ATEX Compliant Gas Analyzer for Hydrogen-cooled Alternators
Type 6553

- CENELEC (ATEX) Certification
  - intrinsically safe to EExia IIC for hydrogen

- Continuous monitoring
  - fail-safe alarms indicate immediate danger conditions

- Direct-reading Katharometer in single, dual and triple range panels
  - low installation and maintenance costs

- Option of independent redundant systems
  - enhanced security of measurement

- Customized LCD indication
  - full flexibility of membrane touch-pad switches

Superior technology and quality from the world leader in hydrogen measurement
Application
Modern high capacity turbogenerators need to be efficiently cooled. Hydrogen, with a thermal conductivity of about seven times that of air, is in general use as the coolant. Great care and accurate measurement is necessary to ensure that the hydrogen remains pure during operation of the machine: air entering the system could produce a potentially explosive mixture.

The highest level of hydrogen purity is required in order to reduce the ‘windage’ losses.

Similarly, when it is necessary to remove the hydrogen for maintenance, it is not desirable to purge directly with air, due to the risk of explosion. The purging sequence therefore comprises two distinct operations: hydrogen is purged from the system using carbon dioxide, nitrogen or argon; followed by the removal of the purge gas with air. This sequence is reversed for refilling.

The Katharometer provides a reliable means of measuring any two component (binary) gas mixtures and is the ideal monitoring system for turbogenerator applications.

Katharometer

Principle of Operation
The Katharometer comprises a Wheatstone bridge, each arm of which contains a fine, glass-coated, platinum wire. One pair of parallel arms is sealed in a reference gas of known thermal conductivity and the other pair is exposed to the sample gas. A constant current is passed through the bridge network. Where sensitivity allows, two filaments can be replaced by fixed resistors.

When a constant current is passed through an electrical conductor surrounded by gas in a chamber, the temperature rises to a point of thermal equilibrium. Providing radiation, convection and end-conduction losses are minimized, the temperature of the conductor depends upon the heat loss by conduction through the gas. The temperature attained is, therefore, related to the thermal conductivity of the surrounding gas and hence, the resistance of the wire is a function of the thermal conductivity.

Any difference between the thermal conductivities of the reference and sample gases causes an imbalance of the bridge. The out-of-balance current is therefore a function of the difference in thermal conductivities of the two gases and a display unit can be calibrated directly in terms of the percentage of one gas with another.
Description
A complete system for the turbogenerator application comprises:
- Display and control monitor
- Two gas analysis assemblies
- Two power supply units

The power supply units Model 4234500 or 4234501 provide the analyzer assemblies with a stable 350mA d.c. supply. These power units must be installed in a ‘safe’ area but the current output from them may be transmitted to the Katharometers in the danger area.

Two gas analysis assemblies (Models 6540–203 or 6548–000) are necessary to provide the three required ranges. Each assembly is fitted with a thermally lagged Katharometer, a needle flow-control valve, a flow gauge and a drying chamber.

The Katharometer system is available in three formats all of which are CENELEC certified EExia IIC T4. T_{env} -20°C/+55°C (Zone 0):
1) One Katharometer system indicates only Hydrogen purity by measuring 100 to 85%, or 85 to 100%, H₂ in air.
   An optional range of 80 to 100% H₂ in air is user selectable.
   This is accompanied by a dual range Katharometer measuring the purge sequence 0 to 100% H₂ in purge gas and 0 to 100% air in purge gas.
2) For applications where duplication of reading is important, two Katharometer systems can be used, each incorporating three-range Katharometers and measuring 85% to 100% H₂ in air; 0 to 100% H₂ in purge gas; and 0 to 100% air in purge gas.
3) Where only the Hydrogen purity measurement is required a single instrument is used measuring 85 to 100% H₂ in air or 100 to 85% H₂ in air.

The Display and Control Monitor Model 6553 is CENELEC Certified EExia IIC T_{env} -20°C/+40°C and designed to be incorporated into the turbogenerator purge control cubicle. Two ABB 4689 Indicators are provided. The upper indicator is calibrated to the required hydrogen-in-air range and is fitted with two-step alarms for falling hydrogen purity and the means to drive the instrument downscale (the low purity end) when the input is open circuited. The lower indicator is dual ranged for the purge sequence and also has a device to drive downscale (to zero) when the input is open circuited. This indicator can also display the hydrogen purity shown in the upper display in addition to the purge ranges.

Where duplication of all three ranges is required they are displayed on both indicators.

Two potentiometers enable the Katharometer zeros to be adjusted from the control cubicle. The overall system is certified intrinsically safe to BAS System No. Ex 01E2044 when wired in accordance with the certified system drawing.

H₂ purity alarms are only active on the hydrogen purity range switch position 1.

Digital Indicators
The 4600 Series universal transmitter provides the operator interface and communication to other devices. The signal from the sensing system is converted by the transmitter and the information is presented on a large, custom designed, easy-to-read, backlit liquid crystal display. This display is used, in conjunction with the four tactile membrane key pads, to prompt the user through the programming procedures.

Zener Diode Safety Barriers
Zener barrier devices, certified to CENELEC standard (Certificate No. BAS 99 ATEX 7285), are included in the Model 6553 cabinet to prevent any dangerous electrical feedback from the indicators to the danger area. The action of the barriers is to pass the signal, with negligible distortion, up to the avalanche voltage of the zener diodes. Above this voltage the zener diodes become conducting and hold the voltage between the terminals to a safe level. The devices are fully encapsulated.
Analyzer Panels

In addition to the Katharometer range options, the Analyzer Panels are also available with options for use on low pressure or high pressure gas sample systems (see system diagrams below and overleaf).

The Model 6540–203 Panels are only suitable for use on systems where the gas sample is vented to atmosphere and the pressure in the analyzer panel is therefore only marginally above atmospheric pressure (1 bar absolute).

For applications where the gas sample may be returned to the generator cooling system at an elevated pressure, the Model 6548–000 Analyzer Panel must be used. This analyzer panel is equipped with items and fittings suitable for such duties and is pressure tested to 10 bar (gauge). As no certification exists for measurements at pressures above 1 bar absolute (nominal), it must be understood that the stated I.S. certification does not cover use at higher pressures.

The system diagrams illustrating these options show the purge gas as being CO₂, with ranges of 0 to 100% H₂ in CO₂ and 0 to 100% air in CO₂. These Katharometers are calibrated specifically for these ranges and cannot be used or modified for use with alternative purge gases, such as Nitrogen or Argon. Similarly the 4689 Digital Display Unit software is dedicated to the specified purge gas to be used.

Where an alternative purge gas is to be used this must be identified at the time of ordering with the appropriate order codes.

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**Low Sample Pressure System – Standard System Interconnection Diagram**

(Model 6553, Analyzer Panels Model 6540–203 and 4234 Series Power Supply Units)
Gas Analyzer for Hydrogen-cooled Alternators
Model 6553

Hazardous Area
Analyzer Panel
Model 6548-000
- H₂ in air
  100% to 85%
or
  85% to 100%
- 0 to 100% H₂ in CO₂
- 0 to 100% air in CO₂

Power Supply Units
Model 4234 Series
- Connect to
  115V (4234501) or
  230V (4234500)
  50/60Hz

Safe Area
Upper and Lower indicator
One retransmission per
position on selector
switch + 2 relays each

Hazardous Area
Analyzer Panel
Model 6548-000
- 85% to 100% H₂ in air
- 0 to 100% H₂ in CO₂
- 0 to 100% air in CO₂

Safe Area
Upper indicator
Two relays
One retransmission

Lower indicator
One retransmission per
position on selector
switch + 2 relays each

High Sample Pressure System – Standard System Interconnection Diagram
(Model 6553, Analyzer Panels Model 6548–000 and 4234 Series Power Supply Units)

2 x 3-Range Interconnection Diagram
(Model 6553, Analyzer Panels 6540–203 or 6548–000 and 4234 Series Power Supply Units)
Purge Gas Systems

Low Pressure System – Sample Vented (all valves except * fully open during operations)

High Pressure System – Sample Non-vented (all valves except * fully open during operations)

Low and High Sample Pressure Systems
The above illustrations show typical sample system arrangements, identifying the choice of gas analyzer panel required to suit either low or high pressure sample conditions.

Cubicles
When simplified installation is required the Model 6553 Display Unit and 4234 Power Supply Units can be supplied ready-mounted in a wall-mounting enclosure.

Access to the display unit is via the front door which is fitted with a window for visibility of the selected range. The two power supplies and the rear of the 6553 unit are accessed by a hinged rear compartment.

The cubicle is pre-wired so that the only electrical connections required are between the customer terminals (in the cubicle and on the analyzer panels) and the electrical supply.
Specification

**Model 6553 Gas Monitor**

**Approvals**
- CENELEC approved
- [EExia] IIC T_{ex} -20°C to +40°C
- BASEEFA Certificate No. BAS 01 ATEX 7043

**Available ranges**
(a) 100 to 85% H₂ in air + others (80% or 85% to 100%)
(b) 0 to 100% H₂ in CO₂
(c) 0 to 100% air in CO₂

**Digital Display Units**
- Air in CO₂/H₂ in CO₂: Model 4689-500
- 100 to 85% H₂ in air: Model 4689-501
- 85 to 100% H₂ in Air: Model 4689-503
- All three ranges: Model 4689-502
- Air in N₂/H₂ in N₂: Model 4689-504
- H₂ in Air/Air in H₂ in A: Model 4689-505

**Range Selector Switch Positions (when fitted)**
1. Percentage by volume, hydrogen in air
2. Percentage by volume, hydrogen in carbon dioxide
3. Percentage by volume, air in carbon dioxide

**Accuracy (display units)**
± 0.25% of scale span

**Ambient Temperature Range**
0 to 45°C (32 to 113°F)

**Power Supply**
110/120V a.c. or 200/220/240V a.c., 50/60Hz (two separate versions)

**Power Consumption**
30VA approximately

**Outline Dimensions**
290 x 362 x 272mm (11.4 x 14.25 x 10.9 in.)

**Weight**
12kg (26.4lb)

**Environment**
Sheltered interior, 0 to 90% RH

**Outputs and Set Points**

**No. of relays**
Two

**No. of set points**
Two

**Set point adjustment**
Programmable

**Set point hysteresis**
±1% fixed

**Local set point annunciation**
Red l.e.d.

**Relay contacts**
Single pole changeover
- Rating: 250V a.c. 250V d.c. max.
- 3A a.c. 3A d.c. max.
- Loading (non-inductive) 750VA 30W max.
- (inductive) 75VA 3W max.

**Insulation**
2kV r.m.s. contacts to earth (ground)

**Retransmission**

**No. of retransmission signals**
One fully isolated – standard

**Output current**
0 to 10mA, 0 to 20mA or 4 to 20mA programmable

**Accuracy**
±0.25% f.s.d. ±0.5% reading

**Resolution**
0.1% at 10mA, 0.05% at 20mA

**Max. load resistance**
750 ohm (20mA max.)
**Gas Analyzer for Hydrogen-cooled Alternators**

**Model 6553**

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### Specification

#### Series 4234 Power Supply Unit

**Approvals**
- CENELEC approved [EExia] IIC Tamb -20°C to 55°C
- BASEEFA Certificate No. BAS 01 ATEX 7041

**Input Voltage**
- 115V a.c. 50/60Hz or (Model 4234501)
- 230V a.c. 50/60Hz (Model 4234500)

**Fuse Rating**
250mA HRC ceramic

**DC Output**
350mA stabilized ±0.14%

**Load Conditions**
- 1 Katharometer 13Ω max.
- Interconnecting cable 2Ω max.

**Ambient Temperature Range**
-20 to 55°C (-4 to 131°F)

**Supply Variations**
- ±15V (115V supply) or ±30V (230V supply) 46 to 64Hz

**Regulation**
- Within ± 0.5% for:
  - (i) Load variation of ± 15%
  - (ii) Supply variation of ± 15%
  - (iii) Ambient temperature variation of ± 20°C (36°F)
  - (iv) ±4Hz frequency variation

**Ripple**
- Less than 0.5% of set output peak/peak across a 10Ω load

**Stability**
- Within ± 0.7% of initial setting, over period of 1 month with load resistance, supply voltage and ambient temperature at nominal stated values

**Outline Dimensions**
- 117 x 170 x 110mm (4.6 x 6.7 x 4.3 in.)

**Weight**
- 2.12kg (4.8 lb) approx.

**Environment**
- Sheltered interior

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#### Models 6540-203 and 6548-000

**Katharometer Analyzer Panel**

**Approvals**
- CENELEC approved EExia IIC T4. T amb -20°C to +55°C
- BASEEFA Certificate No. BAS 01 ATEX 1042

**Power Supply**
- 350mA d.c., from Model 4234500 or 4234501 Power Supply Unit

**Signal Output**
- 0 to 10mV for each range

**Accuracy**
- ± 2% of scale span, each range

**Dead Time**
- Typically 5s

**Response Time**
- Typically 40s for 90% step change at Katharometer
- Tubing and drying chamber introduce extra delays

**Ambient Temperature**
- 55°C (131°F) max.

**Sample Connections**
- Compression couplings:
  - 6mm o.d. tube (Model 6548-000)
  - 8mm o.d. tube (Model 6540-203)

**Sample Pressure**
- Minimum 125mm H₂O
- Maximum 0.35 bar (Gauge) Model 6540–203
- Maximum 10 bar (Gauge) Model 6548–000

**Normal Sample Flowrate**
- 100 to 150ml/min.

**Maximum Gas Flowrate**
- 250ml/min

**Minimum Gas Flowrate**
- 50ml/min

**Outline Dimensions**
- 610 x 305 x 152mm (24 x 12 x 6 in.)

**Weight**
- 8.6kg (18.9lb)

**Environment**
- Sheltered interior

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**Notes.**

1. Systems can be supplied for use with Nitrogen or Argon purge gases as an alternative to the CO₂ ranges. Details on application to the Company.

2. Variations to the earlier certificate (SFA 3012:1972) allow the use of these items in systems supplied previously to that standard.
Overall Dimensions
Dimensions in mm (in.)

Katharometer Analyzer Panel Assembly (Model 6540–203)

Katharometer Analyzer Panel Assembly (Model 6548–000)
**Gas Analyzer for Hydrogen-cooled Alternators**

**Model 6553**

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**Overall Dimensions**

![Diagram showing Overall Dimensions]

**Ordering Information**

**Valid Option Combinations**

(Refer to Ordering Information table opposite)

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<th>Purity Only Single display (Upper)</th>
<th>3-Range Single display (Upper)</th>
<th>Standard Purge System</th>
<th>2 x 3 Ranges</th>
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*Intrinsically Safe Power Supply Unit (Model 4234500 or 4234501)*
### Gas Analyzer for Hydrogen-cooled Alternators

#### Model 6553

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#### Ordering Information

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<thead>
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<th>Atex Compliant Gas Analyzer for Hydrogen-cooled Alternators</th>
<th>6553/</th>
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<tr>
<td><strong>A Features of Upper Indicator</strong></td>
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| 100 to 85% H₂ in Air - Not FailSafe | 1     |
| 100 to 80% H₂ in Air - Not FailSafe | 2     |
| 0 to 100% Air in CO₂, 0 to 100% H₂ in CO₂ | 3     |
| 0 to 100% Air in CO₂, 0 to 100% H₂ in CO₂, 85 to 100% H₂ in Air | 4     |
| 85 to 100% H₂ in Air - Failsafe | 5     |
| 80 to 100% H₂ in Air - FailSafe | 6     |
| 0 to 100% Air in Ar, 0 to 100% H₂ in Ar, 85 to 100% H₂ in Air | 7     |
| 0 to 100% Air in Ar, 0 to 100% H₂ in Ar, 80 to 100% H₂ in Air | 8     |

| **B Scale of Upper Indicator** | 6     |
| Indicator not fitted | 0     |
| Two alarms + retransmission 4 to 20mA | 3     |

| **C Features of Lower Indicator**
| Indicator not fitted | 0     |
| Two alarms + retransmission 4 to 20mA | 3     |

| **D Scale of Lower Indicator**
| Indicator not fitted | 0     |
| 0 to 100% Air in CO₂, 0 to 100% H₂ in CO₂ | 1     |
| 100 to 85% H₂ in Air - Not FailSafe | 2     |
| 100 to 80% H₂ in Air - Not FailSafe | 3     |
| 0 to 100% Air in CO₂, 0 to 100% in CO₂, 85 to 100% H₂ in Air | 4     |
| 0 to 100% Air in CO₂, 0 to 100% in CO₂, 80 to 100% H₂ in Air | 5     |
| 85 to 100% H₂ in Air - FailSafe | 6     |
| 80 to 100% H₂ in Air - FailSafe | 7     |
| 0 to 100% Air in Ar, 0 to 100% H₂ in Ar, 85 to 100% H₂ in Ar | A     |
| 0 to 100% Air in Ar, 0 to 100% H₂ in Ar, 80 to 100% H₂ in Air | B     |

| **E Range Selector Switch**
| Not fitted | 0     |
| Fitted, with facilities for Remote Indication of switch position (upper indicator) | 2     |
| Fitted with two range switches, upper and lower indicator + remote indication | 3     |

| **F Not Used**
| English | 1     |
| French | 2     |
| German | 3     |
| Polish | 4     |

| **H Cubicle Type**
| Without cubicle | 1     |
| Cubicle 2 x 3 range + flow alarms (Ar/CO₂) | 2     |
| Cubicle dual display | 4     |
| Cubicle single display | 5     |

| **J Special Features**
| None | 0     |
| Fitted | 9     |

| **K Mains Supply**
| 115V 50/60Hz | 1     |
| 230V 50/60Hz | 2     |