

30V, 1.2A Step-down High Brightness LED Driver with 5000:1 Dimming

GENERAL DESCRIPTION

The PT4115 is a continuous conduction mode inductive step-down converter, designed for driving single or multiple series connected LED efficiently from a voltage source higher than the total LED chain voltage. The device operates from an input supply between 8V and 30V and provides an externally adjustable output current of up to 1.2A. Depending upon the supply voltage and external components, the PT4115 can provide more than 30 watts of output power.

The PT4115 includes the power switch and a high-side output current sensing circuit, which uses an external resistor to set the nominal average output current, and a dedicated DIM input accepts either a DC voltage or a wide range of pulsed dimming. Applying a voltage of 0.3V or lower to the DIM pin turns the output off and switches the device into a low current standby state.

The PT4115 is available in SOT89-5 and ESOP8 packages.

FEATURES

- Simple low parts count
- Wide input voltage range: 8V to 30V
- Up to 1.2A output current
- Single pin on/off and brightness control using DC voltage or PWM
- Up to 1MHz switching frequency
- Typical 5% output current accuracy
- Inherent open-circuit LED protection
- High efficiency (up to 97%)
- High-Side Current Sense
- Hysteretic Control: No Compensation
- Adjustable Constant LED Current
- ESOP8 package for large output power application

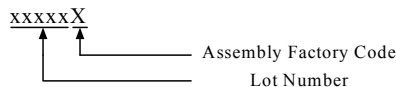
APPLICATIONS

- Low voltage halogen replacement LEDs
- Automotive lighting
- Low voltage industrial lighting
- LED back-up lighting
- Illuminated signs
- SELV lighting
- LCD TV backlighting

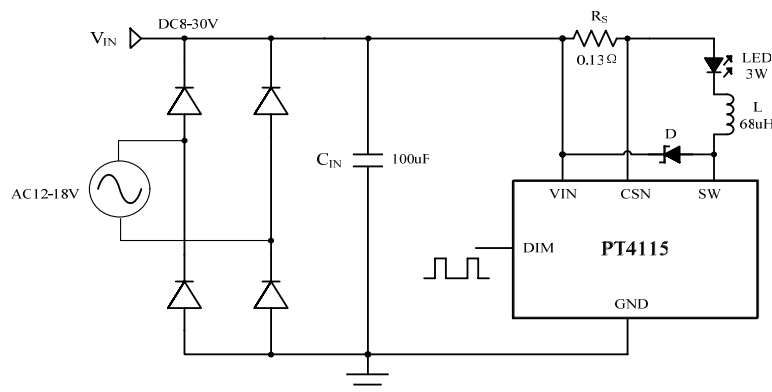
ORDERING INFORMATION

PACKAGE	TEMPERATURE RANGE	ORDERING PART NUMBER	VCSN RANGE	TRANSPORT MEDIA	MARKING
SOT89-5	-40 °C to 85 °C	PT4115-89E	95-101mV	Tape and Reel 1000 units	PT4115 xxxxxX
		PT4115-89E-B	99-105mV		
ESOP8	-40 °C to 85 °C	PT4115-SOH	95-101mV	Tape and Reel 2500 units	PT4115 xxxxxX
		PT4115-SOH-B	99-105mV		

Note:

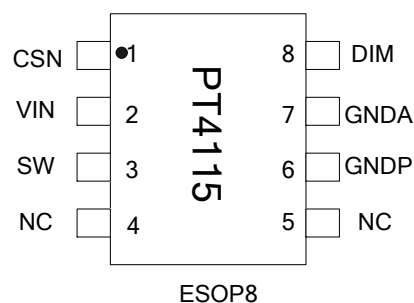
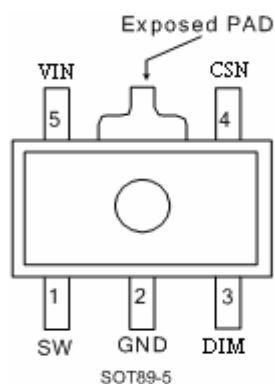


TYPICAL APPLICATION CIRCUIT



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PIN ASSIGNMENT



PIN DESCRIPTIONS

PIN No.	PIN NAMES	DESCRIPTION
1	SW	Switch Output. SW is the drain of the internal N-Ch MOSFET switch.
2	GND	Signal and power ground. Connect directly to ground plane.
3	DIM	Logic level dimming input. Drive DIM low to turn off the current regulator. Drive DIM high to enable the current regulator.
4	CSN	Current sense input
5	VIN	Input Supply Pin. Must be locally bypassed.
-	Exposed PAD	Internally connected to GND. Mount on board for lower thermal resistance.
ESOP8 4,5	NC	No connection

ABSOLUTE MAXIMUM RATINGS (note1)

SYMBOL	ITEMS	VALUE	UNIT
V_{IN}	Supply Voltage	-0.3~45	V
SW	Drain of the internal power switch	-0.3~45	V
CSN	Current sense input (Respect to VIN)	+0.3~(-6.0)	V
DIM	Logic level dimming input	-0.3~6	V
I_{SW}	Switch output current	1.5	A
P_{DMAX}	Power Dissipation (Note 2)	1.5	W
P_{TR}	Thermal Resistance, SOT89-5 θ_{JA}	45	$^{\circ}C/W$
P_{TR}	Thermal Resistance, ESOP8 θ_{JA}	40	$^{\circ}C/W$
T_J	Operation Junction Temperature Range	-40 to 150	$^{\circ}C$
T_{STG}	Storage Temperature	-55 to 150	$^{\circ}C$
	ESD Susceptibility (Note 3)	2	kV

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RECOMMENDED OPERATING RANGE

SYMBOL	ITEMS	VALUE	UNIT
V _{IN}	V _{DD} Supply Voltage	0 ~ 30	V
T _{OPT}	Operating Temperature	-40 to +85	°C

Note 1: Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Recommended Operating Range indicates conditions for which the device is functional, but do not guarantee specific performance limits. Electrical Characteristics state DC and AC electrical specifications under particular test conditions which guarantee specific performance limits. This assumes that the device is within the Operating Range. Specifications are not guaranteed for parameters where no limit is given, however, the typical value is a good indication of device performance.

Note 2: The maximum power dissipation must be derated at elevated temperatures and is dictated by T_{JMAX}, θ_{JA}, and the ambient temperature T_A. The maximum allowable power dissipation is P_{DMAX} = (T_{JMAX} - T_A) / θ_{JA} or the number given in Absolute Maximum Ratings, whichever is lower.

Note 3: Human body model, 100pF discharged through a 1.5kΩ resistor.

ELECTRICAL CHARACTERISTICS (Note 4, 5)

The following specifications apply for V_{IN}=12V, T_A=25 °C, unless specified otherwise.

SYMBOL	ITEMS	CONDITIONS	Min.	Typ.	Max.	UNIT	
V _{IN}	Input Voltage		8		30	V	
V _{UVLO}	Under voltage lock out	V _{IN} falling		6.8		V	
V _{UVLO,HYS}	UVLO hysteresis	V _{IN} rising		500		mV	
F _{SW}	Max. Switching Frequency				1	MHz	
Current Sense							
V _{CSN}	Mean current sense threshold voltage	V _{IN} - V _{CSN}	PT4115-89E PT4115-SOH	95	98	101	mV
			PT4115-89E-B PT4115-SOH-B	99	102	105	mV
V _{CSN_hys}	Sense threshold hysteresis			±15		%	
I _{CSN}	CSN Pin Input Current	V _{IN} -V _{CSN} =50mV		8		μA	
Operating Current							
I _{OFF}	Quiescent supply current with output off	V _{DIM} <0.3V		95		μA	
DIM Input							
V _{DIM}	Internal supply voltage	DIM floating		5		V	
V _{DIM_H}	DIM input voltage High		2.5			V	
V _{DIM_L}	DIM input voltage Low				0.3	V	
V _{DIM_DC}	DC brightness control		0.5		2.5	V	
f _{DIM}	Max. DIM Frequency	f _{OSC} =500kHz			50	kHz	
D _{PWM_LF}	Duty cycle range of low frequency dimming	f _{DIM} =100Hz	0.02%		1		
	Brightness control range				5000:1		

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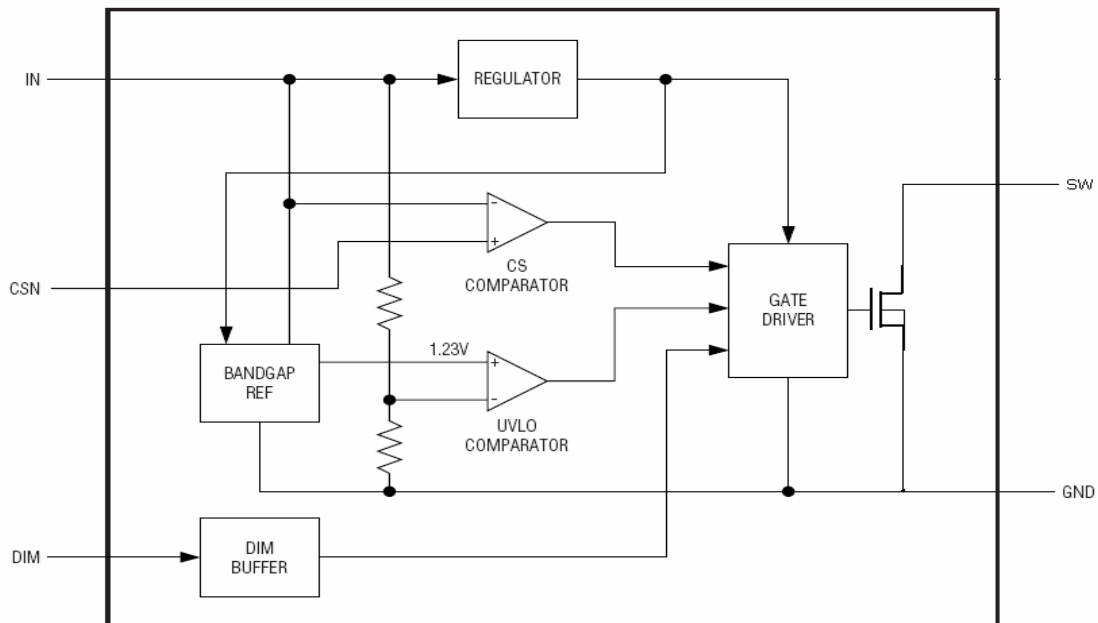
ELECTRICAL CHARACTERISTICS (Continued) (Note 4, 5)

SYMBOL	ITEMS	CONDITIONS	Min.	Typ.	Max.	UNIT
DIM Input						
D_{PWM_HF}	Duty cycle range of high frequency dimming	$f_{DIM}=20KHz$	4%		1	
	Brightness control range			25:1		
R_{DIM}	DIM pull up resistor to Internal supply voltage			200		$K\Omega$
I_{DIM_L}	DIM input leakage low	$V_{DIM} = 0$		25		μA
Output Switch						
R_{SW}	SW On Resistance	$V_{IN}=12V$		0.6		Ω
		$V_{IN}=24V$		0.4		
I_{SWmean}	Continuous SW Current				1.2	A
I_{LEAK}	SW Leakage Current			0.5	5	μA
Thermal Shutdown						
T_{SD}	Thermal Shutdown Threshold			160		$^{\circ}C$
T_{SD-hys}	Thermal Shutdown hysteresis			20		$^{\circ}C$

Note 4: Typical parameters are measured at 25°C and represent the parametric norm.

Note 5: Datasheet min/max specification limits are guaranteed by design, test, or statistical analysis.

SIMPLIFIED BLOCK DIAGRAM



**30V, 1.2A Step-down High Brightness
LED Driver with 5000:1 Dimming**

OPERATION DESCRIPTION

The device, in conjunction with the coil (L1) and current sense resistor (RS), forms a self oscillating continuous-mode buck converter.

When input voltage VIN is first applied, the initial current in L1 and RS is zero and there is no output from the current sense circuit. Under this condition, the output of CS comparator is high. This turns on an internal switch and switches the SW pin low, causing current to flow from VIN to ground, via RS, L1 and the LED(s). The current rises at a rate determined by VIN and L1 to produce a voltage ramp (VCSN) across RS. When $(V_{IN}-V_{CSN}) > 115mV$, the output of CS comparator switches low and the switch turns off. The current flowing on the RS decreases at another rate. When $(V_{IN}-V_{CSN}) < 85mV$, the switch turns on again and the mean current on the LED is determined by
$$\left(\frac{85+115}{2} mV\right) / R_S = 100mV / R_S .$$

The high-side current-sensing scheme and on-board current-setting circuitry minimize the number of external components while delivering LED current with $\pm 5\%$ accuracy, using a 1% sense resistor.

The PT4115 allow dimming with a PWM signal at the DIM input. A logic level below 0.3V at DIM forces PT4115 to turn off the LED and the logic level at DIM must be at least 2.5V to turn on the full LED current. The frequency of PWM dimming ranges from 100Hz to more than 20 kHz.

The DIM pin can be driven by an external DC voltage

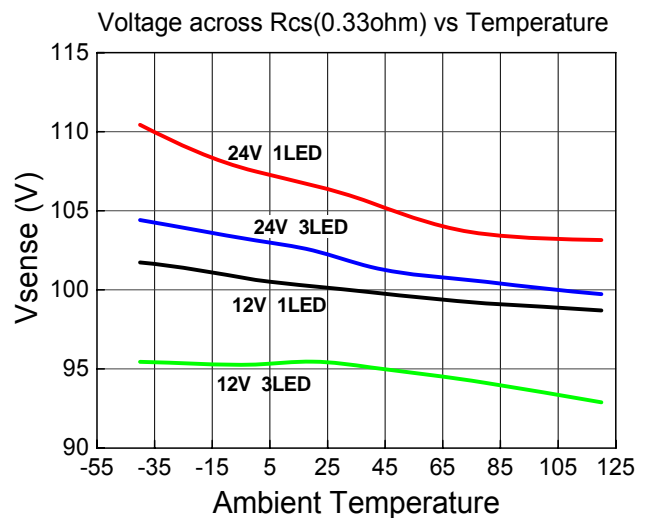
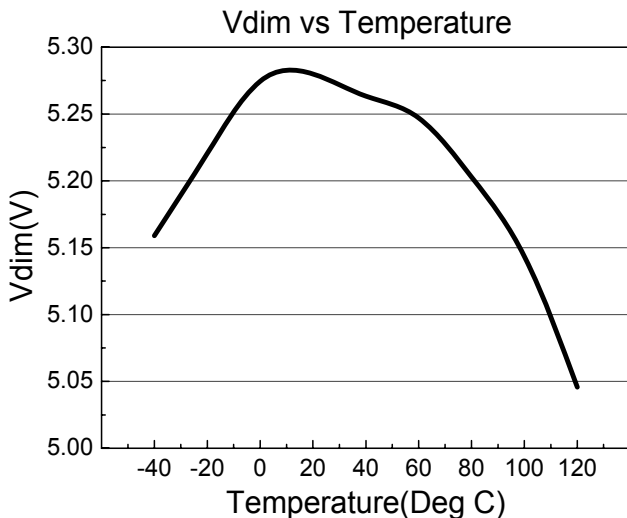
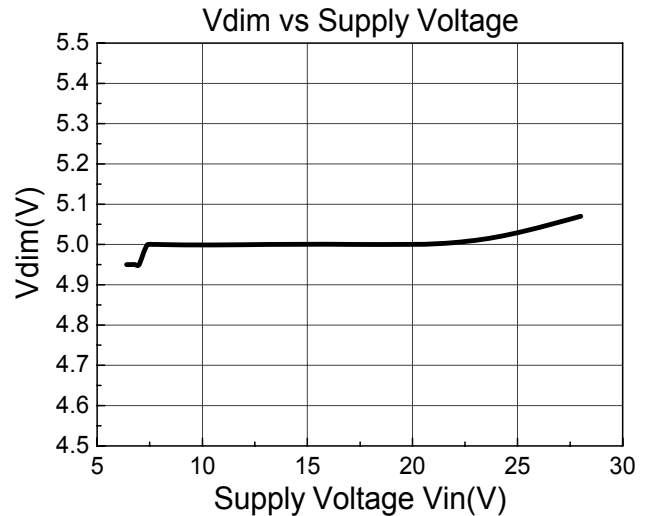
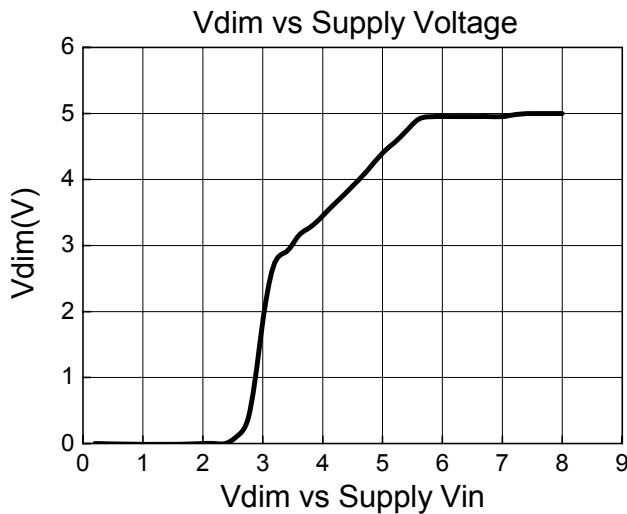
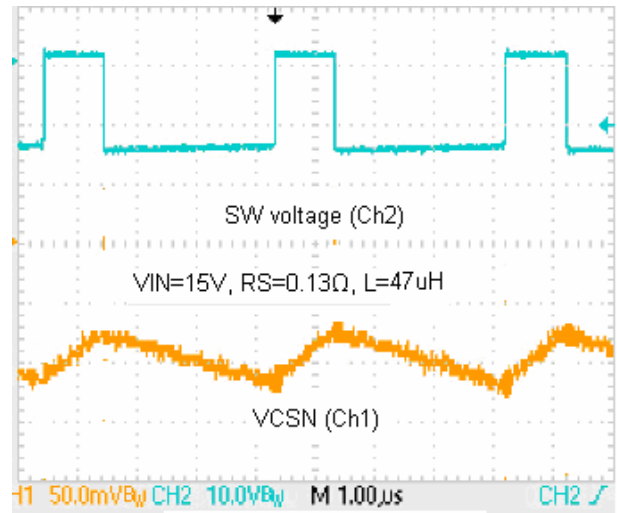
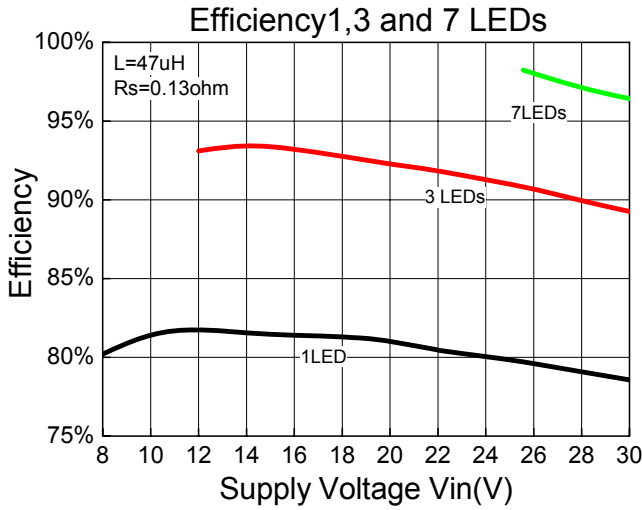
(VDIM) to adjust the output current to a value below the nominal average value defined by RS. The DC voltage is valid from 0.5V to 2.5V. When the dc voltage is higher than 2.5V, the output current keeps constant. The LED current also can be adjusted by a resistor connected to the DIM pin. An internal pull-up resistor (typical 200K Ω) is connected to a 5V internal regulator. The voltage of DIM pin is divided by the internal and external resistor.

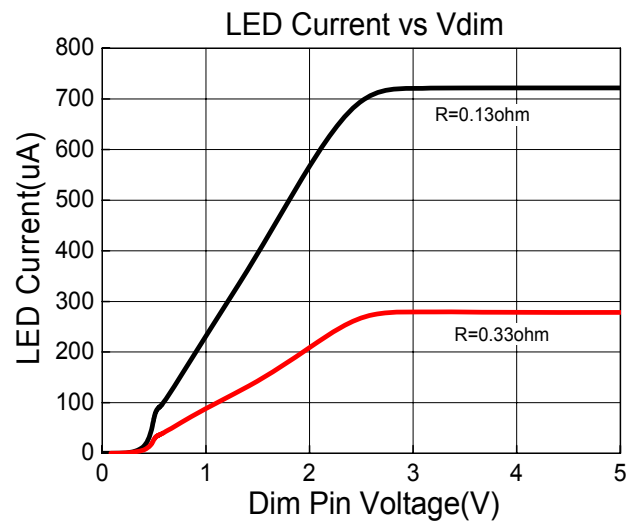
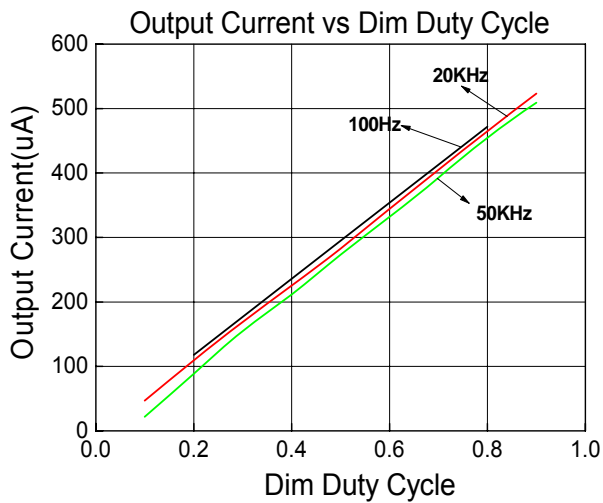
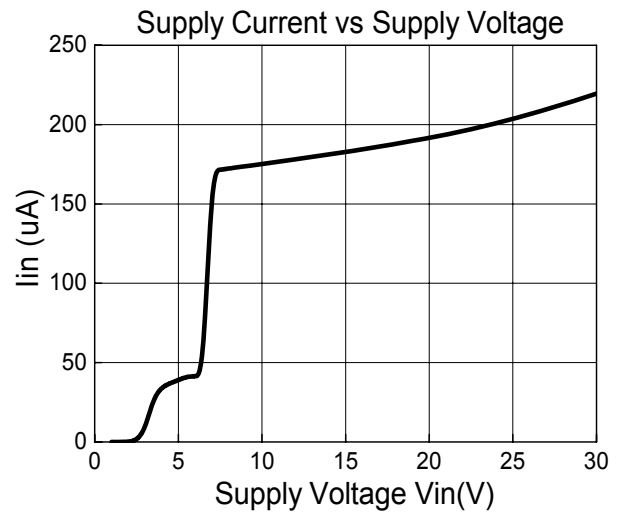
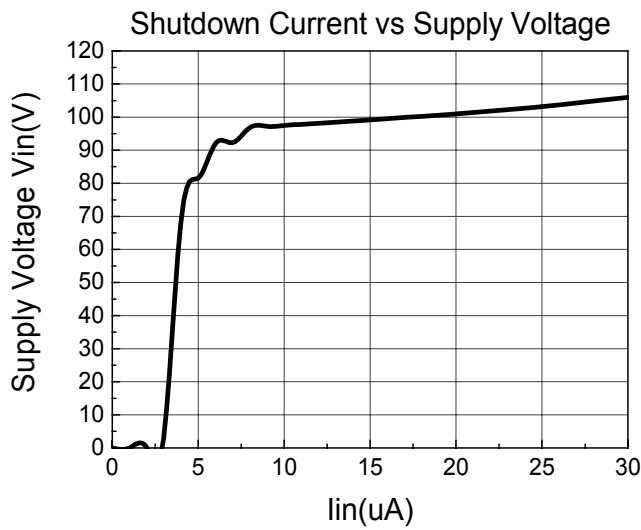
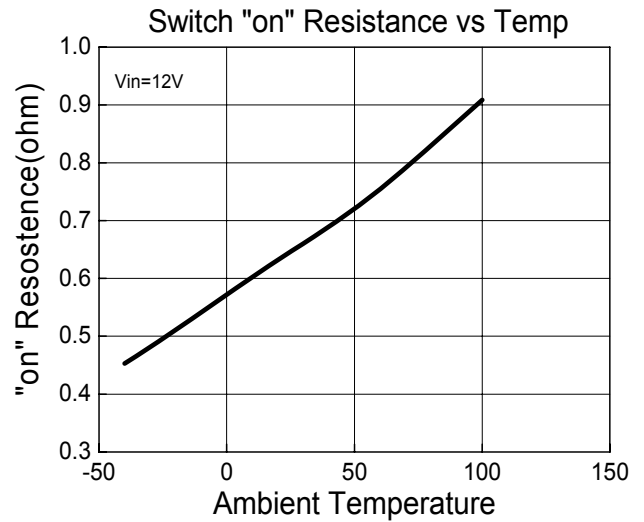
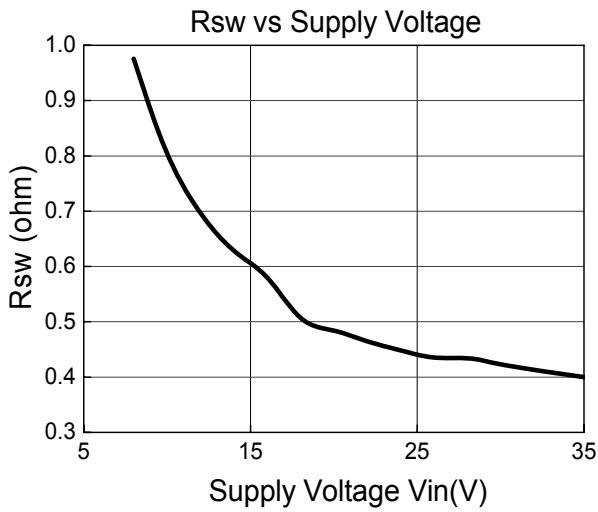
The DIM pin is pulled up to the internal regulator (5V) by a 200K Ω resistor. It can be floated at normal working. When a voltage applied to DIM falls below the threshold (0.3V nom.), the output switch is turned off. The internal regulator and voltage reference remain powered during shutdown to provide the reference for the shutdown circuit. Quiescent supply current during shutdown is nominally 95uA and switch leakage is below 5uA.

Additionally, to ensure the reliability, the PT4115 is built with a thermal shutdown (TSD) protection and a thermal pad. The TSD protects the IC from over temperature (160°C). Also the thermal pad enhances power dissipation. As a result, the PT4115 can handle a large amount of current safely.

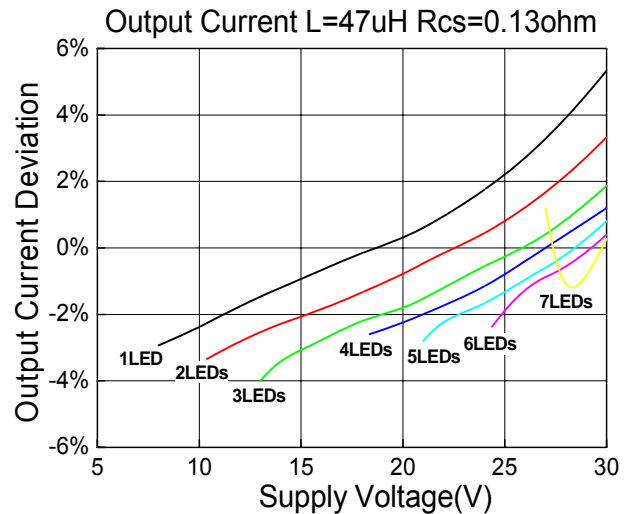
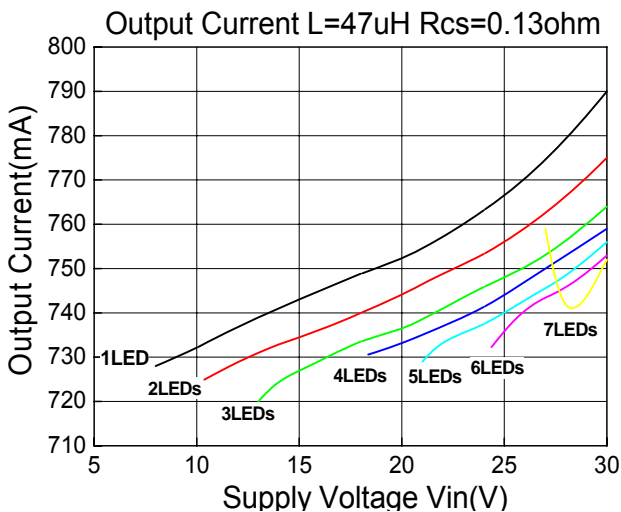
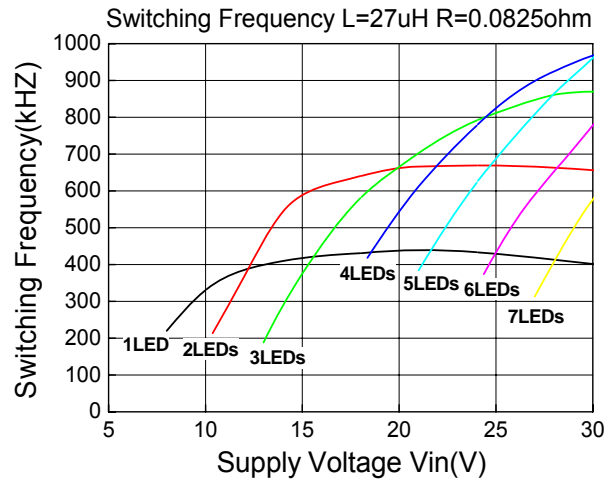
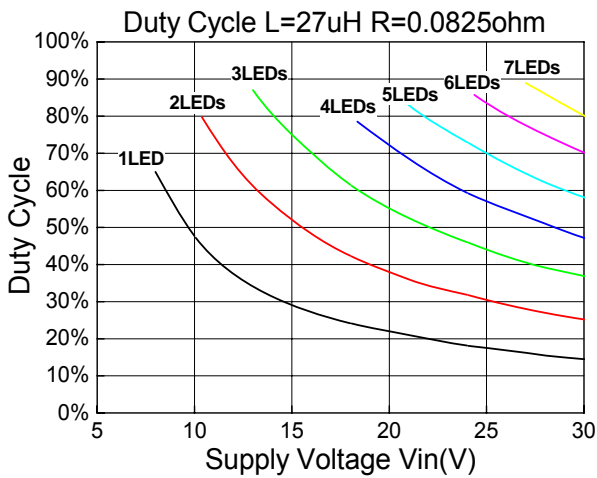
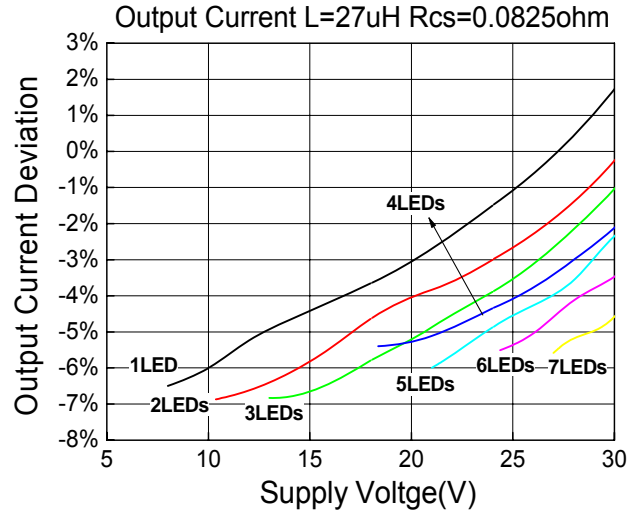
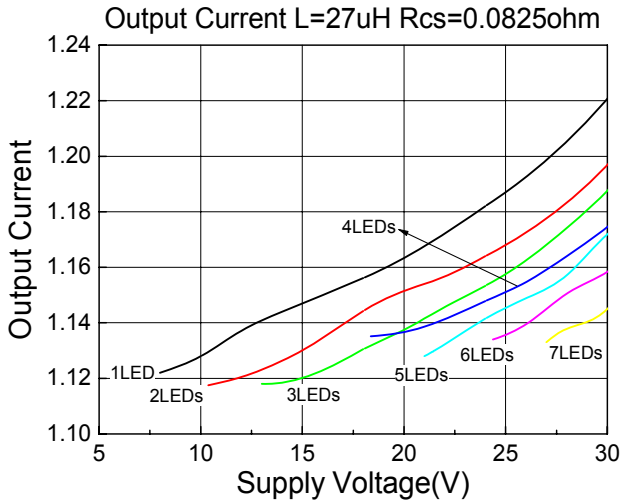
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TYPICAL PERFORMANCE CHARACTERISTICS



30V, 1.2A Step-down High Brightness LED Driver with 5000:1 Dimming


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