
WEBINAR
FANOX
Safely protected



FANOX Relays / Renewable Energy Aplications

Wednesday, October 28th 2020
10:00 AM MADRID

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Why Fanox Protection Relays are the right solution to protect renewable energy source systems.

- Introduction to renewable energy and protections requirements
- Self-powered relays. Added value of self-powered protections
- Wind market and protections
- Photovoltaic market and protections
- Market trends: new challenges and solutions

Duration: 1 hour (approx.)

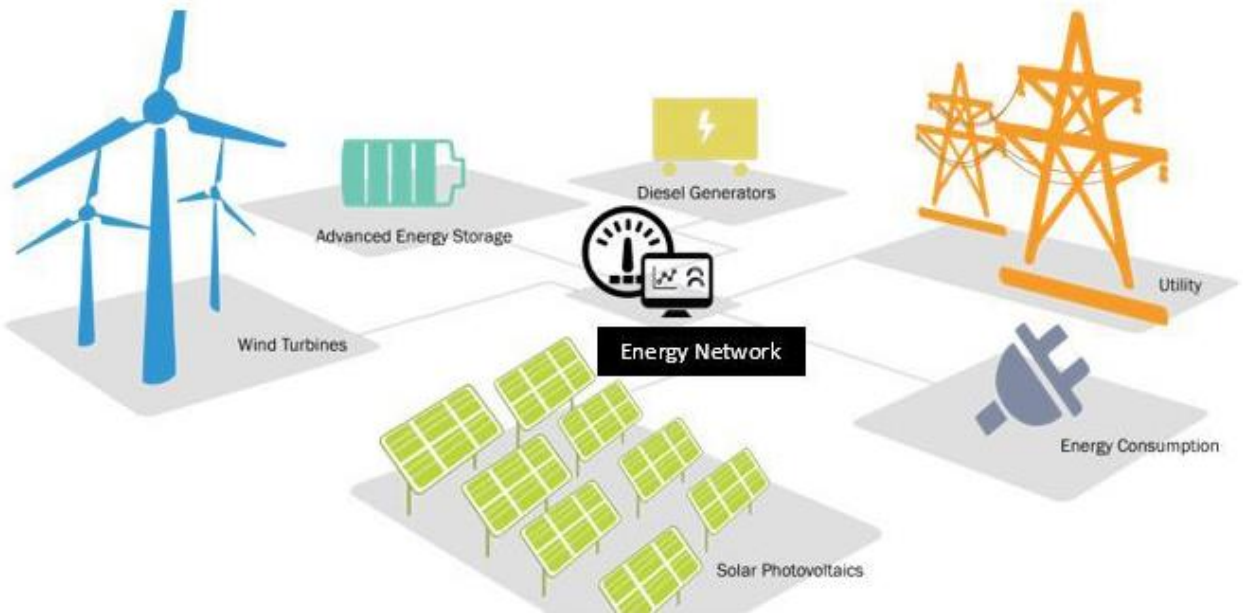
INDEX

1. INTRODUCTION TO RENEWABLE ENERGY AND PROTECTIONS REQUIREMENTS
2. SELF-POWERED RELAYS. ADDED VALUE OF SELF-POWERED PROTECTIONS
3. APPLICATIONS:
   a) WIND MARKET AND PROTECTIONS
   b) PHOTOVOLTAIC MARKET AND PROTECTIONS
4. MARKET TRENDS: NEW CHALLENGES AND SOLUTIONS
5. Q&A

Renewable Energy Sources

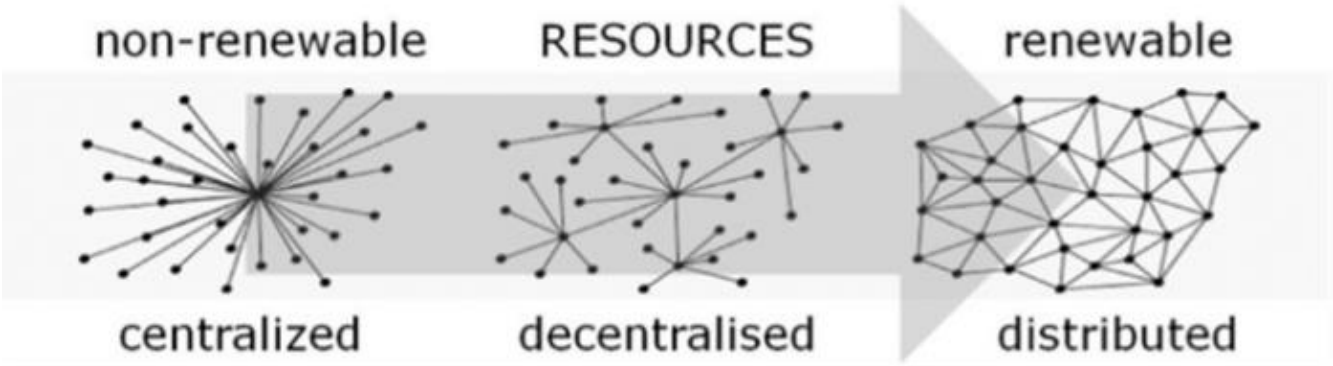
Renewable energy is not a passing trend, are realities. Renewable energy is leading the energy transformation.

Infinite natural resources, such as sunlight, wind, rain, tides, waves, and geothermal heat, is derived from renewable energy.



Renewable Energy Sources

Paradigm shift:



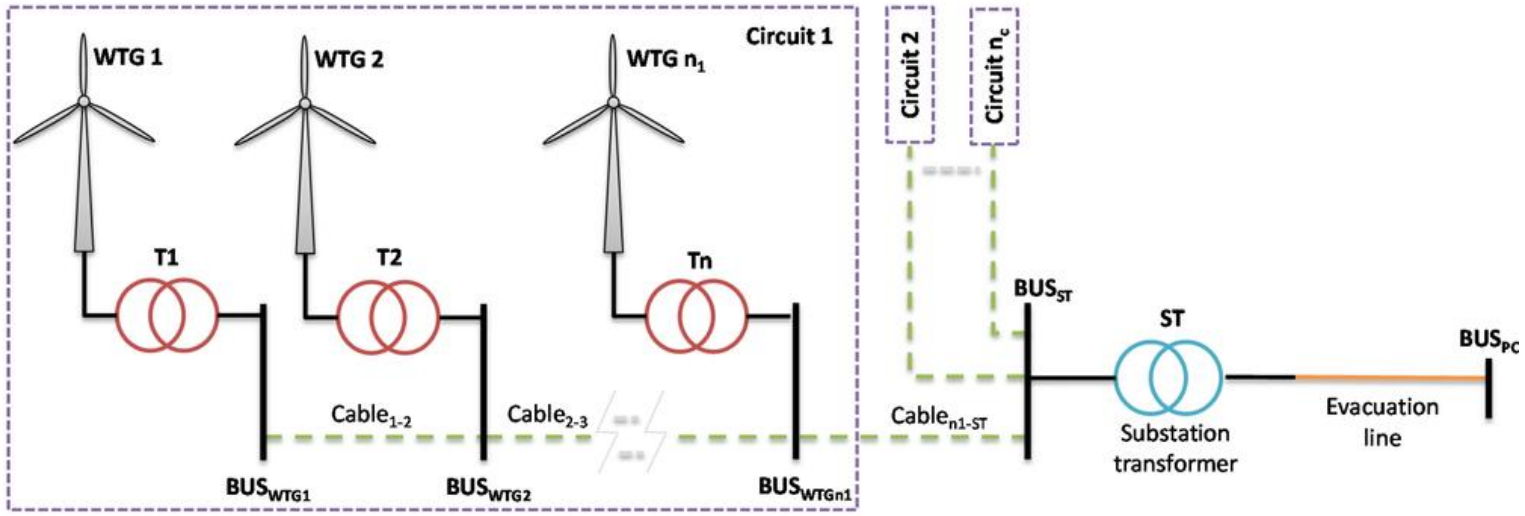
Distributed Generation characteristics:

- Produced closer to consumers, avoiding of the longer transmission of the energy
- Several smaller size distributed instead of less units with larger size

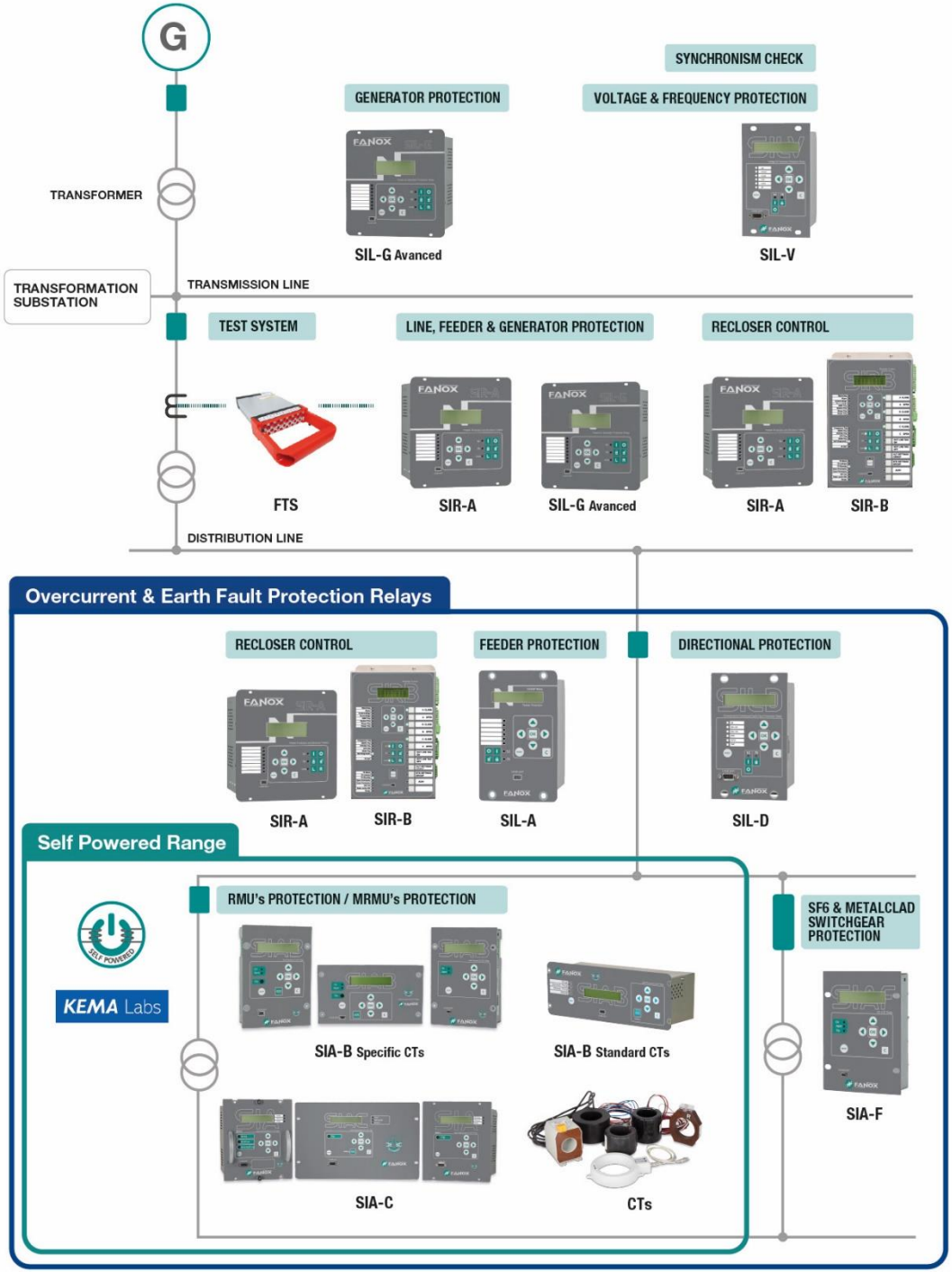
Renewable Energy Sources

We can distinguish two types of needs/protections:

- Protection for interconnection with the Grid (ST)
- Protection inside the farm (T1, T2…):
  - Wind Turbines
  - Solar Inverters



FANOX RELAYS
MEDIUM VOLTAGE



5 Garantía Cinco años

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FANOX SELF-POWERED RELAYS

Why Fanox Protection Relays are the right solution to protect renewable energy source systems.

Dual & Self Powered Overcurrent and Earth Fault Protection Relay for Secondary Distribution



Specialized in
Self Powered Relays

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SELF POWERING CONCEPT
INTRODUCTION

What is “self powering”?

The concept “Self Powering" defines the supplying mode of electronic protection relays for Medium Voltage.

It means that there is no need for auxiliary voltage to power the relay and that the energy is obtained directly from the line that we are protecting.



How do we obtain power from the line?

The energy is obtained through current transformers installed in the line to protect.

There are two options respecting to the transformers:

- **Standard transformers** /1 or /5
- **Specific transformers**: in this case the secondary current is not standard and they provide some special feature respect the standard CTs like a higher saturation level or a wider measurement range.



SELF POWERING CONCEPT

Which opening mechanism is used with self powered relays?

Self powered relays power themselves from the primary current and the energy is limited, so an efficient management of this energy is indispensable.



Due to this situation using coils is not feasible because they have a very high-power consumption. The solution is to use a striker (or low power coil).

But what is a striker?

It's a bistable device with a simple action. It consists on an electromagnet that is charged when the breaker is closed.



The **Trip Voltage Level** setting allows adjusting the trip voltage level required by the selected striker. The default value is 17 Vdc, although there are several options:

12 Vdc
17 Vdc
22 Vdc
24 Vdc

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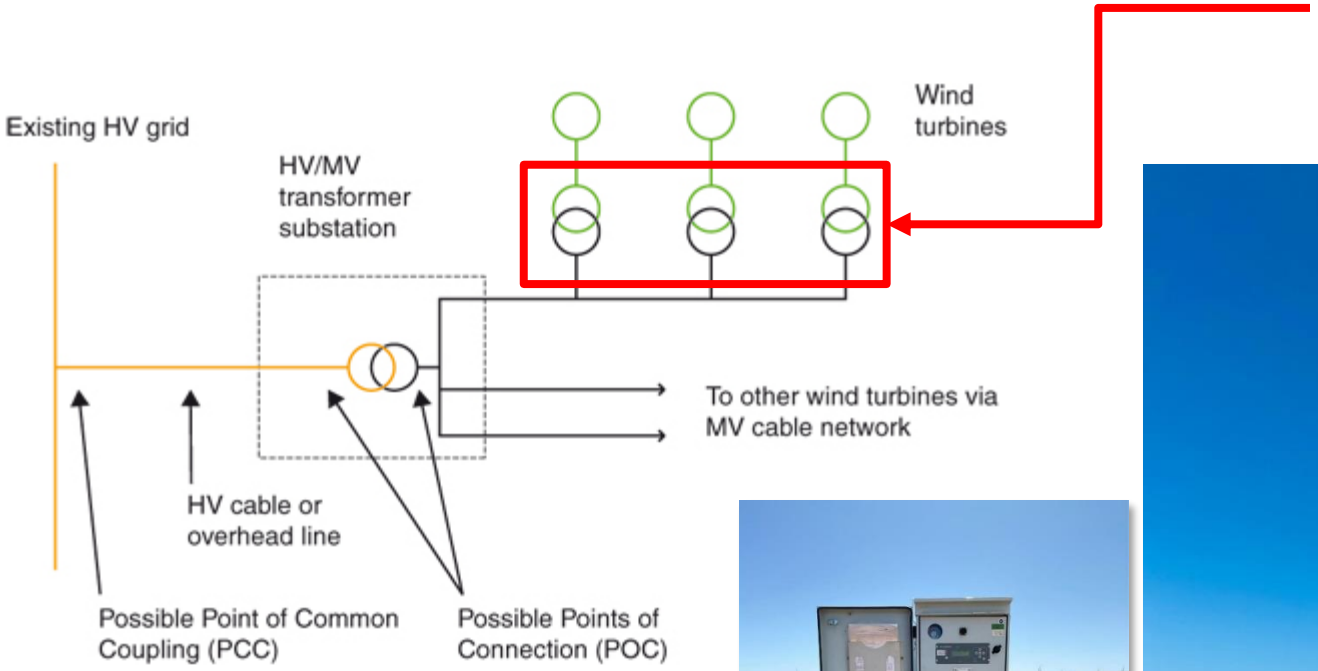
Applications

As **main generator protection** or **backup** of a main protection for installations inside or outside of the windmill.









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Advantages

Depending on the market practices, on the economic costs and on the impact in the network stability there are different approaches to the management of the wind farms.

With traditional relays the management options are reduced, because any **failure of the power supply** system would imply either the **stop of the turbine or** what is worse, a **non-protected generation scenario**.

The electrical protection of the generator cannot be left in hands of an auxiliary powered relay in order to ensure a **non-stop protection**.

"Self-powered protection relays maintain the generator under protection whenever the turbine is connected to the MV network, including the **energizing process**, while other devices of the generator are still in the powering up process."



SELF POWERED RELAYS

SIA-C Standard CTs	SIA-B Standard CTs	SIA-B Specific CTs
Standard CTs /1 or /5	Standard CTs /1	Specific CTs
Local COM-RS232 (Modbus RTU) Remote COM-RS485 (Modbus RTU or IEC60870-5-103)	Local COM-USB (Modbus RTU) Remote COM-RS485 (Modbus RTU or DNP3)	Local COM-USB(Modbus RTU) Remote COM-RS485 (Modbus RTU)
Self-powered + Optional auxiliary supply (24 Vdc, 48 Vdc 100-230 Vac/dc or 230 Vac)	Self-powered + Optional universal auxiliary supply (24-230 Vac/dc)	Self-powered + Optional universal auxiliary supply (24-230 Vac/dc)
Self powering level: 0.1xIn (3-phase)	Self powering level: 0.075xIn (3-phase)	Self powering level: 0.4xInmin (3-phase)
50/51/50G/51G Optional: 46/46BC/CLP/50BF/50_2/50G_2/49/79/52/SHB	50/51/50G/51G/SHB/49/52 Optional: 46/CLP/50BF/50_2/50G_2/Trip block	50/51/50N/51N Optional: 49/SHB/Trip block
Optionally, Configurable I/O	Configurable I/O	Optionally, Configurable outputs
		

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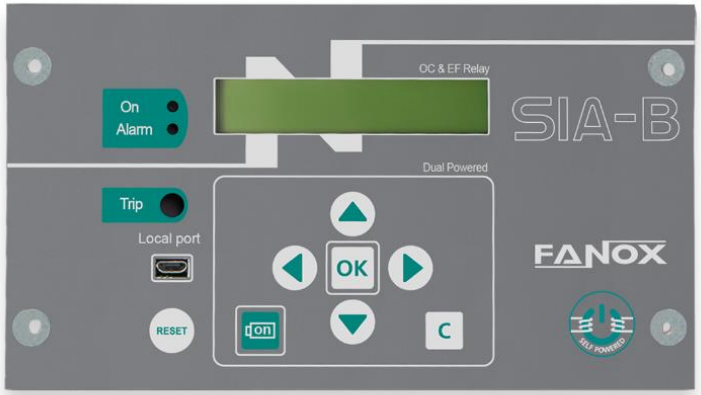
RENEWABLE ENERGY
WIND POWER

SIAB WITH SPECIFIC CTS

Dual & Self Powered Overcurrent and Earth Fault Protection Relay







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SIA-B+SPECIFIC CT

MAIN FEATURES I

SELF POWERED O/C&EF RELAY

ANSI CODE FUNCTIONS

50 Instantaneous phase overcurrent
51 Inverse time overcurrent
51N Inverse time calculated neutral overcurrent
49T External trip
50N Instantaneous calcalated neutral overcurrent
49 Thermal image
49T External trip
PGC Programmable logic control
TB Trip Block for switch disconnector



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SIA-B+SPECIFIC CT

MAIN FEATURES II

SELF POWERED O/C&EF RELAY

- **Overcurrent & Earth Fault Protection relay**. Self powered and Dual Powered (Self+Vaux).
- **Self-powering through Specific Current Transformers** fitted on the lines that allow a **wide range of nominal current**. These CTs are also used to obtain current measurements.
- **Self-powering from very low currents:**
  - **From 3.2 A (Primary).**



TAPED CTS

Special CTs				
Type	Code	*In Range	CT Ratio	Class
CT08-5 Taped	**41465**	3-33 A	7.2 / 0.075 A	5P80
CT16-5 Taped	**41451**	6-65 A	14.4 / 0.075 A	5P80
CT32-5 Taped	**41466**	12-130 A	28.8 / 0.075 A	5P80
CT128-5 Taped	**41519**	51-520 A	115.2 / 0.075 A	5P80

* In is the value of the primary nominal current of the transformer.



EPOXY RESIN

Special CTs				
Type	Code	*In Range	CT Ratio	Class
CT08-5	**41450**	3-33 A	7.2 / 0.075 A	5P80
CT16-5	**41458**	6-65 A	14.4 / 0.075 A	5P80
CT16-10	**41452**	6-65 A	14.4 / 0.075 A	10P80
CT32-5	**41453**	12-130 A	28.8 / 0.075 A	5P80
CT64-5	**41454**	25-260 A	57.6 / 0.075 A	5P80
CT128-5	**41455**	51-520 A	115.2 / 0.075 A	5P80
CT256-5	**41456**	102-1040 A	230.4 / 0.075 A	5P80

* In is the value of the primary nominal current of the transformer.

SIA-B+SPECIFIC CT

MAIN FEATURES III

SELF POWERED O/C&EF RELAY

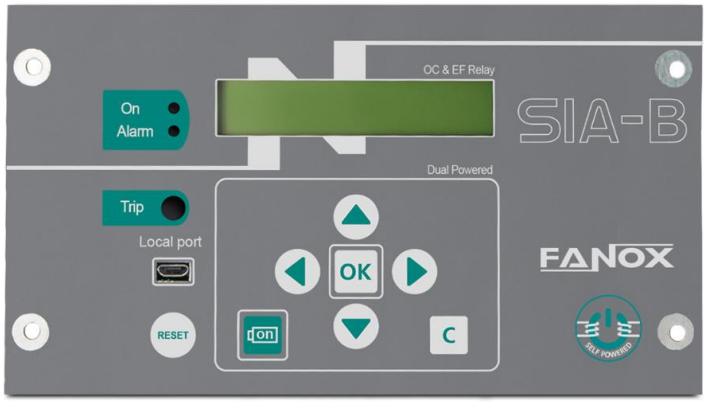
- **SHB protection.**
- **Local COM and optional Remote COM:** micro USB (Modbus RTU) for local. RS-485 port (Modbus RTU) for remote, also in **self powered mode**.
- Up to **2 configurable outputs** (NO-NC), plus a trip output (low power coil), and **external trip input** (without external voltage).
- With **2 frontal LEDs and 1 magnetic indicator (Flag). LCD and HMI** to check and parametrize the relay. Commissioning battery.
- Non-volatile RAM memory stores up to **100 events** and **4 fault reports**, even without auxiliary power (**Real Time Clock**). Self-diagnosis (**Watchdog**).
- **Compact size and light weight, easy to install, standarized engineering and cost saving.**
- **Very fast Switch On To Fault reponse (90ms)**
- **Anticorrosive treatment.**

SIA-B+SPECIFIC CT
ANTICORROSIVE TREATMENT

SELF POWERED O/C&EF RELAY

The constant search for best wind locations has brought wind farms to be installed in really harsh environment locations, such as desserts, tundra or coast side.

For such cases, we have developed, as an option, a special **anticorrosive treatment** for the relay that has **passed successfully** the **Salt Fog Test – Severity 6 (IEC60068-2-52).** A test of 56 days duration under defined humidity and temperature conditions to prove its performance.





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WIND POWER

SIAC WITH STANDARD CTS

Dual & Self Powered Overcurrent and Earth Fault Protection Relay



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SIA-C+STANDARD CT

MAIN FEATURES I

SELF POWERED O/C&EF RELAY

CÓDIGO DE FUNCIONES ANSI

50 Instantaneous Phase Overcurrent
51 Inverse time overcurrent
49T External trip
51G Inverse time measured neutral overcurrent
50G Instantaneous measured neutral overcurrent
46 Phase Balance current Protection
46BC Broken Conductor Detection
49 Thermal Image
SHB Second Harmonic Blocking
CLP Cold Load Pickup
79 AC Reclosing device
52 Breaker wear Monitoring
50BF Circuit Breaker Opening Failure
74TCS Trip Circuit Supervision
60CTS Phase CT Supervision
68 Zone selection interbloking
PGC Programmable Logic Control



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SIA-C+STANDARD CT

MAIN FEATURES II

SELF POWERED O/C&EF RELAY

- **Overcurrent & Earth Fault Protection relay**. Self powered and Dual Powered (Self+Vaux).
- **Self-powering through Standard Current Transformers (/1 or /5)** fitted on the lines. These CTs are also used to obtain current measurements.
- **Self-powering from very low currents:**
  - **0.1xIn (3-phase)**
- **Local COM and optional Remote COM:** DB9 connector (Modbus RTU) for local. RS-485 port (Modbus RTU or IEC 60870-5-103) for remote, also in **self powered mode**.
- Up to **3 configurable outputs** (NO-NC) plus a trip output (low power coil), and up to **2 inputs** (depending on model) plus **external trip input** (no voltage needed).
- With **3 frontal LED, up to 3 magnetic indicators (Flags)** and **Backlight** option. **LCD and HMI** to check and parametrize the relay. Commissioning Battery.
- Non-volatile RAM memory stores up to **1024 events** and **20 fault reports**, even without auxiliary supply (**Real Time Clock**) up to **10 oscillography records in COMTRADE format** (depending on model). Self-diagnosis (**Watchdog**).
- Up to **4 settings groups**, **2 levels of overcurrent protections, SHB** and **reclosing capability** (depending on model).
- **Fast Switch-On-To-Fault**

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Application

On the Medium Voltage cell, as **Step-up Transformer Protection** (solar inverter).

Depending on the size and complexity of the project:

- Self powered relays
- Feeder protection relays



Defies

There is a tendency on the market to go to bigger solar inverters. As the power increases (up to 7.5MVA and more) also the voltages are rising.

The market is demanding not only overcurrent protection, but full data registers and protection and control functions more complex: relays with reclosing capabilities, advanced communications…



Solutions

To accommodate these new requirements, FANOX have worked in two directions:

- A **complete self powered relay**: it is important to have extremely low self powering levels, compact design, relays with sensitive neutral channel for ZCT, oscillography records, full range of IEC and IEEE curves for selectivity or SHB to detect inrush current of the transformer.
- A **non self-powered relay with advance communications** (TCP/IP protocols, IEC61850…) and those additional protection and control functions (ANSI 79, SOTF, 74CT, 46BC).



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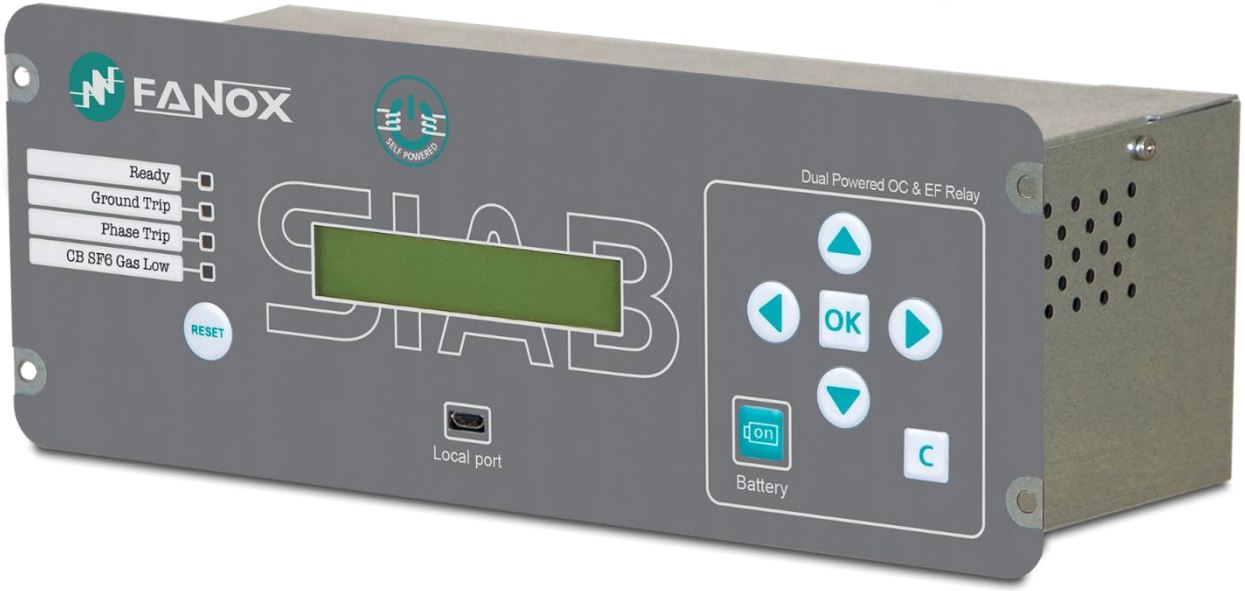
SIAB WITH STANDARD CTS /1A

Dual & Self Powered Overcurrent and Earth Fault Protection Relay



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Self Powered Relays

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SIA-B+STANDARD CT
MAIN FEATURES I

SELF-POWERED O/C&EF RELAY

ANSI CODE FUNCTIONS

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49T External trip

51G Inverse time measured neutral overcurrent

50G Instantaneous measured neutral overcurrent

46 Phase balance current protection

49 Thermal overload

SHB Second Harmonic Blocking

CLP Cold Load Pickup

52 Breaker wear monitoring

50BF Circuit Breaker Failure

68 Zone selection interlocking

PGC Programmable logic control

TB Trip Block for switch disconnector



Multiple options for powering and communication

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SIA-B+STANDARD CT

MAIN FEATURES II

SELF-POWERED O/C&EF RELAY

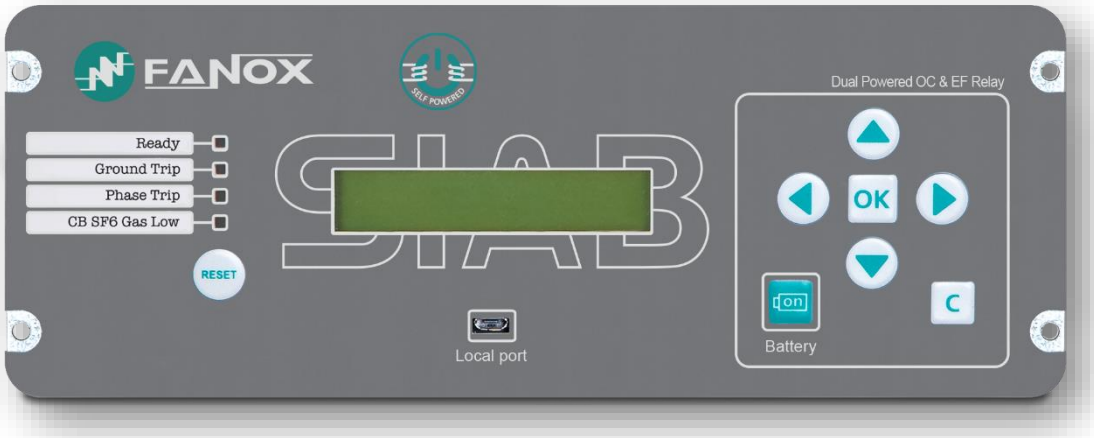
- **Overcurrent & Earth Fault Protection relay**. Self powered and Dual Powered (Self+Vaux).
- **Uses the operating current** through three **/1 standard Current Transformers** fitted on the lines requiring less than 2 VAs. These CTs are also used to obtain current measurements.
- **Self-powered from:**
  - **0.075xIn (3-phase)**
- **Local COM and optional Remote COM:** micro USB connector (Modbus RTU) for local. RS-485 port (Modbus RTU or DNP3) for remote, also in **self powered mode**.
- Non-volatile RAM memory stores up to; **10 Oscillographic records in COMTRADE format** (1 second) **1024 events** and **20 fault reports**, Maintaining date and hour thanks to its internal RTC (**Real Time Clock**). Self-diagnosis (**Watchdog**).

SIA-B+STANDARD CT

MAIN FEATURES III

SELF-POWERED O/C&EF RELAY

- **Compact size and light weight, easy to install and cost saving.**
- With **4 frontal LEDs. LCD and HMI** to check and parametrize the relay. Commissioning Battery.
- **3 inputs y 3 configurable outputs,** plus a trip output (low power coil)
- Up to **4 settings groups**, **2 levels of overcurrent protections, SHB** and **Load Data Profiling** (depending on model).
- **Very fast Switch-On-To-Fault (50 ms)**



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SOLAR POWER

SIL-A ADVANCED FEEDER PROTECTION RELAY

Advanced Overcurrent & Earth Fault Protection Relay



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SIL-A ADVANCED

MAIN FEATURES I

FEEDER PROTECTION RELAY

ANSI CODE FUNCTIONS

50 instantaneous phase overcurrent
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50BF Circuit breaker failure
74TCS Trip circuit supervision
60CT Phase CT supervision
86 Trip output
68 Zone Selection Interlocking
PGC Programmable logic
TB Trip Block for switch disconnector



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SIL-A ADVANCED

MAIN FEATURES II

FEEDER PROTECTION RELAY

- **Advanced Overcurrent & Earth Fault Protection relay**. Universal auxiliary power supply.
- **Working with /1 or /5 standard Current Transformers. Possibility to have shortcircuitable current terminals (/1A)**.
- **Sensitive current measurement:**
  - **From 10mA (secondary)**
- **Restricted Earth Fault protection.**
- Non-volatile RAM memory stores up to **100 Oscillographic records (configurable) in COMTRADE format, 3072 events** and **20 fault reports**, Maintaining date and hour thanks to its internal RTC (**Real Time Clock**).
- Up to **6 inputs** and **6 configurable outputs.** With **8 configurable frontal LEDs. LCD and HMI** to check and parametrize the relay.
- Up to **4 settings groups.**
- **Advanced remote communications:**
  - RS485: Modbus RTU, IEC 60870-5-103 or DNP3
  - RJ45: Modbus TCP/IP, DNP3TCP/IP, IEC60870-5-104, IEC61850
- **Reclosing capabilities** and **extended logic** that allows to implement complex control schemes.

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What are the impacts of Distributed Generation?

On the HV network:
Less traditional power-plants:
- Less inertia (rotating mass)
- Less frequency-, voltage- and power balancing support available

More and larger inverters connected to network
- Without rotational inertia
- With variable nature

Problem:
- HV network capacity constraints may become an issue

On the MV network:
More inverters
- Without rotational inertia
- With variable nature

Problem:
- Traditional MV protection and Islanding detection may maloperation

How to manage those impacts?



Until now, distributed generation units have been required to be **disconnected during utility grid faults / islanding situations**

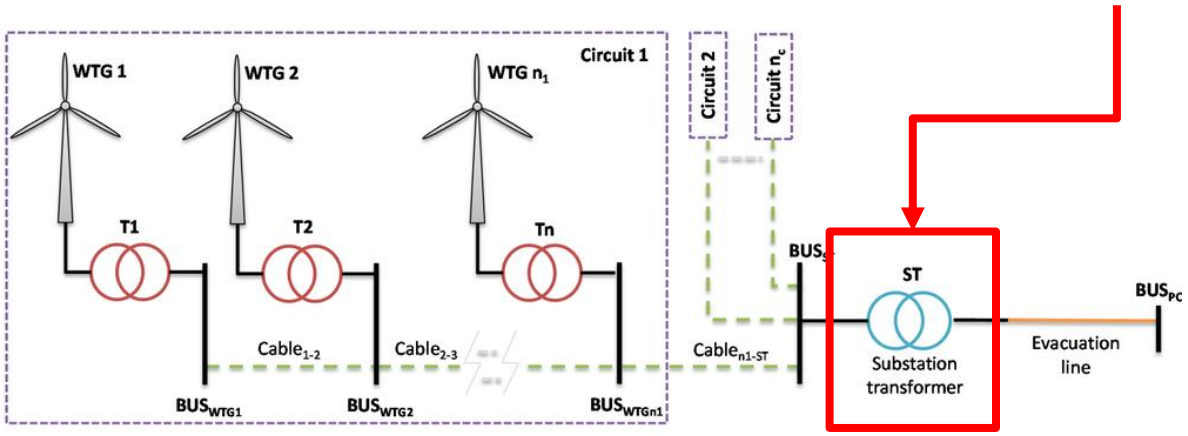
- Based on voltage, frequency, rate-of-change-frequency or vector shift
- Without any specific requirements to support utility grid (HV Network)

Nowadays has become more common to require **HV network stability support** from distributed generation:

- Prevent unnecessary disconnection during HV network faults and frequency disturbances
- Support voltage and frequency during disturbances
  - P/ f and Q/ U control
  - Reactive current contribution during faults/ low voltage situations
  - More advanced MV protection and Islanding detection methods

Fanox Solutions

NEW protection requirements for interconnection with the Grid (ST):



SIR-A:



SIL-G:



Fanox Solutions

Both relays has complete set of protection functions:

Current	50/50N/50G/67/67N/67G/46/49/37/ARC FLASH
Voltage	27/27V1/59/59N
Frequency	81/81R
Power	32

- A complete set of **communication protocols (Modbus, DNP3, IEC 60870-5-103, IEC61850)** and media **(RS485, FO, RJ45, Wifi)**
- Data storage with COMTRADE files, events and fault registering.
- Main difference is each one has specific details to directed to different applications:

SIR-A	SIL-G
• 4 current channels and up to 6 voltage channels. • Voltage measurement through **capacitive and resistive sensors** • Recloser Functions: Sectionalizer or Sequence coordination	• 4 current channels and up to 5 voltage channels. • Voltage measurement through **VT** • Generator Functions: Overfluxing



RENEWABLE ENERGY
WIND REFERENCES

SIEMENS Gamesa RENEWABLE ENERGY

NORDEX

acciona Windpower

SIEMENS

iberapa people on power solutions

ABB

Schneider Electric

Lucy Switchgear

EATON

GE Energy Renewable Energy



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SOLAR REFERENCES

IBERDROLA

enel Green Power

GE Energy Renewable Energy

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NORTHLAND POWER

Ingeteam

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Thanks for your attention!





Questions?

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