# 2.5MHz, Synchronous Boost Regulator with Bypass Mode

## General Description

The RT4803 allows systems to take advantage of new battery chemistries that can supply significant energy when the battery voltage is lower than the required voltage for system power ICs. By combining built-in power transistors, synchronous rectification, and low supply current; this IC provides a compact solution for systems using advanced Li-Ion battery chemistries.

The RT4803 is a boost regulator designed to provide a minimum output voltage from a single-cell Li-Ion battery, even when the battery voltage is below system minimum. In boost mode, output voltage regulation is guaranteed to a maximum load current of 2A. Quiescent current in Shutdown Mode is less than 1μA, which maximizes battery life. The regulator transitions smoothly between Bypass and normal Boost Mode. The device can be forced into Bypass Mode to reduce quiescent current.

The RT4803 is available in the WL-CSP-16B 1.67x1.67 (BSC) package.

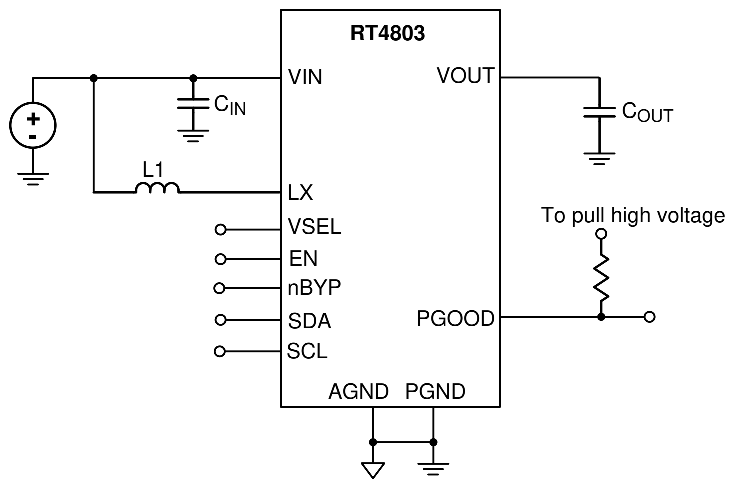
## Features

- **4 Few External Components : 0.47μH Inductor and 0603 Case Size Input and Output Capacitors**
- **Input Voltage Range : 1.8V to 5V**
- **Output Range from 2.85V to 4.4V**
  - **VSEL = L 3.3V**
  - **VSEL = H 3.55V**
- **Maximum Continuous Load Current : 2A at $V_{IN}$ > 2.65V Boosting $V_{OUT}$ to 3.35V**
- **Up to 96% Efficient**
- **True Bypass Operation when $V_{IN}$ > Target $V_{OUT}$**
- **Internal Synchronous Rectifier**
- **Soft-Start with True Load Disconnect**
- **Forced Bypass Mode**
- **$V_{SEL}$ Control to Optimize Target $V_{OUT}$**
- **Short-Circuit Protection**
- **I²C Controlled Interface**
- **Ultra low Operating Quiescent Current**
- **Small WL-CSP 16B Package**
- **Discharge Function**

## Applications

- Single-Cell Li-Ion, LiFePO4 Smart-Phones or Tablet
- 2.5G/3G/4G Mini-Module Data Cards

## Simplified Application Circuit



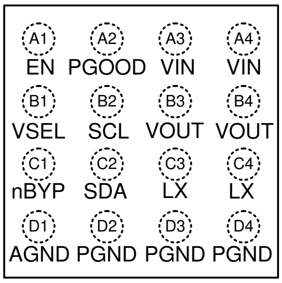
## Ordering Information

RT4803□
Package Type
WSC : WL-CSP-16B 1.67x1.67 (BSC)

Note:
Richtek products are Richtek Green Policy compliant and compatible with the current requirements of IPC/JEDEC J-STD-020

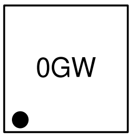
## Pin Configuration

(TOP VIEW)




WL-CSP-16B 1.67x1.67 (BSC)

## Marking Information

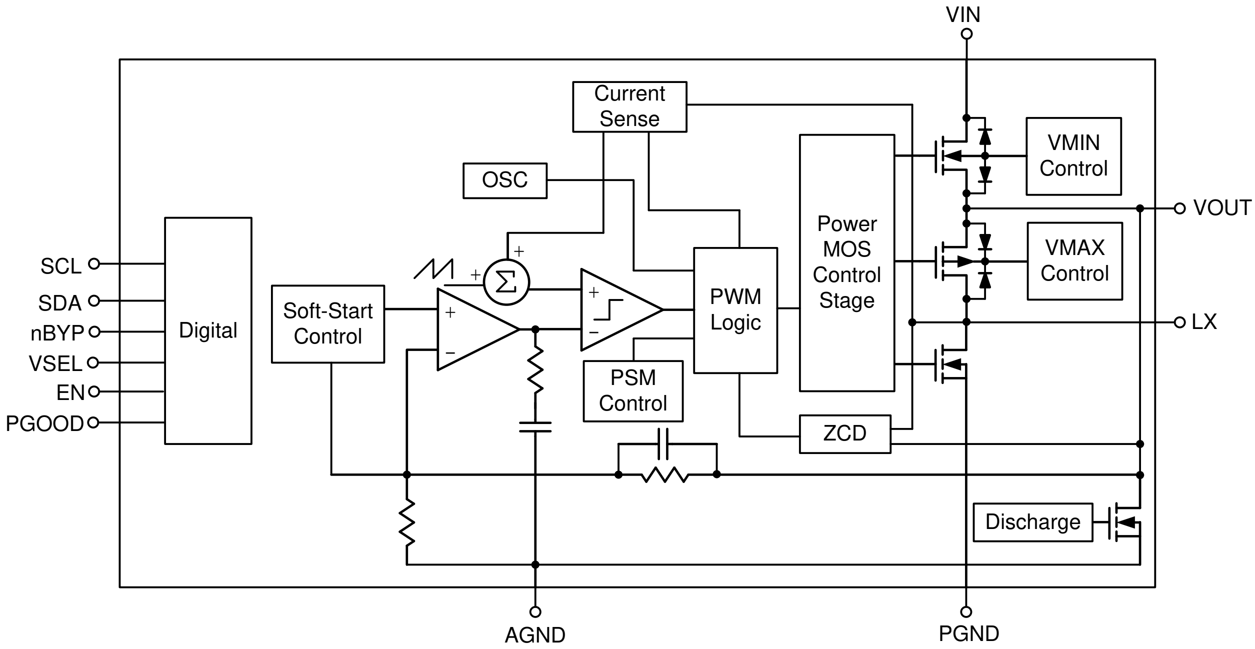



0G : Product Code
W : Date Code

## Functional Pin Description

| Pin No. | Pin Name | Pin Function |
|---|---|---|
| A1 | EN | Enable. When this pin is HIGH, the circuit is enabled. |
| A2 | PGOOD | Power good. It is a open-drain output. PGOOD pin pulls low automatically if the overload or OTP event occurs. |
| A3, A4 | VIN | Input voltage. Connect to Li-Ion battery input power source. |
| B1 | VSEL | Output voltage select. When boost is running, this pin can be used to select output voltage |
| B2 | SCL | Serial interface clock. (Pull down if $I^2C$ is non-used). |
| B3, B4 | VOUT | Output voltage. Place $C_{OUT}$ as close as possible to the device. |
| C1 | nBYP | Bypass. This pin can be used to activate Forced Bypass Mode. When this pin is LOW, the bypass switches are turned on and the IC is otherwise inactive. |
| C2 | SDA | Serial interface date line. (Pull down if $I^2C$ is non-used). |
| C3, C4 | LX | Switching node. Connect to inductor. |
| D1 | AGND | Analog ground. This is the signal ground reference for the IC. All voltage levels are measured with respect to this pin. |
| D2, D3, D4 | PGND | Power ground. This is the power return for the IC. The $C_{OUT}$ bypass capacitor should be returned with the shortest path possible to these pins. |

## Functional Block Diagram



## Operation

The RT4803 combined built-in power transistors, synchronous rectification, and low supply current, it provides a compact solution for system using advanced Li-Ion battery chemistries.

In boost mode, output voltage regulation is guaranteed to a maximum load current of 2A. Quiescent current in Shutdown mode is less than 1μA, which maximizes battery life.

| Mode | | Depiction | Condition |
|---|---|---|---|
| LIN | LIN 1 | Linear startup 1 | $V_{IN} > V_{OUT}$ |
| | LIN 2 | Linear startup 2 | $V_{IN} > V_{OUT}$ |
| Soft-Start | | Boost soft-start | $V_{OUT} < V_{OUT(MIN)}$ |
| Boost | | Boost mode | $V_{OUT} = V_{OUT(MIN)}$ |
| Bypass | | Bypass mode | $V_{IN} > V_{OUT(MIN)}$ |

### LIN State

When $V_{IN}$ is rising, it enters the LIN State. There are two parts for the LIN state. It provides maximum current for 1A to charge the $C_{OUT}$ in LIN1, and the other one is for 2A in LIN2. By the way, the EN is pulled high and $V_{IN}$ > UVLO.

As the figure shown, if the timeout is over the specification, it will enter the Fault mode.

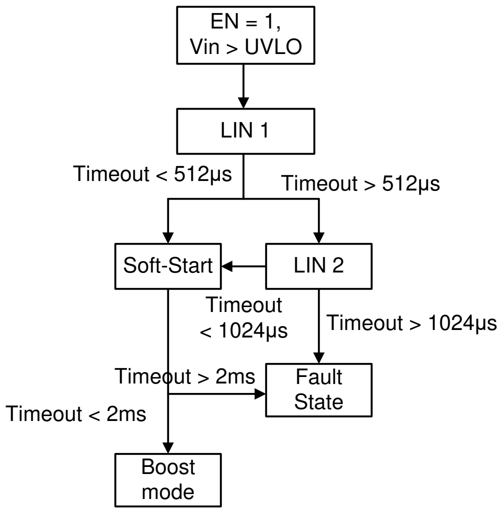



Figure 1. RT4803 State Chart

### Startup and Shutdown State

When $V_{IN}$ is rising and through the LIN state, it will enter the Startup state. If EN is pulled low, any function is turned-off in shutdown mode.

### Soft-Start State

It starts to switch in Soft-start state. After the LIN state, output voltage is rising with the internal reference voltage.

There is a point, it will go to fault condition, if the large output capacitor is used and the timeout is over 2ms after the soft-start state.

### Fault State

As the Figure 1 shown, it will enter to the Fault state as below,

- The timeout of LIN2 is over the 1024μs.
- It is over the 2ms when the state changed from Soft-start state to Boost mode.

It will be the high impedance between the input and output when the fault is triggered. A restart will be start after 1ms.

### Boost Mode

There are two normal operation modes, one is the Boost mode, and the other one is Bypass mode. In the Boost mode, it provides the power to load by internal synchronous switches after the soft-start state.

### Bypass Mode

In Bypass mode, the differential voltage between $V_{IN}$ and $V_{OUT}$ is 250mV. Output voltage will increase when the input voltage is rising after the soft-start state.

### Bypass Mode Operation

In automatic mode, it transits from Boost mode to Bypass mode. As the Figure 2 shown, there are three MOSFET (Q1 to Q3). The Q1 & Q2 is for Boost mode, it is used by Q3 for Bypass mode. $V_{OUT}$ will be followed the $V_{IN}$ when $V_{IN}$ is higher than the target output voltage. As the Figure 3 shown, it is transited by bypass MOSFET (Q3). $V_{OUT}$ followed the $V_{IN}$.

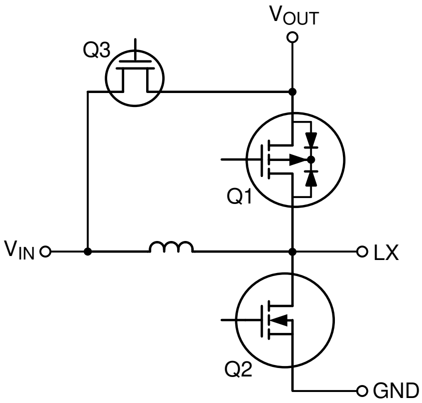



Figure 2. Boost Converter With Bypass Mode

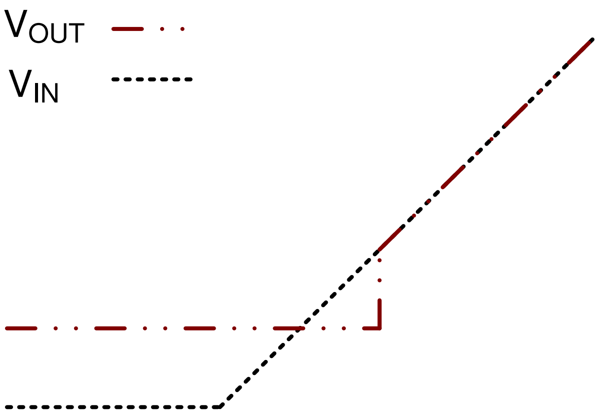



Figure 3. RT4803 mode changed

### Force Pass-Through Mode

When EN pulled high and nBYP pulled low. The device is active in the Force pass-through mode. It supplies current is approximately 15μA typ. From the battery, the device is short circuit protected by a current limit of 4000mA.

### VSEL

It is concerned the minimum output voltage at the heavy load condition. There are two output voltage levels (3.3V & 3.55V) in Boost mode and Bypass mode. It can be selected by VSET, so it must not be floating.

### PGOOD (Power Good)

Power good is a open-drain input. If it is 0, it stands for fault occurred. The power good provide the information to show the state of the system,

- PGOOD pin show high when the sequence of soft-start is completed.
- Any fault cause PGOOD to be pulled low.
- PGOOD low when PMIS current limit has triggered for OR the die the temperature exceeds 120°C. PGOOD is re-asserted when the device cools below to 100°C.

### OCP

The converter senses the current signal when the high-side P-MOSFET turns on. As a result, the OCP is cycle by-cycle current limitation. If the OCP occurs, the converter holds off the next on pulse until inductor current drops below the OCP limit.

### OTP

The converter has an over-temperature protection. When the junction temperature is higher than the thermal shutdown rising threshold, the system will be latched and the output voltage will no longer be regulated until the junction temperature drops under the falling threshold.

### EN & nBYP

It is used to select mode. As the table 1 shown, there are four device states.

If the EN pull low, and nBYP pull high/low, the RT4803 is forced in shut-down mode and the quiescent is less than 1μA. It works in force pass-through mode, if the EN set high and nBYP set low. When EN and nBYP both pull high, the RT4803 is normal operation and enter automatic mode. There should be a delay time (> 60μS) from EN pull high to nBYP pull high to guarantee normal automatic mode operation.

### Discharge

The RT4803 features the discharge function to release the output power when the EN pin goes low condition.

**Table 1**

| EN input | nBYP Input | Device State |
|---|---|---|
| 0 | 0/1 | The device is shut down and the shut down current is down to 1μA. |
| 1 | 0 | The device is active in forced pass-through mode. The device supply current is approximately 15μA typ. From the battery. The device is short circuit protected by a current limit of ca. 4000mA. |
| 1 | 1 | The device is active in auto mode (dc/dc boost, pass-through mode) The device supply current is approximately 65μA typ. from the battery |

## Absolute Maximum Ratings (Note 1)

- VIN, VOUT to AGND ---------- –0.2V to 6V
- EN, VSEL, PGOOD, nBYP to AGND ---------- –0.2V to 6V
- LX ---------- (PGND – 0.2V) to 6V
- Power Dissipation, $P_D$ @ $T_A$ = 25°C
  WL-CSP-16B 1.67x1.67 (BSC) ---------- 2.09W
- Package Thermal Resistance (Note 2)
  WL-CSP-16B 1.67x1.67 (BSC), $\theta_{JA}$ ---------- 47.7°C/W
- Lead Temperature (Soldering, 10 sec.) ---------- 260°C
- Junction Temperature ---------- 150°C
- Storage Temperature Range ---------- –65°C to 150°C
- ESD Susceptibility (Note 3)
  HBM (Human Body Model) ---------- 2kV
  MM (Machine Model) ---------- 200V
  CDM (Charge Device Model) ---------- 1kV

## Recommended Operating Conditions (Note 4)

- Input Voltage Range ---------- 1.8V to 5V
- Output Voltage Range ---------- 2.85V to 4.4V
- Ambient Temperature Range ---------- –40°C to 85°C
- Junction Temperature Range ---------- –40°C to 125°C

## Electrical Characteristics

($V_{IN}$ = 3V, $V_{OUT}$ = 3.55V, $T_A$ = 25°C, unless otherwise specified)

| Parameter | Symbol | Test Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| VIN Operation Range | $V_{IN}$ | | 1.8 | -- | 5 | V |
| VIN Quiescent Current | $I_Q$ | Auto Bypass Mode, $V_{IN}$ = 3.8V | -- | 40 | 70 | μA |
| VIN Quiescent Current | $I_Q$ | Boost mode, $I_{LOAD}$ = 0mA, Switching, $V_{IN}$ = 3V | -- | 65 | 100 | μA |
| VIN Quiescent Current | $I_Q$ | Force Bypass , $V_{IN}$ = 3.6V | -- | 15 | 25 | μA |
| VIN Shutdown Current | $I_{SHDN}$ | EN = 0V, $V_{IN}$ = 3.6V | -- | -- | 1 | μA |
| VOUT to VIN Reverse Leakage | $I_{LK}$ | $V_{OUT}$ = 5V, EN = nBYP = H, $V_{IN}$ < $V_{OUT}$ | -- | 0.2 | 1 | μA |
| VOUT Discharge Impedance | R_DIS_OUT | EN = L | -- | 80 | -- | Ω |
| Under Voltage Lock Out | $V_{UVLO}$ | $V_{IN}$ Rising | -- | 1.6 | 1.8 | V |
| Under Voltage Lock Out Hysteresis | $V_{UVLO\_HYS}$ | | -- | 200 | -- | mV |
| PGOOD Low | $V_{PGOOD}$ | $I_{PGOOD}$ = 5mA | -- | -- | 0.4 | V |
| PGOOD Leakage Current | $I_{PGOOD\_LK}$ | $V_{PGOOD}$ = 5V | -- | -- | 1 | μA |
| Logic Level High EN, VSEL, nBYP, SCL, SDA | $V_{IH}$ | | 1.2 | -- | -- | V |

| Parameter | Symbol | Test Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| Logic Level Low EN, VSEL, nBYP, SCL, SDA | $V_{IL}$ | | -- | -- | 0.4 | V |
| Output Voltage Accuracy | $V_{REG}$ | $V_{OUT} – V_{IN}$ > 100mV, PWM | –2 | -- | 2 | % |
| Minimum On Time | $T_{ON}$ | $V_{IN}$ = 3V, $V_{OUT}$ = 3.5V, $I_{LOAD}$ > 1000mA | -- | 80 | -- | ns |
| Maximum Duty Cycle | $D_{MAX}$ | | 40 | -- | -- | % |
| Switching Frequency | $F_{SW}$ | $V_{IN}$ = 2.65V, $V_{OUT}$ = 3.5V, $I_{LOAD}$ = 1000mA | 2 | 2.5 | 3 | MHz |
| Boost Valley Current Limit | $I_{CL}$ | $V_{IN}$ = 2.9V | 4.4 | 5 | 5.6 | A |
| Soft-Start Input Current Limit | $I_{SS\_PK}$ | LIN1 | -- | 1000 | -- | mA |
| Soft-Start Input Current Limit | $I_{SS\_PK}$ | LIN2 | -- | 2000 | -- | mA |
| Pass Through Mode Current Limit | $I_{BPCL}$ | $V_{IN}$ = 3.2V | 3.5 | 4 | -- | A |
| N-channel Boost Switch $R_{DS(ON)}$ | $R_{DSN}$ | $V_{IN}$ = 3.2V, $V_{OUT}$ = 3.5V | -- | 60 | 95 | mΩ |
| P-channel Boost Switch $R_{DS(ON)}$ | $R_{DSP}$ | $V_{IN}$ = 3.2V, $V_{OUT}$ = 3.5V | -- | 40 | 80 | mΩ |
| N-channel Bypass Switch $R_{DS(ON)}$ | $R_{DSP\_BYP}$ | $V_{IN}$ = 3.2V, $V_{OUT}$ = 3.5V | -- | 40 | 60 | mΩ |
| Hot Die Trigger Threshold | $T_{HD}$ | | -- | 100 | -- | °C |
| Hot Die Release Threshold | $T_{HDR}$ | | -- | 90 | -- | °C |
| Over Temperature Protection | $T_{OTP}$ | | -- | 160 | -- | °C |
| Over Temperature Protection Hysteresis | $T_{OTP\_HYS}$ | | -- | 20 | -- | °C |
| FAULT Restart Time | $T_{RST}$ | | -- | 1 | -- | ms |

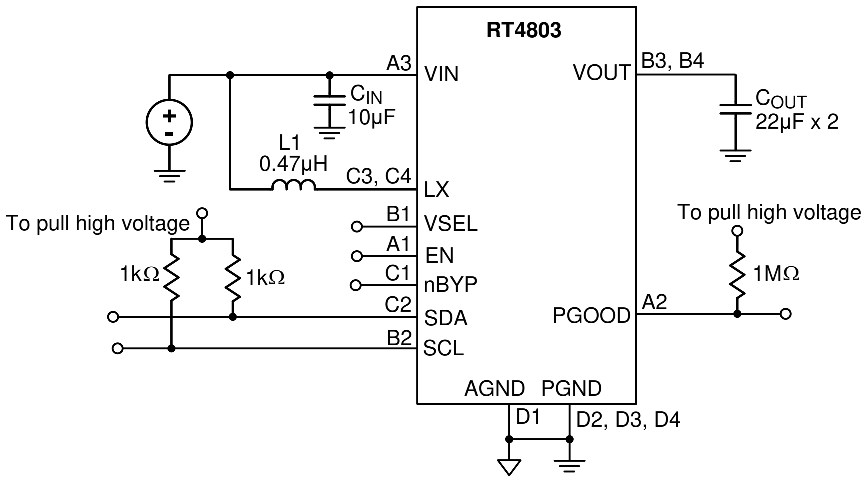
**Note 1.** Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions may affect device reliability.

**Note 2.** $\theta_{JA}$ is measured at $T_A$ = 25°C on a high effective thermal conductivity four-layer test board per JEDEC 51-7.

**Note 3.** Devices are ESD sensitive. Handling precautions are recommended.

**Note 4.** The device is not guaranteed to function outside its operating conditions.

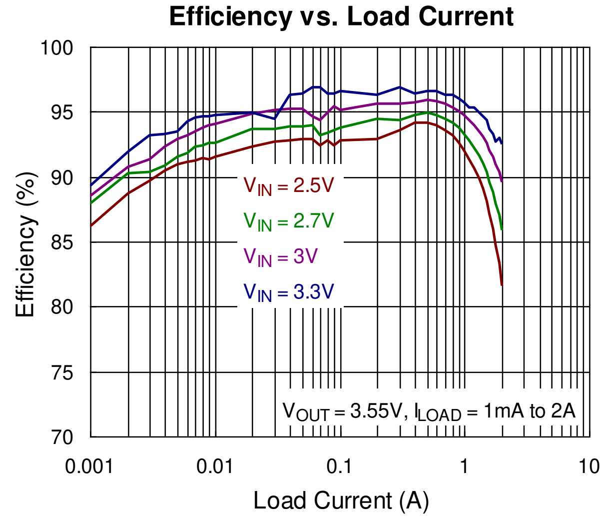
## Typical Application Circuit

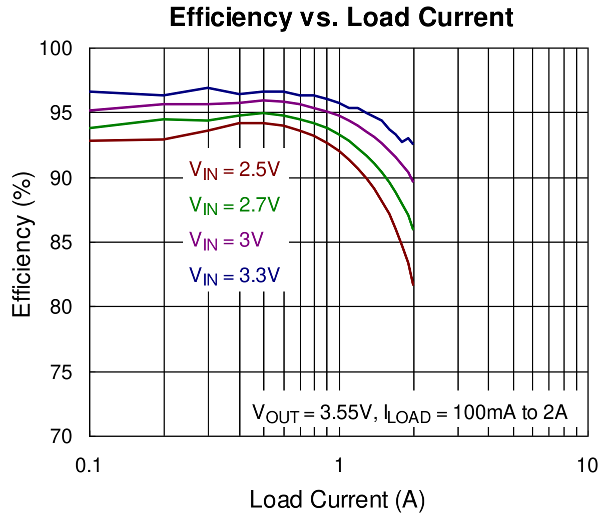


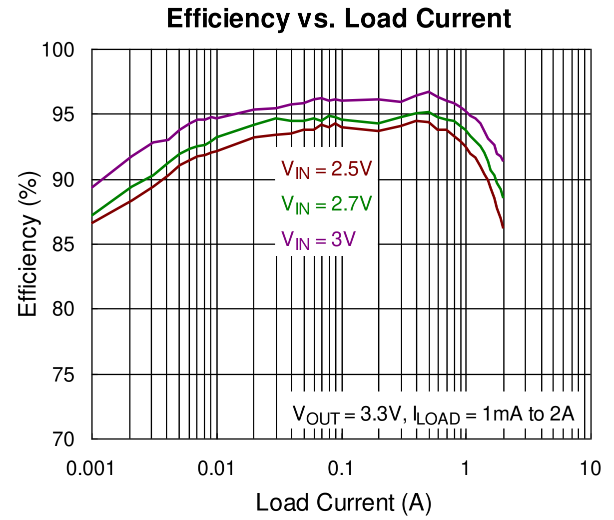

### BOM of Test Board

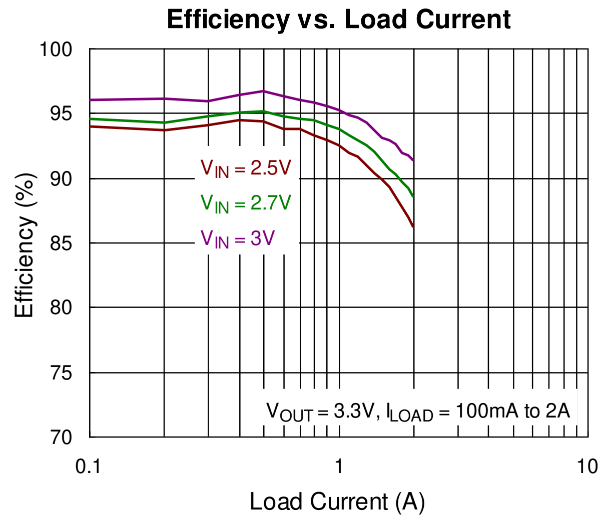
| Reference | Description | Manufacturer | Package | Parameter | Typ. | Unit |
|---|---|---|---|---|---|---|
| $C_{IN}$ | 10μF/16V/X5R | Taiyo : EMK212ABJ106KG | 0805 | C | 10 | μF |
| $C_{OUT}$ | 22μF/10V/X5R | Taiyo : LMK212BBJ226MG | 0805 | C | 22 | μF |
| L1 | 0.47μH, ±20% | TOKO : DFE2520F-R47M | 2520 | L | 0.47 | μH |
| | | | | DCR (Series R) | 29 | mΩ |

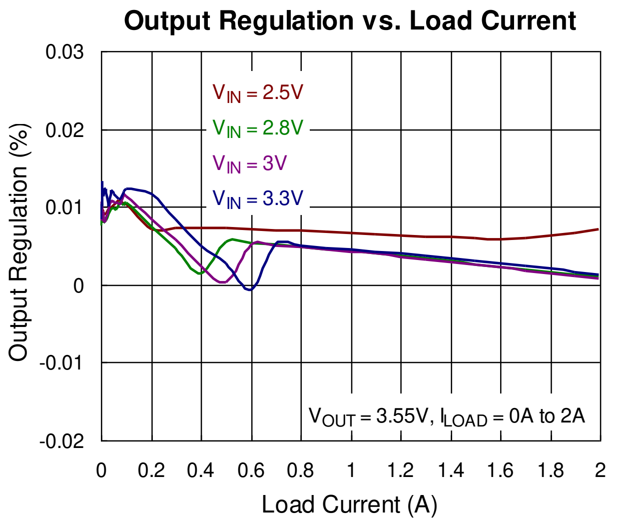
## Typical Operating Characteristics

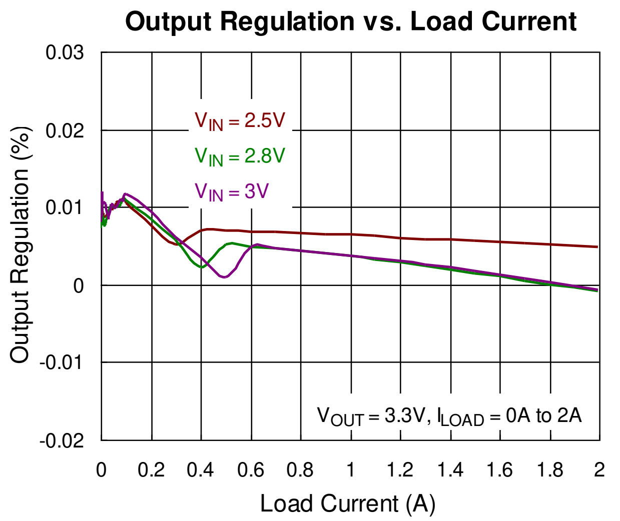


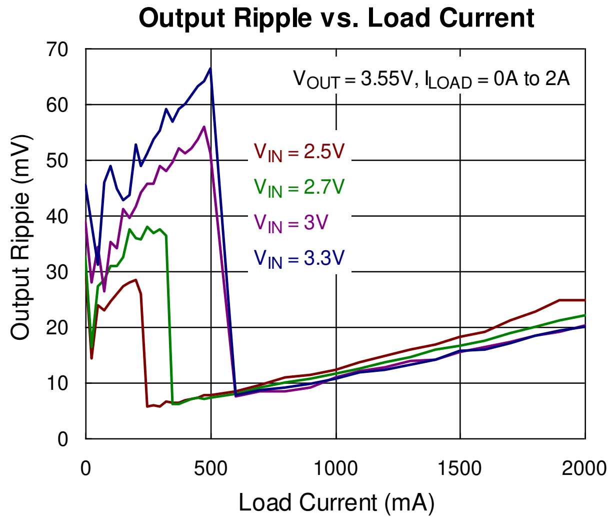



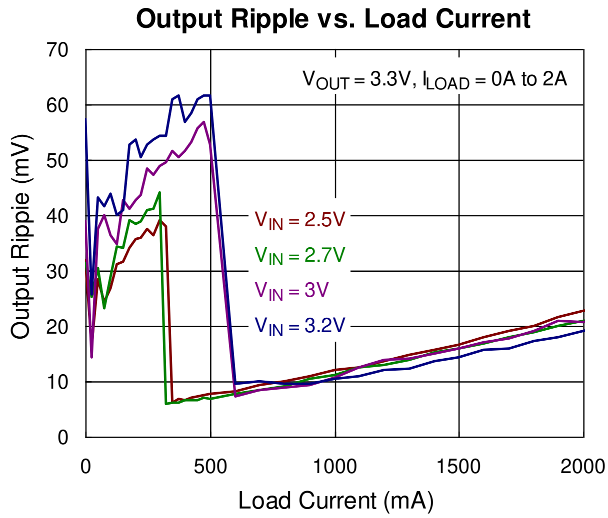




Output Ripple vs. Load Current
$V_{OUT}$ = 3.55V, $I_{LOAD}$ = 0A to 2A
$V_{IN}$ = 2.5V
$V_{IN}$ = 2.7V
$V_{IN}$ = 3V
$V_{IN}$ = 3.3V
Output Ripple (mV)
Load Current (mA)


Output Ripple vs. Load Current
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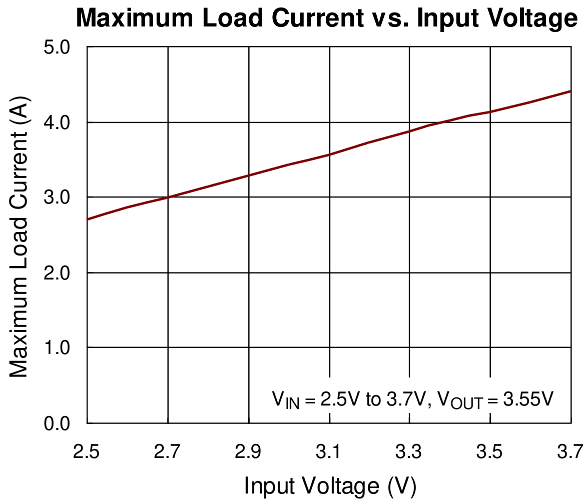
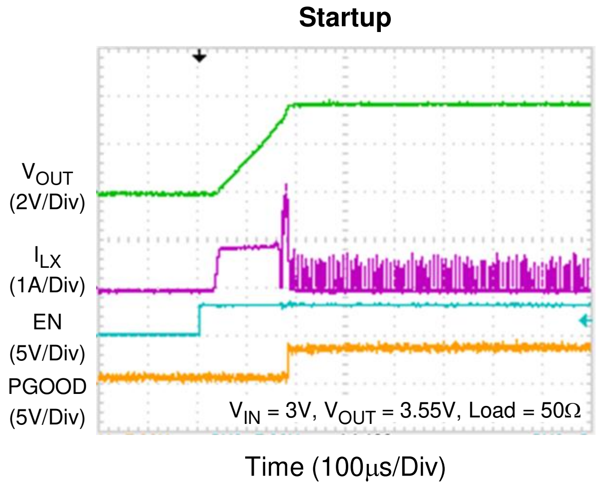
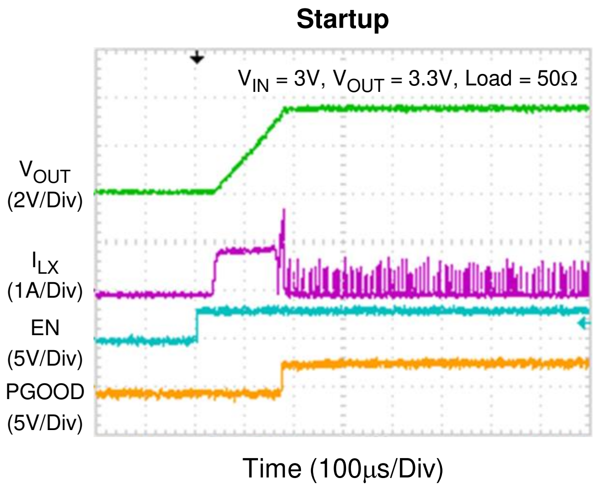
$V_{IN}$ = 2.5V
$V_{IN}$ = 2.7V
$V_{IN}$ = 3V
$V_{IN}$ = 3.2V
Output Ripple (mV)
Load Current (mA)


Maximum Load Current vs. Input Voltage
$V_{IN}$ = 2.5V to 3.7V, $V_{OUT}$ = 3.55V
Maximum Load Current (A)
Input Voltage (V)


Startup
$V_{OUT}$ (2V/Div)
$I_{LX}$ (1A/Div)
EN (5V/Div)
PGOOD (5V/Div)
$V_{IN}$ = 3V, $V_{OUT}$ = 3.55V, Load = 50Ω
Time (100μs/Div)


Startup
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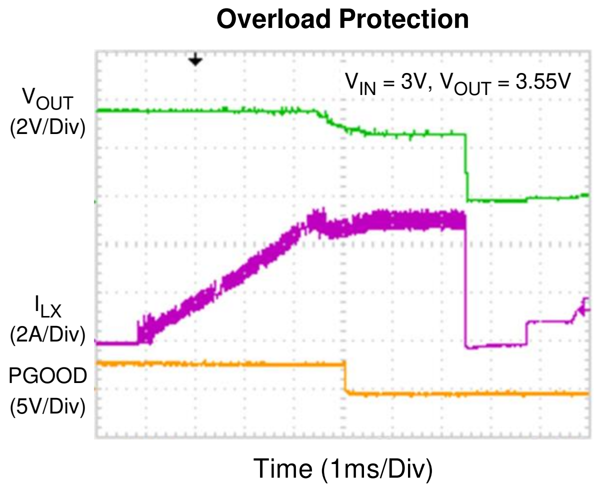
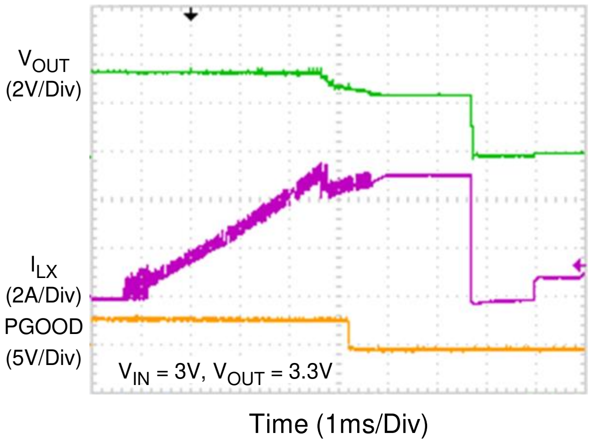
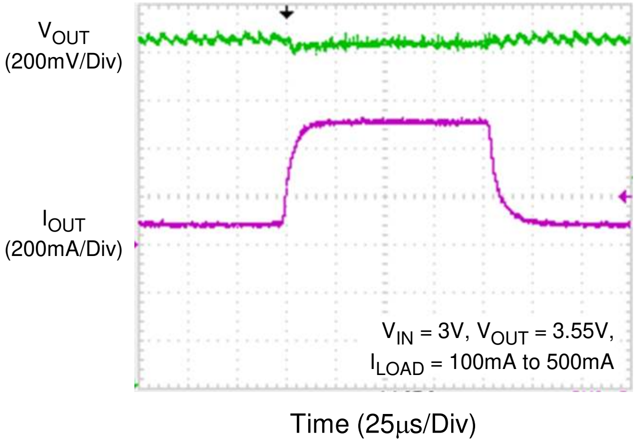
$V_{OUT}$ (2V/Div)
$I_{LX}$ (1A/Div)
EN (5V/Div)
PGOOD (5V/Div)
Time (100μs/Div)


Overload Protection
$V_{IN}$ = 3V, $V_{OUT}$ = 3.55V
$V_{OUT}$ (2V/Div)
$I_{LX}$ (2A/Div)
PGOOD (5V/Div)
Time (1ms/Div)

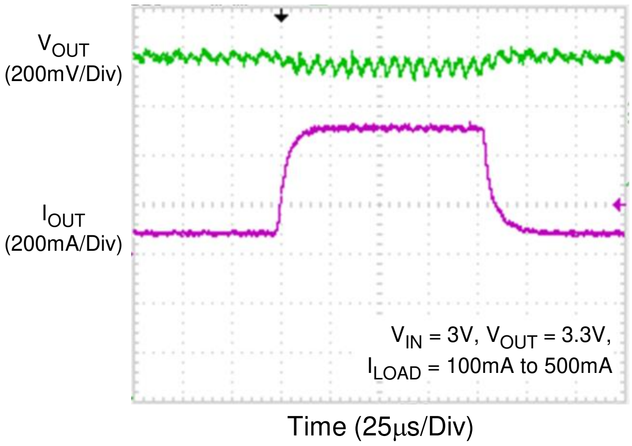
**Overload Protection**



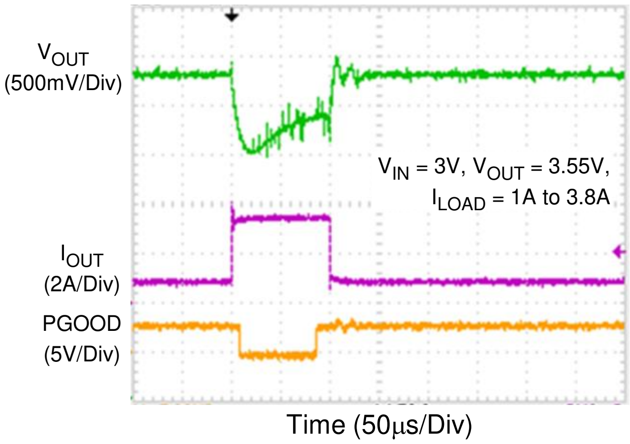

**Load Transient**



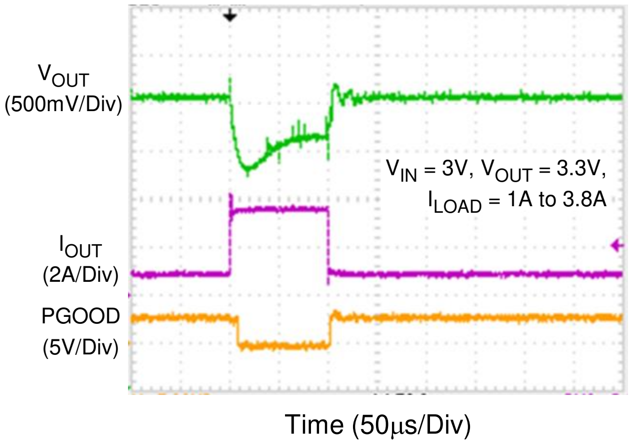

**Load Transient**




**Transient Overload**




**Transient Overload**



## Application Information

***Richtek's component specification does not include the following information in the Application Information section. Thereby no warranty is given regarding its validity and accuracy. Customers should take responsibility to verify their own designs and reserve suitable design margin to ensure the functional suitability of their components and systems.***

### Enable

The device can be enabled or disabled by the EN pin. When the EN pin is higher than the threshold of logic-high, the device starts operating with soft-start. Once the EN pin is set at low, the device will be shut down. In shutdown mode, the converter stops switching, internal control circuitry is turned off, and the load is disconnected from the input. This also means that the output voltage can drop below the input voltage during shutdown.

### Soft-Start State

After the successful completion of the LIN state ($V_{OUT} \geq V_{IN} - 300mV$).

During Soft-Start state, $V_{OUT}$ is ramped up by Boost internal loop. If $V_{OUT}$ fails to reach target value during the Soft-Start period for more than 2ms, a fault condition is declared.

### Output Voltage Setting

User can select the output voltage level by VSEL and I2C. If the VSEL pulled low, the default is 3.3V, and if it pulled high, the default is 3.55V.

The output voltage range is from 2.85V to 4.4V.

### Power Save Mode

PSM is the way to improve efficiency at light load.

When the output voltage is lower than a set threshold voltage, the converter will operate in PSM.

It raises the output voltage with several pulses until the loop exits PSM.

### Under-Voltage Lockout

The under-voltage lockout circuit prevents the device from operating incorrectly at low input voltages. It prevents the converter from turning on the power switches under undefined conditions and prevents the battery from deep discharge. VIN voltage must be greater than 1.7V to enable the converter. During operation, if VIN voltage drops below 1.6V, the converter is disabled until the supply exceeds the UVLO rising threshold. The RT4803 automatically restarts if the input voltage recovers to the input voltage UVLO high level.

### Thermal Shutdown

The device has a built-in temperature sensor which monitors the internal junction temperature. If the temperature exceeds the threshold, the device stops operating. As soon as the IC temperature has decreased below the threshold with a hysteresis, it starts operating again. The built-in hysteresis is designed to avoid unstable operation at IC temperatures near the over temperature threshold.

### Inductor Selection

The recommended nominal inductance value is 0.47μH.

It is recommended to use inductor with dc saturation current ≥ 3500mA

### Input Capacitor Selection

At least a 10μF input capacitor is recommended to improve transient behavior of the regulator and EMI behavior of the total power supply circuit for LX. And at least a 1μF ceramic capacitor placed as close as possible to the VIN and GND pins of the IC is recommended.

### Output Capacitor Selection

At least 22μF x 2 capacitors is recommended to improve $V_{OUT}$ ripple.

Output voltage ripple is inversely proportional to $C_{OUT}$.

Output capacitor is selected according to output ripple which is calculated as :

$$V_{RIPPLE(P-P)} = t_{ON} \times \frac{I_{LOAD}}{C_{OUT}}$$

and

$$t_{ON} = t_{SW} \times D = t_{SW} \times \left(1 - \frac{V_{IN}}{V_{OUT}}\right)$$

therefore :

$$C_{OUT} = t_{SW} \times \left(1 - \frac{V_{IN}}{V_{OUT}}\right) \times \frac{I_{LOAD}}{V_{RIPPLE(P-P)}}$$

and

$$t_{SW} = \frac{1}{f_{SW}}$$

The maximum $V_{RIPPLE}$ occurs when $V_{IN}$ is at minimum and $I_{LOAD}$ is at maximum.

### Output Discharge Function

With the EN pin set to low, the VOUT pin is internally connected to GND by an internal discharge N-MOSFET switch.

This feature prevents residual charge voltages on capacitor connected to VOUT pins, which may impact proper power up of the system.

### Current Limit

The RT4803 employs a valley-current limit detection scheme to sense inductor current during the off-time. When the loading current is increased such that the loading is above the valley current limit threshold, the off-time is increased until the current is decreased to valley-current threshold. Next on-time begins after current is decreased to valley-current threshold. On-time is decided by ($V_{OUT}$ – $V_{IN}$) / $V_{OUT}$ ratio. The output voltage decreases when further loading current increase. As the following figure shown, the current limit function is implemented by the scheme.

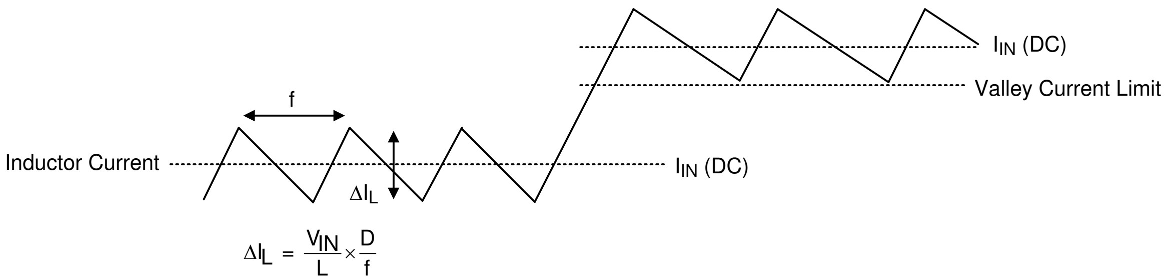


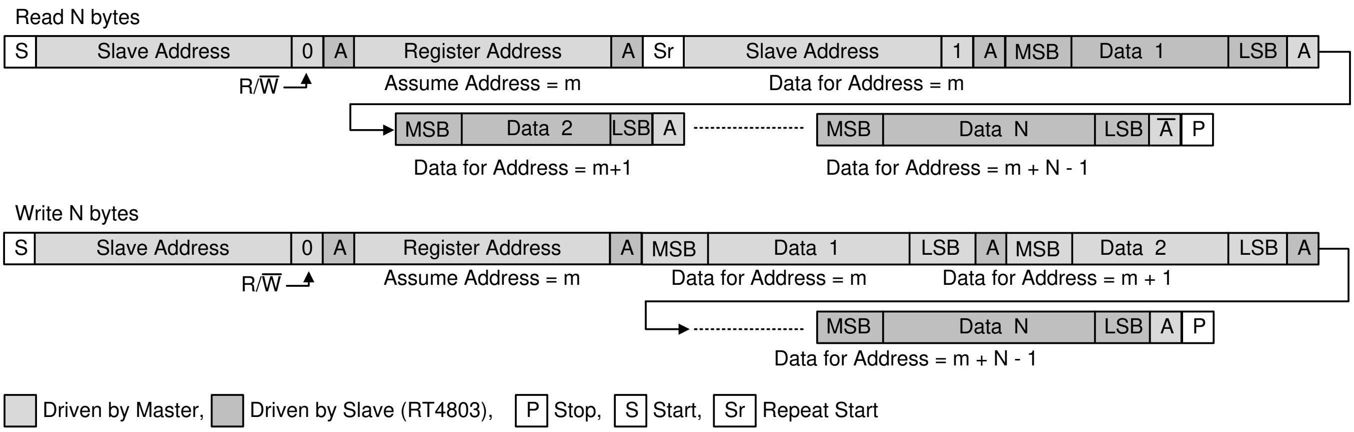

Figure 4. Inductor Currents In Current Limit Operation

**Register Table Lists [Slave address = 1110101 (0x75)]**

| Name | Address | Description |
|---|---|---|
| CONFIG | 0x01 | MODE control & Spread modulation control |
| VOUTFLOOR | 0x02 | Output Voltage Selection |
| VOUTROOF | 0x03 | Output Voltage Selection |
| ILIMSET | 0x04 | Set current limit & Softstart current limit |
| STATUS | 0x05 | Read IC status |

## $I^2C$ Interface

The RT4803 $I^2C$ slave address is 1110101 (7bits). The $I^2C$ interface supports fast mode (bit rate up to 400kb/s). The write or read bit stream (N ≥ 1) is shown below :



| Offset 0x01 | CONFIG | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Bits | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| Name | RESET | ENABLE[1:0] | | RESERVED | PG Config | SSFM | MODE_CTRL[1 : 0] | |
| Reset | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| Type | RW | RW | RW | RW | RW | RW | RW | RW |
| Offset 0x02 | VOUTFLOOR | | | | | | | |
| Bits | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| Name | RESERVED | RESERVED | RESERVED | VOUT[4: 0] | | | | |
| Reset | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| Type | RW | RW | RW | RW | RW | RW | RW | RW |
| Offset 0x03 | VOUTROOF | | | | | | | |
| Bits | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| Name | RESERVED | RESERVED | RESERVED | VOUT[4: 0] | | | | |
| Reset | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 |
| Type | RW | RW | RW | RW | RW | RW | RW | RW |
| Offset 0x04 | ILIMSET | | | | | | | |
| Bits | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| Name | RESERVED | RESERVED | ILIM_OFF | SOFT_START | ILIM[3:0] | | | |
| Reset | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 |
| Type | RW | RW | RW | RW | RW | RW | RW | RW |
| Offset 0x05 | STATUS | | | | | | | |
| Bits | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| Name | TSD | HOTDIE | DCDCMODE | OPMODE | ILIMPT | ILIMBST | FAULT | PGOOD |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Type | RO | RO | RO | RO | RO | RO | RO | RO |

| Name | | Function | Addr | |
|---|---|---|---|---|
| CONFIG | | MODE control & Spread modulation control | 0x01 | |
| Bit | Mode | Name | Reset | Description |
| 7 | R/W | RESET | 0 | 0 : Disable ID detection function<br>1 : Enable ID detection function |
| [6 : 5] | R/W | ENABLE[1 : 0] | 0 | 00 : Device operation follows hardware control signal (refer to table 1)<br>01 : Device operation in auto transition mode (boost/bypass) regardless of the nBYP control signal (EN = 1)<br>10 : Device is forced in pass-through mode regardless of the nBYP control signal (EN = 1)<br>11 : Device is in shutdown mode. The output voltage is reduced to a minimum value ($V_{IN} – V_{OUT} \leq 3.6V$) regardless of the nBYP control signal (EN = 1) |
| 4 | R/W | Reserved | 0 | |
| 3 | R/W | PG Config | 1 | 0 : PG pin = H, Power good indication<br>PG pin = L, IC shut down, it needs retoggle this pin to restart $V_{OUT}$<br>1 : PG pin is for power good indication |
| 2 | R/W | SSFM | 0 | 0 : Spread spectrum modulation is disabled.<br>1 : Spread spectrum modulation is enabled in PWM mode. |
| [1 : 0] | R/W | MODE_CTRL[1 : 0] | 01 | 00 : Device operation follows hardware control signal.<br>01 : PFM with automatic transition into PWM operation.<br>10 : Forced PWM operation.<br>11 : PFM with automatic transition into PWM operation (VSEL = L), forced PWM operation (VSEL = H). |
| **Name** | | **Function** | **Addr** | |
| VOUTFLOOR | | Output Voltage Selection | 0x02 | |
| Bit | Mode | Name | Reset | Description |
| [7 : 5] | R/W | Reserved | 000 | |
| [4 : 0] | R/W | VOUT[4 : 0] | 01001 | 00000 : $V_{OUT}$ = 2.85V<br>00001 : $V_{OUT}$ = 2.9V<br>00010 : $V_{OUT}$ = 2.95V<br>00011 : $V_{OUT}$ = 3V<br>00100 : $V_{OUT}$ = 3.05V<br>…<br>01001 : $V_{OUT}$ = 3.3V (default)<br>…<br>11111 : $V_{OUT}$ = 4.4V |

| Name | | Function | Addr | |
|---|---|---|---|---|
| VOUTROOF | | Output Voltage Selection | 0x03 | |
| Bit | Mode | Name | Reset | Description |
| [7 : 5] | R/W | Reserved | 000 | |
| [4 : 0] | R/W | VOUT[4 : 0] | 01110 | 00000 : $V_{OUT}$ = 2.85V<br>00001 : $V_{OUT}$ = 2.9V<br>00010 : $V_{OUT}$ = 2.95V<br>00011 : $V_{OUT}$ = 3V<br>00100 : $V_{OUT}$ = 3.05V<br>…<br>01110 : $V_{OUT}$ = 3.55V (default)<br>…<br>11111 : $V_{OUT}$ = 4.4V |
| **Name** | | **Function** | **Addr** | |
| ILIMSET | | Set current limit & Soft-start current limit | 0x04 | |
| Bit | Mode | Name | Reset | Description |
| [7 : 6] | R/W | Reserved | 00 | |
| 5 | R/W | ILIM_OFF | 0 | 0 : Current Limit Enabled<br>1 : Current Limit Disabled |
| 4 | R/W | Soft-Start | 1 | 0 : Boost soft-start current is limited per ILIM bit settings<br>1 : Boost soft-start current is limited to ca. 1250mA inductor valley current |
| [3 : 0] | R/W | ILIM[3 : 0] | 1111 | 1000 : 1500mA<br>1001 : 2000mA<br>1010 : 2500mA<br>1011 : 3000mA<br>1100 : 3500mA<br>1101 : 4000mA<br>1110 : 4500mA<br>1111 : 5000mA (default) |

| Name | | Function | Addr | |
|---|---|---|---|---|
| STATUS | | Read IC status | 0x05 | |
| Bit | Mode | Name | Reset | Description |
| 7 | R | TSD | 0 | 0 : Normal operation.<br>1 : Thermal shutdown tripped. The flag is reset after readout. |
| 6 | R | HOTDIE | 0 | 0 : $T_J$ < 115°C.<br>1 : $T_J$ > 115°C. |
| 5 | R | DCDCMODE | 0 | 0 : Device operates in PFM mode.<br>1 : Device operates in PWM mode. |
| 4 | R | OPMODE | 0 | 0 : Device operates in pass-through mode.<br>1 : Device operates in dc/dc mode. |
| 3 | R | ILIMPT | 0 | 0 : Normal operation.<br>1 : Indicates that the bypass FET current limit has triggered. This flag is reset after readout. |
| 2 | R | ILIMBST | 0 | 0 : Normal operation.<br>1 : Indicates that the average input current limit has triggered for 1.5ms in dc/dc boost mode. This flag is reset after readout. |
| 1 | R | FAULT | 0 | 0 : Normal operation.<br>1 : Indicates that a fault condition has occurred. This flag is reset after readout. |
| 0 | R | PGOOD | 0 | 0 : Indicates the output voltage is out of regulation.<br>1 : Indicates the output voltage is within its nominal range. This bit is set if the converter is forced in pass-through mode. |

## Thermal Considerations

For continuous operation, do not exceed absolute maximum junction temperature. The maximum power dissipation depends on the thermal resistance of the IC package, PCB layout, rate of surrounding airflow, and difference between junction and ambient temperature. The maximum power dissipation can be calculated by the following formula :

$P_{D(MAX)} = (T_{J(MAX)} - T_A) / \theta_{JA}$

where $T_{J(MAX)}$ is the maximum junction temperature, $T_A$ is the ambient temperature, and $\theta_{JA}$ is the junction to ambient thermal resistance.

For recommended operating condition specifications, the maximum junction temperature is 125°C. The junction to ambient thermal resistance, $\theta_{JA}$, is layout dependent. For WL-CSP-16B 1.67x1.67 (BSC) package, the thermal resistance, $\theta_{JA}$, is 47.7°C/W on a standard JEDEC 51-7 four-layer thermal test board. The maximum power dissipation at $T_A$ = 25°C can be calculated by the following formula :

$P_{D(MAX)}$ = (125°C − 25°C) / (47.7°C/W) = 2.09W for WL-CSP-16B 1.67x1.67 (BSC) package

The maximum power dissipation depends on the operating ambient temperature for fixed $T_{J(MAX)}$ and thermal resistance, $\theta_{JA}$. The derating curve in Figure 5 allows the designer to see the effect of rising ambient temperature on the maximum power dissipation.

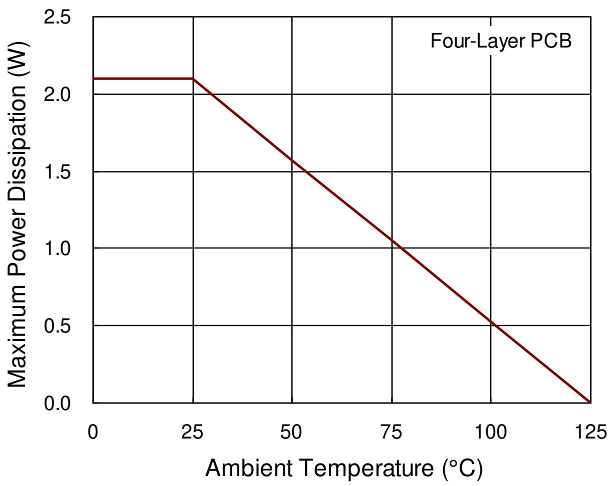



Figure 5. Derating Curve of Maximum Power Dissipation

## Layout Consideration

The PCB layout is an important step to maintain the high performance of the RT4803.

Both the high current and the fast switching nodes demand full attention to the PCB layout to save the robustness of the RT4803 through the PCB layout. Improper layout might show the symptoms of poor line or load regulation, ground and output voltage shifts, stability issues, unsatisfying EMI behavior or worsened efficiency. For the best performance of the RT4803, the following PCB layout guidelines must be strictly followed.

- Place the input and output capacitors as close as possible to the input and output pins respectively for good filtering.
- For thermal consider, it needed to maximize the pure area for the power stage area besides the LX.

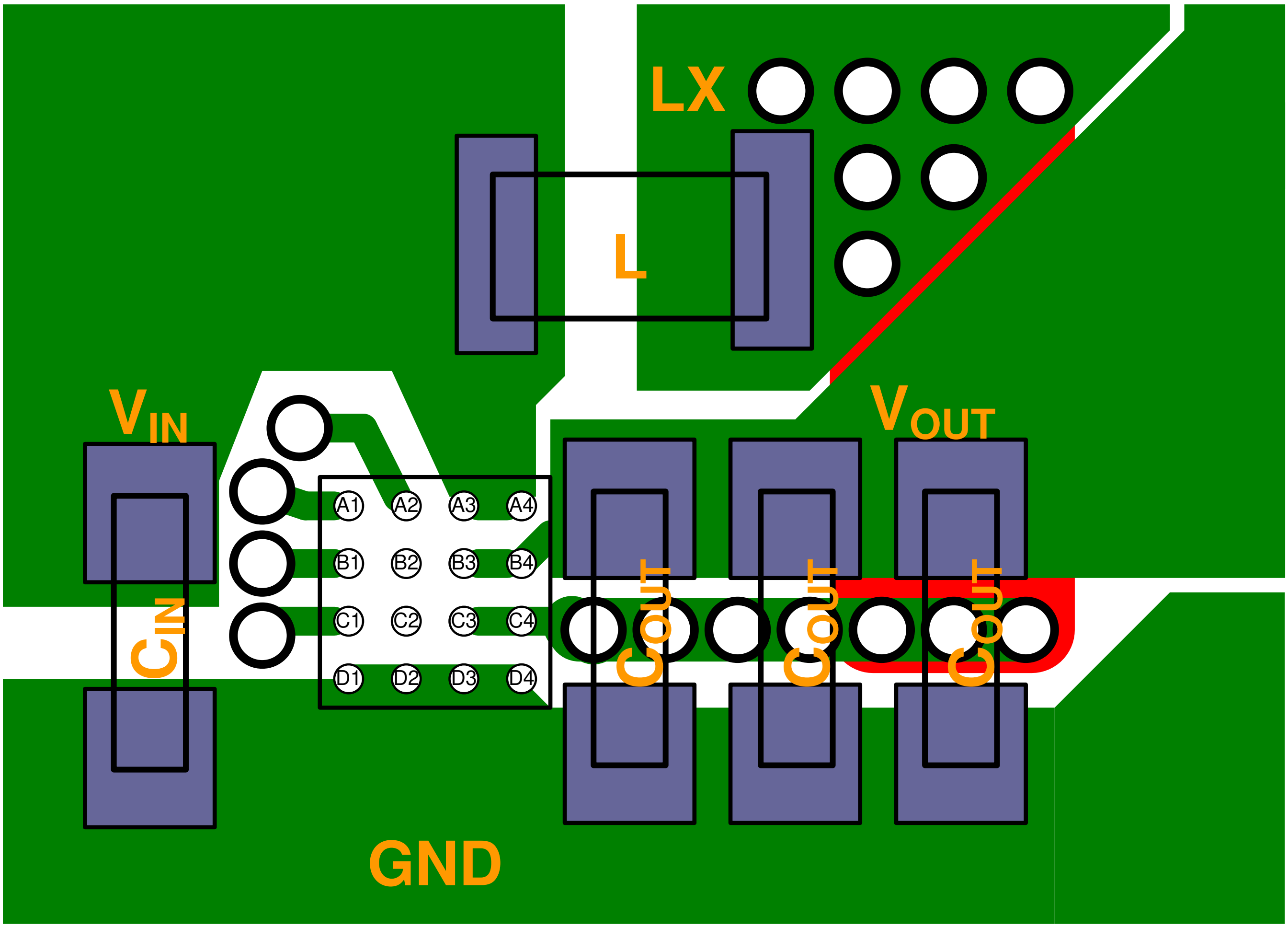
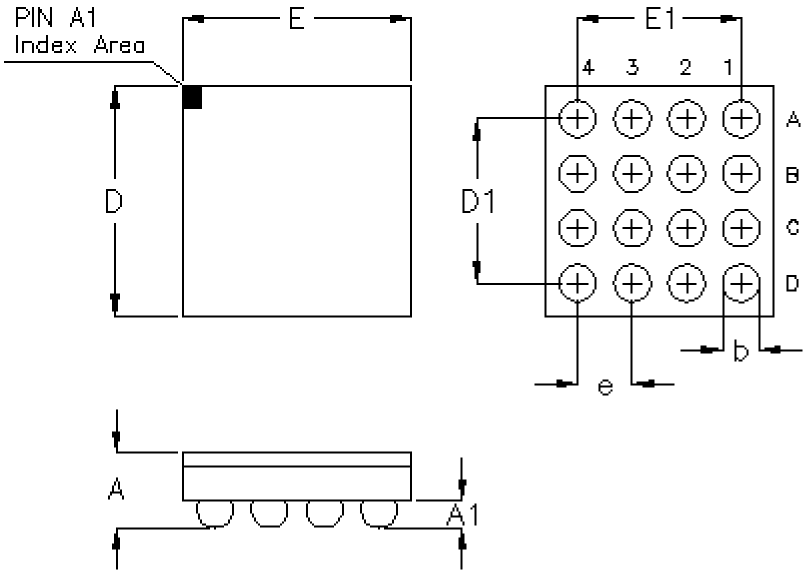



Figure 6. PCB Layout Guide

## Outline Dimension




| Symbol | Dimensions In Millimeters | | Dimensions In Inches | |
|---|---|---|---|---|
| | Min | Max | Min | Max |
| A | 0.500 | 0.600 | 0.020 | 0.024 |
| A1 | 0.170 | 0.230 | 0.007 | 0.009 |
| b | 0.240 | 0.300 | 0.009 | 0.012 |
| D | 1.620 | 1.720 | 0.064 | 0.068 |
| D1 | 1.200 | | 0.047 | |
| E | 1.620 | 1.720 | 0.064 | 0.068 |
| E1 | 1.200 | | 0.047 | |
| e | 0.400 | | 0.016 | |

**WL-CSP-16B 1.67x1.67 (BSC)**

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## Datasheet Revision History

| Version | Date | Description | Item |
|---|---|---|---|
| 04 | 2023/7/21 | Modify | Ordering Information on P2<br>Electrical Characteristics on P8<br>Application Information on P13 |