Gas Density Monitoring System (GDM)

Siemens GDM-Guard

In co-operation with EM TS PLM

© Siemens AG 2017

siemens.com
Substation equipment with SF6 as insulation Gas from conventional AIS to metal encapsulated GIS

Grade of encapsulation

Air-Insulated Substations (AIS)

* MTG – Mixed Technology Switchgear (IEC 82271 – 205)

© Siemens AG 2017
Gas Density Monitoring (GDM)
Standard SF₆ monitoring - density monitor/switch

- Basic safety element to monitor the GIS insulation system regarding density (temperature compensated pressure monitors)
- Density monitors are installed in all gas compartment to provide warning, alarm and blocking (CB) signals via auxiliary contacts
Density sensors

- Density Sensors are available with **20mA**
- HYBRID monitors have **20mA plus micro switches** for hard wired alarms
Gas Density Monitoring System (GDM)
SICAM AI-Unit – multifunctional!

The SICAM AI-Unit 7XV5674 is an 20mA Analog Input device used by utilities in substation environment, and for industrial sectors with increased environmental requirements.

Analog signal acquisition, compression and supervision of:

<table>
<thead>
<tr>
<th>Measurements</th>
<th>Measuring Range</th>
<th>Tolerance limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current Measurement</td>
<td>0 mA to 20 mA</td>
<td>± 0.2 % (reference conditions)</td>
</tr>
<tr>
<td>Channel 1 to 12</td>
<td>4 mA to 20 mA</td>
<td></td>
</tr>
</tbody>
</table>

Protection Device expansion for 20mA, or direct connection to a Substation Controller, control center for processes automation.

Communication Protocols:
- Modbus RTU/TCP/UDP / IEC 61850 GOOSE and Reporting/MMS

How to handle mass data:
1.6 million actual values are compressed by one AI-Unit per day to 24h mean values from 12 channels.
SICAM AI-Unit
Features of “the intelligent IEC61850 clamp”

Ethernet Interface RJ45:
- Integrated Switch (connection with Y-Cable)
- HTTP / NTP
- Modbus TCP / UDP
- IEC 61850 GOOSE, Reporting

4 LEDs:
- For different alarms and signaling

Battery / RTC / Logs:
- Buffered internal real time clock and error- / operational indications. Also log export as .csv file

RS485-Interface (optional):
- Sub-D Connector (9-pol.)
- Insulation 500 V
- Modbus RTU (SIPROTEC 5: SUP-protocol)
  (SIPROTEC 4: RTU 20 mA protocol)

or Optical Interface:
- ST connector plug
- Max. 2 km at 62.5 µm/125 µm multimode
- Max. 1.5 km at 50 µm/125 µm multimode
- Modbus RTU, (SIPROTEC 5 SUP-protocol),
  (SIPROTEC 4: RTU 20mA protocol)

Universal power supply:
- 24-250 VDC and 100-230 VAC (45-65 Hz)

2 x 6 Analog Inputs:
- Accuracy 1.0 % of the rated current (20 mA) over the full range.
  Accuracy 0.2 % under reference condition

Operation:
- Parameterization via Web-Browser e.g. Internet Explorer
- Time Synchronization over NTP, field bus (Modbus RTU/TCP), IEC61850, PC, RTC

Communication:
- Available protocols: HTTP, NTP, Modbus RTU/TCP/UDP and IEC 61850 Server (GOOSE, MMS / Reporting)
The graphical user interface (Web-Server) is stored in the device.

The device is fully operated and parameterized from a connected PC or Notebook with a Web-Browser Microsoft IE6.0 (or higher).

Online value view of actual and mean values. Simulation of Values for commissioning.

16 measurement limits of actual values

4 group indications.

Operational event and diagnostic log with 1ms resolution time stamp. Values can be exported into comma separated file (.csv – file) for viewing in EXCEL.

Free online access to demo device in Internet: http://178.15.1.169:86/

Browser settings:
- add IP-address to Compatibility View
- enabling JavaScript –> Security Level to Medium
In this application 12 measurement currents are connected to one AI-Unit.

The 2x6 20 mA measuring transducers are connected in series with the input of AI-Unit, and parallel to the power supply.

The power supply shall have enough power (min. 12x 20 mA = 240 mA).

The voltage of the power supply shall be higher than the needed voltage of the measuring transducer (e.g. 10 V), added with the voltage drop of AI-Unit at 20 mA (2.8 V at 140 Ohm internal resistance) and the voltage drop of the connection cable.

Recommended power supply: 7XV5810-0AB00 (24 V DC / 250 mA).

1) Example: Gas Density Monitor „Trafag 8783“
SICAM AI-Unit Communication Overview

- Protection
- SCADA
- DMS, EMS
- Automation
- Monitoring System

Communication

- Ethernet Modbus TCP or IEC 61850 (MMS/GOOSE)
- Ethernet Modbus TCP or IEC 61850 with integrated Switch
- Serial RS485 Modbus RTU or SIPROTEC 20mA / SUP protocol
- Serial Fiber Optic Modbus RTU or SIPROTEC 20mA / SUP protocol

- Ethernet Web-Browser for device parameterization and online monitoring of current measured and calculated values

20 mA Inputs

- GIS (Gas Insulated Switchgear)
- Protection (e.g. Fault Location – SIPROTEC 7SA)
- Sensors (Pressure, Temperature, Position etc)
- Other Automation Process
Gas Density Monitoring System (GDM)
Specification for SF₆ Monitoring:

Features of an Gas Density Monitoring System:

- The SF₆ density (temperature compensated pressure) as well as the leakage rate are accessible via communication protocol IEC 61850 (or via a web-based user interface)
- The period until an critical gas filling level is reached will be calculated and displayed
- Measured data is stored over several years and can be simply exported for further analysis
- The system meets state of the art cyber security standards, in particular any access is password protected and provides several user groups
- The system offers one central communication interface for the complete substation (via Ethernet)
- The system has an internal monitoring feature which identifies system failures and triggers alarms
- Algorithm calculates the leakage trend for all connected SF6 gas compartments.

Visualization:

- An HMI displays can be installed near to the GIS or in an dedicated control room
- The actual value and leakage rate can be displayed or transferred to a central SCADA System via IEC 61850 for further processing and alarm handling.
- Easy navigation through the measurement data, alarm list and event history is possible
- Status LEDs will signalize device failures and gas alarms.
Gas Density Monitoring System (GDM)
Development Project – GDM@EM_TS

Idea

GDM-GUARD

Solution

© Siemens AG 2017
Page 12 January 2017
Customer Value:

- Stand-alone solution or integration in existing SCADA
- Environmental protection thanks to early leakage detection
- Documentation of gas losses for authorities (bonus payment or avoiding fines)
- Easy and low budget solution

GDM-Guard 1
Intelligent IEC 61850 clamp
AI-Unit for Data Acquisition
Data Compression
Limit Supervision
Transfer of data and alarm messages

GDM-Guard 2
Automation
Archiving
Alarming

GDM-Guard 3
SCC Visualization
SF₆ Gas Trends, Forecast
Pre-Warning, Alarming
notifying by Mail/SMS
Archiving, Reports
Gas Density Monitoring System (GDM)
SF₆ monitoring system with density sensors

„Siemens GDM-Guard”

V1 – Analogue measurements via Al-Unit only
- Analog sensor with 4…20mA output is required
- Web Interface (bay by bay) viewing of current values at any Notebook/PC
- Future extension easy possible
- This version is the basis for Version 2 and 3
- Connection to SIPROTEC devices possible (V1.2)

V2 – Analogue measurements with central Alarm indication and values saving, Al-Unit + A8000 (e.g. for Medium Voltage)
- Receiving of all analogue values, limits and failures via IEC61850 MMS from Al-Unit
- Archiving of values on local storage
- Retrieving of archive via engineering tool or file transfer
- Alarm Hardwired (DO-8212 or I/O-Unit) or via IEC 60870-5-104 protocol to control center or local HMI e.g. SICAM SCC
- Future extension easy possible
Gas Density Monitoring System (GDM)
Application V1: 20 mA Measurements

- AI-Unit measures each 642ms 12 actual 20mA values and will create average values out of this: 10sec. / 1min. / 1hour / 1day

- Parametrizing and configuration of used AI Inputs will be done via web client

- 16 Limit values can be set up for alarm purpose, using the actual 20mA measuring values

- 4 Group alarms can be created

- Limits, group alarms and failures can be routed to
  - 3 LED’s
  - Log-File
  - read out via Web-client (computer)
  - saved manually in an text file

- integrated Ethernet switch functionality (daisy chain)

- Time synch via NTP-Server possible
Gas Density Monitoring System (GDM)
Application V1.2: 20 mA Measurements to SIPROTEC 5 (IEC 61850 GOOSE)

- In this Application SIPROTEC 5 protection devices are supplied with analogue 20mA measurement values, using an Ethernet communication IEC 61850-GOOSE-protocol.
- The maximal number of AI-Units / Measurements depends on the processing power and workload of the protection device from other functions.
- Any actual Measurements are transmitted cyclic within a settable „max time“ (no transfer of mean values).
- All 12 Measurements are transferred immediately, if one measurement value violates a programmed limit „Dead band“.
- Further processing or signalization of actual measurements is possible using CFC, display, GOOSE, connection to Station Control, HMI or Control Center.
Gas Density Monitoring System (GDM)
Application V2: SF₆ Gas-Monitoring with SICAM A8000

- SICAM A8000 reads and saves (SD-Card) continuously all 12 measurements, average values, limits of actual measurements and alarms from all AI-Units via Ethernet IEC61850 protocol.
- Configuration of SICAM A8000 can be done via “SICAM TOOLBOX II“ or “SICAM WEB“
- Archive on local storage. Retrieving of archive via engineering tool or file transfer.
- SICAM A8000 - Series
  - Receiving of all analogue values, limits and failures via IEC61850 from AI-Unit
  - Configure additional limits for average values within RTU
  - alarm indication via binary outputs (DO-8212 module or I/O-Unit)
- Configuration of AI- and IO-Units via Web-Client
- Time synchronization of all devices via NTP-Server
- Easy connection of AI- and IO-Units via integrated Ethernet switch (daisy chain) up to 20 Devices

Computer with web client (temporary needed)
- Configuration of A8000
- Configuration of AI- and I/O-Units
- Manually reading of actual measurement and average values
- Manually reading of alarms
Gas Density Monitoring System (GDM)
Application V3: SF₆ Gas-Monitoring via SICAM SCC

V3 – Analogue measurements with central Alarm indication and visualizing
- Transfer of all analogue values and limits to an central Monitoring PC via IEC61850
- High level industrial PC / Box PC (with SICAM SCC) for data safety
- Viewing and saving of values in an archive
- Alarm Hardwired or via various IEC protocols
- Web Access to all analogue values from one interface point possible
- Visualizing of SF₆ Gas trends for each Gas Room
- SICAM AI-Unit (IEC 61850-8-1 compatible)
- Limits can be set and shown in SCC
- GIS SF₆ condition state notifying by Mail/SMS (Alarming)
- Customized pictures based on reference
- SICAM SCC on ADVANTEC box PC
- NTP – time synchronization
- Reporting function
- Standard 6-20mA sensors
- Future extension possible
Gas Density Monitoring System (GDM)
Application V3: SF₆ Gas-Monitoring via SICAM SCC

- **SICAM SCC / HMI**
  - Read Actual-/Mean Values and Indications (IEC 61850 MMS)
  - Display and record of Actual-/Mean Value into Archive
  - Set Limits for Actual-/Mean Values in SCC
  - Capture of Limits Violation Indications, alarms in SCC
  - Display of Limits Violation Indications, alarms in SCC, and send to binary output of I/O-Unit (IEC 61850 MMS)
  - GIS SF₆ condition state notifying by Mail/SMS (Alarming)

- **AI- and I/O-Units**
  - Parameterization with Web-Browser (HTTP)
  - Read Actual-/Mean Values and Indications (HTTP)
  - Time synchronization (NTP)

*Easy RSTP* managed only by **one** Switch Device (2Ports!) It runs without RSTP function of Al-/IO-Units
Gas Density Monitoring System (GDM)
SF₆ Gas-Monitoring – Centralized vs. Decentralized

Centralized panel Solution
- around 300 gas rooms can be connected to one panel
- The panel contains:
  - 6 x 6 AI-Units
  - 6 x 1 24V Power Supply (for Sensors)
  - 6 x 1 Opt./el. Switch RS900
  - AC/DC Input for all supply with MCB and panel auxiliary’s
  - Special Terminals for sensor wires
Decentralized Solution (Recommended)

- Required AI-Units will be installed in each local control cubicle LCC separately
- The number of AI-Units varies dependent on switchgear type (1 or 3)
- Sensors will be hard wired via special terminals to each LCC
- Data will be transferred through IEC 61850 to an central PC with SICAM SCC (HMI) in order to visualise and alarm the values
- **Less Sensor cabling efforts required**
Gas Density Monitoring System (GDM)
SF₆ monitoring system – Mobile Version

Mobil Monitoring Panel connected via plug in cable. Visualization of Gas density for the connected feeder

Highlights:
• Transfer of analogue values and limit values to an Monitoring PC via IEC61850
• Visualizing of SF₆ Gas trends for each Gas Room connected
• SICAM AI-Unit installed in an compact way
• Customized pictures based on reference
• SICAM SCC on ADVANTEC box PC
• Saving of all Values to an Excel list
• Reporting function
• Future extension possible

Precondition:
• All sensors + power supply is wired to LCC via one plug
Gas Density Monitoring System (GDM)
Application V3: SICAM SCC Picture

- Delta engineering possible to reflect customer substation arrangement
- SF₆-Gas trends for each gas compartment will be displayed
- Reporting function available
- Colored Limits und Alarms
Gas Density Monitoring System (GDM)

How to order?

1. Project Request - SF6 Gas-Monitoring to EM DG SYS S3
2. Detail clarification about Version required
   • V1 – V2 – V3 - … Installation details (e.g. LCC)
3. Budget Offer / FDS (V3) / Customer Information
   • AI-Unit Engineering by LCC Design Team
4. Hardware and Software Order by Project via EM DG SYS
5. Commissioning of V1 & V2 by GIS Engineer
   • Commissioning of V3 System by EM DG SYS

© Siemens AG 2017

Page 24 January 2017
SICAM AI-Unit
Accessories

- Ethernet Y-adaptor cable 7KE6000-8GD00-0BA2
  1 LAN-plug - 2 LAN-sockets, 0,2m, for cascading of devices with integrated switch function, e.g. 7XV567 units
- Ethernet patch cable 7KE6000-8GD
- FO-cable 6XV8100-0B
- RS485-bus cable system 7XV5103
- SICAM AI-Unit Intranet: Accessories / 7XV5674
  (for Siemens employees only)
- SICAM AI-Unit Internet: Accessories / 7XV5674
- SIPROTEC Internet: www.SIPROTEC.com

Free online access to demo device in Internet: http://178.15.1.169:86/
Browser settings:
- add IP-address to Compatibility View
- enabling JavaScript → Security Level to Medium

Within delivery of AI-Unit:

DVD with complete section of SIPROTEC Accessories Download Pool
(catalogs, manuals, tools, FW updates ..)
“This flexible SICAM AI-Unit is easy usable for many different applications within utilities in substation environment, and industrial automation!”