Intel-IrriS

PRIMA
PARTNERSHIP FOR RESEARCH AND INNOVATION
IN THE MEDITERRANEAN AREA

Intelligent Irrigation System for Low-cost Autonomous Water Control in Small-scale Agriculture

Intel-IrriS

Solar panel
Nakai, october 2023

Jean-François Printanier
IRD Bondy, France

PRIMA
PARTNERSHIP FOR RESEARCH AND INNOVATION IN THE MEDITERRANEAN AREA

Institut de Recherche pour le Développement
FRANCE

Solar panel

PRIMA
PARTNERSHIP FOR RESEARCH AND INNOVATION
IN THE MEDITERRANEAN AREA

Intel-IrriS

Intelligent Irrigation System for Low-cost Autonomous Water Control in Small-scale Agriculture

INTEL-IRRIS – PRIMA S2 2020 – PROJECT ID 1560

Jean-François Printanier
IRD Bondy, France

Institut de Recherche pour le Développement
FRANCE

Solar panel

Before starting

Ask yourself the question: for what purpose are you installing a solar panel:

- Maximum annual energy production (for sell the electricity).

- Maximum production when there is sunshine and you accept the shutdown in overcast weather?

- Autonomy (it must works every day), optimized for difficult days (short days and overcast weather). You accept losing energy when there is a lot of it (sun).

The place to put the panel is important and not easy to find.

Solar panel specifications

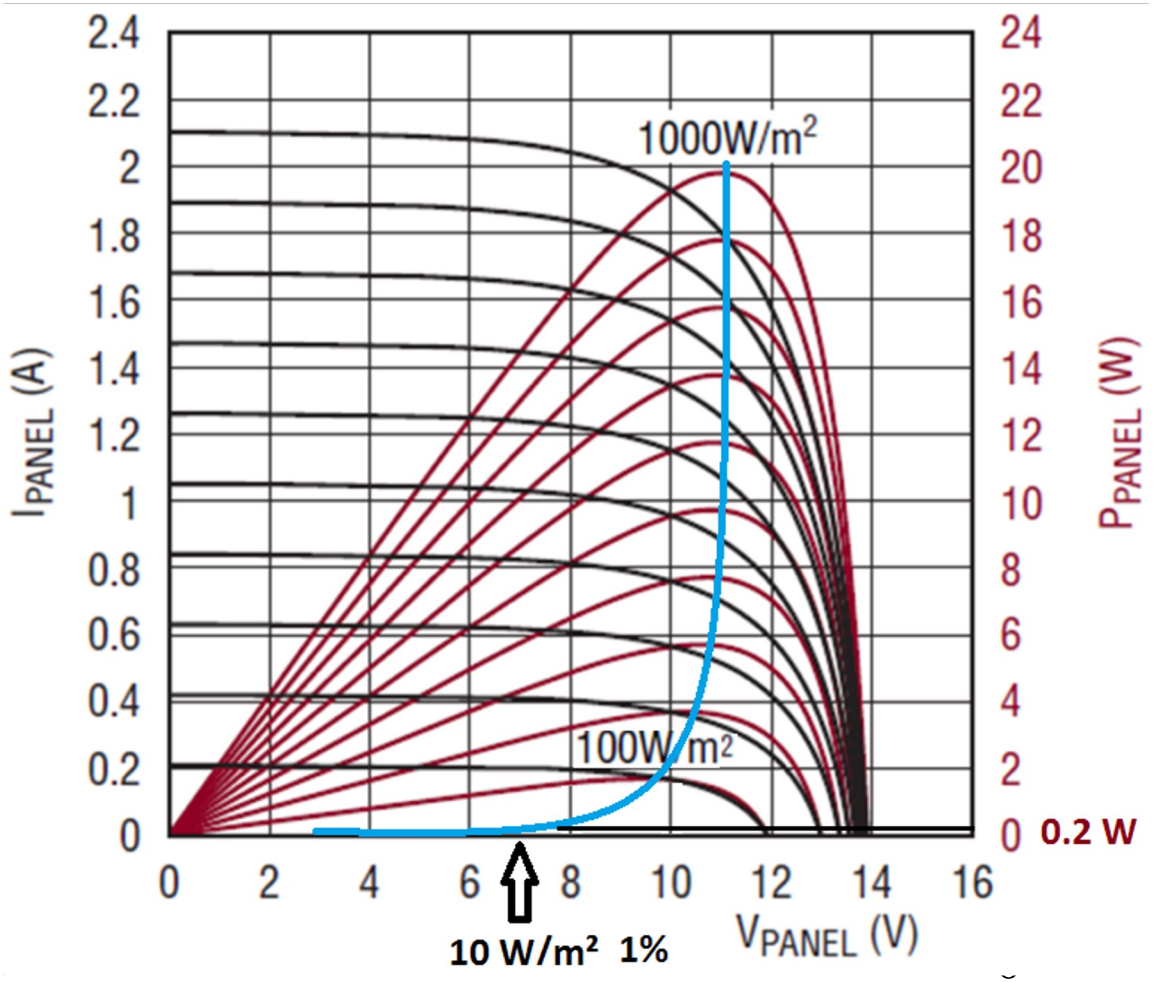
Not a stable generator.

Voltage depends on light and temperature.

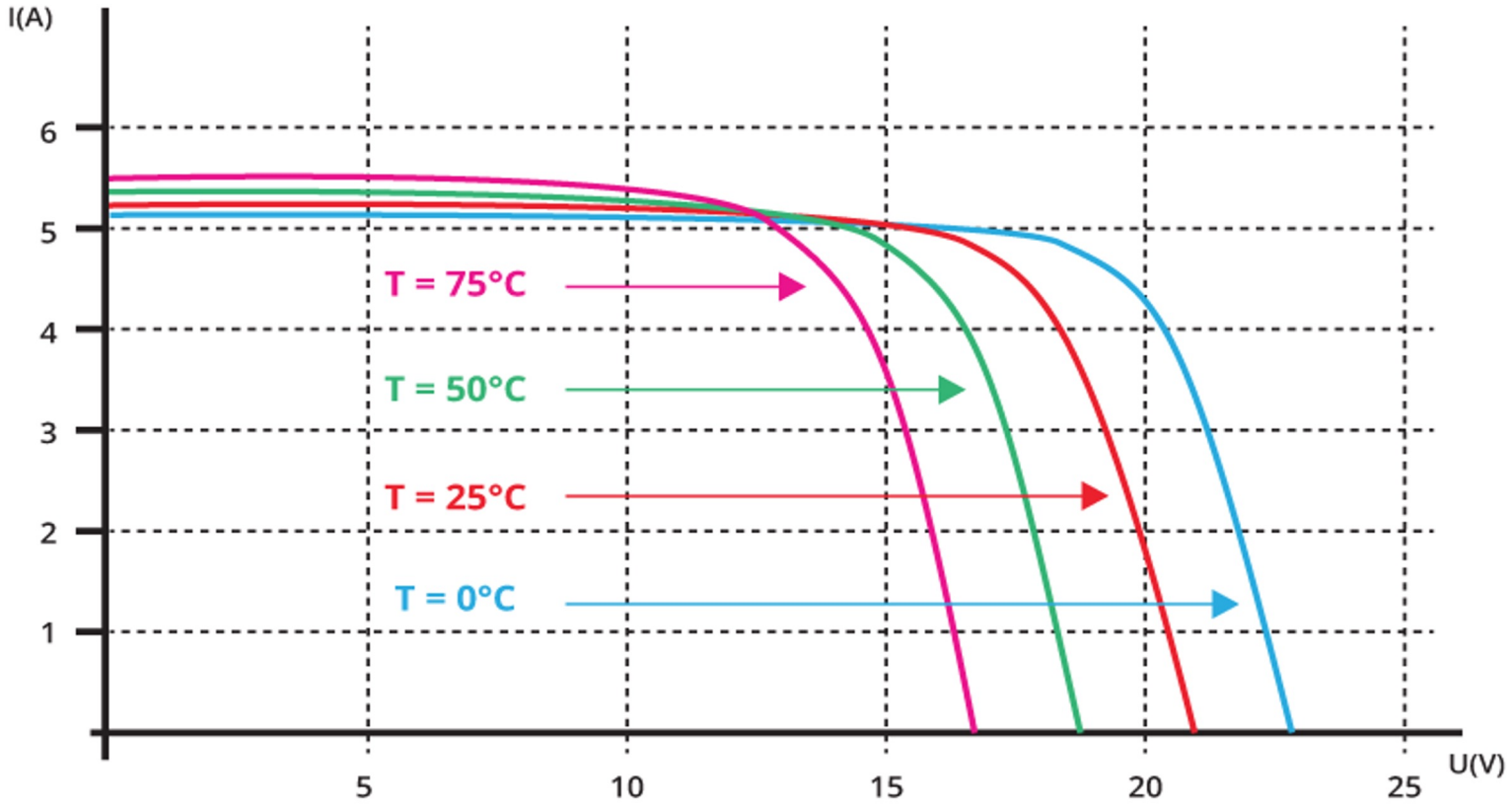
The current depends on the light.

Max power point: about 76% of Voc.

In very bad weather ⇨ you only get 1% of the power when the sun is out.



Solar panel temperature



Battery charger : ON/OFF or PWM or MPPT ?

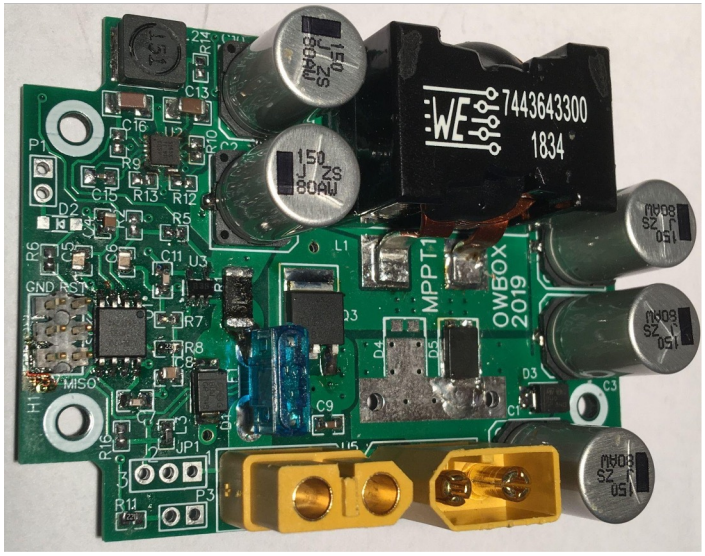
PWM is only in action to limit the battery voltage, not when the battery is discharged. It's the same as a step down converter.

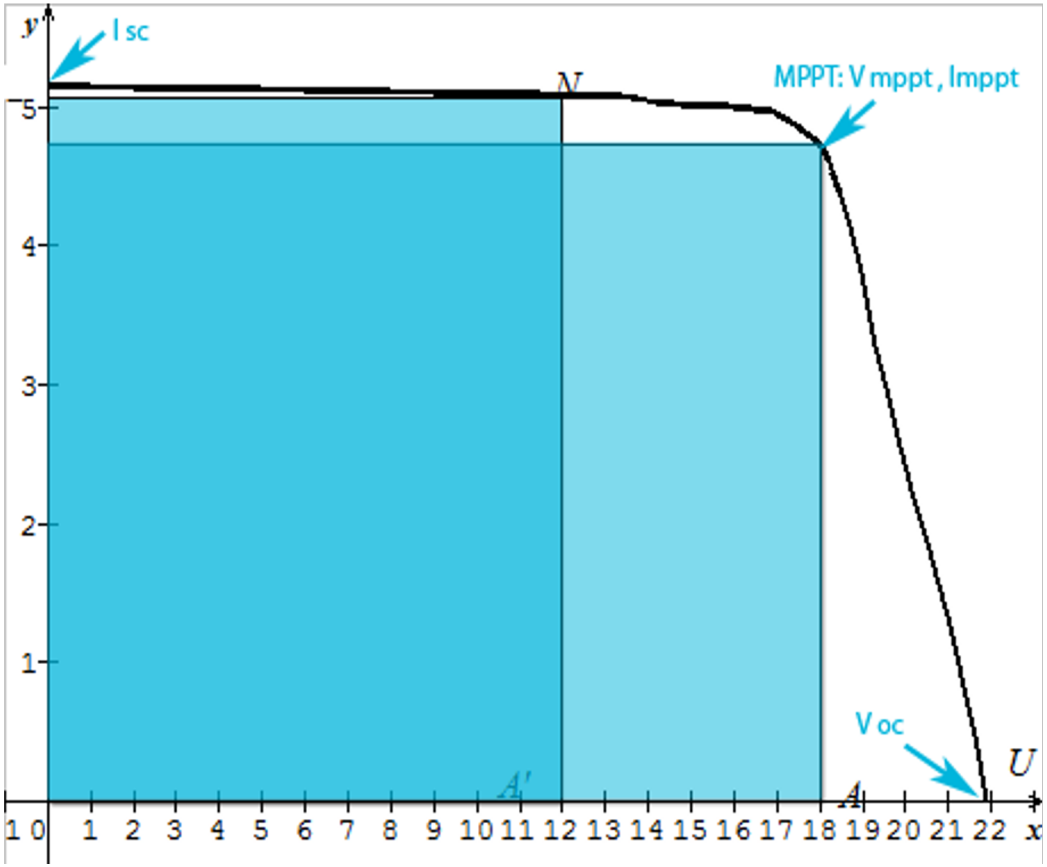
Difference between "true MPPT" and "MPPT voltage":
- True MPPT need an algorithm for the tracking (µP).
- MPPT voltage is a fixed MPP, there is no tracking (only a special PWM chip). It is optimized only for one temperature and one sunshine. If temperature increase or in cloud conditions, the chip is waiting a bigger voltage to charge. Useful only if the voltage of your panel is a lot bigger than the battery voltage.

MPPT gain

About 30% more power in some conditions (sun and low temperature).

P = U.I





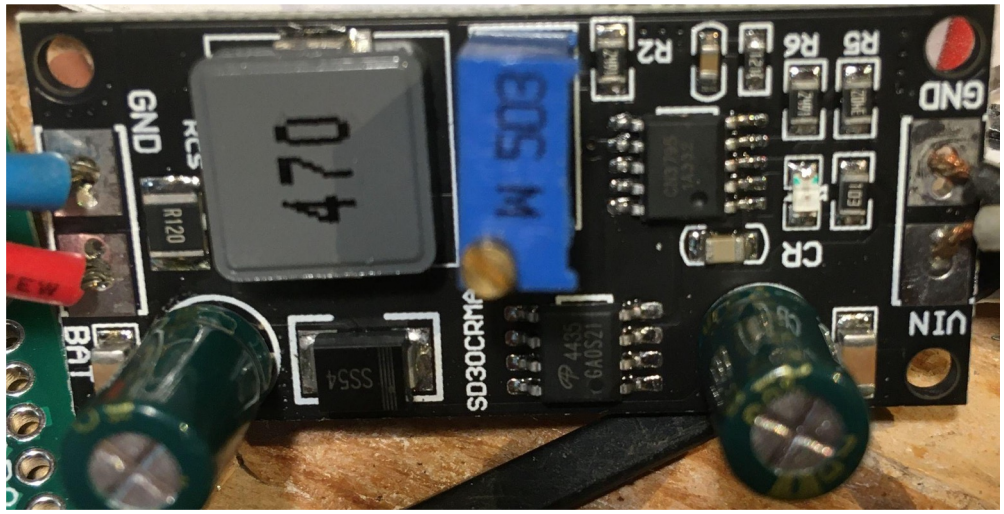
Using small solar panel

MPPT is not a good idea for solar panel less than 10 W:
the electronics for MPPT function can consume more power than the MPPT gain in cloudy condition.

Simple TP5100 chip is good to use because it start to works with only 1 mA.

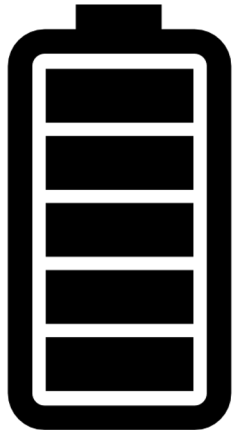
Voltage example

Solar panel 18 V
Voc 24 V
MPPT under sun at 25°C: 18 V
MPPT under sun at 50°C: 16 V
MPPT under shadow: 12 V
MPPT under a lot of cloud: 10 V



MPPT voltage board

Intermittent power need energy storage



Energy is measured in Wh or (Ah x V). Joules is also for energy.
Many people confuse between Watt-hour and Watts.
W is Power, energy is Power x Time.

Battery types:

- Lead-based
- NiMH
- Lithium

Lead-based

Robust but wear if discharge more than 50%.
Nominal 12 V, floating 13.6 V, charge 14.4 V
Difficult to know the status of charge with the voltage.

NiMH

Nominal 1.2, full near 1.4 V.
Difficult to know the end of charging (permanent slow charging is good).
Difficult to know the status of charge with the voltage.
Robust, can charge below 0 degres.

Lithium-ion

Nominal 3.7 V, maximum 4.2 V.
The voltage is the status of charge.

Fire risk.
Require a BMS for the safety: disconnect if over voltage, low voltage, over current, temperature too high.
Contain several cellules in serial for more voltage. In this case the cellules must be balanced together.
Can not be charged below 0 degree.
LIPO is the same use as Lithium-ion.

Lithium LiFePo4

Nominal 3.2 V, maximum 3.6 V.

No fire risk.
Difficult to know the status of charge with the voltage.

Require a BMS: disconnect if over voltage, low voltage, over current, temperature too high.
Contain several cellules in serial for more voltage. In this case the cellules must be balanced together.

Can not be charged below 0 degree.

Calculate the consumption

How long the microcontroller is in sleep mode ?

How much consum the voltage regulator (LDO, DC-DC) ?

How long the microcontroller in normal mode ?

How long the sensor are used ?

How long the radio is connected ?

Add all the energy of each mode (use mWh unit)

Optimize your software for low power.

Calculate the consumption

Example for Intell-Irris capacitive soil sensor for a measurement cyle:

State	Duration (s)	Current (mA)	Power (mW)	Energy (μW)
Wake-up	1.3	5	15	6
Sensor	0.68	8	24	5
Lora radio	1.32	115	350	128
Sleep	3600	0.0047	0.014	14

For 24 h = 3.8 mWh. For 1 year = 1.4 Wh.

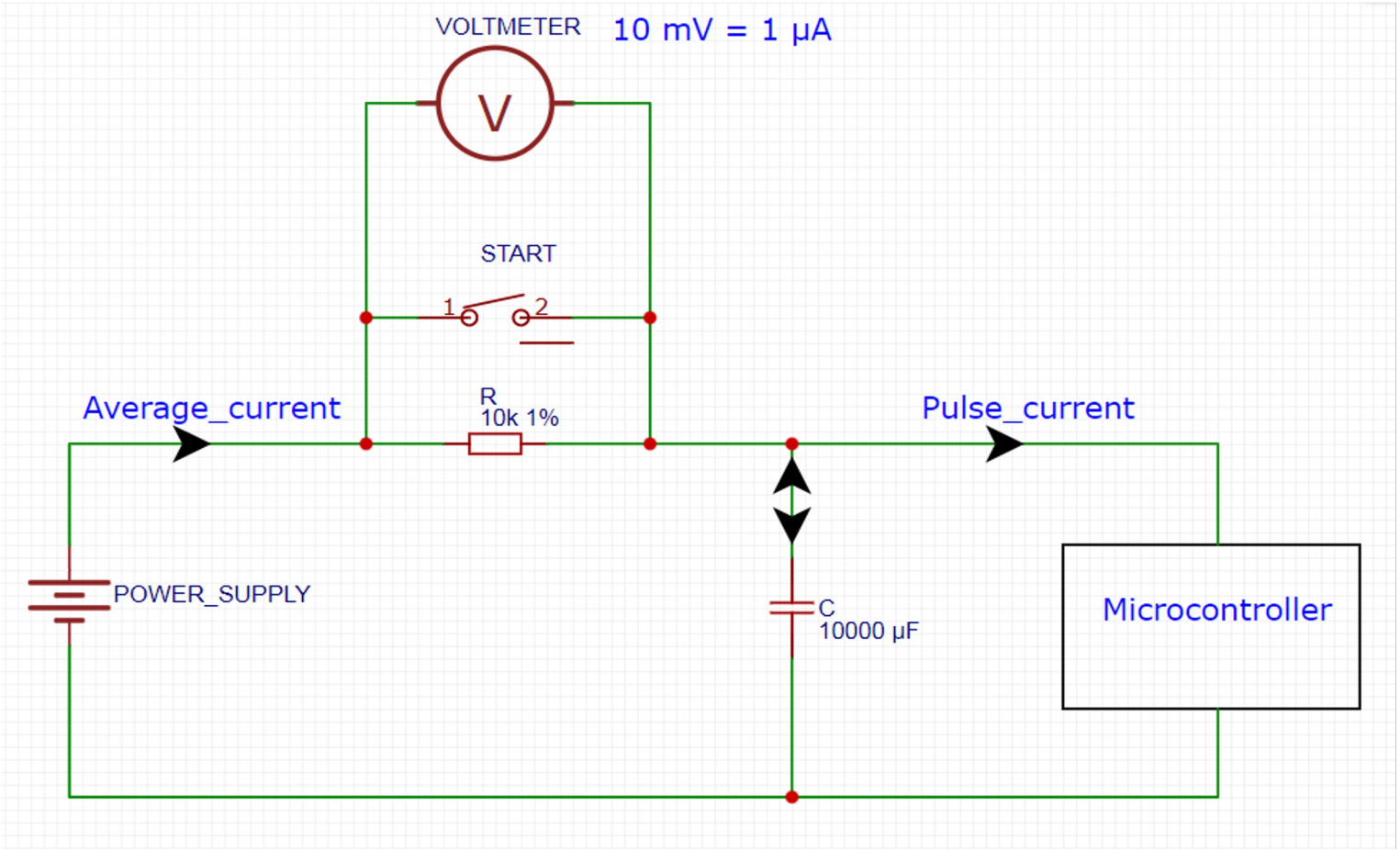
Measure the consumption

It isn't easy to measure the current of a microcontroller because it change a lot:

- sleep mode 3 µA
- wake-up 10 mA (3000x more)
- radio 100 mA (30 000x more than sleep mode)

You can use special board and a oscilloscope
or simply a micro-amp meter with a capacitor to average the current.

Measure the consumption



Calculate the solar energy and battery size

Depend of the climate you live.

How much Wh the panel produce in a day?
How much Wh the device consum?
How long can/need the device be powered only by the battery?

In the worst case : weather with cloudy week (or month ?) .

In the best case : weather with only sun.
In this case, you can add an second usage like charging your mobile phone.

Don’t forget the case of device storage in a cardboard box.

Query ?