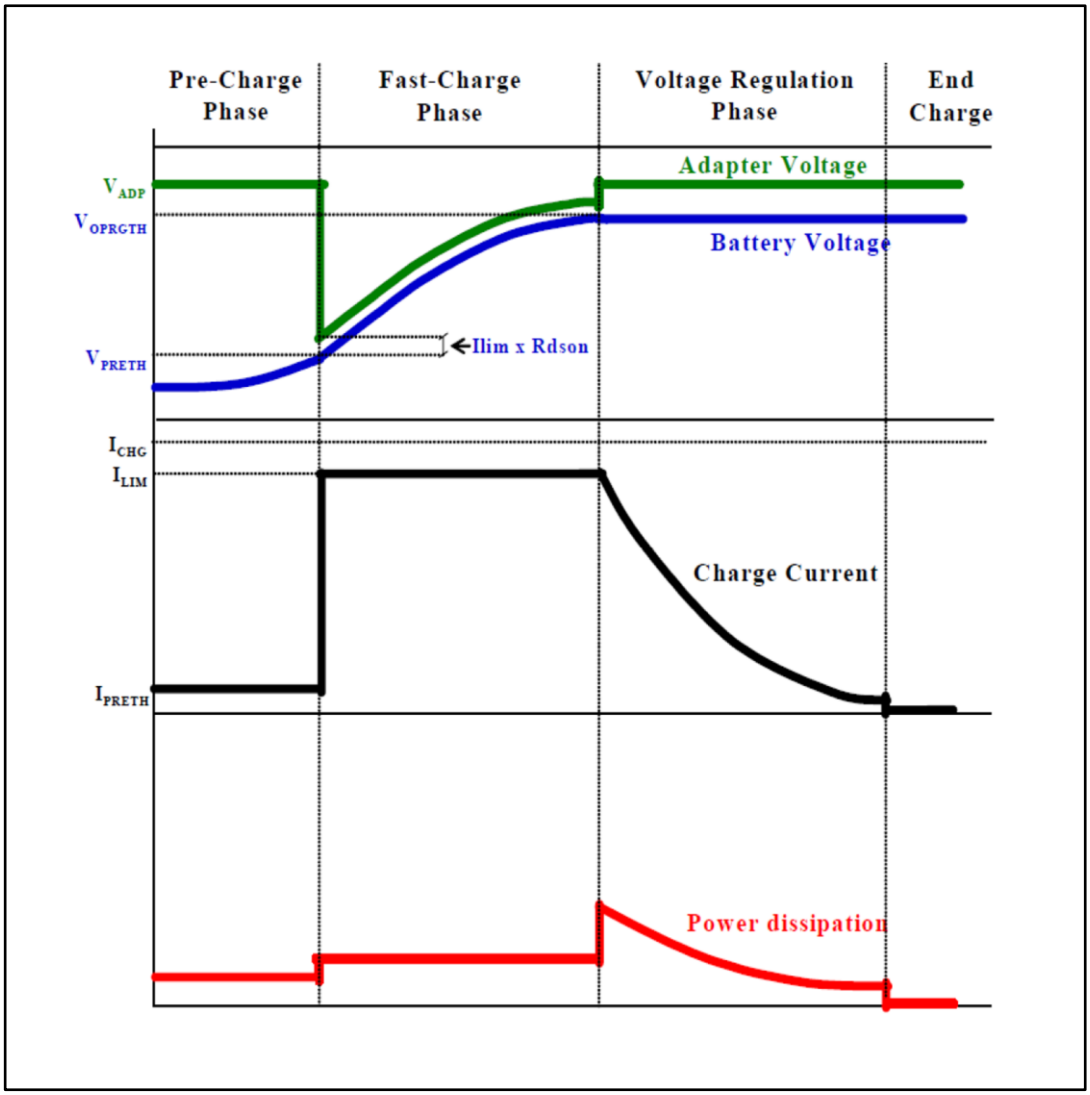
To work in this condition, set the device charging current (with R14) higher than the maximum peak current of the PV panel. During the fast-charge phase, the output voltage of the SPV1040 that supplies the *L6924D* drops down to the battery voltage plus the voltage drop across the power MOSFET of the charger.

In this mode, the L6924D charges the battery with the same three phases as in linear mode, but power dissipation is greatly reduced, as shown in the following figure.

**Figure 7: Typical charge curve in Quasi-pulse mode**




During the fast-charge phase, the output voltage of the SPV1040 (VIN of L6924D) drops down to the battery voltage ($V_{BAT}$) plus the voltage drop across the Power MOSFET ($\Delta V_{MOS}$) of the charger.

Consequently, the internal MOSFET works in saturation mode with a voltage drop given by:

**Equation 1**

$$V_{IN} = V_{ADP} = V_{BAT} + \Delta V_{MOS}$$

where

**Equation 2**

$$\Delta V_{MOS} = R_{DS(on)} \times I_{LIM}$$

$I_{LIM}$ is the current limit of the SPV1040, which depends on solar irradiation.

Neglecting the voltage drop across the charger (ΔVMOS) when the device operates in this condition, its input voltage is equal to the battery's, and therefore a very low operating input voltage (down to 2.5 V) is required. The power dissipated by the device during this phase is:

**Equation 3**

$$P_{CH} = R_{DS(on)} \times I_{LIM}^2$$

The advantage of the quasi-pulse charging method allows the energy harvested by few solar cells to be maximized.

The STEVAL-ISV0012V1 LEDs D1 and D2 indicate (when ON) whether the charge is in progress or is completed, respectively.

R14, and consequently $I_{LIM}$, must be set up according to the power provided by the PV panel at the maximum irradiation, but it is possible that D1 starts flickering (or appearing ON) at lower irradiation levels, while D2 is ON as well.

This is due to the battery charger, which tries to charge the battery at 4.2 V (or 4.1 V, depending on the $V_{OPRG}$ setting) and $I_{LIM}$, but the required power can only be sustained if enough irradiation is available on the PV panel side. If the irradiation is not sufficient, the input voltage of the L6924D drops down to the battery voltage, causing battery charging to stop and D1 to turn ON. Shortly after, the voltage rises back to 4.2 V (or 4.1 V) and the battery charge starts again (D1 turns OFF).

In these low irradiation conditions the battery is charged by current packets anyway.

The plots below demonstrate the behavior in the event of low irradiation.

**Figure 8: Battery charging at low irradiation**

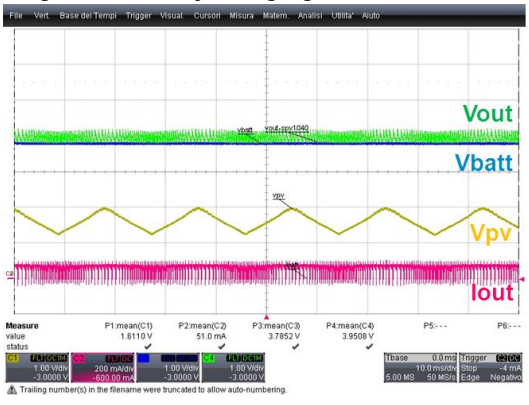
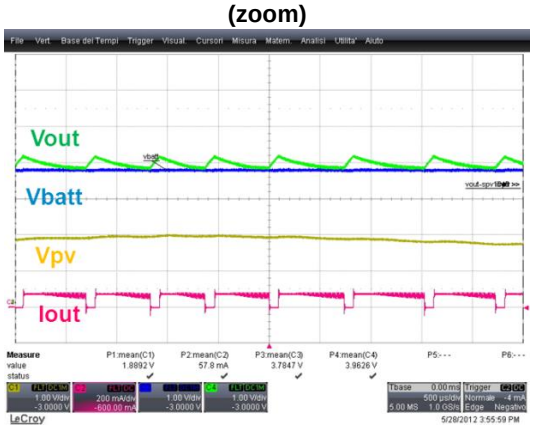



**Figure 9: Battery charging at low irradiation (zoom)**




The plots below show the maximum available current that can be provided to the battery charger according to the input power.

Figure 10: Maximum available current vs. Pin, 200 mW peak PV panel

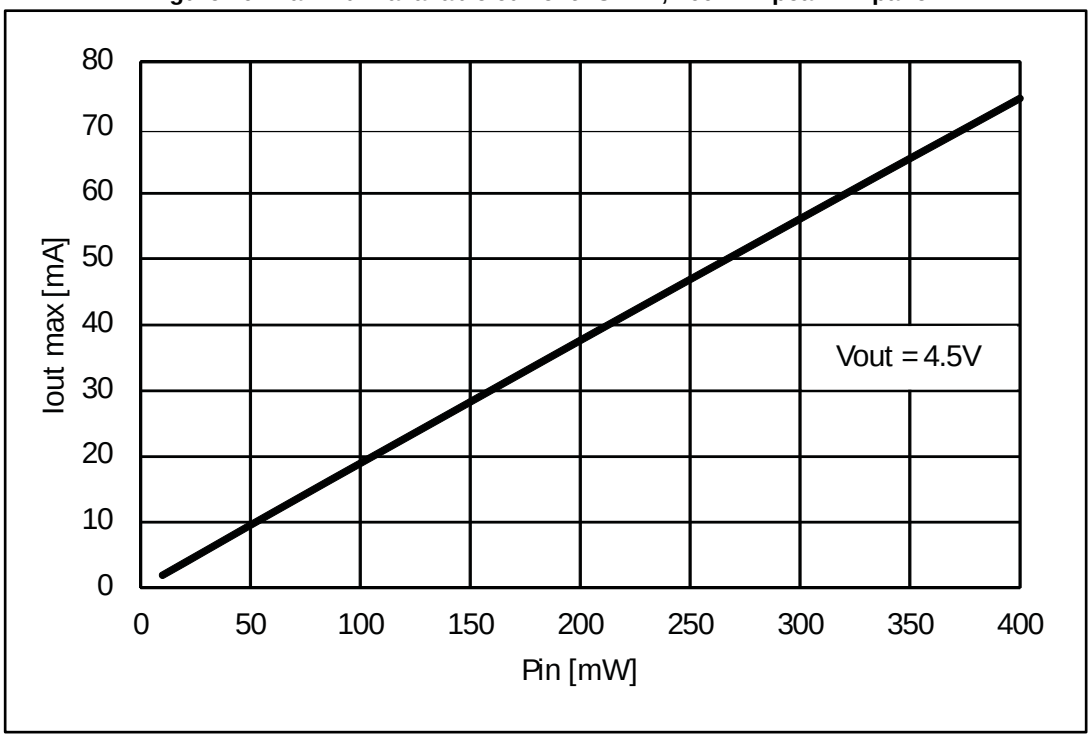
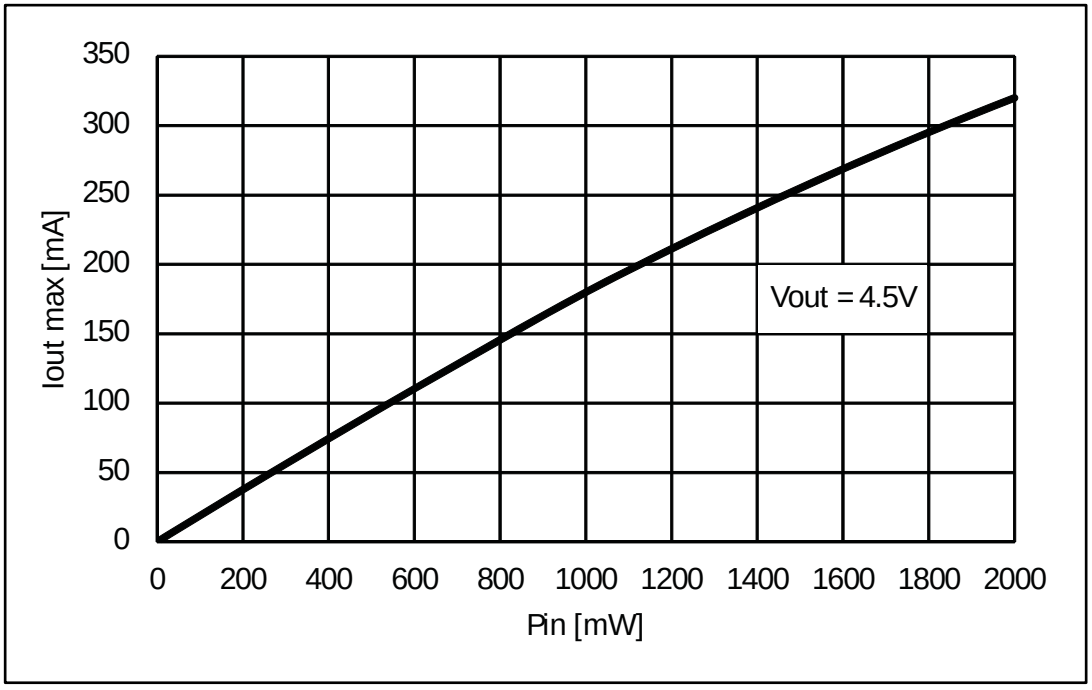


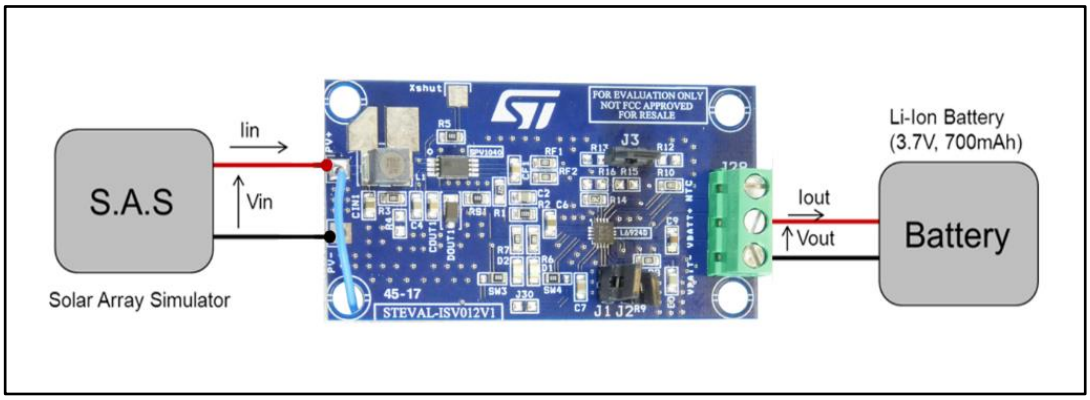

Figure 11: Maximum available current vs. Pin, 2 W peak PV panel



# 3 Reference design description

The set-up used for measurements is shown below.

**Figure 12: Application set-up**




A solar array simulator (SAS, SAS-FL05/01 from CBL Electronics) to simulate the PV module with $V_{OC}$ = 2.5 V, $I_{SC}$ = 210 mA, $V_{mp}$ = 2.0 V, $I_{mp}$ = 200 mA (@ 1000 W/m²) irradiance) and a Li-Ion battery 3.7 V-700 mAh, are used. *Figure 13: "V-I and P-V plot diagrams"* shows the I-V and P-V curves generated by the SAS, obtained using a PV module analyzer (ISM490 from ISOTECH).

**Figure 13: V-I and P-V plot diagrams**

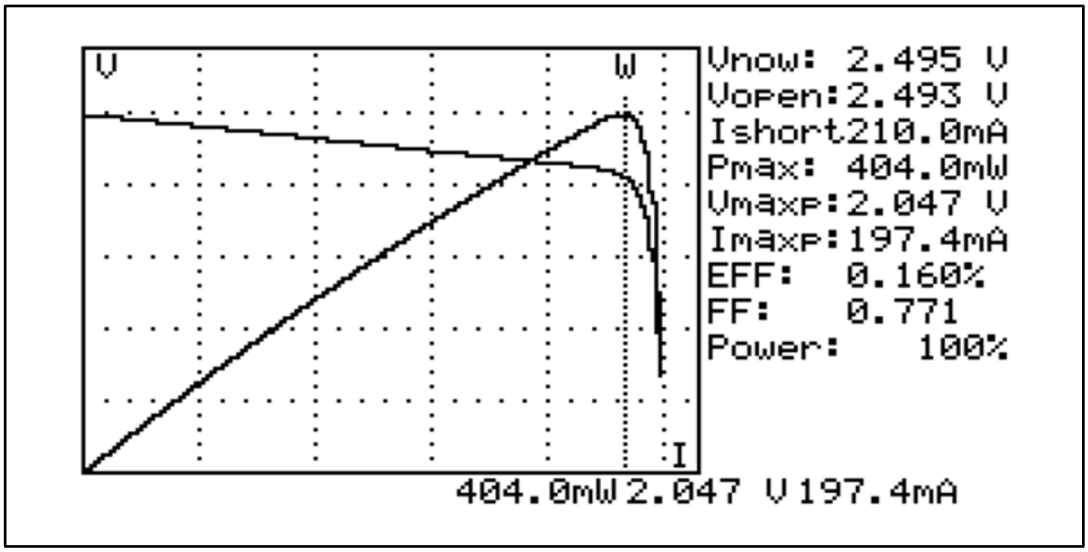



*Figure 14: "Partial charge"* and *Figure 15: "Full charge"* show the partial and full charge curves respectively. The partial charge curve shows charge current and voltage within a one hour time frame at full irradiation starting from a 3.4 V condition. The full charge curve shows charge current and voltage until the fully charged status is triggered, starting from a 3.4 V condition. After the one hour charge period time, the battery voltage reaches 3.8 V.

Different results can be obtained if a different PV panel and/or battery are used[a].

[a] Visit the support section on www.st.com if you require help regarding the use of different PV panels or batteries.

The average overall power efficiency is approximately 85% (94% for *SPV1040* and 90% for *L6924D*).

**Figure 14: Partial charge**

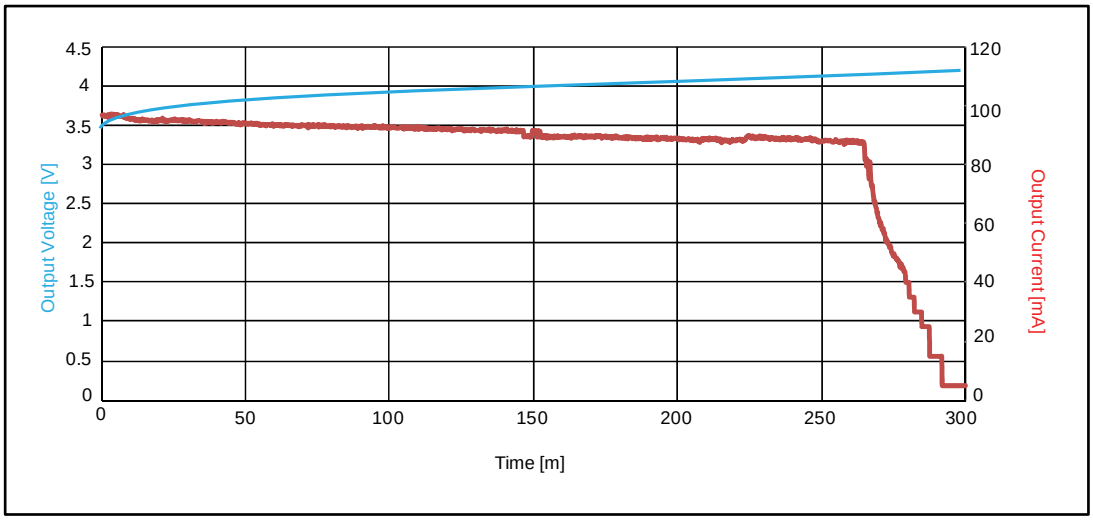



**Figure 15: Full charge**