



High Efficiency Synchronous Boost Converter With Dual Independent 2A Current Sources

■ General Description

The OCP81375 is a dual LED flash driver that provides a high level of adjustability within a small solution size. The OCP81375 utilizes a 2-MHz or 4-MHz fixed-frequency synchronous boost converter to provide power to the dual 2A constant current LED sources. The total LED current the OCP81375 boost can deliver is 2A ($I_{LED1} + I_{LED2}$). The dual 128 level current sources provide the flexibility to adjust the current ratios between LED1 and LED2 with each driver capable of delivering a maximum of 2A. An adaptive regulation method ensures the current sources remain in regulation and maximizes efficiency.

Features of the OCP81375 are controlled via an I²C-compatible interface. These features include: hardware flash and hardware torch pins (STROBE and TORCH/TEMP), a TX interrupt, and an NTC thermistor monitor. The device offers independently programmable currents in each output leg to drive the LEDs in a Flash or Movie Mode (Torch) condition.

The 2-MHz or 4-MHz switching frequency options, over voltage protection (OVP), and adjustable current limit allow for the use of tiny, low-profile inductors and (10-μF) ceramic capacitors. The device operates over a -40°C to 85°C ambient temperature range.

● Features

- 2A Total Allowed LED Current During Operation
- Dual Independent LED Current Source Programmability
- Accurate and Programmable LED Current Range from 3.90mA to 2A
- Optimized Flash LED Current During Low Battery Conditions (IVFM)
- Grounded Cathode LED Operation for Improved Thermal Management
- Small Solution Size: <16mm²
- Hardware Strobe Enable (STROBE)
- Synchronization Input for RF Power Amplifier Pulse Events (TX)
- Hardware Torch Enable (TORCH/TEMP)
- Remote NTC Monitoring (TORCH/TEMP)
- 400-kHz I²C-Compatible Interface
 - OCP81375(I²C Address=0x63)

● Applications

- Camera Phone White LED Flash



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■ **Pin Configuration**
WLCSP-12B (Top View)

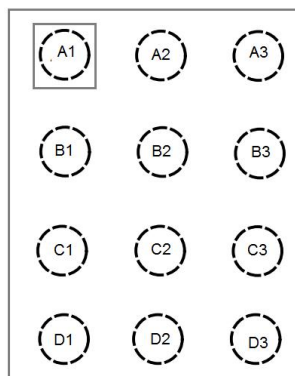


Figure 1, Pin Assignments of OCP81375

Pin Name	Pin No.	I/O	Pin Function
	WLCSP-12B		
GND	A1	P	Ground
IN	A2	I	Input voltage connection. Connect IN to the input supply and bypass to GND with a 10 μ F or larger ceramic capacitor.
SDA	A3	I/O	Serial data input/output in the I ² C Mode on OCP81375.
SW	B1	P	Drain Connection for Internal NMOS and Synchronous PMOS Switches.
STROBE	B2	I/O	Active high hardware flash enable. Drive STROBE high to turn on Flash pulse. Internal pulldown resistor 300k Ω between STROBE and GND
SCL	B3	I/O	Serial clock input for OCP81375
OUT	C1	O	Step-up DC/DC Converter Output. Connect a 10 μ F ceramic capacitor between this terminal and GND.
HWEN	C2	I	Active high enable pin. High = Standby, Low = Shutdown/Reset. Internal pulldown resistor of 300k Ω between HWEN and GND.
TORCH/TEMP	C3	I	Torch terminal input or threshold detector for NTC temperature sensing and current scale back.
LED2	D1	O	High-side current source output for flash LED.
TX	D2	I	Configurable dual polarity power amplifier synchronization input. Internal pulldown resistor of 300k Ω between TX and GND.
LED1	D3	O	High-side current source output for flash LED.

■ Typical Application Circuit

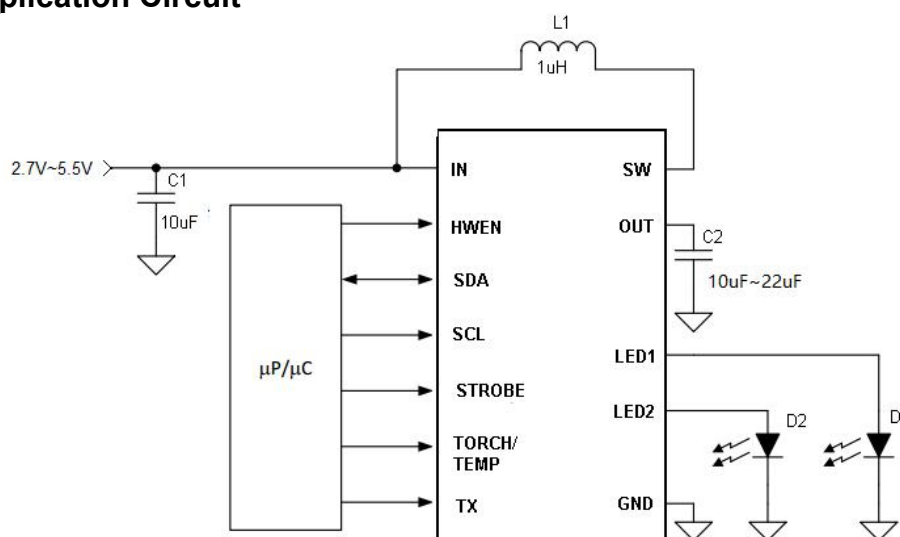


Figure 2, Typical Application Circuit of OCP81375

■ Block Diagram

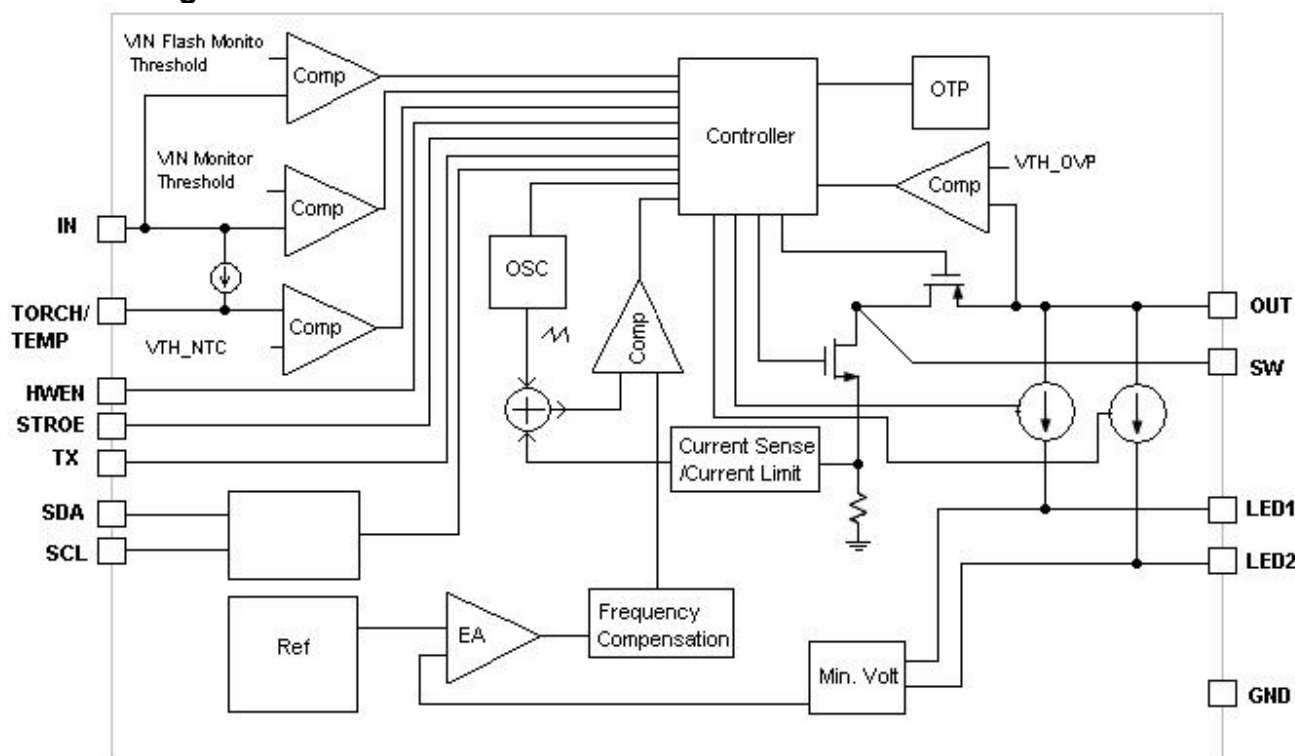


Figure 3, Block Diagram of OCP81375

■ Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted)

Parameter	Symbol	Rating	Unit
V_{IN} , V_{SW} , V_{LED1} , V_{LED2} Pins to GND		-0.3 to +6.0	V
All Other Pins to GND		-0.3 to the lesser of $(V_{IN} + 0.3)/6$	V
Continuous power dissipation		Internally limited	
Operating Junction Temperature Range	T_J	-40 to +150	°C
Maximum Soldering Temperature (at leads, 10 sec)	T_{LEAD}	300	°C



■ Recommended Operating Conditions

Parameter		Symbol	Rating	Unit
V_{IN} Pin Voltage to GND		V_{IN}	+2.7 to +5.5	V
Maximum Thermal Resistance	WLCSP-12B	Θ_{JA}	67.8	°C/W
Ambient temperature		TA	-40 to 85	°C

■ Electrical Characteristics

Typical limits tested at $T_A = 25^\circ\text{C}$. Unless otherwise specified, $V_{IN} = 3.6\text{V}$, $HWEN = V_{IN}$.

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
CURRENT SOURCE SPECIFICATIONS						
I _{LED1/2}	Current source accuracy	flash ,V _{OUT} = 4 V, flash code=0x3F=1A,	-7%	1.0	+7%	A
		torch ,V _{OUT} = 4 V, code =0x3F=249.6mA	-10%	249.6	+10%	mA
V _{OVP}		ON threshold	4.8	5	5.2	V
		OFF threshold	-	4.88	-	
STEP-UP DC/DC CONVERTER SPECIFICATIONS						
R _{NMOS}	NMOS Switch On-Resistance		-	100	-	mΩ
R _{PMOS}	PMOS Switch On-Resistance		-	100	-	mΩ
I _{CL}	Switch Current Limit	Reg0x07, bit[0]=0	-	1.9	-	A
		Reg0x07, bit[0]=1	-	2.8	-	
UVLO	Undervoltage lockout threshold	Falling V _{IN}	-	2.5	-	V
V _{TRIP}	NTC comparator trip threshold	Reg0x09, bits[3:1]='100'	-	0.6	-	V
V _{IVFM}	Input voltage flash monitor tripthreshold	Reg0x02, bits[5:3]='000'	-	2.9	-	V
I _Q	Quiescent supply current	Device not switching pass mode	-	0.6	-	mA
I _{SD}	Shutdown supply curren	Device disabled, HWEN=0V,2.7 V≤VIN≤5.5V	-	0.1	4	uA
I _{SB}	Standby supply current	Device disabled, HWEN=1.8V,2.7V≤VIN≤5.5V	-	2.5	10	uA
HWEN, TORCH/TEMP, STROBE, TX VOLTAGE SPECIFICATION						
V _{IL}	Input logic low	2.7V≤VIN≤5.5V	0	-	0.4	V
V _{IH}	Input logic high		1.2	-	V _{IN}	
I ² C-COMPATIBLE INTERFACE SPECIFICATIONS (SCL, SDA)						
V _{IL}	Input logic low	2.7V≤VIN≤5.5V	0	-	0.4	V
V _{IH}	Input logic high		1.2	-	V _{IN}	
V _{OL}	Output logic low	I _{LOAD} =3mA	-	-	400	mA
Switching Characteristics						
f _{sw}	Switching frequency	Reg0x07, bit[1]=0	-	2	-	MHz
		Reg0x07, bit[1]=1	-	4	-	

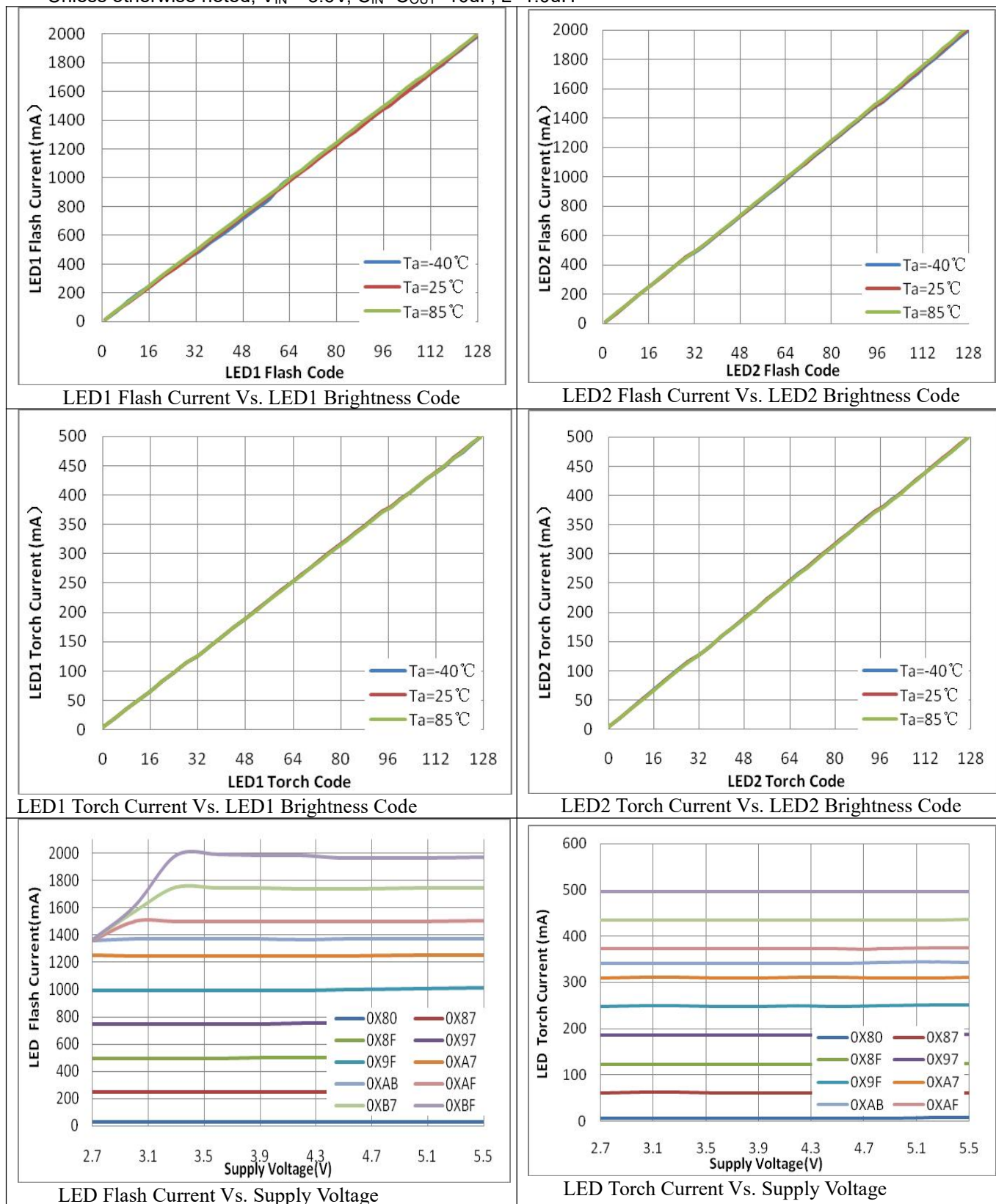
■ Timing Requirements

Symbol	Parameter	Min.	Typ.	Max.	Unit
t1	SCL clock period	2.4	-	-	μs
t2	Data in set-up time to SCL high	100	-	-	ns
t3	Data out stable After SCL low	0	-	-	
t4	SDA low set-up time to SCL Low (start)	100	-	-	
t5	SDA high hold time after SCL high (stop)	100	-	-	



■ Typical Characteristics (continued)

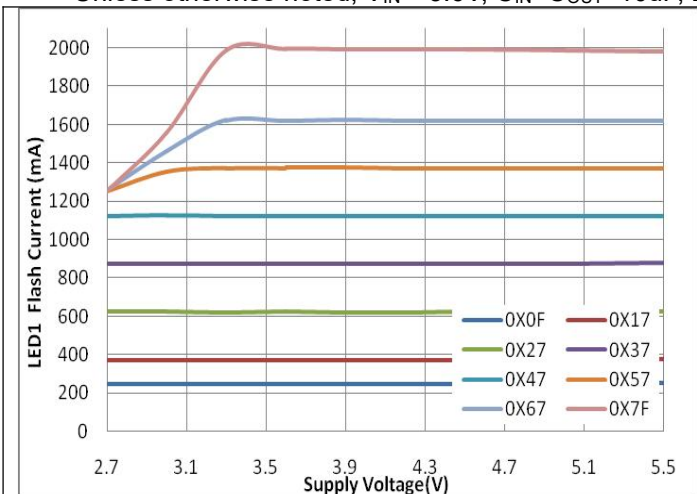
Unless otherwise noted, $V_{IN} = 3.6V$, $C_{IN}=C_{OUT}=10\mu F$, $L=1.0\mu H$



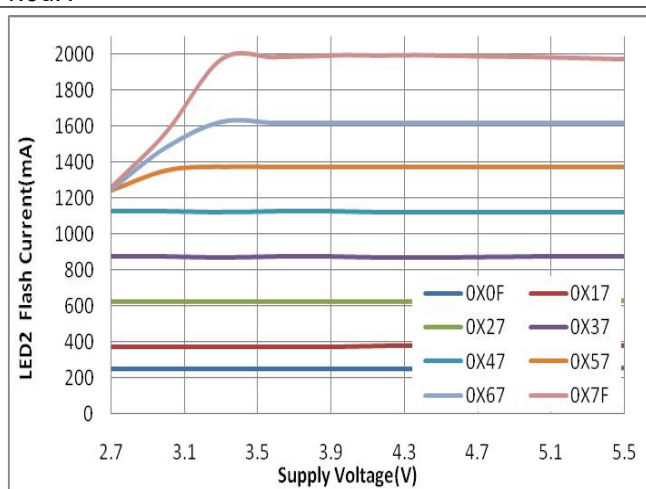


■ Typical Characteristics (continued)

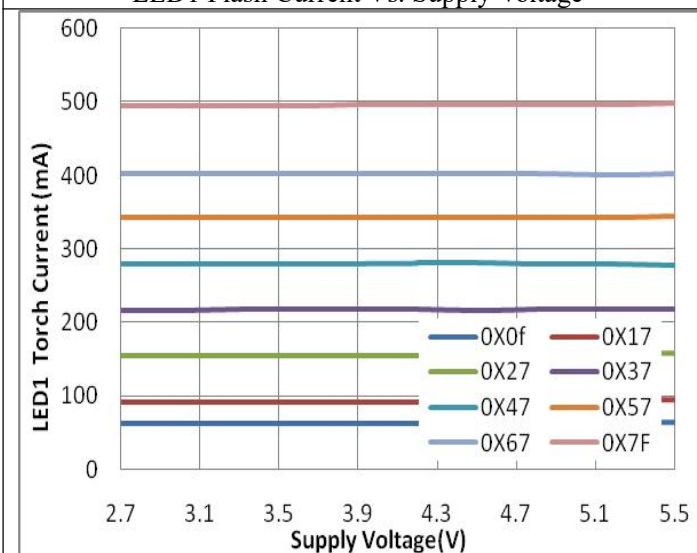
Unless otherwise noted, $V_{IN} = 3.6V$, $C_{IN}=C_{OUT}=10\mu F$, $L=1.0\mu H$



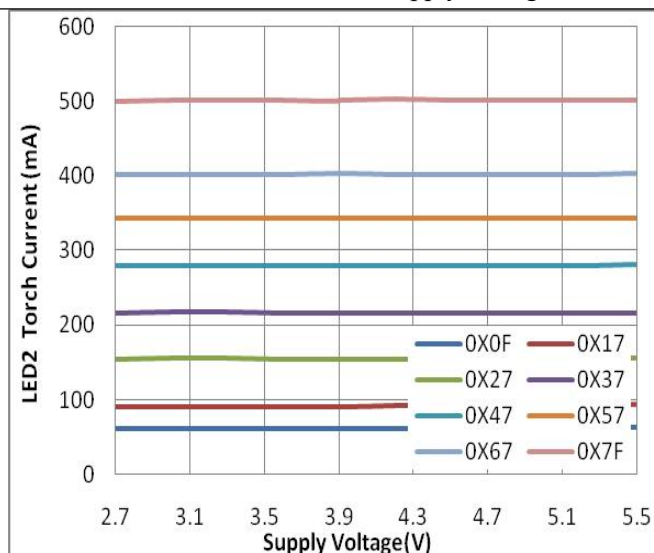
LED1 Flash Current Vs. Supply Voltage



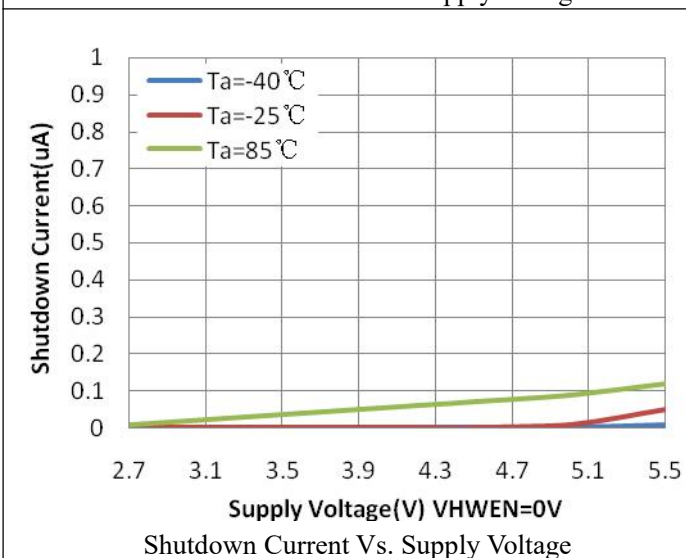
LED2 Flash Current Vs. Supply Voltage



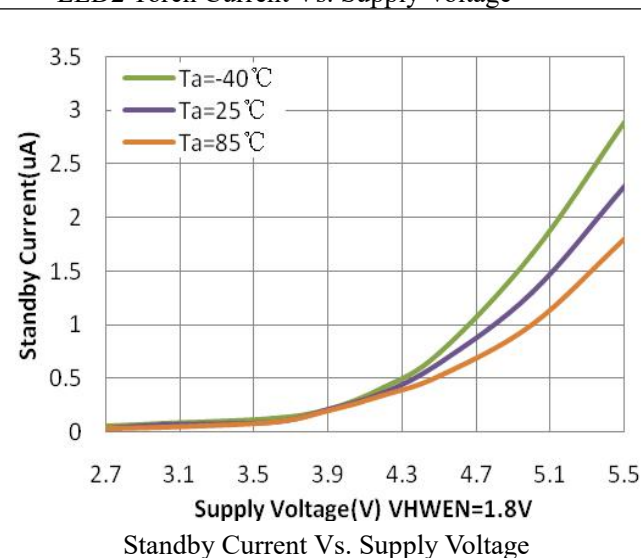
LED1 Torch Current Vs. Supply Voltage



LED2 Torch Current Vs. Supply Voltage



Shutdown Current Vs. Supply Voltage



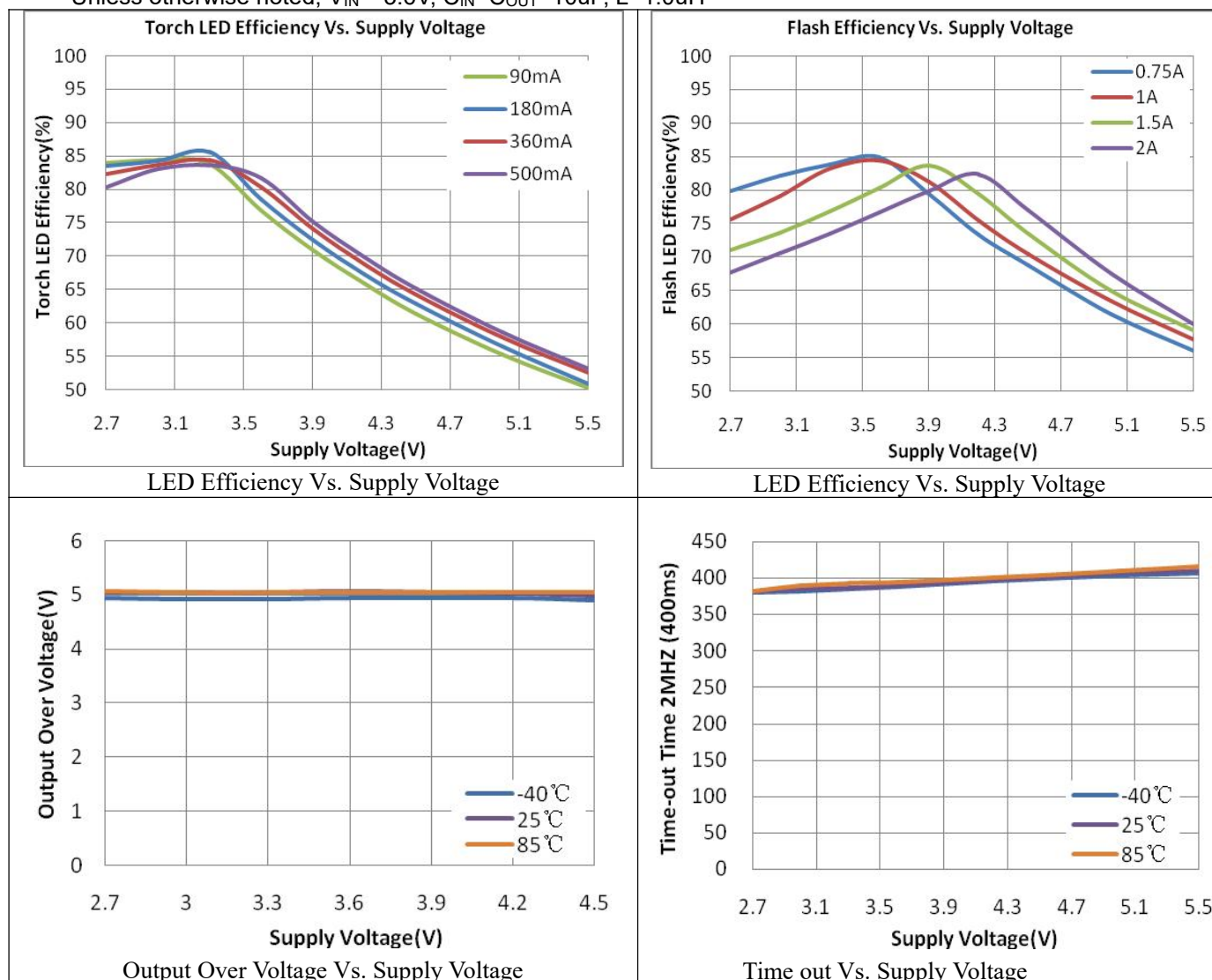
Standby Current Vs. Supply Voltage



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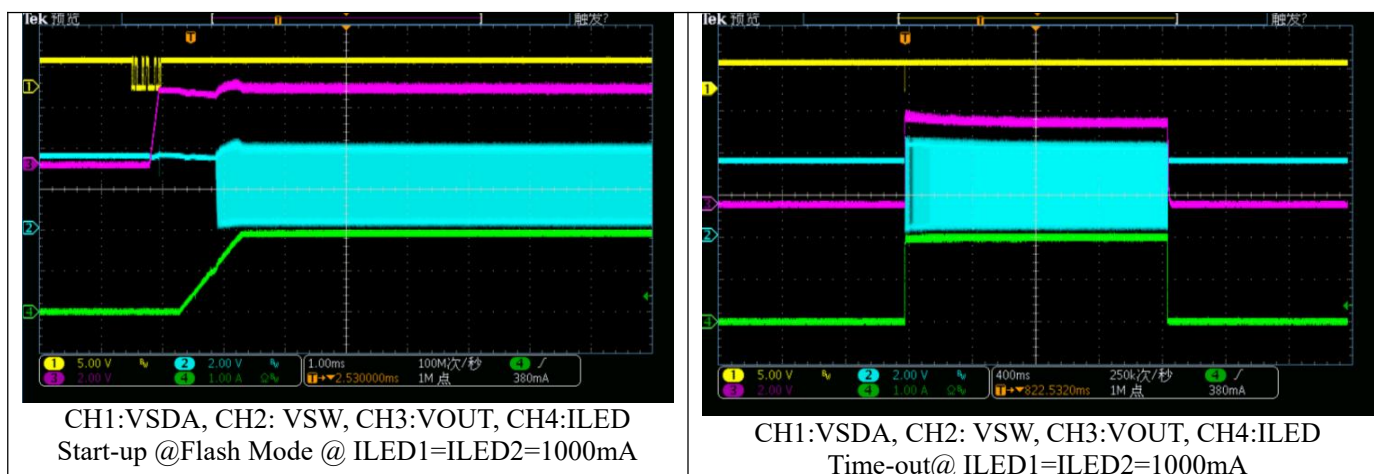
■ Typical Characteristics (continued)

Unless otherwise noted, $V_{IN} = 3.6V$, $C_{IN}=C_{OUT}=10\mu F$, $L=1.0\mu H$



■ Typical Characteristics (continued)

Unless otherwise noted, $V_{IN} = 3.6V$, $C_{IN}=C_{OUT}=10\mu F$, $L=1.0\mu H$





CH1:TX Signal, CH2:VOUT, CH4:ILED
TX Interrupt @ ILED1=ILED2=500mA



CH1:VStrobe, CH2:VOUT, CH3:VLed1, CH4:ILED1
IR Mode



CH1: SW, CH2:VOUT, CH3:VSDA, CH4:ILED
Movie Current Ramp Up@ ILED1= ILED2=187mA



CH1: SW, CH2:VOUT, CH3:VSDA, CH4:ILED
Movie Current Ramp Down@ ILED1= ILED2=187mA



■ Feature Description

Flash Mode

In Flash Mode, the LED current sources (LED1/2) provide 128 target current levels from 15.63mA to 2A. The total allowed LED current during operation is 2A ($I_{LED1} + I_{LED2} = 2A$). Once the Flash sequence is activated the current source(LED) ramps up to the programmed Flash current by stepping through all current steps until the programmed current is reached. The headroom in the two current sources can be regulated to provide 15.63mA to 2A on each of the two output legs. There is an option in the register settings to keep the two currents in the output leg the same.

When the device is enabled in Flash Mode through the Enable Register, all mode bits in the Enable Register are cleared after a flash time-out event.

Torch Mode

In Torch mode, the LED current sources (LED1/2) provide 128 target current levels from 3.9mA to 499.2mA. The Torch currents are adjusted via the LED1 and LED2 LED Torch Brightness Registers. Torch mode is activated by the Enable Register (setting M1, M0 to '10'), or by pulling the TORCH/TEMP pin HIGH when the pin is enabled (Enable Register) and set to Torch Mode. Once the TORCH sequence is activated the active current sources (LED1/2) ramps up to the programmed Torch current by stepping through all current steps until the programmed current is reached. The rate at which the current ramps is determined by the value chosen in the Timing Register.

Torch Mode is not affected by Flash Timeout or by a TX Interrupt event.

IR Mode

In IR Mode, the target LED current is equal to the value stored in the LED1/2 Flash Brightness Registers. When IR mode is enabled (setting M1, M0 to '01'), the boost converter turns on and set the output equal to the input (pass-mode). At this point, toggling the STROBE pin enables and disables the LED1/2 current sources (if enabled). The strobe pin can only be set to be Level sensitive, meaning all timing of the IR pulse is externally controlled. In IR Mode, the current sources do not ramp the LED outputs to the target. The current transitions immediately from off to on and then on to off.

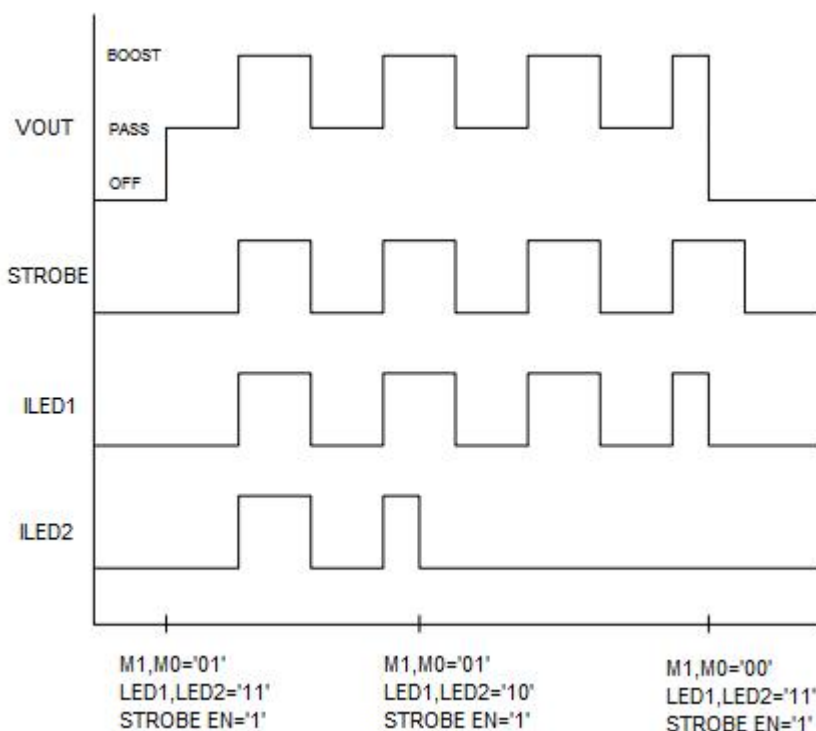


Figure 4, IR Mode with Boost

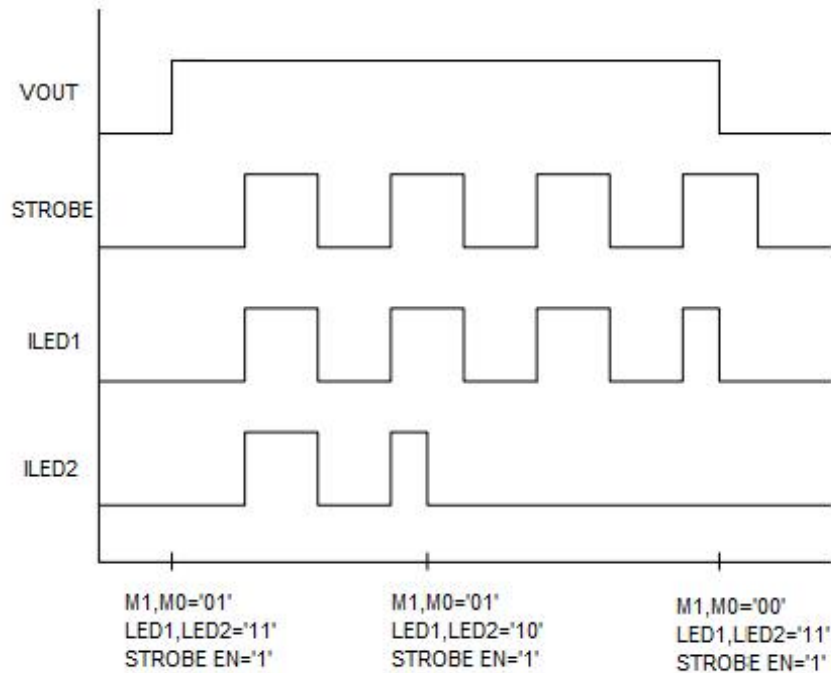


Figure 5, IR Mode Pass Only

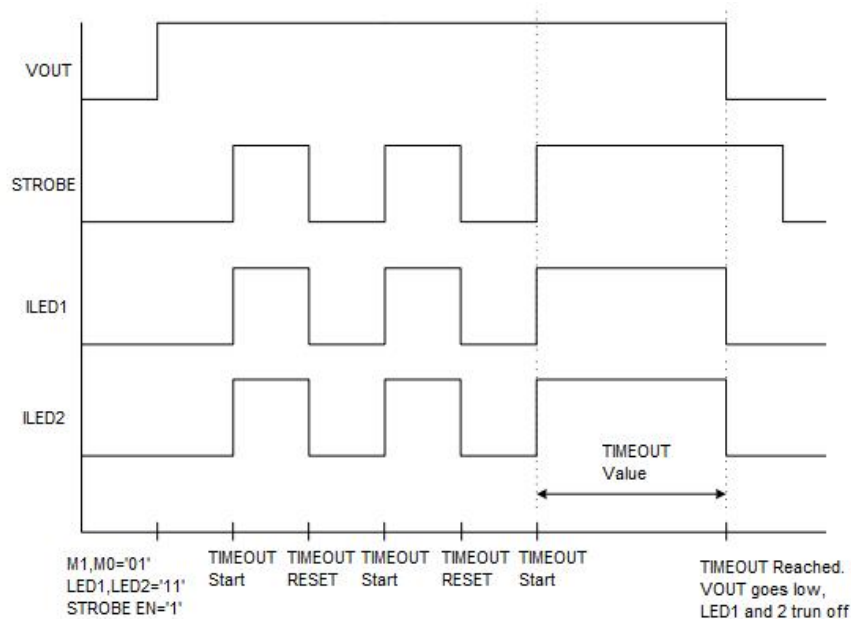


Figure 6, IR Mode Timeout

Start-Up (Enabling The Device)

Turn on of the OCP81375 Torch and Flash modes can be done through the Enable Register. On start-up, when V_{OUT} is less than V_{IN} the internal synchronous PFET turns on as a current source and delivers 200mA (typ.) to the output capacitor. During this time the current source (LED) is off. When the voltage across the output capacitor reaches 2.2V(typ.) the current source turns on. At turn on the current source steps through each FLASH or TORCH level until the target LED current is reached. This gives the device a controlled turn on and limits inrush current from the V_{IN} supply.

Pass Mode

The OCP81375 starts up in Pass Mode and stays there until Boost Mode is needed to maintain regulation. If the voltage difference between V_{OUT} and V_{LED} falls below V_{HR} , the device switches to Boost Mode. In Pass Mode the boost converter does not switch, and the synchronous PFET turns fully on bringing V_{OUT} up to $V_{IN} - I_{LED} \times R_{PMOS}$. In Pass Mode the inductor current is not limited by the peak current limit.



Power Amplifier Synchronization (TX)

The TX pin is a Power Amplifier Synchronization input. This is designed to reduce the flash LED current and thus limit the battery current during high battery current conditions such as PA transmit events. When the OCP81375 is engaged in a Flash event, and the TX pin is pulled high, the LED current is forced into Torch Mode at the programmed Torch current setting. If the TX pin is then pulled low before the Flash pulse terminates, the LED current returns to the previous Flash current level. At the end of the Flash time-out, whether the TX pin is high or low, the LED current turns off.

Input Voltage Flash Monitor (IVFM)

The OCP81375 has the ability to adjust the flash current based upon the voltage level present at the IN pin utilizing the Input Voltage Flash Monitor (IVFM). The adjustable threshold IVFM-D ranges from 2.9 V to 3.6 V in 100-mV steps, with three different usage modes (Stop and Hold, Adjust Down Only, Adjust Up and Down). The Flags2 Register has the IVFM flag bit set when the input voltage crosses the IVFM-D value. Additionally, the IVFM-D threshold sets the input voltage boundary that forces the OCP81375 to either stop ramping the flash current during start-up (Stop and Hold Mode) or to start decreasing the LED current during the flash (Down Adjust Only and Up and Down Adjust). In Adjust Up and Down mode, the IVFM-D value plus the hysteresis voltage threshold set the input voltage boundary that forces the OCP81375 to start ramping the flash current back up towards the target.

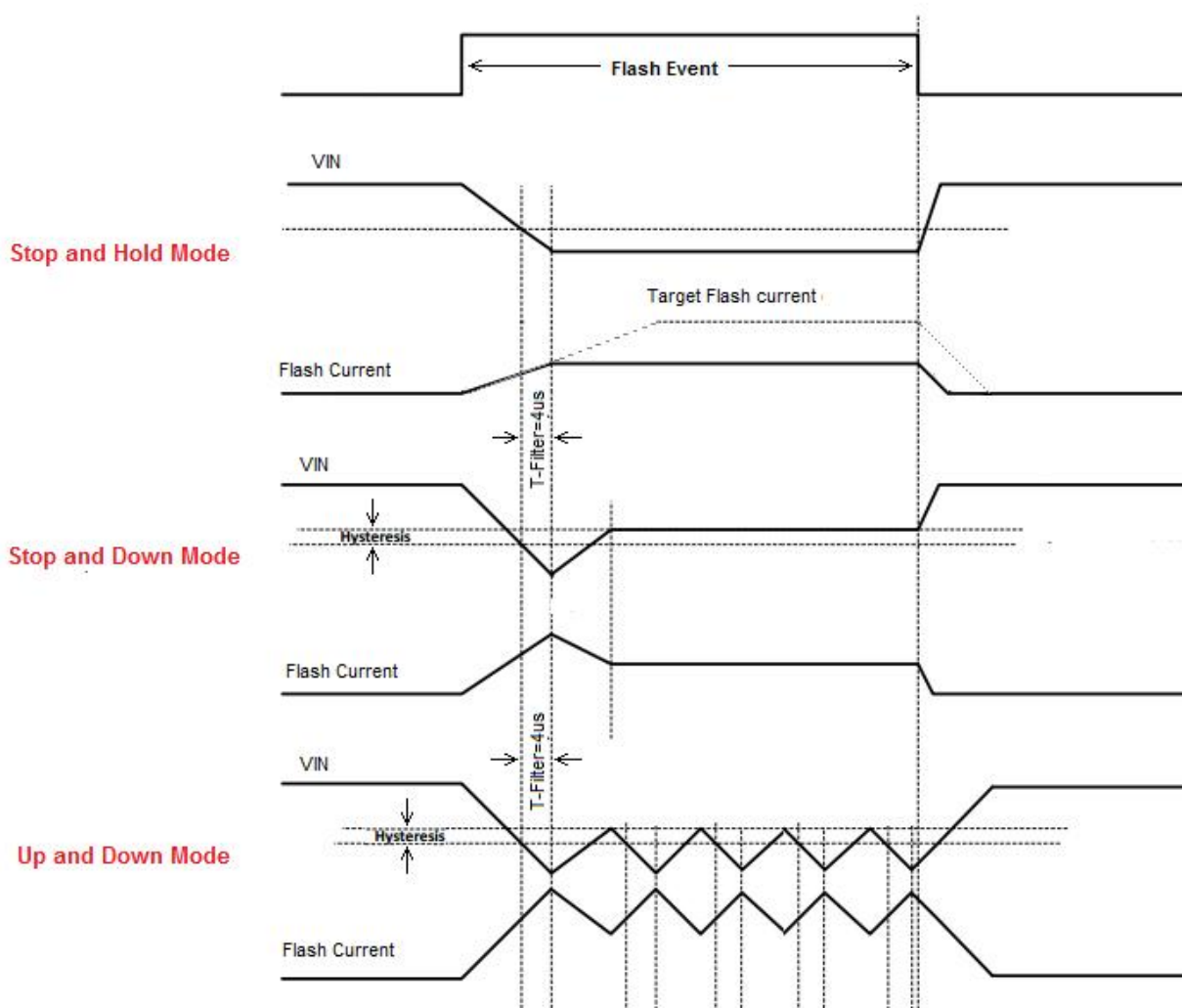


Figure 7, IVFM Modes

Fault Operation

If the OCP81375 enters a fault condition, the device sets the appropriate flag in the Flags1 and Flags2 Registers (0x0A and 0x0B), and place the device into standby by clearing the Mode Bits ([1], [0]) in the Enable Register. The OCP81375 remains in standby until an I²C read of the Flags1 and Flags2 Registers are completed. Upon clearing the flags/faults, the device can be restarted (Flash, Torch, IR, etc.). If the fault is still present, the OCP81375 re-enters the fault state and enters standby again.

**Flash Time-Out**

The Flash Time-Out period sets the amount of time that the Flash Current is being sourced from the current sources (LED1/2). The OCP81375 has 16 timeout levels ranging from 40ms to 1600ms (see Timing Configuration Register (0x08) for more detail).

Overvoltage Protection (OVP)

The output voltage is limited to typically 5V (see V_{OVP} spec in the Electrical Characteristics). In situations such as an open LED, the OCP81375 raises the output voltage in order to try and keep the LED current at its target value. When V_{OUT} reaches 5V (typ.) the overvoltage comparator trips and turns off the internal NFET. The mode bits are cleared and the OVP flag is set.

Current Limit

The OCP81375 features two selectable inductor current limits that are programmable through the I²C-compatible interface. When the inductor current limit is reached, the OCP81375 terminates the charging phase of the switching cycle. Switching resumes at the start of the next switching period. If the over current condition persists, the device operates continuously in current limit.

Since the current limit is sensed in the NMOS switch, there is no mechanism to limit the current when the device operates in Pass Mode (current does not flow through the NMOS in pass mode). In Boost mode or Pass mode if V_{OUT} falls below 2.3V, the device stops switching, and the PFET operates as a current source limiting the current to 200mA. This prevents damage to the OCP81375 and excessive current draw from the battery during output short-circuit conditions. The mode bits are not cleared upon a Current Limit event, but a flag is set.

NTC Thermistor Input (Torch/Temp)

The TORCH/TEMP pin, when set to TEMP mode, serves as a threshold detector and bias source for negative temperature coefficient (NTC) thermistors. When the voltage at TEMP goes below the programmed threshold, the OCP81375 is placed into standby mode. The NTC threshold voltage is adjustable from 200mV to 900mV in 100mV steps. The NTC bias current is set to 50 μ A. The NTC detection circuitry can be enabled or disabled via the Enable Register. If enabled, the NTC block turns on and off during the start and stop of a Flash/Torch event.

Additionally, the NTC input looks for an open NTC connection and a shorted NTC connection. If the NTC input falls below 100mV, the NTC short flag is set, and the device is disabled. If the NTC input rises above 2.3V, the NTC Open flag is set, and the device is disabled. These fault detections can be individually disabled/enabled via the NTC Open Fault Enable bit and the NTC Short Fault Enable bit.

Under voltage Lockout (UVLO)

The OCP81375 has an internal comparator that monitors the voltage at IN and forces the OCP81375 into standby if the input voltage drops to 2.5V. If the UVLO monitor threshold is tripped, the UVLO flag bit is set in the Flags1 Register (0x0A). If the input voltage rises above 2.5V, the OCP81375 is not available for operation until there is an I²C read of the Flags1 Register (0x0A). Upon a read, the Flags1 register is cleared, and normal operation can resume if the input voltage is greater than 2.5V.

Thermal Shutdown (TSD)

When the OCP81375 die temperature reaches 150°C, the thermal shutdown detection circuit trips, forcing the OCP81375 into standby and writing a '1' to the corresponding bit of the Flags1 Register (0x0A) (Thermal Shutdown bit). The OCP81375 is only allowed to restart after the Flags1 Register (0x0A) is read, clearing the fault flag. Upon restart, if the die temperature is still above 150°C, the OCP81375 resets the Fault flag and re-enters standby.

LED and/or VOUT Short Fault

The LED Fault flags read back a '1' if the device is active in Flash or Torch mode and either active LED output experiences a short condition. The Output Short Fault flag reads back a '1' if the device is active in Flash or Torch mode and the boost output experiences a short condition. An LED short condition is determined if the voltage at LED1 or LED2 goes below 500mV (typ.) while the device is in Torch or Flash mode. There is a deglitch time of 256 μ s before the LED Short flag is valid and a deglitch time of 2.048ms before the VOUT Short flag is valid. The LED Short Faults can be reset to '0' by removing power to the OCP81375, setting HWEN to '0', setting the SW RESET bit to a '1', or by reading back the Flags1 Register (0x0A on OCP81375). The mode bits are cleared upon an LED and/or V_{OUT} short fault.



■ Programming

Control Truth Table

MODE1	MODE0	STROBE EN	TORCH EN	STROBE PIN	TORCH PIN	ACTION
0	0	0	0	X	X	Standby
0	0	0	1	X	pos edg	Ext Torch
0	0	1	0	pos edg	X	Ext Flash
0	0	1	1	0	pos edg	Standalone Torch
0	0	1	1	pos edg	0	Standalone Flash
0	0	1	1	pos edg	pos edg	Standalone Flash
1	0	X	X	X	X	Int Torch
1	1	X	X	X	X	Int Flash
0	1	0	X	X	X	IRLED Standby
0	1	1	X	0	X	IRLED Standby
0	1	1	X	pos edg	X	IRLED enabled

■ I²C-Compatible Interface

Data Validity

The data on SDA must be stable during the HIGH period of the clock signal (SCL). In other words, the state of the data line can only be changed when SCL is LOW.

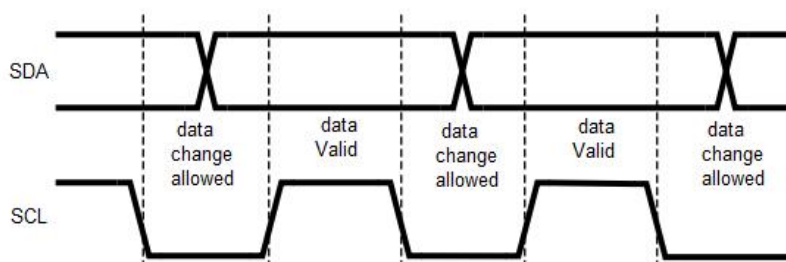


Figure 8, Data Validity Data

A pull up resistor between the controller's VIO line and SDA must be greater than $[(VIO-VOL)/3mA]$ to meet the VOL requirement on SDA. Using a larger pull up resistor results in lower switching current with slower edges, while using a smaller pull up results in higher switching currents with faster edges.

Start and Stop Conditions

START and STOP conditions classify the beginning and the end of the I²C session. A START condition is defined as the SDA signal transitioning from HIGH to LOW while SCL line is HIGH. A STOP condition is defined as the SDA transitioning from LOW to HIGH while SCL is HIGH. The I²C master always generates START and STOP conditions. The I²C bus is considered busy after a START condition and free after a STOP condition. During data transmission, the I²C master can generate repeated START conditions. First START and repeated START conditions are equivalent, function-wise.

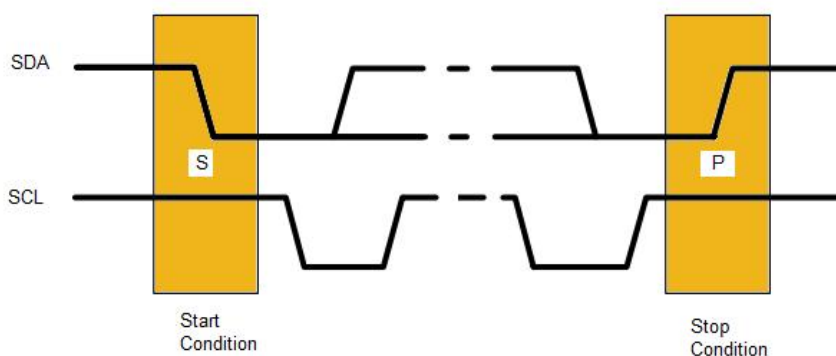


Figure 9, Start and Stop Conditions



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Transferring Data

Every byte put on the SDA line must be eight bits long, with the most significant bit (MSB) transferred first. Each byte of data has to be followed by an acknowledge bit. The acknowledge related clock pulse is generated by the master. The master releases the SDA line (HIGH) during the acknowledge clock pulse. The OCP81375 pulls down the SDA line during the 9th clock pulse, signifying an acknowledge. The OCP81375 generates an acknowledge after each byte is received. There is no acknowledge created after data is read from the device.

After the START condition, the I2C master sends a chip address. This address is seven bits long followed by an eighth bit which is a data direction bit (R/W). The OCP81375 7-bit address is 0x63. For the eighth bit, a '0' indicates a WRITE and a '1' indicates a READ. The second byte selects the register to which the data is written. The third byte contains data to write to the selected register.

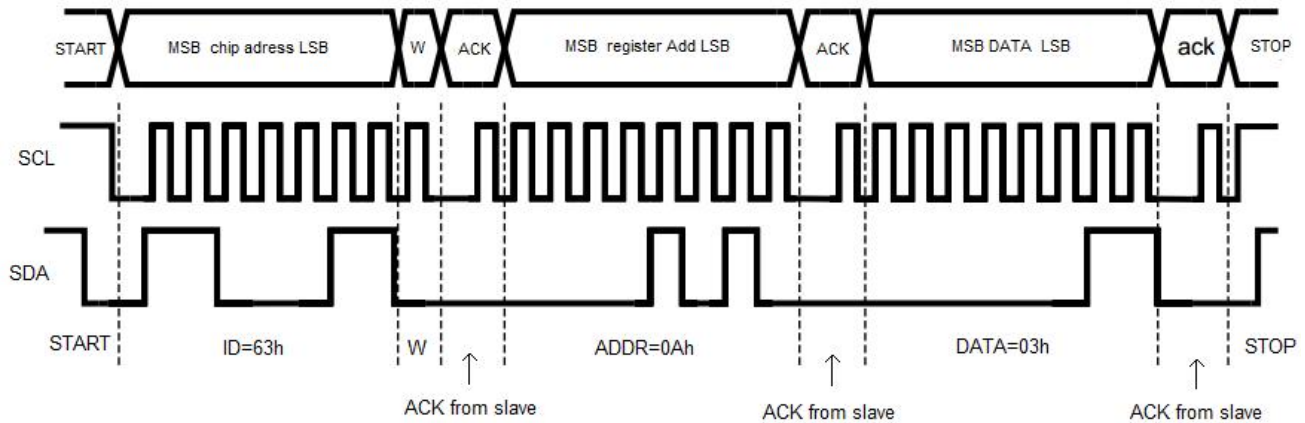


Figure 10, Write Cycle W = Write (SDA = "0") R = Read (SDA = "1") Ack = Acknowledge (SDA Pulled Down by Either Master or Slave) ID = Chip Address, 63h for OCP81375

I²C-Compatible Chip Address

The device address for the OCP81375 is 1100011(0x63). After the START condition, the I²C-compatible master sends the 7-bit address followed by an eighth read or write bit (R/W). R/W = 0 indicates a WRITE and R/W = 1 indicates a READ. The second byte following the device address selects the register address to which the data is written. The third byte contains the data for the selected register.

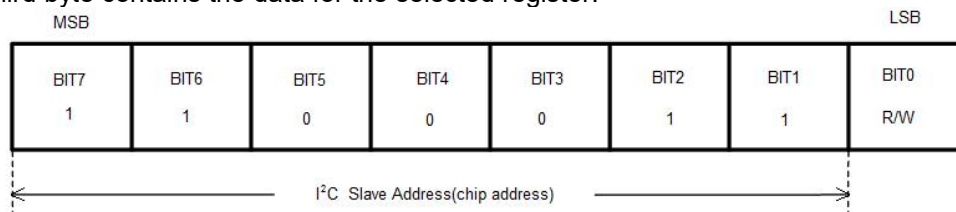


Figure 11, I²C-Compatible Chip Address

Register Descriptions

REGISTER NAME	INTERNAL HEX ADDRESS	POWER ON/RESET VALUE
Enable Register	0x01	0x80
IVFM Register	0x02	0x01
LED1 Flash Brightness Register	0x03	0xBF
LED2 Flash Brightness Register	0x04	0x3F
LED1 Torch Brightness Register	0x05	0xBF
LED2 Torch Brightness Register	0x06	0x3F
Boost Configuration Register	0x07	0x09
Timing Configuration Register	0x08	0x1A
TEMP Register	0x09	0x08
Flags1 Register	0x0A	0x00
Flags2 Register	0x0B	0x00
Device ID Register	0x0C	0x3A
Last Flash Register	0x0D	0x00



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Enable Register (0x01)

Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
TX Pin Enable 0 = Disabled 1 = Enabled (Default)	Strobe Type 0 = Level Triggered (Default) 1 = Edge Triggered	Strobe Enable 0 = Disabled (Default) 1 = Enabled	TORCH/TEMP Pin Enable 0 = Disabled (Default) 1 = Enabled	Mode Bits:M1, M0 '00'=Standby (Default) '01' = IR Drive '10' = Torch '11' = Flash		LED2 Enable 0 = OFF (Default) 1 = ON	LED1 Enable 0 = OFF (Default) 1 = ON

NOTE: 1: Edge Strobe Mode is not valid in IR MODE. Switching between Level and Edge Strobe Types while the device is enabled is not recommended.

2: In Edge or Level Strobe Mode, it is recommended that the trigger pulse width be set greater than 1 ms to ensure proper turn-on of the device.

IVFM Register (0x02)

Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
RFU	UVLO Circuitry (Default) 0=Disabled (Default) 1=Enabled	IVFM Levels 000=2.9V (Default) 001=3V 010=3.1V 011=3.2V 100=3.3V 101=3.4V 110=3.5V 111=3.6V			IVFM Hysteresis 0=0mV (Default) 1=50mV	IVFM Selection 00=Disabled 01=Stop and Hold Mode (Default) 10=Down Mode 11=Up and Down Mode	

NOTE: 1: IVFM Mode Bits are static once the OCP81375 is enabled in Torch, Flash or IR modes. If the IVFM mode needs to be updated, disable the device and then change the mode bits to the desired state.

LED1 Flash Brightness Register (0x03)

Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
LED2 Flash Current Override: 0=LED2 Flash Current is not set to LED1 Flash Current 1 = LED2 Flash current is set to LED1 (Default)		LED1 Flash Brightness Level $I_{FLASH}(mA) \approx (Brightness\ Code \times 15.63mA) + 15.63mA$ 0111111=1000mA (Default) 1111111=2 A					

LED2 Flash Brightness Register (0x04)

Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
RFU	LED2 Flash Brightness Level $I_{FLASH}(mA) \approx (Brightness\ Code \times 15.63mA) + 15.63mA$ 0111111=1000mA (Default) 1111111=2A						

LED1 Torch Brightness Register (0x05)

Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
LED2 Torch Current Override: 0 = LED2 Torch Current is not set to LED1 Torch Current 1=Torch Current is set to LED1 Torch Current (Default)		LED1 Torch Brightness Levels $I_{TORCH}(mA) \approx (Brightness\ Code \times 3.90mA) + 3.90mA$ 0000000=3.90mA 0111111=249.6mA (Default) 1111111=499.2mA					



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LED2 Torch Brightness Register (0x06)

Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
RFU	LED2 Torch Brightness Levels $I_{TORCH} (mA) \approx (Brightness\ Code \times 3.90mA) + 3.90mA$ 0000000=3.90mA 0111111=249.6mA (Default) 1111111=499.2mA						

Boost Configuration Register (0x07)

Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
Software Reset Bit 0=Not Reset (Default) 1=Reset	RFU	RFU	RFU	LED Pin Short Fault Detect 0=Disabled (Default) 1=Enabled (Default)	Boost Mode 0=Normal (Default) 1=Pass Mode Only	Boost Frequency Select 0=2MHz (Default) 1=4MHz	Boost Current Limit Setting 0=1.9A 1=2.8A (Default)

Timing Configuration Register (0x08)

Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
RFU	Torch Current Ramp Time 000=No Ramp 001=1ms (Default) 010=32ms 011=64ms 100=128ms 101=256ms 110=512ms 111=1024ms			0000=40ms 0001=80ms 0010=120ms 0011=160ms 0100=200ms 0101=240ms 0110=280ms 0111=320ms 1000=360ms 1001=400ms 1010=600ms (Default) 1011=800ms 1100=1000ms 1101=1200ms 1110=1400ms 1111=1600ms			

TEMP Register (0x09)

Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
RFU	TORCH Polarity 0=Active High (Default)	NTC Open Fault Enable 0=Disabled (Default) 1=Enable	NTC Short Fault Enable 0=Disabled (Default) 1=Enable	TEMP Detect Voltage Threshold 000=0.2V 001=0.3V 010=0.4V 011=0.5V 100=0.6V (Default) 101=0.7V 110=0.8V 111=0.9V		TORCH/TEMP Function Select 0=TORCH (Default) 1=TEMP	

NOTE: 1: The Torch Polarity bit is static once the OCP81375 is enabled in Torch, Flash or IR modes. If the Torch Polarity bit needs to be updated, disable the device and then change the Torch Polarity bit to the desired state.



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Flags1 Register (0x0A)

Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
TX Flag	V _{OUT} Short Fault	V _{LED1} Short Fault	V _{LED2} Short Fault	Current Limit Flag	Thermal Shutdown (TSD) Fault	UVLO Fault	Flash Time-Out Flag

Flags2 Register (0x0B)

Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
RFU	RFU	RFU	NTC Short Fault	NTC Open Fault	IVFM Trip Flag	OVP Fault	TEMP Trip Fault

Device ID Register (0x0C)

Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
RFU	RFU	Device ID '111'			Silicon Revision Bit '010'		

Last Flash Register (0x0D)

Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
RFU	The value stored is always the last current value the IVFM detection block set. $I_{LED} = I_{FLASH-TARGET} \times ((Code+1)/128)$						



■ Application Information

The OCP81375 can drive two flash LEDs at total currents up to 2A. The total LED current the OCP81375 boost can deliver is 2A ($I_{LED1} + I_{LED2}$). The 2-MHz/4-MHz DC/DC boost regulator allows for the use of small value discrete external components.

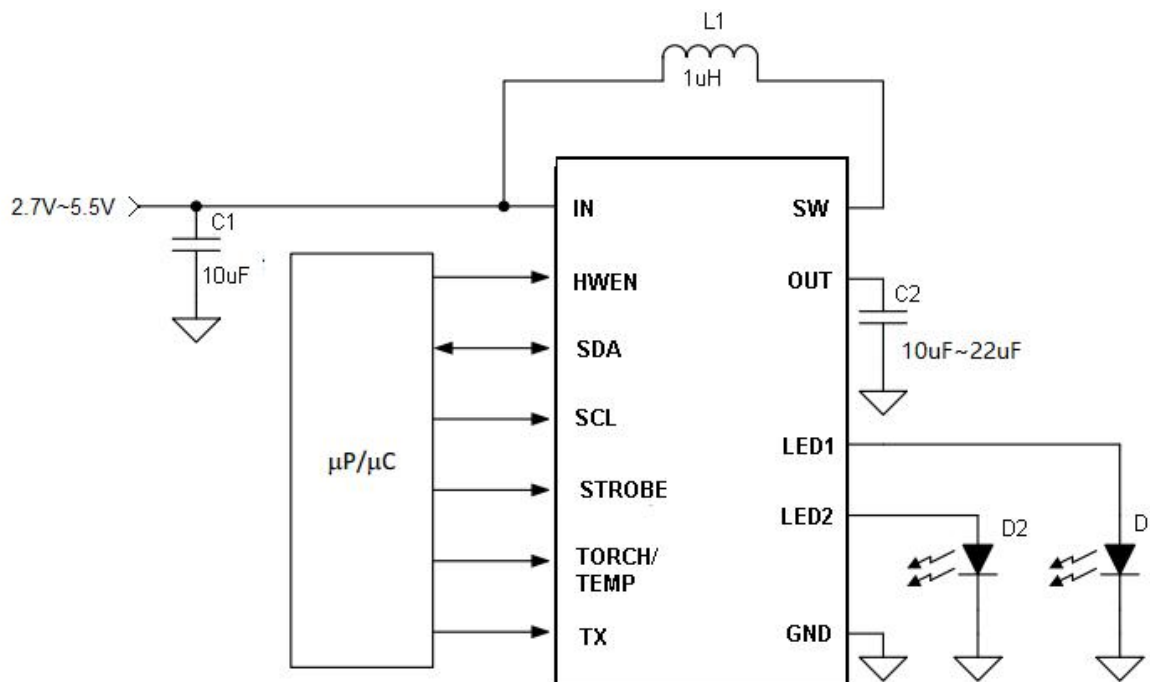


Figure 12, OCP81375 Typical Application

Design Requirements

Example requirements based on default register values:

DESIGN PARAMETER	EXAMPLE VALUE
Input Voltage Range	2.7V to 5.5V
Brightness Control	I ² C Register
LED Configuration	2 Parallel Flash LEDs
Boost Switching Frequency	2MHz (4MHz selectable)

Input Capacitor Selection

Choosing the correct size and type of input capacitor helps minimize the voltage ripple caused by the switching of the OCP81375 boost converter and reduce noise on the boost converter's input pin that can feed through and disrupt internal analog signals. In the typical application circuit, a 10-μF ceramic input capacitor works well. It is important to place the input capacitor as close as possible to the OCP81375 input (IN) pin. This reduces the series resistance and inductance that can inject noise into the device due to the input switching currents.

Output Capacitor Selection

When the boost converter is running, the output capacitor supplies the load current during the boost converter on-time. When the NMOS switch turns off, the inductor energy is discharged through the internal PMOS switch, supplying power to the load and restoring charge to the output capacitor. This causes a sag in the output voltage during the on-time and a rise in the output voltage during the off-time. The output capacitor is therefore chosen to limit the output ripple to an acceptable level depending on load current and input/output voltage differentials and also to ensure the converter remains stable. The output capacitance required depends on required current. A 10μF to 22μF ceramic capacitor works well in most situations.

Inductor Selection

The OCP81375 is designed to use a 0.47-μH or 1-μH inductor. When the device is boosting ($V_{OUT} > V_{IN}$) the inductor is typically the largest area of efficiency loss in the circuit. Therefore, choosing an inductor with the lowest possible series resistance is important. Additionally, the saturation rating of the inductor should be greater than the



maximum operating peak current of the OCP81375. This prevents excess efficiency loss that can occur with inductors that operate in saturation. For proper inductor operation and circuit performance, ensure that the inductor saturation and the peak current limit setting of the OCP81375 are greater than I_{PEAK} in the following calculation:

$$I_{PEAK} = \frac{I_{LOAD}}{\eta} \times \frac{V_{OUT}}{V_{IN}} + \Delta I_L$$

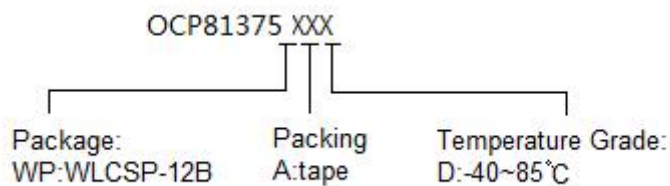
Where

$$\begin{cases} \Delta I_L = \frac{V_{IN} \times (V_{OUT} - V_{IN})}{2 \times f_{SW} \times L \times V_{OUT}} \\ f_{SW} = 2 \text{ or } 4\text{MHz} \end{cases}$$



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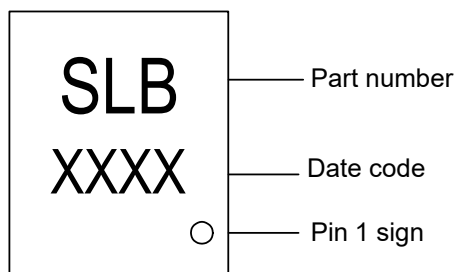
■ **Ordering Information**



Part Number	Driver Capability	Package Type	Package Qty	Temperature	Eco Plan	Lead/Ball Finish
OCP81375WPAD	2A	WLCSP-12B	7-in reel 3000pcs/reel	-40~85°C	Green	Cu Sn

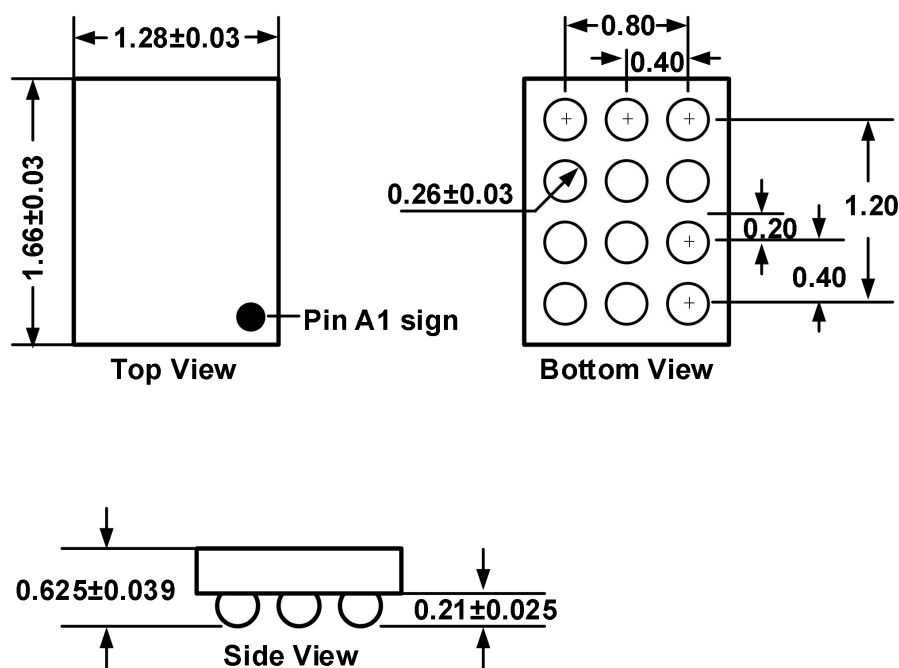
■ **Marking Information**

WLCSP-12B:



■ **Package Information**

WLCSP-12B:

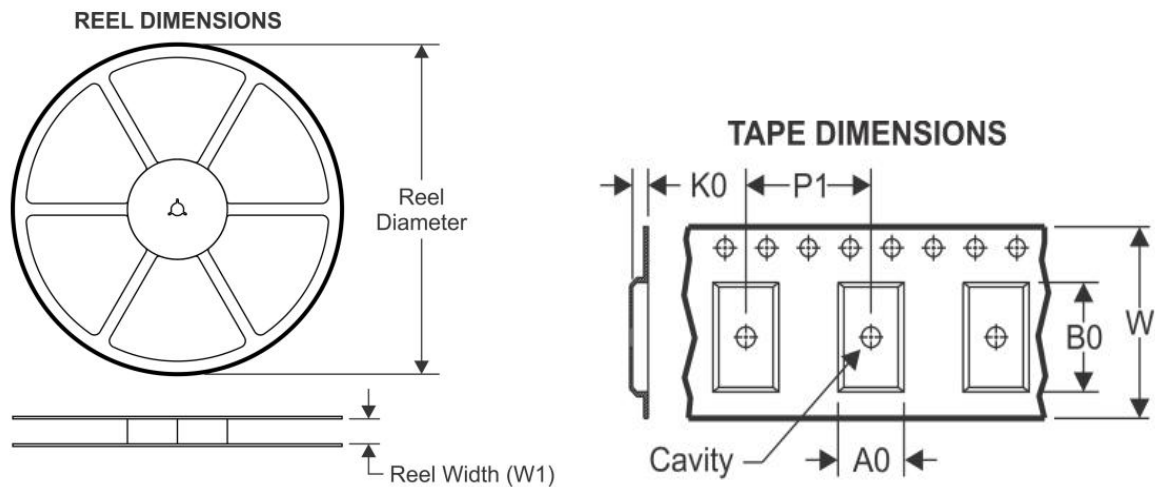


NOTE: All dimensions are in millimeters.



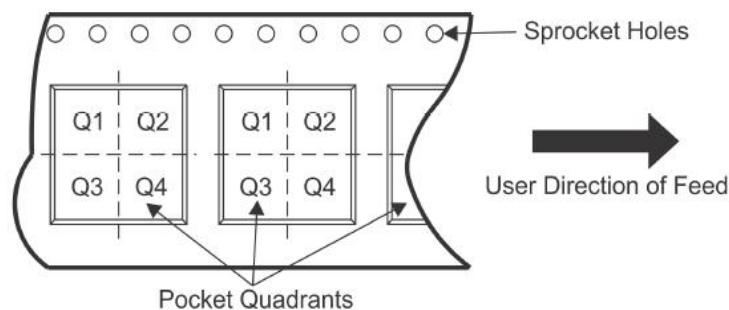
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■ **Packing Information**



A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



Package tape	Package Drawing	MSL	SPQ	Reel Diameter (mm)	Reel Width W1(mm)
12-Ball WLCSP (WLCSP12)	SLB	Level-1-260C	3000	180	8.4
A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	PIN A1 Quadrant
1.4	1.8	0.75	4.0	8.0	Q1

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