

CONNECTING AN ALL-ELECTRIC WORLD

Coil 4.0 meets Digitalization

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Summary Content

The energy systems of the future are increasingly decarbonized, distributed and digitalized. Environmental aspects have to be considered during planning and operation.

With our recent developments and innovative solutions for arc suppression coils (ASC) and earth fault compensation controllers we can support future proof investments for our customers.

These are alternative insulation media, an improved drive concept, an earth-fault compensation controller that has been integrated directly into the motor control cabinet of the coil, and the Senscoil technology as part of Sens Product suit.



Coil Story

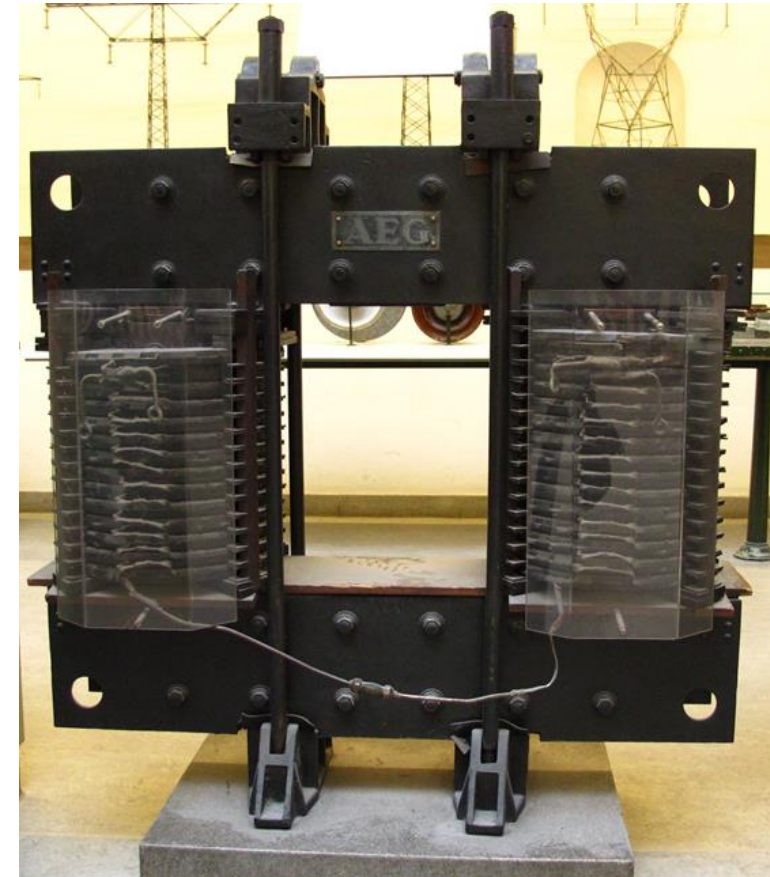
Arc Supression Coil (ASC)
past – actual – future

Coil 1.0 Petersen Coil / Arc Suppression Coil

How everything got started

100 Years of Resonant Grounding was celebrated 2 years ago....

1917 Waldemar Petersen receives a patent for an inductivity between star point and Earth, which conducts a current equal or similar with the capacitive earth fault current. During the following decades arc suppression coils are installed worldwide up to 230 kV. At the begin the adjustment of the inductive current is done stepwise only (step coils).



First 40A arc suppression coil (German Museum München)
Kraftwerk Altwürttemberg AG / Operation 1917 - 1928

Coil 2.0 Arc Suppression Coil with Plunger Core Stepless tuning manually and later with controller

SIEMENS
Ingenuity for life

1938 The first stepless adjustable arc suppression coil is built with the plunger core principle. The tuning is done manually with auxiliary equipment to determine the compensation degree.

1950 The first electromechanical resonance controller was built for automatic adjustment of the arc suppression coil.

1981 The first microprocessor controlled resonance controller was built by Spezielektra (Trench Austria)



Coil 3.0 Actual ASC Design Trench Austria with state of the art controller

Trench Austria in Leonding near Linz exclusively produces reactor/coil products for medium and high voltage electrical systems and is one of the worldwide leading companies in this niche area of applications worldwide

- Arc suppression coils since 1972
- Control electronic since 1976

Voltage levels from 3.6 kV – 145 kV
Power ratings 100 kVAr – 40 MVar

Having in house development and production of ASCs and control devices is a clear USP



Coil 4.0 Solutions for tomorrow

Based on extensive experience in design, construction and application of ASCs, Trench products can meet the most stringent requirement for earth-fault compensating techniques. But we never stop to improve design and our search for new ideas and technologies.

The latest result is...

Coil 4.0

- Fast Drive
- Biodegradable Oil
- Integrated Controller



Fast Drive

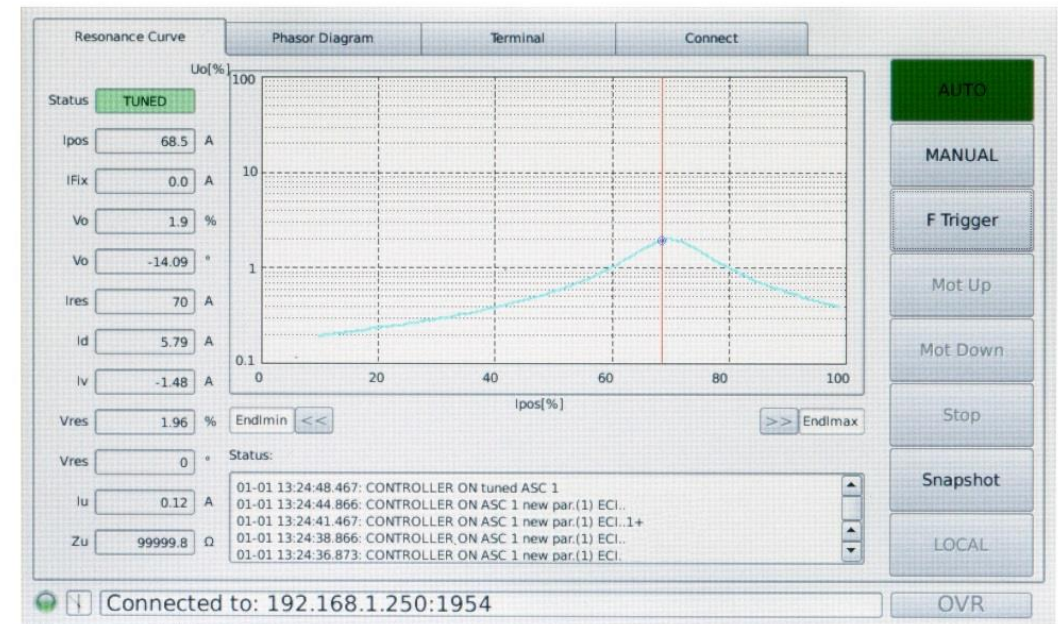
The motor drive unit serves for adjustment of the air gap of a plunger core type ASC according to the operational needs.

The rated power of the new motor drive unit will have 3 kW.

The running time between the upper and lower end position is now reduced to 1 minute.

Benefit of Solution:

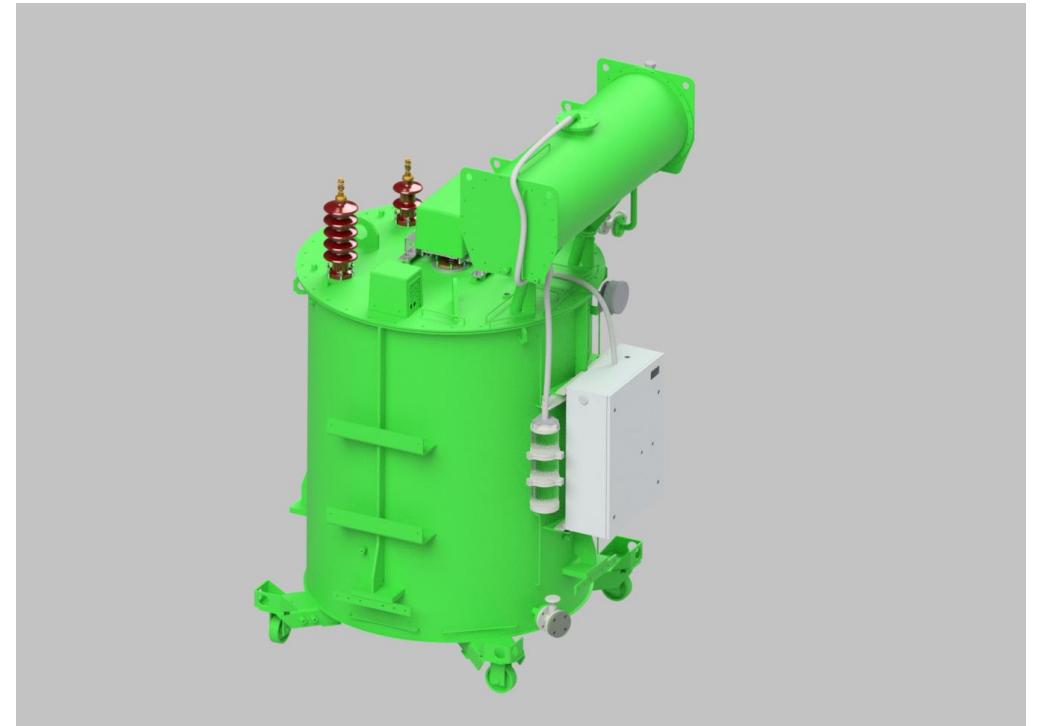
The average time to reach a new well tuned position (resonance point) is 20 seconds. In the growing networks this will be an operational advantage.



Biodegradable Oil

In addition to the transformer oils on naphthenic basis, inhibited or non inhibited, according to IEC 60296:2003 water pollution class 1, and MDEL 7131 synthetic Ester fluid, according to IEC 61099 water pollution class 0, we are now able to provide an alternative to mineral oil and synthetic ester in using **natural ester** as insulation fluid.

For the proof of concept in an ASC application we have tested MDEL eN 1204 (rapeseed based) and MDEL eN 1215 (soybean based) as well as FR3 from Cargill (vegetable oils). We decided to use the FR3 based on customer preferences for pilot project.



Biodegradable Oil Advantage High Fire Point

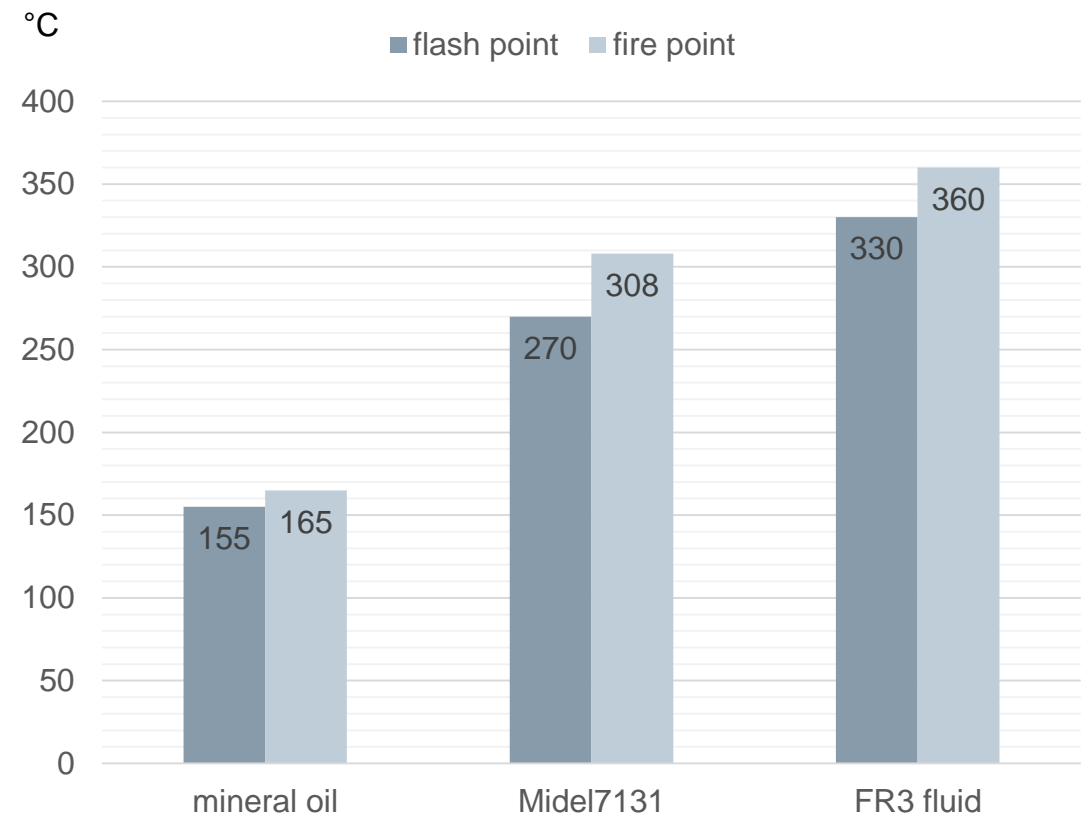
High fire point provides safer, more reliable grid performance

FR3 fluid has a fire point of 360°C, more than twice the fire point of mineral oil. This improves the fire safety for any ASC application.

With this improved fire safety, utilities can:

1. Reduce clearances to buildings and equipment
2. Eliminate the need for more costly fire mitigation systems
3. Potentially reduce insurance premiums and liability reserves

Dielectric fluid fire point comparison

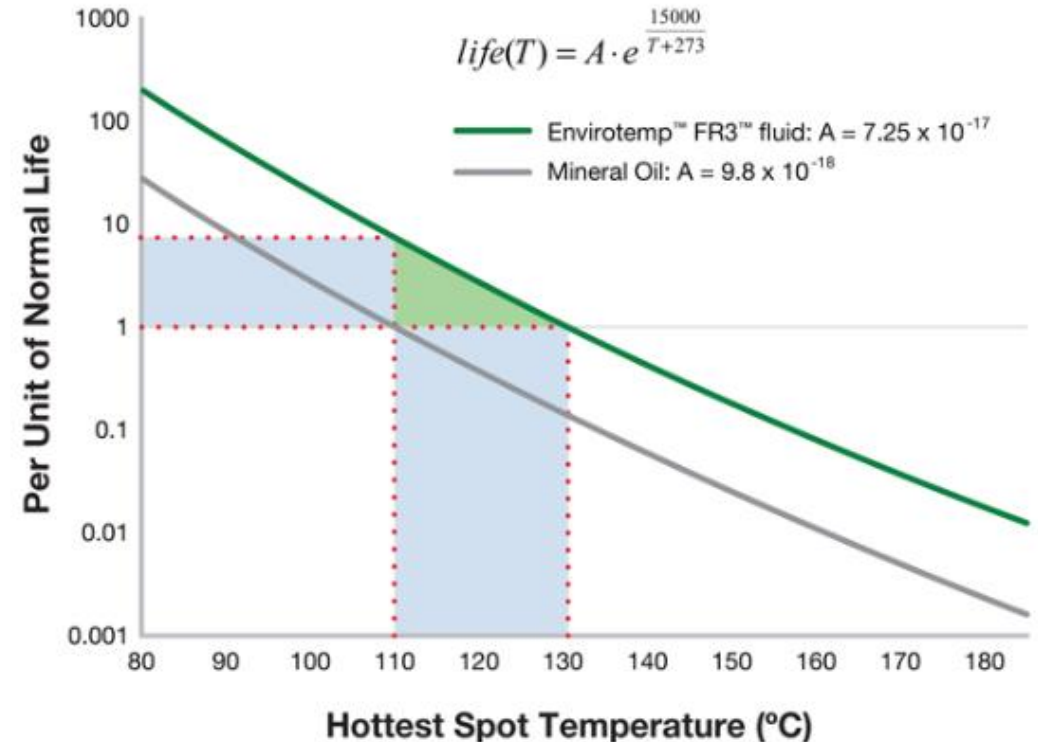


Biodegradable Oil

Advantage Thermal Capabilities – Asset Life Extension

This higher temperature capability enables:

- Slower rate of cellulose ageing than mineral oil
- Longer cellulose lifetime at standard temperatures
- Option to run at a higher temperature, for a standard lifetime
- Provides a higher power output, without the need for high temperature insulation
- Design of smaller ASCs possible -> that could use less fluid and less construction materials

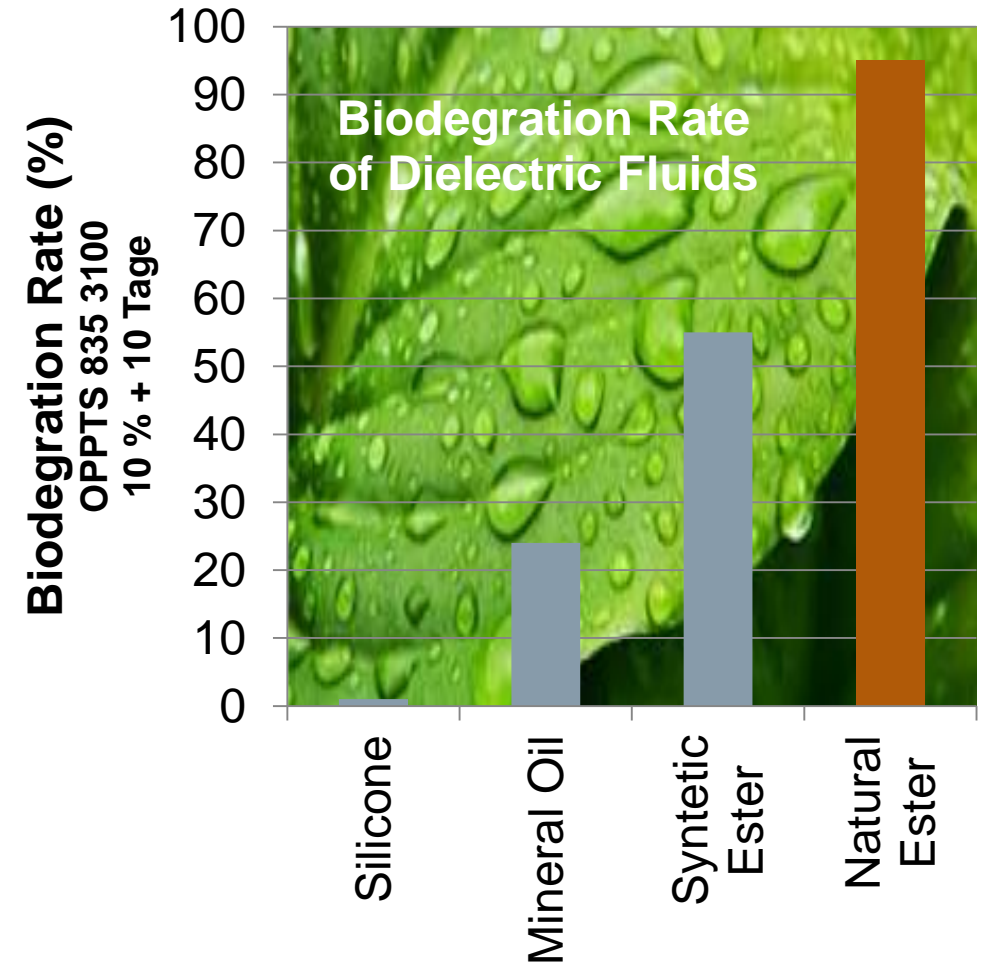


Biodegradable Oil

Advantage Environmental Benefits

Readily biodegradable, non-toxic helps protect the environment

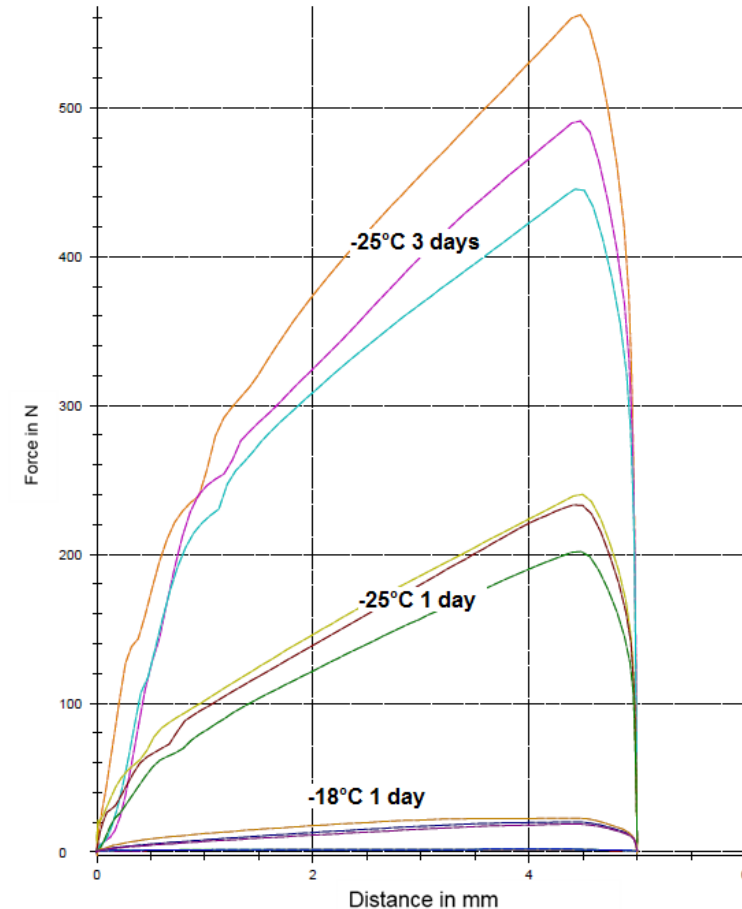
- Made from 100% renewable vegetable oil
- Readily biodegradable (28 days)
- Non-toxic in both oral toxicity tests and aquatic toxicity tests
- Contains no petroleum, halogens, silicones or sulfurs
- Has a reduced carbon footprint – 56x less carbon emissions than mineral oil



Biodegradable Oil Implementation Challenges

Design requirements to make this technology fit for use in ASC applications:

- Heater (3 kW) for very low outside temperature to guarantee the needed difference of 10 K to the pure point. For ester products with lower pourpoint (Midel eN 1204 -31°C) ongoing research if the heater can be omitted
- Rubberbag to avoid oxidation of the natural ester during breathing
- Sealing material Viton is used from DuPont instead nitrile butadiene rubber (NBR)

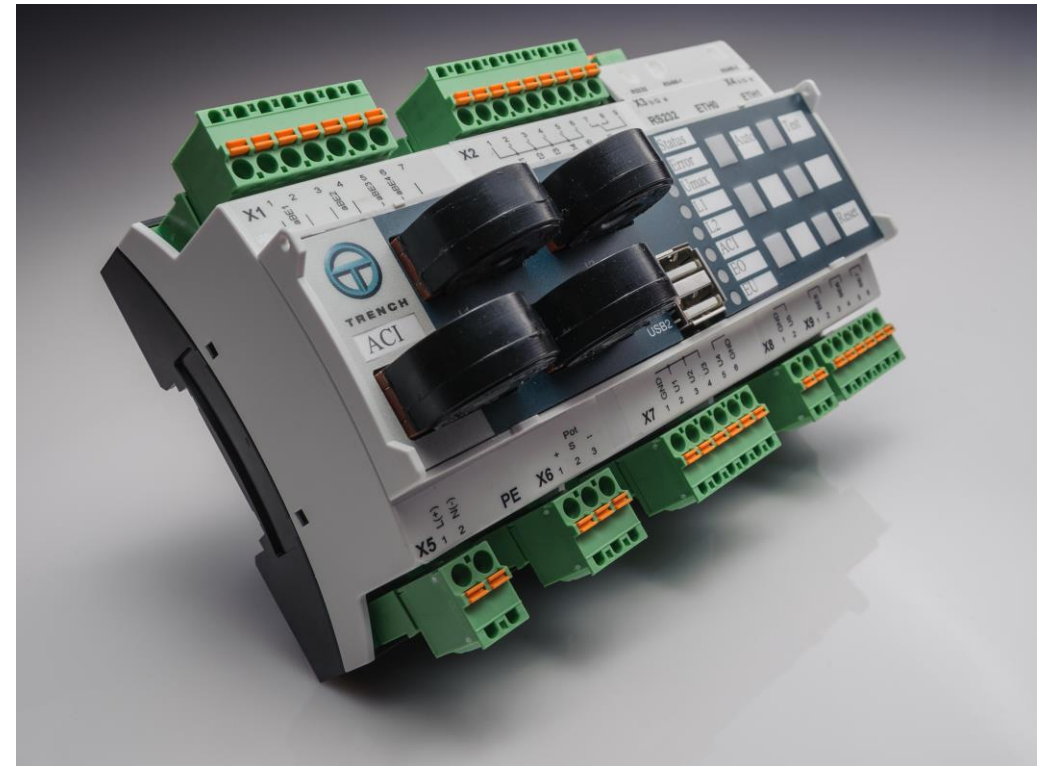


Integrated Controller All-in-one

The controller unit is installed in the control cabinet mounted on the side wall of the ASC tank.

Benefit of Solution:

- All-in-one solution, very fast plug&play start up
- Control unit ready wired in factory
- Calibration for min/max position and linearization done in factory
- Less cabling to control room
- Reduced or no commissioning on site needed



Digitalization

Internet of Energy

SensCoil® – Born connected

Operational customer values through digitalization

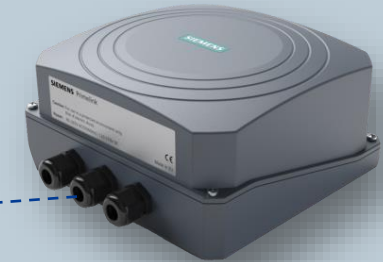


- A standard SensCoil® will provide the following data:
 - 💧 Oil level alarm (min/max)
 - 🌡️ Top oil temperature
 - ⚡ Coil core position/operational time
 - ⚡ Zero sequence voltage
 - 📍 GPS Position/local weather information
- Secure data transmission via GSM based on state of the art technology
- Cloud data storage (AWS – Amazon® Cloud), graphical interface for data visualization and analyze
- App for mobile devices, flexible for extensions and improvements

Product Digitalization - IoT Connectivity Device

SensCoil®

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**Sensformer Connectivity Device –
Outdoor Version**
(IP65 version)

Input Channels of Sensformer Connectivity Device

3 x Analog Channels (4...20mA / ±20mA)

1. Zero Sequence Voltage → mA transducer
USE: Earth fault events (count and duration)
2. Coil Core Position → Existing Sensor
USE: tuning status of coil and Motor lifetime
3. - unused -

1 x Analog Channel (RTD-PT100)

4. Top Oil Temperature → Existing Sensor
USE: Indication for overheating and for lifetime consumption

2 x Digital Channels (100...250VAC/VDC)

5. Oil Level Indicator (Min) → Existing Sensor
USE: Remote Oil Leakage Warning
6. Oil Level Indicator (Max) → Existing Sensor
USE: Remote Oil Expansion Warning

General Principles

Connectable & intelligent

- All Sensgear products using same IoT device to connect to the cloud
- The IoT device only collects data from the sensors for transmission to the cloud – no on site calculations
- By default data transfer to a cloud via GSM or on customer's request transfer to on site customer IT infrastructure possible
- Digitalized products to optimize operations
- Future is in managing and learning from the data
- Software applications for further value creation and operational enhancement (e.g. predict asset life time, for short time duty ASCs calculation of remaining service time)



Disclaimer



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