

### DESCRIPTION

The EV2635A-R-00A, the evaluation Board is designed to demonstrate the capabilities of MPS' MP2635A, a high-integrated, flexible switching charger for a single-cell battery used in portable application.

EV2635A covers two operation modes, charge mode and boost mode, manages the power according to the different input conditions.

When input is present, the board charges a single cell battery with programmable charge currents up to 2A.

When input is absent, the board switches to the boost mode via MODE pin to power the SYS from the battery up to 1A.

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

For guaranteed safe operation, the EV2635A has input over voltage protection, battery over voltage protection, thermal shutdown, battery temperature monitoring, and programmable timer to prevent prolonged charging of a dead battery.

### ELECTRICAL SPECIFICATION

| Parameter                | Symbol           | Value      | Units |
|--------------------------|------------------|------------|-------|
| Input Voltage Range      | $V_{IN}$         | 4.24 – 6   | V     |
| Charge Full Voltage      | $V_{BATT\_FULL}$ | 4.2/ 3.6   | V     |
| Charge Current           | $I_{CHG}$        | 2          | A     |
| Input Current Limit      | $I_{IN\_LIM}$    | 2.7        | A     |
| Battery Voltage          | $V_{BATT}$       | 2.5 – 4.35 | V     |
| SYS Voltage Regulation   | $V_{SYS}$        | 5          | V     |
| SYS Output Current Limit | $I_{SYS}$        | 1          | A     |

### FEATURES

- 4.5V to 16V Input Voltage Range
- Input Current Based Power Management
- Up to 2A Programmable Charge Current
- Selectable 3.6V/ 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 90% Efficiency for Boost Mode
- Up to 1A Programmable Output Current Limit for Boost Mode

### APPLICATIONS

- Sub-battery Application
- Power-bank Application
- Mobile Internet Device
- Portable Media Player

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.

"MPS" and "The Future of Analog IC Technology", are Registered Trademarks of Monolithic Power Systems, Inc.

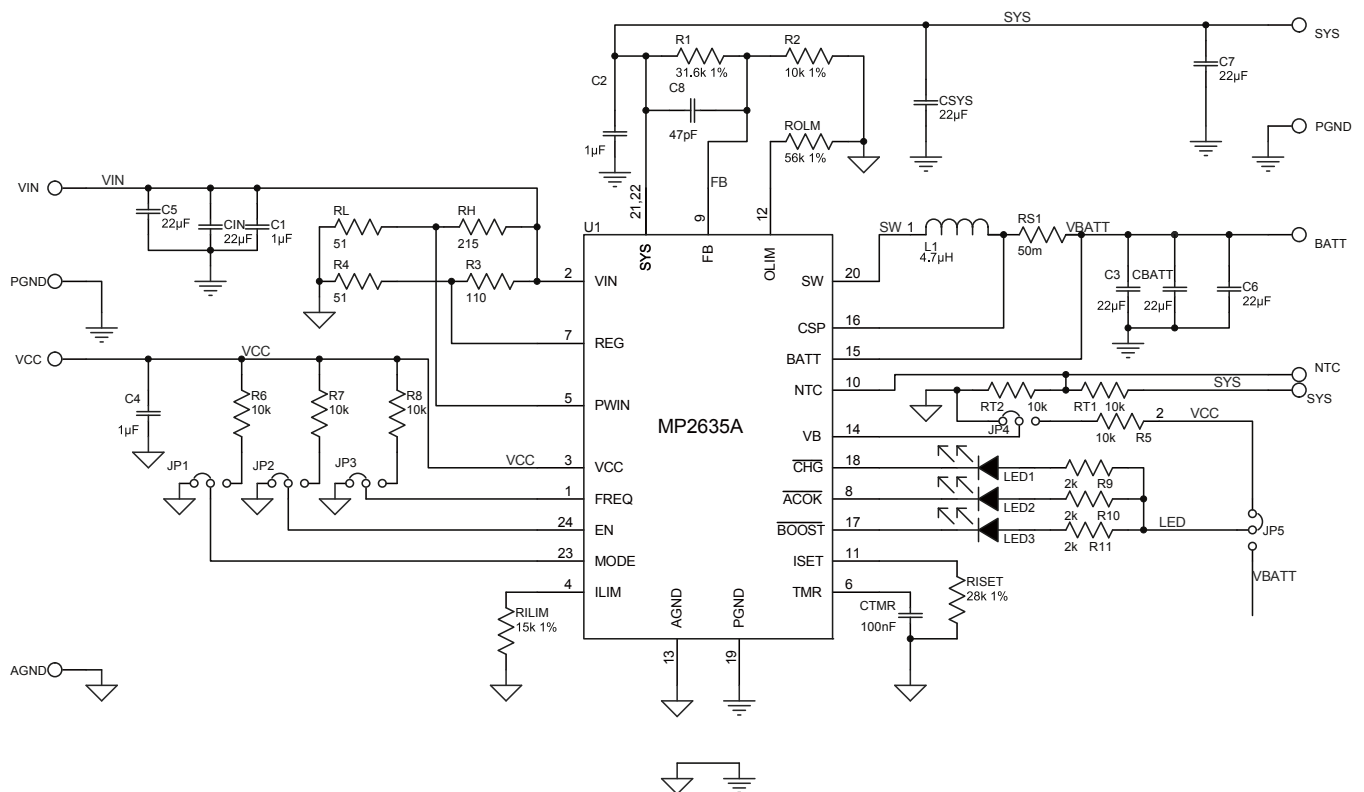
## EV2635A-R-00A EVALUATION BOARD



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

| Board Number  | MPS IC Number |
|---------------|---------------|
| EV2635A-R-00A | MP2635A       |

## EVALUATION BOARD SCHEMATIC



**EV2635A-R-00A BILL OF MATERIALS**

| Qty. | Ref                 | Value             | Description                  | Package      | Manufacture | Manufacture_PN     |
|------|---------------------|-------------------|------------------------------|--------------|-------------|--------------------|
| 1    | C1,                 | 1µF               | Ceramic Capacitor; 25V; X5R  | CAP/0603     | TDK         | C1608X5R1E105K     |
| 1    | C2                  | 1µF               | Ceramic Capacitor; 16V; X7R; | CAP/0603     | muRata,     | GRM188R71C105KA12D |
| 4    | C3, C7, CSYS, CBATT | 22µF              | Ceramic Capacitor; 10V; X7R; | CAP/1206     | muRata      | GRM31CR71A226KE15L |
| 2    | C4, CTMR            | 100nF             | Ceramic Capacitor; 50V; X7R; | CAP/0603     | muRata      | GRM188R71H104KA93D |
| 2    | C5, C6              | NC                |                              |              |             |                    |
| 1    | C8                  | 47pF              | Ceramic Capacitor; 50V; C0G; | CAP/0603     | TDK         | C1608C0G1H470J     |
| 1    | CIN                 | 22µF              | Ceramic Capacitor; 25V; X5R; | CAP/1206     | muRata      | GRM31CR61E226KE15  |
| 1    | L1                  | 4.7µH             | Inductor; 4.7uH;             | SMD          | Würth       | 744311470          |
|      |                     |                   |                              |              | Cooper      | DR73-4R7-R         |
| 2    | LED1, LED3          | BL-HUF35A-TRB     | LED;Red                      | LED/SMD/0805 | BRIGHT LED  | BL-HUF35A-TRB      |
| 1    | LED2                | HL-PSC-2012H203BC | LED;Blue                     | LED/SMD/0805 | BRIGHT LED  | HL-PSC-2012H203BC  |
| 1    | R1                  | 31.6k 1%          | Film Resistor; 1%;           | RES/0603     | Yageo       | RC0603FR-0731K6L   |
| 4    | R2, R5, RT1, RT2    | 10k 1%            | Film Resistor; 1%;           | RES/0603     | Yageo       | RC0603FR-0710KL    |
| 1    | R3                  | 110               | Film Resistor; 1%            | RES/0603     | Yageo       | RC0603FR-07110RL   |
| 2    | R4, RL              | 51                | Film Resistor; 1%            | RES/0603     | Yageo       | RC0603FR-0751RL    |
| 3    | R6, R7, R8          | 10k               | Film Resistor; 5%;           | RES/0603     | Yageo       | RC0603JR-0710K     |
| 3    | R9, R10, R11        | 2k                | Film Resistor; 5%; 1/10W     | RES/0603     | LIZ         | CR0603JA0202G      |
| 1    | RH                  | 215               | Film Resistor; 1%            | RES/0603     | Yageo       | RC0603FR-07215RL   |
| 1    | RILIM               | 15k 1%            | Film Resistor; 1%;           | RES/0603     | Yageo       | RC0603FR-0715KL    |
| 1    | RISSET              | 28k 1%            | Film Resistor; 1%;           | RES/0603     | Yageo       | RC0603FR-0728KL    |

**EV2635A-R-00A BILL OF MATERIALS (continued)**

| Qty. | Ref                                 | Value  | Description                  | Package        | Manufacture | Manufacture_PN    |
|------|-------------------------------------|--------|------------------------------|----------------|-------------|-------------------|
| 1    | ROLM                                | 56k 1% | Film Resistor; 1%            | RES/0603       | Yageo       | RC0603FR-0756KL   |
| 1    | RS1                                 | 50m    | Sense Resistor;<br>1%; 1/2W; | RES/1206       | Yageo       | RL1206FR-070R050L |
| 5    | JP1,<br>JP2,<br>JP3,<br>JP4,<br>JP5 |        | JUMPER/3P/DIP/2<br>.54MM     |                |             |                   |
| 1    | U1                                  |        |                              | QFN24/4X4MM/EP | MPS         | MP2635AGR         |

## PRINTED CIRCUIT BOARD LAYOUT

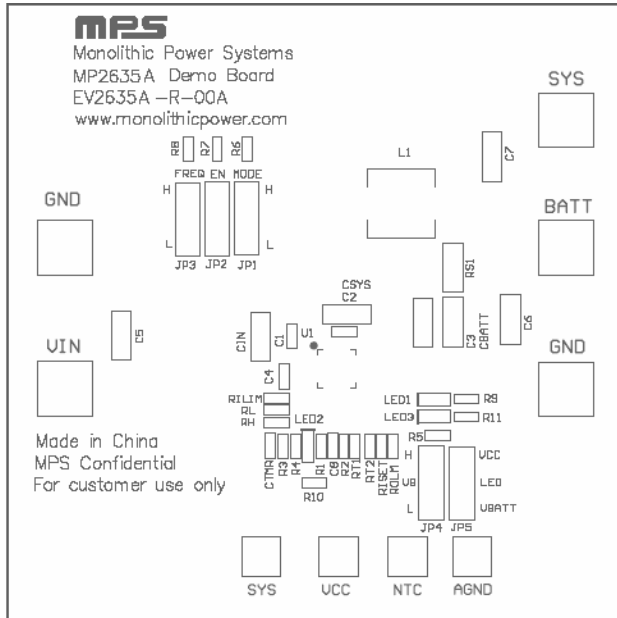


Figure 1: Top Silkscreen Layer

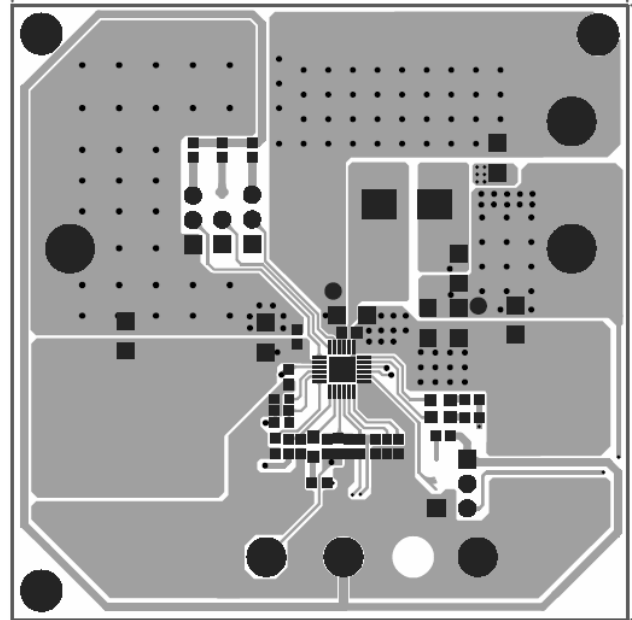


Figure 2: Top Layer

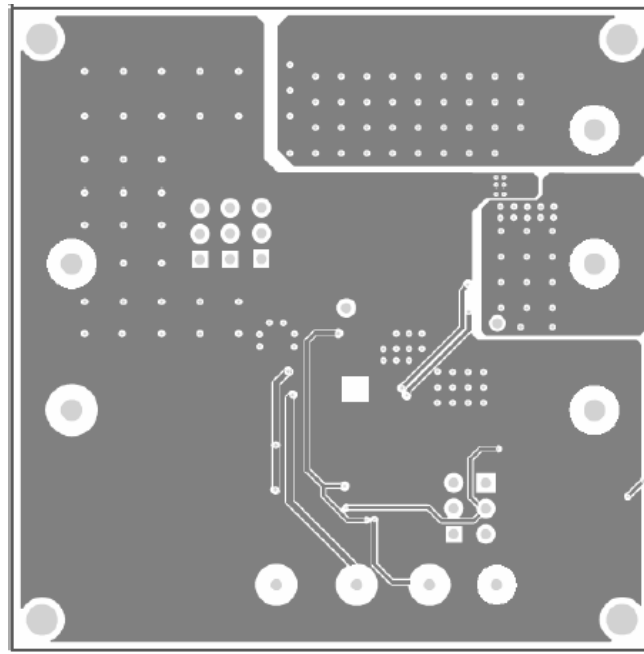


Figure 3: Bottom Layer

## QUICK START GUIDE

This board is designed for MP2635A used as a standalone switching charger with integrated reverse directional boost from BATT to SYS, and layout accommodates most commonly used capacitors. The default function of this board is preset for charger mode and the charge full voltage is preset to 4.2V for 1 cell Li-Ion battery.

### Charge Mode Setting

#### 1. Input Over Voltage Limit Setting

The MP2635A has a PWIN pin to monitor the input voltage. Once the voltage input voltage at PWIN pin exceeds 1.15V, the input to system path is cut off to protect the device connected at the system from being damaged. To the maximum input be designed as 6V, the following equation must be followed.

$$\frac{V_{PWIN}}{V_{IN}} = \frac{1.15}{6} = \frac{R_L}{R_H + R_L} \quad (1)$$

Assume  $R_L=51\Omega$ ,  $R_H$  is  $215\Omega$ . <sup>(1)</sup>

#### 2. REG Voltage Setting

REG pin is the feedback input of the input voltage. Connect this pin to external resistor divider from VIN to GND. The voltage on this pin should be always higher than 1.2V when normal operation.

$$V_{REG} = \frac{R_4}{R_3 + R_4} \times V_{IN\_MIN} > 1.2V \quad (2)$$

If  $V_{IN\_MIN}=4.25V$ , given  $R_4=51\Omega$ ,  $R_3=127\Omega$ . <sup>(1)</sup>

#### 3. Input Current Limit Setting

An input current limit can also be set to be a little bit lower than the max current rating of the input source. When input current hits this limit, the charge current will be decreased to keep the input current constant at the limit value, in order to power the system firstly. This limit can be programmed via RILIM, the resistor connected to LIM pin. To set the input current limit at 2.7A, the 15kΩ RILIM can be used.

$$I_{ILIM}(A) = \frac{40.5(kV)}{R_{ILIM}(k\Omega)} \quad (3)$$

#### 4. Charge Full Voltage Setting

There are two options of the charge full voltage. That is to leave VB pin floating or connect to high logic for 4.2V and to connect to GND for 3.6V.

#### 5. Charge Current Setting

The charge current can be programmed via both RS1 and RISET. With given  $RS1=50m\Omega$ , the charge current can be set by the following formula:

$$I_{CHG}(A) = \frac{70(k\Omega)}{R_{ISET}(k\Omega)} \times \frac{40(mV)}{RS1(m\Omega)} \quad (4)$$

E.g. if the charge current is expected to be 2A, a 28kΩ RISET can be selected.

## 6. Charge Timer Setting

The MP2635A also integrates a charge timer to provide a back-up protection to prevent a damaged battery from being charged after a certain time. The total charge time can be set via the following formula.

$$t_{\text{TOTAL\_TMR}} = 6\text{Hours} \times \frac{C_{\text{TMR}} (\mu\text{F})}{0.1\mu\text{F}} \times \frac{1(\text{A})}{I_{\text{CHG}} (\text{A})} \quad (5)$$

So if the charge current is set to 2A, a 0.1μF generates 3hours timer.

## Boost Mode Setting

### 1. System Output Voltage Setting

When the EV2635A works in the boost mode, it can be enabled or disabled via MODE pin. And the output voltage can also be adjustable via resistive divider composing of R1 and R2, the setting formula is shown as follows,

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

Select R1 and R2 as 31.6kΩ and 10kΩ can make the system voltage 5V.

### 2. System Output Current Limit Setting

The system output current limit in boost mode to make the EV2635A like a standard adapter. The output current limit can be set via the following equation.

$$I_{\text{OLIM}} (\text{A}) = \frac{70(\text{k}\Omega)}{R_{\text{OLIM}} (\text{k}\Omega)} \times \frac{40(\text{mV})}{RS1(\text{m}\Omega)} \quad (7)$$

## Others

### 1. Operating Frequency Setting

For both charger and boost mode, the operation frequency can be programmable to optimize the design. The frequency is set to 1.2MHz by connecting the FREQ pin to “H” or leaving the FREQ pin floating, while set to 600kHz by connecting the FREQ pin to “L”.

**For the other detailed description on the operation of the MP2635A, please refer to the datasheet.**

**Note: 1. Considering these resistors (R3, R4, RH, RL) as the dummy load at input port, recommend resistors with hundreds of ohms to increase the power off speed.**

## EQUIPMENT REQUIREMENT

Before the evaluation, the following equipments should be prepared:

1. A DC power source. The output voltage range should be greater than 6V, and output current greater than 2A.
2. A battery simulator or a single-cell battery pack. The output rating of battery simulator should be greater than 4.5V/2.5A. While use the real battery pack, please observe all precautions on the battery manufacturer’s data sheet first and then make sure the charger’s setting doesn’t exceed the absolute maximum specification of the battery.
3. An oscilloscope. A single voltage probe and a single current probe are required at least.
4. A multi-meter.

### Charge Function

- (1) Connect the jumper “EN” to “H” and the “MODE” to “L” with 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) firstly.
- (3) Preset the DC power source to 5V. 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 to work. Verify the 2A charge current is being delivered to the battery with the oscilloscope.
- (5) Remove the shunt between the “EN” and “L” to disable charging.
- (6) Re-insert the shunt between the “EN” and “H” to enable charging.

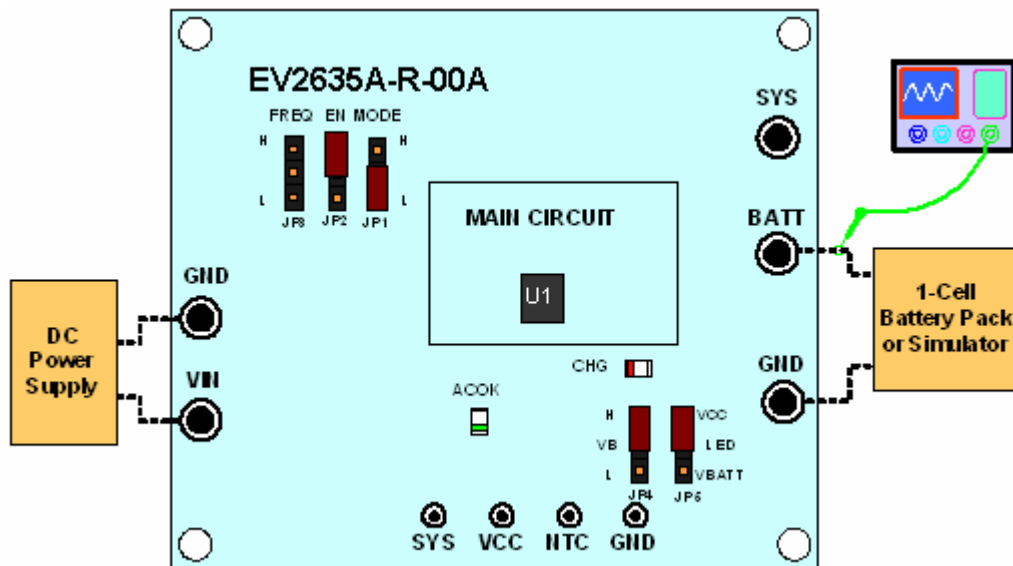


Figure 4: Setup for Charge Mode

### 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 1A.

- (4) Remove the shunt between the “MODE” and “L” to disable boost.
- (8) Install the shunt between the “MODE” and “H” to enable boost.

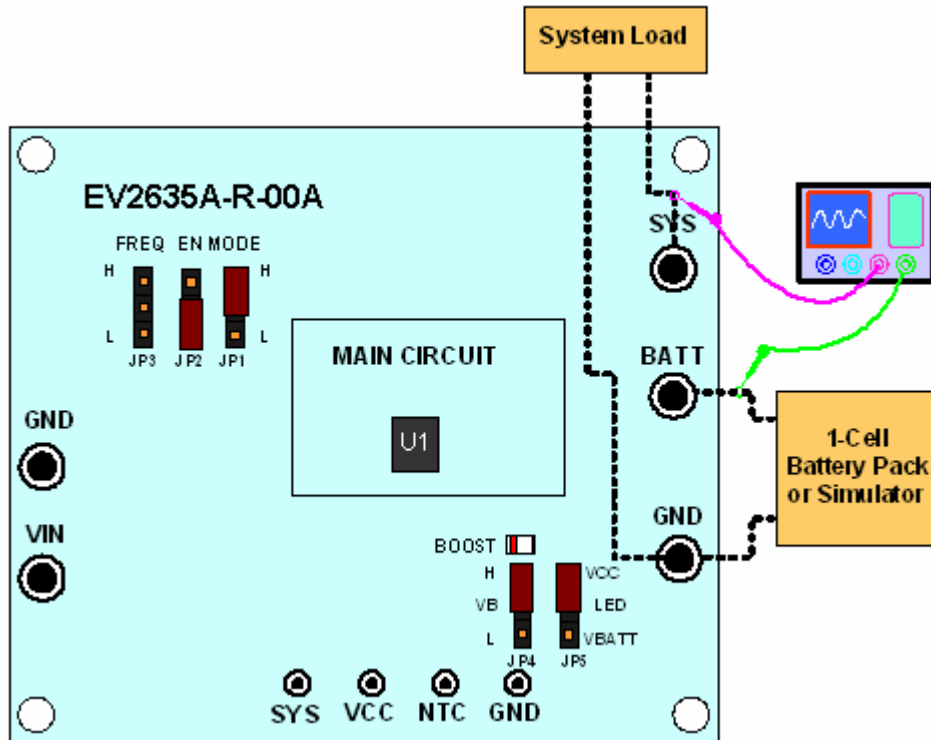


Figure 5: Setup for Boost Mode

**NOTICE:** The information in this document is subject to change without notice. Users should warrant and guarantee that third party Intellectual Property rights are not infringed upon when integrating MPS products into any application. MPS will not assume any legal responsibility for any said applications.