UMW PT4115

30V/1.2A high dimming ratio LED constant current driver

1.Description

UMW PT4115 is a step-down and constant current source with continuous inductor current conduction mode, which is used to drive one or more LEDs in series.The input voltage range of PT4115 is from 6V to 30V, and the output current is adjustable, up to 1.2A.Depending on the input voltage and external devices, PT4115 can drive LEDs up to tens of watts. PT4115 has built-in power switch. It uses high-end current sampling to set the average LED current. Through the dim pin, it can accept analog dimming and a wide range of PWM dimming.When the voltage of dim is lower than 0.3 V, the power switch will be turned off and PT4115 will enter the standby state of extremely low working current.

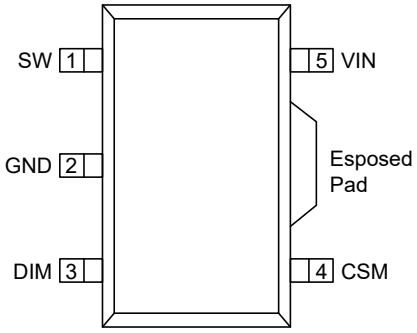
2.Features

- Very few external components
- Wide input voltage range: from 6 V to 30 v Output current of 1.2 A
- LED switch, analog dimming and PWM dimming are realized by multiplexing dim pins
- 5% accuracy of output current
- Up to 97% efficiency
- Constant current control method with adjustable output

3.Applications

Low voltage LED spotlight instead of halogen lamp, vehicle LED light,Led standby lamp, LED signal lamp

4.Pinning Information



SOT89-5

Outlet function

SOT89-5	Pin Name	Description
1	SW	Drain end of power on
2	GND	Power and ground signals
3	DIM	Switch enable, analog and PWM dimming terminals
4	CSN	The sampling resistor is connected between CSN and VIN
5	VIN	The power input terminal must be connected with the bypass capacitor nearby
-	Exposed PAD	Cooling end, internal grounding, pasted on PCB to reduce thermal resistance

5.Absolute Maximum Ratings (1)

Parameter	Value	Value	Units
Supply voltage	V_{IN}	-0.3 to 35	V
Drain terminal of power switch	SW	-0.3 to 35	V
Current sampling terminal (relative V_{IN})	CSN	0.3 to -6	V
Switch enable, analog and PWM dimming terminals	DIM	-0.3 to 6	V
Power switch output current	I_{SW}	1.5	A
Power waste(2)	P_{DMAX}	1.5	W
Thermal resistance, SOT89-5 (θJA)	CSC_R	45	°C/W
Working junction temperature range	T_J	-40 to 150	°C
Storage temperature range	T_{STG}	-55 to 150	°C

explain:

1. "Maximum rating" refers to the possibility of chip damage beyond the operating range."Electrical parameters" define the specifications for DC and AC parameters of the device within the operating range and under test conditions that guarantee specific performance indicators.For the parameters without given upper and lower limits, the typical values reasonably reflect the device performance.

2. The maximum power consumption decreases as the temperature increases, which is determined by the maximum junction temperature T_{JMAX}, θ_{JA}, and ambient temperature T_A. The maximum permissible power consumption is P_{DMAX} =(T_{JMAX} -T_A) / θ_{JA} or the number given in the "Maximum Rating" (lower).

6.Recommended scope of work (1)

Parameter	Value	Value	Units
Supply voltage	V_{IN}	6 to 30	V
Working temperature	T_{OCSC}	-25 to 85	°C

explain:

1. "Recommended operating range" means that within this range, the device functions normally, but does not fully guarantee the performance limit."Electrical parameters" define the specifications for DC and AC parameters of the device within the operating range and under test conditions that guarantee specific performance indicators.

7.Electrical Characteristics

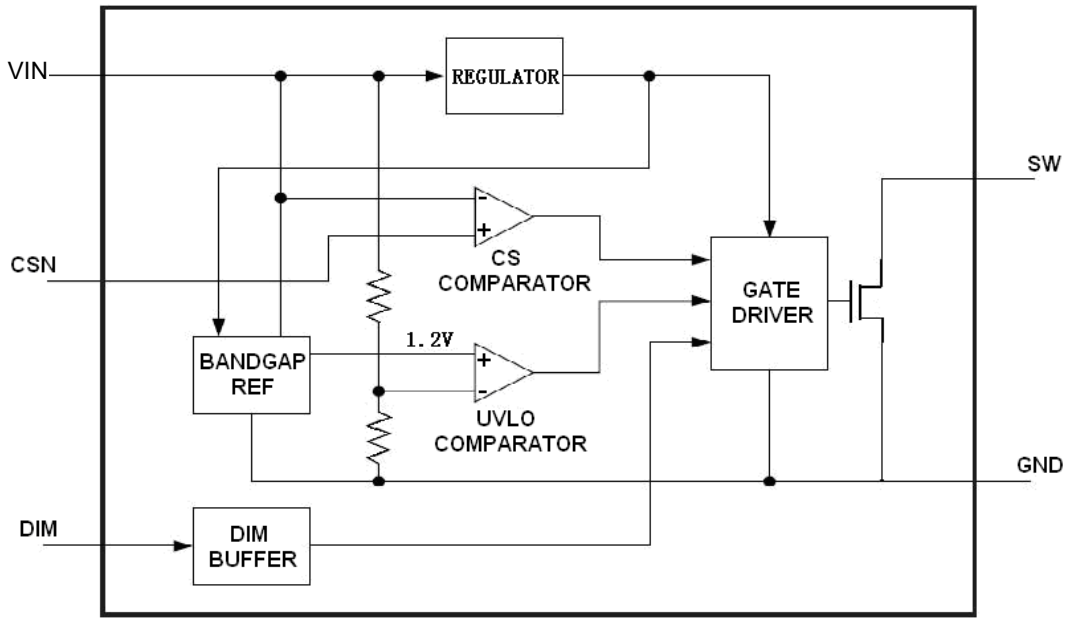
Unless otherwise specified: T_A=25°C, V_{IN}=12V

Parameter	Symbol	Test conditions	Min	Typ	Max	Units
input voltage	V_{IN}		6		30	V
Under voltage protection	V_{UVLO}	V_{IN} decreased		5.1		V
Under voltage protection hysteresis	$V_{UVLO, HYS}$	V_{IN} increased		500		mV
Maximum operating frequency	F_{SW}				1	MHz
Current sampling						
Average sampling voltage	V_{CSN}	V_{IN} − V_{CSN}	95	100	105	mV
Sampling voltage hysteresis	V_{CSN_HYS}			±15		%
Input current of CSN pin	I_{CSN}	V_{IN} − V_{CSN}=50mV		8		μA
Turn off current						
Turn off current	I_{OFF}	V_{DIM} < 0.3V		60		μA
Dim input						
Working voltage of internal circuit	V_{DIM}	Dim floating		5		V
Dim input high level	V_{DIM_H}		2.5			V
Dim input low level	V_{DIM_L}				0.3	V
Analog dimming voltage range	V_{DIM_DC}		0.5		2.5	V
Maximum PWM dimming frequency	f_{DIM}	f_{OSC}=500kHz			50	kHz
Low frequency PWM dimming duty cycle range around	D_{PWM_LF}	f_{DIM}=100Hz	0.02%		1	
Low frequency PWM dimming ratio				5000:1		
High frequency PWM dimming duty cycle range around	D_{PPWM_HF}	f_{DIM}=20kHz	4%		1	
Low frequency PWM dimming ratio				25:1		
Dim pull up internal working voltage resistance	R_{DIM}			200		KΩ
Dim earth leakage current	I_{DIM_L}	V_{DIM}=0		4.2		μA

Parameter	Symbol	Test conditions	Min	Typ	Max	Units
Power switch						
SW on resistance	R_{SW}	V_{IN} =24V		0.4		Ω
		V_{IN} =12V		0.6		Ω
SW continuous current	I_{SWmean}				1.2	A
SW leakage current	I_{LEAK}			0.5	5	μA
Overheating protection						
Overheat protection temperature	T_{SD}			160		°C
Overheating protection hysteresis	T_{SD-hys}			20		°C

8.Function Description

Functional block diagram



Working principle description

UMW PT4115, inductor (L) and current sampling resistor (RS) form a self oscillating continuous inductor current mode buck constant current LED controller.When V_{IN} is powered on, the initial current of inductance (L) and current sampling resistor (RS) is zero, and the output current of LED is also zero.At this time, the output of CS comparator is high, the internal power switch is on, and the potential of SW is low.The current flows from V_{IN} to ground through inductance (L), current sampling resistor (RS), led and internal power switch. The slope of current rise is determined by V_{IN}, inductance (L) and led voltage drop, resulting in a voltage difference V_{CSN} on RS.When (V_{IN}− V_{CSN})> 115mV, the output of CS comparator becomes low, the internal power switch is turned off, and the current flows through inductance (L), current sampling resistance (RS), led and Schottky diode (D) at another slope.(V_{IN}-V_{CSN}, < 85MV, the power switch is re opened, so that the average current on the LED is:

$$I_{OUT} \frac{0.085+0.115}{2 \times R_S} 0.1/R_S$$

The high-end current sampling structure makes the number of external components very small. The sampling resistor of 1% accuracy is adopted, and the output current of LED is controlled at Accuracy of ± 5%.

UMW PT4115 can add PWM signal to DIM pin for dimming. When the voltage of DIM pin is lower than 0.3 V, turn off LED current, and when it is higher than 2.5 V, all LED current will be turned on. The frequency range of PWM dimming is from 100 Hz to more than 20 kHz.When the high level is at Between 0.5 V and 2.5 V, dimming is also possible. See the following application instructions for details.

DIM current can also be adjusted by adjusting the maximum DC current of the LED through the external resistance of the LED.Mective dimming range for DC voltage (V_{DIM}) is 0.5 V to 2.5 v. DC voltage (V_{DIM}) is higher than the output LED current remains constant and is set by (0.1 / Rs) .The LED current can also be adjusted by connecting a resistor between DIM and ground. There is a pull-up resistor (typical 1.2 megaohm) connected to the internal regulated voltage of 5V. The voltage of the DIM pin is determined by the internal and external resistance voltage.

DIM pins can float in the air during normal operation.When the voltage applied to the dim is less than 0.3 V, the internal power switch is turned off and the LED current drops to zero.During the shutdown period, the internal voltage stabilizing circuit maintains standby operation, and the static current is only 60μa.

In addition, in order to ensure reliability, the PT4115 contains a thermal protection function (TSD), and the package contains a heat dissipation PAD.The overheat protection function protects the chip and system when the chip is overheated (160°C), and the external heat dissipation PAD enhances the chip power consumption. Therefore, PT4115 can safely output large current.PT4115 can also connect the thermistor (NTC) to the LED through the DIM pin, detect the temperature, dynamically adjust the LED current, and protect the LED. See the application instructions below for details.

9.Application Description

1) RS rage LED current is set by external sampling resistance R

The average LED current is set by the external current sampling resistor R_S.The average current of the LED is determined by the resistance R_S connected at both ends of V_{IN} and CSN:

$$I_{OUT}=0.1/ R_S \ (R_S \geq 0.082\ \Omega)$$

The above equation is based on the assumption that the dim terminal is floating or the external dim terminal voltage is higher than 2.5V (but must be lower than 5V).actually,RS is the maximum output current of LED. Through DIM, the actual output current of LED can be reduced to any value.

2) Analog dimming by DC voltage

DC voltage(V_{DIM}) can be applied to dim to reduce the LED output current. The maximum LED output current is set by ($0.1/R_S$ Led average output current calculation formula:

$$I_{OUT} \quad \frac{0.1 \times V_{DM}}{2.5 \times R_s} \quad (0.5V \le V_{DIM} \le 2.5V)$$

When V_{DIM} is in the range of ($2.5\ V \le V_{DIM} \le 5\ V$), the LED maintains 100% current, which is equal to I_{OUT}= 0.1 / Rs

3) Dimming by PWM signal

The maximum average current of LED is determined by the resistance RSconnected at both ends of VIN and CSN. By adding PWM signal with variable duty cycle to dim pin, the output current can be reduced to realize dimming. The calculation method is as follows:

$$I_{OUT} \quad \frac{0.1 \times D}{R_s} \quad (0 \le D \le 100\%,\ 2.5V < V_{PULSE} < 5V)$$

If the high level is less than 2.5V, then

$$I_{OUT} \quad \frac{V_{PULSE}\ 0.1 \times D}{2.5 \times R_s} \quad (0 \le D \le 100\%,\ 0.5V < V_{PULSE} < 2.5V)$$

4) Turn off mode

By connecting the voltage below 0.3V at the DIM terminal, the system is turned off.Normally, the quiescent current of the system is kept at 60μA following

5) Soft start mode

By connecting an external capacitor into the DIM, the voltage at the DIM terminal will rise slowly when starting, so that the current of LED will also rise slowly, so as to realize soft start.In general, the relationship between soft start time and external capacitance is about 0.8 ms / nF.

6) Bypass capacitance

A bypass capacitor with low equivalent series resistance (ESR) must be connected to the power input. The larger the ESR, the greater the efficiency loss.The bypass capacitor should be able to withstand a large peak current, make the input current of the power supply average, and reduce the impact on the input power supply.For DC input, the minimum value of the bypass capacitance is 4.7 μF. in AC input or low voltage input, the bypass capacitance needs to be larger.The bypass capacitor is as close as possible to the input pin of the chip.In order to ensure the stability under different temperature and working voltage, it is recommended to use X5R / X7R capacitor.

7) Select inductance

The recommended inductance parameter range of PT4115 is 27 μH ~ 100μH.The saturation current of the inductor must be 30% to 50% higher than the output current.The smaller the output current of LED is, the larger the inductance value is recommended.On the premise that the current capacity meets the requirements, it is hoped that the inductance will be larger, so that the effect of constant current will be better.The inductor should be placed as close to VIN and SW as possible to avoid efficiency loss caused by parasitic resistance.The following table gives suggestions for inductance selection:

Output current	Inductance Value	Saturation Current
I_{OUT} > 1A	27 ~ 33μH	It is 1.3 ~ 1.5 times higher than the output current
0.8A <I_{OUT} ≤ 1A	33 ~ 47μH	
0.4A <I_{OUT} ≤ 0.8A	47 ~ 68μH	
I_{OUT} ≤ 0.4A	68 ~ 100μH	

8) Select diode

In order to ensure maximum efficiency and performance, Schottky diodes with fast recovery, low forward voltage drop, low parasitic capacitance and low leakage current should be selected for diode (D). The current capacity and withstand voltage depend on the specific application, but a margin of 30% should be maintained, which is conducive to stable and reliable operation.It should also be noted that Schottky's reverse leakage current should be considered when the temperature is higher than 85°C.Excessive leakage will increase the power dissipation of the system.The Schottky diode with low voltage drop must be selected for AC12V rectifier diode (D) to reduce its power dissipation.

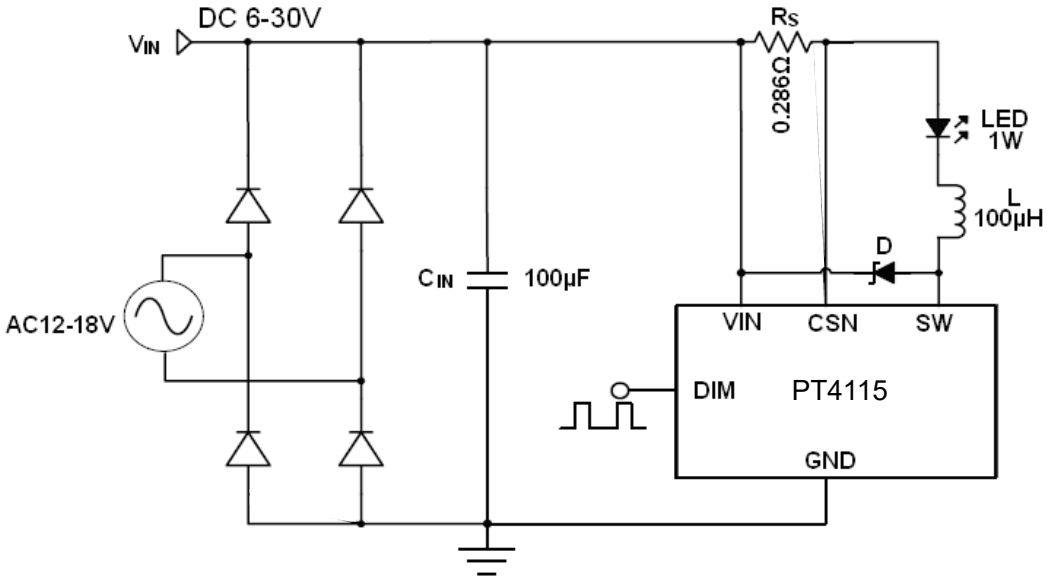
9) TSIc (TSIc protection)

The over temperature protection function (TSD) is set in PT4115 to ensure the stable and reliable operation of the system.When the IC chip temperature exceeds 160°C, the IC will enter the TSD protection state and stop the current output. When the temperature is lower than 140°C, the IC will return to the working state.

10) Notes on PCB layout

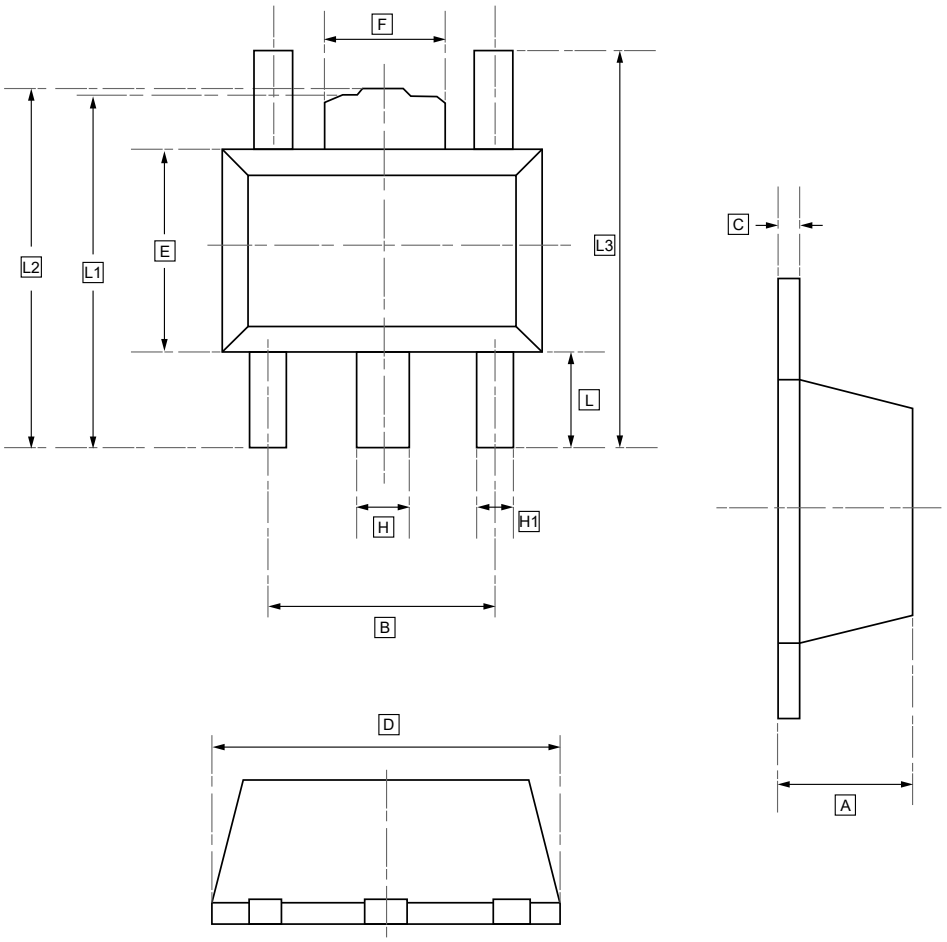
Reasonable PCB layout is very important to ensure system stability and low noise.Using multi-layer PCB is an effective way to avoid noise interference.In order to effectively reduce the noise of the current circuit, the input bypass capacitor should be grounded separately.PCB copper foil should be well connected with heat dissipation PAD and GND of PT4115.The high current grounding circuit, the grounding lead of input bypass capacitor and the grounding lead of output filter are connected to the same point (Star grounding method) to minimize the grounding noise.

10.Application Circuit Diagram



Application Figure 1, 1W spotlight application

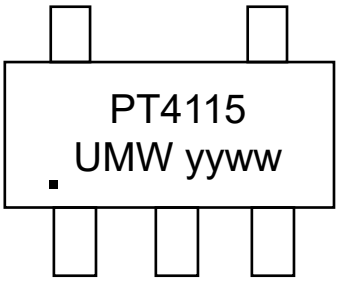
11.SOT89-5 Package Outline Dimensions



DIMENSIONS (mm are the original dimensions)

Symbol	A	B	C	D	E	F	H	H1	L	L1	L2	L3
Min	1.450	2.950	0.330	4.450	2.450	1.650	0.450	0.370	0.900	4.100	4.100	4.350
Max	1.550	3.050	0.430	4.550	2.550	1.750	0.580	0.480	1.000	4.300	4.350	4.450

12.Ordering Information



yy: Year Code
ww: Week Code

Order Code	Package	Base QTY	Delivery Mode
UMW PT4115	SOT89-5	1000	Tape and reel

13.Disclaimer

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