RICHTEK®

High Voltage High Current LED Driver Controller for Buck, Boost or Buck-Boost Topology

General Description

The RT8494 is a current mode PWM controller designed to drive an external MOSFET for high current LED applications. With a current sense amplifier threshold of 190mV, the LED current is programmable with one external current sense resistor. With the maximum operating input voltage of 36V and output voltage up to 90V, the RT8494 is ideal for Buck, Boost or Buck-Boost operation.

With the switching frequency programmable over 100kHz to 1MHz, the external inductor and capacitors can be small while maintaining high efficiency.

Dimming can be done by either analog or digital. The built-in clamping comparator and filter allow easy low noise analog dimming conversion from digital signal with only one external capacitor.

The RT8494 is available in SOP-14 package.

Ordering Information

RT8494 □□

    Package Type
    S : SOP-14

    Lead Plating System
    G : Green (Halogen Free and Pb Free)
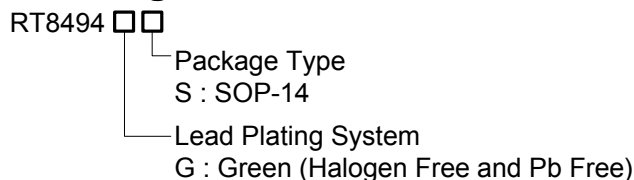
Note :

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.

Features

- **High Voltage Capability : V$_{IN}$ up to 36V, LED Sensing Threshold Common Mode Voltage up to 90V**
- **Buck, Boost or Buck-Boost Operation**
- **Programmable Switching Frequency**
- **Easy Dimming Control : Analog or Digital Converting to Analog with One External Capacitor**
- **Programmable Soft-Start to Avoid Inrush Current**
- **Programmable Over-Voltage Protection**
- **V$_{IN}$ Under-Voltage Lockout and Thermal Shutdown**
- **AEC-Q100 Compliance**

Applications

- General Industrial High Power LED Lighting
- Desk Lights and Room Lighting
- Building and Street Lighting
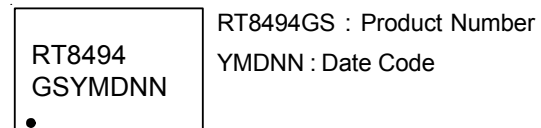- Industrial Display Backlight

Pin Configurations

(TOP VIEW)

RSET	1	14 GATE
ISW	2	13 GBIAS
ISP	3	12 GND
ISN	4	11 VCC
VC	5	10 OVP
ACTL	6	9 EN
DCTL	7	8 SS
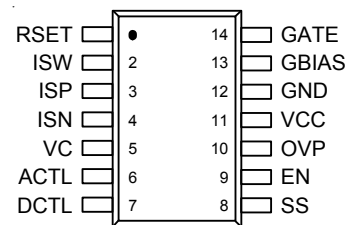
SOP-14

Marking Information

RT8494
GSYMDNN

RT8494GS : Product Number
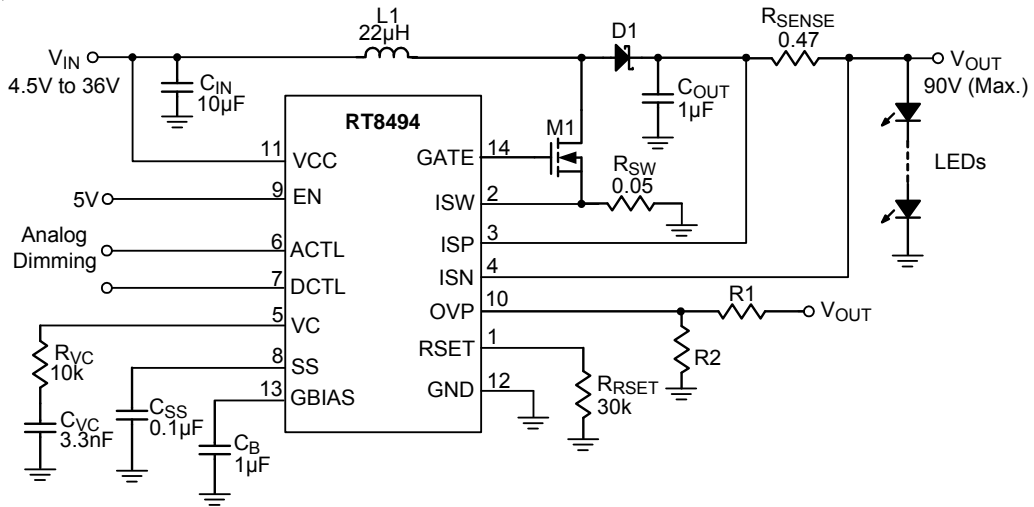
YMDNN : Date Code

Typical Application Circuit

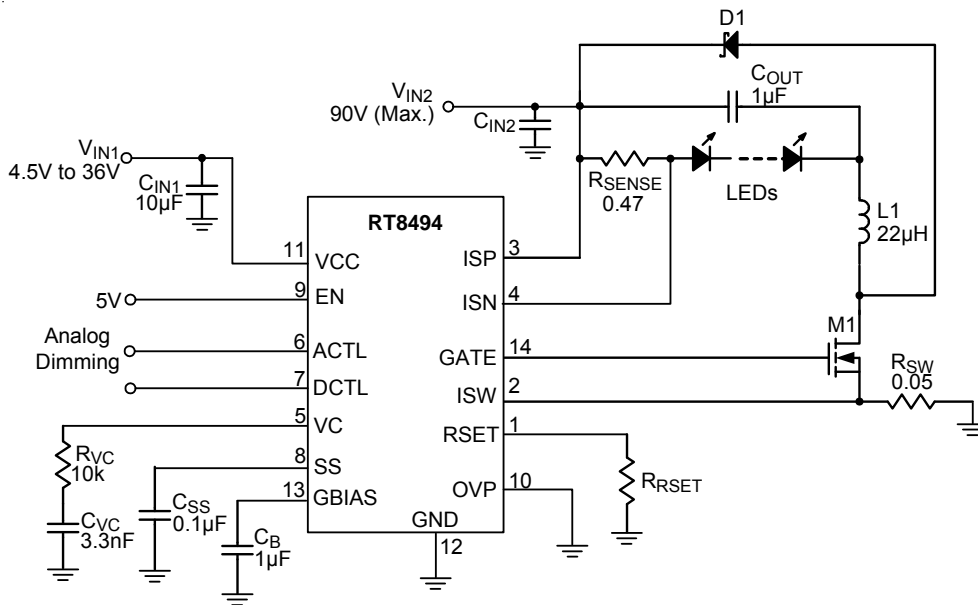Figure 1. Analog Dimming in Boost Configuration

Figure 2. Analog Dimming in Buck Configuration

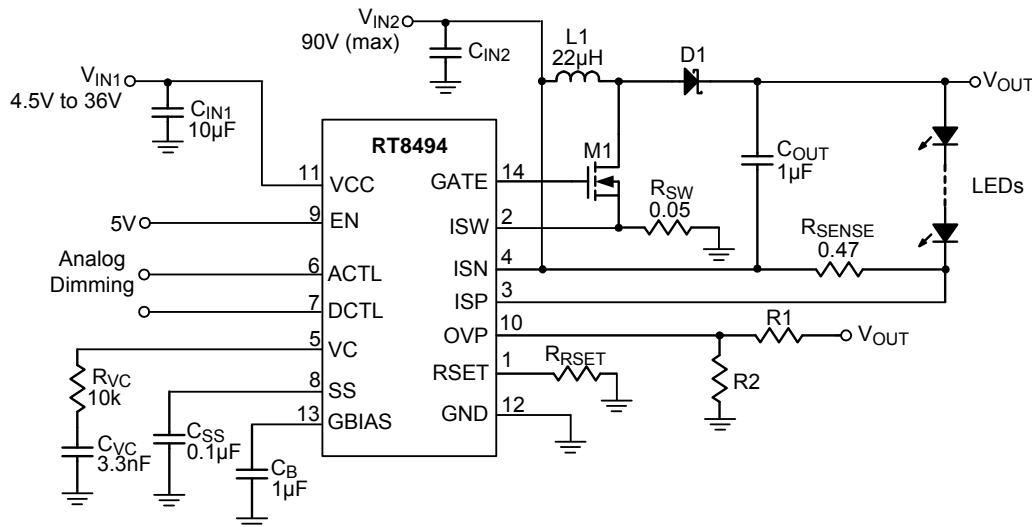Figure 3. Analog Dimming in Buck-Boost Configuration

Functional Pin Description

Pin No.	Pin Name	Pin Function
1	RSET	Switch Frequency Setting. Connect a resistor from RSET to GND. $R_{RSET} = 30k\Omega$ will set $f_{SW} = 350kHz$.
2	ISW	External MOSFET Switch Current Sense. Connect the current sense resistor between external N-MOSFET switch and the ground.
3	ISP	LED Current Sense Amplifier Positive Input with Common Mode up to 90V.
4	ISN	LED Current Sense Amplifier Negative Input. Voltage threshold between ISP and ISN is 190mV with common mode voltage up to 90V.
5	VC	PWM Control Loop Compensation.
6	ACTL	Analog Dimming Control. The effective programming voltage range of the pin is between 0.2V and 1.2V.
7	DCTL	By adding a $0.47\mu F$ filtering capacitor on ACTL pin, the PWM dimming signal on DCTL pin can be averaged and converted into analog dimming signal on the ACTL pin.
8	SS	Soft-Start Time Setting. A capacitor of at least 10nF is required for proper soft-start.
9	EN	Enable Control Input (Active High). When this pin voltage is low, the chip is in shutdown mode.
10	OVP	Over-Voltage Protection. The PWM converter turns off when the voltage of the pin goes to higher than 1.18V.
11	VCC	Power Supply of the Chip. For good bypass, a low ESR capacitor is required.
12	GND	Ground. The Exposed Pad must be Soldered to a Large PCB and Connected to GND for Maximum Power Dissipation.
13	GBIAS	Internal Gate Driver Bias. A good bypass capacitor is required.
14	GATE	External MOSFET Switch Gate Driver Output.

RT8494

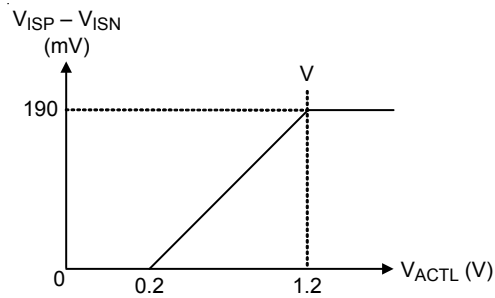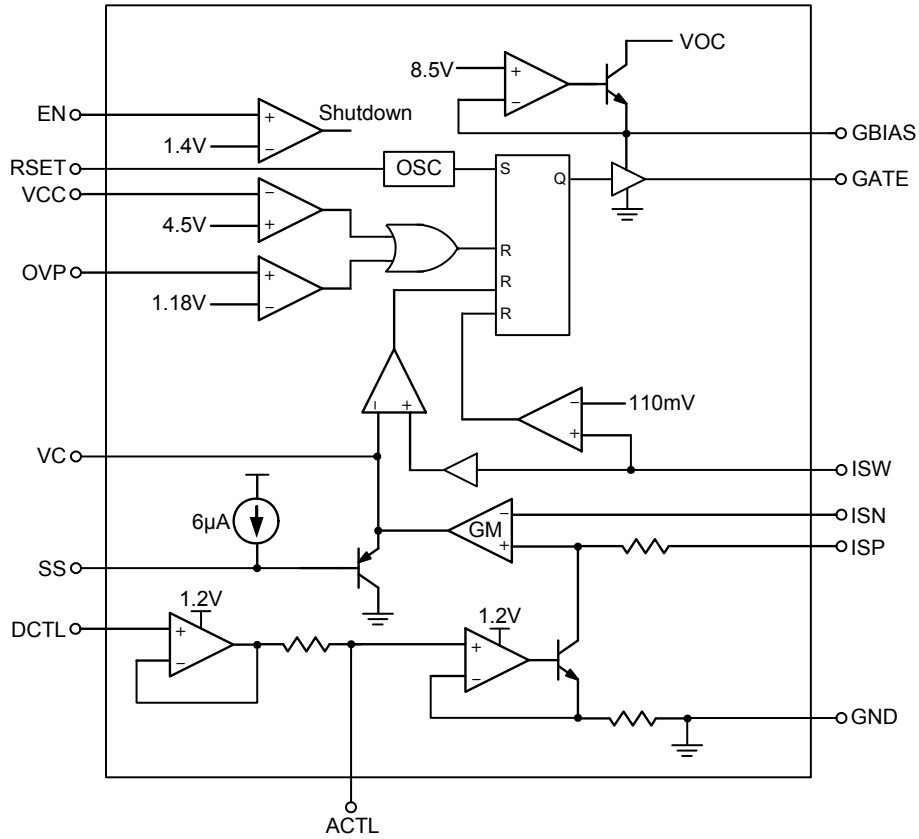## Function Block Diagram

Figure 4

Operation

The startup voltage of the RT8494 is around 4.5V. When VCC voltage is greater than 4.5V, the RT8494 starts operation and a regulated GBIAS supply voltage is generated by an internal LDO circuit. With VCC greater than 10V, the GBIAS supply will be regulated around 8.5V to supply the power for the internal GATE pin driver circuit.

As the system starts, the capacitor at the soft-start pin is slowly charged by an internal current source around 6μA. During soft-start period, the VC pin voltage follows the soft-start pin voltage up by one VBE and gradually ramps up. The slowly rising VC pin voltage allows the PWM duty to increase gradually to achieve soft-start function.

In normal operation, the GATE turns high when the oscillator (OSC) turns high. The ISW pin voltage is the triangular feedback signal of the sensed switch current (which equals inductor current ramp).

The PWM comparator compares the ISW pin voltage to the VC pin voltage. When the ISW pin voltage exceeds the VC pin voltage, the PWM comparator resets the latch and turns off GATE. If the ISW pin voltage does not exceed the VC pin voltage by the end of the switching cycle, the GATE will be turned off by the OSC circuit for a minimum off time. The cycle repeats when the GATE is turned on at the beginning of the next OSC cycle.

The RT8494 features high voltage LED driver control. The common mode operation voltage of the ISP and ISN pins can be high up to 90V. The regulated ($V_{ISP} - V_{ISN}$) sense threshold voltage is around 190mV. If the sensed ($V_{ISP} - V_{ISN}$) voltage is lower than 190mV, the VC pin will be charged higher by the internal OP AMP in the PWM control loop and vice versa. By the PWM closed loop control, the ($V_{ISP} - V_{ISN}$) voltage is regulated to 190mV.

The actual LED output current can be adjusted by the sense resistor between the ISP and ISN pins.

The dimming can be done by varying the ACTL/DCTL pin voltage signal. The internal sense threshold reference for ($V_{ISP} - V_{ISN}$) regulation follows the ACTL/DCTL signal to achieve dimming control.

The fault protection features of the RT8494 include (1) VCC Under-Voltage Lockout (UVLO) (2) VOUT Over-Voltage Protection (OVP) (3) switch Over-Current Protection (OCP) (4) Over-Temperature Protection (OTP).

Absolute Maximum Ratings   (Note 1)

- Supply Input Voltage, VCC -- −0.3V to 38V
- GBIAS, GATE -- −0.3V to 10V
- ISW -- −0.3V to 1V
- ISP, ISN --- −0.3V to 100V
- DCTL, ACTL, OVP --- −0.3V to 8V (Note 2)
- EN --- −0.3V to 20V
- Power Dissipation, P_D @ T_A = 25°C
  SOP-14 --- 0.87W
- Package Thermal Resistance   (Note 3)
  SOP-14, θ_{JA} --- 113.9°C/W
- Junction Temperature -- 150°C
- Lead Temperature (Soldering, 10 sec.) --- 260°C
- Storage Temperature Range --- −65°C to 150°C
- ESD Susceptibility   (Note 4)
  HBM (Human Body Model) --- 2kV
  MM (Machine Model) --- 200V

Recommended Operating Conditions   (Note 5)

- Supply Input Voltage Range, VCC --- 4.5V to 36V
- Junction Temperature Range -- −40°C to 125°C

Electrical Characteristics

(V_{CC} = 24V, No Load on any Output, −40°C < T_A < 125°C, unless otherwise specified)

Parameter		Symbol	Test Conditions	Min	Typ	Max	Unit
Overall							
Supply Current		I_{VCC}	$V_{VC} \leq 0.4V$ (Switching off)	--	6	7.2	mA
Shutdown Current		I_{SHDN}	$V_{EN} \leq 0.7V$	--	12	--	μA
EN Threshold Voltage	Logic-High	V_{IH}		2	--	--	V
	Logic-Low	V_{IL}		--	--	0.5	
EN Input Current			$V_{EN} \leq 3V$	--	--	1.2	μA
Current Sense Amplifier							
Input Threshold ($V_{ISP} - V_{ISN}$)			$V_{ACTL} \geq 1.25V$, 12V ≤ common mode ≤ 90V	182	190	198	mV
			1.25V ≥ V_{ACTL} ≥ 1.2V, (Note 7) 12V ≤ common mode ≤ 90V	--	188	--	
ISP Input Current		I_{ISP}	$4.5V \leq V_{ISP} \leq 90V$	--	140	--	μA
ISN Input Current		I_{ISN}	$4.5V \leq V_{ISN} \leq 90V$	--	60	--	μA
VC Output Current		I_{VC}	$0.5V \leq V_C \leq 2.4V$	--	±20	--	μA
VC Threshold for PWM Switch Off				--	0.7	--	V

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
LED Dimming						
Analog Dimming ACTL Pin Input Current	I_{ACTL}	V_{ACTL} = 1.2V	--	1	--	μA
		V_{ACTL} = 0.2V	--	10	--	
LED Max Current Threshold at ACTL	V_{ACTL_On}		--	1.3	--	V
LED Current Off Threshold at ACTL	V_{ACTL_Off}		--	0.2	--	V
DCTL Input Current	I_{DCTL}	$0.3V \leq V_{DCTL} \leq 5V$	--	--	0.5	μA
DCTL Threshold Voltage	V_{DCTL_H}	(Note 6)	2	--	--	V
	V_{DCTL_L}	(Note 6)	--	--	0.3	
PWM Control						
Switching Frequency	f_{SW}	R_{RSET} = 30kΩ	280	350	420	kHz
Minimum Off-Time		R_{RSET} = 30kΩ	--	250	--	ns
		Switch Gate Driver				
GBIAS Voltage	V_{GBIAS}	I_{GBIAS} = 20mA	7.8	8.5	9.2	V
GATE Voltage High	V_{GATE_H}	I_{GATE} = −50mA	6	7.2	7.8	V
		I_{GATE} = −100μA	7.5	7.8	7.9	
GATE Voltage Low	V_{GATE_L}	I_{GATE} = 10mA	--	0.5	1	V
		I_{GATE}= 100μA	--	0.1	0.9	
GATE Drive Rise and Fall Time		1nF Load at GATE	--	20	100	ns
PWM Switch Current Limit Threshold	I_{SW_LIM}		80	110	145	mV
OVP and Soft-Start						
OVP Threshold	V_{OVP_th}		--	1.18	--	V
OVP Input Current	I_{OVP}	$0.7V \leq V_{OVP} \leq 1.5V$	--	--	0.1	μA
Soft-Start Pin Current	I_{SS}	$V_{SS} \leq 2V$	--	6	--	μA
Thermal Shutdown Protection	T_{SD}		--	145	--	°C
Thermal Shutdown Hysteresis	ΔT_{SD}		--	10	--	

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. If connected with a 20kΩ serial resistor, ACTL and DCTL can go up to 36V.

Note 3. θ_{JA} is measured at T_A = 25°C on a high effective thermal conductivity four-layer test board per JEDEC 51-7. θ_{JC} is measured at the exposed pad of the package.
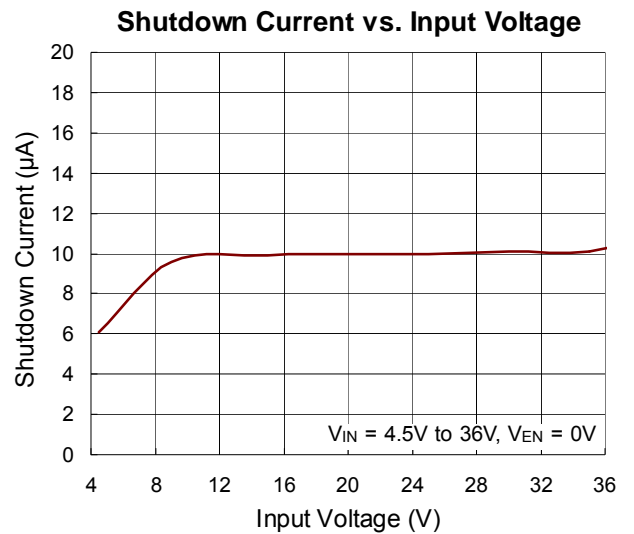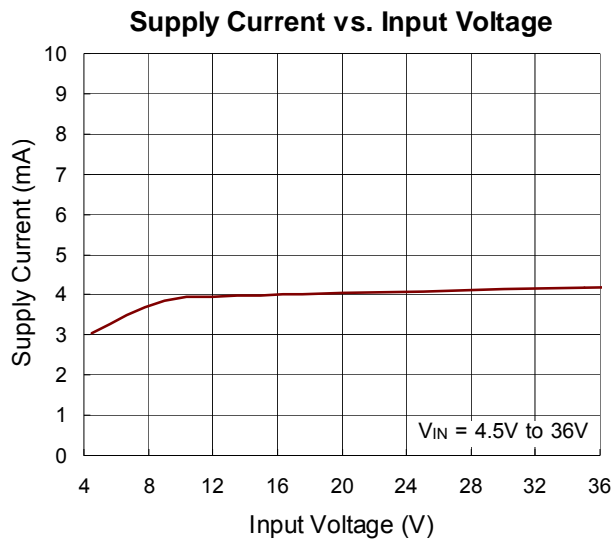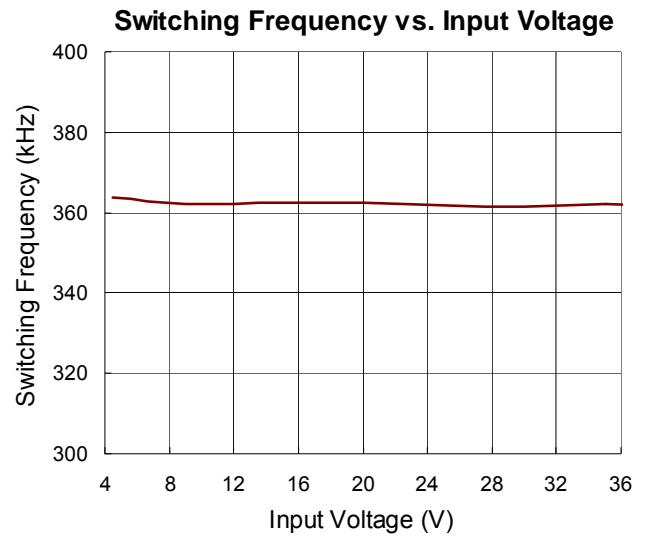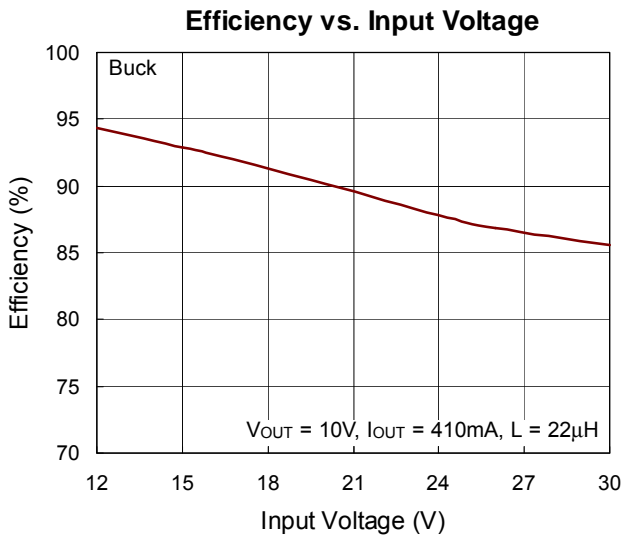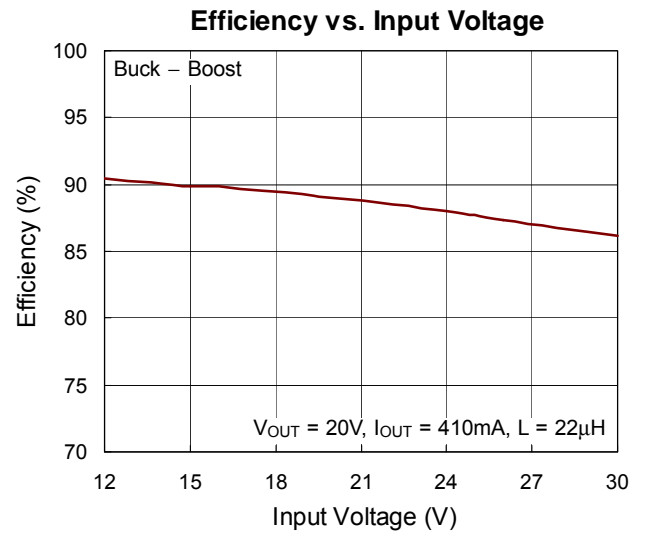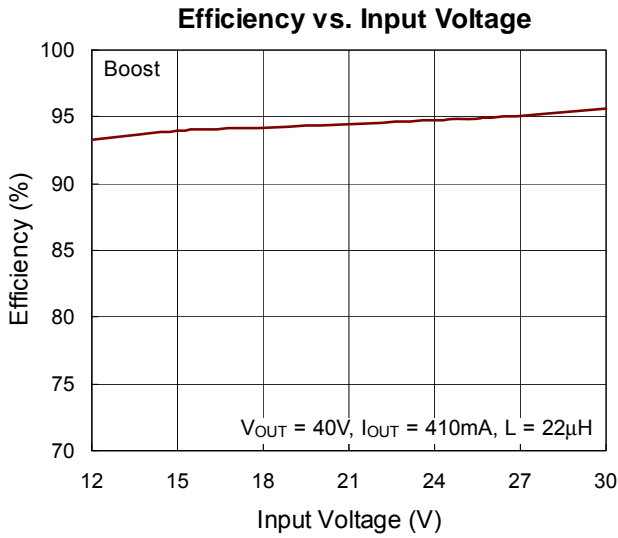
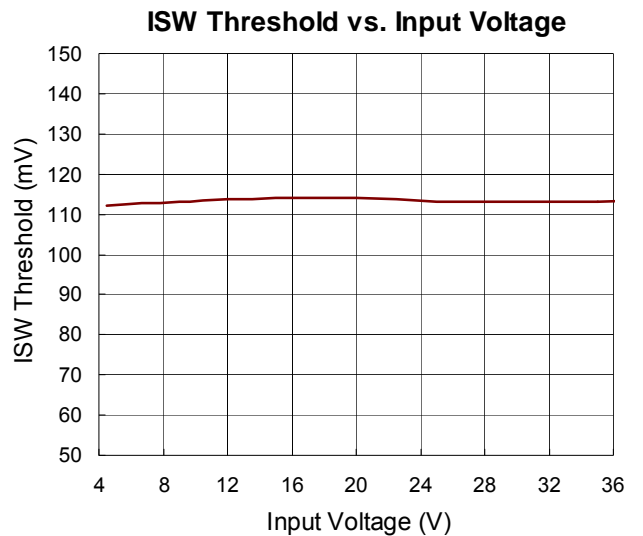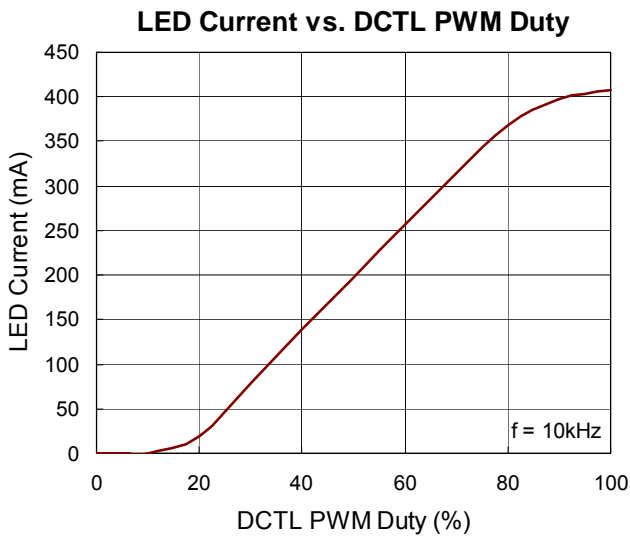**Note 4.** Devices are ESD sensitive. Handling precaution is recommended.
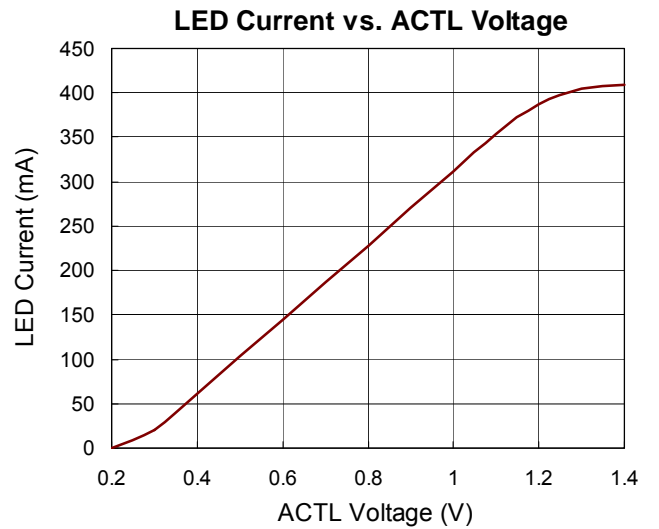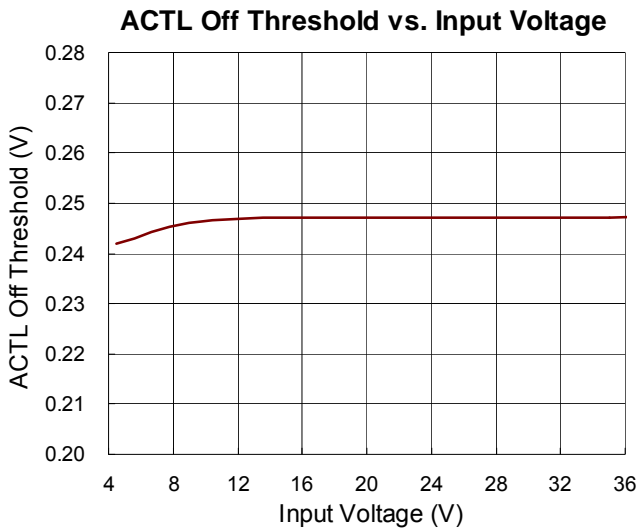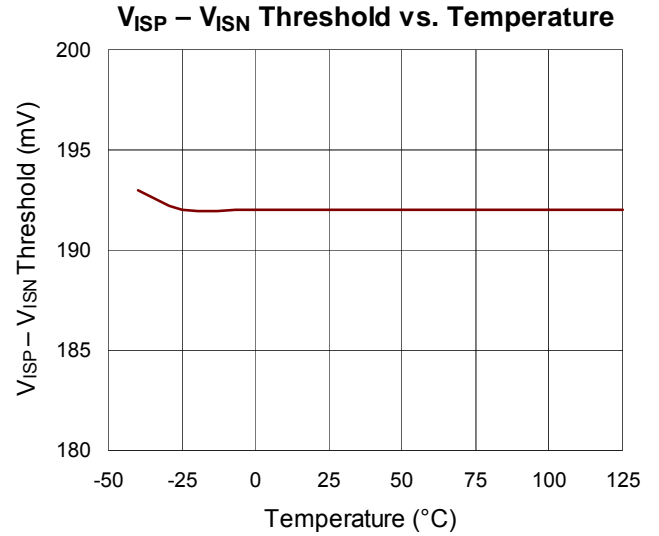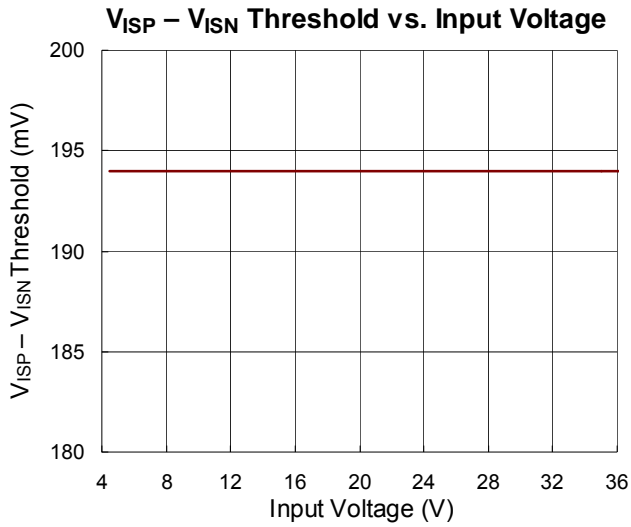
Note 5. The device is not guaranteed to function outside its operating conditions.

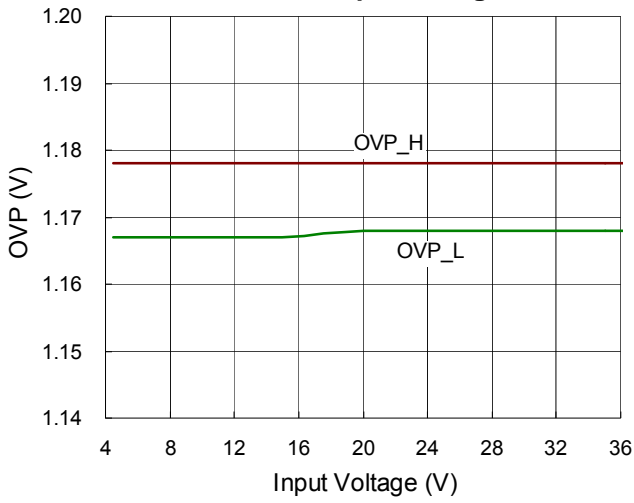**Note 6.** Guaranteed by design, not subjected to production test.

Note 7. The ACTL dimming curve is saturating when $V_{ACTL} \geq 1.2V$. Please refer to typical operation characteristics curve of I_{LED} vs V_{ACTL}. This item is not subjected to production test.
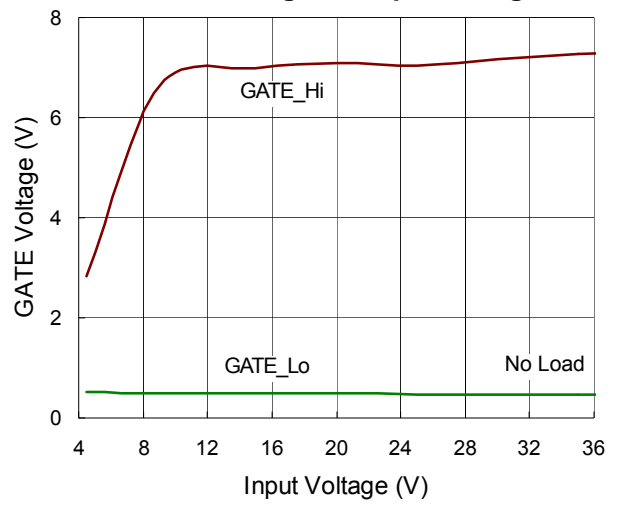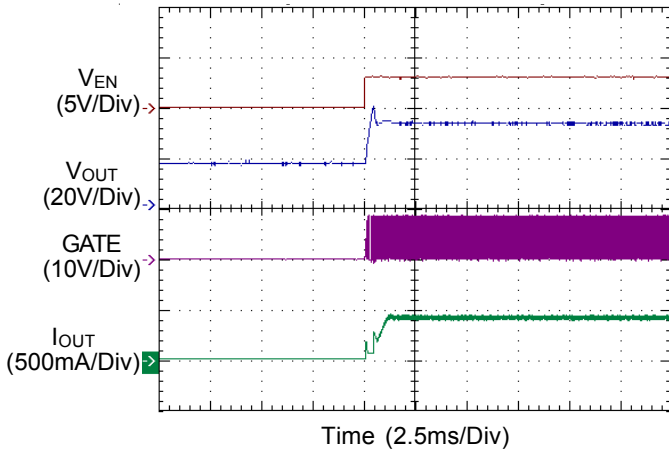
Typical Operating Characteristics

Efficiency vs. Input Voltage

Boost

V_{OUT} = 40V, I_{OUT} = 410mA, L = 22μH

Efficiency vs. Input Voltage

Buck − Boost

V_{OUT} = 20V, I_{OUT} = 410mA, L = 22μH

Efficiency vs. Input Voltage

Buck

V_{OUT} = 10V, I_{OUT} = 410mA, L = 22μH

Switching Frequency vs. Input Voltage

Supply Current vs. Input Voltage

V_{IN} = 4.5V to 36V

Shutdown Current vs. Input Voltage

V_{IN} = 4.5V to 36V, V_{EN} = 0V

V$_{ISP}$ − V$_{ISN}$ Threshold vs. Input Voltage

V$_{ISP}$ − V$_{ISN}$ Threshold vs. Temperature

ACTL Off Threshold vs. Input Voltage

LED Current vs. ACTL Voltage

LED Current vs. DCTL PWM Duty

f = 10kHz

ISW Threshold vs. Input Voltage

OVP vs. Input Voltage

OVP (V) vs Input Voltage (V)

OVP_H

OVP_L

GATE Voltage vs. Input Voltage

GATE Voltage (V) vs Input Voltage (V)

GATE_Hi

GATE_Lo

No Load

Power On from EN

V_EN (5V/Div)

V_OUT (20V/Div)

GATE (10V/Div)

I_OUT (500mA/Div)

Time (2.5ms/Div)

Power Off from EN

V_EN (5V/Div)

V_OUT (20V/Div)

GATE (10V/Div)

I_OUT (500mA/Div)

Time (100μs/Div)
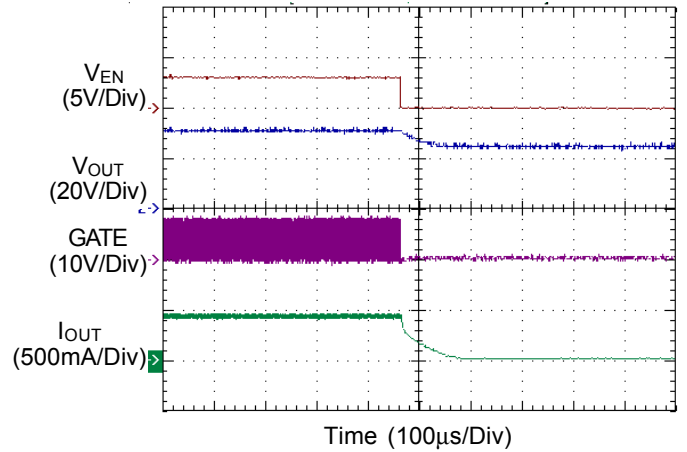
Applications Information

The RT8494 is a current mode PWM controller designed to drive an external MOSFET for high current LED applications. The LED current can be programmed by an external resistor. The input voltage range of the RT8494 can be up to 36V and the output voltage can be up to 90V. The RT8494 provides analog and PWM dimming to achieve LED current control.

GBIAS Regulator and Bypass Capacitor

The GBIAS pin requires a capacitor for stable operation and to store the charge for the large GATE switching currents. Choose a 25V rated low ESR, X7R or X5R ceramic capacitor for best performance. The value of a 1μF capacitor will be adequate for many applications.

Place the capacitor close to the IC to minimize the trace length to the GBIAS pin and also to the IC ground. An internal current limit on the GBIAS output protects the RT8494 from excessive on-chip power dissipation.

The GBIAS pin has its own under voltage disable (UVLO) set to 4.3V(typical) to protect the external FETs from excessive power dissipation caused by not being fully enhanced. If the input voltage, VIN, will not exceed 8V, then the GBIAS pin should be connected to the input supply. Be aware if GBIAS supply is used to drive extra circuits besides RT8494, typically the extra GBIAS load should be limited to less than 10mA.

Loop Compensation

The RT8494 uses an internal error amplifier whose compensation pin (VC) allowing the loop response optimized for specific application. The external inductor, output capacitor and the compensation resistor and capacitor determine the loop stability. The inductor and output capacitor are chosen based on performance, size and cost. The compensation resistor and capacitor at VC are selected to optimize control loop response and stability. For typical LED applications, a 3.3nF compensation capacitor at VC is adequate, and a series resistor should always be used to increase the slew rate on the VC pin to maintain tighter regulation of LED current during fast transients on the input supply to the converter an external resistor in series with a capacitor is connected from the VC pin to GND to provide a pole and a zero for proper loop compensation. The typical compensation for the RT8494 is 10kΩ and 3.3nF.

Soft-Start

The soft-start of the RT8494 can be achieved by connecting a capacitor from SS pin to GND. The built-in soft-start circuit reduces the start-up current spike and output voltage overshoot. The soft-start time is determined by the external capacitor charged by an internal 6μA constant charging current. The SS pin directly limits the rate of voltage rise on the VC pin, which in turn limits the peak switch current.

The soft-start interval is set by the soft-start capacitor selection according to the equation :

$$t_{SS} = C_{SS} \times \frac{2.4V}{6\mu A}$$

A typical value for the soft-start capacitor is 0.1μF. The soft-start capacitor is discharged when EN/UVLO falls below its threshold, during an over temperature event or during an GBIAS under voltage event.

LED Current Setting

The LED current is programmed by placing an appropriate value current sense resistor between the ISP and ISN pins. Typically, sensing of the current should be done at the top of the LED string. The ACTL pin should be tied to a voltage higher than 1.2V to get the full-scale 190mV (typical) threshold across the sense resistor. The ACTL pin can also be used to dim the LED current to zero, although relative accuracy decreases with the decreasing voltage sense threshold. When the ACTL pin voltage is less than 1.2V, the LED current is :

$$I_{LED} = \frac{(V_{ACTL} - 0.2) \times 0.19}{R_{SENSE}}$$

Where,

R_{SENSE} is the resistor between ISP and ISN.

When the voltage of ACTL is higher than 1.2V, the LED current is regulated to :

$$I_{LED(MAX)} = \frac{190mV}{R_{SENSE}}$$

The ACTL pin can also be used in conjunction with a thermistor to provide over temperature protection for the LED load, or with a voltage divider to V_{IN} to reduce output power and switching current when V_{IN} is low. The presence of a time varying differential voltage signal (ripple) across ISP and ISN at the switching frequency is expected.

The amplitude of this signal is increased by high LED load current, low switching frequency and/or a smaller value output filter capacitor. The compensation capacitor on the VC pin filters the signal so the average difference between ISP and ISN is regulated on the user-programmed value.

Programmable Switching Frequency

The RSET frequency adjust pin allows the user to program the switching frequency from 100kHz to 1MHz for optimized efficiency and performance or external component size. Higher frequency operation allows for smaller component size but increases switching losses and gate driving current, and may not allow sufficiently high or low duty cycle operation. Lower frequency operation gives better performance but with larger external component size. For an appropriate R_{RSET} resistor value see Table 1 or Figure 5. An external resistor from the RSET pin to GND is required and do not leave this pin open.

Table 1. Switching Frequency vs. R_{RSET} Value (1% Resistors)

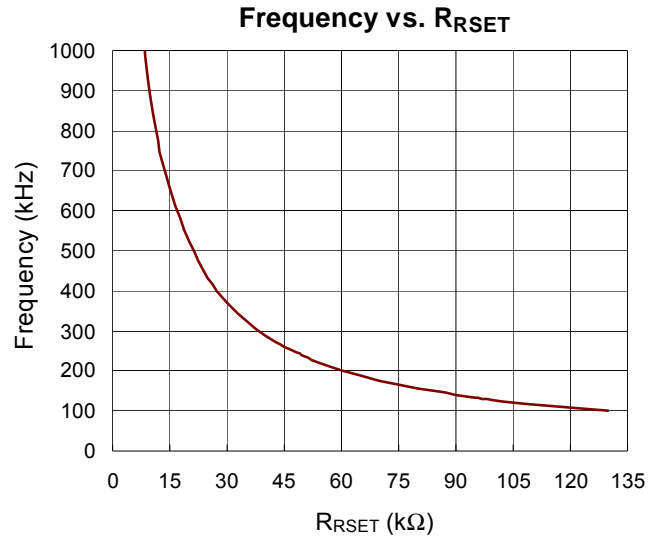| f$_{OSC}$ (kHZ)	R$_{RSET}$ (kΩ)
1000	8.34
800	11.41
600	16.68
500	20.9
300	38.04
200	60.35
100	130

Figure 5. Switching Frequency vs. R_{RSET}

Output Over-Voltage Setting

The RT8494 is equipped with an Over-Voltage Protection (OVP) function. When the voltage at OVP pin exceeds a threshold of approximately 1.18V, the power switch is turned off. The power switch can be turned on again once the voltage at OVP pin drops below 1.18V. For the Boost and Buck-Boost application, the output voltage could be clamped at a certain voltage level. The OVP voltage can be set by the following equation :

$$V_{OUT, OVP} = 1.18 \times \left(1 + \frac{R1}{R2}\right)$$

Where,

R1 and R2 are the voltage divider from V_{OUT} to GND with the divider center node connected to OVP pin.

For Buck-Boost application, select a resistor according to :

$$R_{SW, Buck-Boost} = \left(\frac{V_{IN} \times 0.08V}{(V_{IN} + V_{OUT}) \times I_{OUT}}\right)$$

For Boost application, select a resistor according to :

$$R_{SW, Boost} = \left(\frac{V_{IN} \times 0.08V}{V_{OUT} \times I_{OUT}}\right)$$

The placement of R_{SW} should be close to the source of the N-MOSFET and GND of the RT8494. The ISW pin input to RT8494 should be a Kelvin connection to the positive terminal of R_{SW}.

Over-Temperature Protection

The RT8494 provides an Over-Temperature Protection (OTP) function to prevent the excessive power dissipation from overheating. The OTP function will shut down switching operation when the die junction temperature exceeds 145°C. The chip will automatically start to switch again when the die junction temperature cools off.

Inductor Selection

The converter operates in discontinuous conduction mode when the inductance value is less than the value L_{BCM}. With an inductance greater than L_{BCM}, the converter operates in Continuous Conduction Mode (CCM). The inductance L_{BCM} is determined by the following equations.

For Buck application :

$$L_{BCM} = \frac{V_{OUT}}{2 \times I_{OUT} \times f} \times \left(\frac{V_{IN} - V_{OUT}}{V_{IN}} \right)$$

For Boost application :

$$L_{BCM} = \frac{V_{IN}^2}{2 \times I_{OUT} \times f} \times \left(\frac{V_{OUT} - V_{IN}}{V_{OUT}^2} \right)$$

For Buck-Boost application :

$$L_{BCM} = \frac{V_{IN}^2}{2 \times I_{OUT} \times f} \times \frac{V_{OUT}}{\left(V_{IN} + V_{OUT} \right)^2}$$

where

V_{OUT} = output voltage.

V_{IN} = input voltage.

f = operating frequency.

I_{OUT} = LED current.

Choose an inductance based on the operating frequency, input voltage and output voltage to provide a current mode ramp signal during the MOSFET on period for PWM control loop regulation. The inductance also determines the inductor ripple current. Operating the converter in CCM is recommended, which will have the smaller inductor ripple current and hence the less conduction losses from all converter components.

As a design example, to design the peak to peak inductor ripple to be ±30% of the output current, the following equations can be used to estimate the size of the needed inductance :

For Buck application :

$$L = \frac{V_{OUT}}{2 \times 0.3 \times I_{OUT} \times f} \times \left(\frac{V_{IN} - V_{OUT}}{V_{IN}} \right)$$

For Boost application :

$$L = \frac{V_{IN}^2}{2 \times 0.3 \times I_{OUT} \times f} \times \left(\frac{V_{OUT} - V_{IN}}{V_{OUT}^2} \right)$$

For Buck-Boost application :

$$L = \frac{V_{IN}^2}{2 \times 0.3 \times I_{OUT} \times f} \times \frac{V_{OUT}}{\left(V_{IN} + V_{OUT} \right)^2}$$

The inductor must also be selected with a saturation current rating greater than the maximum inductor current during normal operation. The maximum inductor current can be calculated by the following equations.

For Buck application :

$$I_{PEAK} = I_{OUT} + \frac{V_{OUT}}{2 \times L \times f} \times \left(\frac{V_{IN} - V_{OUT}}{V_{IN}} \right)$$

For Boost application :

$$I_{PEAK} = \frac{V_{OUT} \times I_{OUT}}{\eta \times V_{IN}} + \frac{V_{IN}}{2 \times L \times f} \times \left(\frac{V_{OUT} - V_{IN}}{V_{OUT}} \right)$$

For Buck-Boost application :

$$I_{PEAK} = \frac{\left(V_{IN} \times V_{OUT} \right) \times I_{OUT}}{\eta \times V_{IN}} + \frac{V_{IN}}{2 \times L \times f} \times \left(\frac{V_{OUT}}{V_{IN} + V_{OUT}} \right)$$

where

η is the efficiency of the power converter.

Power MOSFET Selection

For applications operating at high input or output voltages, the power N-MOS FET switch is typically chosen for drain voltage VDS rating and low gate charge. Consideration of switch on-resistance, $R_{DS(ON)}$, is usually secondary because switching losses dominate power loss. The GBIAS regulator on the RT8494 has a fixed current limit to protect the IC from excessive power dissipation at high VIN, so the N-MOSFET should be chosen so that the product of Qg at 5V and switching frequency does not exceed the GBIAS current limit.

ISW Sense Resistor Selection

The resistor, R_{SW}, between the Source of the external N-MOSFET and GND should be selected to provide adequate

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switch current to drive the application without exceeding the current limit threshold set by the ISW pin sense threshold of RT8494. The ISW sense resistor value can be calculated according to the formula below :

$$R_{SW} = \frac{\text{Current Limlit Threshold Minimum Value}}{I_{OCP}}$$

where I_{OCP} is about 1.33 to 1.5 times of inductor peak current I_{PEAK}.

The placement of RSW should be close to the source of the N-MOSFET and the IC GND of the RT8494. The ISW pin input to RT8494 should be a Kelvin sense connection to the positive terminal of R_{SW}.

Schottky Diode Selection

The Schottky diode, with their low forward voltage drop and fast switching speed, is necessary for the RT8494 applications. In addition, power dissipation, reverse voltage rating and pulsating peak current are the important parameters for the Schottky diode selection. Choose a suitable Schottky diode whose reverse voltage rating is greater than maximum output voltage. The diode's average current rating must exceed the average output current. The diode conducts current only when the power switch is turned off (typically less than 50% duty cycle). If using the PWM feature for dimming, it is important to consider diode leakage, which increases with the temperature, from the output during the PWM low interval. Therefore, choose the Schottky diode with sufficiently low leakage current.

Capacitor Selection

The input capacitor reduces current spikes from the input supply and minimizes noise injection to the converter. For most the RT8494 applications, a 10μF ceramic capacitor is sufficient. A value higher or lower may be used depending on the noise level from the input supply and the input current to the converter.

In Boost application, the output capacitor is typically a ceramic capacitor and is selected based on the output voltage ripple requirements. The minimum value of the output capacitor C_{OUT} is approximately given by the following equation :

$$C_{OUT} = \frac{I_{OUT} \times V_{OUT}}{V_{IN} \times V_{RIPPLE} \times f_{SW}}$$

For LED applications, the equivalent resistance of the LED is typically low and the output filter capacitor should be sized to attenuate the current ripple. Use of X7R type ceramic capacitors is recommended. Lower operating frequencies will require proportionately higher capacitor values.

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 θ_{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, θ_{JA}, is layout dependent. For SOP-14 packages, the thermal resistance, θ_{JA}, is 113.9°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 :

$$P_{D(MAX)} = (125°C - 25°C) / (113.9°C/W) = 0.87W \text{ for SOP-14 package}$$

The maximum power dissipation depends on the operating ambient temperature for fixed $T_{J(MAX)}$ and thermal resistance, θ_{JA}. The derating curves in Figure 6 allow the designer to see the effect of rising ambient temperature on the maximum power dissipation.
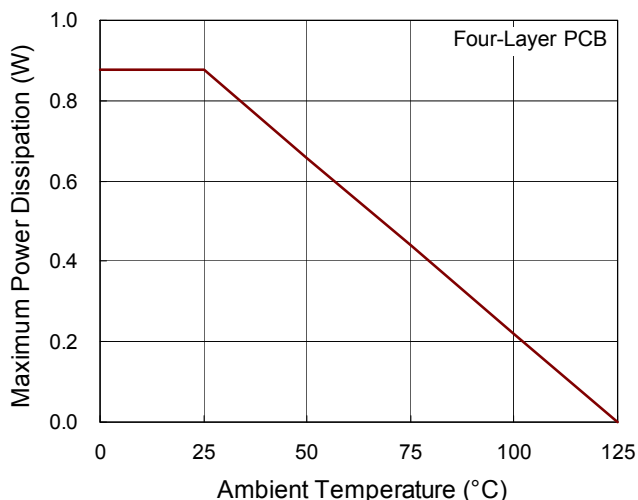

Figure 6. Derating Curve of Maximum Power Dissipation

Layout Consideration

PCB layout is very important to design power switching converter circuits. The layout guidelines are suggested as follows :

▸ The power components L1, D1, C_{IN}, M1 and C_{OUT} must be placed as close to each other as possible to reduce the ac current loop area. The PCB trace between power components must be as short and wide as possible due to large current flow through these traces during operation.

▸ The input capacitor C_{VCC} must be placed as close to VCC pin as possible.

▸ Place the compensation components to VC pin as close as possible to avoid noise pick up.

▸ Connect GND pin and Exposed Pad to a large ground plane for maximum power dissipation and noise reduction.

Place these components as close as possible
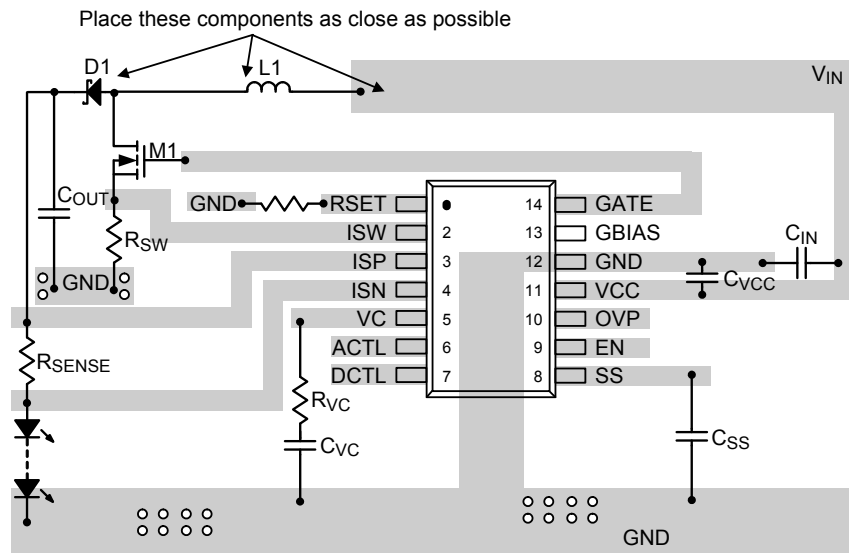
Figure 7. PCB Layout Guide

Outline Dimension
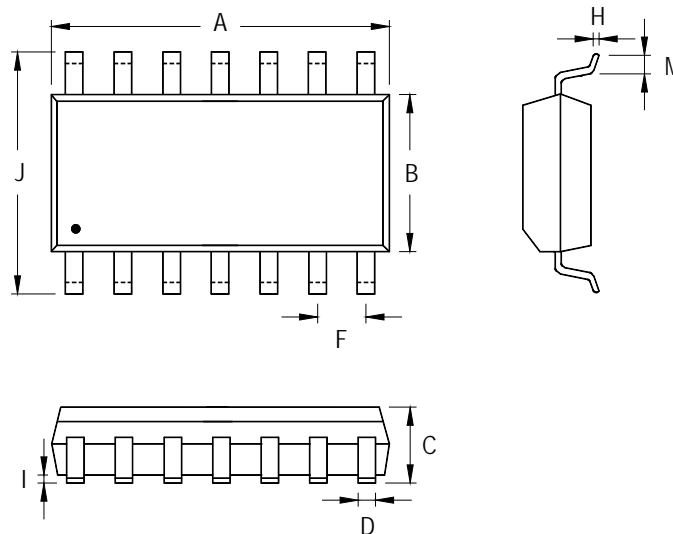
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	**Max**	**Min**	**Max**
A	8.534	8.738	0.336	0.344
B	3.810	3.988	0.150	0.157
C	1.346	1.753	0.053	0.069
D	0.330	0.508	0.013	0.020
F	1.194	1.346	0.047	0.053
H	0.178	0.254	0.007	0.010
I	0.102	0.254	0.004	0.010
J	5.791	6.198	0.228	0.244
M	0.406	1.270	0.016	0.050

14–Lead SOP Plastic Package