

GENERAL DESCRIPTION

PT4305 is a 1x/1.5x auto-adjust charge pump white LED driver with maximum 350mA load. Auto-adjust charge pump achieves high efficiency for Li-Ion battery supply. Few external components (two flying capacitors, two filter capacitors at VIN and VOUT, and one feedback resistor) make PT4305 ideally suited for mobility application.

The current through the LED can be pre-set by feedback resistor. And the LED can also be dimmed by PWM control signal. Built-in soft-start circuit prevents the inrush current from supply source during power on and 1x/1.5x mode change. Thermal shutdown and current limiter prevent PT4305 being damaged by the high-level current through it. Shutdown current less than 1uA makes the battery time longer. PT4305 is packaged with QFN-10, MSOP-10 and SOP-14, and it is also available with different feedback voltage references: 315mV, 236mV, 157mV, and 78mV.

FEATURES

- 1x/1.5x auto-adjust charge pump
- 350mA maximum load current
- <10% feedback voltage reference error
- Dimming LED by PWM signal through EN/PWM pin
- Less than 1uA shutdown current
- Built-in soft-start and soft mode decision
- Less than 1uA shutdown current r
- Thermal shutdown n
- Shorted LED protection

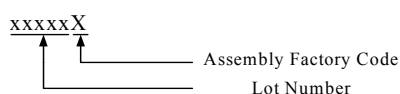
APPLICATIONS

- Cell Phones
- Camera Flash Driver
- Small LCD Displays
- 1 Watt White LED Driver
- Handheld Computers and PDAs

ORDERING INFORMATION

PACKAGE	TEMPERTURE RANGE	FEEDBACK VOLTAGE	ORDERING PART NUMBER	TRANSPORT MEDIA	MARKING
DFN-10	-40 °C to 85 °C	315mV	PT4305EQFN-315	Tape and Reel 3000 units	PT4305 xxxxxX
		236mV	PT4305EQFN-236		
		157mV	PT4305EQFN-157		
		78mV	PT4305EQFN-78		
MSOP-10	-40 °C to 85 °C	315mV	PT4305EMSI-315	Tape and Reel 3000 units	PT4305 xxxxxX
		236mV	PT4305EMSI-236		
		157mV	PT4305EMSI-157		
		78mV	PT4305EMSI-78		
SOP-14	-40 °C to 85 °C	315mV	PT4305ESON-315	Tube 50 units	PT4305 xxxxxX
		236mV	PT4305ESON-236		
		157mV	PT4305ESON-157		
		78mV	PT4305ESON-78		

Note:



TYPICAL APPLICATION CIRCUIT

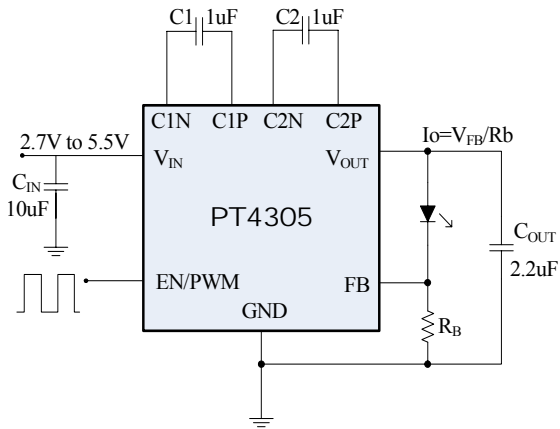


Figure 1. Li-Ion Driver for Flash LED

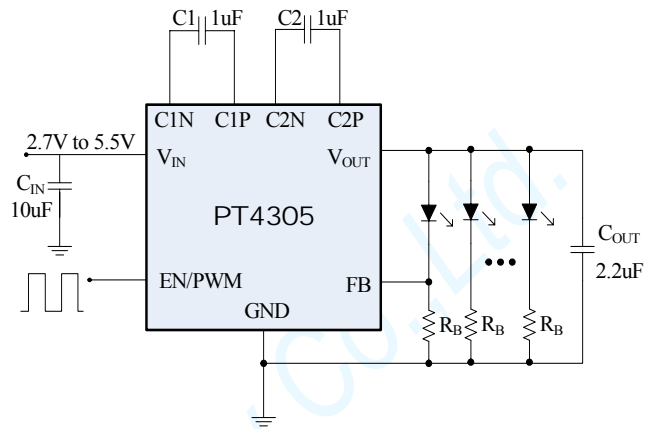
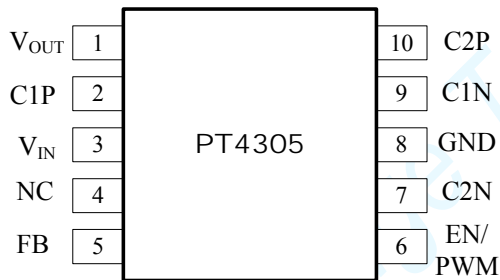
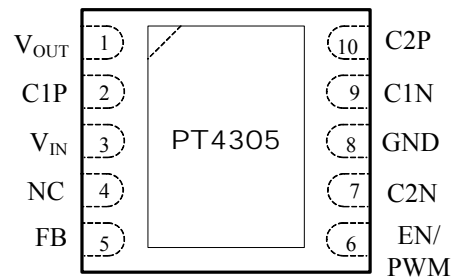


Figure 2. Li-Ion Driver for LCD Backlight

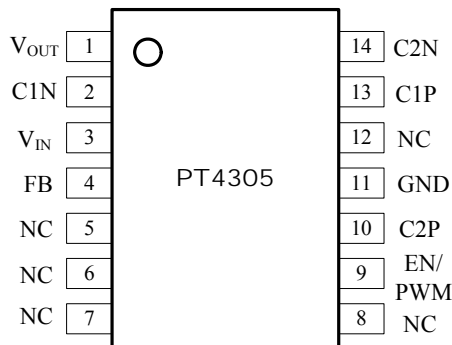
PIN ASSIGNMENT



MSOP-10 Top View



DFN10 (3X3mm²) Top View



SOP-14 Top View

PIN DESCRIPTIONS

MSOP-10/DFN-10 PIN No.	SOP-14 PIN No.	PIN NAMES	DESCRIPTION
1	1	V _{OUT}	Output voltage source connecting to the 1uF ceramic capacitor's positive and LED's anodes.
2	13	C1P	Positive terminal of fly capacitor 1
3	3	V _{IN}	Power supply
4	5,6,7,8,12	NC	Not connected
5	4	FB	Feedback pin for output current setting. LED currents are set by the resistor R _B connected from the FB pin to ground. Do not short the FB pin to ground, its voltage is supposed to be 315mV, 236mV, 157mV, or 78mV.
6	9	EN/PWM	Chip enable and LED current sink programming pin
7	14	C2N	Negative terminal of fly capacitor 2
8	11	GND	Ground
9	2	C1N	Negative terminal of fly capacitor 1
10	10	C2P	Positive terminal of fly capacitor 2

ABSOLUTE MAXIMUM RATINGS (Note 1)

SYMBOL	ITEMS	VALUE	UNIT
V _{IN}	Input Voltage	-0.3 ~ 6	V
V _{OUT}	Output Voltage	-0.3 ~ 6	V
V _{EN/PWM}	The voltage of EN/PWM	-0.3 ~ V _{IN} +0.3	V
P _{TR}	Thermal Resistance, θ _{JA}	DFN-10	50
		MSOP-10	190
		SOP-14	105
P _{DMAX}	Power Dissipation (Note 2)	Internally Limited	W
T _J	Operation Junction Temperature Range	-40 ~ 150	°C
T _{stg}	Storage Temperature	-55 ~ 150	°C
T _{solder}	Package Lead Soldering Temperature	260°C, 10s	
	ESD Susceptibility (Note 3)	2	kV

RECOMMENDED OPERATING RANGE (Note 4)

SYMBOL	ITEMS	VALUE	UNIT
V _{IN}	V _{IN} Supply Voltage	+2.7 ~ +5.5	V
V _{LED}	The LED Forward Voltage at 350mA	< 4	V
T _{OPT}	Operating Temperature	-40 ~ +85	°C

Note 1: Absolute Maximum Ratings indicate limits beyond which damage to the device may occur.

1x/1.5x Auto-Adjust Charge Pump One Channel White LED Driver for Flash

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 $P_{DMAX} = (T_{JMAX} - T_A) / \theta_{JA}$ or the number given in Absolute Maximum Ratings, whichever is lower.

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

Note 4: Recommended operating Range indicates conditions for which the device is functional, but does not guarantee specific performance limits.

ELECTRICAL CHARACTERISTICS (Note 5,6,7)

$V_{IN}=3.5V$, $V_{FB}=315mV$, $C1=C2=1\mu F$, $C_{IN}=10\mu F$, $C_{OUT}=2.2\mu F$ (Ceramic, ESR=0.03 Ω), $T_A=25^\circ C$, unless specified otherwise.

SYMBOL	ITEMS	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Input Characteristics						
V_{IN}	Input Voltage		2.7		5.5	V
I_{OFF}	Operating Current (Shutdown)	EN/PWM=0			1	μA
I_q	Operating Current (Quiescent)	$V_{IN}=2.7V$ to 5.5V 100 μA load Current		0.5	3	mA
Charge Pump						
F_{CLK}	Switching Frequency		0.8	1.2	1.5	MHz
T_{SS}	Soft-start time (Note 8)			250		μs
$V_{1.5-1}$	The Threshold of 1.5X \rightarrow 1X	$V_{LED}=3.4V$, $I_{LED}=300mA$		4.1		V
$V_{1-1.5}$	The Threshold of 1X \rightarrow 1.5X	$V_{LED}=3.4V$, $I_{LED}=300mA$		3.8		V
Output Characteristics						
I_{OUT}	Maximum LED output current	$3.4 < V_{IN} < 5.5$, $V_{LED}=3.4V$		350		mA
V_{Rip}	V_{OUT} Ripple	1.5X Mode, $I_{OUT}=300mA$		80		mV
V_{FB}	Feedback Voltage Reference	315mV Feedback Type	283	315	347	mV
		157mV Feedback Type	141	157	173	
I_{OLP}	Over Load Protection Trigger Current	Short V_{OUT} to GND		550		mA
V_{ovp}	Over output voltage protection	$V_{IN} = 4V$, Open LED		5.5		V
Chip Enable						
V_{IL}	EN/PWM Maximum Low Level Threshold	$2.7V \leq V_{IN} \leq 5.5V$			0.4	V
V_{IH}	EN/PWM Minimum High Level Threshold	$2.7V \leq V_{IN} \leq 5.5V$	1.6			V
Thermal						
T_{SD}	Thermal Shutdown Threshold	Temperature rise		160		$^\circ C$
T_{HY}	Thermal Shutdown Hysteresis			10		$^\circ C$

Note 5: 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 recommended 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 6: Typical values are measured at 25°C and represent the parametric norm.

Note 7: Datasheet min/max specification limits are guaranteed by design, test, or statistical analysis.

Note 8: Soft-start time is related to V_{IN} and V_{OUT} .

SIMPLIFIED BLOCK DIAGRAM

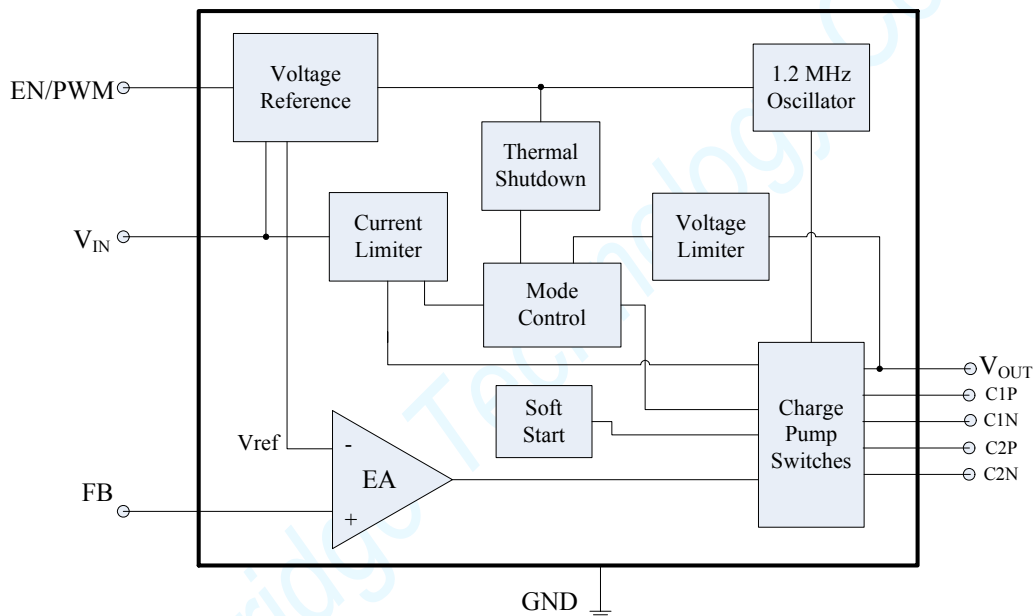


Figure 3. Simplified Block Diagram of PT4305

OPERATION DESCRIPTION

PT4305 is a 1.5x/1x charge pump and can be used to drive white LED for flash. In 1x mode, it can achieve high efficiency for high input voltage. 1.5x charge pump guarantees the enough current through the LED for low level input voltage. The current through the LED can be pre-set by external resistor. That the LED is on or off can be controlled by EN/PWM terminal, so you can dim LED by PWM control signals.

● Mode Decision

PT4305 uses a 1.5x/1x charge pump. The switch between two modes is a smart process. PT4305 senses

the voltage at FB, the input and the output to select the charge pump mode in order to achieve the maximum efficiency. User intervention isn't needed to complete this process.

● Soft Start

Soft start circuit would be started at power on or mode switching process in order to reject the inrush current from V_{IN} . The circuit would increase the input current step by step during a long period. Soft start time is dependent on the input level, the output current and the LED forward voltage.

● **Over Load Protection**

PT4305 employs the over-load protection to avoid the high current from V_{IN} . PT4305 would decrease the input current to protect the chip and battery, whenever the input current rises above the threshold.

● **Over Voltage Protection**

PT4305 employs the over voltage protection circuit to

detect the output voltage in 1.5x mode. Whenever the output voltage level rises above the threshold in 1.5x mode, PT4305 would shutdown the charge pump until the output voltage falls below the threshold.

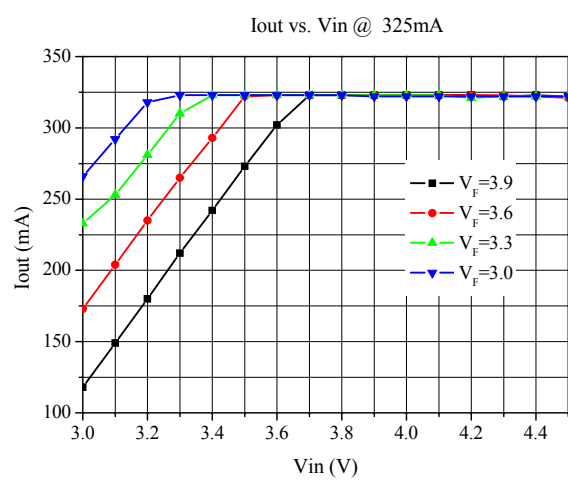
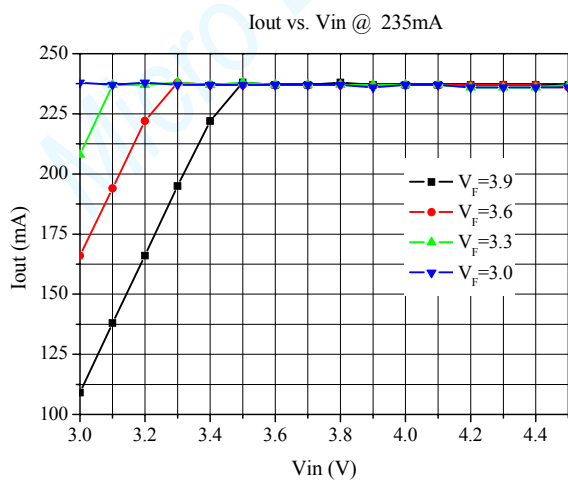
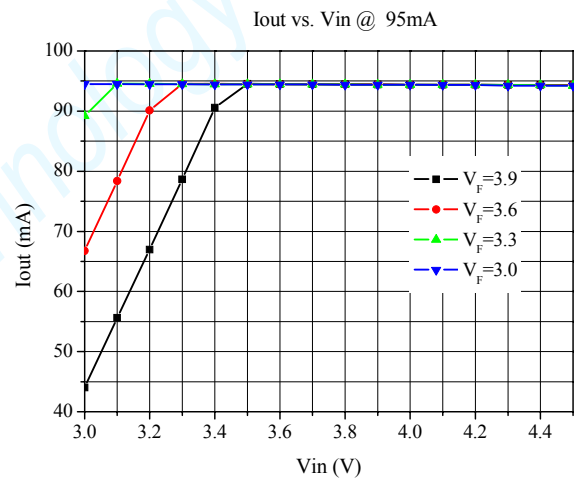
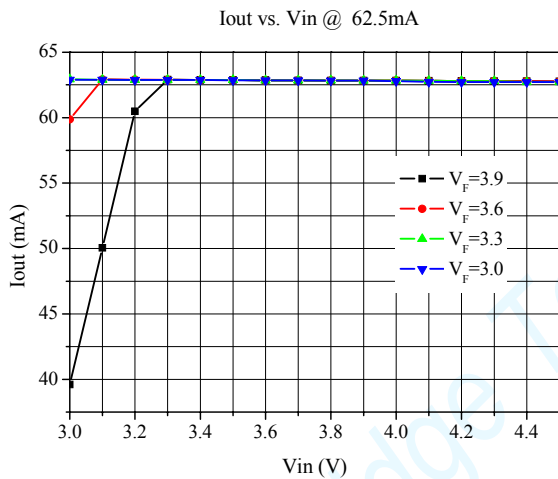
● **Thermal Shutdown**

When the chip temperature rises above the 160 °C, PT4305 would shutdown the charge pump to protect the chip from thermal damage.

TYPICAL PERFORMANCE CHARACTERISTICS

Note: Typical characteristics are obtained in the following condition:

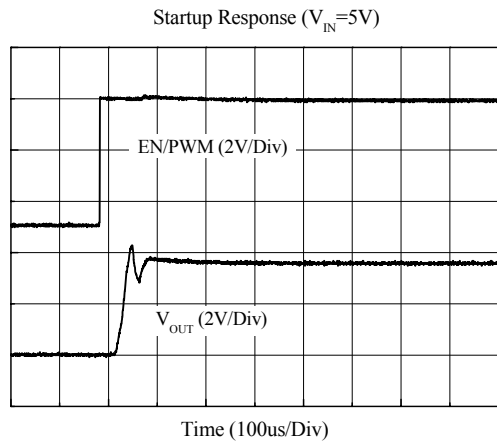
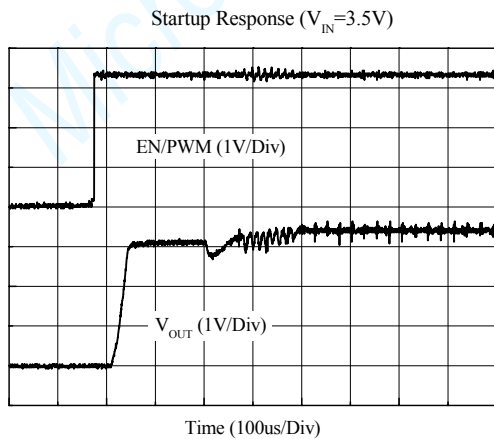
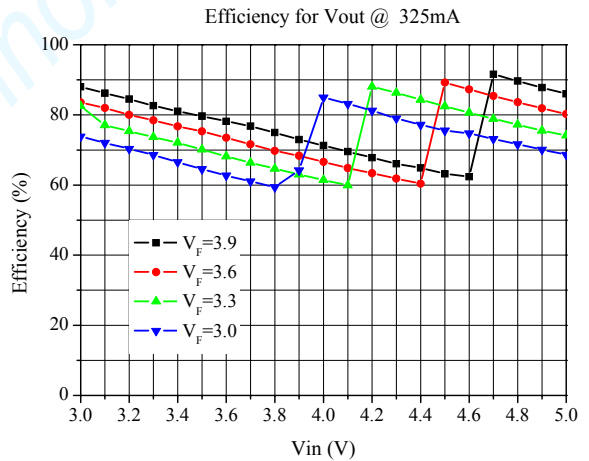
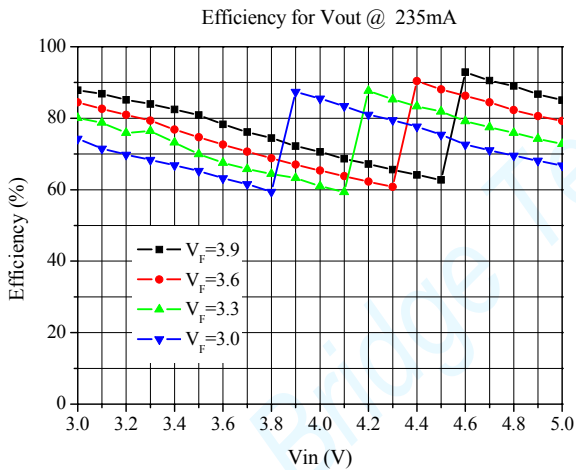
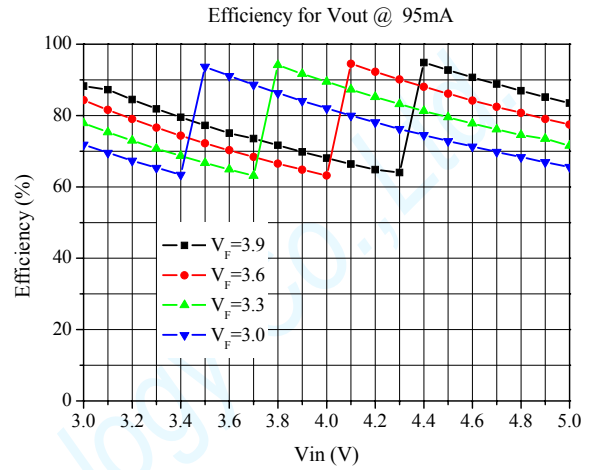
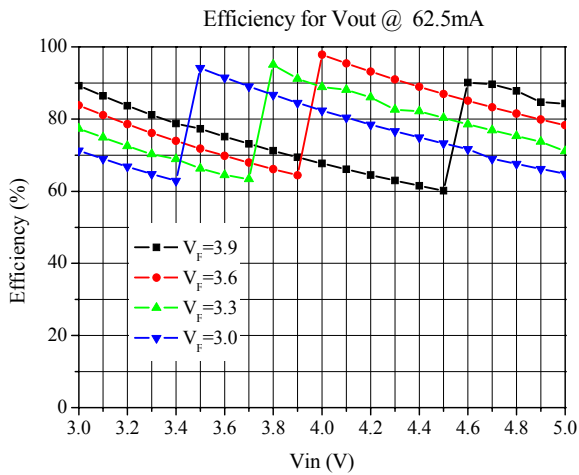
$C_1 = C_2 = 1\mu\text{F}$, $C_{IN} = 10\mu\text{F}$, $C_{OUT} = 2.2\mu\text{F}$ (Ceramic, ESR=0.03Ω), $T_A = 25^\circ\text{C}$, unless specified otherwise.



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APPLICATION INFORMATION

- PCB Board Layout**

PT4305 is a high-frequency switched-capacitor converter. For best performance, place all of the components as close to IC as possible. Besides a solid ground plane is recommended on the bottom layer of the PCB, the ground should be connected C_{IN} and C_{OUT} together and as close to the IC as possible. Figure 4 shows the typical layout of PT4305's EVB board

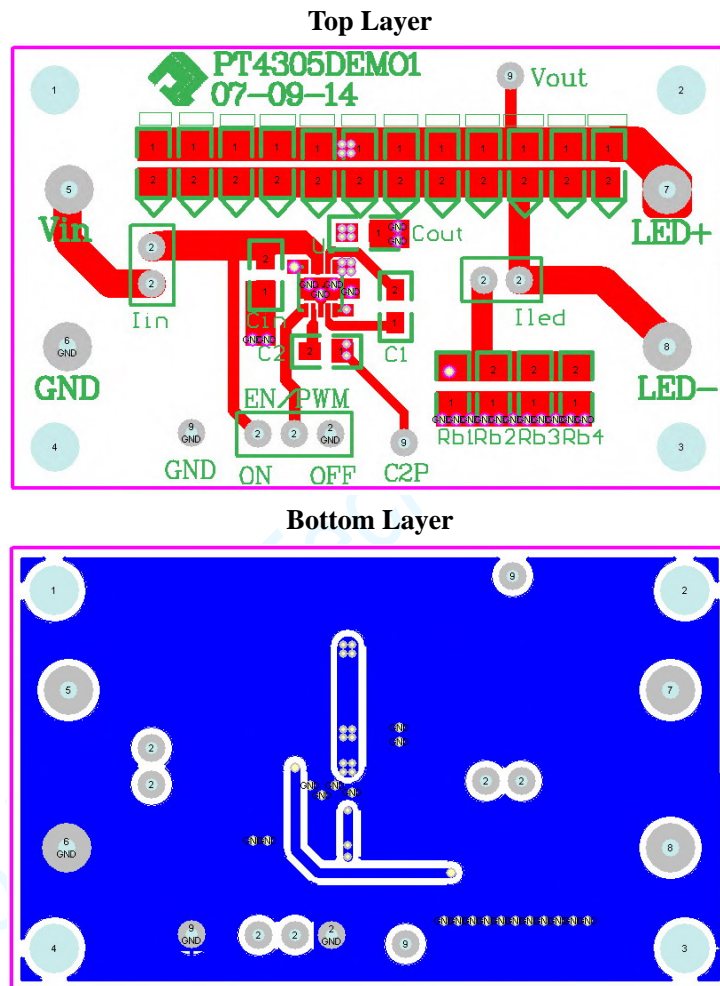


Figure 4. PT4305 EVB board

- Component Selection**

PT4305 can drive a white LED up to 350mA; the forward voltage of LED can range from 2.7V to 4.0V.

The selection of the four external capacitors C_{IN} , C_1 , C_2 and C_{OUT} is important because they will affect turn-on time, output ripple, and stability. Low ESR capacitor is recommended for low ripple value.

PT4305 can be set to a fixed LED current by a resistor R_B connected from FB to GND. The current flowing into LED can be calculated by the formula as below:

$$I_{LED} = V_{FB} (V) / R_B (\Omega)$$

Manufacturer	Part Number	Capacitance/ Voltage	Capacitor Size/Type/Thickness	ESR at 100KHz
TDK/www.tdk.com	C1005X5R0J105M	1uF/6.3V	0402/X5R/0.5mm	0.03Ω
	C1608X5R0J225K	2.2uF/6.3V	0603/X5R/0.9mm	0.02Ω
Murata/www.murata.com	GRM155R60J105KE19B	1uF/6.3V	0402/X5R/0.55mm	0.03Ω
	GRM188R61A225KE34B	2.2uF/6.3V	0603/X5R/0.9mm	0.02Ω

● Configuring as Cellphone Camera Flash Driver

PT4305 is capable of delivering up to 350mA current, which is competent to drive the most common LEDs in today's market.

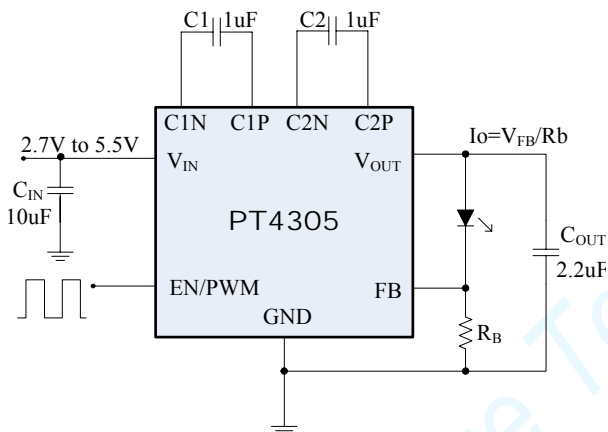


Figure 5. Camera Flash Driver

● Configuring as LCD Backlight

PT4305 is able to efficiently drive up to fifteen 20mA white LEDs in parallel and maintain a constant wide operating voltage range (2.7V to 5.5V).

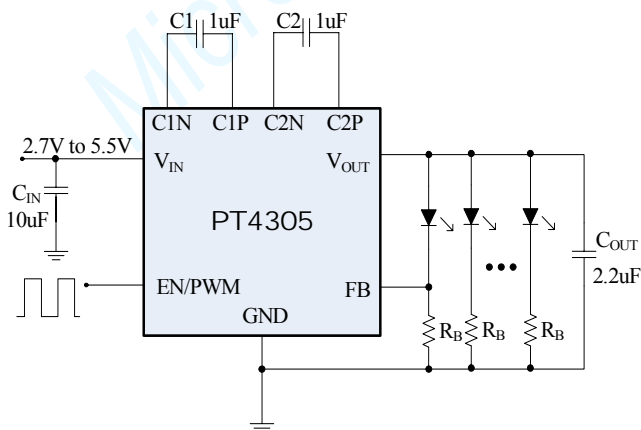


Figure 6. LCD Backlighting Driver

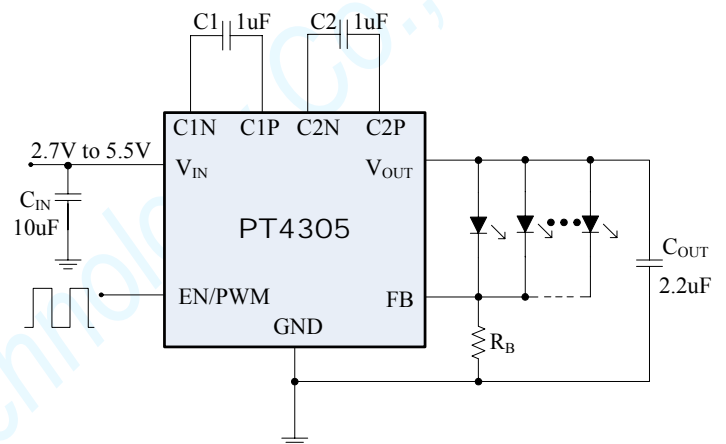


Figure 7. LCD Backlighting Driver

● Configuring as Camera Flash + Torch Drive

PT4305 can be configured as a flash/ torch LED driver which in some applications require constant torch current used for motion pictures (i.e. movie mode).

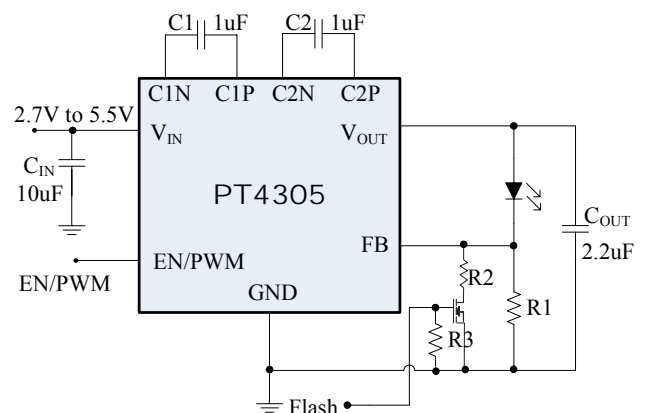
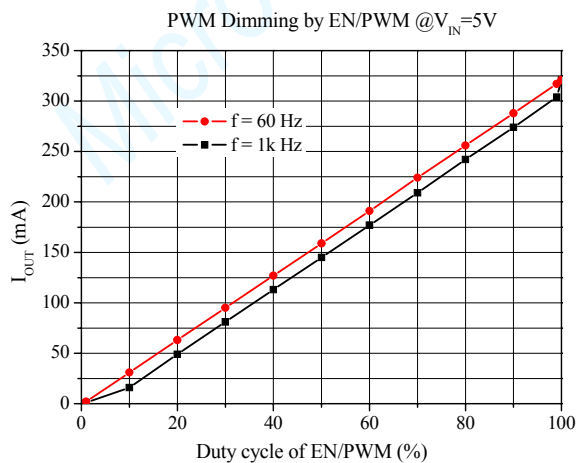
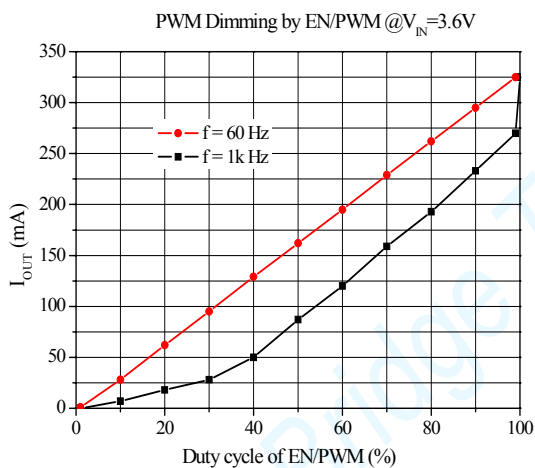


Figure 8. Flash/ Torch LED Driver

● Brightness Control Using PWM

Dimming control can be achieved by applying a PWM control signal to the EN/PWM pin. The brightness of the white LEDs is controlled by increasing and decreasing the duty cycle of the PWM signal. While operating frequency range is from 60 Hz to 1k Hz, the recommended maximum brightness frequency range is from 60 Hz to 200 Hz. A repetition rate of at least 60 Hz is required to prevent flicker. The following two figures plot the average output current versus duty cycle at different V_{IN} and PWM frequency. The soft start time will last longer at $V_{IN}=3.6V$ than at $V_{IN}=5V$, so the average output current is smaller at $V_{IN}=3.6V$. When PWM frequency becomes large, this phenomenon become more evident.



● Configuring as Voltage or Current Source

Since V_{FB} is supposed to be 0.315V, you can get different V_{OUT} by choosing proper ratio of $Rb1/Rb2$ as show below. V_{OUT} can range from 2.7V to 1.5VIN. As a current source, LED driver is the best application case.

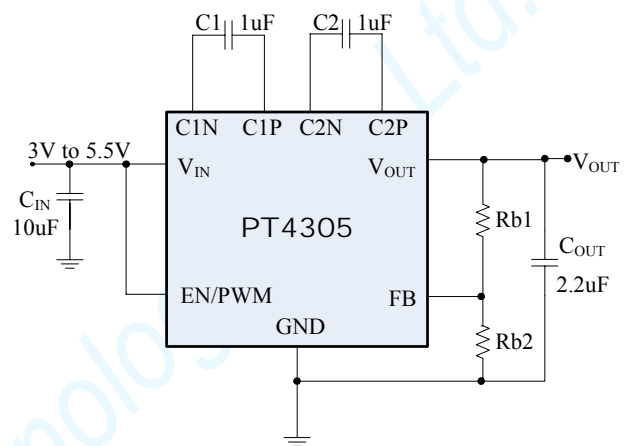
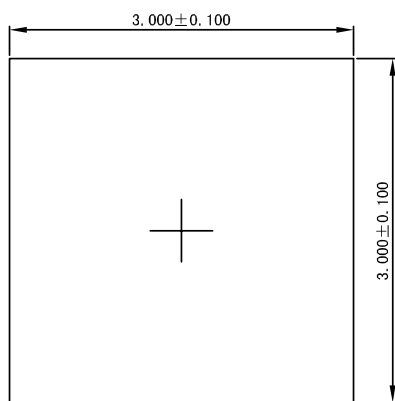


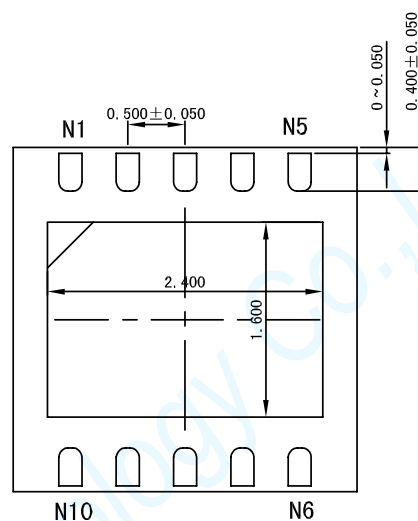
Figure 9. Voltage Source

PACKAGE INFORMATION

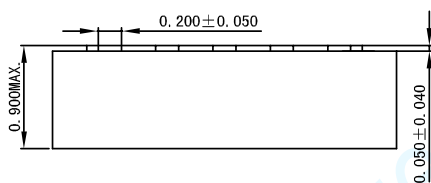
DFN-10(3mm×3mm)



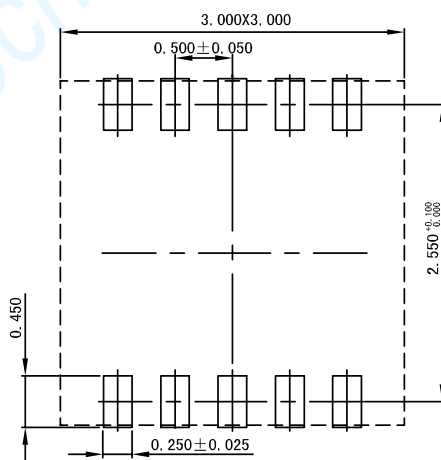
Top View



Bottom View



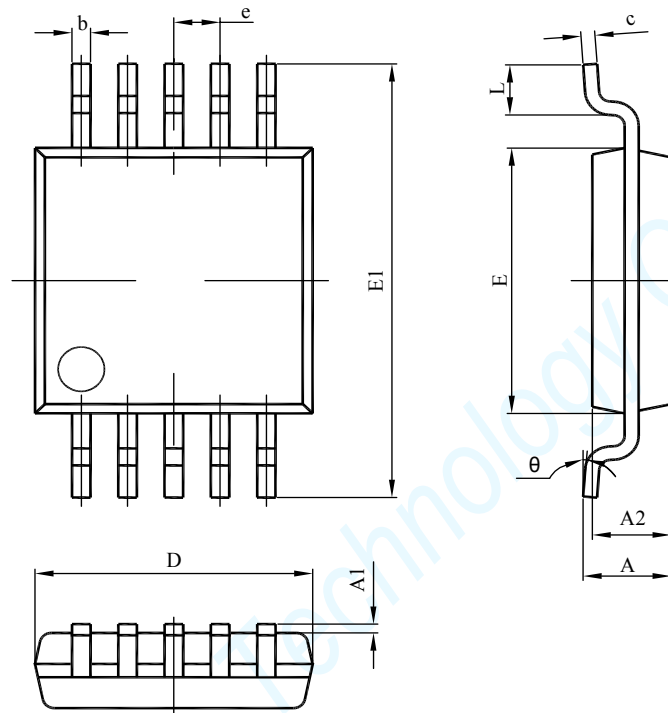
Side View



(LAND PATTERN RECOMMENDATION)

PACKAGE INFORMATION

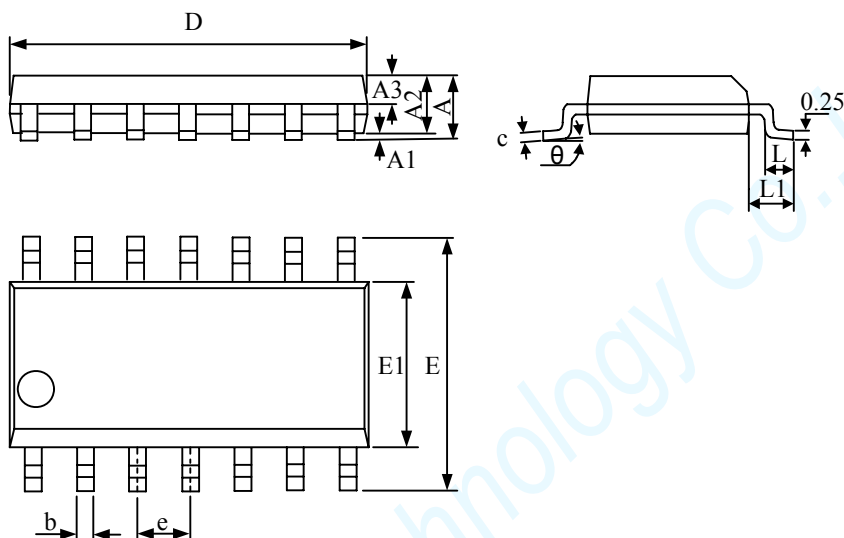
MSOP-10



SYMBOL	MILLIMETER		INCHES	
	MIN	MAX	MIN	MAX
A	0.820	1.100	0.032	0.043
A1	0.020	0.150	0.001	0.006
A2	0.750	0.950	0.030	0.037
b	0.180	0.280	0.007	0.011
c	0.090	0.230	0.004	0.009
D	2.900	3.100	0.114	0.122
e	0.50(BSC)		0.020 (BSC)	
E	2.900	3.100	0.114	0.122
E1	4.750	5.050	0.187	0.199
L	0.400	0.800	0.016	0.031
θ	0°	6°	0°	6°

PACKAGE INFORMATION

SOP-14



SYMBOL	MILLIMETERS		
	MIN	NOM	MAC
A	-	-	1.77
A1	0.08	0.18	0.28
A2	1.20	1.40	1.60
A3	0.55	0.65	0.75
b	0.39	-	0.48
b1	0.38	0.41	0.43
c	0.21	-	0.26
c1	0.19	0.20	0.21
D	8.45	8.65	8.85
E	5.80	6.00	6.20
E1	3.70	3.90	4.10
e	1.27BSC		
L	0.50	0.65	0.80
L1	1.05BSC		
θ	0		8°