UM1806
User manual

EFL700A39 evaluation board kits and design-in board user guide

Introduction

This note describes the operation and the instruction for using the two boards developed for training and supporting the design of the solid state thin film battery EnFilm™ EFL700A39.

The evaluation kit (order number: EFL700EVALKIT) allows to discover the operation of the EFL700A39 and to monitor the voltage and the dynamic charge / discharge current in real use-case condition.

The power management board (order number: EFL700PMB) is rather a design-in board including all the necessary power management circuit around the EFL700A39 and can be directly connected and used in the application for a fast evaluation.

Figure 1. EFL700EVALKIT

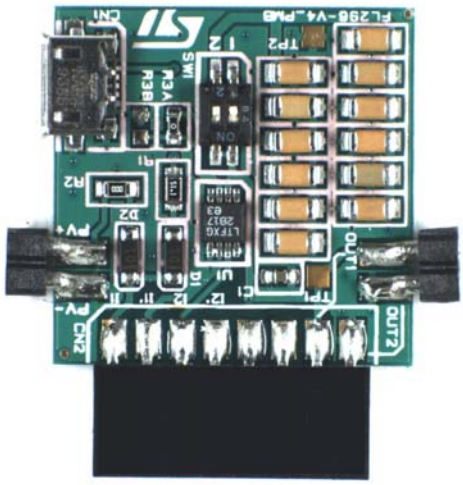
Figure 2. EFL700PMB

1 EFL700 power management board (EFL700PMB)

1.1 Pictures of the power management board (PMB)

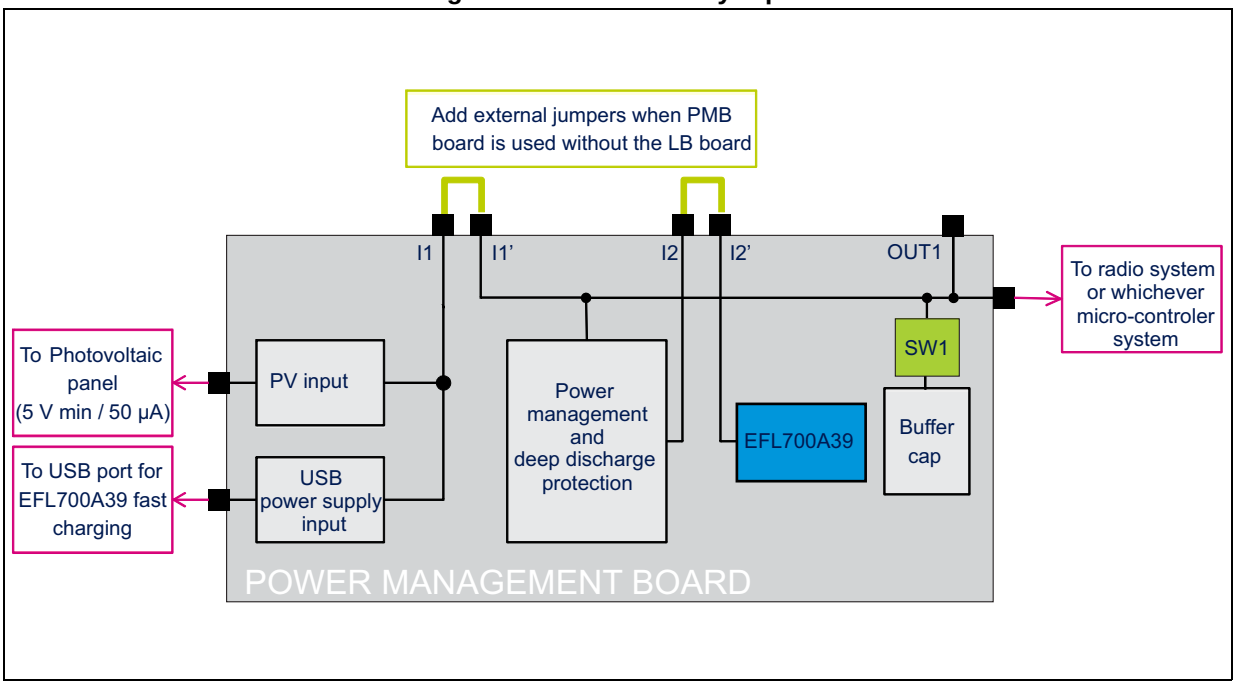
Figure 3. EFL700PMB board top side

Figure 4. EFL700PMB board bottom side



1.2 Block diagram of the power management board (PMB)

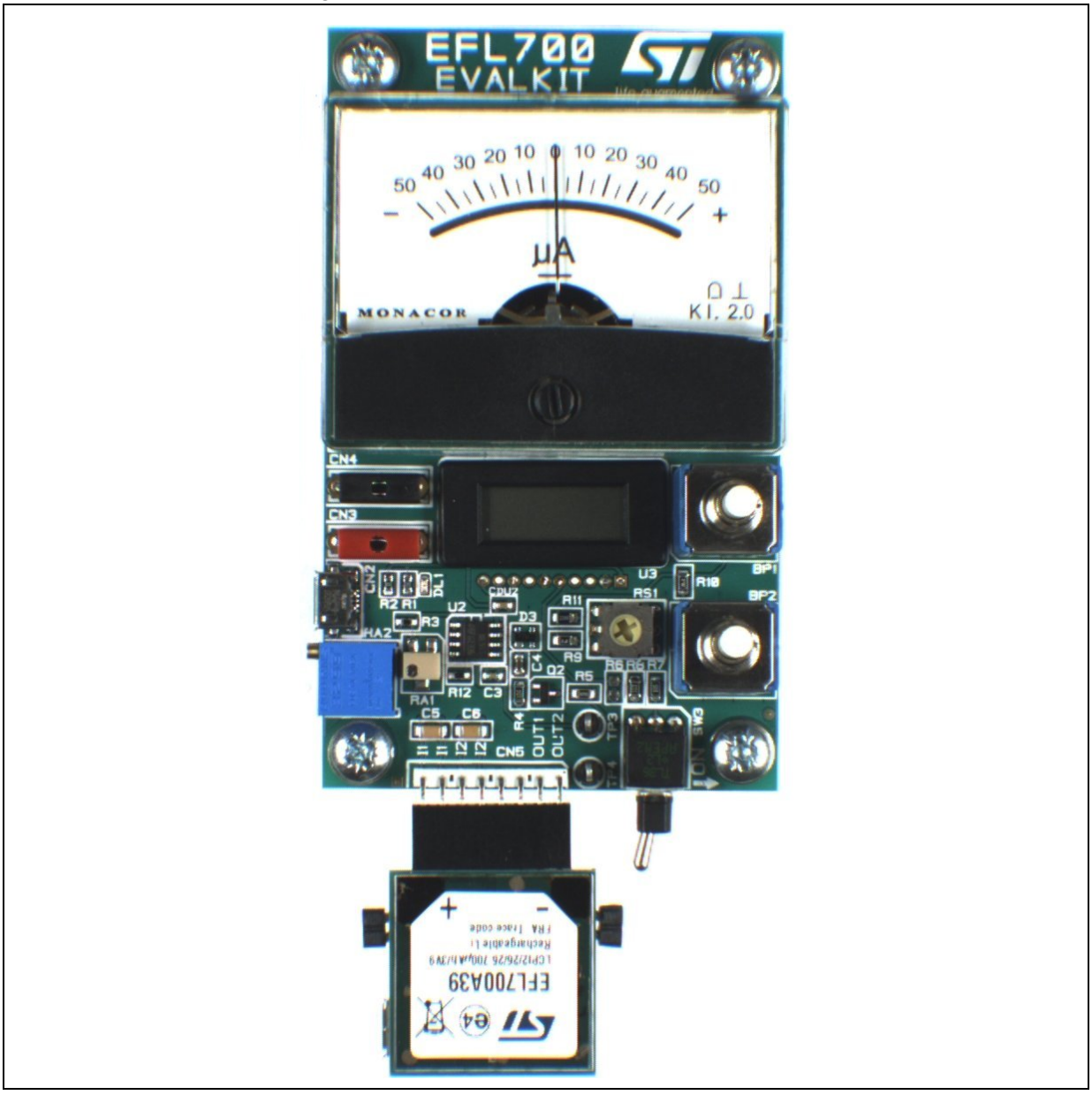
Figure 5. EFL700PMB synoptic



2 EFL700 evaluation kit (EFL700EVALKIT)

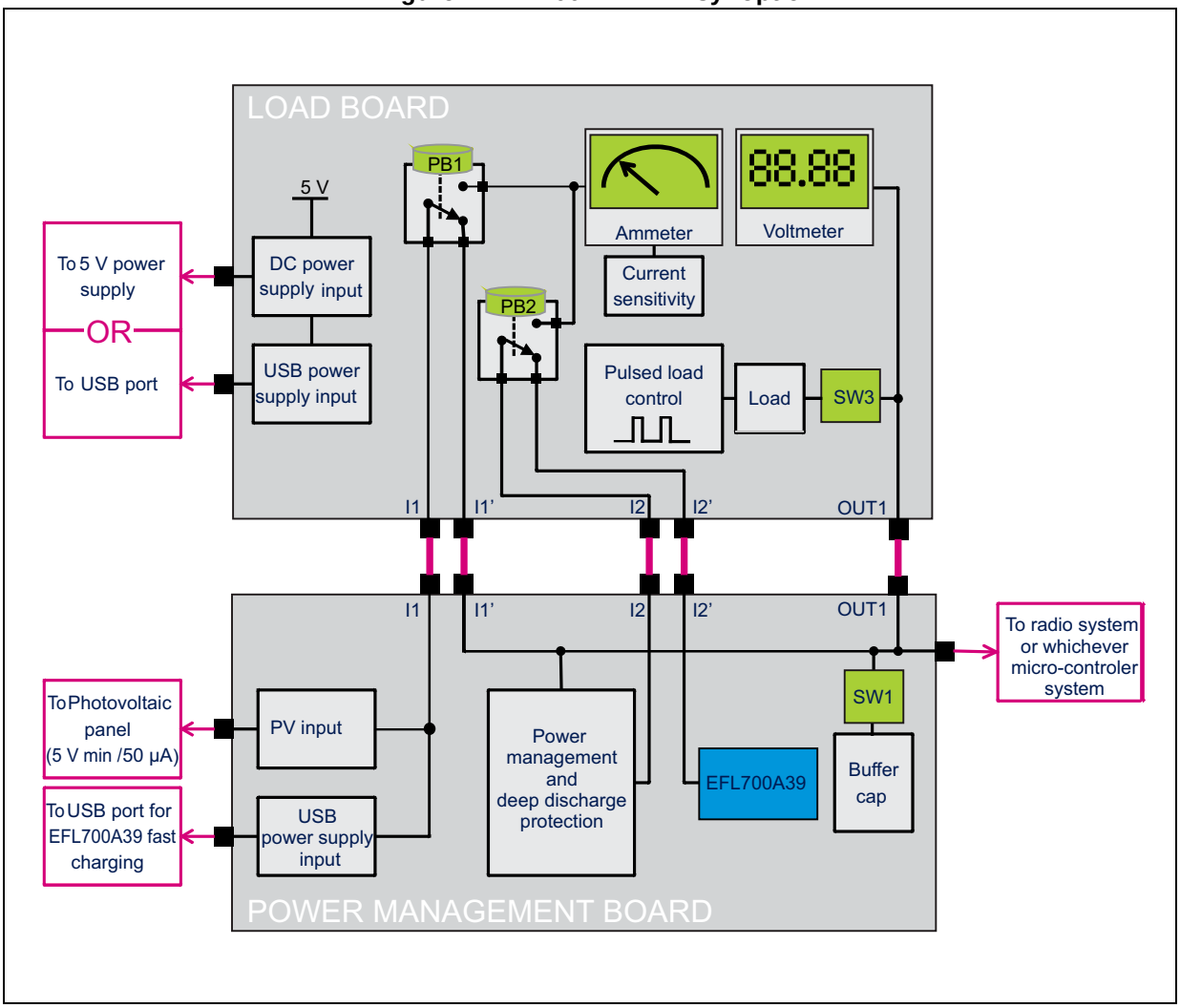
2.1 Picture of the complete evaluation kit with the PMB connected to the load board (LB)

Figure 6. EFL700EVALKIT boards connected



2.2 Block diagram of the complete evaluation kit with the PMB connected to the load board (LB)

Figure 7. EFL700EVALKIT synoptic



3 General description and features

The EFL700A39 EnFilm ™ battery brings many benefits compared to conventional battery:

- Low thickness
- Low self-discharge
- Extremely long calendar and cycle life time
- High safety with no risk of burning or explosion

EFL700PMB and EFL700EVALKIT kits were developed to help designers to evaluate the charge and discharge performances of the EFL700A39 with a proper setup of power management.

The EFL700PMB includes one PCB: The power management board (PMB), same size as the EFL700A39 battery mounted on the top side.

The EFL700EVALKIT includes two PCB: The power management board (PMB) and the additional load board (LB).

The power management board (PMB):

- Manages the charge and the voltage regulation of the EFL700A39
- Protects battery against deep discharge
- Supports the recharge through an external energy harvesting
- Includes buffer capacitors to sustain high pulsed discharge current. Buffer capacitors can be disconnected with the switch SW1

The PMB can be used in association with USB port, photovoltaic panel or any kind of harvester with its own power management. The PMB can be connected to any kind of load with its own power management circuit.

Whatever the harvester and load system are, the PMB allows a safe and efficient use of the EFL700A39 micro-battery.

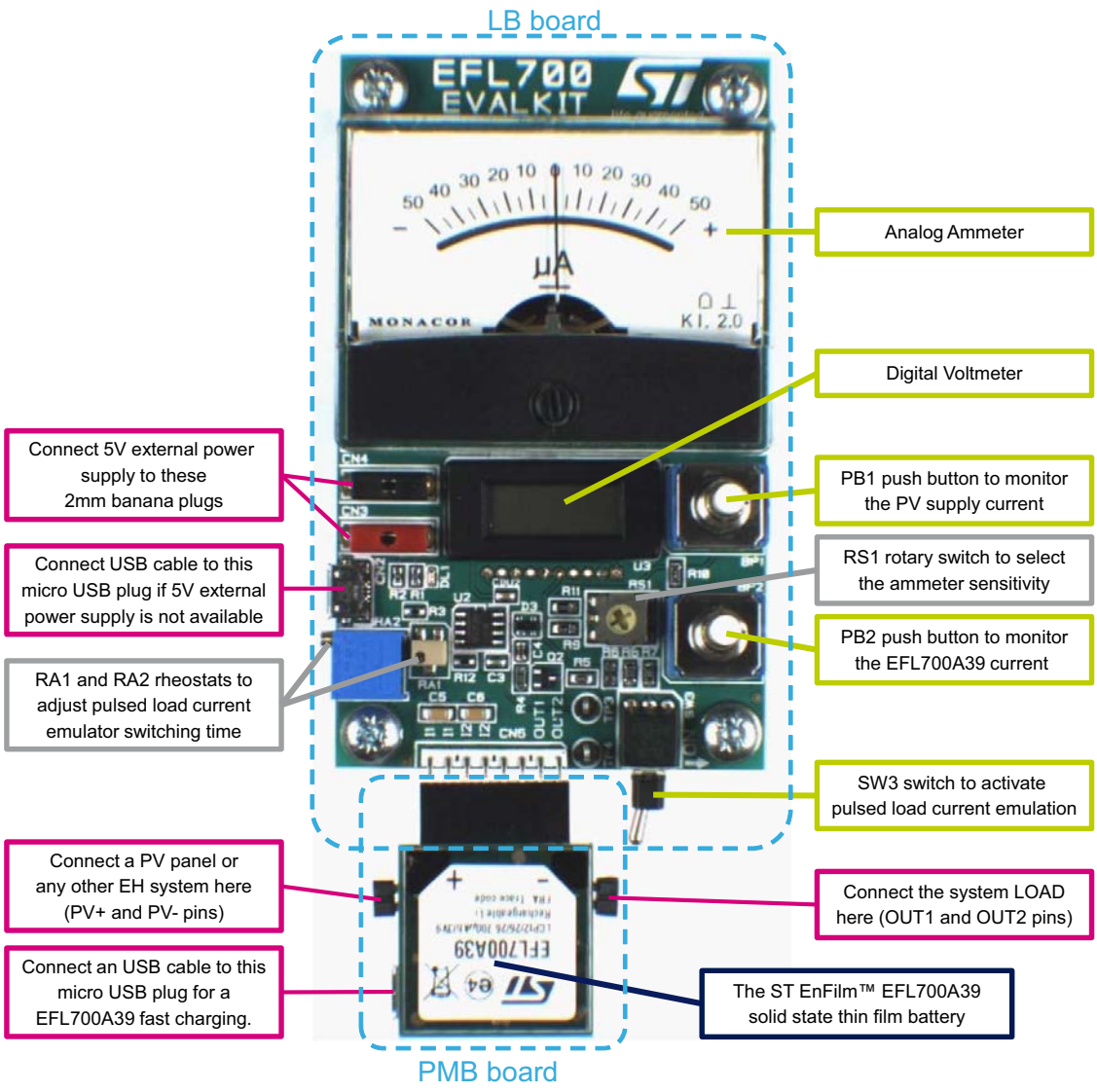
The load board (LB):

- Includes an analog ammeter and a digital voltmeter allowing the user to monitor:
  - The current delivered by the source by pressing PB1.
  - The current going through the EFL700A39 battery by pressing PB2.
  - The battery voltage
- Includes a pulsed load emulator with the possibility to adjust the pulsed load cyclic ratio. Its features are:
  - Enable / disable function by toggling the switch SW3.
  - Default pulsed load current set to 5 mA during a pulse time of 100 ms every 10 s.
  - Tunable pulse duration from 1 ms up to 100 ms through RA1 rheostat.
  - Tunable pulse repetition time from 1 s up to 10 s through RA2 rheostat.

The LB can be powered via 2 mm banana connectors or a micro-USB plug.

4 EFL700EVALKIT in details

Figure 8. Description of the PMB and LB boards



5 Using the complete evaluation kit

The use of the EFL700EVALKIT discovery kit is recommended to get familiar with the PMB board operation and thus with the EFL700A39 electrical management characteristics. The complete discovery kit gives the possibility to monitor the EFL700A39 charging and discharging currents as if the EFL700A39 battery was used in a real case application with high pulse current load. It also helps to monitor the charging current delivered by an external charger like an energy harvesting device or an USB port.

First connect +5 V power supply on LB board via 2 mm banana plugs or USB connector. Toggle the SW3 switch to the left position in order to switch “OFF” the pulsed load emulator operation.

Then, connect an external PV panel or any other energy harvesting device having an output voltage above 5 V to the left side connector of the PMB board as shown in *Figure 8* (PV+ and PV- pins).

In order to monitor the current delivered by the PV through the analog ammeter, press the PB1 push button. The ammeter sensitivity can be adjusted by selecting the correct position of the RS rotary switch (depending on the PV current capability):

- Position 1: “10” marking on the ammeter means 10 mA current is flowing.
- Position 2: “10” marking on the ammeter means 1 mA current is flowing.
- Position 3: “10” marking on the ammeter means 100 µA current is flowing.

Pressing the PB2 push button will show through the ammeter the current that goes in or out of the EFL700A39 micro-battery.

When turning “ON” both SW1 switches on the PMB board, the user connects 12 SMD buffer capacitors mounted on the PMB board to the output node. Buffer capacitors work in parallel with the EFL700A39 micro-battery and are dedicated for high current pulse applications. As shown in the *Figure 9*, SW1 is a two-way switch. Turning "ON" the way #1 connects 4 of the 12 buffer capacitors. Turning "ON" the way #2 connects 8 of the 12 buffer capacitors. Each of the 12 buffer capacitor is a 220 µF 1206 HiCap MLCC capacitor resulting actually in a typical 800 µF capacitance value under 4 V bias when all buffer cap are connected.

The digital voltmeter indicates the charging voltage of either both EFL700A39 and buffer capacitor when SW1 switch is “ON” or EFL700A39 alone when SW1 switch is “OFF”. This digital voltmeter shall indicate +4.2 V when the EFL700A39 is fully charged.

By turning “ON” the SW3 switch (right position), a current burst operation mode is emulated (default settings: 5 mA / 100 ms every 10 s). In order to see the behavior of the PMB board and particularly the EFL700A39 and buffer cap behavior press PB1 or PB2 (never press both at the same time). This will show how the charger and PMB work together. If the charge source does not provide enough current, the PMB board will supply burst current until the EFL700A39 voltage gets down to its security range. Indeed, when the battery voltage falls below 3.2 V the power management IC embedded on the PMB board will disconnect the EFL700A39 in order to prevent it from deep discharge.

The adjustment of the pulsed load duty cycle can be performed with RA1 and RA2 rheostats. RA1 controls the pulse duration whereas RA2 controls the pulse repetition time. A probe scope can be connected between TP3 and TP4 test points to tune the switching time of the pulse load.

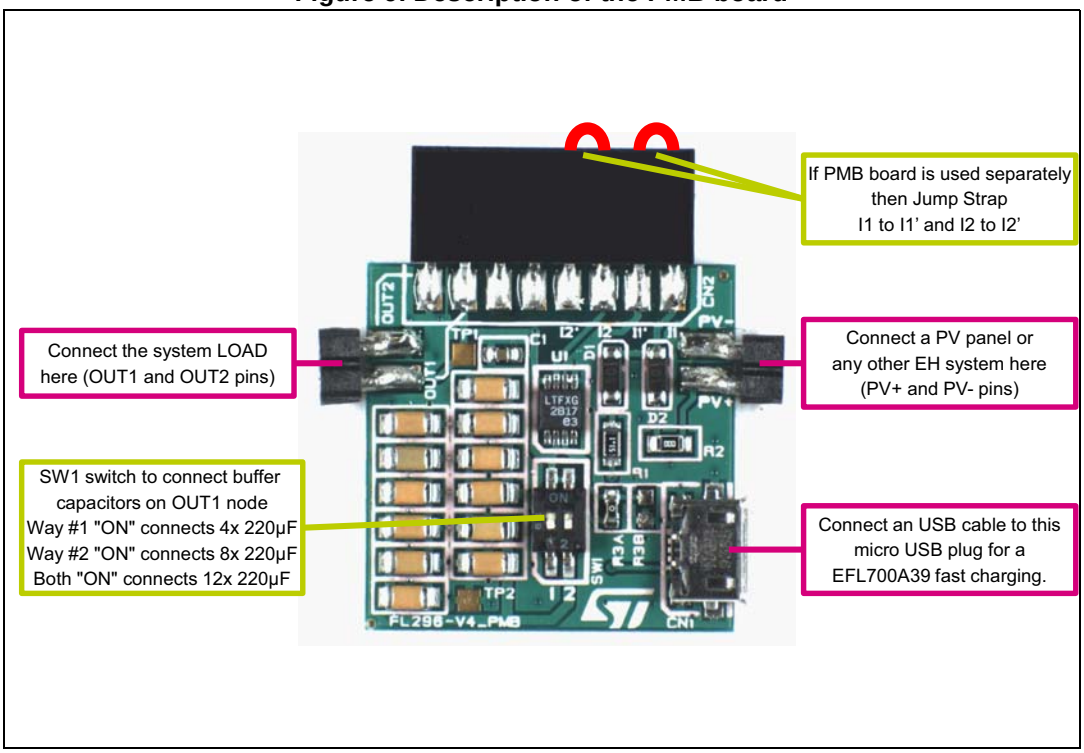
If for any reason there is a need to fast charge the EFL700A39 and buffer capacitors then users can connect the PMB board micro USB plug to an external USB port.

6 Using the PMB board separately

The PMB board can be used separately for your own application. It can be used to supply a real IoT (Internet of Things) application case with a micro-controller and radio circuit.

For this it will be necessary to jump strap the I1 to I1' pins and I2 to I2' pins as shown below in *Figure 9*.

Figure 9. Description of the PMB board



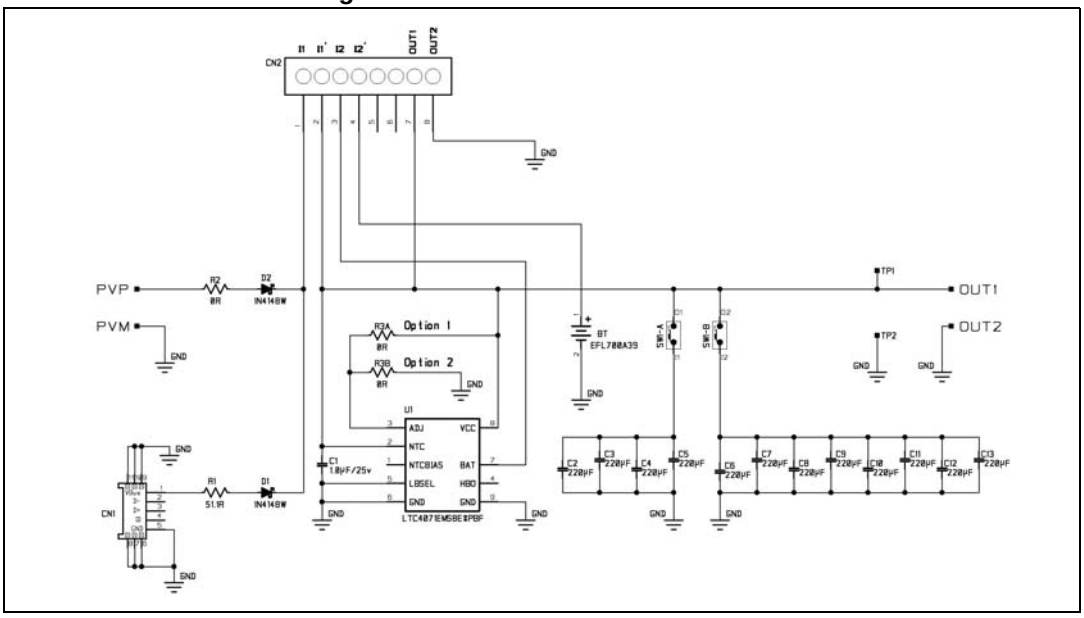
The PMB board characteristics are the following at 25°C:

- 4.2 V output voltage limitation during the charge of the battery
- Deep discharge battery protection when output voltage gets down to 3.2 V
- USB fast recharge

7 Electrical schematics

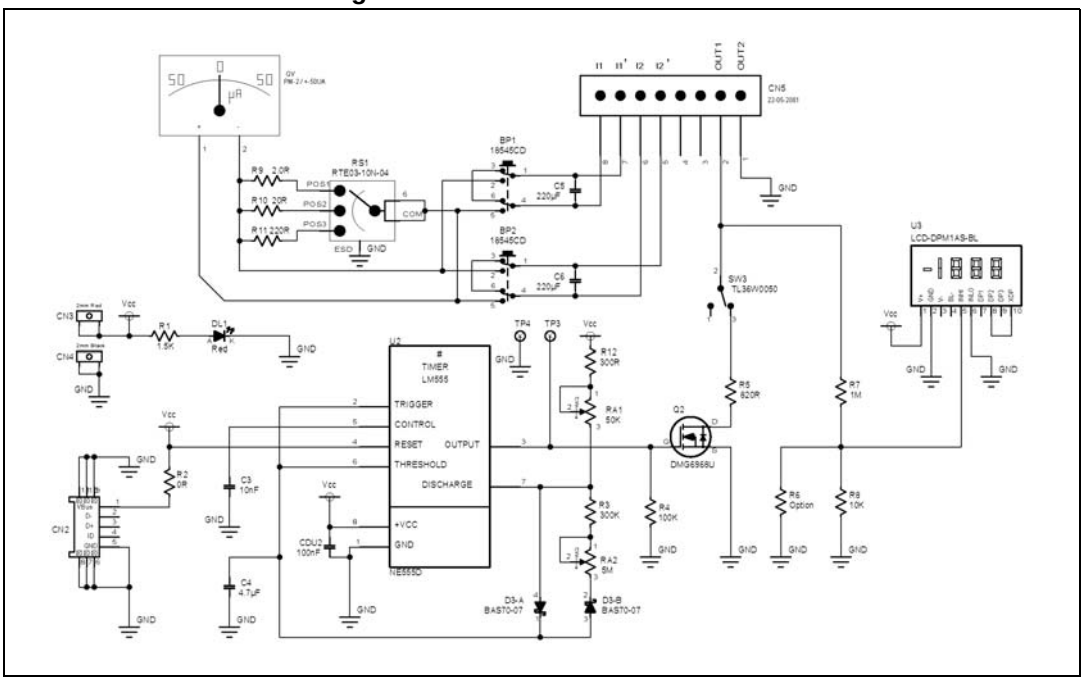
7.1 Power management board

Figure 10. PMB electrical schematic



7.2 Load board

Figure 11. LB electrical schematic



8 Bill of materials

Table 1. BOM of the power management board (PMB)

Reference	Designation	Supplier	Ref. parts	Value
BT	EnFilm™ - rechargeable solid state lithium thin film battery	STMicroelectronics	EFL700A39	700µA.h / 3.9 V
C1	Ceramic capacitor	AVX	06033D105KAT2A	1µF
C2-C13	Ceramic buffer capacitors	MURATA	GRM31CR60J227M	220µF
CN1	Connector Micro-USB	TE Connectivity	1981584-1	
CN2	Connector board-to-board	MULTICOMP	2212S-08SG-85	8 way / 2.54 mm pitch
D1	Diode	MULTICOMP	1N4148W	
D2	Diode	MULTICOMP	1N4148W	
OUT1, OUT2	Connector	Winslow	W35532TRC	2 way / 2.54 mm pitch
PVP, PVM	Connector	Winslow	W35532TRC	2 way / 2.54 mm pitch
R1	Resistor	PANASONIC	ERJP06F51R1V	51.1 ohms / 0.5W
R2	Resistor	PANASONIC	ERJ6GEY0R00V	0 ohms
R3A	Resistor	PANASONIC	ERJ3GEY0R00V	0 ohms
R3B	optional / not populated			
SW1	DIP Switch	MULTICOMP	MCDHN-02F-T-V	2 way / 1.27 mm pitch
U1	Shunt battery charger system with low battery disconnect	LINEAR TECHNOLOGY	LTC4071EMS8E	
PCB	PMB board	AXIANE		

Table 2. BOM of the load board (LB)

Reference	Designation	Supplier	Ref. parts	Value
BP1	SWITCH PUSH BUTTON	APEM	18545CD	
BP2	SWITCH PUSH BUTTON	APEM	18545CD	
C3	Ceramic Capacitor	AVX	06035C103JAT2A	10nF
C4	Ceramic Capacitor	KEMET	C0603C475K9PACTU	4.7µF
C5	Ceramic capacitor	MURATA	GRM31CR60J227M	220µF
C6	Ceramic capacitor	MURATA	GRM31CR60J227M	220µF
CDU2	Ceramic Capacitor	KEMET	C0603C104K4RACTU	100nF
CN2	Micro-USB SMD connector	TE Connectivity	1981584-1	
CN3	2mm Standard tip plug	WIMA	105-0752-001	Red

Table 2. BOM of the load board (LB) (continued)

Reference	Designation	Supplier	Ref. parts	Value
CN4	2mm Standard tip plug	WIMA	105-0753-001	Black
CN5	Board-to-Board Connector	MOLEX	22.05.2081	8 way / 2.54 mm pitch
D3	Schottky diodes	NXP	BAS70-07	
DL1	LED	WURTH	150060RS75000	Red
GV	Ammeter PM-2 / +-50UA	MONACOR	29.045	
Q2	N-Channel MOSFET	DIODES INC.	DMG6968U7	
R1	Resistor	BOURNS	CR0603FX1501ELF	1,5K ohms
R2	Resistor	BOURNS	CR0603J000ELF	0 ohms
R3	Resistor	PANASONIC	ERJ3EKF3003V	300K ohms
R4	Resistor	PANASONIC	ERA6ARW104V	100K ohms
R5	Resistor	PANASONIC	ERJU06F8200V	820 ohms
R6	optional / not populated			
R7	Resistor	PANASONIC	ERA6AEB105V	1M ohms
R8	Resistor	PANASONIC	ERA6AEB103V	10K ohms
R9	Resistor	PANASONIC	ERJ6RQF2R0V	2 ohms
R10	Resistor	PANASONIC	ERJ6ENF20R0V	20 ohms
R11	Resistor	VISHAY	CRCW0805220RFKEA	220 ohms
R12	Resistor	PANASONIC	ERJP03F3000V	300 ohms
RA1	Trimmer 50KOHM, 10%, 12TURN	BOURNS	3224X-1-503E	0-50K ohms
RA2	Trimmer 5MOHM, 10%, 25TURN	BOURNS	3299P-1-505LF	0-5M ohms
RS1	Rotary DIP Switch	C&K	RTE03-10N-04	
SW3	SPDT On-On Switch	APEM	TL36W0050	
U2	Precision Timer	STMicroelectronics	NE555D	
U3	Digital voltmeter	LASCAR	DPM 1AS-BL	
PCB	LB board	AXIANE		

9 Use case with PV energy harvester

Step 1: Control of the efficiency of the PV energy harvester

The load is disconnected. Pressing PB1 permits the user to monitor the current delivered by the PV energy harvester.

Figure 12. Step1 schema

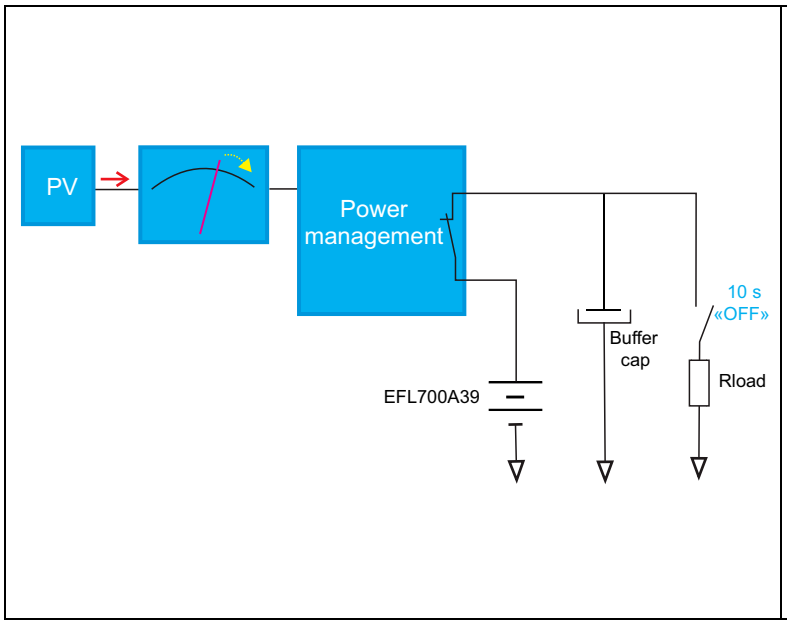


Figure 13. Step1 picture

Step 2: Connection of the load for 100 ms

PB2 monitors the current in the EFL700A39. The load is mainly supplied with buffer cap energy at the same time the EFL700A39 also participates. Voltage drops consequently from some tens of mV.

Figure 14. Step2 schema

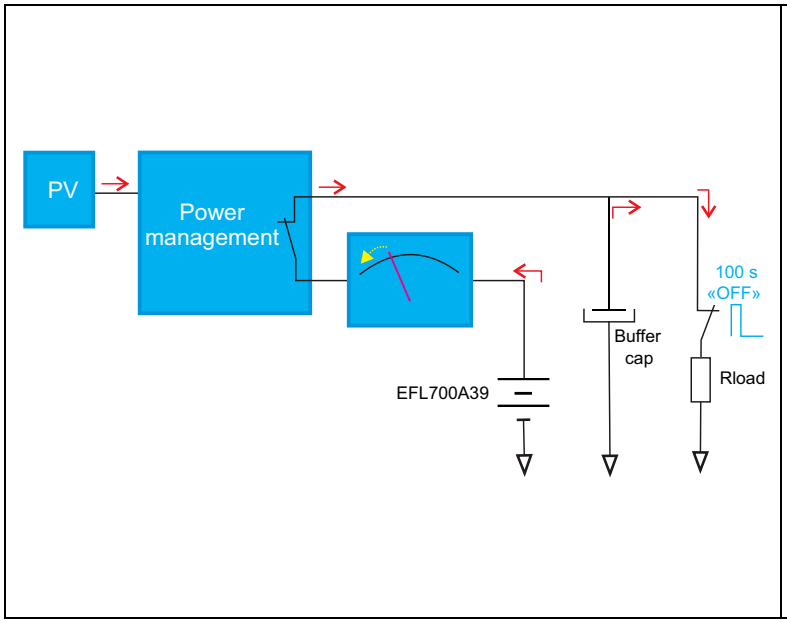


Figure 15. Step2 picture

Step 3: At the very beginning of disconnection of the load

PB2 monitors the current in the EFL700A39. The EFL700A39 is recharging the buffer cap, so current is still negative but reduces as the super-cap gets charged.

Figure 16. Step3 schema

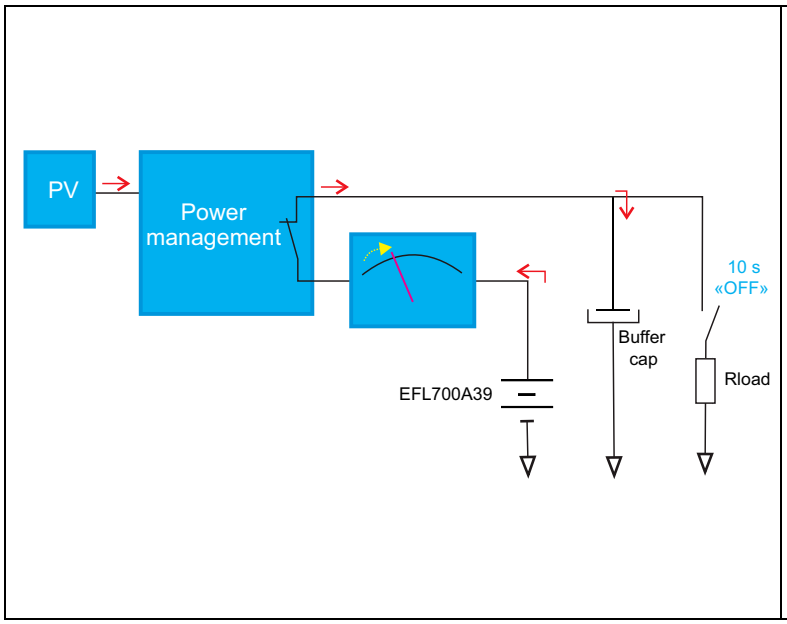


Figure 17. Step3 picture

Step 4: Load disconnected after a while

PB2 monitors the current in the EFL700A39. Once the buffer cap is charged, the EFL700A39 is getting charged at its turn by the PV harvesting system so the current is positive now until the voltage threshold of 4.2 V is reached.

Figure 18. Step4 schema

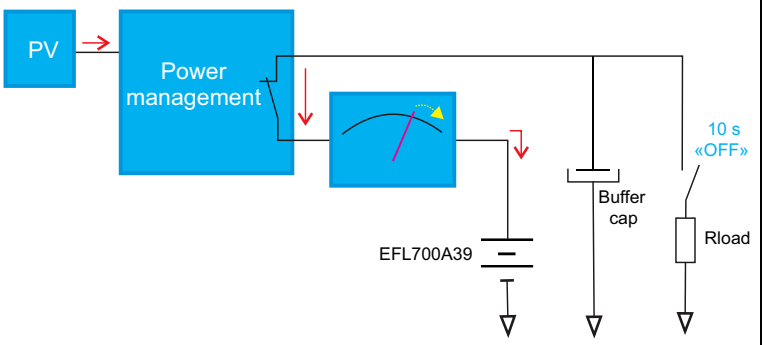


Figure 19. Step4 picture

10 Revision history

Table 3. Document revision history

Date	Revision	Changes
19-Jan-2015	1	Initial release.
20-Aug-2015	2	Updated *Figure 1*, *Figure 2*, *Figure 3*, *Figure 4*, *Figure 6*, *Figure 8*, *Figure 9*, *Figure 10*, *Figure 11*. Updated *Section 8: Bill of materials* and minor text changes to improve readability.