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REPORT:

5 YEARS OF REMOTELY CONTROLLED OFF MEASUREMENTS: LESSONS LEARNED

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ABSTRACT:

In the last decade we started producing cyclic interrupters to complement our dataloggers for cathodic protection. When the diffusion of remote monitoring systems did start, we were challenged by the possibility of remotely controlling E_{OFF} measurements. We decided to integrate the necessary electronics in our dataloggers. Now, after 5 years of field experience, we want to share some lessons learned and put under the spotlight some statistical data obtained with different measuring methodologies. The goal is to invite the corrosion community to use the new low cost technologies as a brute force approach for theory verification in real operating contexts.

RÉSUMÉ:

Pendant la décennie passée, nous avons commencé la production d'interrupteurs cycliques comme complément à nos enregistreurs de données pour la protection cathodique. Quand les systèmes de monitorage à distance ont commencé leur diffusion, nous nous sommes lancé le défi de faire des mesures de potentiel OFF à distance. Nous avons décidé d'intégrer l'électronique nécessaire dans nos enregistreurs. Maintenant, après 5 années d'expérience sur le terrain, nous voulons échanger ce retour d'expérience et mettre en évidence quelques données statistiques obtenues par des méthodologies différentes. Notre objectif est d'inviter la communauté des spécialistes en corrosion à utiliser les nouvelles technologies à bas prix pour une approche par force brute à la vérification des théories dans des contextes opérationnels réels.

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INTRODUCTION.

Even if we are engaged in the field of cathodic protection monitoring from the end of the 80's, the majority of requests we had was for ON potential and for protection current monitoring.

At the start of the 90's we already had our own cyclic interrupter, but the tests in Italy were always made by interrupting the connection between rectifier and pipe.

With the rise of remote monitoring, we integrated the possibility of taking OFF measures, using an higher sampling rate to obtain more information on potential gradients.

Interrupting the flow of current from rectifier to pipe has its peculiar problems, as the need of dissipating the heat produced during the transients, the risk incurred if some hardware failure permanently interrupts the flow of protection current and the necessity of precisely synchronize the interruption and the measurements (and of synchronizing the interruptions where there are more than one rectifier insisting on the same sector, without insulating joins).

Another class of problems, when taking OFF potentials directly on the pipe, are due to the degree of interference: in Italy the main source of interference was due to d.c. transit systems, so that kind of measures were made during the night, when the source of interference was absent or less present.

Due to this kind of constraints, up to 5 years ago the only kind of OFF measure we developed was the possibility of graphing the evolution of the potential after the disconnection, with a sampling rate of 10 to 20 samples per second.

When our horizon started to widen outside of Italy, we started to deal with a new set of constraints. After 5 years of development and with some thousands of Remote Monitoring Units installed that take daily ON/OFF potential measurements, we are now able to give back to the corrosion community some feedback on the results and on the techniques.

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THE OLD WAY.

As I said, up to 5 years ago we customized our firmware to take only one kind of "OFF" measurements. The RMUs could be programmed to go in IOFF mode, choosing the start time and date, the duration, the length in seconds of the ON and of the OFF cycle.
When in IOFF mode, the RMU started storing 10 samples per second, so even a few hours of sampling generated a lot of data and all that data took a lot of time and money to transmit. In the following generation of RMUs, the doubling of the storing rate and the higher number of decimals worsened the issue.
A side problem is that more data to transmit means longer transmissions and the reliability of the communication media is of paramount importance. This generates additional requests for managing the possibility of resuming incomplete transmissions.

THE NEW CHALLENGES.

Even if we managed to solve all this kind of issues, this type of measuring strategy was designed to take OFF potential values on pipes, where the length of the transient was an important consideration.

Moving outside of Italy we started to take OFF values on coupons and we decided to evaluate the possibility of changing the metering strategy.

A frequent request was that of having the possibility of tracking faster phenomena, of taking faster measures to avoid the possibility of taking a partially depolarized coupon potential.

So during the last three years we have progressively modified the firmware, adding further configuration parameters.

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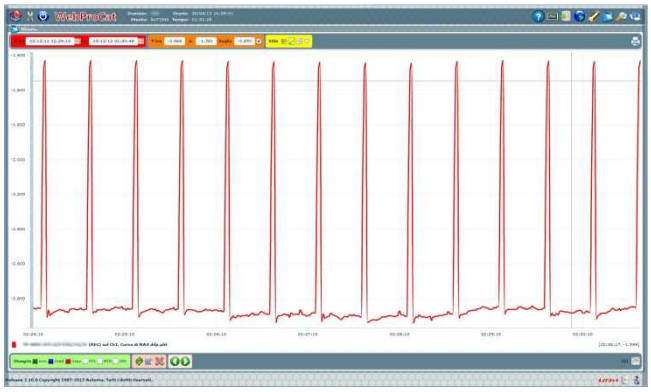
The focus has been moved from following the potential variation, to taking fast samples.

The added value of taking fast sample is the possibility of sampling for a longer time with shorter OFF cycles.

The added value of having both strategy is the possibility of evaluating each context and choosing the right measuring strategy.



THE CURRENT STATE.

Following this evolution path, we reached a new equilibrium: the former IOFF strategy has been complemented with the new continuous OFF strategy; the channel connected to the coupon can be configured to continuously operate ON/OFF cycles, but the parameters can be modified in 500 µsec steps; even the integration period can be set in 500 µsec steps.

With the second strategy, every day we can have a short report with OFF values on coupon (the usual data: min, max, average, rms, mode, …). If necessary, in presence of anomalies we can ask the RMU to transmit the complete data second by second and compare the various channels to analyze ac interference, dc interference, current intensity or density.

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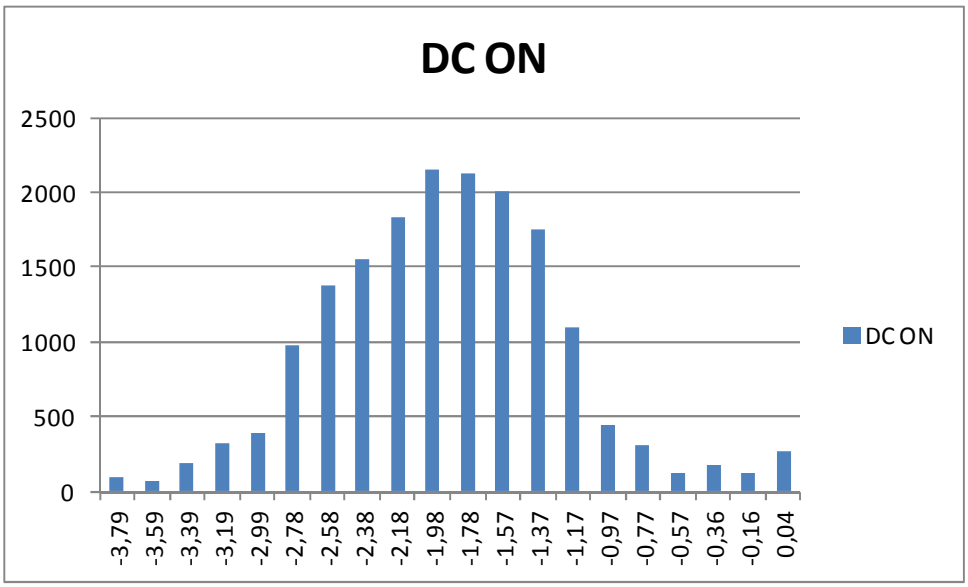
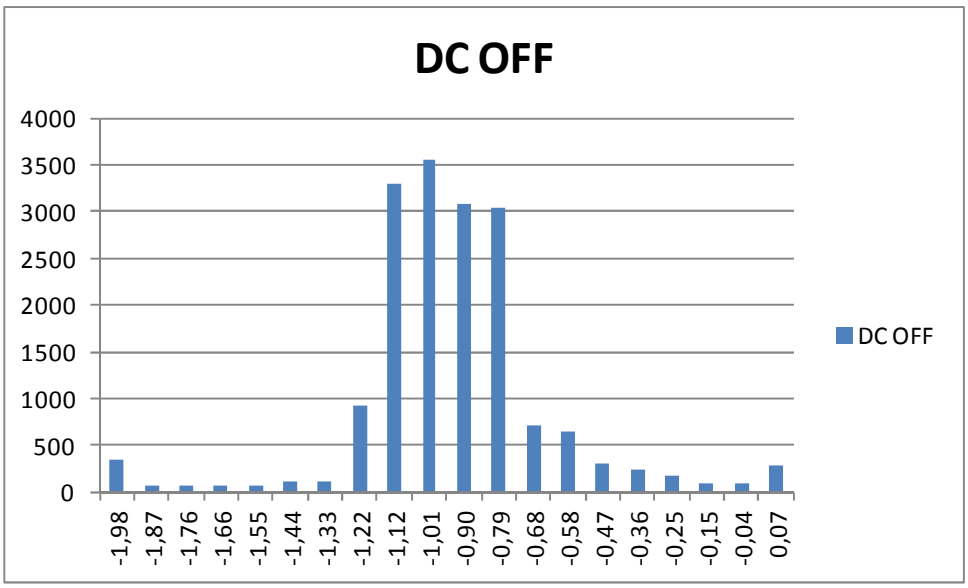
SOME STATISTICAL DATA.

Just to have an idea of what kind of information, we have collected two week worth of data on over 1000 testposts, to show what can be obtained from this kind of measurement.

As we could expect, OFF values are less sparse than ON values, as can be seen comparing the two following histograms:





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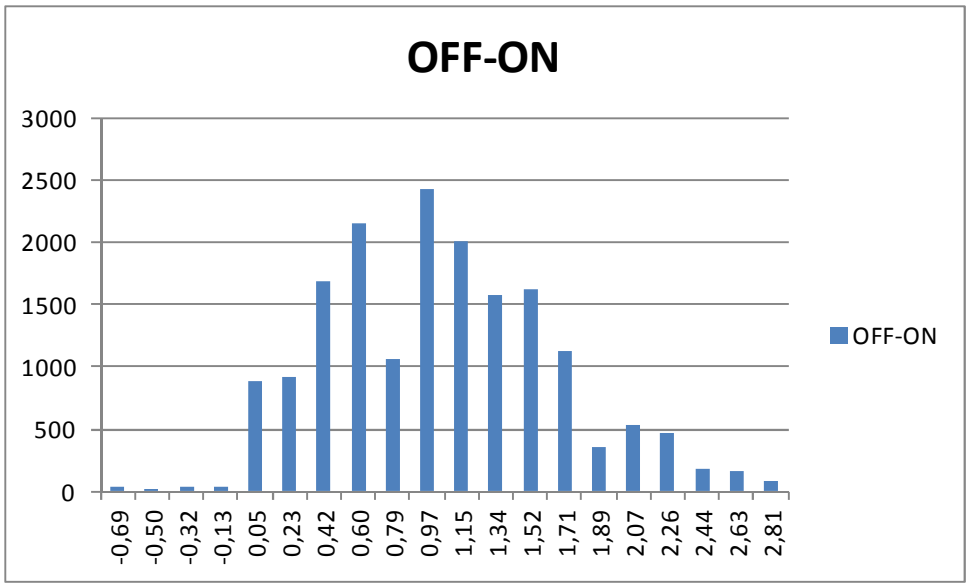
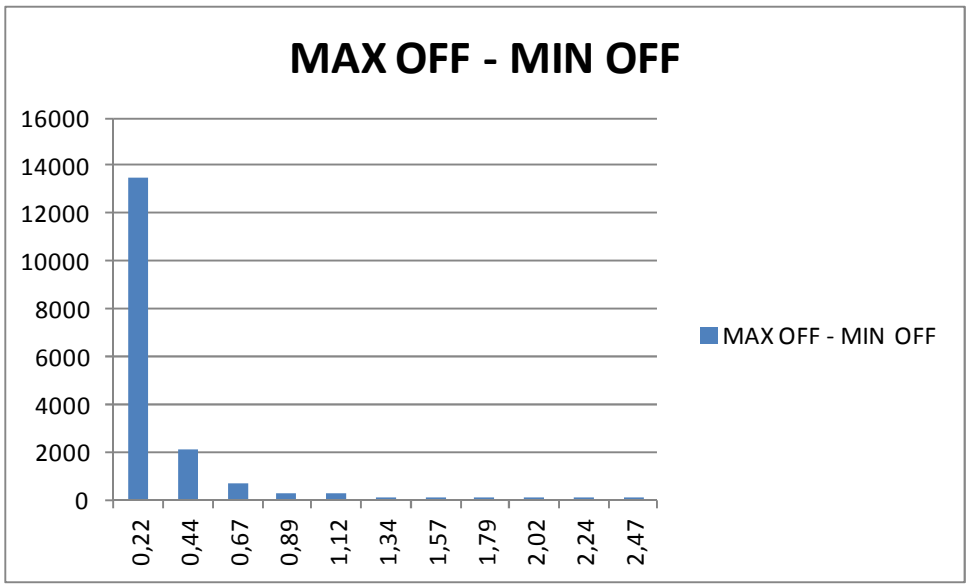
The same kind of behavior become apparent when analyzing the difference between the mode of ON and OFF values, while the OFF value stay quite stable during the day, as can be seen comparing the max and min value:





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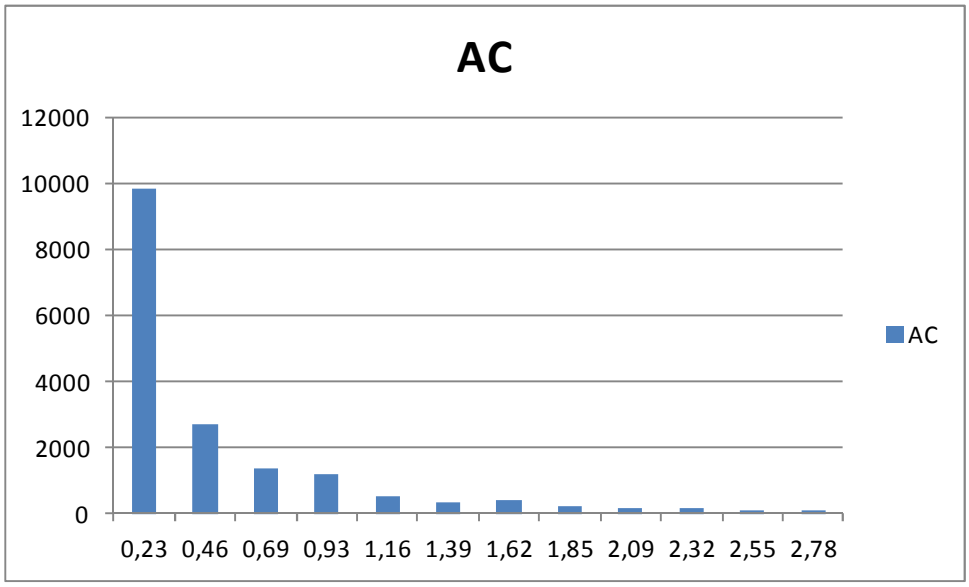
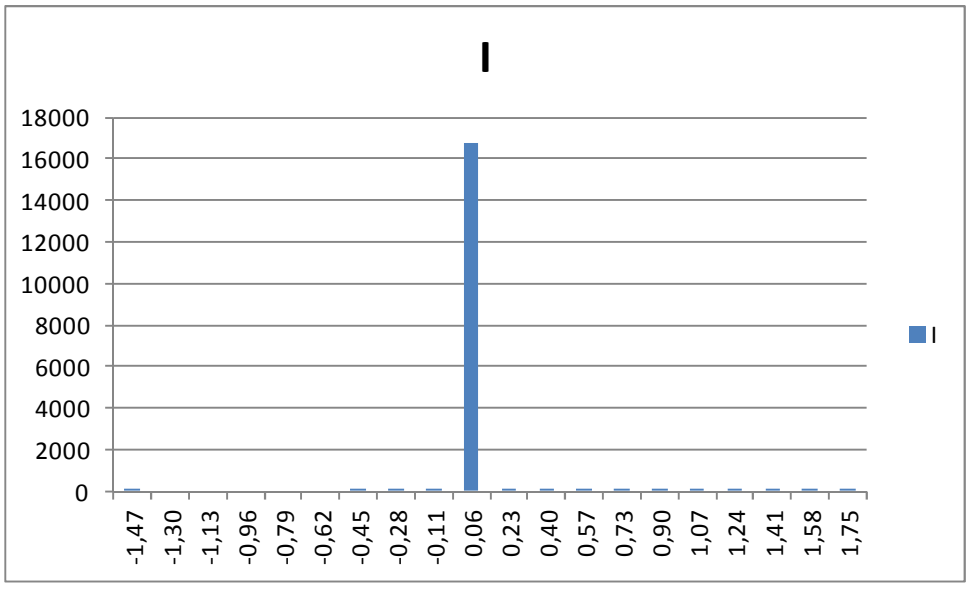
As a curiosity we also graphed ac and current values on the same data sample:





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WHAT PERSPECTIVE ?

After these years of testing, we're now convinced that standardizing the testposts is the first step to take, because that gives us the possibility of comparing data throughout the network.

The result of this comparison gives us more confidence on the quality of collected data and based upon this confidence we can start to identify what are the critical contexts, where we need to focus and, if necessary, to use different, more strict (and costly) strategies.

The availability of a daily flow of E_{OFF} data opens new perspectives: we now have the possibility of a better control of the rectifiers output.

The integration of this kind of data with modeling software will give us the possibility of optimizing and evolving the design of CP systems, continuously verifying theoretical models by means of simulations and field feedbacks.

And the low cost of data collection also gives us the possibility of using them for research activities, quickly confirming or rejecting results obtained in laboratory.

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