INTRODUCTION

The power output of PV modules may degrade, due to electrical potential between the frame and the cells, and this effect is known as “potential-induced degradation” (PID). The main factors that have an influence on the PID process are the following: A) Treatments of the front face of the cells and the anti-reflective coating B) Dielectric strength of the encapsulating material, typically EVA C) Leakage current.

The control of PID in fabrication process of cells is critical and cannot guarantee 100% absence of PID; even though many module manufacturers are now promoting PID-resistant modules.

PID is related to leakage currents flowing through the encapsulant (EVA) that produce an accumulation of positive charges, which then cause short-circuiting (shunting) in the solar cell. The dielectric strength is a very important control parameter of PID. Over time the encapsulant loses electrical insulation, which increases the chances of generation of PID and rises as time goes by.

In PV modules whose cells are working with a negative voltage relative to ground the probability that the occurrence of PID appears is important. The mechanism of this phenomenon is complex and extensively studied.

In grid-connected PV systems the most common configuration of DC connection is the floating mode and half of the modules of the strings work with negative voltages to ground.

One solution proposed is connecting the negative to ground, although it is a valid solution in principle, it creates problems of safety and security as it implies that the current generated after the first failure be very high. On the other hand, all AC circuits of the inverters and the transformers would have a DC voltage component referenced to ground and the (+) peak voltage is increased (See annex-1).

The sensitivity of a module or cells to PID can be detected in accelerated damp-heat climate chamber tests. Several standards are being developed but the most widely applied is IEC 62804 System voltage durability test for crystalline silicon modules.

It may be expected that different grades of PID appear in systems with negative voltages to ground throughout the entire life-cycle of the module reducing available output power.

Due to the experience in the fields of, manufacturing and laboratory analysis of both cells and modules, ATERSA has carried out appropriate tests and measurements on the subject to detect and fix this problem.

Modules affected by PID can be easily detected via an electroluminescence analysis as involved cells (or some areas of the cells at the beginning of the process) no longer contribute to power output and are recognized as “black-cells” in electroluminescence images.

PIDFREE

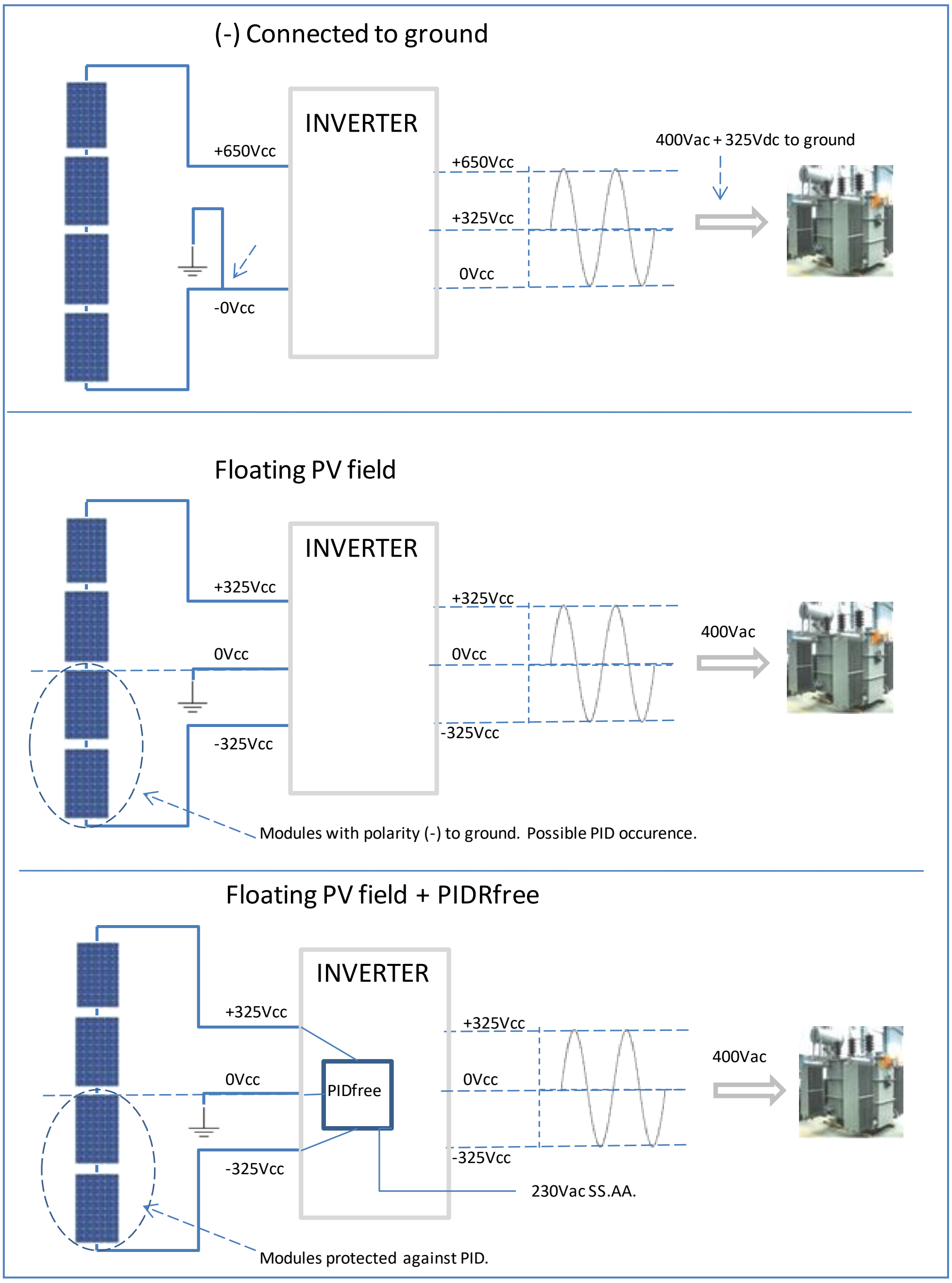
The best way to solve the problem of PID is by using active systems such as **PID-Free**. It enables the connection of field floating panels without having to modify the protections of the installation and prevents modules from PID as its dielectric strength is reduced over time.

The PIDfree equipment regularly measures the voltage between the PV array and ground and applies an appropriate dose of current/voltage offset in order to recover the negative charges at evening time. It ensures that PID will not appear over the life-cycle of the PV array. On the other hand, the PIDfree is able to recover PV arrays which have already been partially affected by the PID restoring the power lost almost completely.

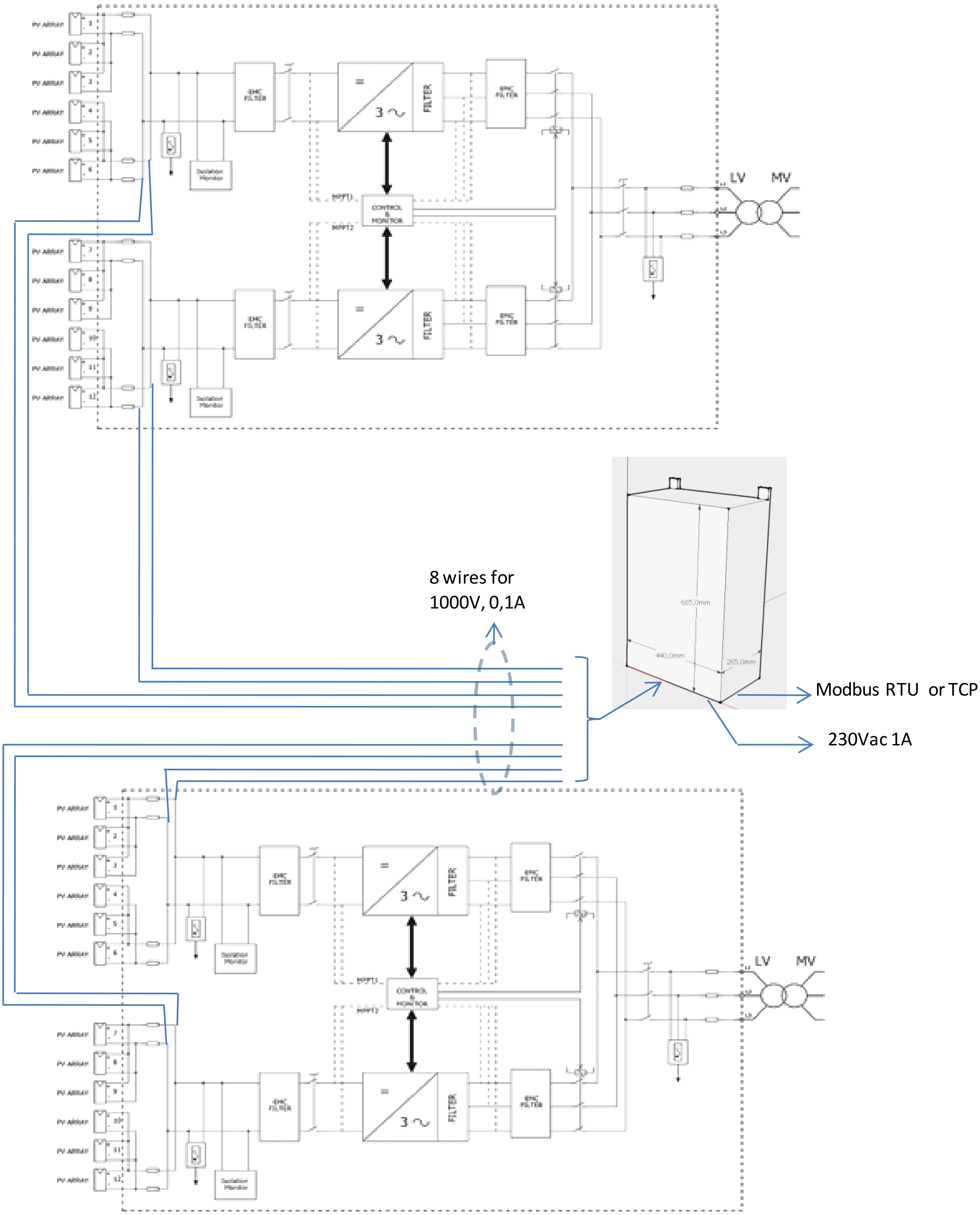
TECHNICAL DATA

GENERAL DATA	
Supply	230Vac
Display	LCD
Current consumption (max)	1A
PV field protected (max).	Up to 2MW
# of MPPT or inverters with one input	Up to 6
Maximum voltage at night	200-650V (programable)
Maximum current gives at night	50-200mA
IP	44
INPUTS	
6(+) till +1Kv(dc)	Disconnect terminals
6(-) till -1Kv(dc)	Disconnect terminals
Consumption (230ac)	magneto thermic
Earth	Terminal
OUPUTS	
Night voltage enabled	Potential-free relay Normally open
Leakage failure (Voltage programed /0.2A) (factory value 3KOmh)	Potential-free relay Normally open
Dimensions	665X440X265(mm)
Weight	18Kg

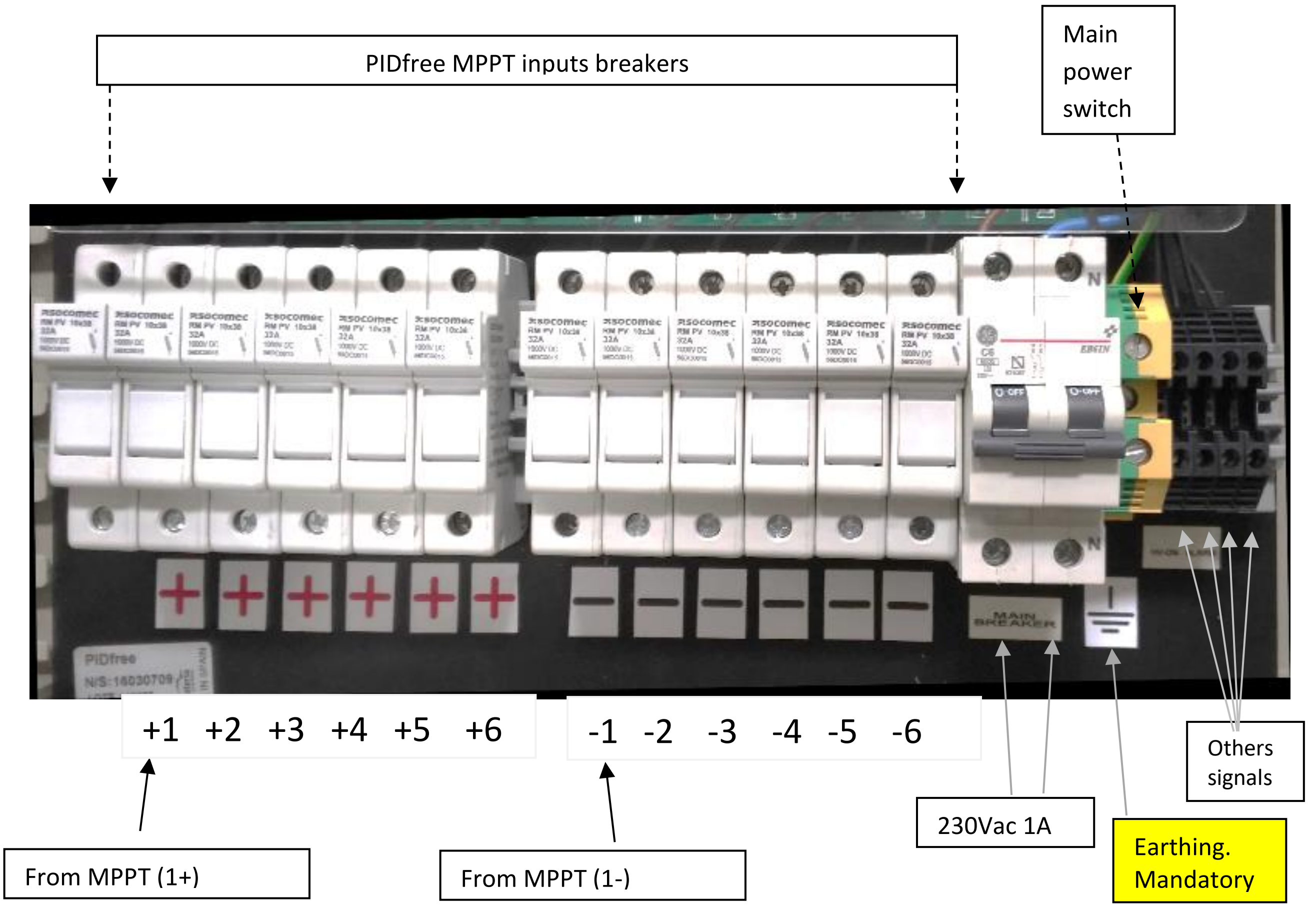
Annex-1

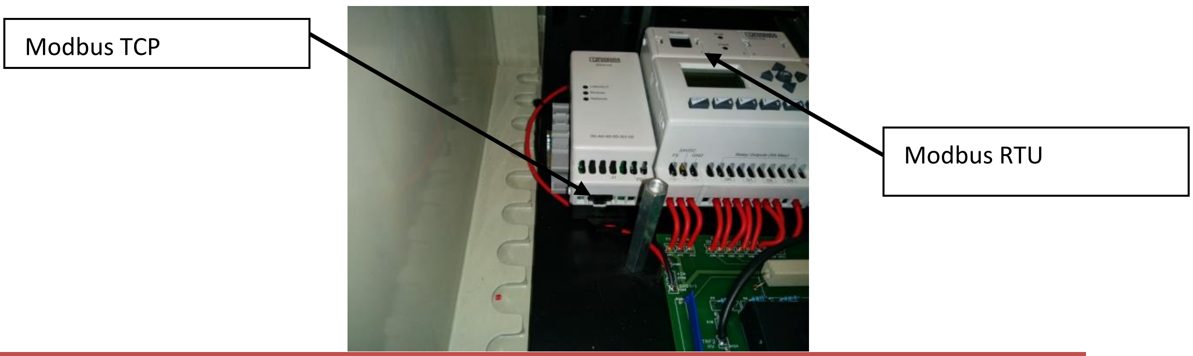

(-) Connected to ground
INVERTER
+650Vcc
-0Vcc
+650Vcc
+325Vcc
0Vcc
400Vac + 325Vdc to ground
Floating PV field
INVERTER
+325Vcc
0Vcc
-325Vcc
+325Vcc
0Vcc
-325Vcc
400Vac
Modules with polarity (-) to ground. Possible PID occurence.
Floating PV field + PIDRfree
INVERTER
+325Vcc
0Vcc
-325Vcc
PIDfree
+325Vcc
0Vcc
-325Vcc
230Vac SS.AA.
400Vac
Modules protected against PID.

Example for 2 inverter 1MW,   4 MPPT in total



INTERNAL CONNECTIONS



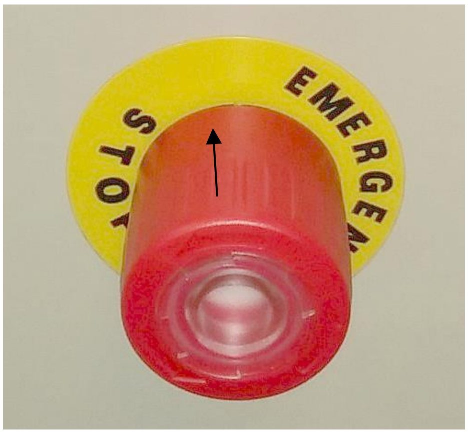


WIRING

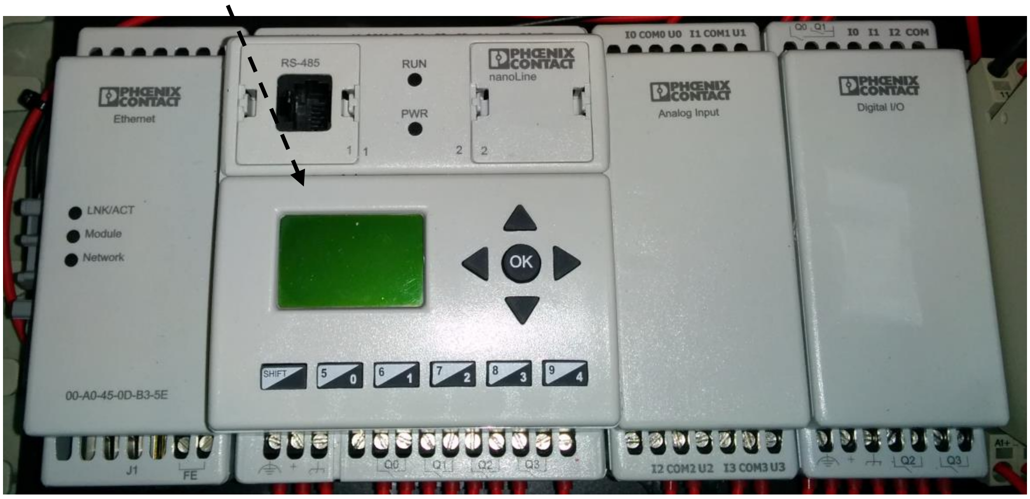
1. Open all PIDfree MPPT input breakers.
2. Connect Earth.
3. Connect Main 230Vac 1A.
4. Connect MPPT+ and MPPT- from each inverter module MPPT.
5. Verify correct polarity and level. Vcc < 1000Vdc for each MPP pair inputs.
6. Keep opened all PIDfree MPPT input breakers.

COMMISSIONING

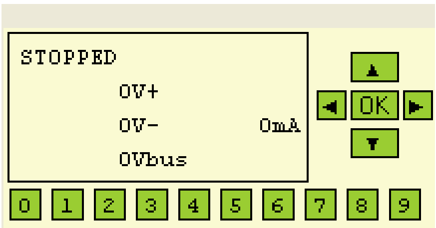
1. Push Emergence STOP button. All is secure. Generator cannot start.



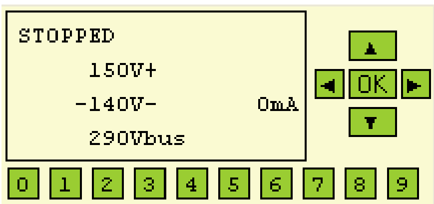
2. Close main power switch
3. See at PLC display



4.

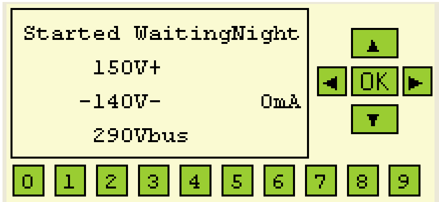


5. Close PIDfree MPPT (1+ and 1-) input breakers. Then, measured bus voltage must be shown.

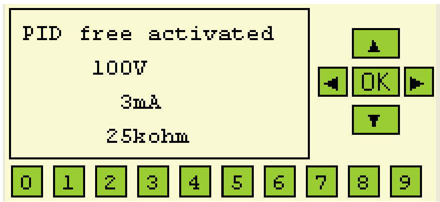


6. Close all PIDfree MPPT input breakers (sequence not relevant). Verify measured bus voltage is coherent.

7. Pull Emergence Stop button to start PIDfree. While Vbus > 50Vdc it is waiting for night.

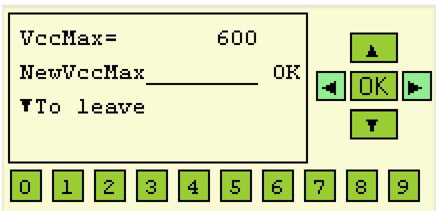


8. At night, PIDfree starts and supply some current to all field modules and inverter MPPT inputs. Also, leakage resistor is measured.

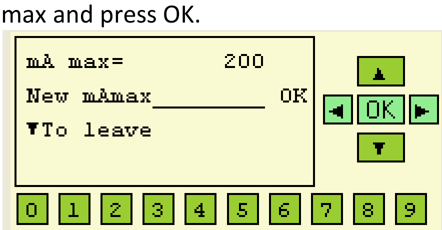


PARAMETERS

1. All parameters are defined in origin for each installation, but settings are changeable.
2. It is possible to reduce the maximum Vcc If there is any limitation. Push at the same time <- and -> to enter in the menu:



3. Select new value for VccMax and press OK.
4. Select new value for mA max and press OK.



COMMUNICATIONS

Next table shows the addresses and names of holding registers in the PLC. All data can be read via Modbus TCP or RTU.

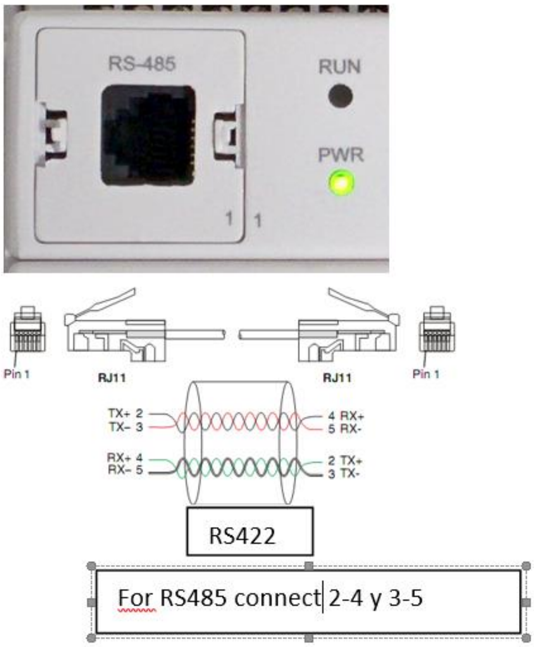
For TCP it is necessary to know the fixed IP address available in the LAN. It must be programmed by our Quality Control before delivery to the consumer, cannot be changed by costumer.

ID	Label	Retentive	Type	Comments
R-000	Vbus	☐	Integer	
R-001	ContadorTiempoPIDactivado	☐	Integer	Copia del contador (minutos) para ver en datos
R-002	mAfugas	☐	Integer	
R-003	Max-mA-fugas-Permitido	☑	Integer	Maximo permitido
R-004	VccMax	☑	Integer	Limite máximo de generaciónVcc para PID
R-005	LecturaVbus-	☐	Integer	Copia de valor analógico
R-006	LecturaVbus+	☐	Integer	Copia de valor analógico
R-007	PendienteRampa	☐	Integer	0=stop 1=sube -1=baja
R-008	MaxFugasRegistrado-mA	☐	Integer	
R-009	ResistenciaFugas	☐	Integer	
R-010	LimiteEstadoRampa	☐	Integer	Para limitar la rampa de subida segun Vcc maxima
R-011	Max-mA-fugas-alarma	☑	Integer	Generará alarma
R-012	VbusFiltrada	☐	Integer	
R-013	ContadorTiempoStarted	☐	Integer	minutos
R-014	ContadorTiempoSopped	☐	Integer	minutos
R-015	Vbalance	☑	Integer	Vmedia, pasabajos de 1 semana, integra cada 20minutos

OTHERS SIGNAL CONTACTS.

For future applications.
HV ON are two isolated contacts that are closed when PIDfrre is generating High Voltage.
ALARM are two isolated contacts that are closed when leakage current is higher than expected.

RS422-485.



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