# Delomatic 4 GAS CHP controller
# OPERATOR'S MANUAL

## DELOMATIC 4, DM-4 GAS

**CHP controller**

- Functional description
- User interface
- Log books
- Alarm handling

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# 1. About this document

## General purpose

This document is the Operator's Manual for DEIF's Delomatic 4, DM-4 Gas Combined Heat and Power (CHP) plant controller. The document mainly includes general product information, display readings, Operator interface, alarm handling descriptions and presentation of the log list.

The general purpose is to give the user important information on how to carry out the daily operation of the unit.

**Please make sure to read this handbook before working with the DM-4 Gas controller and the gen-set to be controlled. Failure to do this could result in damage to the equipment or human injury.**

## Intended users

This operator's manual is mainly intended for the daily user. On the basis of this document, the operator will be able to carry out simple procedures such as start/stop and control of the generator set.

## Contents/overall structure

The document is divided into chapters, and in order to make the structure simple and easy to use, each chapter will begin from the top of a new page.

# 2. Warnings and legal information

## Legal information and responsibility

DEIF takes no responsibility for installation or operation of the generator set. If there is any doubt about how to install or operate the generator set controlled by the unit, the company responsible for the installation or the operation of the set must be contacted.

**In order to obtain safe and trouble-free use of the DM-4 Gas, it is important that transport, storage, mounting and commissioning is done according to standards.**

**The units are not to be opened by unauthorised personnel. If opened anyway, the warranty will be lost.**

## Electrostatic discharge awareness

Sufficient care must be taken to protect the terminals against static discharges during the installation. Once the unit is installed and connected, these precautions are no longer necessary.

## Safety issues

Installing the unit implies work with dangerous currents and voltages. Therefore, the installation should only be carried out by authorised personnel who understand the risks involved in working with live electrical equipment.

**Be aware of the hazardous live currents and voltages. Do not touch any AC measurement inputs as this could lead to injury or death.**

Extra care must be taken that components are not replaced with power on the system.

## Definitions

Throughout this document, a number of notes and warnings will be presented. To ensure that these are noticed, they will be highlighted in order to separate them from the general text.

**Notes**

**The notes provide general information which will be helpful for the reader to bear in mind.**

**Warnings**

**The warnings indicate a potentially dangerous situation which could result in death, personal injury or damaged equipment, if certain guidelines are not followed.**

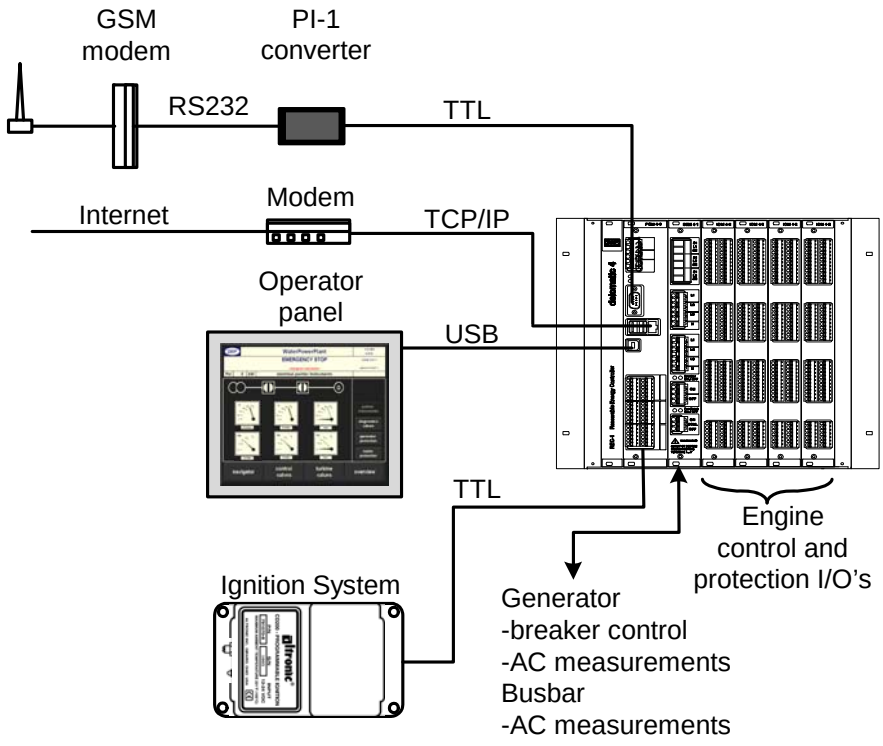
# 3. General overview

As a minimum, the DM-4 Gas system consists as minimum of a double-height (6 HE, 266 mm height) 19" rack mounted with the necessary I/O modules and a 12" colour graphic touchscreen operator interface.

The DM-4 Gas has a TCP/IP interface with a built-in webserver. This means that the graphic screens are stored here and can be accessed from any computer on the internet, using a free of charge DEIF HMI Client software and thereby enabling remote control and monitoring from anywhere in the world.

Connecting an RS232 GSM modem enables SMS clear text alarm messages.

General system layout:




**The ignition system and internet/GSM modems are not DEFI supply.**

# 4. Functional description

The Delomatic 4 Gas control system is laid out for control of a CHP plant driven by a gas engine. The following functions are carried out:

- Cooling water circuit control
- Gas mixer control
- Throttle valve control
- Exhaust temperature monitoring
- Exhaust gas flap control
- Synchronising
- Power control
- Automatic power reduction
- CosPhi control
- Mains failure protection
- Generator protection

The integrated visualisation software allows for uncomplicated operation using a panel touch PC placed in a console or on the wall. For remote control, it is possible to use an RS485 Modbus or an Ethernet TCP/IP.

- Graphic visualisation of functions and values
- Trend curves
- Log books
- Running hours dependent service timers

All the above are available as strong help tools for the operator, to give a quick overview, to make service easy and to handle problems in a quick way.

Parameters can be changed. They are password-protected.

## Measurements

- Generator and busbar/mains 3-phase AC voltages
- Generator 3-phase AC currents
- Power per phase/total
- Reactive power per phase/total
- 4-quadrant counter for power consumed/produced and reactive power consumed/produced
- Running hours
- Breaker operation counter
- Engine temperatures and pressures
- Exhaust temperatures
- Water circuit temperatures
- Room temperature
- $CH_4$ value
- Lambda voltage (if lambda sensor is present)
- Pulse counter, configurable
- Misc. plant measurements

## Protections

- Mains failure according to VDEW/VEÖ rules
- Support of a hardware safety chain with reset function acc. to VDE 0116
- Generator protections
    - Over-/undervoltage
    - Over-/underfrequency
    - Current asymmetry
    - Overload
    - Reverse power
    - Minimum load
    - Overcurrent
    - Thermal curve overcurrent
    - Reactive power high
    - Reactive power low (loss of AVR)
    - Vector jump
    - Df/dt
- Overspeed
- Wire fail safe monitoring of breaker position(s)
- Lube oil pressure
- Cooling water temperature
- Exhaust temperatures
- Exhaust back pressure
- Emergency stop
- Water level or water flow monitoring for cooling and heating circuits
- Digital error messages by monitoring switches and safety devices
- Error messages with configurable texts and fail classes
- Monitoring of regulators with regard to deviation from setpoint
- Monitoring of mixer pressure
- Tooth-to-tooth control of cranking
- Level monitoring of external oil storages (lube oil, waste oil)

## Control functions

- Automatic start/stop
- RPM with controlled ramp-up by start
- Synchronising with voltage matching and time monitoring
- Power ramp function (ramp up/ramp down)
- Sliding setpoint acc. to $CH_4$ value, gas level, gas pressure or mains power consumption
- Pre- and post-running of auxiliaries
- Engine post run
- Power reduction by oil temperature, water temperature and exhaust temperature
- Room temperature control in steps or analogue output to fan frequency converter
- Water cooling circuit control by 3-way valve and fan control
- Heating water circuit valve control
- Emergency cooling circuit control with 3-way valve and fan control
- Control of heating circuit pump, engine cooling circuit pump, heat exchanger pump
- Engine pre-heating
- Interval-controlled lube oil topping up, optional
- Exhaust flap control
- Control of air vent flaps
- $CH_4$ value control with correction of mixer position and power adaptation
- Gas compressor control
- Gas leak control
- Activation of ignition, starter motor, gas valve, throttle valve steps
- Mixer control

# 5. Operator interface

At the graphical operator interface, a number of pre-defined pages offer easy access to all data. The pages are arranged according to functions and can be accessed via the menus or via a central navigator page. In the status field, which is equal in all pages, a single look gives access to the condition of the plant and – if active – the most important error messages.

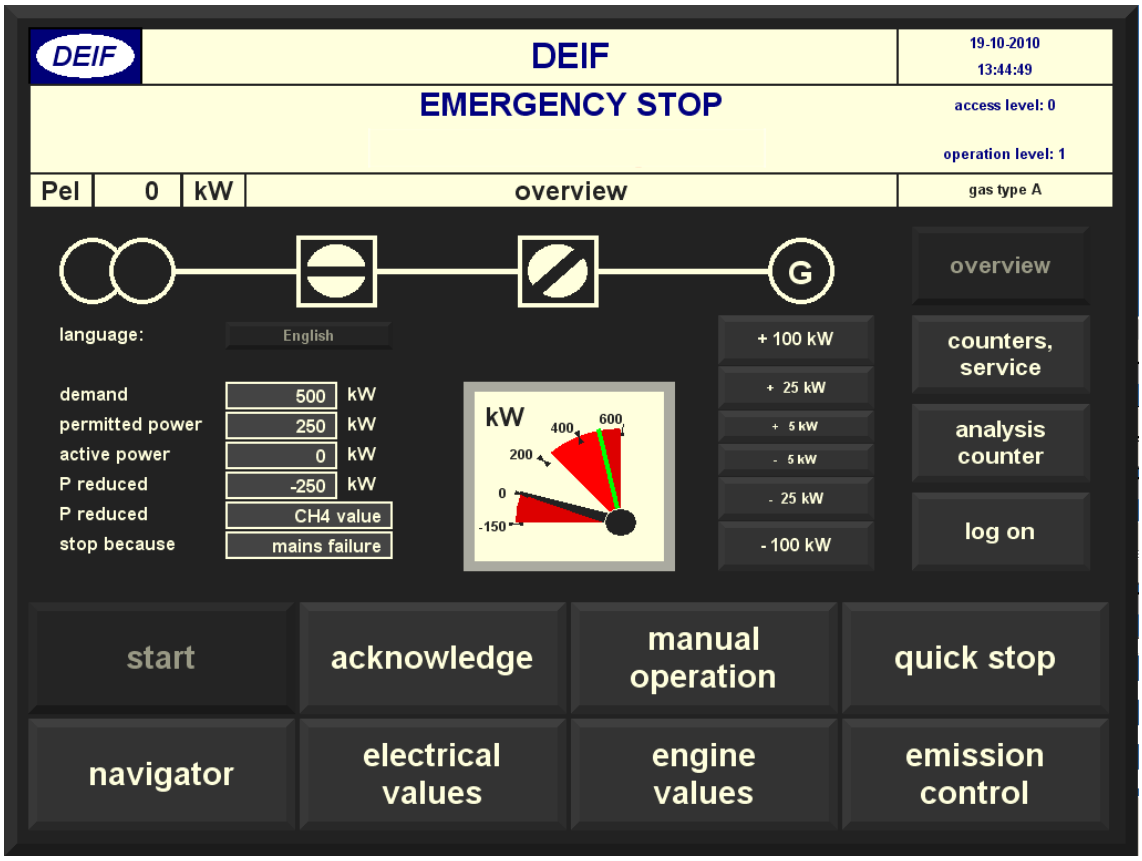
Graphic elements like e.g. breaker position, bar graphs and pointer instruments for electrical measuring values (kW, A, V, CosPhi) gives a good overview of the condition of the engine, generator, mains and plant.

The protective functions can be seen on special diagnostic pages with the present status, measured values limit values and running timers.

In the following, a number of examples are shown.

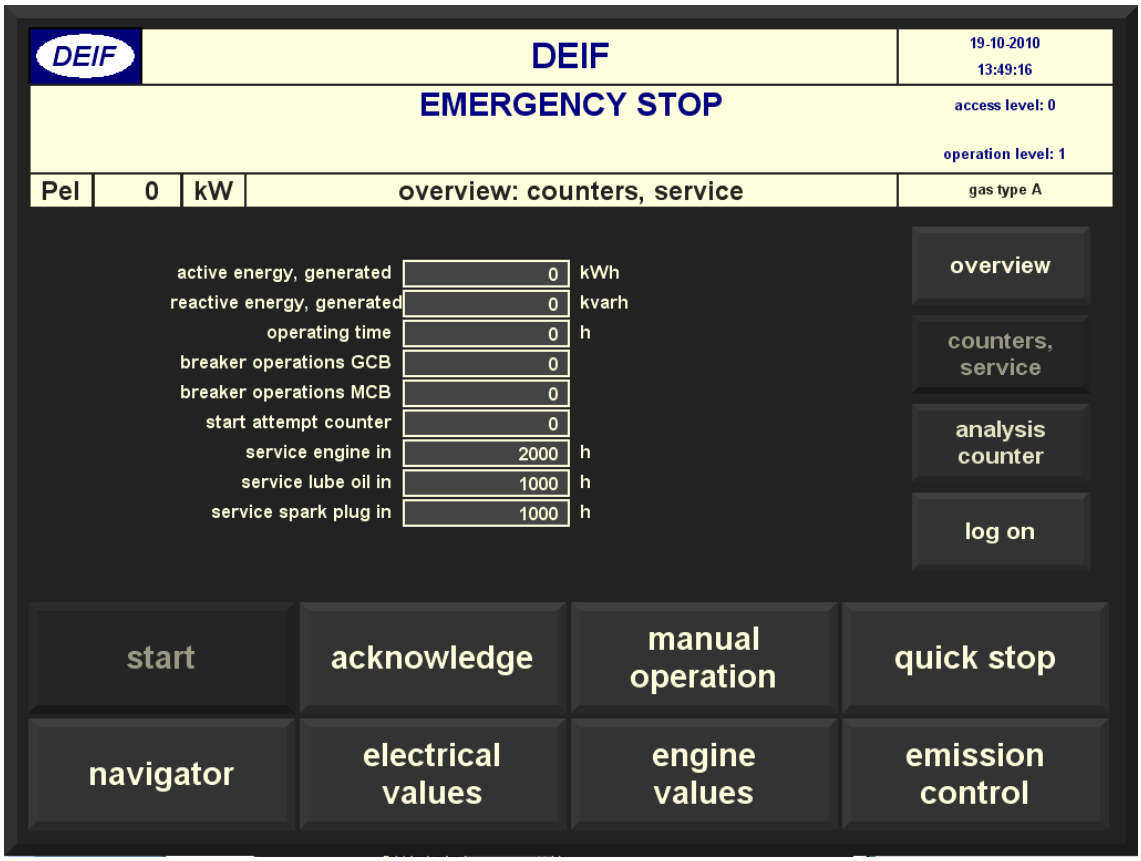
## Overview

The overview page gives a fast view of the present status of the plant. Using the eight selection buttons at the bottom of the screen, the most important pages can be accessed directly.



## Counters, service

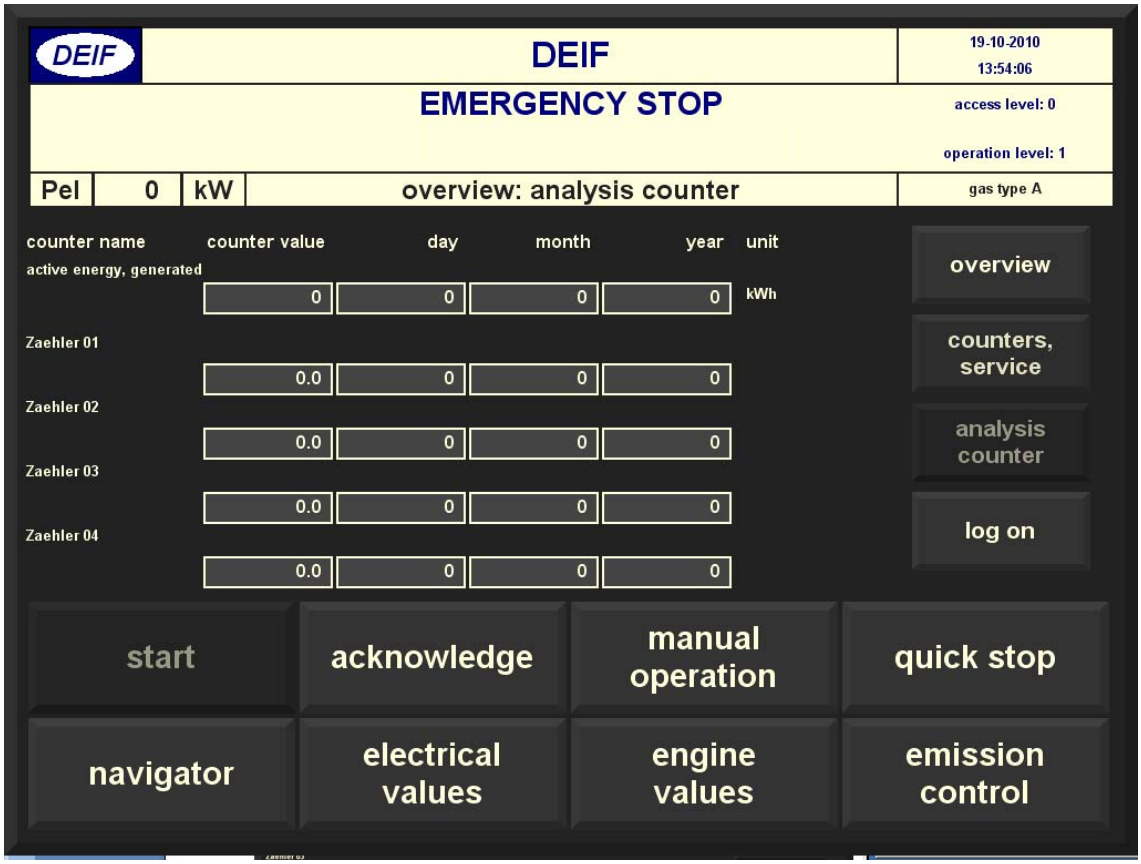
Display of energy counters (active, reactive) and plant hour counters. Besides these, the service timer, lube oil change timer and spark plug change timers are important. By accessing the parameter page for service timers, a run out timer can be reset.



## Analysis Counter

This page shows the counters for kWh and the configurable counters.

Behind the actual counter value, data for day, month and year are also indicated.

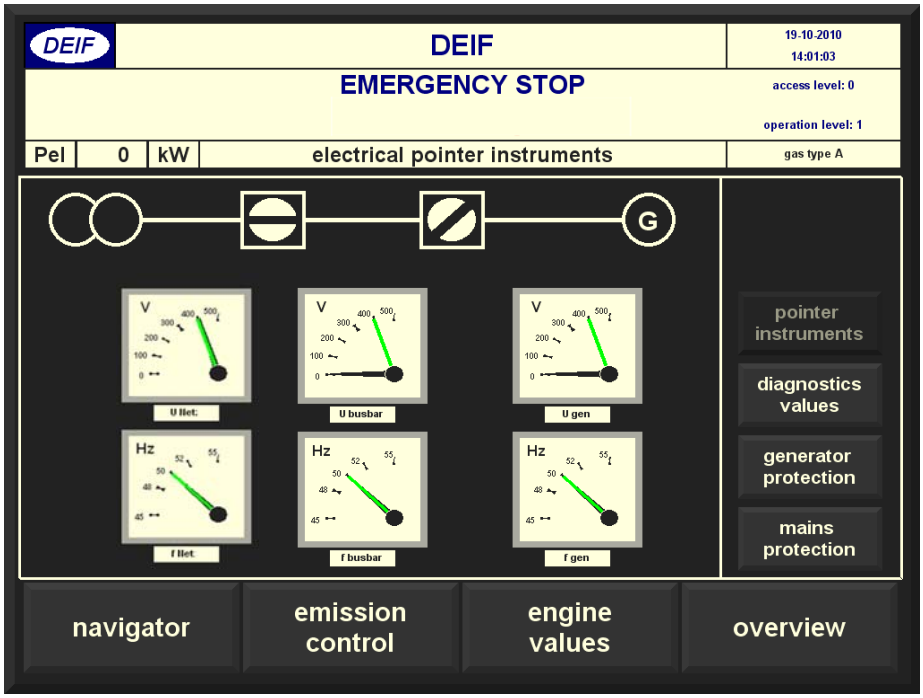



## Log on/log off

On the overview pages, you can log on/log off the system. If you are logged on the button "log on" changes name to "log off". It is always recommended to log off before you leave the system unattended.
Log off will happen automatically after a certain time without operation.

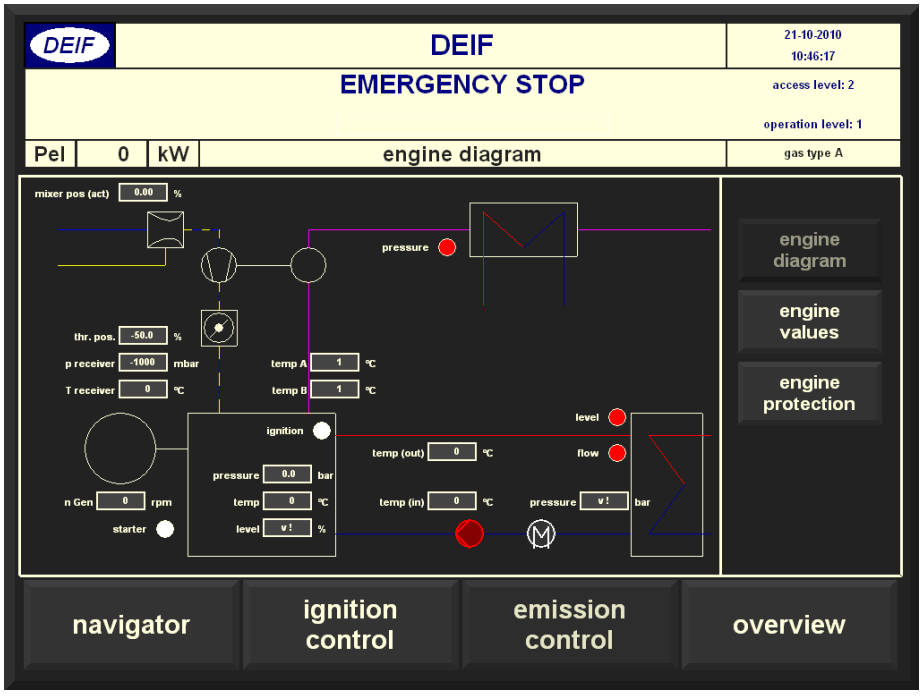
## Electrical values

These values are accessible via the overview page and the navigator.
In parallel with mains the currents as well as the power and CosPhi will be shown.



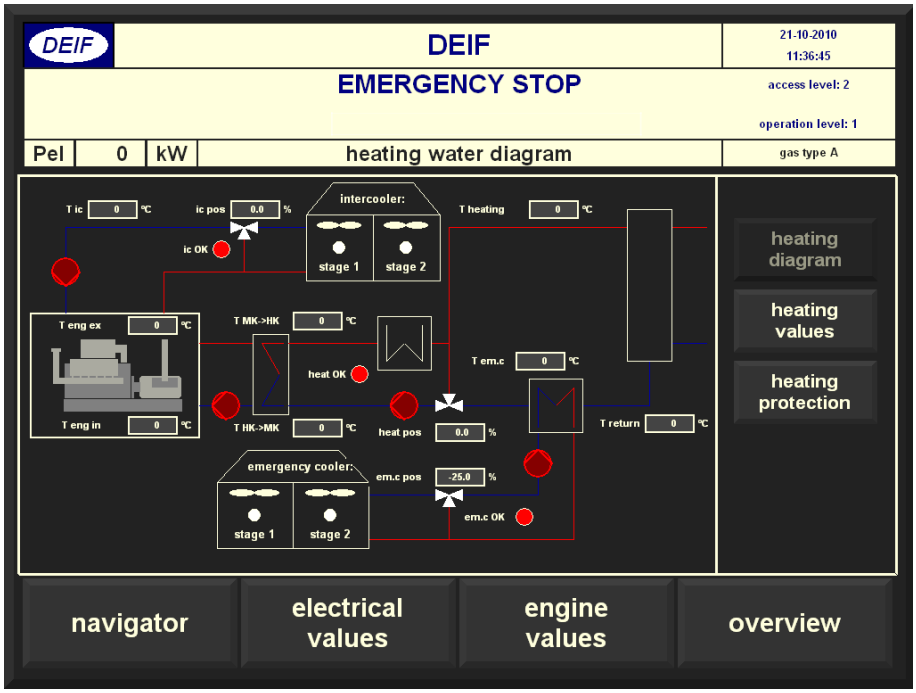

## Engine values

In the navigator engine values can be selected. There is a choice between pages engine diagram, engine values and engine protections. This illustrates the engine diagram:



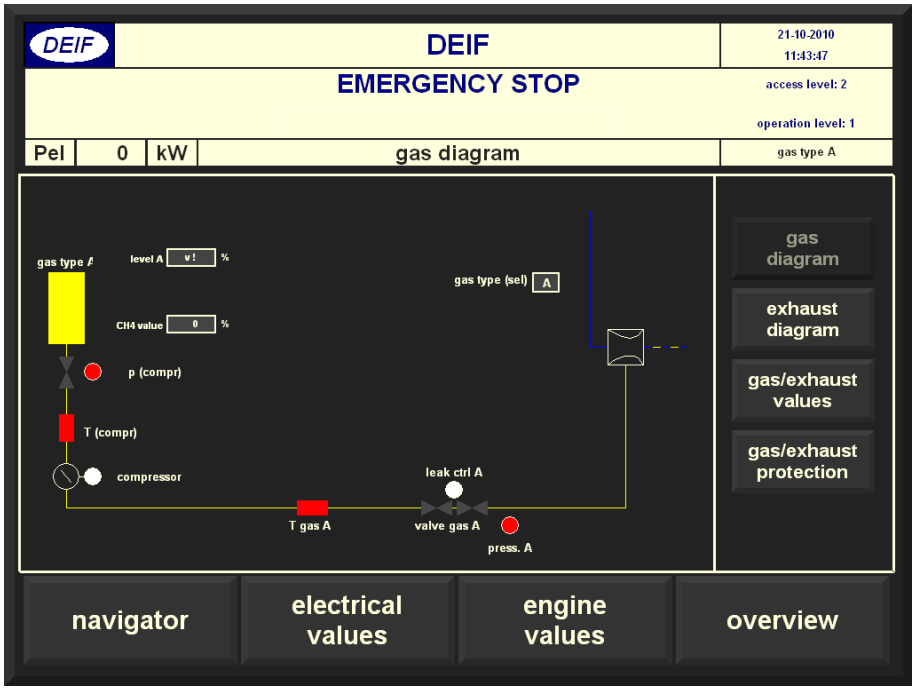
## Heating water diagram

In the navigator, heating water diagram can be selected. There is a choice between heating diagram (shown), heating values and heating protection pages. The intercooler and emergency cooler circuits are only shown if selected in the parameters.



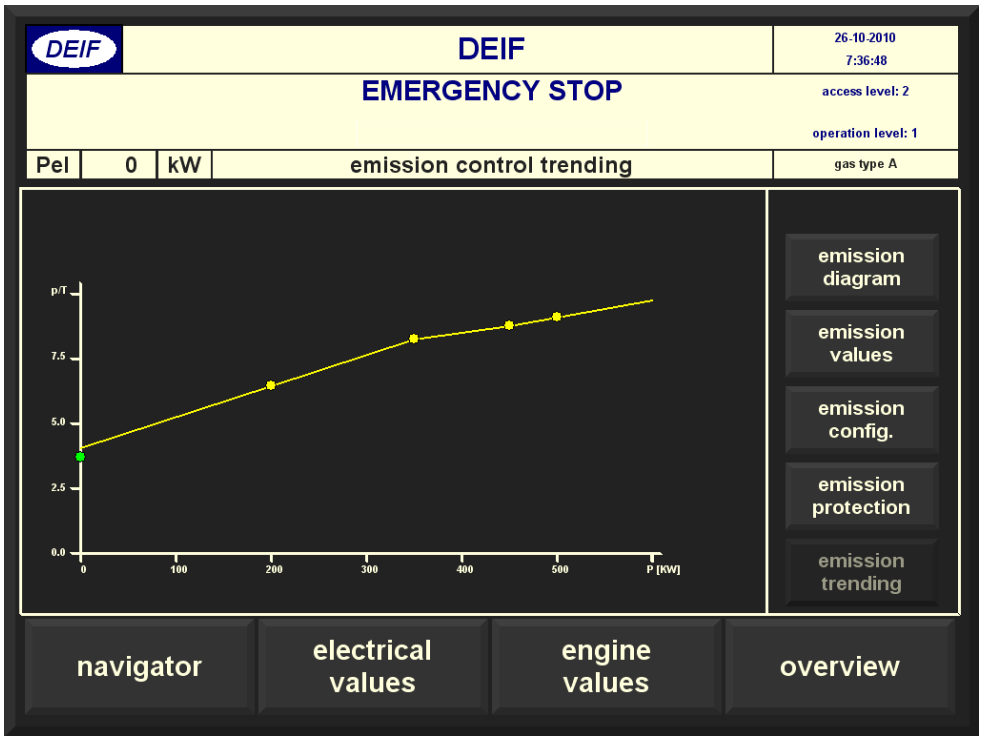

## Gas/Exhaust system

In the navigator, when selected, the gas/exhaust pages are shown. There is a choice between gas diagram (shown), exhaust diagram, gas/exhaust values and gas/exhaust protection.



## Emission control

The emission control pages can be accessed from the overview or navigator pages. It gives pages showing trending (shown), protection, configuration, values and diagram.
The trending shows the actual p/T value compared to the generator power production (the green dot). The yellow line is created in the configuration page, using a 4-point curve setting (illustrated by the yellow dots). The curve setting is done during commissioning by using the p/T values giving the lowest emission of harmful gases (measured in the exhaust).The green dot must follow the yellow line when the engine is running to maintain lowest possible emission values.



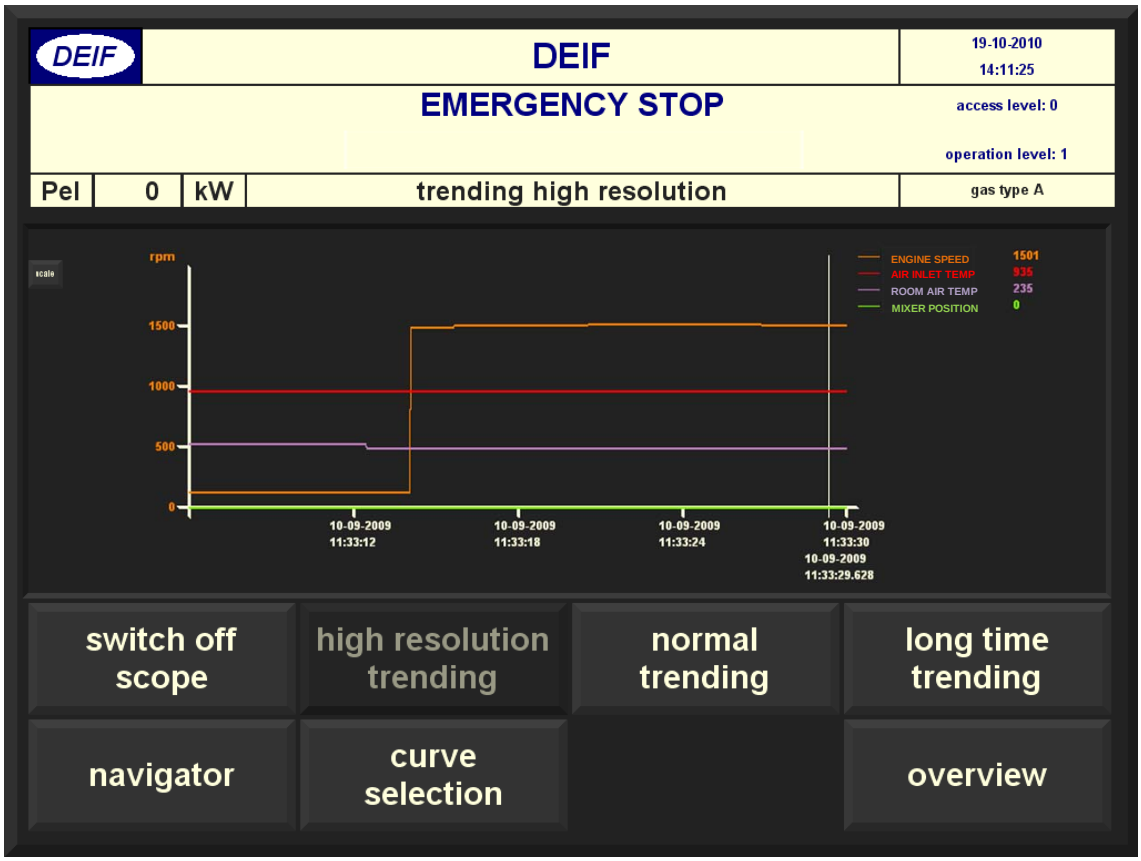

As an alternative, Lambda sensor emission control can be used. If Lambda is chosen in the gas mixer parameters, the mixer will be controlled based on the Lambda signal instead of the p/T signal.

## Trending

Trend curves can be accessed via the navigator. They are especially useful during commissioning. There is a choice of high resolution, normal resolution and long time trending. As soon as "switch scope on" is activated, the trending will start. For every available value, 600 points with time stamps can be saved.

### Curve view

The view can handle up to 10 different values.

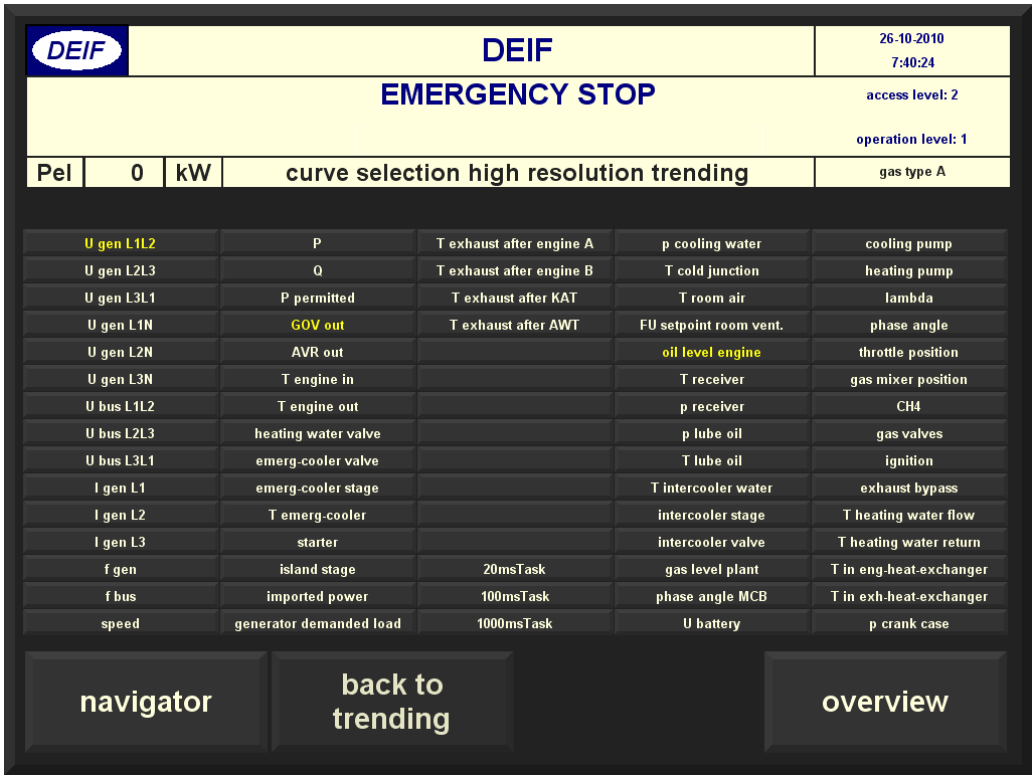



The small "scale" button in the top left corner by the side of the unit axis makes it possible to select the axis scaling to match the curves chosen.

When clicking "switch off scope", the trending is stopped and the values stored can be analysed.

### Curve selection

The available curves are shown when clicking on "curve selection".




The chosen values are highlighted (yellow).
The curve storing continues as long as the scope is ON.

## Logs

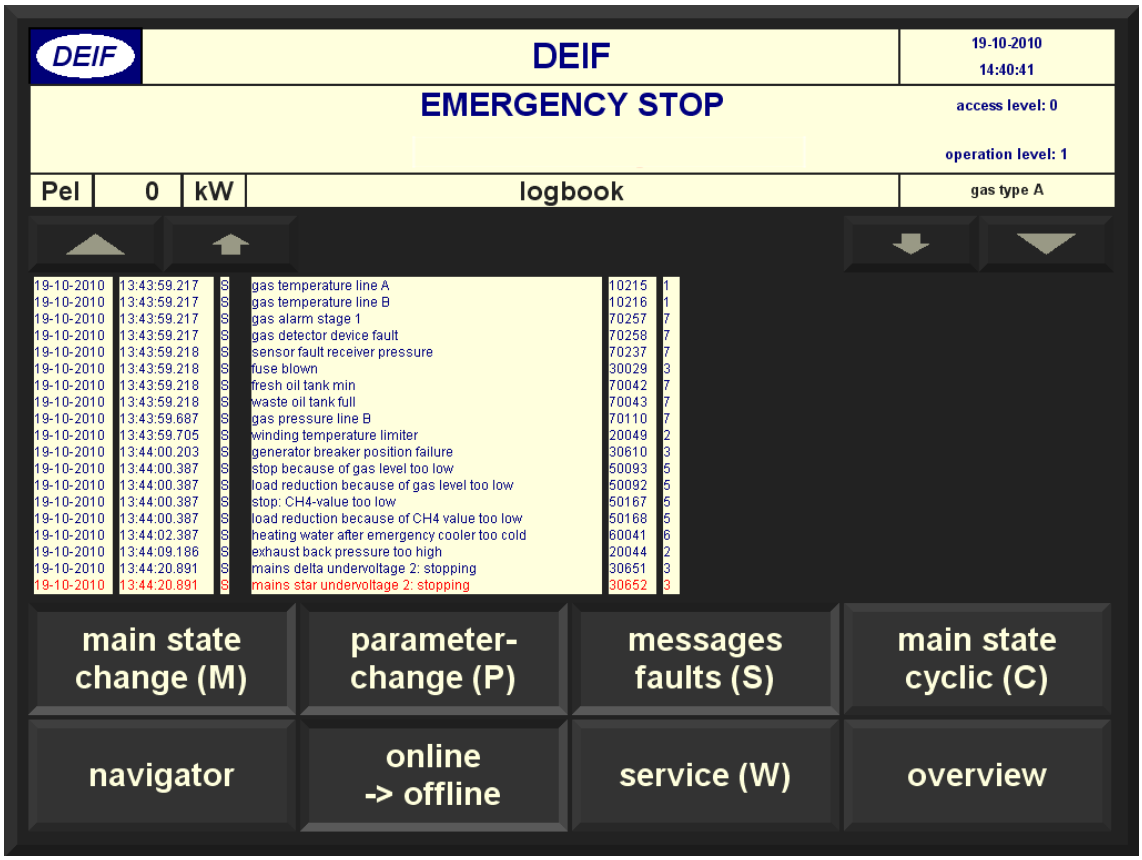
Logs are accessible via the navigator page. In the logs, the following abbreviations are used:

M: Event log
P: Parameter setting changed
S: Alarm log
C: Cyclic events
W: Service log

By activating the corresponding buttons, the log in question will be shown in the list. The logs will be presented sorted by time.

If "Offline" is chosen, it is possible to see all historic logs.

In "Online", the log shows the actual logs, the newest logs are at the bottom of the list.




Offline mode: the triangular buttons are used to scroll up and down in the logs. The offline mode only shows the logs up to the time of selection of the offline mode. When scrolling, the view scrolls 18 indications, leaving the 19$^{th}$ from the previous view. If there are less than 19 logs, the upper line will be greyed out.

### Main state change

The main state change selection makes it possible to follow the main states of the system. These are shown as: date, time, M, state and level.
Max no. of logs: 250.

### Parameter change

Every parameter change is logged and can be seen when activating this button. The changes are shown as: date, time, P, parameter text, parameter number, old value, new value.

The parameter number equals the number shown in the parameter editor. The number is specific, which rules out mistakes.

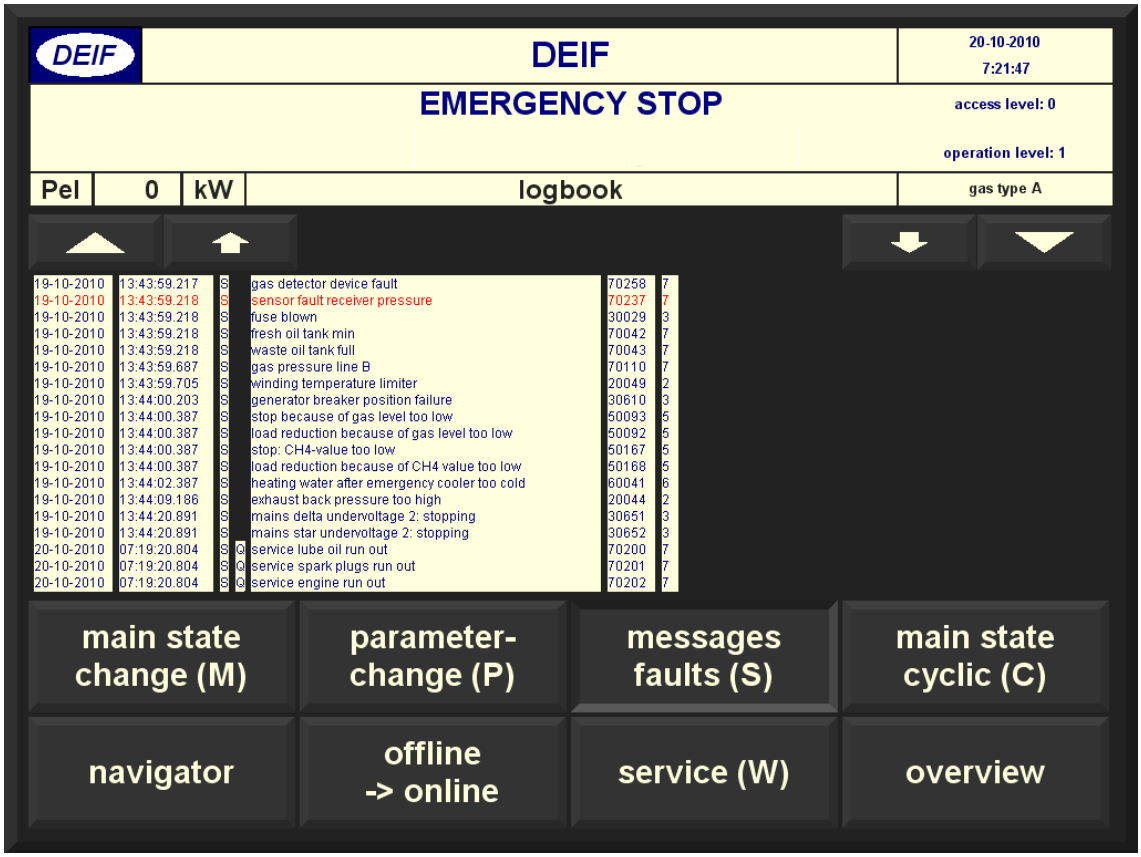
Special loggings: login (user, service or master) is logged under parameter change.

The log holds 250 loggings.

### Messages/faults

A column is added here indicated if the message/fault has been acknowledged (Q). The lines read: date, time, S, [Q], text, message number, level.

**The active alarms can be read and acknowledged on the page "active alarms", which can be accessed via the navigator page**



### Main state cyclic

Every full hour, a log of the actual state of the system is made, including total gas consumption, running hours and produced energy (kWh).
Each line shows: date, time, C, state, level, gas consumption, running hours, produced energy.

Number of logs: 250.

### Service

The service log shows the coming up services as well as already carried out services (Q), indicated when the counter is reset.
Each line shows: date, time, W, [Q], text, running hours.

Number of logs: 200.

# 6. Conditions and error messages

The present main condition of the system is at all times indicated on the user interface. Right below the main condition, the sub-conditions are indicated. Also a red text will indicate an active alarm. The alarm indication will, in case of more active alarms, indicate the most severe alarm condition.

## Main conditions

The following main conditions are present:

SYSTEM BOOT
SYSTEM START
EMERGENCY STOP
SHUTDOWN
RESET SAFETY CHAIN
START BLOCKED
READY TO START
STOPPING
START PREPARE
CRANKING
IGNITION
GAS VALVE OPENING
ACCELERATING
IDLE
POST RUN
BREAKER OPENING
PARALLEL TO GRID
TEST RUN

## Sub-conditions

The following sub-conditions are present:

Water valve closed
Air flaps opening
Air flaps closed
Exhaust flap opening
Exhaust flap closing
Pre-glow
Ignition ON
Cranking ON
Crank pause
Engine running
Voltage adjustment
Cos Phi adjustment
Frequency adjustment
Power adjustment
Power reduction
Ramp down
Waste oil pump running

## Error messages

Error messages are presented in clear text. For each error message, there will, next to the text, be a running level indication.

The levels are:

| Level | Level name |
|---|---|
| **0** | System Boot, System Start |
| **1** | Emergency stop |
| **2** | Fast stop |
| **3** | GCB trip, sync block |
| **4** | Synchronise but do not close GCB |
| **5** | Normal run (may cause soft stop, dependent on the alarm in question). |
| **6** | Power reduction (reserved, not used) |
| **7** | Warning |

The first number in the error indication is the level which is accepted by the error in question. In the status field, the most important error messages are shown.

Some error messages initiates the following actions:

- A – Open generator breaker
- R – Regulator stop
- N – Emergency stop

DEIF A/S reserves the right to change any of the above.