

## 2.5MHz, Synchronous Boost Regulator with Bypass Mode

### General Description

The RT4805A 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 RT4805A 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 1 $\mu$ A, 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 RT4805A is available in the WL-CSP-16B 1.67x1.67 (BSC) package.

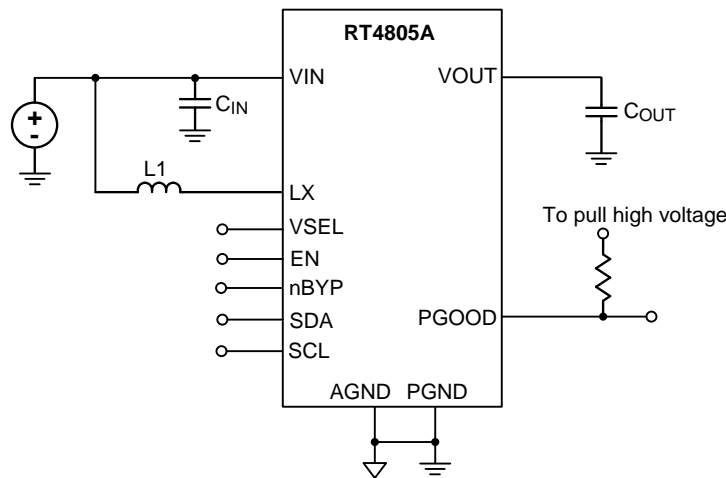
### Features

- **4 Few External Components: 0.47 $\mu$ H 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 3.6V**
  - ▶ **VSEL = H 3.7V**
- **Maximum Continuous Load Current: 2A at  $V_{IN} > 2.65V$  Boosting  $V_{OUT}$  to 3.35V**
- **Up to 96% Efficient**
- **True Bypass Operation when  $V_{IN} > \text{Target } V_{OUT}$**
- **Internal Synchronous Rectifier**
- **True Load Disconnect when Shut Down**
- **Forced Bypass Mode**
- **VSEL Control to Optimize Target  $V_{OUT}$**
- **Short-Circuit Protection**
- **I<sup>2</sup>C Controlled Interface**
- **Ultra low Operating Quiescent Current**
- **Small WL-CSP 16B Package**

### Applications

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

### Simplified Application Circuit



## Ordering Information

RT4805A □  
 Package Type  
 WSC : WL-CSP-16B 1.67x1.67 (BSC)

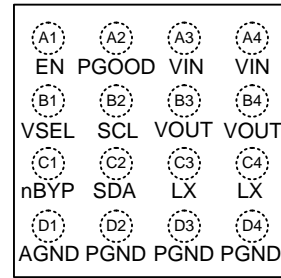
Note :

Richtek products are :

- ▶ RoHS compliant and compatible with the current requirements of IPC/JEDEC J-STD-020.
- ▶ Suitable for use in SnPb or Pb-free soldering processes.

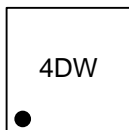
## Pin Configuration

(TOP VIEW)



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

## Marking Information

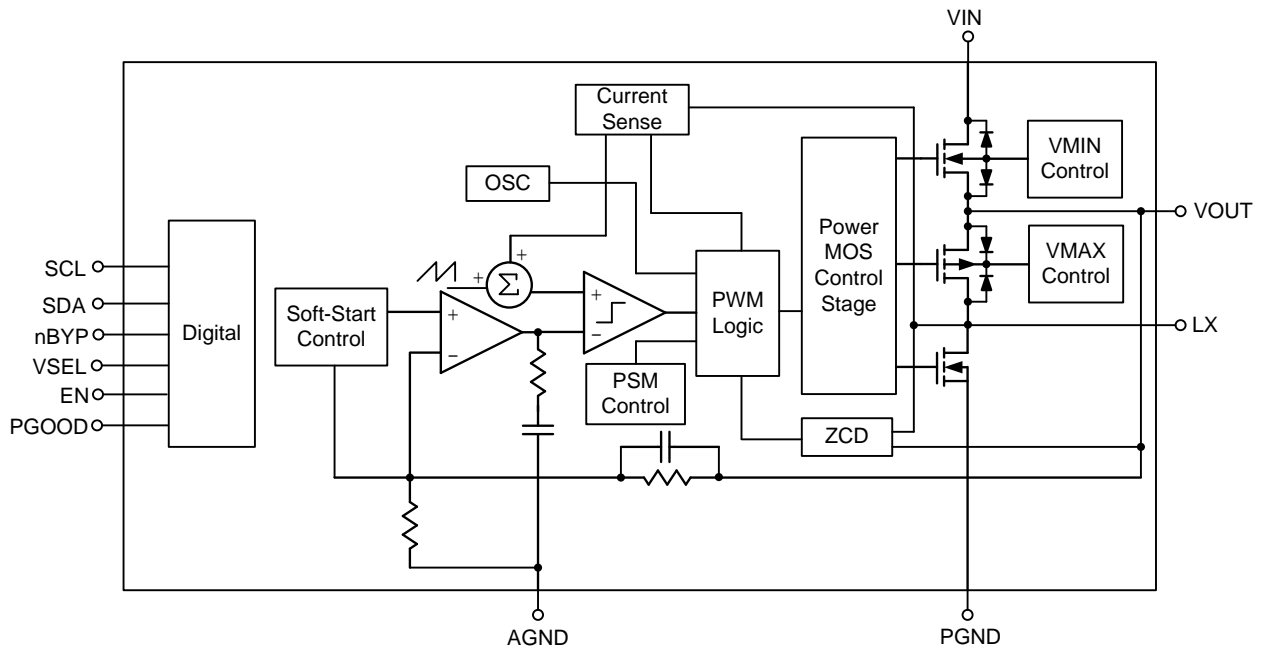


4D : Product Code  
 W : Date Code

## 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 an 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 <sup>2</sup> C is non-used).
B3, B4	VOUT	Output Voltage. Place C <sub>OUT</sub> 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 Data Line. (Pull down if I <sup>2</sup> C 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 <sub>OUT</sub> bypass capacitor should be returned with the shortest path possible to these pins.

**Functional Block Diagram**



## Operation

RT4805A 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 1 $\mu$ A, 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.

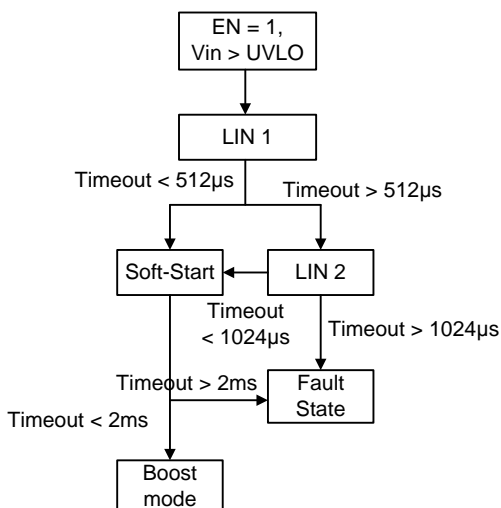


Figure 1. RT4805A State Chart

### 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 1024 $\mu$ s.
- ▶ 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, output voltage will increase with  $V_{IN}$  when 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  $V_{IN}$ .

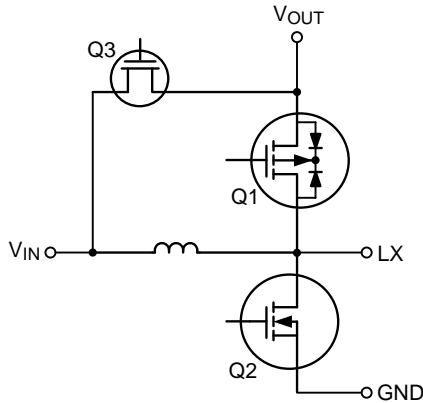


Figure 2. Boost Converter With Bypass Mode

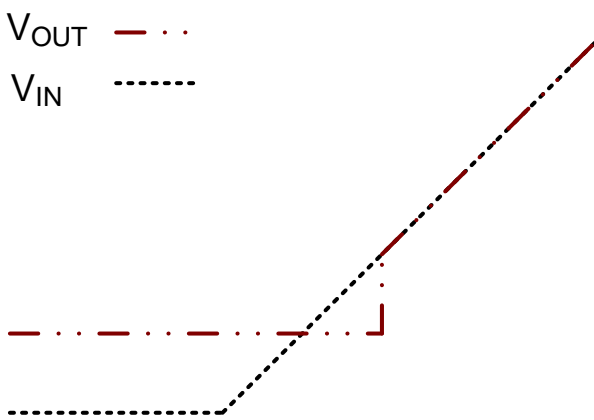


Figure 3. RT4805A mode changed

**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 15 $\mu$ A 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 (3.6V & 3.7V) in Boost mode and Bypass mode. It can be selected by VSET, so it must not be floating.

**PGOOD (Power Good)**

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

- PGOOD pin shows high when the sequence of soft-start is completed.
- Any fault causes PGOOD to be pulled low.
- PGOOD low when PMOS current limit has triggered for OR the die temperature exceeds 120°C. PGOOD is re-asserted when the device cools below 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. When EN and nBYP both pull high, RT4805A is normal operation and enters automatic mode.

If the EN pull low, and nBYP pull high/low, RT4805A is forced in shut-down mode and the quiescent is less than 1 $\mu$ A. It works in force pass-through mode, if the EN set high and nBYP set low.

Table 1

EN input	nBYP input	Device State
0	0/1	The device is shut down mode, and features a shutdown current down to ca. 1 $\mu$ A typ.
1	0	The device is active in forced pass-through mode. The device supply current is approximately 15 $\mu$ A 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 55 $\mu$ A 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<sub>D</sub> @ T<sub>A</sub> = 25°C  
 WL-CSP-16B 1.67x1.67 (BSC) ----- 2.09W
- Package Thermal Resistance (Note 2)  
 WL-CSP-16B 1.67x1.67 (BSC), θ<sub>JA</sub> ----- 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<sub>IN</sub> = 3V, V<sub>OUT</sub> = 3.4V, T<sub>A</sub> = 25°C, unless otherwise specified)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
VIN Operation Range	V <sub>IN</sub>		1.8	--	5	V
VIN Quiescent Current	I <sub>Q</sub>	Auto Bypass Mode, V <sub>IN</sub> = 3.8V	--	35	70	μA
VIN Quiescent Current	I <sub>Q</sub>	Boost mode, I <sub>LOAD</sub> = 0mA, Switching, V <sub>IN</sub> = 3V	--	55	100	μA
VIN Quiescent Current	I <sub>Q</sub>	Force Bypass without LIQ, V <sub>IN</sub> = 3.6V	--	15	25	μA
VIN Shutdown Current	I <sub>SHDN</sub>	EN = 0V, V <sub>IN</sub> = 3.6V	--	--	1	μA
VOUT to VIN Reverse Leakage	I <sub>LK</sub>	V <sub>OUT</sub> = 5V, EN = nBYP = H, V <sub>IN</sub> < V <sub>OUT</sub>	--	0.2	1	μA
VOUT Leakage Current	I <sub>LK_OUT</sub>	V <sub>OUT</sub> = 0V, EN = 0V, V <sub>IN</sub> = 4.2V	--	0.1	1	μA
Under Voltage Lock Out	V <sub>UVLO</sub>	V <sub>IN</sub> Rising	--	1.6	1.8	V
Under Voltage Lock Out Hysteresis	V <sub>UVLO_HYS</sub>		--	200	--	mV
PGOOD Low	V <sub>PGOOD</sub>	I <sub>PGOOD</sub> = 5mA	--	--	0.4	V
PGOOD Leakage Current	I <sub>PGOOD_LK</sub>	V <sub>PGOOD</sub> = 5V	--	--	1	μA
Logic Level High EN, VSEL, nBYP, SCL, SDA	V <sub>IH</sub>		1.2	--	--	V

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
Logic Level Low EN, VSEL, nBYP, SCL, SDA	V <sub>IL</sub>		--	--	0.4	V
Output Voltage Accuracy	V <sub>REG</sub>	V <sub>OUT</sub> – V <sub>IN</sub> > 100mV, PWM	–2	--	2	%
Minimum On Time	T <sub>ON</sub>	V <sub>IN</sub> = 3V, V <sub>OUT</sub> = 3.5V, I <sub>LOAD</sub> > 1000mA	--	80	--	ns
Maximum Duty Cycle	D <sub>MAX</sub>		40	--	--	%
Switching Frequency	F <sub>SW</sub>	V <sub>IN</sub> = 2.65V, V <sub>OUT</sub> = 3.5V, I <sub>LOAD</sub> = 1000mA	2	2.5	3	MHz
Boost Valley Current Limit	I <sub>CL</sub>	V <sub>IN</sub> = 2.9V	3.5	4	4.5	A
Soft-Start Input Current Limit	I <sub>SS_PK</sub>	LIN1	--	1000	--	mA
Soft-Start Input Current Limit	I <sub>SS_PK</sub>	LIN2	--	2000	--	mA
Pass Through Mode Current Limit	I <sub>BPCL</sub>	V <sub>IN</sub> = 3.2V	--	4	--	A
N-Channel Boost Switch R <sub>DS(ON)</sub>	R <sub>DSN</sub>	V <sub>IN</sub> = 3.2V, V <sub>OUT</sub> = 3.5V	--	60	95	mΩ
P-Channel Boost Switch R <sub>DS(ON)</sub>	R <sub>DSP</sub>	V <sub>IN</sub> = 3.2V, V <sub>OUT</sub> = 3.5V	--	40	80	mΩ
N-Channel Bypass Switch R <sub>DS(ON)</sub>	R <sub>DSP_BYP</sub>	V <sub>IN</sub> = 3.2V, V <sub>OUT</sub> = 3.5V	--	40	60	mΩ
Hot Die Trigger Threshold	T <sub>HD</sub>		--	100	--	°C
Hot Die Release Threshold	T <sub>HDR</sub>		--	90	--	°C
Over Temperature Protection	T <sub>OTP</sub>		--	160	--	°C
Over Temperature Protection Hysteresis	T <sub>OTP_HYS</sub>		--	20	--	°C
FAULT Restart Time	T <sub>RST</sub>		--	1	--	ms

**Note 1.** Stresses beyond those listed “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.

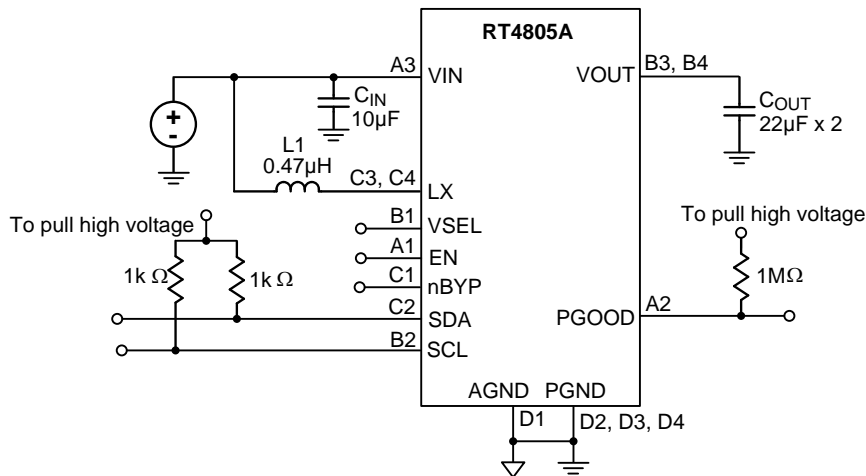
**Note 2.**  $\theta_{JA}$  is measured at T<sub>A</sub> = 25°C on a high effective thermal conductivity four-layer test board per JEDEC 51-7.

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

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



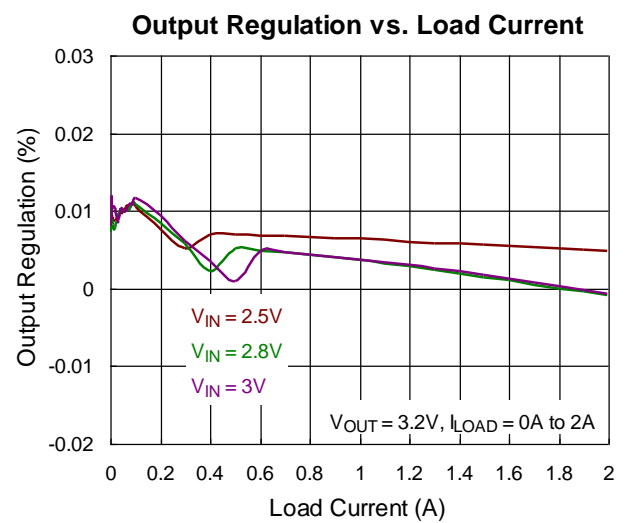
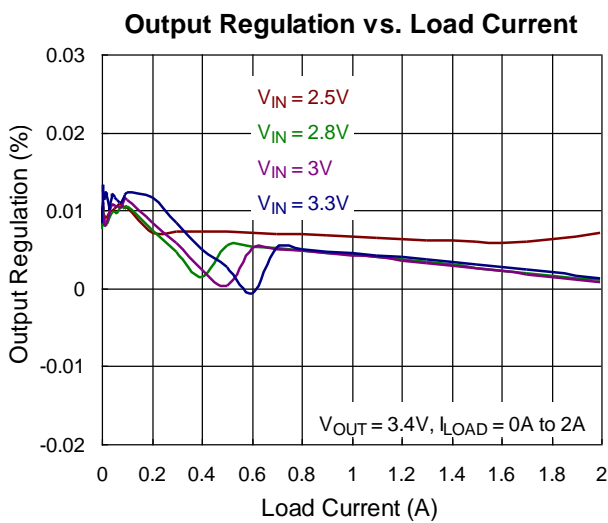
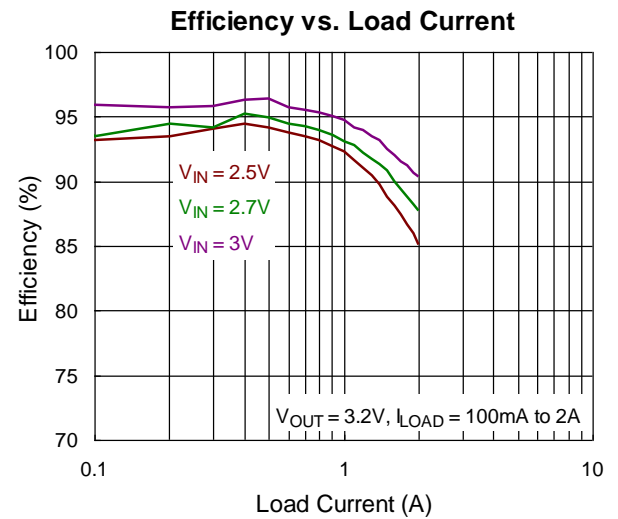
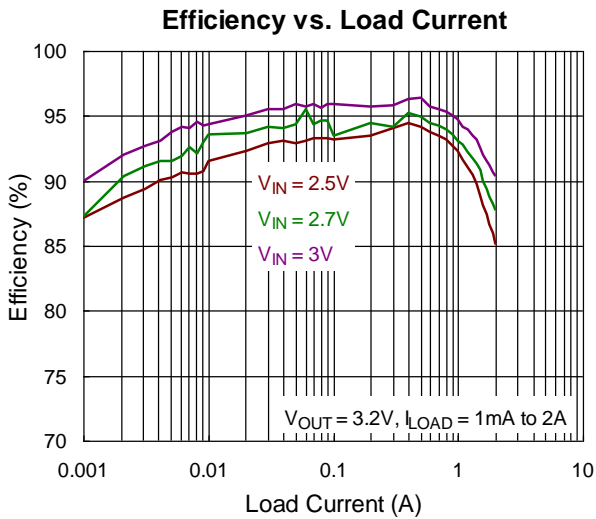
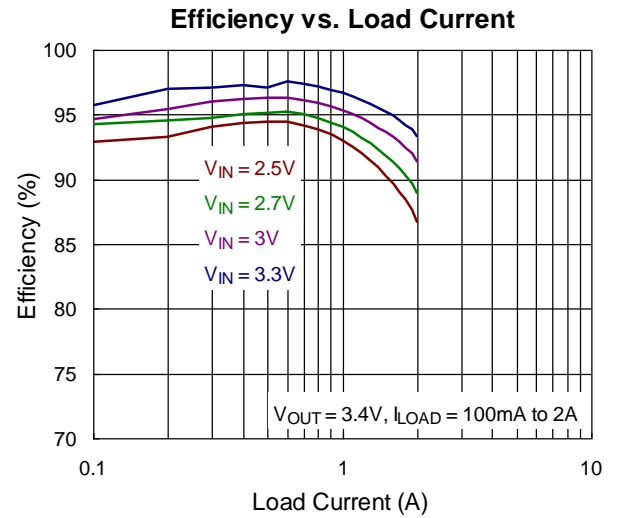
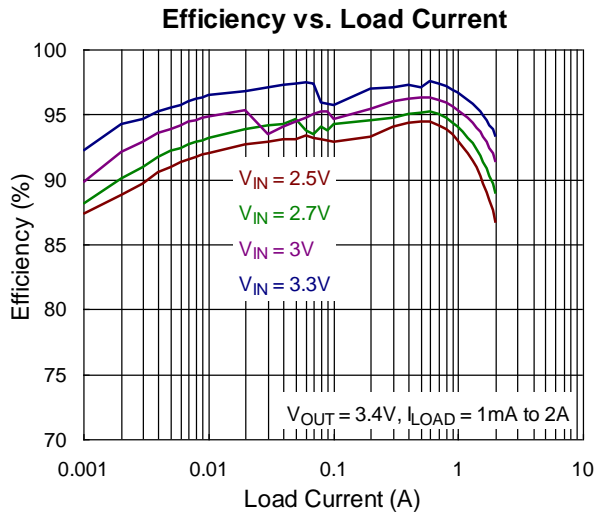
**Typical Application Circuit**

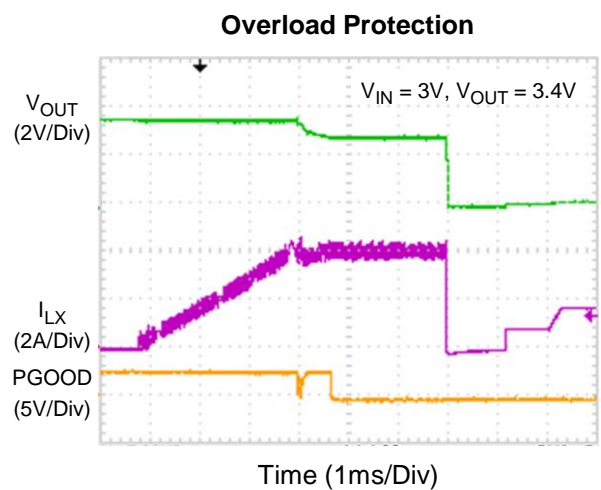
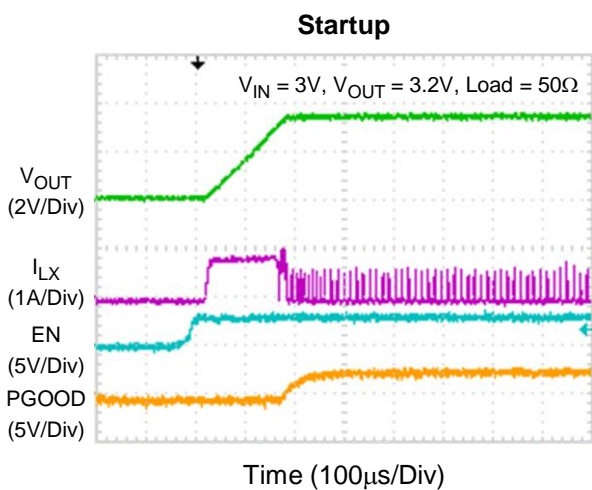
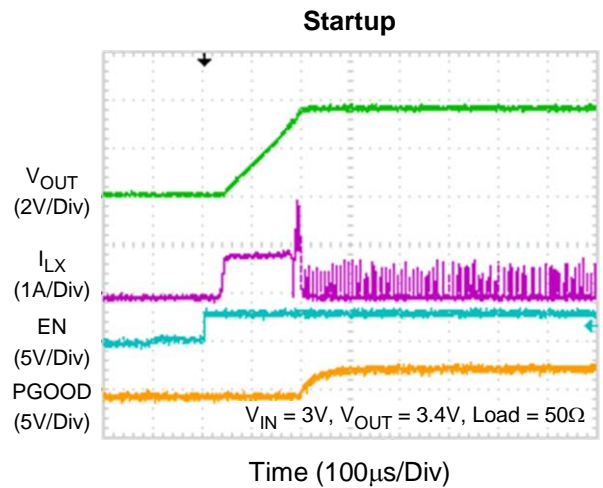
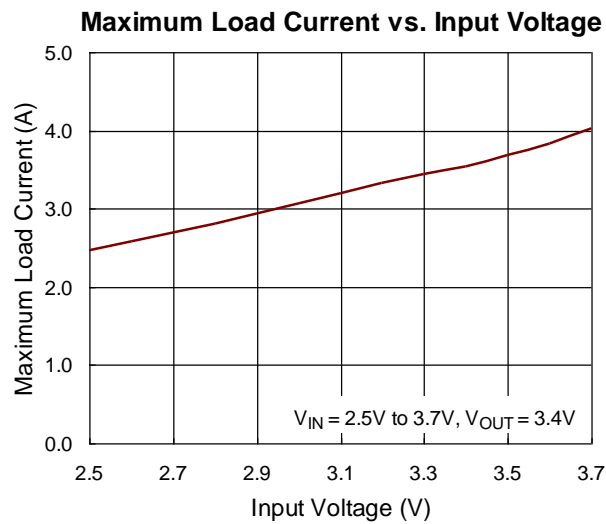
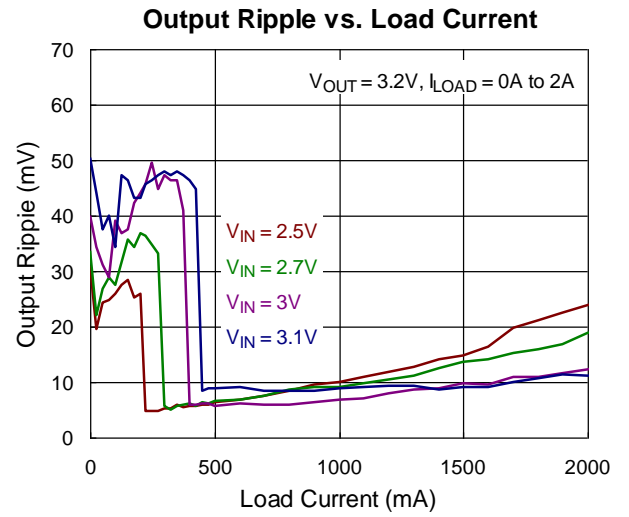
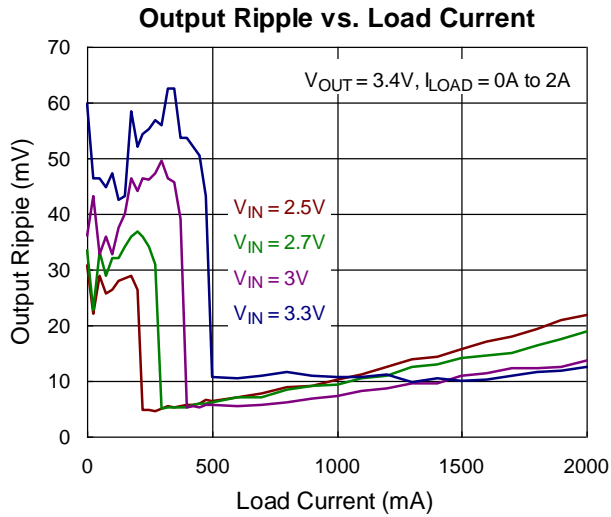


**BOM of Test Board**

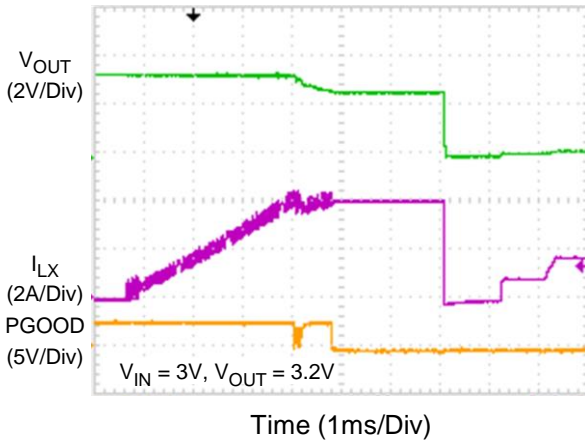
Reference	Description	Manufacturer	Package	Parameter	Typ.	Unit
C <sub>IN</sub>	10µF/16V/X5R	Taiyo : EMK212ABJ106KG	0805	C	10	µF
C <sub>OUT</sub>	22µF/10V/X5R	Taiyo : LMK212BBJ226MG	0805	C	22	µF
L1	0.47µH, ±20%	TOKO : DFE2520F-R47M	2520	L	0.47	µH
				DCR (Series R)	29	mΩ

Typical Operating Characteristics

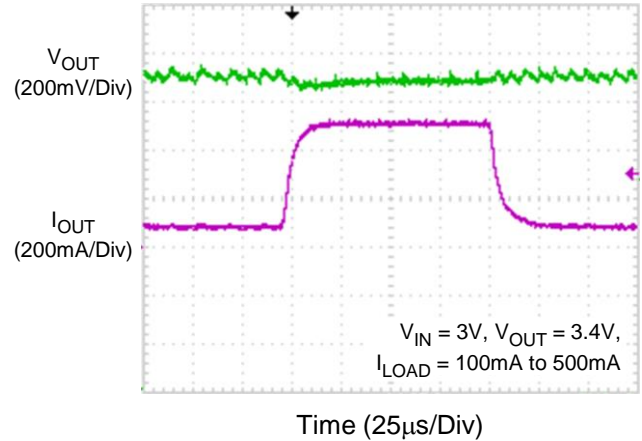




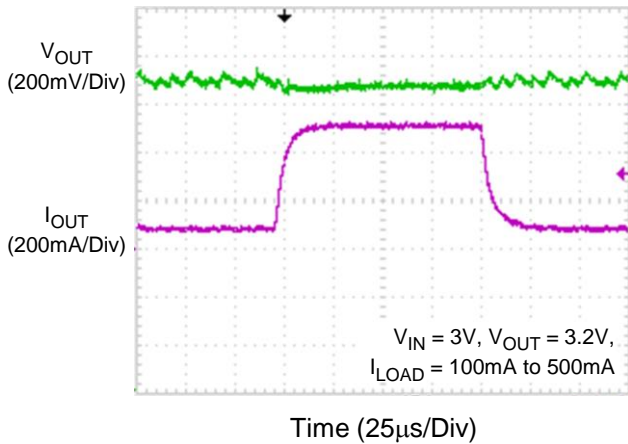
Overload Protection



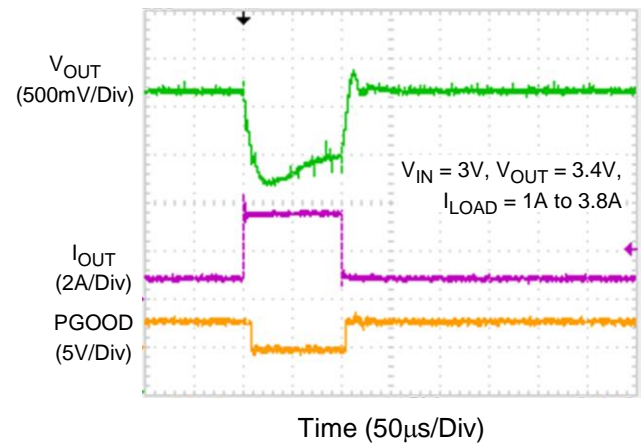
Load Transient



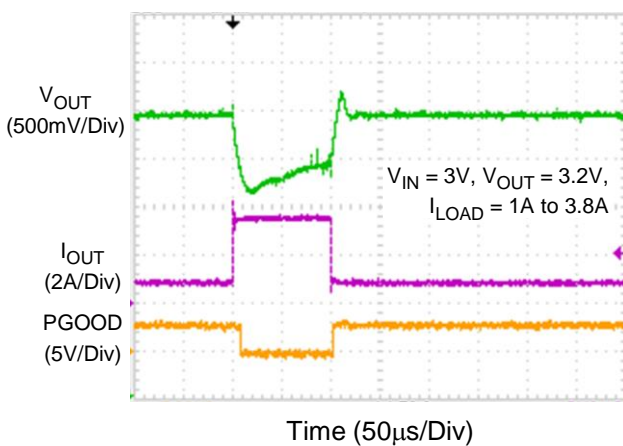
Load Transient



Transient Overload



Transient Overload



## Application Information

### 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 ( $V_{OUT} \geq V_{IN} - 300\text{mV}$ ).

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 3.6V, and if it pulled high, the default is 3.7V.

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.  $V_{IN}$  voltage must be greater than 1.7V to enable the converter. During operation, if  $V_{IN}$  voltage drops below 1.6V, the converter is disabled until the supply exceeds the UVLO rising threshold. The RT4805A 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 1.5 $\mu$ H.

It is recommended to use inductor with dc saturation current  $\geq 3500\text{mA}$

### Input Capacitor Selection

At least a 10 $\mu$ F 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 1 $\mu$ F ceramic capacitor placed as close as possible to the  $V_{IN}$  and GND pins of the IC is recommended.

### Output Capacitor Selection

At least 22 $\mu$ F 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 :

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

and

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

therefore :

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

and

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

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

RT4805A 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.

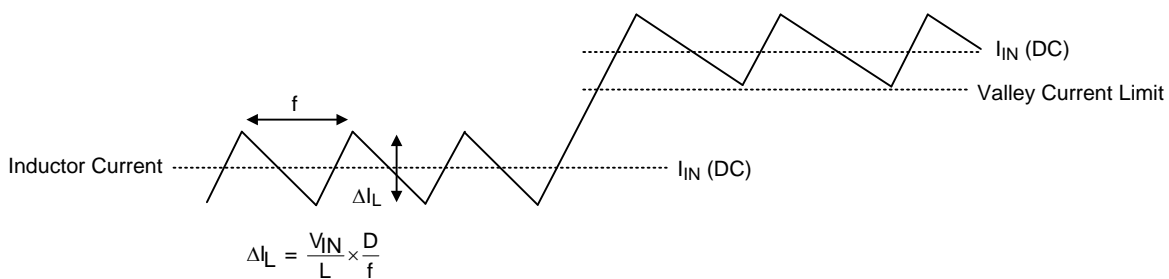


Figure 4. Inductor Currents In Current Limit Operation

### Protection

The RT4805A features some protections, such as OCP, OVP, UVP and OTP. As the table shown, it is described the protection actions.

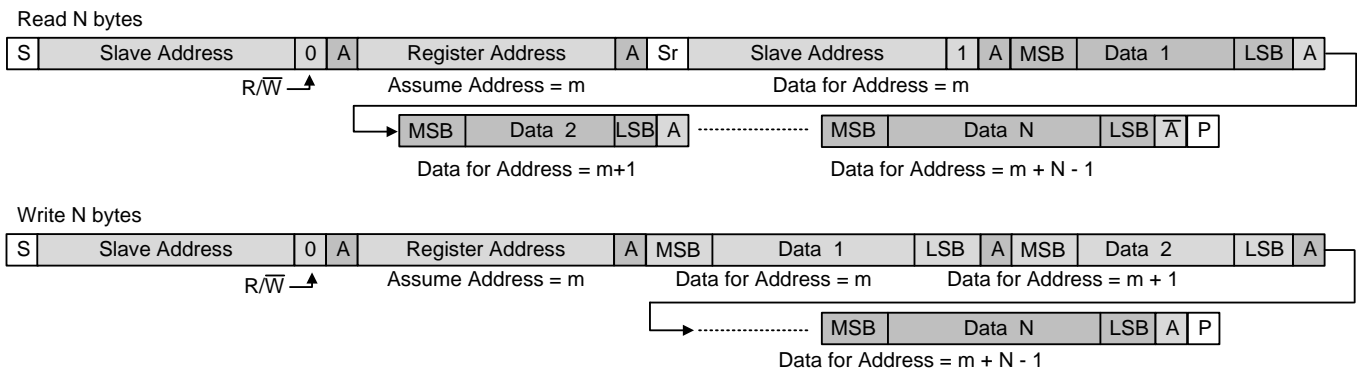
Protection Type	Threshold Refer to Electrical Spec.	Protection Method	Shut Down Delay Time	Reset Method
OCP	$I_L > 4A$	Turn on UG until $I_L < 4A$	2ms	After FAULT 1ms
OVP	$V_{IN} > 6V$	Turn off UG, LG, BYP_MOS	No delay	$V_{IN} < 5.7V$
UVP	$V_{IN} < 1.6V$	Turn off UG, LG, BYP_MOS	No delay	$V_{IN} > 1.7V$
OTP	$TEMP > 160^\circ C$	Turn off UG, LG, BYP_MOS	No delay	OTP Hysteresis = $20^\circ C$

**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 & Soft-start current limit
STATUS	0x05	Read IC status

**I<sup>2</sup>C Interface**

The RT4805A I<sup>2</sup>C slave address is 1110101 (7bits). The I<sup>2</sup>C interface supports fast mode (bit rate up to 400kb/s). The write or read bit stream (N ≥ 1) is shown below :



Driven by Master,  Driven by Slave (RT4805A),  P Stop,  S Start,  Sr Repeat Start

Offset 0x01		CONFIG						
Bits	7	6	5	4	3	2	1	0
Name	RESET	ENABLE<1>	ENABLE<0>	RESERVED	PG Config.	SSFM	MODE_CTRL<1>	MODE_CTRL<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	VSEL<4>	VSEL<3>	VSEL<2>	VSEL<1>	VSEL<0>
Reset	0	0	0	0	1	1	1	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	VSEL<4>	VSEL<3>	VSEL<2>	VSEL<1>	VSEL<0>
Reset	0	0	0	1	0	0	0	1
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>	ILIM<2>	ILIM<1>	ILIM<0>
Reset	0	0	0	1	1	1	0	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 1 : Enable ID detection function
[6 : 5]	R/W	ENABLE[1 : 0]	0	00 : Device operation follows hardware control signal (refer to table 1) 01 : Device operation in auto transition mode (boost/bypass) regardless of the nBYP control signal (EN = 1) 10 : Device is forced in pass-through mode regardless of the nBYP control signal (EN = 1) 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, it is not allowed. PG pin = L, it is shut down. 1 : PG pin is for power good indication.
2	R/W	SSFM	0	0 : Spread spectrum modulation is disabled. 1 : Spread spectrum modulation is enabled in PWM mode.
[1 : 0]	R/W	MODE_CTRL[1 : 0]	01	00 : Not allowed. 01 : PFM with automatic transition into PWM operation. 10 : Forced PWM operation. 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]	01111	00000 : $V_{OUT} = 2.85V$ 00001 : $V_{OUT} = 2.9V$ 00010 : $V_{OUT} = 2.95V$ 00011 : $V_{OUT} = 3V$ 00100 : $V_{OUT} = 3.05V$ ... 01111 : $V_{OUT} = 3.6V$ (default) ... 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]	10001	00000 : V <sub>OUT</sub> = 2.85V 00001 : V <sub>OUT</sub> = 2.9V 00010 : V <sub>OUT</sub> = 2.95V 00011 : V <sub>OUT</sub> = 3V 00100 : V <sub>OUT</sub> = 3.05V ... 10001 : V <sub>OUT</sub> = 3.7V (default) ... 11111 : V <sub>OUT</sub> = 4.4V
Name		Function	Addr	
ILIMSET		Set current limit & Softstart current limit	0x04	
Bit	Mode	name	Reset	Description
[7 : 6]	R/W	Reserved	00	
5	R/W	ILIM_OFF	0	0 : Current Limit Enabled 1 : Current Limit Disabled
4	R/W	Soft-Start	1	0 : Boost soft-start current is limited per ILIM bit settings 1 : Boost soft-start current is limited to ca. 1250mA inductor valley current
[3 : 0]	R/W	ILIM[3 : 0]	1101	1000 : 1500mA 1001 : 2000mA 1010 : 2500mA 1011 : 3000mA 1100 : 3500mA 1101 : 4000mA (default) 1110 : 4500mA 1111 : 5000mA

Name		Function	Addr	
STATUS		Read IC status	0x05	
Bit	Mode	name	Reset	Description
7	R	TSD	0	0 : Normal operation. 1 : Thermal shutdown tripped. The flag is reset after readout.
6	R	HOTDIE	0	0 : $T_J < 115^{\circ}\text{C}$ . 1 : $T_J > 115^{\circ}\text{C}$ .
5	R	DCDCMODE	0	0 : Device operates in PFM mode. 1 : Device operates in PWM mode.
4	R	OPMODE	0	0 : Device operates in pass-through mode. 1 : Device operates in dc/dc mode.
3	R	ILIMPT	0	0 : Normal operation. 1 : Indicates that the bypass FET current limit has triggered. This flag is reset after readout.
2	R	ILIMBST	0	0 : Normal operation. 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. 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. 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 on a standard JEDEC 51-7 four-layer thermal test board. The maximum power dissipation at  $T_A = 25^\circ\text{C}$  can be calculated by the following formula :

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

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.

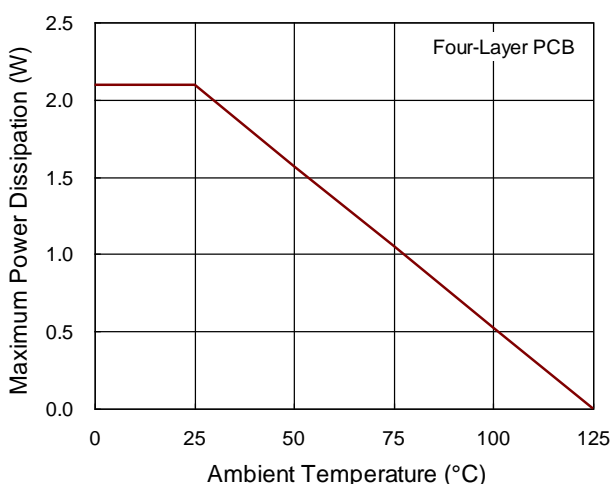


Figure 5. Derating Curve of Maximum Power Dissipation

## Layout Consideration

The PCB layout is an important step to maintain the high performance of RT4805A.

Both the high current and the fast switching nodes demand full attention to the PCB layout to save the robustness of the RT4805A 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 RT4805A, 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.

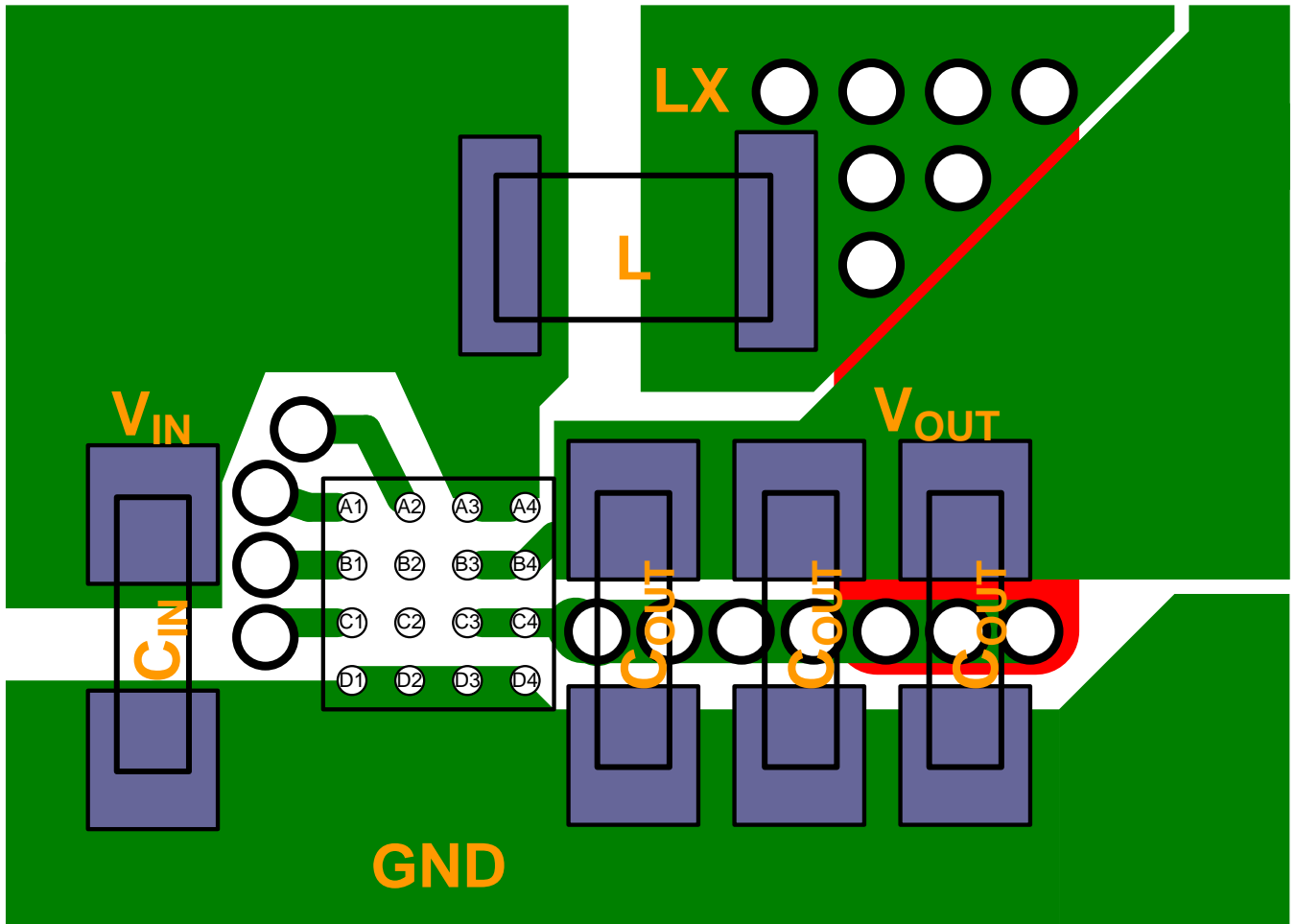
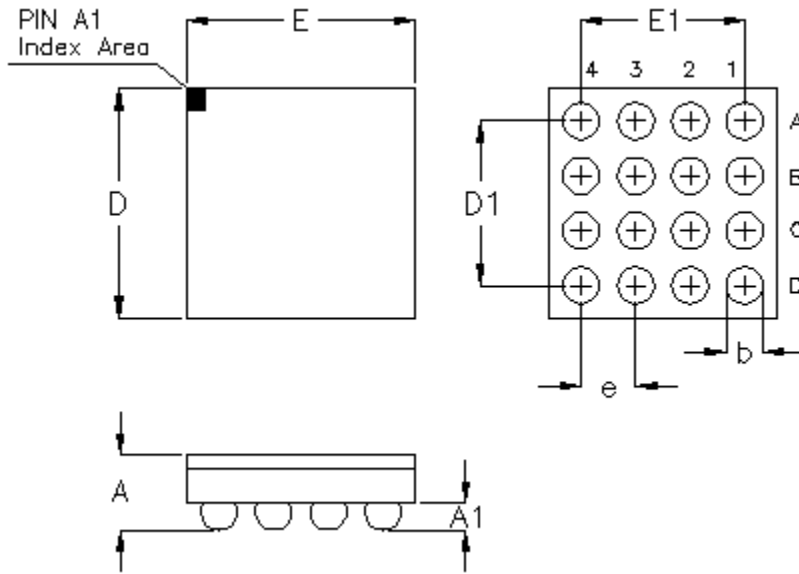


Figure 6. PCB Layout Guide

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)

Richtek Technology Corporation

14F, No. 8, Tai Yuen 1<sup>st</sup> Street, Chupei City

Hsinchu, Taiwan, R.O.C.

Tel: (8863)5526789

Richtek products are sold by description only. Richtek reserves the right to change the circuitry and/or specifications without notice at any time. Customers should obtain the latest relevant information and data sheets before placing orders and should verify that such information is current and complete. Richtek cannot assume responsibility for use of any circuitry other than circuitry entirely embodied in a Richtek product. Information furnished by Richtek is believed to be accurate and reliable. However, no responsibility is assumed by Richtek or its subsidiaries for its use; nor for any infringements of patents or other rights of third parties which may result from its use. No license is granted by implication or otherwise under any patent or patent rights of Richtek or its subsidiaries.

Copyright © 2016 Richtek Technology Corporation. All rights reserved. **RICHTEK** is a registered trademark of Richtek Technology Corporation.