Handbuch/Manual/Manuel/Manuale 12/2002

gas analysis

CALOMAT 6

für die Applikation 'Turbogenerator-Überwachung'
for the turbo generator monitoring application
pour l'application 'Surveillance de turboalternateurs'
para la aplicación 'control de turbogenerador'
per l'applicazione 'Monitoraggio turbogeneratore'

SIEMENS

English

Contents

1 General information 3

2 Device description 4

2.1 Scope 4
2.2 Task definition 4
2.3 Explosion protection, Device variants 5

3 Technical data 6

4 Operation. 7

4.1 General information 7
4.2 Introduction to the operating levels 7
4.3 Default parameterization of the analyzer 8

5 Filling and emptying the analyzer. 9

6 Calibration 10

6.1 Calibration with inert gas, hydrogen and air 10
6.2 Changing the inert gas 11
6.3 Making ready for operation 11

7 Maintenance 12

8 Spare parts list 13

1 General information

These additional operating instructions describe only the changes that are necessary for operation of turbo generator monitoring compared to the standard operating instructions for the CALOMAT 6. For more detailed information about the CALOMAT 6, please refer to the standard operating instructions (order no. A5E00116455).

When using an analysis system (system cabinet with CALOMAT 6E type withdrawable units) for operation in Ex zone 2, the “**Special Conditions**” in the **EC Type Test Certificate** enclosed with the CALOMAT 6 must always be observed.

Under certain circumstances, the technical data listed in these additional operating instructions may deviate from that described in the standard CALOMAT 6 operating instructions. In this case, the technical data presented in Chapter 3 of these additional operating instructions is applicable.

To achieve perfect, reliable operation of the analysis equipment and any additional equipment required, it may only be used in the manner described by the manufacturers. In addition the perfect and safe operation of this product is conditional upon proper transport, storage and installation as well as careful operation and maintenance.

These additional operating instructions are aimed at technically qualified personnel. Familiarity with and technically perfect application of the safety instructions and warnings described in these additional operating instructions are a prerequisite for safe installation and commissioning. Only qualified personnel have the necessary professional knowledge to be able to correctly interpret the safety information and warnings given in general terms in these additional operating instructions and to put them into practice in actual individual cases.

These additional operating instructions are included in the delivery of the analyzer, even if separate ordering has been made possible for logistic reasons. For clarity reasons thess instructions cannot cover all possible cases in connection with installation, operation, maintenance or the use in systems. Should you require further information, or should particular problems occur which are not handled in sufficient depth in these instructions, help can be requested through your local Siemens office or representative.

2 Device description

2.1 Area of application

Turbo generators are cooled with hydrogen, because this allows greater power dissipation than when operating in air, without increasing the temperature of the windings. A further benefit results from the higher electrical breakdown strength and lower internal friction. Against these advantages is the disadvantage that hydrogen is flammable and is explosive when mixed with air at concentrations of between 3 and 77%.

In order to prevent the formation of a flammable mixture, the air must be displaced with an inert gas before the generator is filled with hydrogen. Argon or carbon dioxide are used for this purpose. The filling process can be interrupted if the emerging inert gas/air mixture contains more than 95% inert gas. The subsequent filling process with hydrogen can be completed at a concentration of 96…98%.

The generator is emptied in the same way as it is filled: Hydrogen is displaced by inert gas and the generator is then filled with air.

For monitoring hydrogen-cooled turbo generators, redundant measurement is required in accordance with EN 60034 and IEC 60842. Therefore two independently functioning analyzers must be used for each generator.

2.2 Task definition

Filling, operating and emptying a turbo generator cooled with hydrogen requires constant monitoring, which is done using a CALOMAT 6 that works on the thermal conductivity measuring principle. The CALOMAT 6 variant optimized for this measuring task has three measuring ranges, which can be used to perform the following tasks:

- **Monitoring of the filling and emptying process**
  As mentioned in the introduction, in the **filling process** the displacement of the air by the inert gas and its displacement by the hydrogen are monitored. In the same way, the **emptying process** involves displacing the hydrogen with the inert gas and then displacing this with air.
  For this task, two of the CALOMAT 6's measuring ranges are set as follows:

  0...100 % inert gas in air
  0...100 % hydrogen in inert gas

- **Monitoring of the operating state**
  To prevent the formation of a flammable mixture **during operation**, the purity of the hydrogen is monitored in the measuring range of

  80...100 % hydrogen in air

2.3 Explosion protection/device variants

If the occurrence of hydrogen vapors cannot be ruled out in the immediate vicinity of the analysis equipment, the equipment must be suitable for use in areas with a risk of explosion.

When using CALOMAT 6E type withdrawable units for use in Zone 2 areas with a risk of explosion, the “Special Conditions” in the enclosed EC Type Test Certificate must be observed. For this application, the analyzers must be installed in a suitable enclosure (switch cabinet) with protection class IP 54 or higher. This enclosure must have ventilation slits, which ensure sufficient air change. For the CALOMAT 6E an air change value L of at least 1/h is required!

When using field version analyzers (CALOMAT 6F) for use in Zone 2 areas with a risk of explosion, no special protective measures are necessary as these devices conform to protection class IP 65. However, controlled external ventilation with inert gas is required in this case (simplified pressurization).

If the possibility of an explosive gas mixture occasionally forming in the analyzers’ measuring gas path cannot be ruled out, flame arresters must be fitted in the measuring gas supply lines. If the measuring gas is discharged into an area with no risk of explosion, there is no need for flame arresters on the device outlets.

The necessary supply and discharge lines should be stainless steel pipes with an external diameter of 6mm or ¼" with clamping ring connections (e.g. Swagelok); cutting ring connections may not be used for this purpose!

3 Technical Data*)

Measuring ranges	0...100 % inert gas in air 0...100 % H_2 in inert gas 80...100 % H_2 in air

Electrical Data

EMC immunity (Electromagnetic compatibility)**)	to EN 61326, NAMUR NE 21 (08/98)
Electrical safety	to EN 61010-1, Overvoltage category II
Power supply (see nameplate)	AC 100V -10%...120V+10%, 47 to 63 Hz or AC 200V -10%...240V+10%, 47 to 63 Hz
Power consumption	approx. 20 VA
Fuse values	100 ... 120V T 1/250 200 ... 240V T 0,63/250

Construction, Housing

Normal position	Front panel vertical
Degree of protection	
- Withdrawable enclosure C6 E***)	IP 20 to EN 60529
- Field enclosure C6 F	IP 65 to EN 60529
Weight	
- Withdrawable unit C6 E	approx. 10 kg
- Field device C6 F	approx. 25 kg

Gas path

Materials in contact with gas:	
- Sensor	Si, SiOxNy, Au, glass, Epoxy resin
- Gas connections, internal gas path	Measuring cell body, Stainless steel 1.4571
- Seals (O-rings)	FFKM (e.g. Chemraz)
Consistency	Leakage < 1 µl/s

Gas input conditions

Measuring gas pressure	800...1100 hPa (abs.)
Measuring gas flow	30...90 l/h (0.5...1.5 l/min)
Measuring gas temp.	0 to 50°C
Measuring gas humidity	< 90% RH [1])
Measuring cell temp.	approx. 60°C
Purging gas pressure in C6 F	165 hPa, short-time 250 hPa

Measuring and time response[3])

Warming-up time	< 30 min[2])
Display delay T90	< 5 s
Elec. attenuation	0 to 100 s, adjustable
Idle time (at 1 l/min)	approx. 0.5 s
Output signal fluctuation**)	< ±0.75 % of smallest poss. measuring range as per nameplate at electronic attenuation of 1s (σ = 0.25 %)
Drift	< 1% / week of smallest possible measuring span as per nameplate
Repeat accuracy	<1% of relevant measuring span
Linearization	Measuring range 1 and 3 linearized
Linearity deviation	<±1% of relevant measuring span for measuring range 1 and 3; <±5% of measuring span for measuring range 2)

Influencing variables [3])

Ambient temperature	< 1% / 10 K, related to smallest possible measuring span as per nameplate
Measuring gas flow	< 0.2 % of smallest possible measuring span as per nameplate at a flow change of 0.1 l/min within permissible flow range
Measuring gas pressure	< 1% at a pressure change of 100 hPa
Power supply	< 0.1% of output signal voltage at rated voltage ±10%

Electrical inputs and outputs

Analog output	0 / 2 / 4 at 20 mA, zero potential; Load impedance max. 750 Ohm
Relay outputs	6, with change-over contacts, freely parameterizable; current carrying capacity: AC/DC 24 V / 1A, zero potential
Analog inputs	2, set to 0 / 2 / 4 to 20 mA for ext. pressure sensor and lateral gas correction
Binary inputs	6, set to 24 V, zero potential; freely parameterizable
Serial interface	RS 485
Options	Additional electronics with 8 additional binary inputs and relay outputs; additional electronics for PROFI-BUS PA/DP

Ambient conditions

Permissible ambient temperature	-30 to +70°C for storage and transportation, +5 to +45 °C in operation
Permissible humidity	< 90% RH[1]) for storage and transportation

[1])RH = Relative humidity

[2])Maximum accuracy is achieved after 2 hours

[3])based on measuring gas pressure 1 bar abs., 1 l/min measuring gas flow and 25°C ambient temperature

*)based on EN 61207 / IEC 120

**) all signal lines must be shielded. In areas with strong electromagnetic interference, measured value deviations of up to ±0.1 % H_2 can occur.

***) If a natural air change value of > 1/h cannot be guaranteed, forced ventilation of the installation site (e.g. switch cabinet) must be carried out.

4 Operation

4.1 General Information

Warning
Before operating the device, the safety information in chapter 4.1 of the CALOMAT 6 operating instructions must be observed.

Note
The operator must also familiarize himself with chapter 5 (“Operation”) of the CALOMAT 6 operating instructions.

Compared to the standard CALOMAT 6 version, the firmware (software) for the turbo generator monitoring application has been changed in certain respects. In particular, this relates to the following menu items:

"Calibration":	Operating functions 20, 21, 22, 23 and 24 have been removed Operating functions 26, 27 and 28 are new
"Measuring ranges":	Operating function 41 has been removed. Operating function 40 has been changed.
"Configuration":	Operating functions 78 and 79 have been changed.

4.2 Introduction to the operating levels

After being turned on, the device can only be operated after approx. 15 minutes, as the measuring cell first has to be heated to 60°C (warming-up time). When the device is turned off briefly after operation, it goes back into its warm-up phase, which in this case only lasts around 5 min.

Depending on the operating level, the entry of code numbers is required. These code numbers are preset to the following values in the factory:

Code level 0: **0 0 1** Code level 1: **1 1 1** Code level 2: **2 2 2**

These codes should be changed at the user’s own discretion (operating function 79: "Edit codes"). The individual code numbers are confirmed by pressing the **ENTER** key.

4.3 Default parameterization of the analyzer

The analyzer is delivered from the factory with preset default parameterization:

- Analog current output (function 70): 4-20 mA
- Analog current memory (function 77): 4 mA
- Relay assignment (funktion 71):

No.	Function
1	Fault
2	Function check
3	- not assigned -
4	- not assigned -
5	Measuring range code MB3
6	Maintenance request

This parameterization can be changed by the operator at any time.

5 Filling and emptying the generator space

First of all, the appropriate measuring range must be activated using operating function 40 (Select measuring range). The filling and emptying process can be observed in the measuring screen.

- **Filling**

  Before the generator is filled with hydrogen, the air in it must be replaced by an inert gas. For this,

  measuring range 1 (0...100 % inert gas in air)

  should be selected. During the filling process, the measured value display increases towards 100% inert gas. When a particular inert gas concentration is reached (e.g. 95%), filling with hydrogen can begin and

  measuring range 2 (0...100 % hydrogen in inert gas)

  is then selected. After filling with hydrogen is complete, the turbo generator is ready to operate and the purity of the hydrogen is then monitored using

  measuring range 3 (80...100 % hydrogen in air).

  The device now displays the hydrogen concentration in the operating state. If air gets in, resulting in a risk of explosive mixtures forming, the CALOMAT 6 can trigger set alarms.

- **Emptying**

  To remove the hydrogen from the generator, first of all

  measuring range 2 (0...100 % hydrogen in inert gas)

  is selected and then the flow of inert gas is started. The measured value falls towards 0% hydrogen. When a particular inert gas concentration is reached (e.g. 5 %), the flow of air can be started. For this,

  measuring range 1 (0...100 % inert gas in air)

  should be selected. The measured value falls towards 0% inert gas.
  The emptying process is complete when the inert gas concentration falls below a particular level (e.g. 2.5%).

6 Calibration

6.1 Calibration with inert gas, hydrogen and air

Regular calibration with inert gas and hydrogen is carried out using the menu-controlled calibration process under operating function 26 (“Start calibration process”).

Calibration with air is not normally required/desirable. The ‘Air’ measuring point is set in the factory with synthetic air (80% nitrogen, 20% oxygen).

- Inert gas (argon or carbon dioxide)
  First of all, the operator is prompted to introduce the relevant inert gas. When the actual value is stable, the calibration process can be launched. After confirmation of successful inert gas calibration, the device prompts the operator to introduce hydrogen.

- Hydrogen (H_2)
  The calibration process proceeds in the same way as for inert gas. After the message that hydrogen calibration was successful, it is possible to switch into measuring mode by pressing the MEAS key and transferring the changes.

- Air
  Although it is possible to calibrate measuring range 1 with air (operating function 27), this should only be used in exceptional cases (e.g. after replacing a defective measuring cell or changing the inert gas – e.g. from carbon dioxide to argon); for this reason it is not one of the operating functions that the operator can access at code level 0.

- Plausibility monitoring
  The device detects the introduction of an incorrect calibration gas (e.g. air instead of inert gas) for the calibration process. In this case, the calibration process cannot be launched. The message “Cal. threshold violated” then appears in the display.

- Canceling calibration
  Canceling the calibration process at any point discards all parameters determined during that particular calibration. The original state before calibration is thus restored.

6.2 Changing the inert gas

Before delivery of the device, the measuring ranges have been calibrated with carbon dioxide (CO_2), hydrogen (H_2) and synthetic air, consisting of 80% nitrogen (N_2) and 20% oxygen (O_2).

If necessary, argon can be chosen as the inert gas instead of carbon dioxide. The change is made under operating function 28 (“Select inert gas”).

Recalibration of the measuring ranges is then necessary (see above section). Calibration with air should also be carried out. This is done using operating function 27. The single-stage process is similar to that described under operating function 26.

6.3 Making ready for operation

To make the device ready for operation, the following steps should be carried out:

- Switch to measuring range 3 (80…100% hydrogen in air); at the same time the switching contact on relay 5 closes.
- Pressing the MEAS key again codes the device and it is then ready to operate. In the status bar, the display item CODE switches to “on” and the display item CTRL (function control) changes to “off”. At the same time the switching contact on relay 2 opens.
- The make contacts of all relays described are closed while the relay coil is in an idle state.

7 Maintenance

- **Maintenance request, Fault**
  Relay 6 (maintenance request) and relay 1 (fault) always close when a corresponding message has been entered in the log book. To remove the causes of these messages, the measures described in chapter 6 (“Maintenance”) of the CALOMAT 6 operating instructions should be carried out.

- **Leak test**
  As specified in the EC Type Test Certificate, a leak test on the gas path must be carried out at regular intervals. The maintenance interval for this test is at the discretion of the operator. The testing level and the procedure for this test are set out as follows:

  At an excess pressure of 100 hPa (100 mbar) the gas enclosed in the gas path may fall by 2 hPa in 5 minutes at a total volume of 12 ml (volume of the CALOMAT 6 between the measuring gas inlet and outlet). If the enclosed volume is greater than 12 ml for the leak test, the test criteria should be altered by a factor of V/12 ml (either by reducing the permissible pressure drop or extending the duration of the test). A tube with an internal diameter of 4 mm and a length of one meter has a volume of approx. 12.6 ml.

- **Changing the filter**
  Withdrawable CALOMAT 6E type units for use in Zone 2 areas with a risk of explosion must be fitted in a suitable enclosure (switch cabinet) with a minimum protection class of IP 54 and allowing an air change value of at least 1/h, as specified in the EC Type Test Certificate. In order to guarantee an appropriate gas exchange rate with a natural air change (no forced ventilation) using filter mats integrated into the switch cabinet, the filter mats should be checked at regular intervals. If necessary, they should be cleaned or replaced. The frequency of these checks depends primarily on the local conditions.

Please observe the more detailed maintenance instructions in the standard operating instructions (chapter 6).

8 Spare parts list

With the exception of the components listed below, the spare parts for the ‘Turbo generator monitoring’ application are outlined in the standard operating instructions (chapter 7). These exceptions are as follows:

Description	Order no.
Baseplate without firmware	C79451-A3474-B601
Baseplate with generator monitoring firmware, German	A5E00185971
Baseplate with generator monitoring firmware, English	A5E00185972
Baseplate with generator monitoring firmware, French	A5E00185973
Baseplate with generator monitoring firmware, Spanish	A5E00185974
Baseplate with generator monitoring firmware, Italian	A5E00185975
Generator monitoring firmware, German	A5E00185976
Generator monitoring firmware, English	A5E00185977
Generator monitoring firmware, French	A5E00185978
Generator monitoring firmware, Spanish	A5E00185979
Generator monitoring firmware, Italian	A5E00185980

For the ‘Turbo generator monitoring’ application, please do **not** order the firmware or baseplates with firmware from the standard operating instructions (chapter 7) with the order numbers

A5E00092676 ... 92680 or
A5E00124006 ... 124011.

4 019169 118743

1P A5E00185981

Siemens AG

Bereich Automation and Drives
Geschaeftsgebiet Process Instrumentation
D-76181 Karlsruhe

www.siemens.com

A5E00185981-01

A5E00185981D-01 GN: 30120 - Colomat 6