

TECHNICAL REPORT

Title: **Self-powered Protection Systems**

Product: ekorRP-100/200/300 Protection, Measuring and Control Units

Specification: IG-159-GB

Data: 20 February 2008

The aim of the present technical report is to clarify in detail how the self-powered system works in the protection ekorRPG unit.

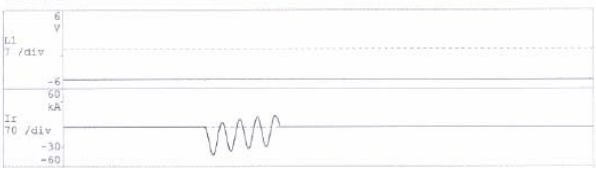
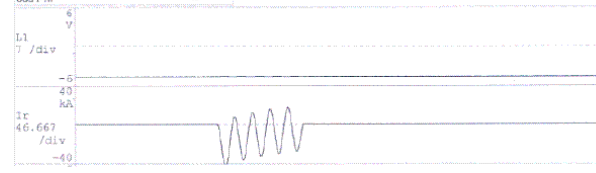
SELF-POWERED FUNCTION DESCRIPTION

The technical characteristics of the ekorRPG units are stated in the Ormazabal technical specification of the product IG-159-GB. The self-powered function is based on the energy supplied by the current transformers. The protection unit incorporates three measuring magnetic cores and another three magnetic cores to supply the protection unit. So, this system allows the protection to be ready for complete operation when the current in any phase is above 5 Amp. In fact, if the primary current is present in the three phases the relay starts its operation even in lower values. It means that the pick-up setting for phase-to-phase or phase-to-earth faults may be adjusted at 5 Amp and the system does not require any auxiliary supply. Settings below 5 Amp need external supply. The minimum value of current operation, 5 Amps in a single phase, is one of the lowest in the market for this type of self-powered protection systems. The operation time and pick-up values are not influenced by any auxiliary supply nor the internal battery. The self-power system is autonomous and independent of any other source of energy internal or external.

The ekorRPG unit also registers the values of the fault when the trip occurs. The values recorded are the fault current value, relay tripping time, type of phase-to-phase fault or phase-to-earth fault, maximum current phase, time and date. The register of these values is also independent of the internal battery or the external auxiliary supply. It is directly recorded in a non volatile memory immediately after the trip. The recorded event and its maintenance is guarantee without the energy of the internal battery or auxiliary supply. This information is very useful when a real fault occurs and it has to be analysed. Most of the self-powered protection systems only indicates if it has operated or not by means of a simple mechanical flag, and there is no information at all to help analysing the problem.

Several tests in the High Power Laboratory were performed to guarantee the correct operation of the ekorRPG unit, integrated in circuit breaker cubicle CGM-CMP-V. The

expedient of these tests is B125-01-CF 09.11.2001 LABEIN. The following oscillograms show different tests comparing protection trips using auxiliary supply and full battery with no auxiliary supply and no internal battery.

Short-circuit test 16kA																																											
<table border="1"> <tr><td>V_R (eficaz/RMS)</td><td>---</td></tr> <tr><td>I_R (eficaz/RMS)</td><td>16.55 kA</td></tr> <tr><td>I_R (cresta/peak)</td><td>42.72 kA</td></tr> <tr><td>t_R</td><td>0.0852 s</td></tr> <tr><td>$I_R^2 \cdot t$</td><td>3.96E+07 AAs</td></tr> </table> <table border="1"> <tr><td>V_S (eficaz/RMS)</td><td>---</td></tr> <tr><td>I_S (eficaz/RMS)</td><td>16.67 kA</td></tr> <tr><td>I_S (cresta/peak)</td><td>32.82 kA</td></tr> <tr><td>t_S</td><td>0.0842</td></tr> <tr><td>$I_S^2 \cdot t$</td><td>2.80E+07 AAs</td></tr> </table> <table border="1"> <tr><td>V_T (eficaz/RMS)</td><td>---</td></tr> <tr><td>I_T (eficaz/RMS)</td><td>16.47 kA</td></tr> <tr><td>I_T (cresta/peak)</td><td>33.35 kA</td></tr> <tr><td>t_T</td><td>0.0868 s</td></tr> <tr><td>$I_T^2 \cdot t$</td><td>2.53E+07 AAs</td></tr> </table> <table border="1"> <tr><td>t_{total}</td><td>0.085 s</td></tr> <tr><td>$I_{meda/mean}$</td><td>16.66 kA</td></tr> </table> 	V_R (eficaz/RMS)	---	I_R (eficaz/RMS)	16.55 kA	I_R (cresta/peak)	42.72 kA	t_R	0.0852 s	$I_R^2 \cdot t$	3.96E+07 AAs	V_S (eficaz/RMS)	---	I_S (eficaz/RMS)	16.67 kA	I_S (cresta/peak)	32.82 kA	t_S	0.0842	$I_S^2 \cdot t$	2.80E+07 AAs	V_T (eficaz/RMS)	---	I_T (eficaz/RMS)	16.47 kA	I_T (cresta/peak)	33.35 kA	t_T	0.0868 s	$I_T^2 \cdot t$	2.53E+07 AAs	t_{total}	0.085 s	$I_{meda/mean}$	16.66 kA	<table border="1"> <tr><td>Fecha / Date:</td><td>9/11/01</td></tr> <tr><td>N° EXPEDIENTE:</td><td>B125-01-CF</td></tr> <tr><td>N° OSCILOGRAMA:</td><td>138</td></tr> </table>	Fecha / Date:	9/11/01	N° EXPEDIENTE:	B125-01-CF	N° OSCILOGRAMA:	138		
V_R (eficaz/RMS)	---																																										
I_R (eficaz/RMS)	16.55 kA																																										
I_R (cresta/peak)	42.72 kA																																										
t_R	0.0852 s																																										
$I_R^2 \cdot t$	3.96E+07 AAs																																										
V_S (eficaz/RMS)	---																																										
I_S (eficaz/RMS)	16.67 kA																																										
I_S (cresta/peak)	32.82 kA																																										
t_S	0.0842																																										
$I_S^2 \cdot t$	2.80E+07 AAs																																										
V_T (eficaz/RMS)	---																																										
I_T (eficaz/RMS)	16.47 kA																																										
I_T (cresta/peak)	33.35 kA																																										
t_T	0.0868 s																																										
$I_T^2 \cdot t$	2.53E+07 AAs																																										
t_{total}	0.085 s																																										
$I_{meda/mean}$	16.66 kA																																										
Fecha / Date:	9/11/01																																										
N° EXPEDIENTE:	B125-01-CF																																										
N° OSCILOGRAMA:	138																																										
<table border="1"> <tr><td>V_R (eficaz/RMS)</td><td>---</td></tr> <tr><td>I_R (eficaz/RMS)</td><td>16.23 kA</td></tr> <tr><td>I_R (cresta/peak)</td><td>42.03 kA</td></tr> <tr><td>t_R</td><td>0.0965 s</td></tr> <tr><td>$I_R^2 \cdot t$</td><td>3.96E+07 AAs</td></tr> </table> <table border="1"> <tr><td>V_S (eficaz/RMS)</td><td>---</td></tr> <tr><td>I_S (eficaz/RMS)</td><td>16.34 kA</td></tr> <tr><td>I_S (cresta/peak)</td><td>31.95 kA</td></tr> <tr><td>t_S</td><td>0.0930</td></tr> <tr><td>$I_S^2 \cdot t$</td><td>2.81E+07 AAs</td></tr> </table> <table border="1"> <tr><td>V_T (eficaz/RMS)</td><td>---</td></tr> <tr><td>I_T (eficaz/RMS)</td><td>16.11 kA</td></tr> <tr><td>I_T (cresta/peak)</td><td>32.96 kA</td></tr> <tr><td>t_T</td><td>0.0980 s</td></tr> <tr><td>$I_T^2 \cdot t$</td><td>2.77E+07 AAs</td></tr> </table> <table border="1"> <tr><td>t_{total}</td><td>0.096 s</td></tr> <tr><td>$I_{meda/mean}$</td><td>16.23 kA</td></tr> <tr><td>$\cos \Phi_{th}$</td><td>---</td></tr> </table> 	V_R (eficaz/RMS)	---	I_R (eficaz/RMS)	16.23 kA	I_R (cresta/peak)	42.03 kA	t_R	0.0965 s	$I_R^2 \cdot t$	3.96E+07 AAs	V_S (eficaz/RMS)	---	I_S (eficaz/RMS)	16.34 kA	I_S (cresta/peak)	31.95 kA	t_S	0.0930	$I_S^2 \cdot t$	2.81E+07 AAs	V_T (eficaz/RMS)	---	I_T (eficaz/RMS)	16.11 kA	I_T (cresta/peak)	32.96 kA	t_T	0.0980 s	$I_T^2 \cdot t$	2.77E+07 AAs	t_{total}	0.096 s	$I_{meda/mean}$	16.23 kA	$\cos \Phi_{th}$	---	<table border="1"> <tr><td>Fecha / Date:</td><td>9/11/01</td></tr> <tr><td>N° EXPEDIENTE:</td><td>B125-01-CF</td></tr> <tr><td>N° OSCILOGRAMA:</td><td>135</td></tr> </table>	Fecha / Date:	9/11/01	N° EXPEDIENTE:	B125-01-CF	N° OSCILOGRAMA:	135
V_R (eficaz/RMS)	---																																										
I_R (eficaz/RMS)	16.23 kA																																										
I_R (cresta/peak)	42.03 kA																																										
t_R	0.0965 s																																										
$I_R^2 \cdot t$	3.96E+07 AAs																																										
V_S (eficaz/RMS)	---																																										
I_S (eficaz/RMS)	16.34 kA																																										
I_S (cresta/peak)	31.95 kA																																										
t_S	0.0930																																										
$I_S^2 \cdot t$	2.81E+07 AAs																																										
V_T (eficaz/RMS)	---																																										
I_T (eficaz/RMS)	16.11 kA																																										
I_T (cresta/peak)	32.96 kA																																										
t_T	0.0980 s																																										
$I_T^2 \cdot t$	2.77E+07 AAs																																										
t_{total}	0.096 s																																										
$I_{meda/mean}$	16.23 kA																																										
$\cos \Phi_{th}$	---																																										
Fecha / Date:	9/11/01																																										
N° EXPEDIENTE:	B125-01-CF																																										
N° OSCILOGRAMA:	135																																										
Auxiliary supply 230Vac and full internal battery	No auxiliary supply and no internal battery																																										
Total current time 0.085 seconds (This time includes the relay, tripping coil, CB mechanism and current interruption times)	Total current time 0.096 seconds (This time includes the relay, tripping coil, CB mechanism and current interruption times)																																										

BATTERY DESCRIPTION

The settings of the relay may be modified when there is load in primary circuit, or when the cubicle is not in service by using simple current test equipment in the CT test points, or connecting the 230Vac auxiliary supply. The aim of the internal battery is to supply energy to the relay to activate the display and the keys when the previous situations are not convenient. In fact, under these conditions the led "On" in the front will not be lighting, so the protection is not in operation mode.

The expected life of the battery is 10 years if the number of consultations on the relay for setting or display data fault under no load or auxiliary supply is not excessive. The number of consultations is approximately 6000 times under the previous conditions.

When the final discharge of the battery or its end-of-life occurs, no effect is observed in the protection function of the ekorRPG unit. But, the internal clock of the relay used for recording the values in case of a fault may be misadjusted if the load is interrupted and there is no auxiliary supply. In any case, the deviation of a clock in an autonomous system not externally synchronized may be greater than the one due to load interruption. Another effect that may be observed in case of no internal battery and no auxiliary supply is that in case of a trip the values of the recorded fault are not displayed by touching a key in the frontal panel. To see the data is necessary to close the circuit breaker for the load to go through the current transformers, or use a current test equipment or auxiliary supply. Alternatively, for these cases when the previous situations are not convenient, there is a

simple portable tool to be connected in the frontal port of the relay during the consultation process. It activates the display and the keys to see all the information of the fault.

CONCLUSIONS

The self-powered protection ekorRPG unit operates under its technical specifications of all the protection functions and fault data record independently of any external auxiliary supply or the amount of energy in the internal battery.

The self-powered protection ekorRPG unit offers much more information and settings capability than the most of self-powered protection systems in the market. In order to facilitate working with this information, an internal battery is included. This internal battery is exclusively used to active the display and the keys under no load condition, no current test equipment used and no external supply.

When the final discharge of the battery or its end-of-life occurs any procedure of the stated above may be used to consult the equipment. If none of them is convenient a simple portable tool may be connected in the frontal port of the relay during the consultation or new setting process.

Nowadays Ormazabal has thousands of self-powered protection units in service. There is a small rate of internal batteries discharges and are mainly caused by the manufacturing process, wrong stockage, intensively consultations, etc. Very occasionally, in some wind turbines due to the speed of the wind we have observed an accelerated discharge of the battery, however these problems have not made any affect on neither the protection function or fault recording of the relay. In all the cases, the protections of the installations are fully operative and the only implication is to use additional means for the extra features that ekorRPG offers compared with other self-powered systems.