



The Future of Analog IC Technology®

# EV2636-R-00A

## Full-Power-Management IC For Single-Cell Battery System

### DESCRIPTION

The EV2636-R-00A is the evaluation board designed to demonstrate the capabilities of MPS' MP2636, a highly-integrated, flexible switch-mode battery charge management and system power path management device for a single-cell Li-ion and Li-Polymer battery used in a wide range of portable applications.

EV2636 uses two operating modes—charge mode and boost mode—to allow management of system and battery power based on the state of the input.

When input power is present, the board charges a single-cell battery with a programmable charge current of up to 2.5A.

In the absence of an input source, the board switches to boost mode through the MODE pin to power the SYS pins from the battery with a current of up to 2.5A.

The evaluation board provides full-operating-status indicators to distinguish charge mode from boost mode.

To guarantee safe operation, the EV2636 has input-over-voltage protection, battery over-voltage protection, thermal shutdown, battery-temperature monitoring, and a programmable timer to prevent prolonged charging of a dead battery.

### FEATURES

- 4.5V-to-6V Operating Input Voltage Range
- Power Management Function Integrated Input-Current-Limit and Input Voltage Regulation
- Up to 2.5A Programmable Charge Current
- Selectable 4.35V / 4.3V / 4.2V Charge Voltage with 0.5% Accuracy
- Battery Temperature Monitoring
- Full Operation Indicators
- Programmable Timer-Back-Up Protection
- Battery-Reverse-Leakage Blocking
- Reverse-Boost-Operation for Powering System
- Up to 94% 5V Boost Mode Efficiency @ 2.5A with BATT=4.35V
- Up to 2.5A Programmable Output Current Limit in Boost Mode

### APPLICATIONS

- Sub-battery Applications
- Power-bank Applications for Smart-Phone, Tablet and Other Portable Devices

All MPS parts are lead-free and adhere to the RoHS directive. For MPS green status, please visit MPS website under Products, Quality Assurance page.

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### ELECTRICAL SPECIFICATION

Parameter	Symbol	Value	Units
<b>Charge Mode</b>			
Input Voltage Range	V <sub>IN</sub>	4.5 – 6	V
Charge-Full Voltage	V <sub>BATT_Full</sub>	4.2 / 4.3 / 4.35	V
Charge Current	I <sub>CHG</sub>	2.5	A
Input Current Limit	I <sub>IN_LIM</sub>	2.7	A
<b>Boost Mode</b>			
Battery Voltage	V <sub>BATT</sub>	3-4.5	V
SYS Voltage Regulation	V <sub>SYS</sub>	5	V
SYS Output Current Limit	I <sub>SYS</sub>	2.5	A

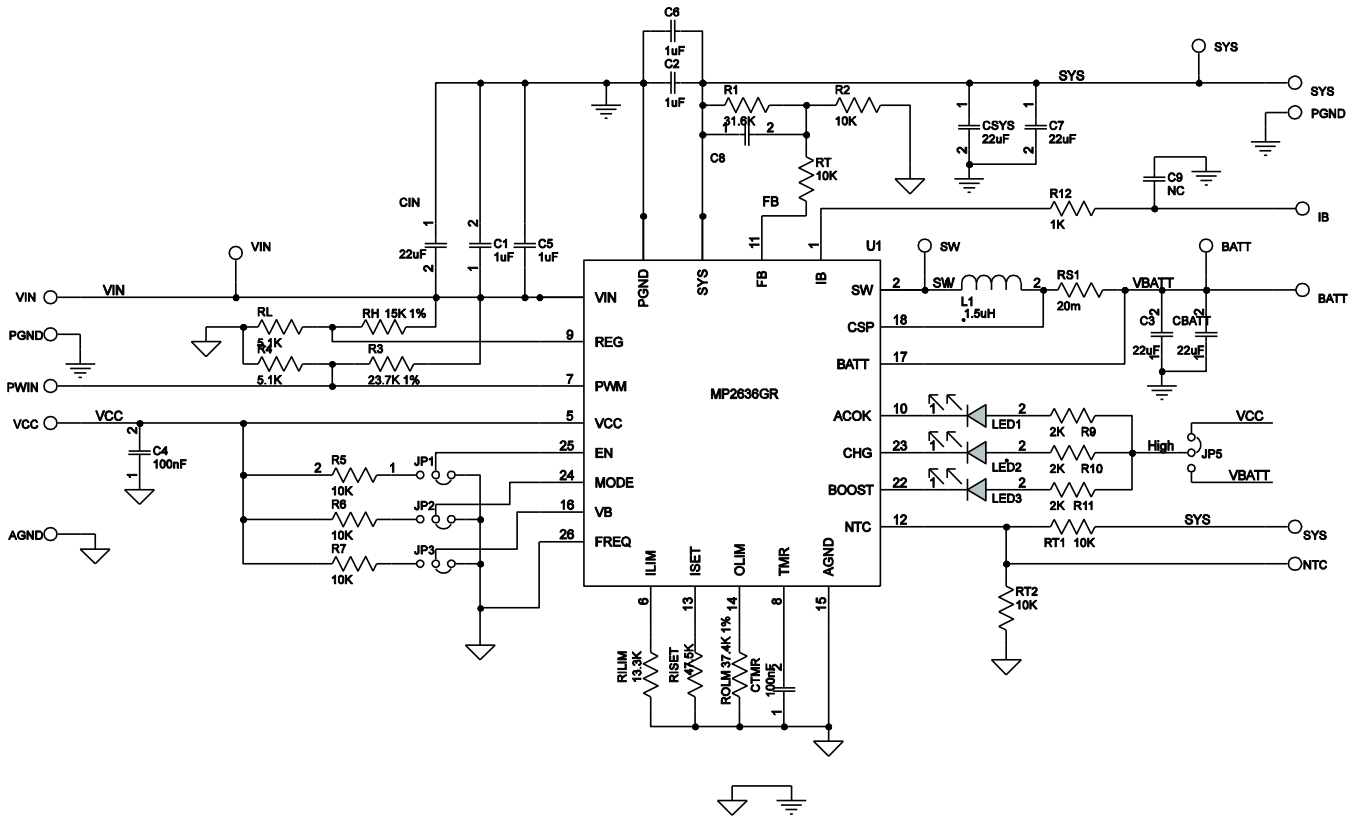
## EV2636-R-00A EVALUATION BOARD



(L x W x H) 6.1cm x 5.1cm x 1.3cm

Board Number	MPS IC Number
EV2636-R-00A	MP2636GR

## EVALUATION BOARD SCHEMATIC



**EV2636-R-00A BILL OF MATERIALS**

Qty.	Ref	Value	Description	Package	Manufacture	Manufacture_PN
2	C1, C5	1 $\mu$ F	Ceramic Capacitor; 25V;X7R	0603	TDK	C1608X7R1E105K
2	C2, C6	1 $\mu$ F	Ceramic Capacitor; 16V;X7R;0603;	0603	muRata	GRM188R71C105KA12 D
4	C3, C7, CBATT, CSYS	22 $\mu$ F	Ceramic Capacitor; 10V;X7R;1206	1206	muRata	GRM31CR71A226KE15 L
2	C4, CTMR	100nF	Ceramic Capacitor; 50V;X7R;0603;	0603	muRata	GRM188R71H104KA93 D
2	C8, C9	NC		0603		
1	CIN	22 $\mu$ F	Ceramic Capacitor; 25V;X5R;	1206	muRata	GRM31CR61E226KE15
1	L1	1.5 $\mu$ H	Inductor;1.5 $\mu$ H;10m; 14A	SMD	Würth	744311150
2	LED1, LED3	BL- HUF35A -TRB	LED; Red	0805	BRIGHT LED	BL-HUF35A-TRB
1	LED2	BL- HGB35A -TRB	LED; Green	0805	BRIGHT LED	BL-HGB35A-TRB
1	R1	31.6k $\Omega$	Film Resistor;1%;	0603	Yageo	RC0603FR-0731K6L
4	R2, RT, RT1, RT2	10k $\Omega$	Film Resistor;1%;	0603	Yageo	RC0603FR-0710KL
1	R3	23.7k $\Omega$	Film Resistor;1%	0603	Yageo	RC0603FR-0723K7L
2	R4, RL	5.1k $\Omega$	Film Resistor;1%;	0603	Yageo	RC0603FR-075K1L
4	R5, R6, R7, R8	10k $\Omega$	Film Resistor;5%;	0603	Yageo	RC0603JR-0710K
3	R9, R10, R11	2k $\Omega$	Film Resistor; 5%; 1/10W	0603	LIZ	CR0603JA0202G
1	R12	1k $\Omega$	Film Resistor;1%	0603	Yageo	RC0603FR-071KL
1	RH	15k $\Omega$	Film Resistor;1%;	0603	Yageo	RC0603FR-0715KL
1	RILIM	13.3k $\Omega$	Film Resistor;1%	0603	Yageo	RC0603FR-0713K3L
1	RISET	47.5k $\Omega$	Film Resistor;1%	0603	Yageo	RC0603FR-0747K5L
1	ROLM	37.4k $\Omega$	Film Resistor;1%	0603	Yageo	RC0603FR-0737K4L
1	RS1	20m $\Omega$	Film Resistor; 1%; 1W;	2512	CYNTEC	RL3264-6-R020-FN
5	JP1, JP2, JP3, JP4, JP5					
5	JP1, JP2, JP3, JP4, JP5		JUMPER			
1	U1	MP2636 GR		QFN4x4-30	MPS	MP2636GR

PRINTED CIRCUIT BOARD LAYOUT

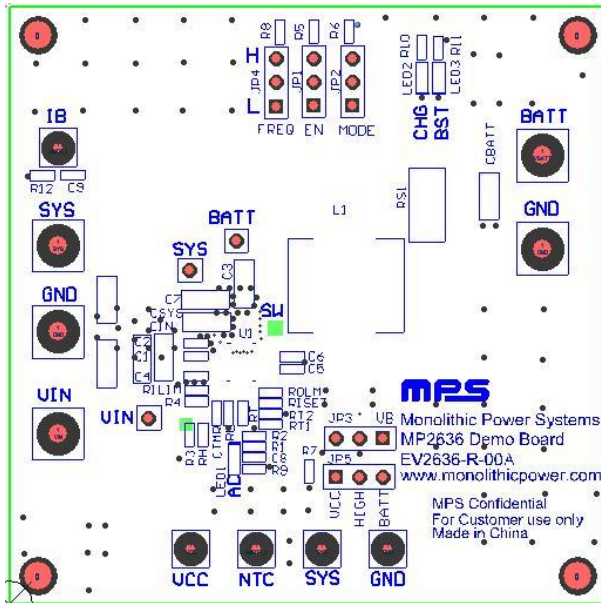


Figure 1: Top Silkscreen Layer

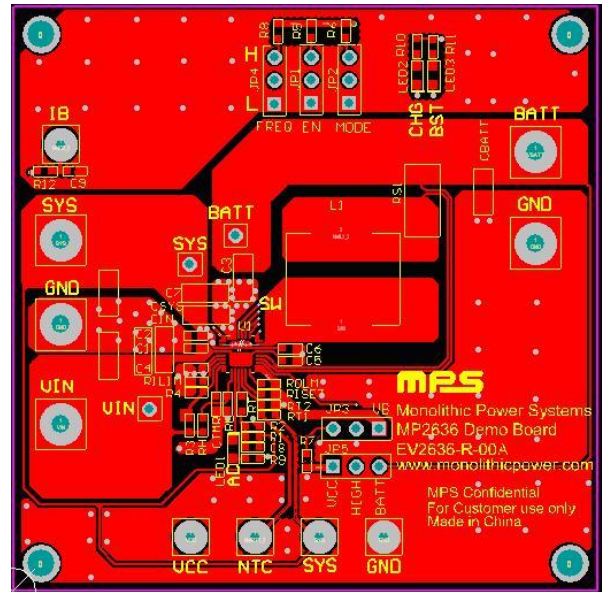


Figure 2: Top Layer

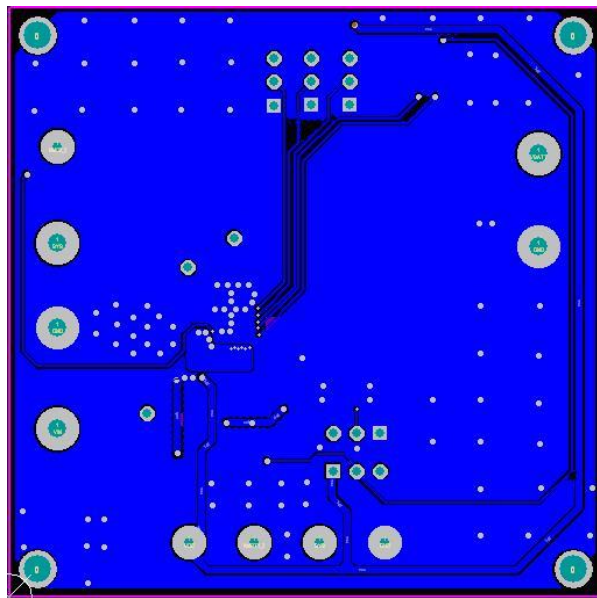


Figure 3: Bottom Layer

## QUICK START GUIDE

This board is designed for the MP2636, a stand-alone switch-mode battery charge management and system power path management device with integrated reverse directional boost from BATT to SYS. The board' layout accommodates most commonly-used capacitors. The default function of this board is preset at charge mode, and the charge full voltage is preset to 4.2V for a 1-cell Li-Ion battery.

### Charge Mode Setting

#### 1. Input-Over-Voltage-Limit

The MP2636 has a PWIN pin to monitor the input voltage. Once the voltage input voltage at PWIN pin is below 0.8V, the input to system path is cut off to protect the device from Vin UVLO. The minimum input is 4.5V, and the external resistor divider must meet the following equation:

$$\frac{V_{PWIN}}{V_{IN}} = \frac{0.8V}{4.5V} = \frac{R4}{R3 + R4} \quad (1)$$

Assume that R4=5.1kΩ, then R3 is 23.5kΩ.

#### 2. REG Voltage

When the input power source is not sufficient to support both the charge current and system load current, the charge current is reduced to allow priority of system power and maintain the input voltage avoid dropping further. The REG pin is the input-voltage regulation feedback. The input voltage can be regulated by a resistor divider from VIN pin to REG pin to AGND

$$V_{REG} = 1.2V \times \frac{R_H + R_L}{R_L} (V) \quad (2)$$

If  $V_{REG}=4.75V$ , given  $R_L=5.1k\Omega$ , then  $R_H=15k\Omega$ .

#### 3. Input Current Limit

An input current limit can be set slightly below the input source's maximum current rating. When the input current hits this limit, the charge current will decrease to keep the input current constant at the limit value to initially power the system.  $R_{ILIM}$ —the resistor connected to the ILIM pin—programs this limit. To set the input current limit at 2.7A, use an  $R_{ILIM}$  of 15kΩ.

$$I_{ILIM}(A) = \frac{43.3(k\Omega)}{R_{ILIM}(k\Omega)} - 0.05 \quad (3)$$

#### 4. Charge-Full Voltage

To set the charge-full voltage, either leave the VB pin floating, or connect it to high logic for 4.2V and to connect to GND for 4.35V.

#### 5. Charge Current

The charge current can be programmed via both RS1 and  $R_{ISET}$ . With given RS1=20mΩ, determine the charge current using the following formula:

$$I_{CHG}(A) = \frac{2400}{R_{ISET}(k\Omega) \times RS1(mA)} \quad (4)$$

For example, for a charge current of 2.5A, use a 47.5kΩ  $R_{ISET}$ .

## 6. Charge Timer

The MP2636 has a charge timer as an extra precaution against charging damaged batteries. The total charge time can be set as:

$$\tau_{\text{TOTAL\_TMR}} = \frac{3.4 \times 10^6 \times 1.6(\text{V}) \times C_{\text{TMR}}(\mu\text{F})}{1.25 \times I_{\text{CHG}}(\text{A}) \times \text{RS1}(\text{m}\Omega) + 2\mu\text{A}} \text{ (s)} \quad (5)$$

So if the charge current is 2.5A, a  $C_{\text{TMR}}$  of 0.1 $\mu\text{F}$  provides a  $t_{\text{TOTAL\_TMR}}$  of 2.4 hours.

## Boost Mode

### 1. System Output Voltage

The MODE pin can enable or disable the EV2636 when in boost mode. The resistor divider—R1 and R2—can adjust the output voltage as per the following equation:

$$V_{\text{SYS\_REG}}(\text{V}) = 1.2\text{V} \times \frac{\text{R1} + \text{R2}}{\text{R2}} \quad (6)$$

Select R1 and R2 as 31.6k $\Omega$  and 10k $\Omega$ , respectively, for a system voltage of 5V.

### 2. System-Output-Current Limit

Set the system-output-current limit in boost mode for the EV2636 to operate like a standard adapter. Set the output current limit as per the following equation:

$$I_{\text{OLIM}}(\text{A}) = \frac{2400 \times 0.92}{\text{R}_{\text{OLIM}}(\text{k}\Omega) \times \text{RS1}(\text{m}\Omega)} \quad (7)$$

**For the other detailed description on the operation of the MP2636, please refer to the datasheet.**



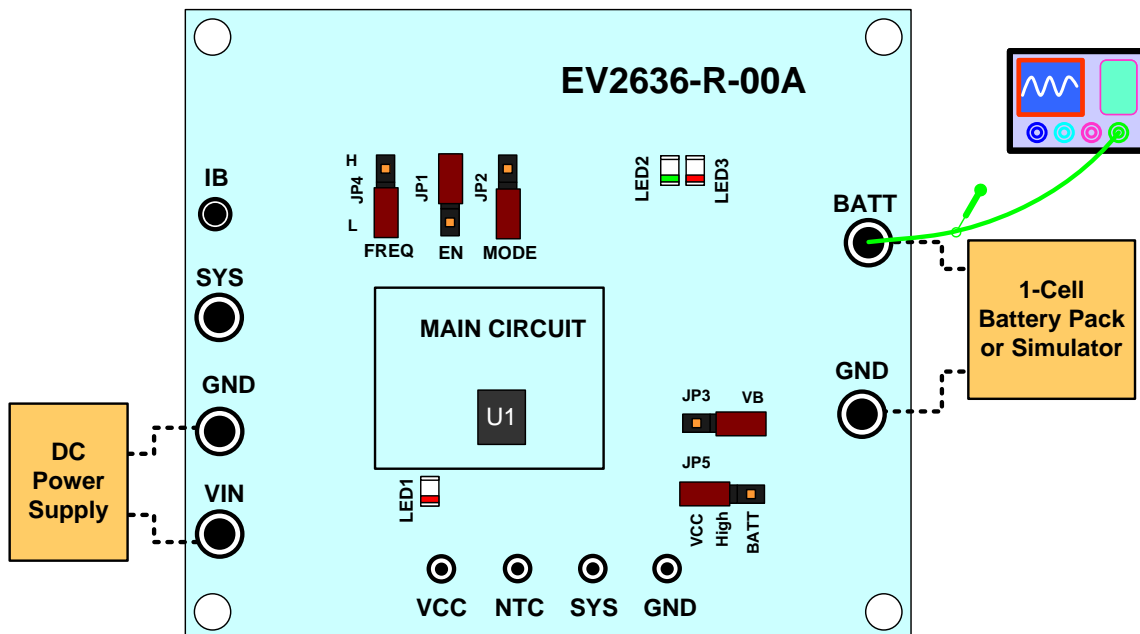
## EQUIPMENT REQUIREMENT

Evaluation requires the following equipments:

1. DC power source. The output voltage should exceed 6.0V, and output current greater than 2.5A.
2. Battery simulator or a single-cell battery pack. The battery simulator's output rating should exceed 4.5V/3.0A. When using a real battery pack, please observe all precautions on the battery manufacturer's data sheet first and ensure the charger's setting doesn't exceed the battery's absolute maximum specifications.
3. An oscilloscope. A single voltage probe and a single current probe.
4. Multi-meter.

### Charge Function

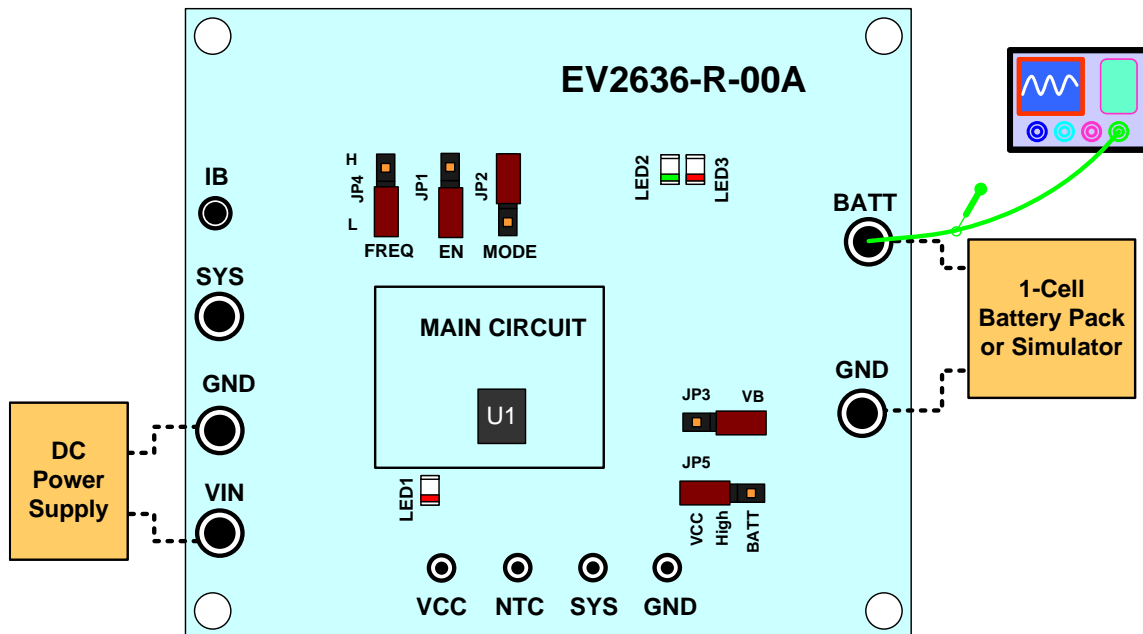
- 1 Connect the jumper "EN" to "H" and the "MODE" to "L" to shunts, respectively!
- 2 Attach the positive and negative ends of the battery to the "BATT" and "GND" terminals, respectively. If it's a battery simulator, please preset the voltage to 3.8V (typical value) first.
- 3 Preset the DC power source to 5.0V. Then attach the DC output port and ground to the "VIN" and "GND" terminals, respectively.
- 4 Turn on the DC power source. The charger will start. Use the oscilloscope to verify that the 2.5A charge current is being delivered to the battery.
- 5 Remove the shunt between the "EN" and "H" to disable charging.
- 6 Re-insert the shunt between the "EN" and "H" to enable charging.



**Figure 4: Setup for Charge Mode**

**Boost Function**

- 1 Connect the jumper “MODE” to “H” and the “EN” to “L” with shunts respectively!
- 2 Attach the load to the “SYS” and “GND” terminals respectively.
- 3 Attach the positive and negative ends of the battery to the “BATT” and “GND” terminals respectively. If it’s a battery simulator, please preset the voltage to 3.8V (typical value) firstly. The boost will start to work. Verify the system output current is limited at 2.5A.
- 4 Remove the shunt between the “MODE” and “H” to disable boost.
- 5 Install the shunt between the “MODE” and “H” to enable boost.


**Figure 5: Setup for Boost Mode**

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