Product note

SACE Emax 2
Protection and grid connection integrated into one device

Among the trip units for the innovative Emax 2 circuit breaker developed by ABB, one can be of interest to anyone protecting the thriving segment of the distribution and management of energy resources.

Ekip G is the name of a new kind of protection trip unit for low voltage breakers.

For the first time, a trip unit offers several functions dedicated to the protection of a generation set and its interconnection with the grid in order to respond to the types of protections suggested in international standards such as; IEC 60034-1, IEEE C37.102 or IEEE 242.

Any time a low voltage synchronous generator is involved (typically for applications around and over 1 MVA: mini-hydro installation, medium size cogeneration, generation from biomasses, diesel generation) Ekip G can provide a complete set of dedicated protection functions.

Any time any source of distributed energy is connected to the grid, Ekip G can provide a simple and effective set of anti-islanding functions (ROCOF –Rate of Change of Frequency- being among them).

Ekip G works by acquiring signals from both the line and the load side. By using its own current and voltage sensors, the Emax 2 solution minimizes the need for acquisition and cabling of external devices. In fact, current and voltage sensors are internal and connected to the measuring module of the trip unit, called Ekip Measuring.

Currently, the most popular solution for generator protection includes using a circuit breaker in conjunction with external relays. Emax 2 with Ekip G incorporates some 21 dedicated functions into the breaker itself, in addition to its standard distribution functions, to eliminate the need for extra equipment and the expense and complications that can come with them.

Furthermore, using the most advanced version of the Ekip G relay (the Hi-Touch), it is possible to have two thresholds for every voltage and frequency protection in order to meet the widest range of interconnection requirements around the world. A quick overview of specific generator protections is listed here.

Function	Description	ANSI Code	ABB Code
Synchrocheck	Control of the conditions for paralleling	25	SC
Active overpower protection	Protection for maximum active power supplied	32OF	OP
Reactive overpower protection	Protection for maximum reactive power supplied	32OF	OQ
Reverse active power protection	Protection for active power consumption	32R	RP
Directional overcurrent protection	Protection for directional current	67	D
Active underpower protection	Protection against minimum active power supplied	32LF	UP
Loss of field or reverse reactive power protection	Protection against an energizing anomaly, check of reactive power supplied	40/32R	RQ
Overload Protection	Current protection against temperature rise	49	L
Instantaneous overcurrent protection	Instantaneous protection against overcurrent between phases	50	I
Time-delayed overcurrent protection	Time-delayed protection against overcurrent between phases	50TD 51	S
Earth fault protection	Time-delayed protection against earth overcurrent	50NTD 51N ; 50GTD 51G ;	G ; Gext ;
Differential ground fault protection	Protection against internal earth fault on generator winding	87N	Rc
Voltage controlled overcurrent protection	Protection against short circuit between threshold phases depending on voltage	51V	S(V)
Residual overvoltage protection	Protection detecting loss of insulation in the machine	59N	RV
Undervoltage Protection	Protection against voltage drop	27	UV
Overvoltage protection	Protection against voltage increase	59	OV
Current unbalance protection	Protection against unbalance of phase currents	46	IU
Voltage unbalance protection	Protection against voltage unbalance and detection of rotation direction of phases	47	VU
Rate of change of frequency protection	Protection against rapid frequency changes	81R	Rocof
Overfrequency protection	Protection against frequency increase	81H	OF
Underfrequency protection	Protection against frequency reduction	81L	UF

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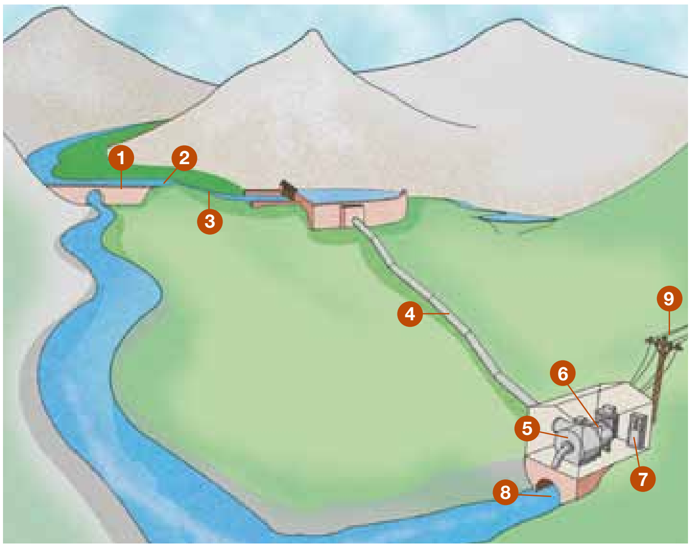
An example of application: a mini-hydro generation plant



1. Weir
2. Setting tank
3. Canal
4. Penstock
5. Turbine
6. Generator
7. Control panel
8. Tailrace
9. Transmission

Small hydro plants may be connected to national electrical distribution networks as a source of (renewable) energy.
In some countries (where the cost per kWh is high) there is an interesting economic convenience to realize new–or, often, revamp old power hydro plants.
Consider that mini hydro installations are common in Europe (Italy, Norway, Austria etc.) and in the USA. In some other countries, where the centralized generation capacity is not large enough to meet the necessities, small hydro plants are often the only solution for electrification of remote areas. Examples of this type of installation can easily be found both in Asia (Nepal, Malaysia, Pakistan, Bhutan, etc.) and in Africa (Zambia, South Africa, etc.).

For a typical 1 MVA installation, the point of coupling with the national grid will be very likely in medium voltage.
For this reason, we can consider a generic diagram like this:

In medium-voltage connection to the public utility network, the natural goal of a SACE Emax 2 with an Ekip G protection trip unit is to protect the single low-voltage generator.

The protections most commonly used for this are those defined by the following ANSI codes:

40 (loss of excitation);

27 (minimum voltage);

59 (maximum voltage);

50 (maximum instantaneous current);

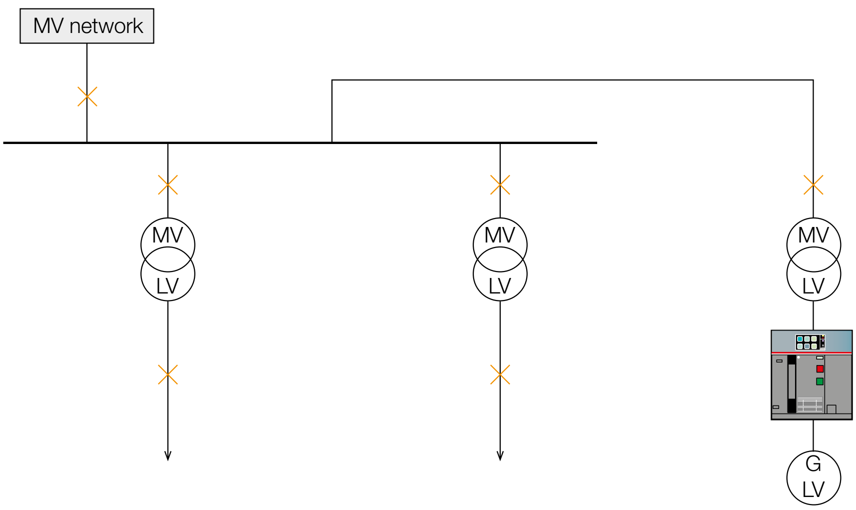
51 (maximum time-delayed current);

81H (maximum frequency);

81L (minimum frequency);

49 (overload);

32R (active power consumption-reverse).

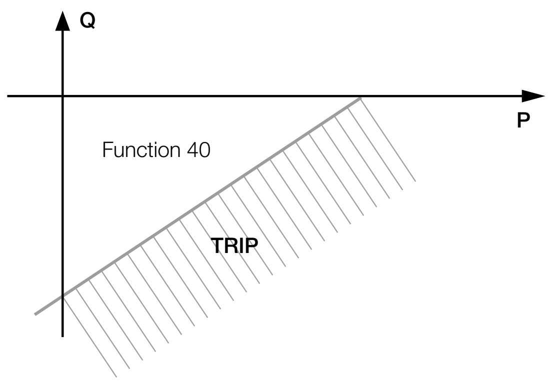


Some of the current off-the-shelf low voltage breakers may offer up to eight out of these nine protection functions: but only Ekip G can offer integrated protection against the loss of excitation.
The loss of excitation in a synchronous generator mainly arises from faults in the energizing unit or in the field circuit. Consequently, the electromotive force in the generator is disabled and there is a reduction in the reactive power supplied. The machine then operates as an asynchronous generator, consuming reactive power from the network.

The new operating condition, with the circulation of reactive power supplied by the network, increases the temperature in the rotor circuit. In addition to the phenomenon that involve the machine, voltage is reduced significantly, with consequent loss of system stability.

The protection for this phenomenon works by acquiring the total active and reactive power values. If the working point is below the set protection line and this condition persists for a time greater than the set trip delay time, the protection trips to open the breaker or generate an alarm signal.

Power Protection RQ - ANSI 40



ABB's suggestion for settings of this protection (and all the other generator protection functions) can be found in the White Paper named "Generators protection: Ekip G trip unit for SACE Emax 2".

A further application: interconnection with the grid

Islanding refers to the condition in which a distributed energy resource continues to power a location even though the grid is no longer present. Islanding can be dangerous, so distributed generators must be equipped with anti-islanding features.

Generally speaking, boundary conditions are put on voltage and frequency. Often, a more sensitive anti-islanding function is required as well: the rate of change of frequency (ROCOF – ANSI code 81R). This protection enables both positive and negative frequency changes to be detected rapidly and with greater sensitivity, thus ensuring a protection that is faster than what is possible with traditional minimum or maximum frequency functions.
Typical settings (different form country to country) range between 0.2 Hz/s and 1 Hz/s. Ekip G Hi-Touch contains built in ROCOF protection.

For more information please contact:

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