), a defined transformer vector group, and the switching response time, the switch-on command is calculated and transmitted in advance so that the main contacts of the power switch are closed at the point of synchronicity.

Synchronization occurs under the following conditions:
- The "Synchronization selection" command is set using a software application
- The device is ready
- The defined limit for voltage difference is not exceeded (dUmax)
- The defined limits for frequency difference are not exceeded (dfmax and dfmin)
- The defined limit for the phase angle (incl. transformer vector group dalpha) is maintained (phimax)

The actual synchronization is activated if the conditions for the phase angle are met the first time and the phase window is exited. It should be noted that the conditions for voltage and frequency difference do not need to be fulfilled the first time.
This means that if the phase difference lies within the phase window when making the demand, a new entry for "activation" is no longer necessary. In order to cancel synchronization when in an activated state, the command "Synchronization with slip" must be reset.
Following the activation of the synchronization command, the synchronization window of all the above synchronization conditions must be opened from any direction of phase movement in order to obtain a synchronization impulse according to the switch lead time.

At very low frequencies, or equivalent frequency, and in adherence to the conditions described above, synchronization will also take place when entering the synchronization window a second time. The synchronization impulse is first issued only at a phase angle = 0°.
In low differential frequencies, the switch is not immediately engaged when the phase window is reached, but only when synchronization is possible at the point of synchronicity.

DO4 changes its state from LOW to HIGH when all conditions are met. It changes back from HIGH to LOW after the defined pulse duration has elapsed.

Synchro – Check

The device can be used as synchronization check in this operating mode. The "DO4" relay stays on, as long as the following conditions have been met:
- The "Enable Synchro Check" command is set using a software application
- The device is ready
- The defined limit for voltage difference is not exceeded (dUmax)
- The defined limits for frequency difference are not exceeded (dfmax and dfmin)
- The defined limit for the phase angle is not exceeded (phimax)

DO4 stays at HIGH as long as all conditions have been met.

Switching to voltage-free "dead bus"

The switch-on command for the power switch is output without synchronization if the following conditions have been met:
- The "Enable Dead Bus" command is set using a software application
- The device is ready
- The bus bar is voltage-free (USS < 5% UN)
- The generator voltage and frequency can be any valid value.

DO4 changes its state from LOW to HIGH when all conditions are met. It changes back from HIGH to LOW after the defined pulse duration has elapsed.

Bus bar voltage measurement and zero voltage monitoring

The bus bar voltage is monitored for 3 phases. The measured values are represented as combined values as well as phase values. The D03 output is set when there is no voltage (below the lower limit of the defined parameter) on the bus bar (X5 terminal).

Measurement functions

General measured parameters

- External line voltages
- Phase voltages
- Frequency

Measured parameters for generator mains network (X3)

- Phase currents
- Current average
- Dynamic current average
- Neutral conductor current
- External line voltages
- Phase voltages
- Voltage average
- Total apparent power
- Total reactive power
- Total effective power
- Active power factor
- Frequency

Measured parameters between synchronization mains networks

- Differential angle
- Differential voltage

Thermal over-current

Thermal overload monitoring is in accordance with IEC 255-8 "Electrical relays; Relays for protecting against thermal overload (overload relays)" and IEC 255-17 "Electrical relays; Relays for protecting against the thermal overload of motors (overload relays for motors).

Unbalanced load monitoring

Unbalanced load monitoring protects against unbalanced load in three-phase producers and three-phase networks. Changeable parameters make it possible to match the tripping characteristics to different generator types while taking their special thermal time constants into consideration.

An unbalanced load can be caused by uneven distribution of current in the network due to unbalanced load, asymmetrical conductor short-circuits, line interruptions and even switching operations. Unbalanced loads result in reverse system currents in the stator, which cause harmonics with an uneven ordinal number in the stator winding and harmonics with an even ordinal number in the rotor winding. In this situation, the rotor is at particular risk because the harmonics cause additional load on the rotor winding and induce turbulent flow in the rotor's solid iron, which could melt the metal or damage the metal structure. An unbalanced load can be permissible under certain conditions and by accounting for the thermal load limit of the generator. To avoid premature failure of the generator when an unbalanced load occurs, the trigger characteristic of the unbalanced load protection should be adjusted to the thermal characteristics of the generator. Unbalanced load protection can also be triggered by external errors on the power mains caused by asymmetric short-circuits.

Short-circuit current monitoring

The error message "Over-current/Short-circuit" is generated after the defined delay time has elapsed if an over-current/short-circuit occurs and the limit is exceeded.

Voltage asymmetry monitoring

The trigger value, which is adjustable by percentage, is always based on the defined nominal range of the generator mains network. This value describes the maximum deviation from one of the three differential voltages between the three monitored, combined phase voltages.

The error message "Voltage asymmetry" is signaled after the defined delay time has elapsed if this value is exceeded above the upper limit or below the lower limit.

Exciter failure

Reactive power monitoring can be used to protect a generator against operating outside the permissible range. The capacitive reactive power monitor offers protection against underexcitation (exciter failure). The error message "Exciter failure" is generated after the defined delay time has elapsed if the lower limit is exceeded.

Register description

Asynchronous register

Register	ID	Description		Resolution	Length in bytes	Configuration Read	Configuration Write
2578	ConfigOutput01	Synchronization mains network nominal voltage 70 V..65k V (U_{NomSyn})	UINT	1 V	2		•
2582	ConfigOutput02	Generator mains network nominal voltage 70 V..65 kV (U_{NomGen})	UINT	1 V	2		•
2586	ConfigOutput03	Bus bar nominal voltage 70 V..65 kV (U_{NomBBr})	UINT	1 V	2		•
2590	ConfigOutput04	Nominal generator current 0 .. 65 kA (I_{Nom})	UINT	1 A	2		•
2594	ConfigOutput05	Multiplier for bus bar	UINT	0.01	2		•
2598	ConfigOutput06	Multiplier for generator mains network	UINT	0.01	2		•
2602	ConfigOutput07	Multiplier for synchronization mains network 1	UINT	0.01	2		•
2606	ConfigOutput08	Multiplier for synchronization mains network 2	UINT	0.01	2		•
2610	ConfigOutput09	Multiplier for current transformer	UINT	1	2		•
2614	ConfigOutput10	Nominal frequency 48.0 .. 62.0 Hz	UINT	0.1 Hz	2		•
2626	ConfigOutput11	Max. differential frequency 0.02 .. 0.49 Hz (df Max)	UINT	0.01 Hz	1		•
2630	ConfigOutput12	Min. differential frequency 0.00 .. -0.49 Hz (df Min)	INT	0.01 Hz	1		•
2634	ConfigOutput13	Max. differential voltage 0.1% - 30.0% U_{NomSyn} (d Umax)	UINT	0.1%	2		•
2638	ConfigOutput14	Max. differential angle 0..60° (phimax))	UINT	0.1°	2		•
2618	ConfigOutput15	Phase rotation of sync mains network 1(dalpha)	UIINT	0.1°	2		•
2561	ConfigOutput20	Nominal voltage range of generator mains network 100V/400 V	BOOL	0 – 1			•
2563	ConfigOutput21	Nominal voltage range of bus bar 100V/400 V	BOOL	0 – 1			•
2565	ConfigOutput22	Nominal voltage range of sync – mains network 1 100 V/400 V	BOOL	0 – 1			•
2567	ConfigOutput23	Nominal voltage range of sync – mains network 2 100 V/400 V	BOOL	0 – 1			•
2569	ConfigOutput24	Nominal current range 1 A/5 A	BOOL	0 – 1			•
2571	ConfigOutput25	ARON connection	BOOL	0 – 1			•
2658	ConfigOutput16	Overvoltage of a phase 0.0% - 200.0% U_{NomGen}	UINT	0.1%	2		•
2710	ConfigOutput26	Reaction time for umax	UINT	0.1 s	2		•
2662	ConfigOutput27	Undervoltage of a phase 0.0% - 200.0% U_{NomGen}	UINT	0.1%	2		•
2718	ConfigOutput28	Reaction time for umin	UINT	0.1 s	2		•
2666	ConfigOutput29	Over-frequency	UINT	0.1%	2		•
2726	ConfigOutput30	Reaction time for fmax	UINT	0.1 s	2		•
2670	ConfigOutput31	Under-frequency	UINT	0.1%	2		•
2734	ConfigOutput32	Reaction time for fmin	UINT	0.1 s	2		•
2674	ConfigOutput33	Voltage asymmetry 0.0% – 30.0% U_{NomGen}	UINT	0.1%	2		•
2742	ConfigOutput34	Reaction time for Uas	UINT	0.1 s	2		•
2774	ConfigOutput35	Load time constant for current asymmetry	UINT	0.1 s	2		•
2678	ConfigOutput36	Neutral conductor current, maximum 0.0% - 100.0% I_{Nom}	UINT	0.1%	2		•
2750	ConfigOutput37	Reaction time for ingw	UINT	0.1 s	2		•
2682	ConfigOutput38	Short-circuit current 100.0% - 500.0% I_{Nom}	UINT	0.1%	2		•
2758	ConfigOutput39	Reaction time for ks	UINT	0.01 s	2		•
2650	ConfigOutput40	Bus bar voltage min. 0.0% - 100% U_{NomBBr}	UINT	0.1%	2		•
2622	ConfigOutput58	Dead bus voltage 0.0% – 100% $U_{Nom Syn}$	UINT	0.1%	2		•
2782	ConfigOutput41	Lower-pass filter for total power 0 – 300ms	UINT	1 ms	2		•

2686	ConfigOutput42	Thermal over-current 100.0% - 200.0% I_{Nom}	UINT	0.1%	2		•
2690	ConfigOutput43	Integration coefficient for iths 0.1 – 2.0	UINT	0.1	2		•
2694	ConfigOutput44	Capacitive reactive power	INT	1 kVAr	2		•
2766	ConfigOutput45	Reaction time for qsmin	UINT	0.1 s	2		•
2790	ConfigOutput46	Pulse value of counter output energy	UINT	1 kWh/Imp	2		•
2794	ConfigOutput47	Min. pulse length of switch-on relay 0.040 .. 0.500 s	UINT	0.001 s	2		•
2798	ConfigOutput48	Switching response time of power switch 40 .. 300 ms	UINT	0.001 s	2		•
2050	ConfigOutput49	Phase current of generator I1, maximum	INT	1 A	2	•	
2054	ConfigOutput50	Phase current of generator I2, maximum	INT	1 A	2	•	
2058	ConfigOutput51	Phase current of generator I3, maximum	INT	1 A	2	•	
2062	ConfigOutput52	Total effective power, max.	INT	1 kW	2	•	
2066	ConfigOutput53	Neutral conductor current, max.	INT	1 A	2	•	
2076	ConfigOutput54	Active energy counter	DINT	100 kWh	4	•	
2084	ConfigOutput55	Reactive energy counter	DINT	100 KVrh	4	•	
2654	ConfigOutput56	Synchronization configuration	UINT	- -	1		•
2698	ConfigOutput57	Function DO1	UINT	-	2		•
2834	ConfigOutput60	Reset phase current of generator I1, max.	INT	1 A	2		•
2838	ConfigOutput61	Reset phase current of generator I2, max.	INT	1 A	2		•
2842	ConfigOutput62	Reset phase current of generator I3, max.	INT	1 A	2		•
2846	ConfigOutput63	Reset total effective power, max.	INT	1 kW	2		•
2850	ConfigOutput64	Reset neutral conductor current, max.	INT	1 A	2		•
2860	ConfigOutput66	Write to the active energy counter	DINT	100 kWh	4		•
2868	ConfigOutput67	Write to the reactive energy counter	DINT	100 kVrh	4		•

Nominal voltage for synchronization (U_{NomSyn}) 70V .. 65 kV

For converting various synchronization voltage limits from a percentage into physical units.

Nominal voltage for generator (U_{NomGen}) 70V .. 65 kV

For converting various generator voltage limits from a percentage into physical units.

Nominal voltage for bus bar (U_{NomBBr}) 70V .. 65 kV

For converting various bus bar voltage limits from a percentage into physical units.

Nominal generator current (I_{Nom}) 0A .. 65 kA

For converting various generator current limits from a percentage into physical units.

Multiplier for bus bar 0.01 .. 655.35

A multiplier is used based on the input of the bus bar voltage for converting the bus bar voltage to V.

Multiplier for generator voltage 0.01 .. 655.35

A multiplier is used based on the input of the generator voltage for converting the generator voltage to V.

Multiplier for synchronization mains network 1 0.01 .. 655.35

A multiplier is used based on the input of the synchronization mains network 1 for converting the synchronization mains network 1 to V.

Multiplier for synchronization mains network 2 0.01 .. 655.35

A multiplier is used based on the input of the synchronization mains network 2 for converting the synchronization mains network 2 to V.

Multiplier for current transformer

A multiplier is used based on the input of the generator current for converting the generator currents to A.

Nominal frequency 48.0 .. 62.0 Hz

For converting various nominal frequency limits from a percentage into physical units.

Max. differential frequency 0.02 .. 0.49 Hz (df Max)

This value specifies the upper frequency deviation (positive slip – synchronization mains network frequency 1 is greater than synchronization mains network frequency 2).
The condition for a switch-on command is not met as long as this limit is not exceeded at the low end.

Min. differential frequency 0.00 .. -0.49 Hz (df Min)

This value specifies the lower frequency deviation (negative slip – synchronization mains network frequency 1 is smaller than synchronization mains network frequency 2).
The condition for a switch-on command is not met as long as this value is not exceeded.

Max. differential voltage 0.1% - 30.0% U_{NomSyn} (dUmax)

The condition for a switch-on command is not met as long as the differential voltage between both synchronization mains networks is greater than the defined differential voltage.

Max. differential angle 0..60° (phimax)

The condition for a switch-on command is met if the value of the defined differential angle between the synchronization mains networks is below the lower limit.

Phase rotation of sync mains network 1(dalpha)

For correcting any phase shifting of transformer vector groups.

Synchro – Check

Bit for setting the synchronization Synchro – check. (see Synchro Check function)
This mode requires that the value is less than the maximum differential angle.

Nominal voltage range of generator mains network 100V/400V

Bit for configuring the generator mains network voltage range (100 V/400 V)

Nominal voltage range of bus bar 100V/400V

Bit for configuring the bus bar voltage range (100 V/400 V)

Nominal voltage range of sync – mains network 1 100V/400V

Bit for configuring the synchronization mains network voltage range 1 (100 V/400 V)

Nominal voltage range of sync – mains network 2 100V/400V

Bit for configuring the synchronization mains network voltage range 2 (100 V/400 V)

Nominal current range

Bit for configuring the measurement current range (1A/5A)

ARON connection

Configuration bit for switching to the power measurement principle of the Aron connection

Overvoltage on a phase 0.0% - 200.0% U_{NomGen}

Adjustable limit for overvoltage on a phase. The error message "Overvoltage" is generated after the defined delay time has elapsed when this value, based on the nominal voltage of the generator mains network, is exceeded.

Reaction time for umax

Umax is signaled after this reaction time has elapsed.

Undervoltage on a phase 0.0% - 200.0% U_{NomGen}

Adjustable limit for undervoltage on a phase. The error message "Undervoltage" is generated after the defined delay time has elapsed when the lower limit of this value, based on the nominal voltage of the generator mains network, is exceeded.

Reaction time for umin

Umin is signaled after this reaction time has elapsed.

Over-frequency (f_{max})

The error message "Over-frequency" is generated after the defined delay time has elapsed if the limit, based on the nominal frequency, for over-frequency is exceeded.

Reaction time for f_{max}

fmax is signaled after this reaction time has elapsed.

Under-frequency (f_{min})

The error message "Under-frequency" is generated after the defined delay time has elapsed if the limit, based on the nominal frequency, for Under-frequency is not reached.

Reaction time for f_{min}

fmin is signaled after this reaction time has elapsed.

Voltage asymmetry 0.0% – 30.0% U_{NomGen}

The trigger value, which is adjustable by percentage, is always based on the defined nominal range of the generator mains network. This value describes the maximum deviation from one of the three differential voltages between the three monitored, chained phase voltages.
The error message "Voltage asymmetry" is signaled after the defined delay time has elapsed if the value is exceeded.

Reaction time for U_{as}

Uas is signaled after this reaction time has elapsed.

Load time constant for current asymmetry (t_{per})

Value of the load time constant for current asymmetry (see the description of unbalanced load protection).

Neutral conductor current, maximum 0.0% - 100.0% I_{Nom}

Configurable limit for the neutral conductor current. The error message "Neutral conductor current" is signaled after the defined delay time has elapsed if the value is exceeded.

Reaction time for I_{ngw}

Ingw is signaled after this reaction time has elapsed.

Short-circuit current 100.0% - 500.0% I_{Nom}

Configurable limit for the short-circuit current. The error message "Over-current/Short-circuit" is signaled after the defined delay time has elapsed if an over-current/short-circuit occurs and the limit is exceeded.

Reaction time for ks

ks is signaled after this reaction time has elapsed.

Bus bar voltage min. 0.0% - 100% U_{NomBBr}

Configurable threshold for zero voltage monitoring of the bus bar based on the nominal voltage of the bus bar.

Dead bus voltage 0.0% – 100% UNom Syn

Configurable threshold for Dead Bus synchronization of the respectively configured Sync mains network, based on the nominal voltage of the Sync mains network.

Lower-pass filter for total power 0 – 300ms

Parameter for delay time of the low-pass filter of the total power P, Q and S. The maximum values of the total power should be recorded unfiltered.

Thermal over-current 100.0% - 200.0% INom

(see the description of Thermal over-current)

Integration coefficient for this 0.1 – 2.0

(see the description of Thermal over-current)

Exciter failure

Reactive power monitoring can be used to protect a generator against operating in an invalid range. The capacitive reactive power monitor offers protects against underexcitation (exciter failure). The error message "Exciter failure" is generated after the defined delay time has elapsed if the lower limit is exceeded.

Reaction time for qsmin

qsmin is signaled after this reaction time has elapsed.

Min. pulse length of switch-on relay 0.040 .. 0.500 s

The duration of the switch-on pulse can be configured for DO4 here.

Switching response time of power switch 40 .. 300 ms

The actuation time of the power switch is equal to the lead time of the switch-on command. The switch-on command is made at the defined amount of time before the point of synchronicity.

DO1 functions (Reg 2698, ConfigOutput 57)

The digital output can be set after the defined delay time has elapsed according to the assignment of the monitoring variables of generator mains network (X3).
The monitoring variables mentioned above can be assigned to this input either individually or using an OR operation with additional monitoring variables. This makes it possible to set the relay when there are multiple monitoring variables.

The monitoring functions that can be assigned to the monitoring relay:

Bit	Monitoring variables
0	Overvoltage (of one phase)
1	Undervoltage (of one phase)
2	Over-frequency
3	Under-frequency
4	Voltage asymmetry
5	Current asymmetry
6	Neutral conductor current, maximum
7	Short circuit current
8	Over-current, thermal
9	Capacitive reactive power (exciter failure)
10	Ready

Note:
The minimum pulse duration when addressing a monitoring function on the error bit via X2X as well as on the relay is 500 ms.

Maximum value buffer (Reg 2834 -- 2850)

Nonvolatile maximum value buffer for storing maximum values that occur in operation. After restarting, the stored maximum values are loaded back into their register. It is possible to reset the stored maximum values using an asynchronous register.
The maximum values are recorded by measurement values before a configurable filter. The maximum values must be able to be read and written as an asynchronous register.

Measurement variables:
- Max. phase currents $I1_{max}$, $I2_{max}$, $I3_{max}$
- Max. neutral conductor current In_{max}
- Max. total effective power P_{max}

Synchronization configuration (Reg 2654)

Parameter for configuring which mains networks or voltages should be synchronized with each other. This configuration makes it possible to synchronize the AC network on the X4 terminal with either the X3, X5 or X6 terminal.
In all cases, the synchronization mains network 1 (X4) is the mains network to synchronize with.

Terminals	Configuration
X4 – X6	00
X4 – X5	01
X4 – X3	10
Reserved	11

Synchronous register

Register	Description	Data type	Resolution	Length (bytes)	Configuration	
					Read	Write
2	Phase current of generator I1	INT	1 A	2	•	
6	Phase current of generator I2	INT	1 A	2	•	
10	Phase current of generator I3	INT	1 A	2	•	
14	Current average I1, I2, I3	INT	1 A	2	•	
18	Neutral conductor current In	INT	1 A	2	•	
22	Current average, dynamic (in the dyn)	UINT	0.1%	2	•	
26	External line voltage of generator UG12	INT	1 V	2	•	
30	External line voltage of generator UG23	INT	1 V	2	•	
34	External line voltage of generator UG31	INT	1 V	2	•	
38	Line voltage of generator UG1	INT	1 V	2	•	
42	Line voltage of generator UG2	INT	1 V	2	•	
46	Line voltage of generator UG3	INT	1 V	2	•	
50	External line voltage of bus bar US12	INT	1 V	2	•	
54	External line voltage of bus bar US23	INT	1 V	2	•	
58	External line voltage of bus bar US31	INT	1 V	2	•	
62	Line voltage of bus bar US1	INT	1 V	2	•	
66	Line voltage of bus bar US2	INT	1 V	2	•	
70	Line voltage of bus bar US3	INT	1 V	2	•	
74	Total effective power, filtered P	INT	1 kW	2	•	
78	Total reactive power, filtered Q	INT	1 kVAr	2	•	
82	Total apparent power, filtered S	INT	1 kVA	2	•	
86	Voltage average UG12, UG23, UG31	INT	1 V	2	•	
90	Power factor cosφ	INT	0.01	2	•	
94	Frequency of the generator mains network	UINT	0.1 Hz	2	•	
98	External line voltage of sync mains network 1 US1	INT	1 V	2	•	
102	External line voltage of sync mains network 2 US2	INT	1 V	2	•	
106	Frequency of sync mains network 1	UINT	0.1 Hz	2	•	
110	Frequency of sync mains network 2	UINT	0.1 Hz	2	•	
114	Differential angle between synchronization mains networks	UINT	0.1°	2	•	
118	Differential voltage between synchronization mains networks	UINT	1 V	2	•	
122	Error register	UINT	-	2	•	
126	Status Digital OUT	UINT	-	2	•	
514	Digital_OUT	USINT	-	1		•
518	Synchronization with slip	BOOL	0 – 1			•
518	Dead bus	BOOL	0 – 1			•
518	Synchro – Check	BOOL	0 – 1			•

Current average, dynamic (in the dyn)

Display of the maximum value of the average of the three phase currents, decaying via an e-function. The dynamic current average characterizes how smooth the generator motor runs.

Error-Register (Reg 122)

Bit		Description
15..11		RESERVED
10	1	Not ready
	0	Ready, OK
9	1	Capacitive reactive power (exciter failure), present
	0	Capacitive reactive power (exciter failure), OK
8	1	Over-current, thermal, present
	0	Over-current, thermal, OK
7	1	Short-circuit-current, present
	0	Short-circuit-current, OK
6	1	Maximum neutral conductor current exceeded
	0	Maximum neutral conductor current, OK
5	1	Current asymmetry, present
	0	Current asymmetry, OK
4	1	Voltage asymmetry, present
	0	Voltage asymmetry, OK
3	1	Under-frequency, present
	0	Under-frequency, OK
2	1	Over-frequency, present
	0	Over-frequency, OK
1	1	Undervoltage (of one phase), present
	0	Undervoltage (of one phase), OK
0	1	Overvoltage (of one phase), present
	0	Overvoltage (of one phase), OK

Digital_OUT (Reg 514)

Bit		Description
15..2		RESERVED
1		DO6
0		DO5

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Engineering information
DIA.NE WIN

DIA.NE WIN 1.1

DIALOG NETWORK FOR WINDOWS SYSTEMS

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1   Introduction

DIA.NE WIN is a new Windows-based man/machine interface for GE Jenbacher gas engines. The system offers both customers and GE Jenbacher maintenance staff a wide range of functionalities for commissioning, monitoring and maintaining installations and for diagnostic purposes.

DIA.NE WIN makes it possible to control and monitor the engines using a standard PC and Internet Explorer. The operating stations can be connected to the central on-site computer (server) via a local area network (LAN), a dial-in connection (modem) or via the Internet. Various operating stations can be operated parallel to and independent of one another.

GE Jenbacher has used state-of-the-art technology to develop DIA.NE WIN. DIA.NE WIN expands the functionality of DIA.NE XT when it comes to ease-of-operation, historical data analysis and remote control of the installation. DIA.NE WIN is the ultimate step in PC-based systems and offers accessibility via standardised interfaces.

The system is built around a fast industrial PC (server) which is integrated into the switch cabinet of the installation and which stores historical data and generates alarms. This computer also functions as a web server and modem server. The system is operated (by the customers) via ordinary PCs. Internet Explorer is used as an operating platform.

DIA.NE WIN is one of the applications of the HERMES remote data transmission program and comes as an option with DIA.NE XT.

2 Structure and interfaces

2.1 Network structure and interfaces
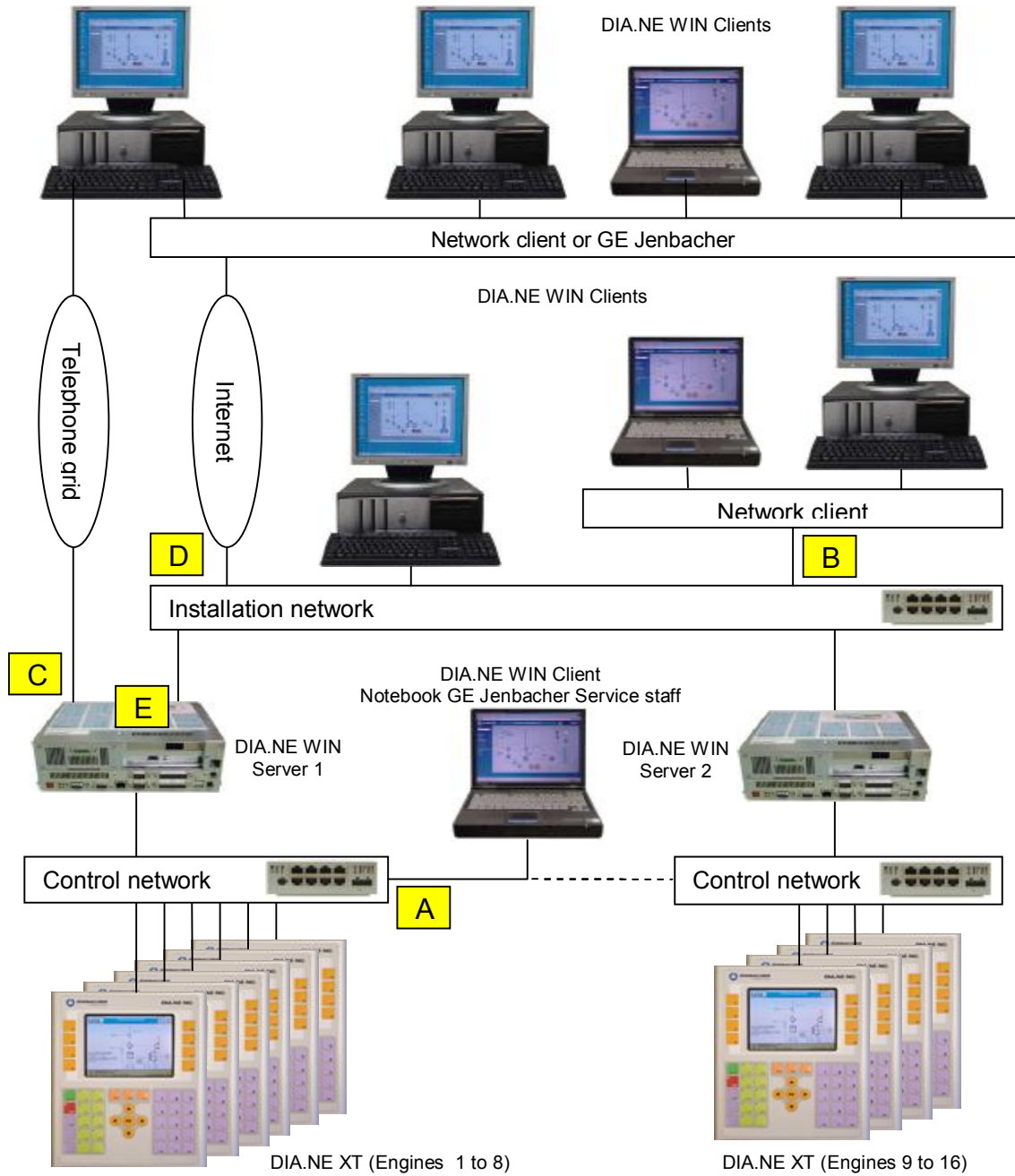
Illustration 1: Network structure for a system with up to 16 engines

2.2 Control network

The control network connects the engine controls (DIA.NE XT) to the DIA.NE WIN server(s). Up to 8 engines can be operated with a single DIA.NE WIN server. In the case of installations with more than 8 engines, an additional DIA.NE WIN server is used. All participants within the network are arranged radially (Ethernet 10/100BaseT) around the hub.

2.3 Installation network

In the case of installations with more than 8 engines, the installation network interconnects all DIA.NE WIN servers. Once again, a radially arranged Ethernet network (Ethernet 100BaseT) is used.

2.4 Interface A: Direct connection to the control network

This interface is intended solely to connect the notebooks of GE Jenbacher service staff while they are commissioning and maintaining the installation. This interface is not meant to be used by the customer.

2.5 Interface B: LAN connection

This interface is used to connect DIA.NE WIN clients to the DIA.NE WIN server(s) via a local area network (LAN). If an installation-specific network is installed, the network hub will be equipped with a connection (Ethernet 100BaseT) for this purpose. In all other cases, the customer's network is connected directly to the network card in the DIA.NE WIN server.

2.6 Interface C: Modem connection

This interface is used to connect DIA.NE WIN clients to the DIA.NE WIN server(s) via a dial-in and/or modem connection. To that end the DIA.NE WIN server is equipped with an integrated, analog dial-in modem that can be used worldwide.

2.7 Interface D: Internet connection

This interface is used to connect DIA.NE WIN clients to the DIA.NE WIN server(s) via an Internet connection. Communication is only HTTP-based (port 80).

Available as of 2nd quarter 2004.

2.8 Interface E: OPC

OPC (OLE for process control) is a standardised interface for data communication which is generally used in automation and is supported by almost all control systems. Various measurement values are made available on the DIA.NE WIN Server in the OPC DA 2.0 format. These measurement data can be read by other control systems (OPC Clients).

3 Functionality

The goal when developing DIA.NE WIN was to offer both customers and GE Jenbacher maintenance staff a multi-purpose tool for supporting commissioning, ongoing management, monitoring and maintenance of installations and for diagnostic purposes. DIA.NE WIN was developed to add value to DIA.NE XT in terms of ease of control, historical data analysis and remote control of the installation.

3.1 Process screens

The system consists of various process screens in which all measurement data are displayed in a structured way. Special attention was paid to the clear presentation of the control processes. All cylinder-specific measurement values (e.g. ignition voltages) are displayed using bar graphs. With DIA.NE WIN, all setpoints can be set and control commands can be issued.

All process screens can be displayed by working through a menu at the left side of the display (A). Important information, such as the engine status (B), the alarm status (collective alarm) (C) and the actual electrical output of the engine (D) are always displayed, irrespective of the selected process screen. The actual time (local time at the installation site), the user who is logged in and his authorisation group are always displayed. In the case of multi-engine installations, a specific engine can be selected using a combobox.
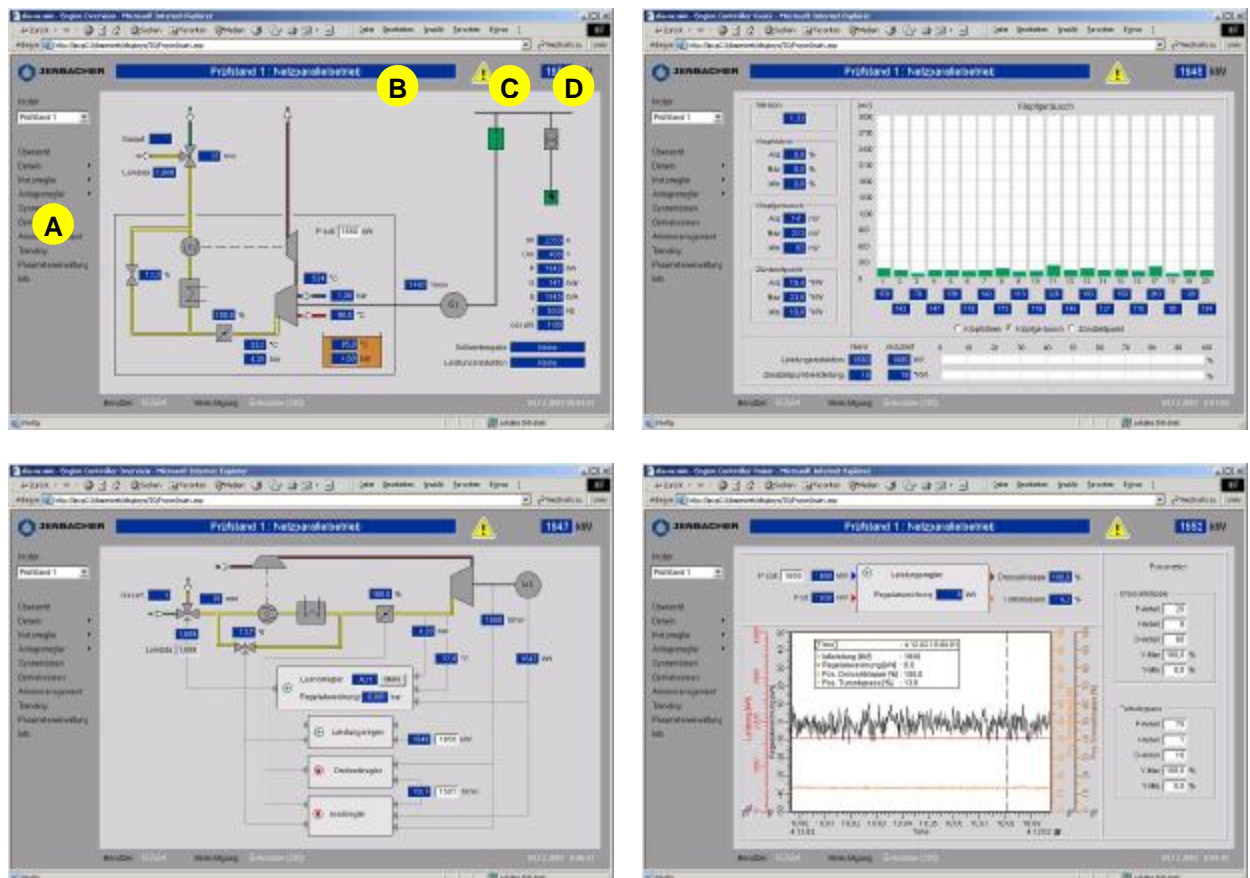

Illustration 2: Various process screens

3.2 Trends

The extensive trend-monitoring functionalities enable current and historical measurement data to be displayed as trends. Users can load various trend configurations, enabling them to display or hide every single bar and the relevant Y axis. Various trend configurations with different refreshment rates (1 second to 30 minutes) and registration periods (1 hour to 6 months) can be set. Users also have a ruler and easy-to-use zoom functionalities at their disposal. The trend display can be printed or exported into a file (CSV file).
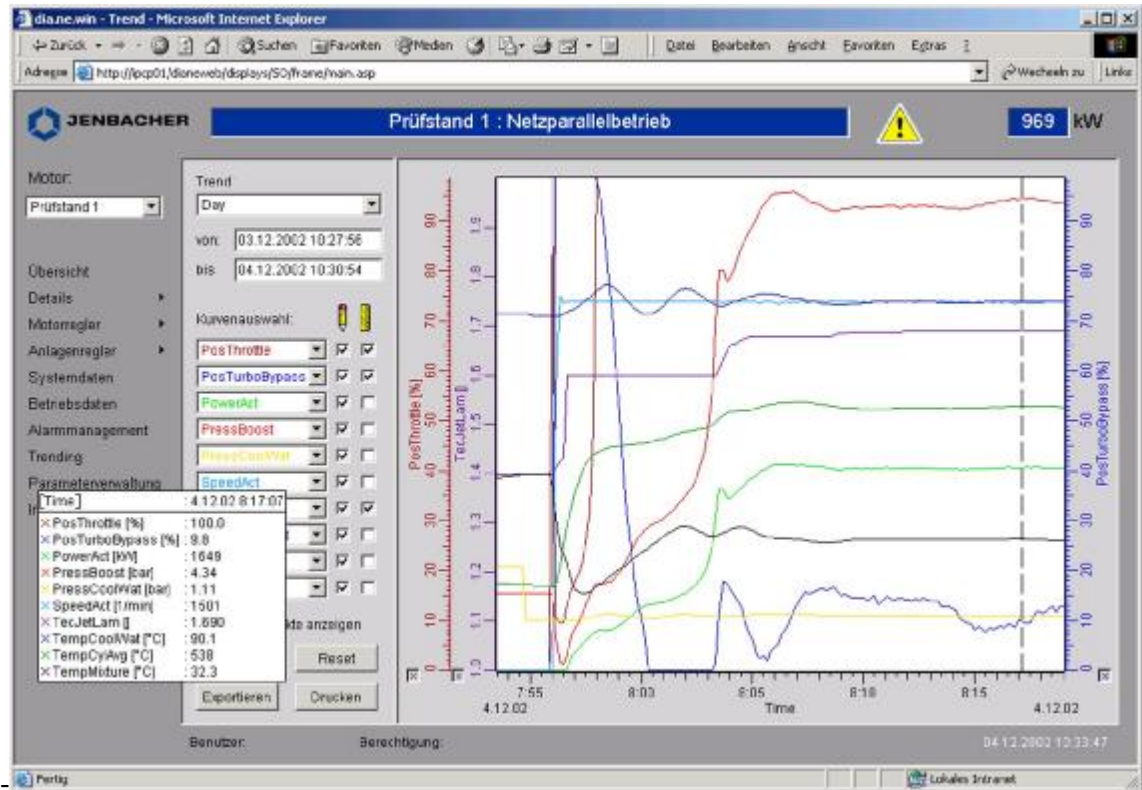

Illustration 3: Trend overview

3.3 Alarm management

To facilitate current monitoring and the historical diagnosis of the installation, DIA.NE WIN is equipped with a powerful alarm management functionality. The current messages and the recorded messages (history) are displayed in tables. The various message types (operational messages, warnings and failures that have resulted in the installation being switched off) and message conditions are displayed using different colours. All messages are recorded for up to one year. The message list can be exported into a file (CSV file).
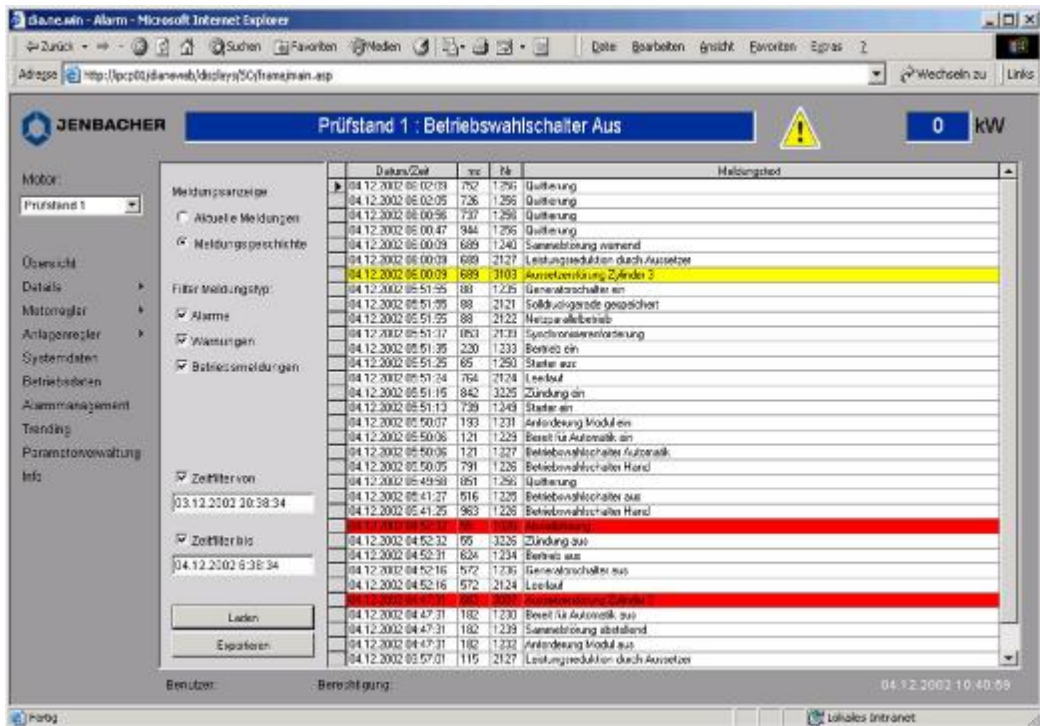
Illustration 4: Message overview

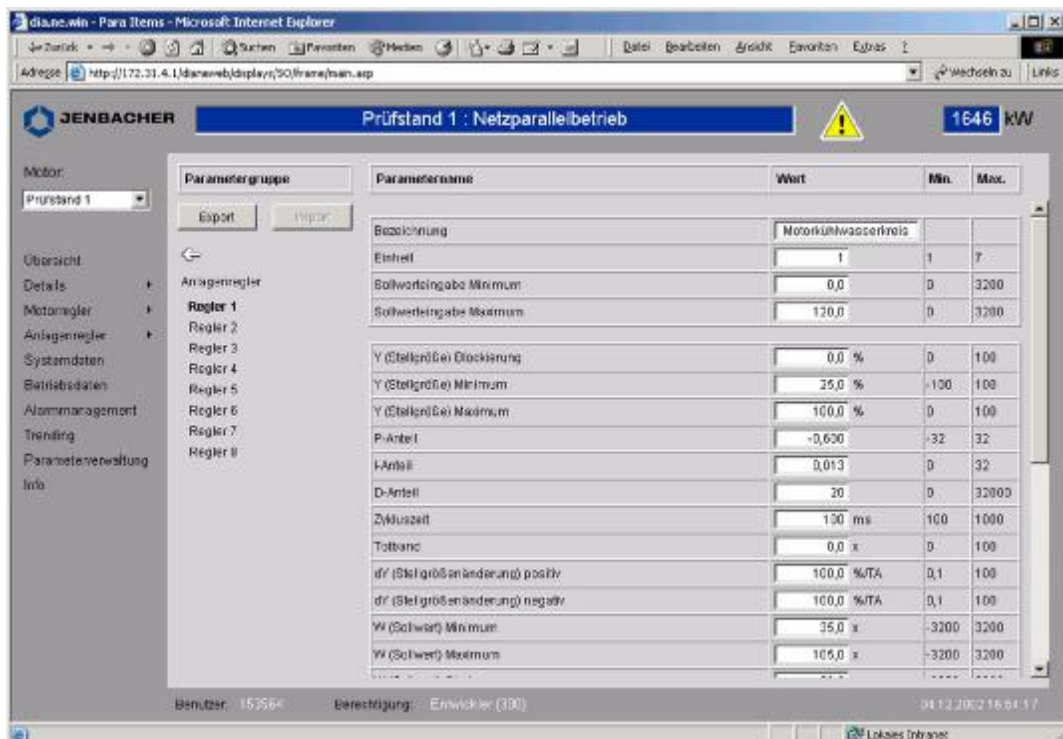## 3.4 Parameter management

Illustration 5: Parameter management

Parameters are used to enter basic engine settings before commissioning (engine type, options) and for certain re-adjustments during commissioning. All parameters can be set using integrated parameter management. The values can be exported to and imported into a file. The parameters are divided into so-called parameter groups according to theme. A parameter group can be selected using a tree structure (several levels). To ensure user friendliness and reliability of operation, only those parameters are displayed and/or released for editing that are important for the specific user authorisation group.

3.5 Access protection

When accessing the system, every user must log in using his own user name and user code. This enables user identification and the release of specific functionalities and allows the user interface to be adapted to the specific user authorisation group.

3.6 Activity recording

All user activities, e.g. login, logout, set-point changes, parameter changes, etc. are recorded (activity logging).

3.7 Operational data protocol

Measurement values (current value, maximum and minimum) are saved in a databank according to a regular cycle for the operational data log. These logs can be easily displayed and printed.

Available as of mid-2004.

3.8 Multilinguality

The user interface is available in several languages. You can select the language of your choice or switch between languages any time. The pressure and temperature display values can be changed between "Bar" and "Psi" and/or between "degrees Celsius" and "degrees Fahrenheit". Any country-specific format settings of the operating system (e.g.: decimal comma, date and time format, etc.) are also modified.

The following languages are available:

German, English, Spanish, Finnish, French, Hungarian, Italian, Dutch, Norwegian, Portuguese, Russian, Turkish, Danish.

Greek (available as of 2nd quarter 2004)

The following languages can be requested as needed:

Estonian, Latvian, Polish, Slovakian, Slovenian, Czech, Serbian

3.9 Multi-station system

The system is built around a Client/Server structure. Various operating stations (clients) can access the server and operate and monitor the installation simultaneously and independently. A single client can be used to access various servers simultaneously. All active users of a server can be shown separately.

3.10 Remote data transfer using HERMES

The customer's DIA.NE WIN Client is always connected to the DIA.NE WIN server using the connection option of the HERMES remote data transfer program. The following connection options are possible:

- LAN (local area network)
- Modem (dial-in connection)
- Internet (*available as of 2nd quarter 2004*).

4 DIA.NE WIN server

The DIA.NE WIN server is an industrial PC without any peripherals (keyboard, mouse, VDU). The computer is installed in the control cabinet (system control cabinet) and has the following main tasks:

- Data communication with the engine control systems (DIA.NE XT)
- Data preparation
- Measured value recording
- Message recording
- Activity recording
- Data base server (MS SQL 2000)
- OPC server
- HTTP server for the web application "DIA.NE WIN"
- FTP server for data transmission
- Operational data registration

Windows 2000 is used as the operating system for the DIA.NE WIN server.

5 DIA.NE WIN Client

The DIA.NE WIN clients are ordinary PCs. They can be the notebooks of GE Jenbacher service staff, a desk PC belonging to the customer or an operating station in the control room. The operating systems Windows 98, Windows NT, Windows 2000 and Windows XP are all compatible. Every client must be connected with the DIA.NE WIN server via TCP/IP. The platform for the user interface is Microsoft Internet Explorer (Version 6.0 or higher). The client must be equipped with a keyboard, a mouse and a VDU with a resolution of at least 1024 * 768 pixels. The DIA.NE WIN client hardware is not part of DIA.NE WINs scope of supply.

5.1 Prerequisites

- Standard PC with monitor, mouse and keyboard
- Performance equivalent to at least a PIII
- At least 128 MB of RAM

- Monitor resolution at least 1024 x 768 pixels
- Operating system Windows 98, Windows NT, Windows 2000 or Windows XP
- Microsoft Internet Explorer, version 6.0 or higher
- JAVA support ("Java Virtual Machine" from Microsoft)
- Network connection to DIA.NE WIN server based on TCP/IP

6   Licence

A (first) "DIA.NE WIN" license includes user access rights for 2 simultaneous users (e.g. local operating station and access via remote connection) to the DIA.NE WIN server or serves of a system. Each additional license allows another user simultaneous access to the system.

After on-site training by the service personnel, 5 different user IDs and the associated access codes for DIA.NE XT are provided. If a license has already been purchased, these user IDs can also be used for accessing DIA.NE WIN.

The installation of DIA.NE WIN Client on the operating-station will be carried out by service personnel or by the client according to the manual.

Regardless of the licensing, a maximum of 5 users can access a DIA.NE WIN server at any given time.

7   Advantages of DIA.NE WIN

- Clear visualisation and user comfort (mouse, VDU, Windows technology)
- Resolution 1024 * 768 pixels
- Extensive trend-monitoring functionalities
- Clear alarm management
- Storage over long periods of time of measured values and alarm messages in a standard database
- Multi-station system
- Remote control
- Hardware-independent control stations
- Internet Explorer as an operating platform
- Open (standardised) interfaces to PC-based systems
- Export/import functionality of parameter settings
- Export/printing of alarm-message listings and trend diagrams
- Operational data logs

8   Summary

DIA.NE WIN means that the GE Jenbacher gas engines can be remotely monitored, controlled and diagnosed. DIA.NE WIN is the easy-to-use man/machine interface for both specialist and ordinary users. The open system was developed by GE Jenbacher based on state-of-the-art technologies and functions as an add-on to the engine visualisation DIA.NE XT.

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