

# High Voltage Multi-Topology LED Driver

## General Description

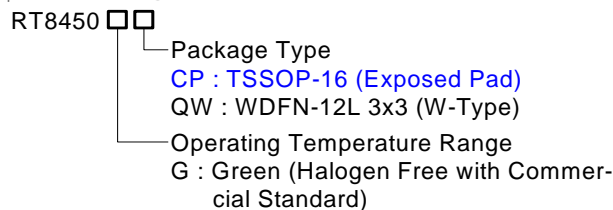
The RT8450 is a current mode PWM regulator for LED driving applications. With an 1.5A switch on board and wide input (4.5V to 40V) and/or output (up to 60V) ranges the RT8450 can operate in any of the three common topologies : Buck, Boost or Buck-Boost.

With a 1MHz operating frequency, the external PWM inductor and input/output capacitors can all be small. High efficiency is achieved with a 190mV current sensing.

Dimming can be either analog or PWM digital, an unique built-in clamping comparator and filtering resistor allow easy low noise analog dimming conversion from PWM signal with only one external capacitor.

The RT8450 is available in a [TSSOP-16 \(Exposed Pad\)](#) and [WDFN-12L 3x3](#) power packages.

## Ordering Information



Note :

Richtek Green 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.

## Marking Information

For marking information, contact our sales representative directly or through a Richtek distributor located in your area, otherwise visit our website for detail.

## Features

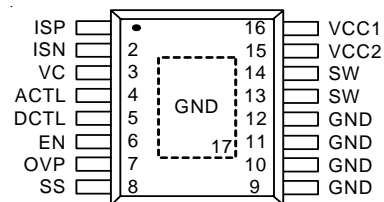
- **High Voltage** :  $V_{IN}$  Up to 40V,  $V_{OUT}$  Up to 60V
- **1.5A Switch Current**
- **Buck, Boost or Buck-Boost Operation**
- **Current Mode PWM with 1MHz Switching Frequency**
- **Easy Dimming** : Analog, PWM Digital or PWM Converting to Analog with One External Capacitor
- **Programmable Soft Start to Avoid Inrush Current**
- **Programmable Over Voltage Protection to Limit Output Voltage**
- **$V_{IN}$  Under Voltage Lockout and Thermal Shutdown**
- **RoHS Compliant and Halogen Free**

## Applications

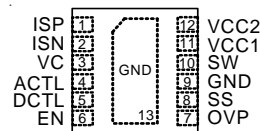
- GPS, Portable DVD Backlight
- Desk Lights and Room Lighting
- Industrial Display Backlight

## Pin Configurations

(TOP VIEW)



[TSSOP-16 \(Exposed Pad\)](#)



[WDFN-12L 3x3](#)

Typical Application Circuit

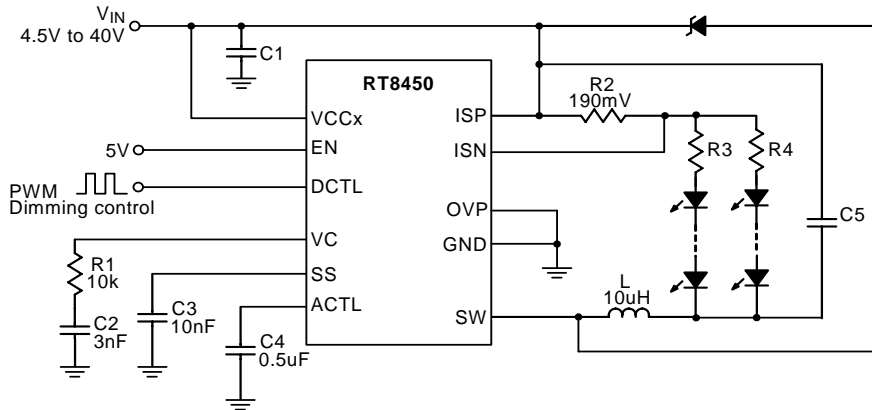


Figure 1. PWM to Analog Dimming BUCK Configuration

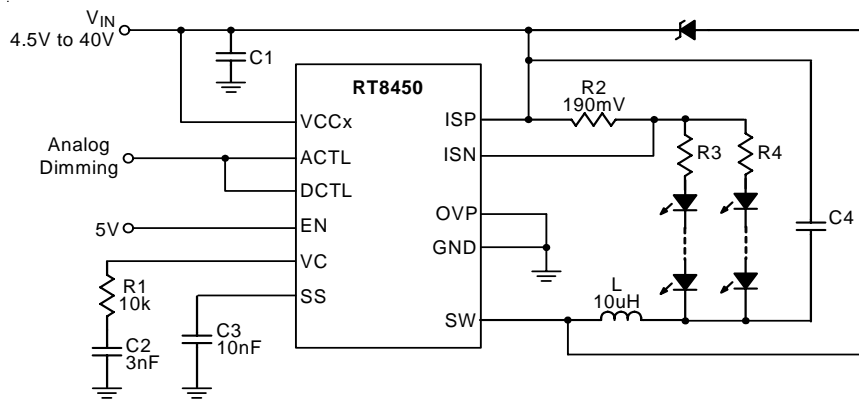


Figure 2. Analog Dimming BUCK Configuration

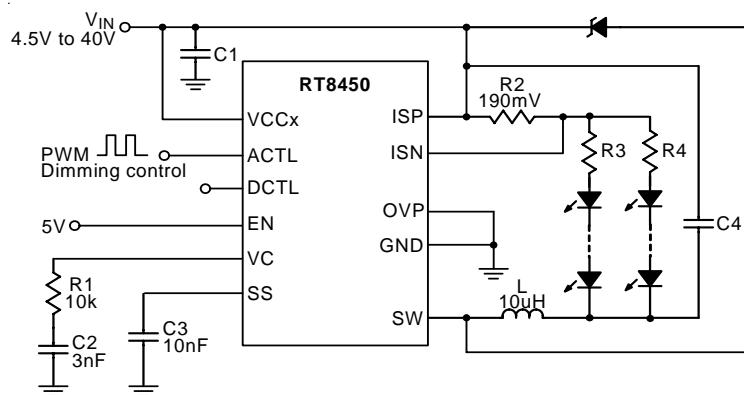


Figure 3. PWM Dimming BUCK Configuration Through ACTL Pin

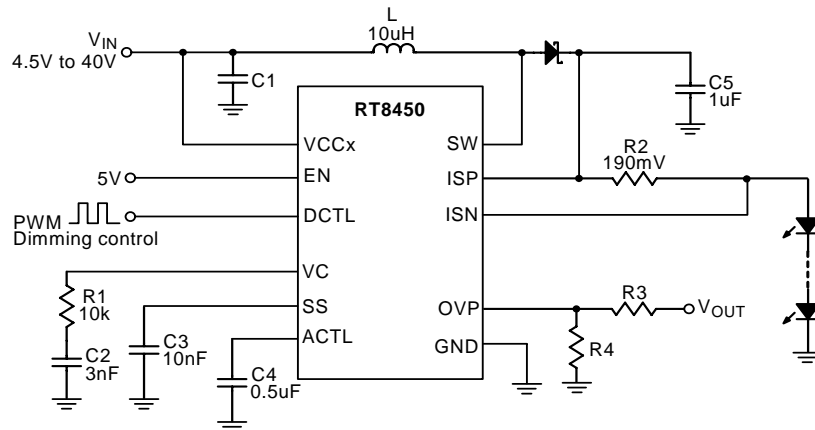


Figure 4. PWM to Analog Dimming BOOST Configuration

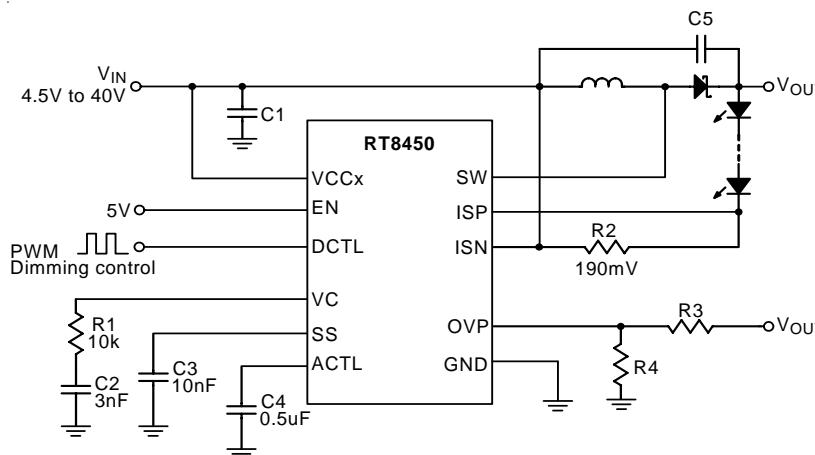


Figure 5. PWM to Analog Dimming BUCK-BOOST Configuration

### Functional Pin Description

Pin No.		Pin Name	Pin Function
TSSOP-16 (Exposed Pad)	WDFN-12L 3x3		
1	1	ISP	Current Sense Amplifier Positive Input.
2	2	ISN	Current Sense Amplifier Negative Input. Voltage threshold between ISP and ISN is 190mV.
3	3	VC	PWM Boost Converter Loop Compensation Node.
4	4	ACTL	Analog Dimming Control. Effective programming range is between 0.3V and 1.2V.
5	5	DCTL	By Adding a 0.1uF Filtering Capacitor on ACTL Pin, the PWM dimming signal on DCTL pin will be averaged and converted into analog dimming signal on ACTL pin. $V_{ACTL} = 1.2V \times \text{PWM dimming duty cycle}$ .
6	6	EN	Chip Enable (Active High), when low chip is in shutdown mode.
7	7	OVP	Over voltage protection. PWM boost converter turns off when $V_{OVP}$ goes higher than 1.2V.

To be continued

Pin No.		Pin Name	Pin Function
TSSOP-16 (Exposed Pad)	WDFN-12L 3x3		
8	8	SS	Soft Start Pin, a capacitor of at least 10nF is required for soft start.
9, 10, 11, 12, 17 (Exposed Pad)	9, 13 (Exposed Pad)	GND	Ground. The exposed pad must be soldered to a large PCB and connected to GND for maximum power dissipation.
13, 14	10	SW	PWM Boost Converter Switch Node.
15	12	VCC2	Bipolar Power Switch Base Current Supply. Typical beta of the power NPN switch is approximately 70. VCC2 can be connected either to VCC1 or to a separate lower voltage, as low as 3V, for better system efficiency and/or heat concern. A good bypass is necessary.
16	11	VCC1	Power Supply of the Chip. For good bypass, a low ESR capacitor is required.

Function Block Diagram

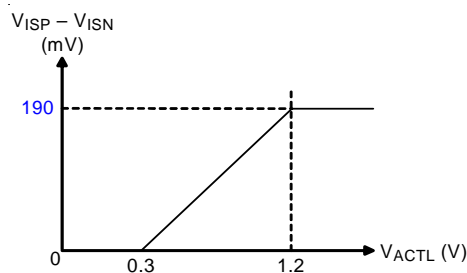
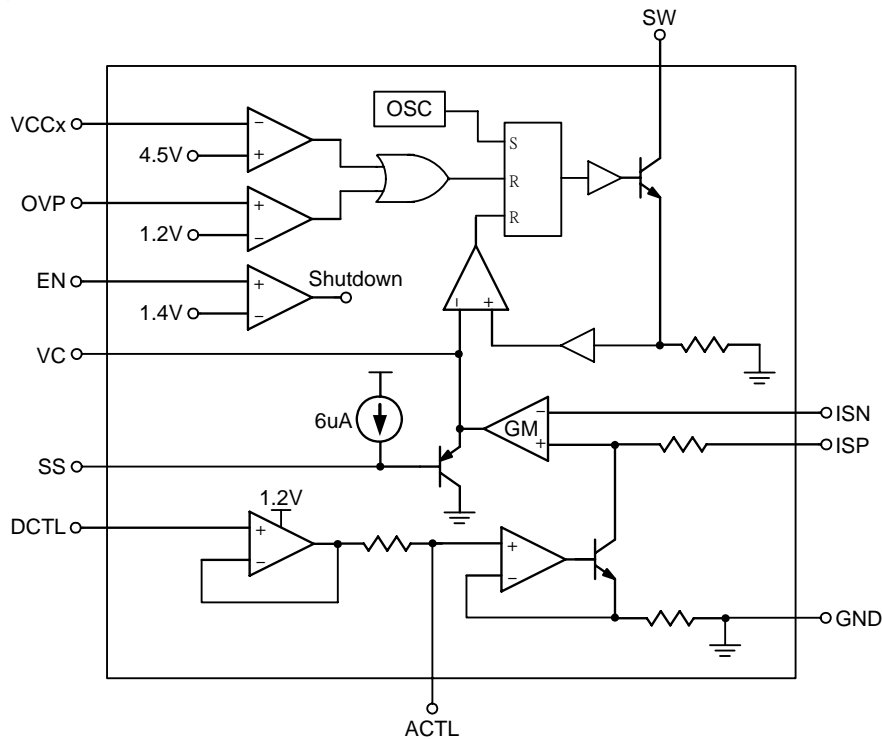


Figure 6

**Absolute Maximum Ratings** (Note 1)

- Supply Input Voltage,  $V_{CC}$  ----- 45V
- SW Pin Voltage at Switching Off, ISP, ISN ----- 65V
- DCTL, ACTL, EN, OVP Pin Voltage ----- 20V
- Power Dissipation,  $P_D$  @  $T_A = 25^\circ\text{C}$ 
  - TSSOP-16 ----- 2.66W
  - WDFN-12L 3x3 ----- 1.667W
- Package Thermal Resistance (Note 4)
  - TSSOP-16,  $\theta_{JA}$  ----- 47°C/W
  - WDFN-12L 3x3,  $\theta_{JA}$  ----- 60°C/W
  - WDFN-12L 3x3,  $\theta_{JC}$  ----- 8.2°C/W
- Junction Temperature ----- 150°C
- Lead Temperature (Soldering, 10 sec.) ----- 260°C
- Storage Temperature Range ----- -65°C to 150°C
- ESD Susceptibility (Note 2)
  - HBM (Human Body Mode) ----- 2kV
  - MM (Machine Mode) ----- 200V

**Recommended Operating Conditions** (Note 3)

- Junction Temperature Range ----- -40°C to 125°C
- Ambient Temperature Range ----- -40°C to 85°C

**Electrical Characteristics**

( $V_{CC} = 12\text{V}$ , No Load on any Output,  $T_A = 25^\circ\text{C}$ , unless otherwise specified)

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
<b>Overall</b>						
Supply Voltage	$V_{CC1}$		4.5	--	40	V
Supply Voltage VCC2 for Switch Base Drive	$V_{CC2}$		3	--	40	V
Supply Current	$I_{VCC1}$	$V_C \leq 0.4\text{V}$ (Switching off)	--	4	6	mA
Supply Current	$I_{VCC2}$	$3\text{V} \leq V_{CC2} \leq 40\text{V}$ , $I_{SW} \leq 1\text{A}$	--	$I_{SW}/70$	$I_{SW}/40$	A
Shutdown Current	$I_{SHDN\_VCC1}$	$V_{EN} \leq 0.7\text{V}$	--	12	--	uA
Shutdown Threshold	$V_{EN}$		--	1.4	--	V
EN Input Current		$V_{EN} \leq 5\text{V}$	--	--	0.5	uA
<b>Current Sense Amplifier</b>						
Input Threshold ( $V_{ISP} - V_{ISN}$ )		$4.5\text{V} \leq \text{common mode} \leq 60\text{V}$	170	190	210	mV
Input Current	$I_{ISP}$	$V_{ISP} = 24\text{V}$	--	240	--	uA
Input Current	$I_{ISN}$	$V_{ISN} = 24\text{V}$	--	40	--	uA
Output Current	$I_{VC}$	$2.4\text{V} > V_C > 0.2\text{V}$	--	$\pm 20$	--	uA
VC Threshold for PWM Switch Off			--	0.7	--	V

To be continued

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
<b>LED Dimming</b>						
Analog Dimming ACTL Pin Input Current	I <sub>ACTL</sub>	$0.3V \leq V_{ACTL} \leq 1.3V$	--	--	1	μA
LED Current Off Threshold at ACTL	V <sub>ACTL</sub>		--	0.3	--	V
DCTL Input Current	I <sub>DCTL</sub>	$0.3V \leq V_{DCTL} \leq 6V$	--	--	0.5	μA
<b>PWM BOOST Converter</b>						
Switching Frequency	f <sub>SW</sub>		800k	1M	1.2M	Hz
Maximum Duty Cycle (Note 5)			--	86	--	%
Minimum on Time			--	250	--	ns
SW On-Voltage	V <sub>SW</sub>	I <sub>SW</sub> = 0.5A	--	0.4	--	V
SW Current Limit	I <sub>LIM_SW</sub>		1.25	1.5	--	A
<b>OVP and Soft Start</b>						
OVP Threshold	V <sub>OVP</sub>		--	1.2	--	V
OVP Input Current	I <sub>OVP</sub>	$0.7V \leq V_{OVP} \leq 1.5V$	--	--	0.1	μA
Soft Start SS Pin Current	I <sub>SS</sub>	V <sub>SS</sub> ≤ 2V	--	6	--	μA

**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 for extended periods may affect device reliability.

**Note 2.** Devices are ESD sensitive. Handling precaution is recommended.

**Note 3.** The device is not guaranteed to function outside its operating conditions.

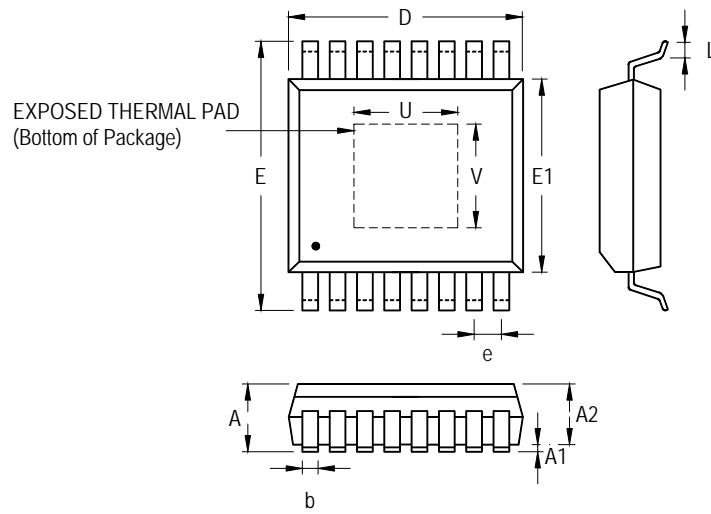
**Note 4.** θ<sub>JA</sub> is measured in the natural convection at T<sub>A</sub> = 25°C on a high effective four layers thermal conductivity test board of JEDEC 51-7 thermal measurement standard.

**Note 5.** When the natural maximum duty cycle of 1MHz switching frequency is reached, the switching cycle will be skipped (not reset) as the operating condition requires to effectively stretch and achieve higher on cycle than the natural maximum duty cycle set by the 1MHz switching frequency.

**Datasheet Revision History**

Version	Date	Page No.	Item	Description
00C	2007/10/5			first edition
01C	2007/10/9			Modify
02C	2007/11/28		Application Circuit & Spec.	Add and Modify
03C	2008/6/24		General Description Typical Application Circuit Functional Pin Description Absolute Maximum Ratings Electrical Characteristics	Modify
04C	2008/8/5			Add TSSOP-16 (Exposed Pad) Package

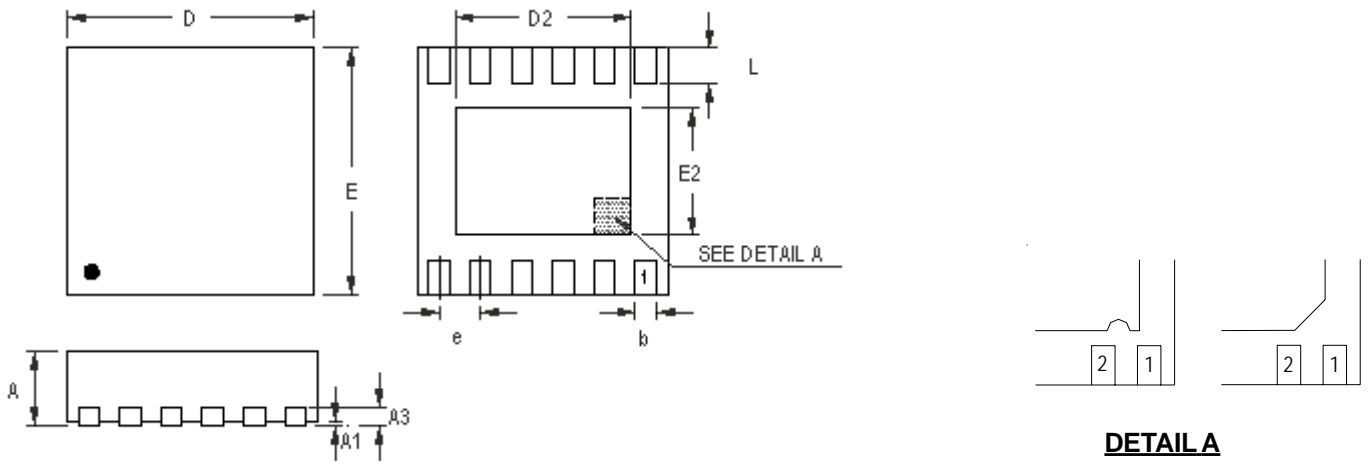
Outline Dimension



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	0.850	1.200	0.033	0.047
A1	0.000	0.150	0.000	0.006
A2	0.800	1.050	0.031	0.041
b	0.190	0.300	0.007	0.012
D	4.900	5.100	0.193	0.201
e	0.65		0.026	
E	6.200	6.600	0.244	0.260
E1	4.300	4.500	0.169	0.177
L	0.450	0.750	0.018	0.030
U	2.000	3.000	0.079	0.118
V	2.000	3.000	0.079	0.118

16-Lead TSSOP (Exposed Pad) Plastic Package





**DETAIL A**

Pin #1 ID and Tie Bar Mark Options

Note : The configuration of the Pin #1 identifier is optional, but must be located within the zone indicated.

Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	0.700	0.800	0.028	0.031
A1	0.000	0.050	0.000	0.002
A3	0.175	0.250	0.007	0.010
b	0.150	0.250	0.006	0.010
D	2.950	3.050	0.116	0.120
D2	2.300	2.650	0.091	0.104
E	2.950	3.050	0.116	0.120
E2	1.400	1.750	0.055	0.069
e	0.450		0.018	
L	0.350	0.450	0.014	0.018

**W-Type 12L DFN 3x3 Package**

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