

LV MPPT Test Report

The design is partially based on Application Report **AN-2121 SolarMagic SM3320-BATT-EV Charge Controller Reference Design** (SNOSB76C). However, the controller used in this design is the **SM72445**, and the gate driver for the DC-DC stage is the **NCP51513ABMNTWG**, instead of the SM72295 used in reference design.

Design Specifications

- **Switching frequency:** ~110 kHz
- **Input voltage (Vin):** 12 V to 90 V
- **Maximum current:** 60 A (input or output, whichever limit is reached first)
- **Output voltage (Vout):** 9 V to 50.4 V
- **Power:** ~600 W to ~3000 W
- **Load:** 12 V or 48 V Li-Ion battery systems

The hardware configuration allows operation with either 12 V or 48 V battery systems depending on component settings.

The MPPT system should be able to extract power from **solar panels or a DC power source**.

Problem description

Test Bench

The system was tested using:

- *Variable voltage/current power supply*
- *Input voltage:*
 - **Vin ≈ 30 V**
- *Output current range:*
 - **~1 A to 3 A**
- *Load:*
 - **3S1P 5200 mAh Li-Ion battery**

Oscilloscope Signals

- **Vin** (red)
- **Vbat / Vout** (blue)
- **Iout** (yellow)
- **High-side MOSFET BST node** (green)

Observed Behavior

At this stage of the project, the system is configured for **12 V output operation**.

The MPPT begins operating at approximately **2 A input current** and exits at approximately **1.4 A**.

When the system **starts with an input current greater than ~1 A**, the SM72445 enters a **burst-mode-like behavior** during startup.

If the input current is initially limited to approximately **1 A**, the following sequence occurs:

1. The SM72445 begins operating in **boost mode** after about 1 s.
2. When the input current exceeds **~2 A**, the controller transitions into **buck mode**, as expected.

Figures 1–3 show the input voltage, output voltage, and output current for this condition when the **initial input current limit is set to 1 A**.

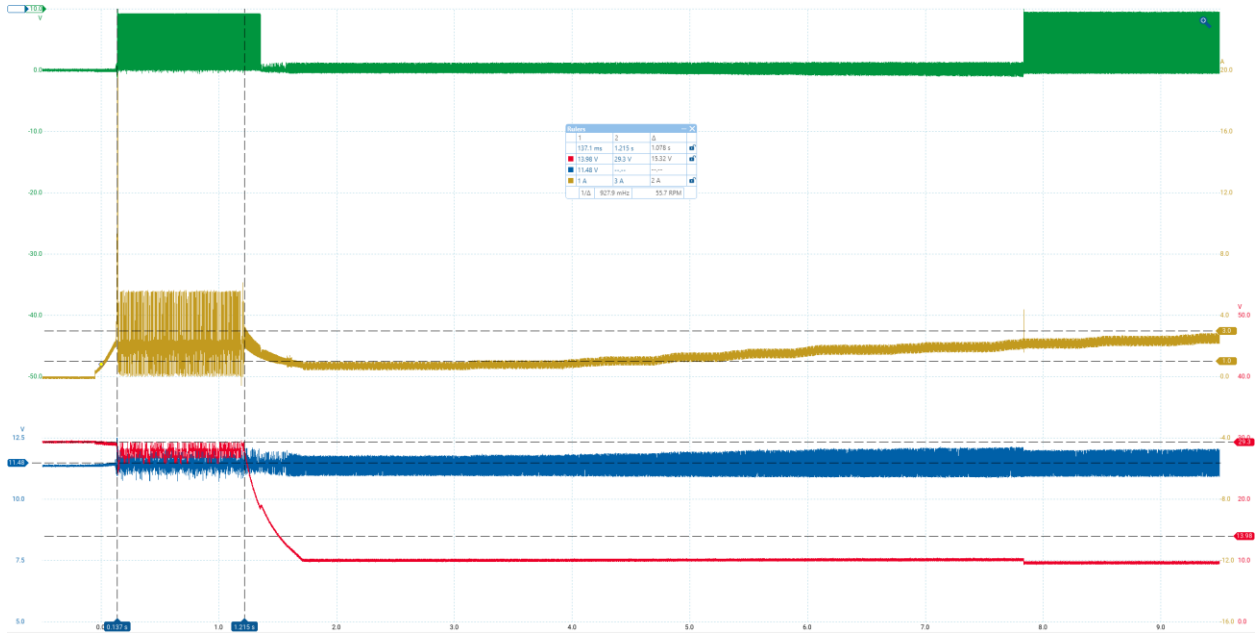


Figure 1 Input current limited to 1 A. After approximately 1 s, the burst behavior stops and the system continues operating while the input current limit increases to 3 A.

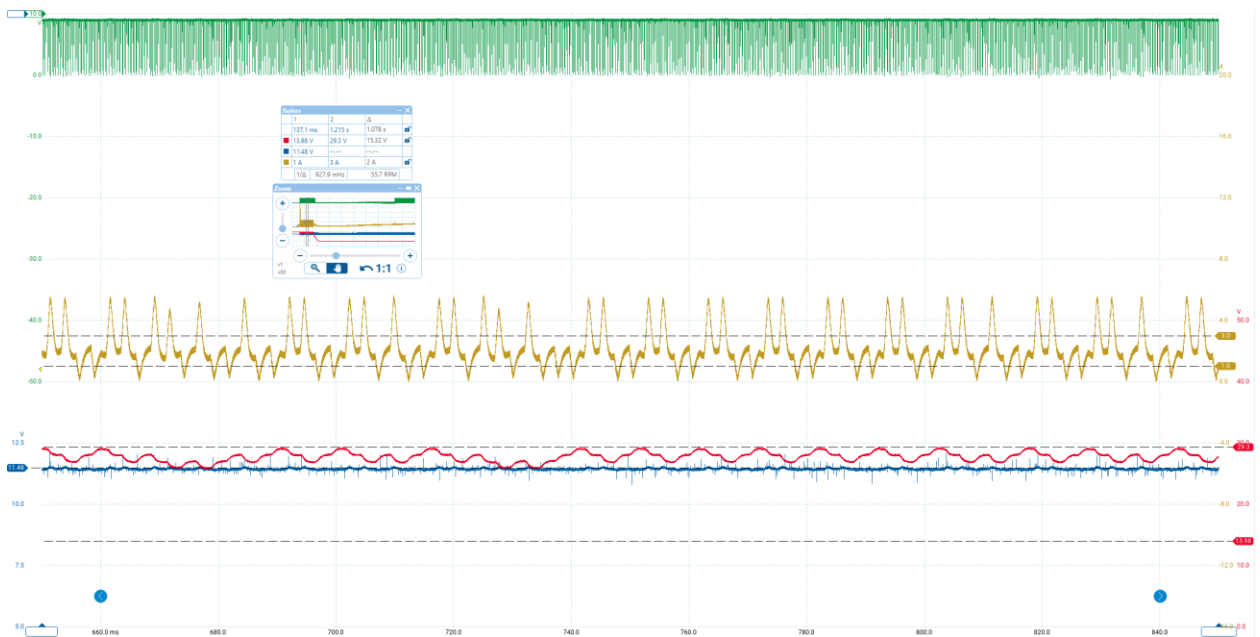


Figure 2 Startup burst behavior (close-up from Figure 1).

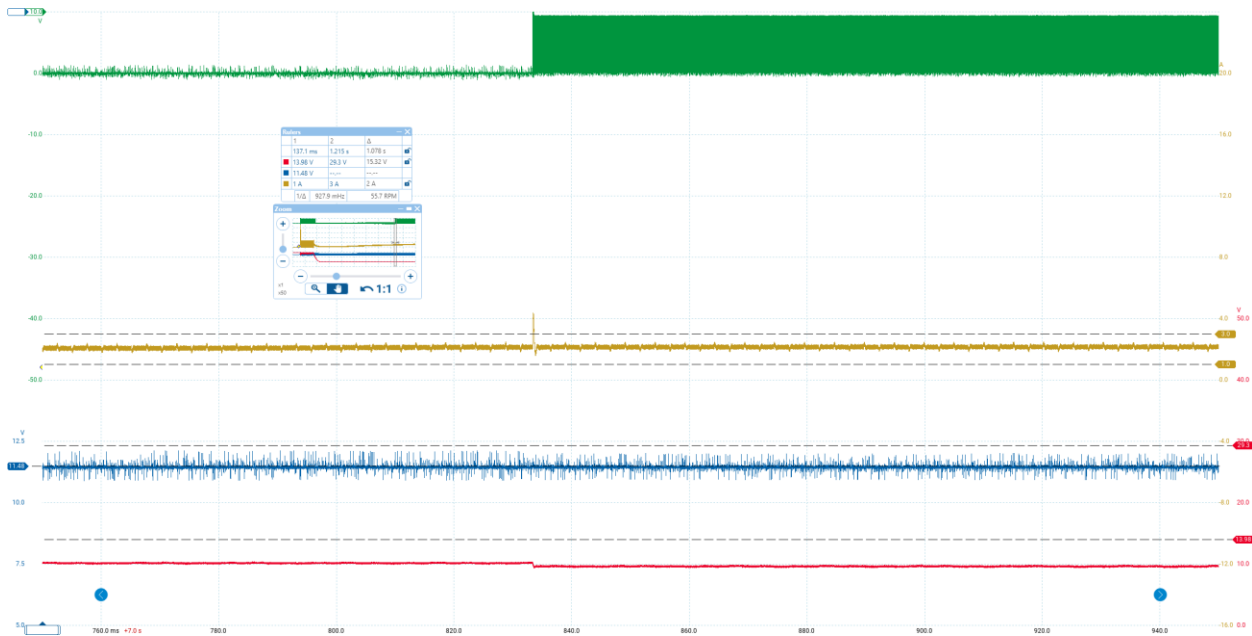


Figure 3 SM72445 transitions to buck mode at approximately 2 A (close-up from Figure 1).

Power Cycle Behavior

If the system is **power-cycled** and the initial input current limit is again set to **1 A**, the burst behavior does **not** occur. In this case, the SM72445 transitions into buck mode once the input current exceeds approximately **2 A**, as shown in Figure 4.

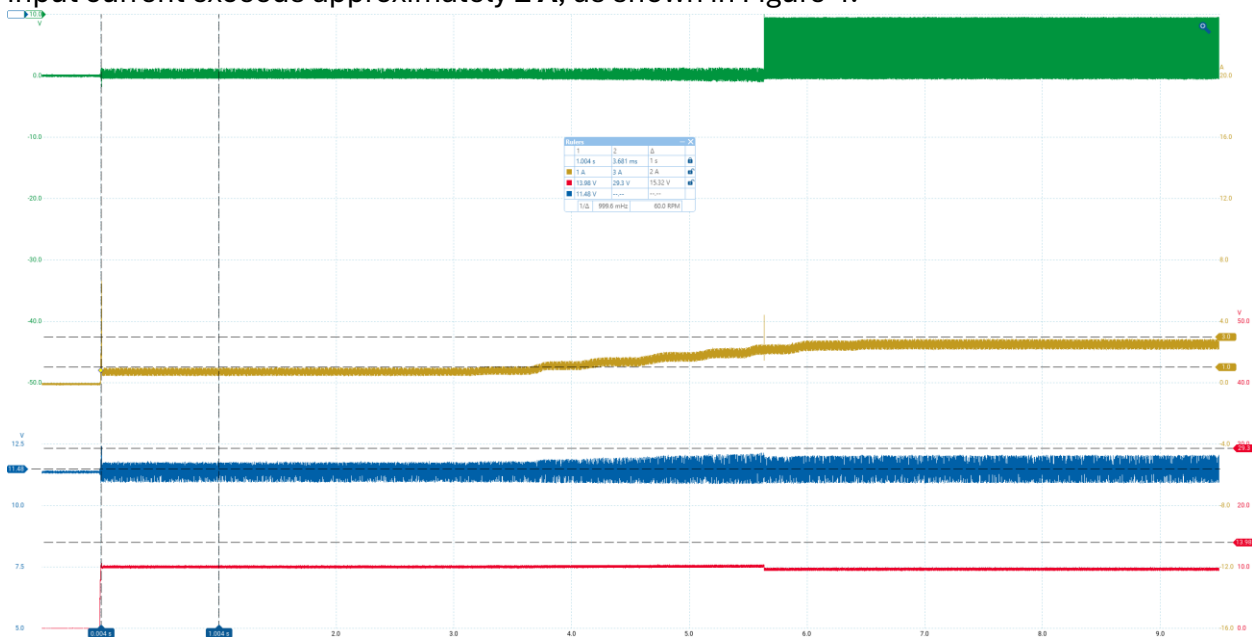


Figure 4 Vin, Vbat, and Iout after power cycling with an initial input current limit of 1 A.

Persistent Burst Behavior

An unexpected behavior occurs when the system **starts with a higher input current limit (e.g., 3 A)**.

In this case:

- SM72445 enters the burst-mode condition during startup.
- The system **remains in this mode indefinitely**.
- Normal operation is restored **only after a power cycle**.

This behavior is shown in Figures 5–7.

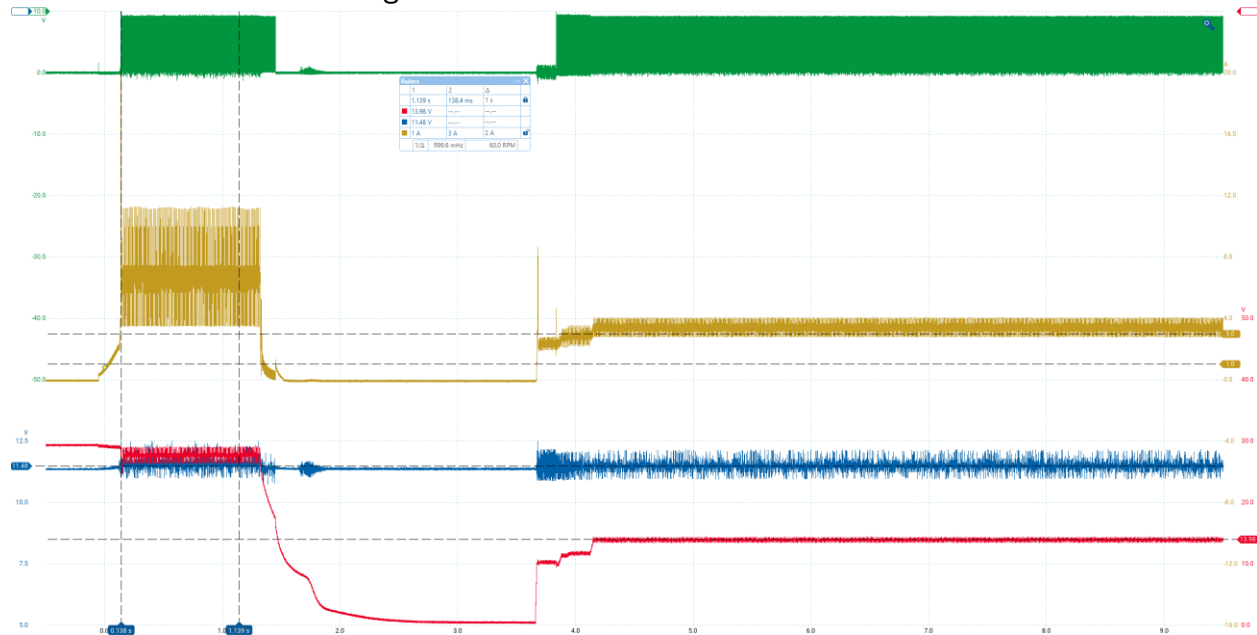


Figure 5 Startup with an input current limit of 3 A. The system remains in burst mode until power cycling.

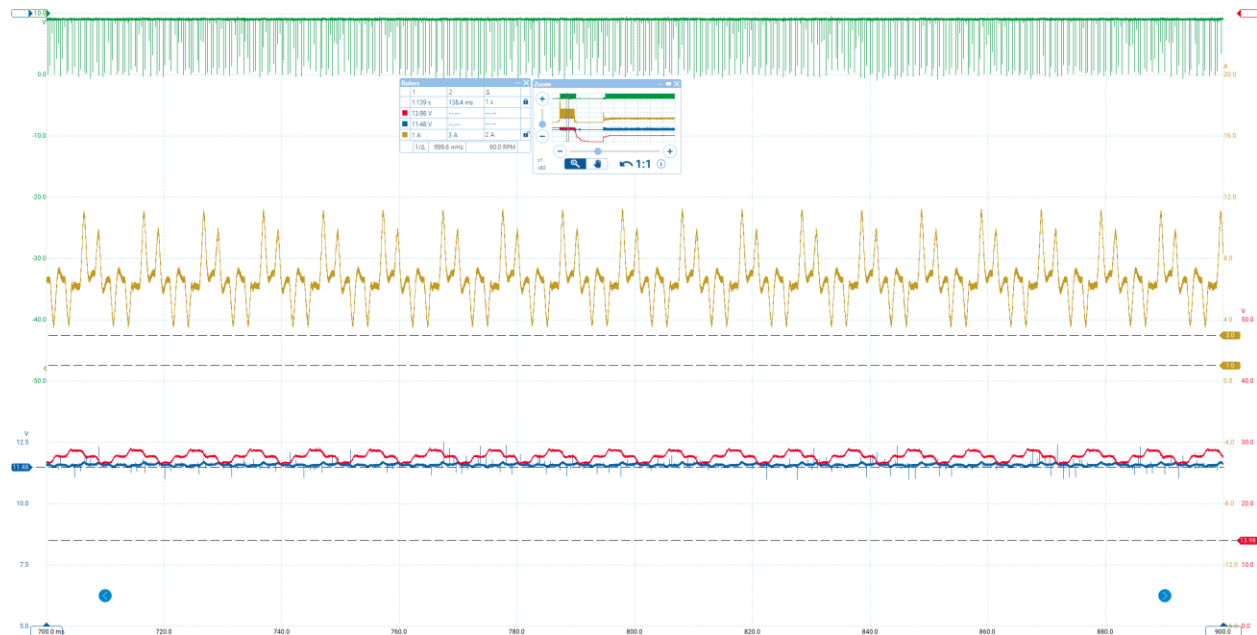


Figure 6 Startup burst behavior (close-up from Figure 5).

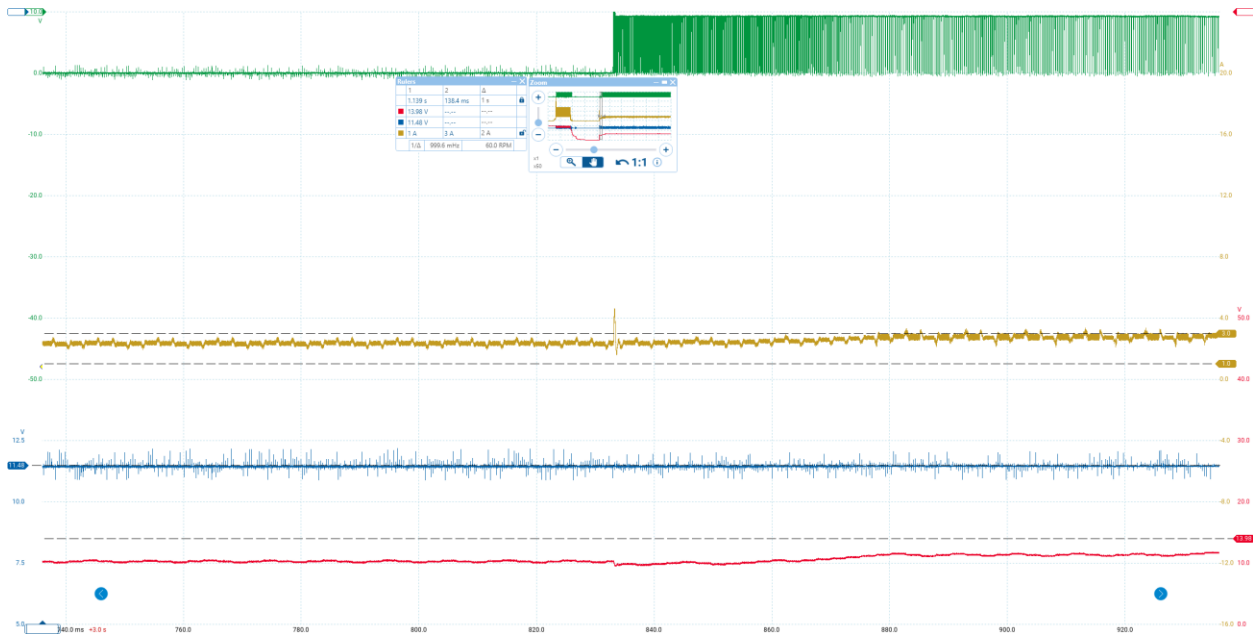


Figure 7 SM72445 transitions to buck mode at approximately 2 A after power cycling (close-up from Figure 5).

Additional Observation

According to **Section 15 (Charging a Li-Ion Battery)** of the reference design SNOSB76C, the resistor between **VDD** and **VDDA** (referenced in the SM72445 datasheet) should be **0 Ω** (**shorted**) instead of **49.9 Ω** when operating with Li-Ion batteries.

Implementing this change caused the system to remain in a **burst-mode-like behavior continuously**, regardless of whether the input current limit was set to **1 A** or **3 A**.

Final Comments

The observed behavior differs from the expected operation.

Therefore, it is unclear whether:

- The **SM72445 controller is suitable for the intended system requirements**, or
- Additional configuration changes are required.

It should also be noted that the testing described in this report was performed at **only a fraction of the system's rated voltage and current**.

Further investigation may be required to determine whether the observed behavior is related to:

- startup conditions,
- controller configuration, or
- limitations of the SM72445 for this application.