SMART EARTHS CONNECTOR

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ABSTRACT

In the last years, the low voltage loads in the distribution networks are changing due to the massive introduction of computers, air conditioning equipment and many other household appliances. This high frequency capacitive loads and some other factors like ground faults in the LV network, connections/disconnections in the MV network, etc, sometimes provoke transient overvoltages that ends up in a wrong tripping of the domestic electrical differential protection. This domestic outage is really annoying for our customers and sometimes can cause serious problems.

INTRODUCTION

Gas Natural fenosa´s grid has an isolated neutral in MV and solidly earth neutral in the LV network. In the secondary substations, the earth of the neutral is isolated from the protection earth of the metallic elements, which is also connected to the screen of the MV cables.

Client side, most of the domestic differential protections are AC type and the typical behavior is shown in the fig 1:

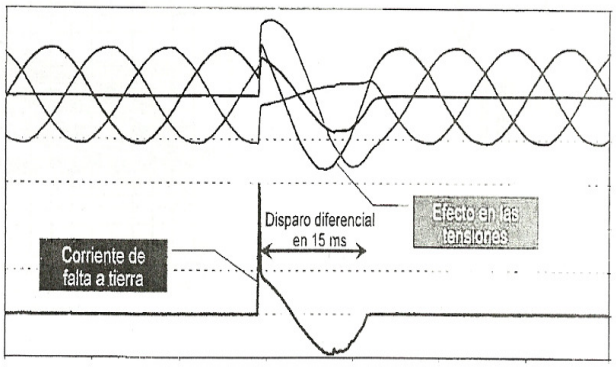

Fig.1 Voltage/Current diag. of AC differential protection

DESCRIPTION OF THE INVENTION

To solve this important problem, a new device has been designed. If a difference of voltage is detected between both neutral and protection earth, the device connects both of them. This way, the earth resistance of the secondary substation is greatly reduced and therefore the transient overvoltages are drained and do not trip the domestic differential protections. To accomplish this function, the device uses a net analyzer and two power thyristors, controlled by a microprocessor.

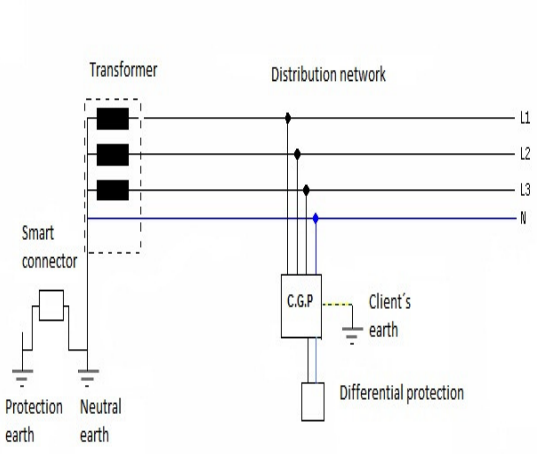

Fig. 2 Smart earths connector diagram.

If the device detects a difference higher than 10V between the protection earth and the neutral earth, it connects both and prevents higher voltage differences. The reaction time of a power thyristor is around 500 microseconds, while the reaction time of a domestic differential protection is typically between 10 and 50 miliseconds. The reaction time of the thyristors ensures that the voltage control will be much faster than the differential protection trip, therefore wrong tripping is prevented.

The device will disconnect both earths if the current rises up to 20A for security reasons, as it could rise the

voltage of the metallic parts of the secondary substation. In case that both earths are connected for one second, and the voltage difference persists, the conclusion is that there is a fault in the LV network, so the device disconnect the earths and send a "Fault in LV" signal. This signal is collected by the data concentrator, which is also used for smart meters and other smart grids functionalities.

It has three outputs, two of them connected to both protection and neutral earth and another one by means of fiber optic for the remote management.

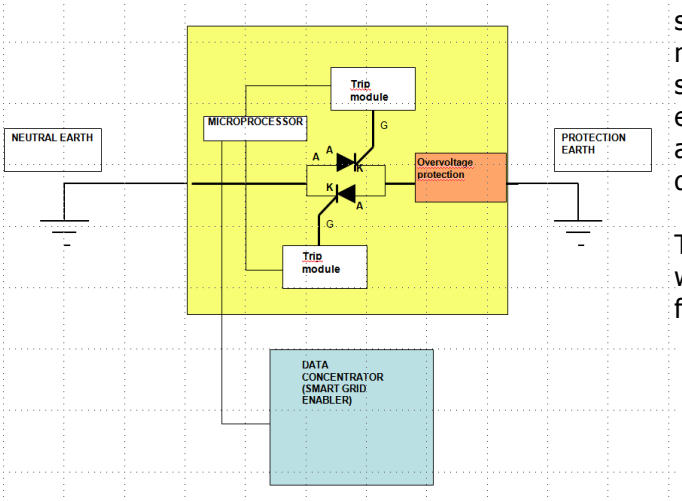

Fig. 3 Smart earths connector internal diagram.

ON FIELD TESTS

Several devices have been installed in secondary substations affected by transient overvoltages. These secondary substations feed clients in low voltage, affected by wrong tripping of the differential protection. This issue provokes regular complains to our company.

Before installing the smart earth connector, voltage monitoring between the protection and the neutral earth was carried out (fig. 4). The voltage peaks between both earths, were as high as 225V, enough to disturb some of the clients differential protection.

Later on, a smart earth connector was installed in the same secondary substation and once again voltage monitoring between both earths is carried out. The smart earth connector is configured to connect both earths at 10V, so the voltage peaks are highly reduced, and there is not any disturbance on the domestic differential protection detected.

The results of the voltage monitoring between earths with the smart earth connector installed can be seen in fig. 5 and a detail of the highest peak detected in fig. 6

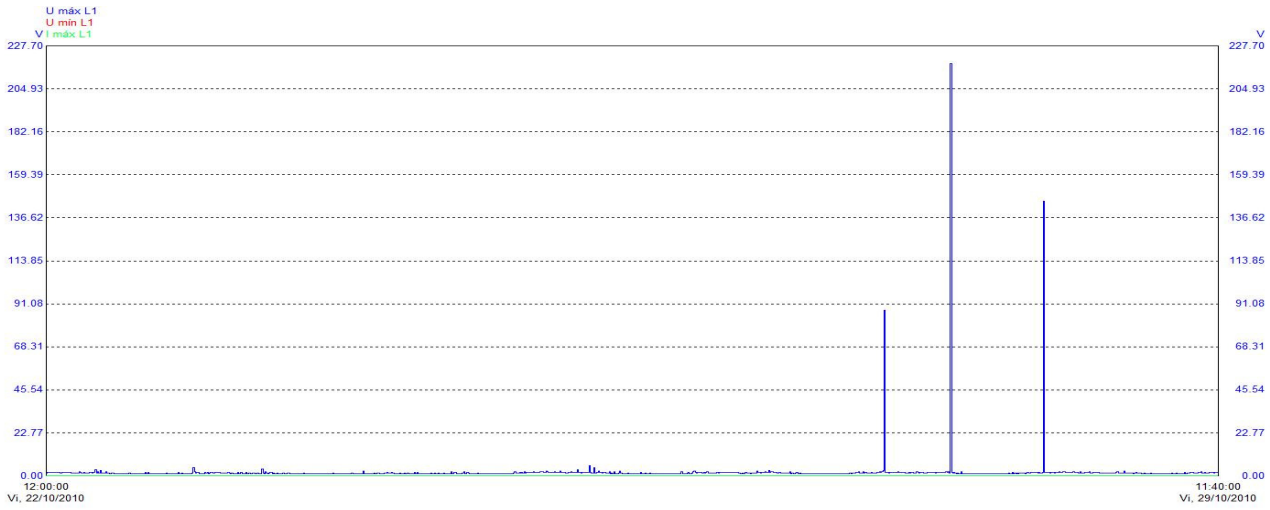

Fig. 4 Voltage between neutral and protection earth before installing the smart earth connector.

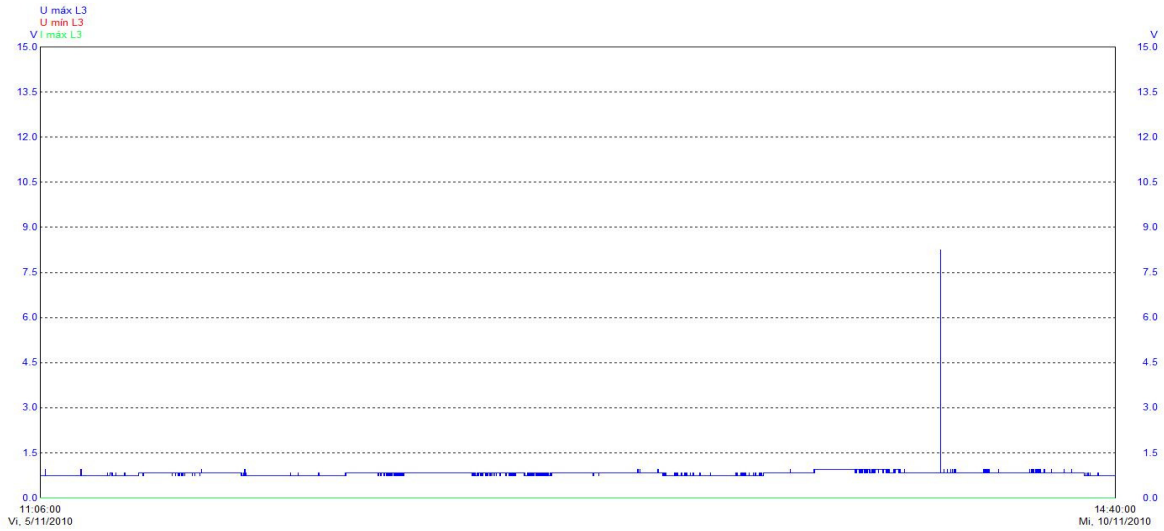

Fig. 5 Voltage between neutral and protection earth after installing the smart earth connector.

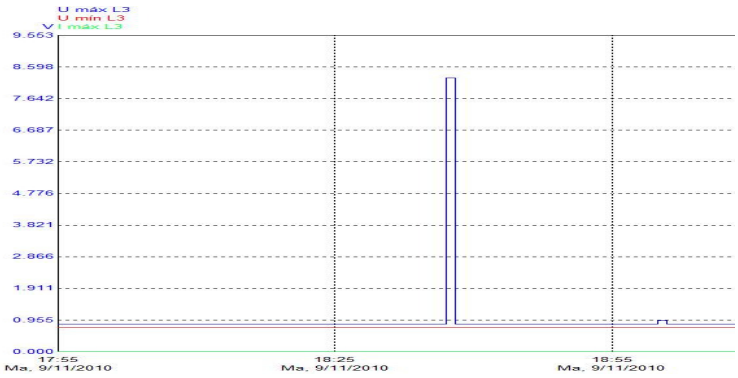

Fig. 6 Detail of the highest voltage peak of fig. 5.

CONCLUSIONS

In this paper, a new device has been illustrated. The function of this device is to improve the earth of a secondary substation by connecting both neutral and protection earths in a very short time, enough to drain a overvoltage before disturbing the domestic differential protections.

The device is secure, as it is programmed to disconnect before the voltage of the protection earth rises up to dangerous levels.

The smart connector has proved its functionality on field test and has completely solved the disturbances in several secondary substations. It has proved to be a cost effective solution.

The device is also capable of detecting permanent phase to earth faults in the low voltage grid and it can also send a signal to the central control grid management, shortening the reparation works.