APPLICATION NOTE

Charging Systems for ITEN Powency

Version 2.9 – April 2025

ITEN Solid State Powency can be used in different applications as power assist, power back or in an always-on design. One key feature of ITEN Powency is its ability to charge quickly in a few minutes. To achieve such quick charging, several types of architecture are available and described in this document.

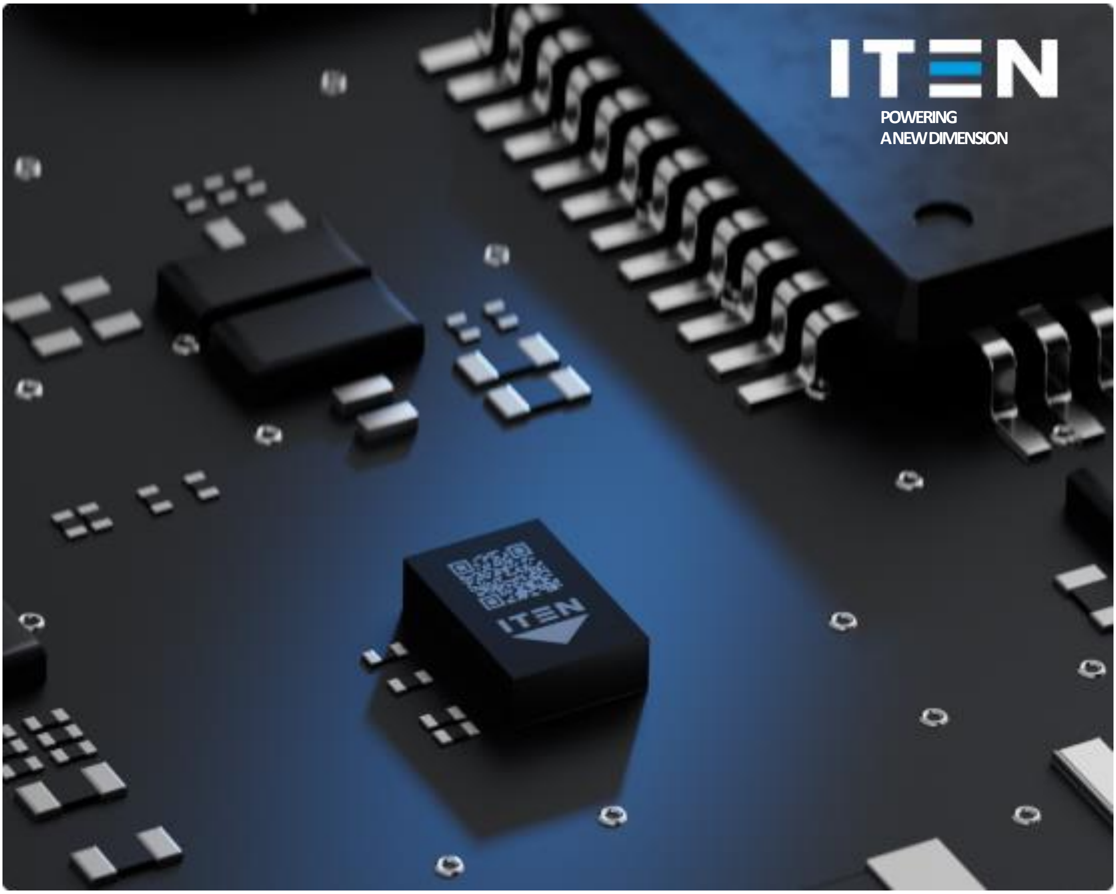


Table of content

Overview

To achieve quick charging, several types of architecture are available as shown in the below figure.

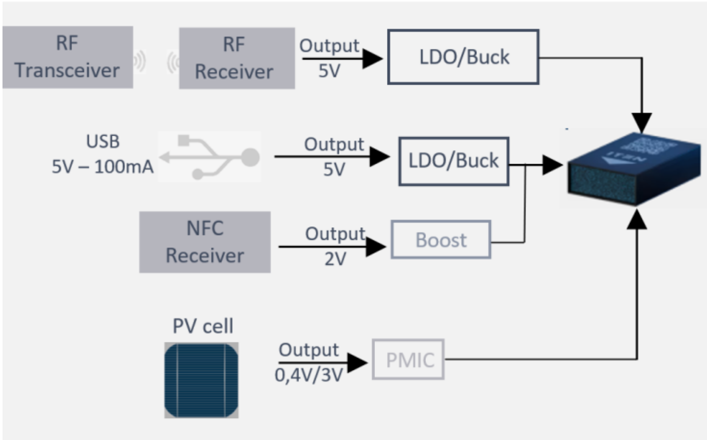


Figure 1: Different ways to charge ITEN Powency

Current ITEN Powency such as PWY0150S model uses 2.7V voltage as charging voltage. Depending the voltage level available on the system, several charging options are available:

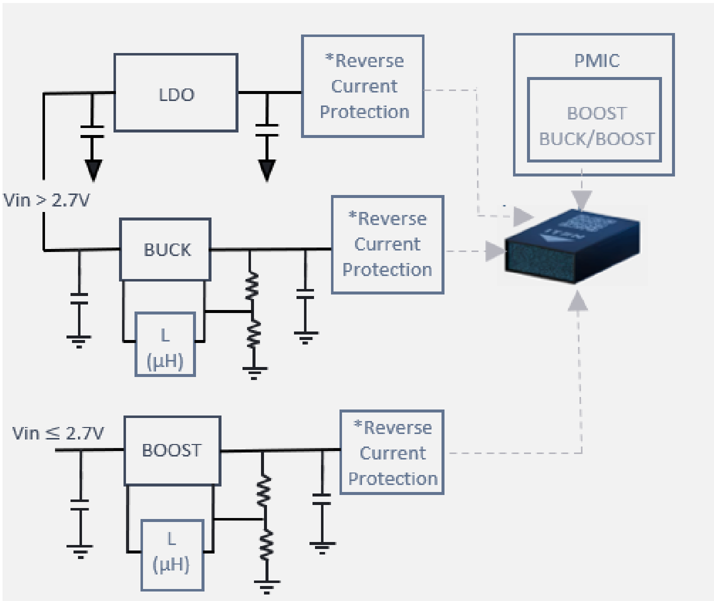


Figure 2: Component selection to charge ITEN Powency

There are numerous methodologies on how to charge micro batteries. ITEN battery can be charged from a stable fixed voltage of 2.7 V. The battery's current falls as the battery is charging, it is considered fully charged once the current reaches a rate of C/10. This application note presents very simple and low-cost systems for a constant voltage charging. Users must select the preferable design for their aspect of use.

LDO Voltage Regulator

Low-dropout regulators (LDO) are a simple way to regulate an output voltage powered from a higher input voltage. Typical implementation of LDO voltage regulator with ITEN Powency :

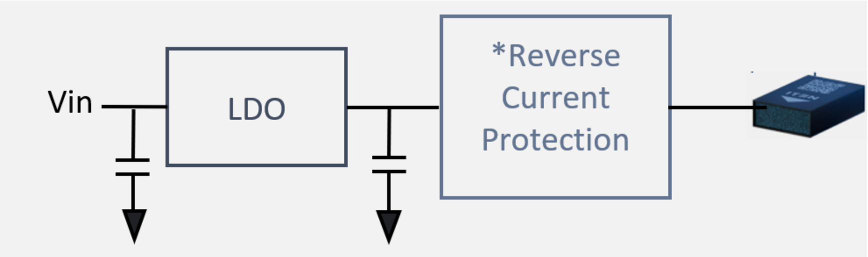


Figure 3: Typical implementation of LDO voltage regulator with ITEN Powency

01 Component Selection

Part Number	Manufacturer	Output	Footprint	RP* required
TPS70927	Texas Instruments	Fixed (2.7V)	SOT23 WSON	**Yes** (diode/NMOS/PMOS)
TPS78227	Texas Instruments	Fixed (2.7V)	SOT23 WSON	**Yes** (diode/NMOS/PMOS)
XC6240A263XR-G	Torex	Fixed (2.7V)	SSOT-24 USPN-4 USP-6B06	**Yes** (diode/NMOS/PMOS)
RT9073/N-27	Richtek	Fixed (2,7V)	SC-70-5 SOT-25	

02 Schematic

Figure 4: Schematic of TPS70927 (TI) Fixed 2.7V output voltage, LDO voltage regulator

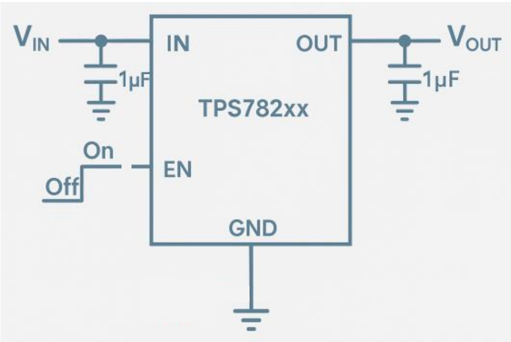


Figure 5: Schematic of TPS782 (TI) Fixed 2.7V output voltage, LDO voltage regulator

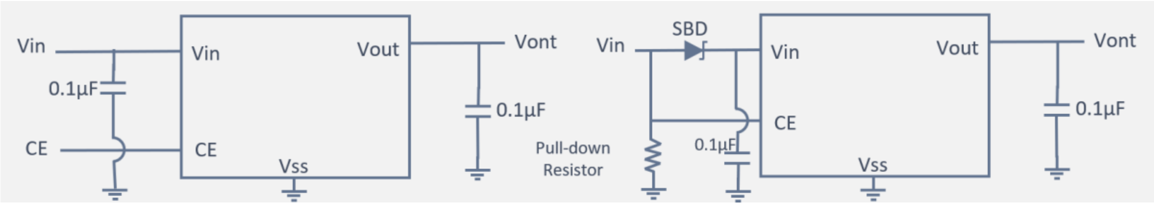


Figure 6: Schematic of XC6240A263XR-G LDO voltage regulator
(Left Standard regulator circuit Right With reverse current prevention)

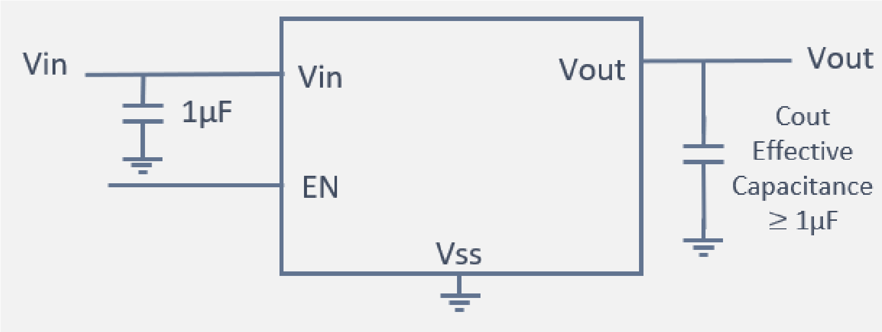


Figure 7: Schematic of RT9073 (Richtek) LDO voltage regulator

Recommendation: A reverse current protection circuit is required between the LDO and the battery except for the right side of Figure 6.(cf section 8 solution A).

Buck Charge Circuit

The buck converter is a very simple type of DC-DC converter that produces an output voltage that is less than its input. The buck converter is so named because the inductor always "bucks" or acts against the input voltage. The output voltage of an ideal buck converter is equal to the product of the switching duty cycle and the supply voltage.

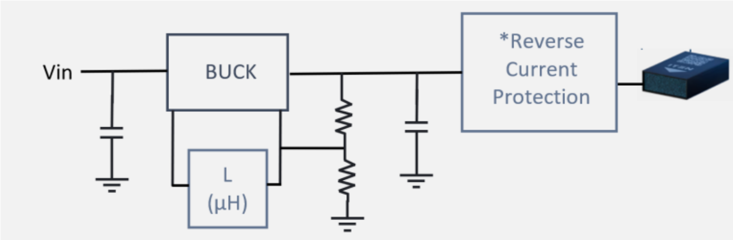


Figure 8: Typical implementation of buck circuit with ITEN Powency

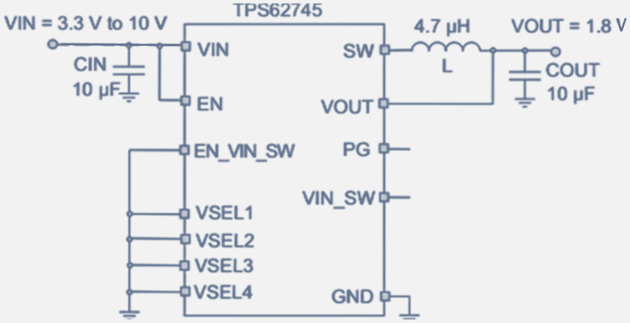
01 Component Selection

Part Number	Manufacturer	Output	Footprint	Efficiency* @5V input	RP* required
TPS62745	Texas Instruments	Fixed	WSON	90%	**Yes** (diode/NMOS/PMOS)
ST1PS02C1	ST Microelectronics	Fixed (2.7V)	TQFN12	82%	**Yes** (diode/NMOS/PMOS)
LTC3103	Analog Devices	Adjustable	DFN-10 MSOP-10	85%	**Yes** (diode)

* Based on the datasheet over a 10mA –10uA current range

02 Schematic

TPS62745 (TI)
Fixed output voltage
1Meg EN to GND + EN to Vin
Reverse Current protection



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DS page 15

TPS62745
VSEL4-3-2-1 = [1001] with diode (2.7V)
VSEL4-3-2-1 = [1100] with NMOS as diode (3V)

Figure 9: Schematic of TPS62745 buck converter

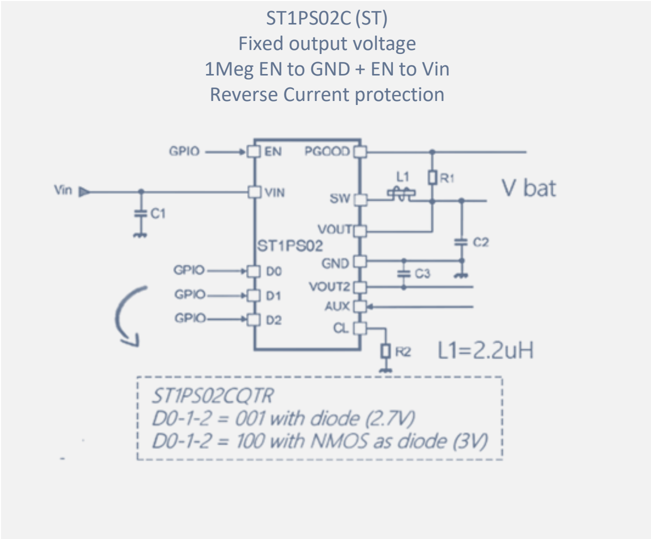


Figure 10: Schematic of ST1PS02C buck converter

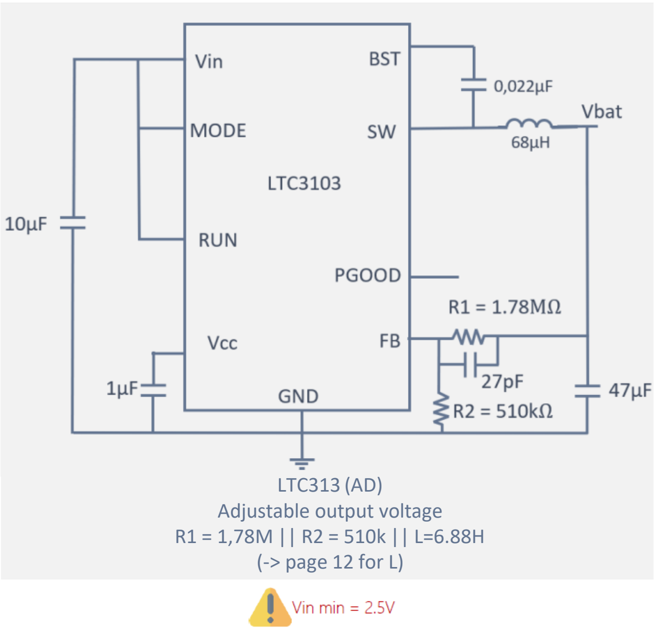


Figure 11: Schematic of LTC3103 buck converter

Boost Converter

It is a step-up converter that increases the input voltage to a stable output voltage; therefore, it can only be used for systems with a power supply lower than 2.7 V. Beware of the lower limit of the input voltage that can be used depending on the converter chosen.

In this case, the N-MOS is not used, as it needs a minimum Vgs voltage usually higher than 2.7 V. Consequently, there is a leakage current that can't be blocked.

Output voltage is often regulated by a resistor divider, as is indicated in the datasheet of the converter. Next figure shows a typical implementation of boost converter with ITEN Powency

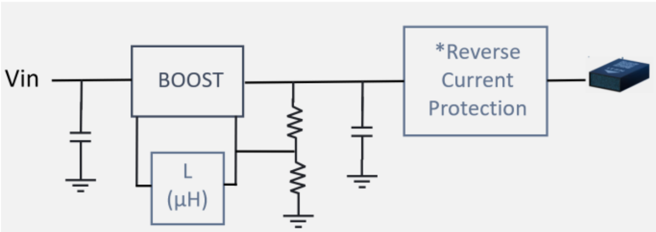
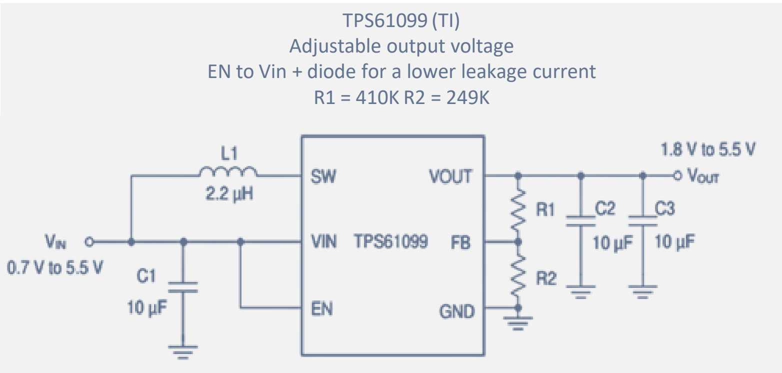


Figure 12: Typical implementation of boost converter with ITEN Powency

01 Component Selection

Part Number	Manufacturer	Output	Footprint	Efficiency* @1.5V input	RP* required
TPS61099	Texas Instruments	Adjustable	YFF-6 DRV-6P	82%	**Yes** (diode) Enable = Vin
MAX1724EZK27	Analog Devices	Fixed	uDFN	78%	**Yes** (diode/NMOS as diode)

02 Schematic



VOUT [V][1]	INDUCTANCE [µH]	SATURATION CURRENT [A]	DC RESISTANCE [mΩ]	SIZE (LxWxH)	PART NUMBER	MANUFACTURER
> 3.0	2.2	1.95	80	2.5 x 2.0 x 1.2	74404024022	Würth Elektronik
	2.2	1.7	92	2.5 x 2.0 x 1.1	LQH2HPN2R2MJR	muRata
	2.2	1.45	163	2.0 x 1.6 x 1.0	VLS201610CX-2R2M	TDK
≤ 3.0	1.0	2.6	37	2.5 x 2.0 x 1.2	74404024010	Würth Elektronik
	1.0	2.3	48	2.5 x 2.0 x 1.0	MLP2520W1R0MT0S1	TDK
	1.0	1.5	80	2.0 x 1.2 x 1.0	LQM21PN1R0MGH	muRata

Figure 13: Schematic of TPS61099 boost converter

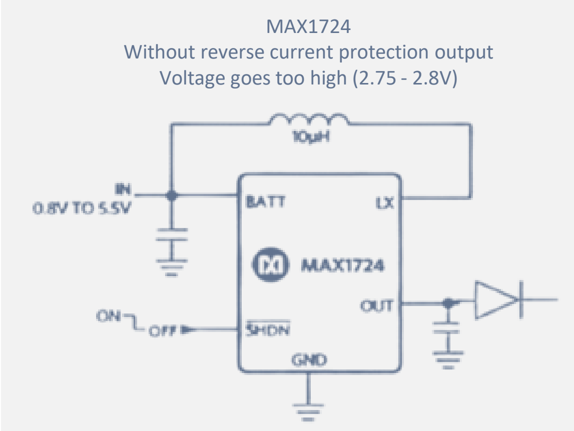


Figure 14: Schematic of MAX1724 boost converter

Energy Harvesting Charge Circuit

The Energy harvesting PMICs are specialized units designed to collect energy from ambient energy sources. They significantly improve energy conversion efficiency by reducing energy losses to improve device performance.

3 PMICs have been tested with the following configurations:

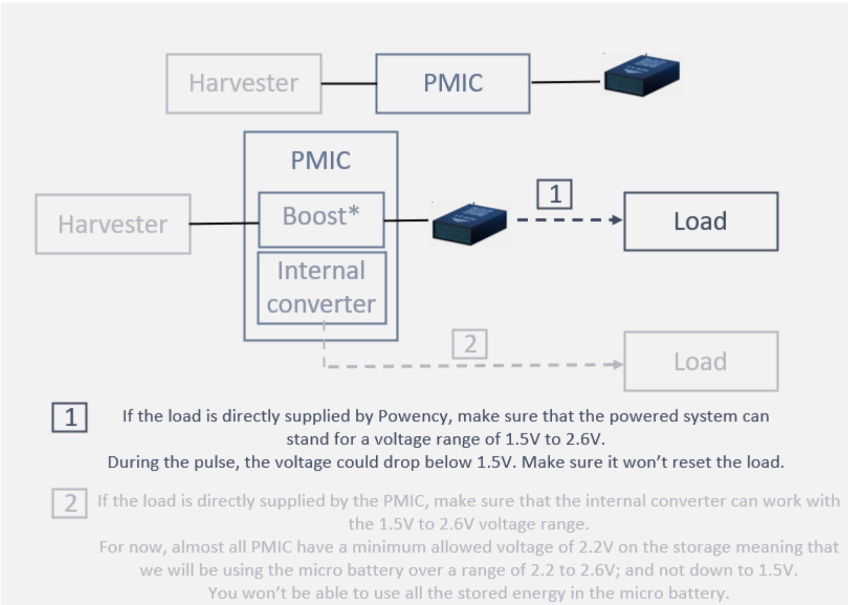


Figure 15: Typical implementation of energy harvester PMIC with ITEN Powency

01 Component Selection

Part Number	Manufacturer	Voltage configuration		Other parameters
TPS61099	Texas Instruments	VBIAS = 1.21V VBAT_OK = 2.5V VBAT_OV = 2.7V VBAT_UV = 2.2V VBAT_OK_HYST = 2.6V	ROK1 = 4.64M ROK2 = 5.34M ROK3 = 10k ROV1 = 6.65M ROV2 = 3.16M	Rout1 = 3.48M Rout2 = 1.6M => for 1.8V output voltage ROC1 & ROC2 to be chosen according to the harvester MPP ratio International converter = BUCK Vmin = 2.2V
ADP5092	Analog Devices	V_INT REF = 1.02 V VBAT_TERM = 2.73 V VSETSD = 2,06 V VSETPG_FALLING = 2.18V VSETPG_RISING = 2.22 V VSETBK = 2,06 V	RBK1=5M49 = R4 RBK2=5M36=R11 RTERM1=4.95M=R5 RTERM2=6.49M=R12 RSD1=5M49=R3 RSD2=5M36=R10 R hyst=100k=R8 R PG1=5.49M=R6 R PG2=4.64M=R13	RVID = R2 = 14k to select 1.8V as output voltage Remove R9 on EVK R7 = 0 R Internal converter = LDO
AEM10941	e-peas	Vovch = 2.7V Vchrdy = 2.3V Vovdis = 2.2 V	Vovch = 2.7V CFG2-1-0 = H-L-L Custom mode available For Vchrdy level >2.3V Internal converter = LDO Vmin = 2.2V	BAL = GND ENHV = H to enable the HVOUT LDO ENLV = H to enable the LVOUT LDO SELMPPO&1 to select according to the harvester used

Zener Diode

Low-cost solution to consider when the energy transfer does not have to be efficient, and in a stable thermal environment. The Zener diode is highly dependent on the temperature.

01 Component Selection

Part Number	Manufacturer	Characteristics
BZX84-A2V7	Nexperia	Zener Diode 2.7V 250 mW
BZX55C2V7	Vishay Semiconductor	Zener Diode 2.7V 500 mW
MTZJ2V7SA	Vishay Semiconductor	Zener Diode 2.65V 500 mW

02 Schematic

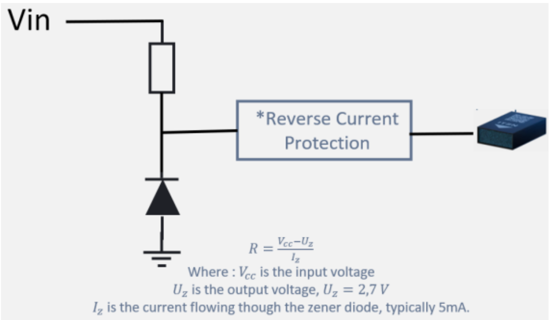


Figure 16: Charging circuit with Zener diode

Solution comparison

Charging System	Efficiency	Cost	Leakage current	Thermal stability	EMC compatibility	Charging Time
LDO Converter	✓	✓	✓	✓	✓	✓
Buck Converter	✓	✓	✓	✓	✗	✗
Boost Converter	✓	✓	✗ ✗	✓	✗	✓
Energy Harvesting PMIC	✓	✗	✓	✓	✓	✓
Zener Diode	✗ ✗	✓ ✓	✓ ✓	✗ ✗	✓	✓

Reverse Current Protection

If the DCDC converter does not include any reverse current protection, one should be added to avoid discharging ITEN solid state battery when the source goes missing.

Be careful that an enable pin might not be quick enough according to the converter behavior. A 1M Ohm resistor could help between the enable and the ground to force the converter when the source goes missing. We recommend testing the behavior of the system if you don't follow our recommendations.

If a leakage occurs in the DCDC converter, several options exist:

- An NMOS transistor with the gate connected to the source after the DCDC converter as shown in figure 17. Be careful that the source might need to be at a certain level to enable the complete charge to 2.7V according to the Vgs threshold.

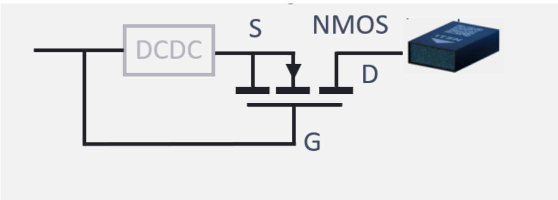


Figure 17: Reverse current protection with NMOS

- An NMOS transistor connected as a diode as shown in figure 18.

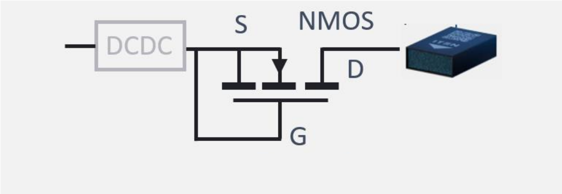


Figure 18: Reverse current protection with NMOS

- An PMOS transistor after the converter with the gate to the GND and the source connected to the converter output as shown in figure 19.

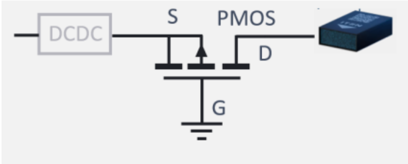


Figure 19: Reverse current protection with PMOS

- A Schottky diode as shown in figure 20.

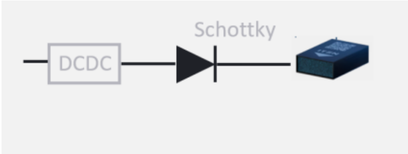


Figure 20: Reverse current protection with Schottky diode

- An ideal diode as shown in figure 21.

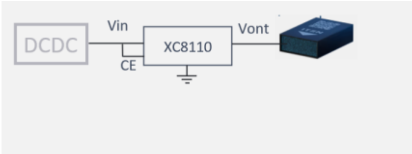


Figure 21: Reverse current protection with ideal diode

01 NMOS transistor

For the figure 22, according to the source voltage, the Vgs should be small enough to allow a voltage up to 2.7V on the micro battery. For the figure B, the Vgs should be as small as possible, and the converter output should be defined as (2.7V + Vgs min).

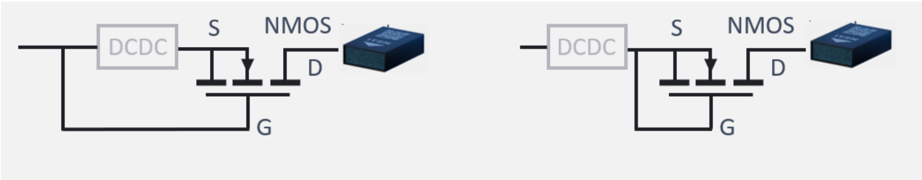


Figure 22: NMOS transistor selection for reverse current protection

Part Number	Vgs Th	V source Minimum
DMT6010LSS	0,8V	3,4V
SSM37K3	0,7V	3,3V

02 PMOS transistor

Please be careful at the converter behaviour when the source goes off. If the output of the output converter node remains charged, the transistor won't be opened quick enough, and the micro battery will be discharged.

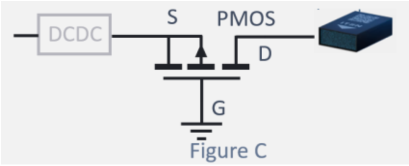


Figure 23: Reverse current protection with PMOS

Part Number	Vgs Th
IRF9393PBF	-1,8V

03 Schottky diode

Figure 24: Reverse current protection with Schottky diode

Part Number	Voltage Forward @10mA	Voltage Forward @1A	Package
DMT6010LSS	0,8V	3,4V	SOD323
SSM37K3	0,7V	3,3V	SOD123

04 Ideal diode load switch

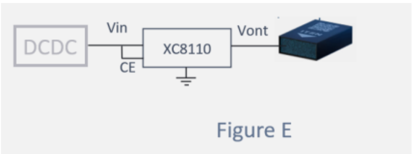
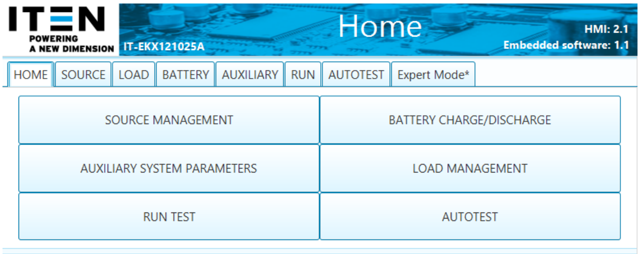


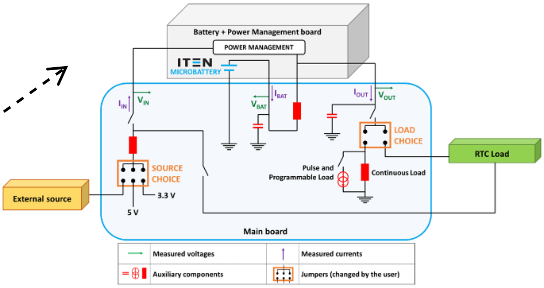
Figure 25: Reverse current protection with ideal diode

Part Number	Voltage Forward @10mA
XC8110AA01	20mW

Charging Systems Evaluation

Customer willing to test and measure performances of ITEN Powency can use ITEN Evaluation kit, which provide a customizable platform for both source and load. Next figure shows Iten evaluation kit :



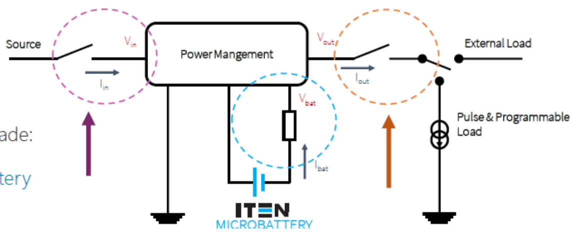


- A ITEN micro battery provided
- Software provided
- Working with NUCLEO F767ZI
- Current and voltage measurement

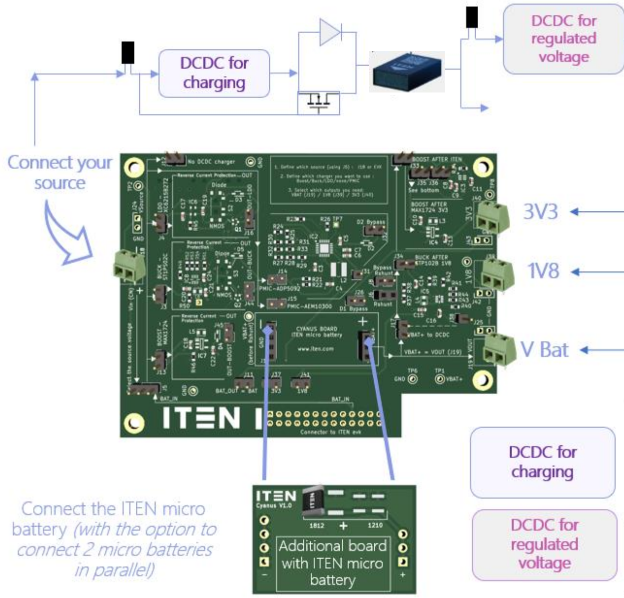
Evaluation Kit Behavior :

Voltages and Current measurement are made:

- Before the charging IC
- After the charging IC to the micro battery
- On the way to the load



ITEN evaluation kit could be used in association with ITEN dev board which offers multiple charging systems.



IC1	AEM10300	AEM10300-QFN
IC2	ADP5092ACPZ-1-R7	ADP5092ACPZ-1-R7
IC6	XC6215B272NR	XC6215B272NR
IC7	MAX1724EZK27+T	MAX1724EZK27+T
IC8	ST1PS02CQTR	ST1PS02CQTR
IC4	MAX1724EZK33+T	MAX1724EZK33+T
IC5	ST1PS02BQTR	ST1PS02BQTR
IC3	TPS3899DL15DSER	TPS3899DL01DSER

Figure 26: Development board overview with charging IC references

Revision History

Date	Revision	Change
22 Avril 2025	V2.9	Changing the template Add Richtek LDO
30 September 2024	V2.8	Remove efficiency column in table 1 Update figure 6 with and without reverse current Add ideal diode for reverse current solution
03 June 2024	V2.7	Fixed TOREX LDO reference in table 1
17 May 2024	V2.6	Fixed SBD placement with XC6240 (section 2.2) Update corporate application note template
21 June 2023	V2.5	Add Figure 2 : Component selection to charge ITEN Powency
15 May 2022	V2.4	Add EVK overview

Contact

For any technical questions or Charging IC recommendations, please send us an email to:

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For any commercial requests, please send us an email to:

sales@iten.com

About Us

ITEN is a French industrial gem, leader in the development and production of solid state batteries with unrivalled power density. It is one of the few global players with the capacity for industrial production of this technology, mastering the entire design and production chain. These revolutionary batteries meet the power and miniaturization needs of electronic systems used in connected objects, autonomous sensors and wearables.

At the heart of the French DeepTech ecosystem, ITEN holds over 200 patents. ITEN is the two-time winner of the global innovation competition in 2015 and 2017, the French Tech 120 winner in 2023 and 2024 and won the CES 2024 Best of Innovation Awards in Las Vegas for its Powency 250µAh battery (the second French company to be honoured since CES was founded in 1967).