High Voltage Buck LED Driver with Dimming Control

General Description

The RT8406 is a current-mode LED driver supporting wide input voltage range from 10V to 60V. With internal adjustable operating frequency 135kHz and 270kHz, the size of the external inductor and input/output capacitors can be minimized at high operating frequency. High efficiency is achieved by a 100mV current sensing control. In addition, the RT8406 features low standby power. LED dimming control can be done from either analog or PWM signal and share the same pin. The RT8406 provides thermal shutdown to prevent the device from overheat. The RT8406 is available in the SOP-8 package.

Ordering Information

RT8406 □□

- Package Type
  S : SOP-8
- 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.

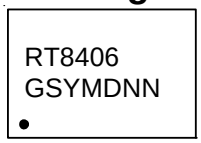
Features

- **1% Low Dimming Precision**
- **Low Standby Power Consumption**
- **High Input Voltage : VIN up to 60V**
- **Current-Mode PWM Control**
- **135kHz/270kHz Adjustable Switching Frequency**
- **Analog and PWM Dimming Control and Share the Same Pin**
- **Under-Voltage Lockout**
- **Cycle-by-Cycle Current Limitation**
- **Thermal Shutdown**
- **RoHS Compliant and Halogen Free**

Applications

- DC-DC LED Lighting Driver

Marking Information

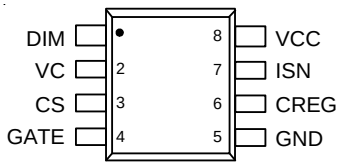


RT8406GS : Product Number

YMDNN : Date Code

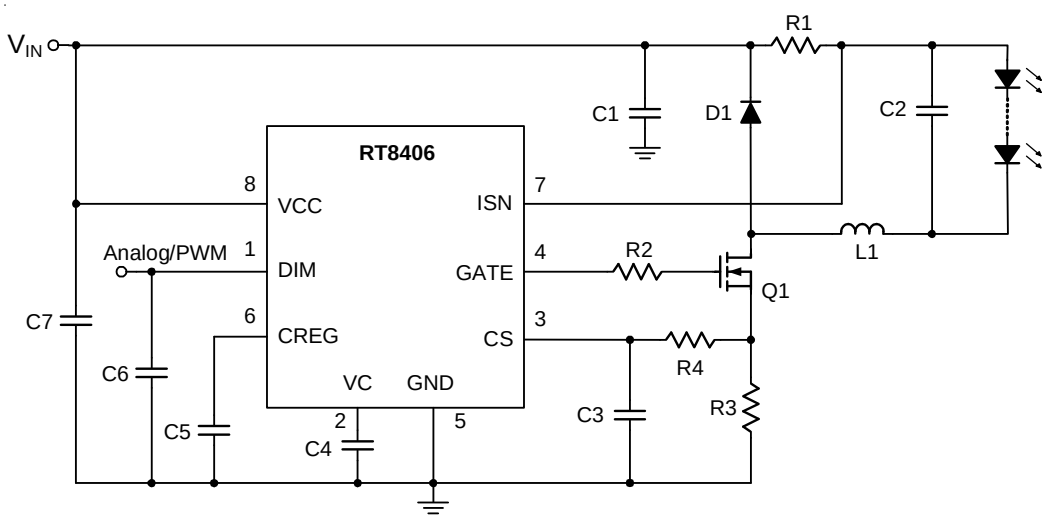
Pin Configuration

(TOP VIEW)



SOP-8

Typical Application Circuit



Suggested Component Values

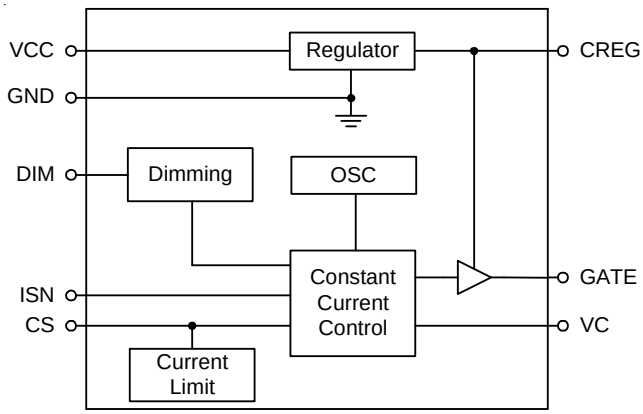
C4 (nF)	C5 (μF)	C6 (pF)	C7 (μF)	R2 (Ω)
1	1	47 Optional	1	22 Optional

Switch Frequency	C3 (nF)	R4 (kΩ)
270kHz	0.68	1
135kHz	1	2

Functional Pin Description

Pin No.	Pin Name	Pin Function
1	DIM	Analog or PWM dimming control input.
2	VC	PWM loop compensation node.
3	CS	MOSFET current sense input.
4	GATE	Gate driver output for external MOSFET switch.
5	GND	Ground of the controller.
6	CREG	Regulator output.
7	ISN	LED current sense input. Voltage threshold between VCC and ISN is100mV.
8	VCC	Supply voltage input. The controller will be enabled when VDD exceeds V_{TH_ON} and disabled when VDD is lower than V_{TH_OFF}.

Functional Block Diagram



Absolute Maximum Ratings (Note 1)

- VCC, ISN to GND ---------- –0.3V to 65V
- CREG, GATE to GND ---------- –0.3V to 20V
- DIM, VC, CS to GND ---------- –0.3V to 6V
- Power Dissipation, P_D @ T_A = 25°C
  SOP-8 ---------- 0.53W
- Package Thermal Resistance (Note 2)
  SOP-8, θ_{JA} ---------- 188°C/W
  SOP-8, θ_{JC} ---------- 47°C/W
- Junction Temperature ---------- 150°C
- Lead Temperature (Soldering, 10 sec.) ---------- 260°C
- Storage Temperature Range ---------- –65°C to 150°C
- ESD Susceptibility (Note 3)
  HBM (Human Body Model) ---------- 2kV

Recommended Operating Conditions (Note 4)

- Supply Input Voltage, VCC ---------- 12V to 60V
- Junction Temperature Range ---------- –40°C to 125°C
- Ambient Temperature Range ---------- –40°C to 85°C

Electrical Characteristics

(V_{CC} = 12V, C_{IN} = 1μF, T_A = 25°C, unless otherwise specified)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
VCC Section						
Rising UVLO Threshold Voltage	V_{TH_ON}		--	10	--	V
Falling UVLO Threshold Voltage	V_{TH_OFF}		--	8	--	V
Creg UV			--	7.8	--	
Supply Current	I_{VCC}		--	--	1.2	mA
Shutdown Current	I_{SD}		--	60	--	μA
Current Sense Section						
Input Current of ISN Pin	I_{ISN}	VISN = 60V	--	20	--	μA
Mean Current Sense Threshold Voltage		VCC – ISN DIM = 3V	--	100	--	mV
Current Limit			--	150	--	mV
Dimming Section						
Dimming High Threshold Voltage	V_{DIM_H}		--	2.8	--	V
Dimming Enabled Voltage	V_{DIM_EN}		--	0.35	--	V
Dimming Disabled Voltage	V_{DIM_DIS}		--	0.3	--	V
Dimming Enabled Hysteresis	V_{DIM_Hys}		--	50	--	mV
DIM sourcing Current	I_{DIM}		--	10	--	μA

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
Timing Control Section						
High Switching Frequency	f_{SW_H}	R_{LP} = 1kΩ, C_{LP} = 680pF	--	270	--	kHz
Low Switching Frequency	f_{SW_L}	R_{LP} = 2kΩ, C_{LP} = 1nF	--	135	--	kHz
Leading Edge Blanking time	t_{LEB}		--	150	--	ns
Shutdown Delay			--	2	--	s
Gate driving Section						
Rising Time	t_R	VCC = 15V, C_L = 1nF (10%~90%)	--	21	--	ns
Falling Time	t_F	VCC = 15V, C_L = 1nF (90%~10%)	--	18	--	ns
Gate Output Clamping Voltage	V_{CLAMP}	VCC = 15V	--	10	--	V
Internal Pull Low Resistor	R_{GATE}	VCC = 15V	--	40	--	kΩ
Over-Temperature Protection (OTP) Section						
OTP Temperature Threshold	T_{OTP}		--	150	--	°C
OTP Temperature Hysteresis	$T_{OTP-Hys}$		--	20	--	°C

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. θ_{JA} is measured under natural convection (still air) at T_A = 25°C with the component mounted on a high effective-thermal-conductivity four-layer test board on a JEDEC 51-7 thermal measurement standard. θ_{JC} is measured at the exposed pad of the package.

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

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

Application Information

LED Current Setting

$$I_{LED} = \frac{100mV}{R1}$$

Inductor Selection

Recommended : Inductor current ripple = ±30%

$$L1 = \frac{V_{LED}}{2 \times I_{LED} \times 30\%} \times (1 - \frac{V_{LED}}{V_{IN}}) \times \frac{1}{f_{SW}}$$

Current Limit Setting

Recommended : I_{OCP} = 150% x I_{LED}

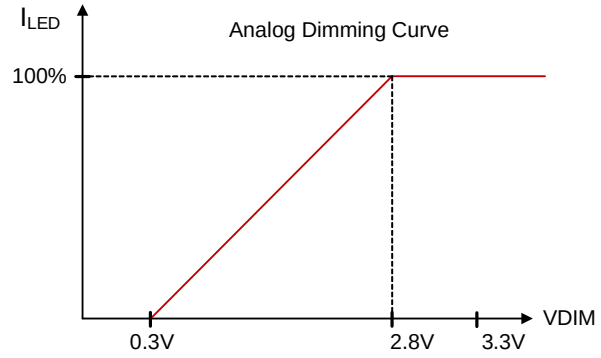
$$I_{OCP} = \frac{150mV}{R3}$$

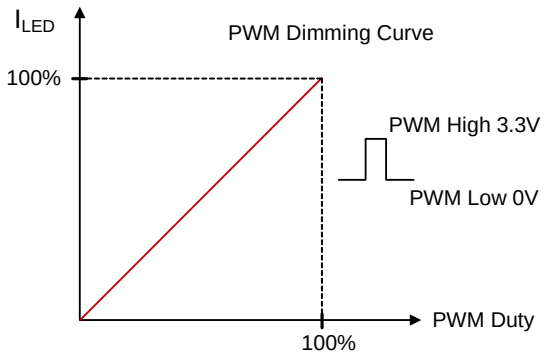
Dimming Application

Analog DIM : 0.3 to 2.8V

PWM DIM : Recommended PWM_H = 3.3V, PWM_L = 0V, Freq. = 500 to 1kHz.

Non-DIM : Connect a 47pF cap (optional).





Thermal Considerations

The junction temperature should never exceed the absolute maximum junction temperature $T_{J(MAX)}$, listed under Absolute Maximum Ratings, to avoid permanent damage to the device. The maximum allowable power dissipation depends on the thermal resistance of the IC package, the PCB layout, the rate of surrounding airflow, and the difference between the junction and ambient temperatures. The maximum power dissipation can be calculated using 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 continuous operation, the maximum operating junction temperature indicated under Recommended Operating Conditions is 125°C. The junction-to-ambient thermal resistance, θ_{JA}, is highly package dependent. For a SOP-8, the thermal resistance, θ_{JA}, is 188°C/W on a standard JEDEC 51-7 high effective-thermal-conductivity four-layer test board. The maximum power dissipation at T_A = 25°C can be calculated as below :

$P_{D(MAX)}$ = (125°C – 25°C) / (188°C/W) = 0.53W for a SOP-8 package.

The maximum power dissipation depends on the operating ambient temperature for the fixed $T_{J(MAX)}$ and the thermal resistance, θ_{JA}. The derating curves in Figure 1 allows the designer to see the effect of rising ambient temperature on the maximum power dissipation.

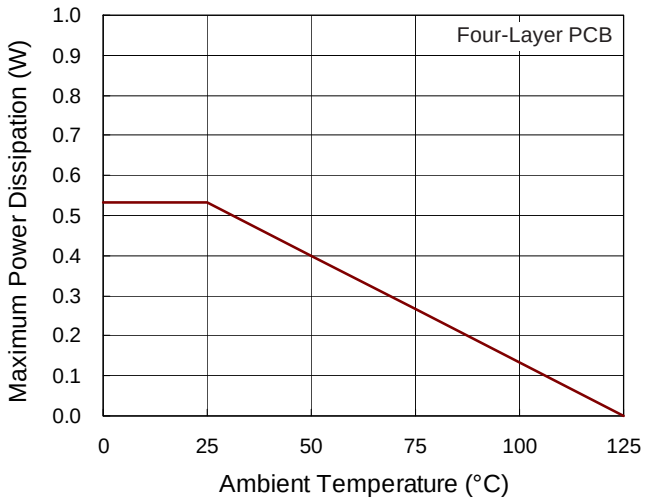
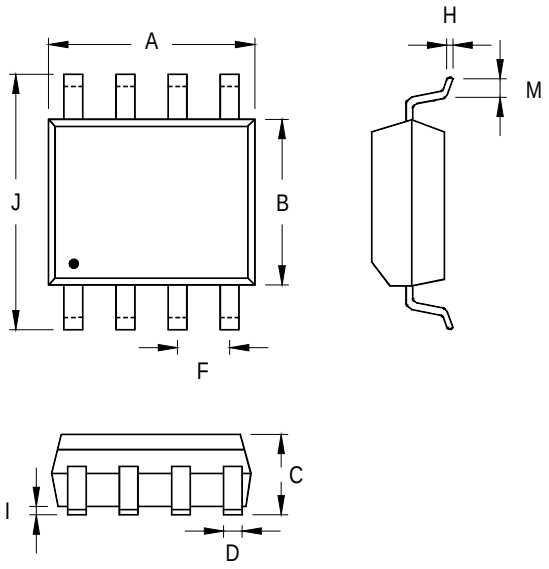


Figure 1. Derating Curve of Maximum Power Dissipation

Outline Dimension



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	4.801	5.004	0.189	0.197
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	0.170	0.254	0.007	0.010
I	0.050	0.254	0.002	0.010
J	5.791	6.200	0.228	0.244
M	0.400	1.270	0.016	0.050

8-Lead SOP Plastic Package

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Datasheet Revision History

Version	Date	Item	Description
P00	2016/4/26		First Edition
P01	2017/12/19	Headline General Description Ordering Information Features Applications Marking Information Pin Configuration Typical Application Circuit Functional Pin Description Functional Block Diagram Absolute Maximum Ratings Electrical Characteristics Application Information	Modify