Boost Controller For Double AA Cell or Li-Ion Battery For White LED Application

DESCRIPTION

SiP12401 is a boost controller IC for double cell NiMH or Alkaline battery and Li Ion battery, which can drive white LEDs connected in series to provide backlight in hand-held devices. Series connection of the LEDs provides identical LED currents resulting in uniform brightness and eliminating the need for ballast resistors. For best efficiency performance, the SiP12401 is designed to operate in PWM mode with 600 kHz switching. The voltage-mode PWM design is internally compensated, reducing the external parts count. It accepts input voltages from 1.8 V to 5.0 V. The LED current can be adjusted externally for its brightness control. SiP12401 features low shutdown current of under 1 µA.

SiP12401 is available in a lead (Pb)-free 6-pin, PowerPAK MLP33 package and is specified to operate over the industrial temperature range of - 40 °C to 85 °C.

FEATURES

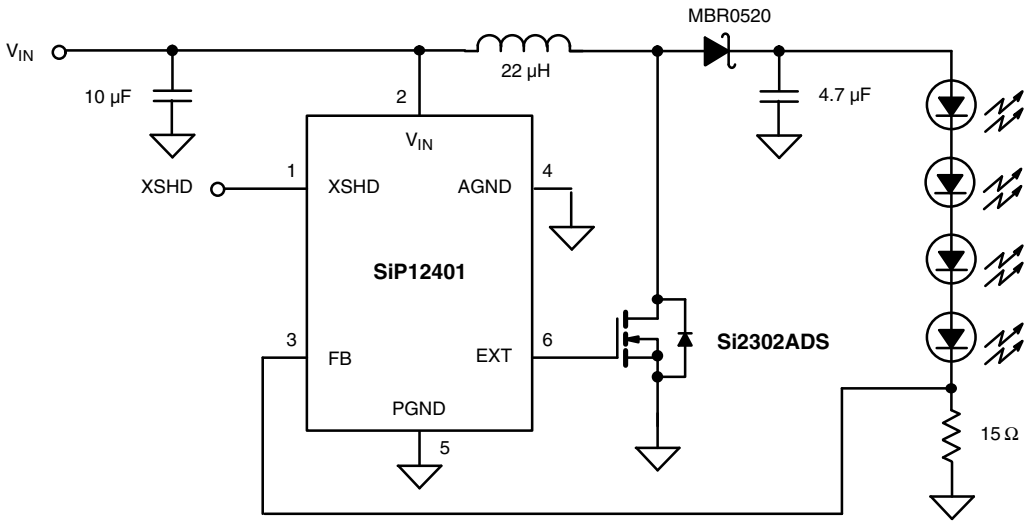
- Voltage Mode Control with Internal Frequency Compensation
- 1.8 V to 5.0 V Input Voltage Range
- PWM Control with 600 kHz Fixed Switching Frequency
- Analog Control of LED Intensity
- Regulated Output Current
- Integrated UVLO and Soft-Start
- Logic Controlled Shutdown (< 1 µA)
- High Efficiency: Typical 80 %
- PowerPAK® MLP33-6 Package

Pb-free
RoHS COMPLIANT

APPLICATIONS

- White LED Backlighting
- LCD Bias Supplies
- Handheld Devices
- Digital Cameras
- Portable Applications

TYPICAL APPLICATION CIRCUIT



ABSOLUTE MAXIMUM RATINGS (all voltages referenced to GND = 0 V)

Parameter		Limit	Unit
Input Voltage, V_{IN}		- 0.3 to 6	V
EXT Voltage		- 0.3 to V_{IN} + 0.5	
XSHD Voltage		- 0.3 to V_{IN} + 0.5	
FB Voltage		- 0.3 to V_{IN} + 0.5	
Maximum Junction Temperature		150	°C
Storage Temperature		- 55 to 150	
Operating Junction Temperature		125	
Power Dissipation[a]	PowerPAK MLP33-6 (T_A = 70 °C)[a]	1100	mW
Thermal Resistance[b]	PowerPAK MLP33-6	50	°C/W

Notes:
a. Derate 20 mW/°C above 70 °C.
b. Device Mounted with all leads soldered or welded to PC board.

Stresses beyond those listed under "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 for extended periods may affect device reliability.

RECOMMENDED OPERATING RANGE (all voltages referenced to GND = 0 V)

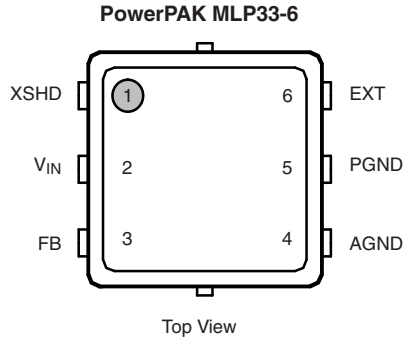
Parameter	Limit	Unit
Input Voltage, V_{IN}	1.8 to 5	V
XSHD, EXT Voltage	0 V to V_{IN}	
LX Voltage	0 to V_{OUT} + 0.5	
FB Voltage	0 to 5	
Operating Temperature Range	- 40 to 85	°C

SPECIFICATIONS[a]

Parameter	Symbol	Test Conditions Unless Specified V_{IN} = 3 V, T_A = 25 °C	Temp[a]	Limits Min[b]	Limits Typ[c]	Limits Max[b]	Unit
Input Voltage	V_{IN}		Full	1.8		5	V
UVLO	V_{UVLO}		Full		1.65	1.77	
UVLO Hysteresis	$V_{UVLOHYST}$				0.1		
Feedback Voltage	V_{FB}			0.291	0.3	0.309	
			Full	0.282		0.318	
Feedback Input Current	I_{FB}	V_{FB} = 0.3 V			1		nA
Maximum PWM Duty Cycle	MAXDTY			77	85		%
PWM Switching Frequency	f_{OSC}		Full	425	600	775	kHz
Quiescent Current	I_Q	V_{FB} = 0.4 V			200	300	µA
Stand-By Current	I_{STB}	XSHD = 0 V	Full			1	
XSHD Input High Level	V_{XSHDH}		Full	1.2			V
XSHD Input Low Level	V_{XSHDL}		Full			0.2	
EXT High On Resistance	R_{EXTH}	I_{EXT} = 10 mA			35		Ω
EXT Low On Resistance	R_{EXTL}				30		

Notes:
a. Full = - 40 to 85 °C.
b. The algebraic convention whereby the most negative value is a minimum and the most positive a maximum (- 40° to 85 °C).
c. Typical values are for DESIGN AID ONLY, not guaranteed nor subject to production testing.

PIN CONFIGURATION AND TRUTH TABLE



ORDERING INFORMATION		
Part Number	**Temperature Range**	**Marking**
SiP12401DMP-T1-E3	- 40 to 85 °C	2401

PIN DESCRIPTION		
Pin Number	**Name**	**Function**
1	XSDH	Logic Controlled Shutdown Input, XSHD = High: Normal Operation, XSHD = Low: Shutdown
2	V_{IN}	Battery Input Voltage
3	FB	Output Voltage Feedback Pin
4	AGND	Signal Ground
5	PGND	Power Ground
6	EXT	Drive Pin for External Power MOS

PIN FUNCTIONS

XSHD (Pin 1)

XSHD is the logic controlled shutdown input pin. When XSHD is low, the IC is shutdown and it's quiescent current is less than 1 µA. When XSHD is high, the IC is working in normal operation.

V_{IN} (Pin 2)

V_{IN} is the pin connected to battery input voltage. The IC gets its power supply from V_{IN}.

FB (Pin 3)

FB is the feedback pin of the output voltage via resistor divider. FB is about 0.3 V and its difference from 0.3 V reference voltage is amplified by the error amplifier.

AGND (Pin 4)

AGND is the pin for ground of controlling circuit.

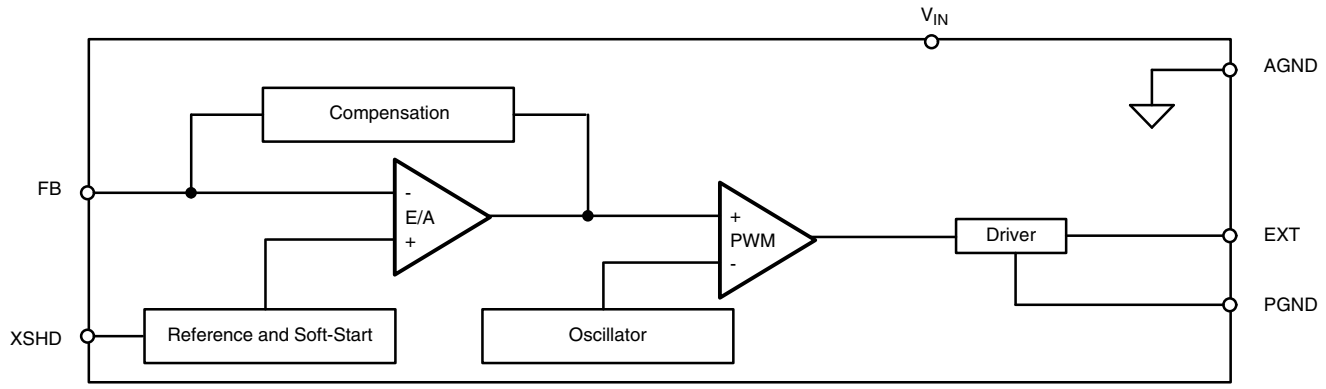
PGND (Pin 5)

PGND is the pin for ground of the internal power MOS driver.

EXT (Pin 6)

EXT is the output pin of internal driver. It's connected to the gate of external power MOSFET.

FUNCTIONAL BLOCK DIAGRAM



DETAILED OPERATION

SiP12401 is a 600 kHz boost controller IC, packaged in 6-pin MLP33, for white LED applications. It features fixed frequency voltage mode PWM control with internal frequency compensation. With the low $r_{DS(on)}$ external power MOSFET, this device maintains high efficiency over a wide range of load current.

Soft-Start

During soft-start, the loop compensation guarantees the slow increase of the output voltage and inrush current, so that no large voltage overshoot and inrush current occur when the soft-start is ended.

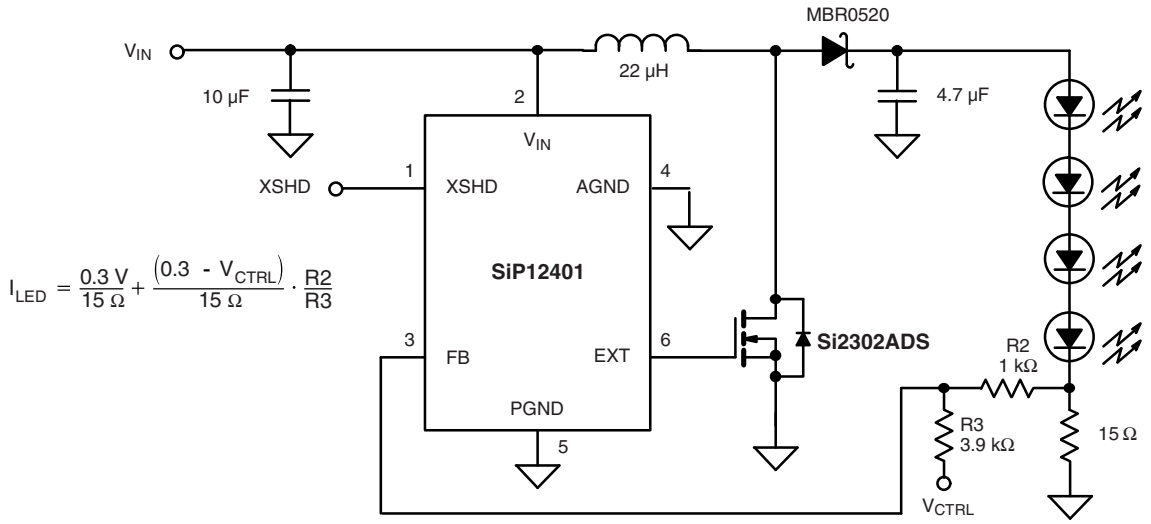
PWM operation

After soft-start, the device is working in PWM operation with a fixed frequency of 600 kHz.

APPLICATION INFORMATION

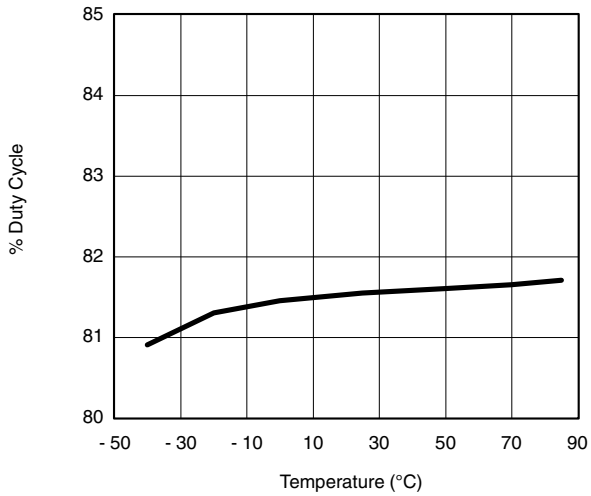
White LED Brightness Control

The current of white LED can be adjusted by PWM signal on the XSHD pin or by a variable dc voltage to control its brightness, (see Figure 1.) As control voltage V_{CTRL} increases, the voltage drop on R2 increases and the voltage drop on R1 decreases. Thus, the LED current decreases. The selection of R2 and R3 will make the current from V_{CTRL} much smaller than LED current and much larger than the FB pin bias current.

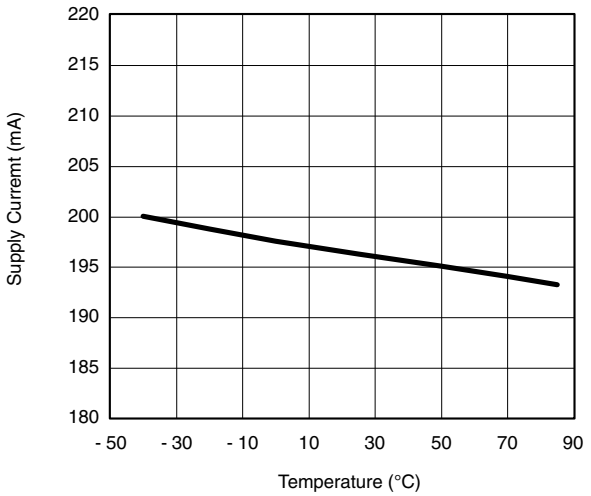


$$I_{LED} = \frac{0.3\ V}{15\ \Omega} + \frac{(0.3\ -\ V_{CTRL})}{15\ \Omega} \cdot \frac{R2}{R3}$$

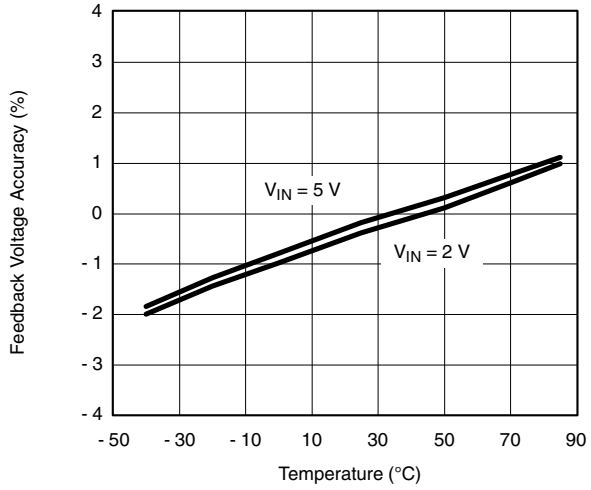
TYPICAL CHARACTERISTICS



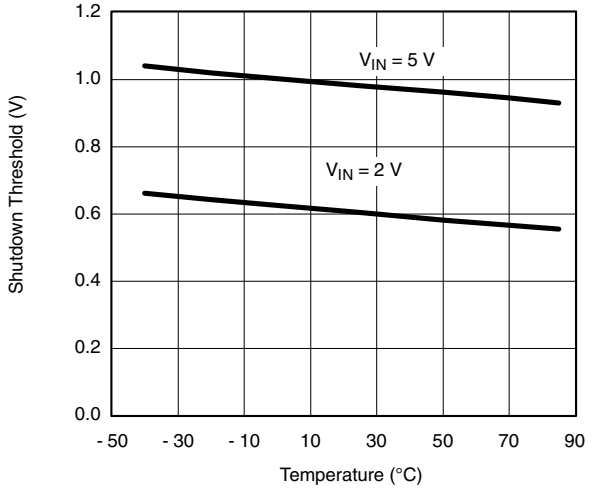
Maximum PWM Duty Cycle vs. Temperature



Supply Current vs. Temperature



Feedback Voltage vs. Temperature



Shutdown Threshold vs. Temperature

TYPICAL WAVEFORMS

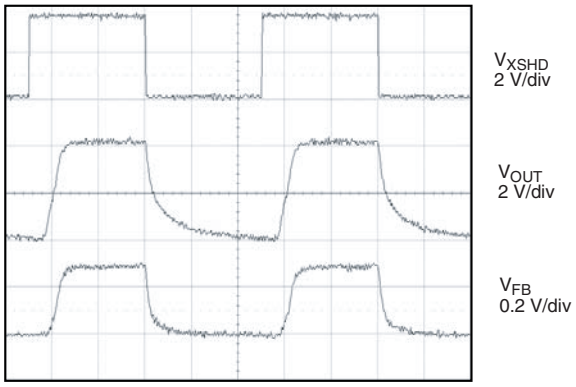


Figure 1. PWM Dimming Control
200 Hz 50 % Duty Cycle PWM Signal on XSHD Pin

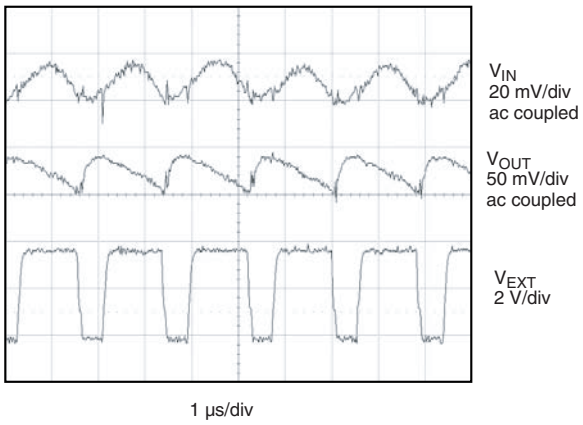
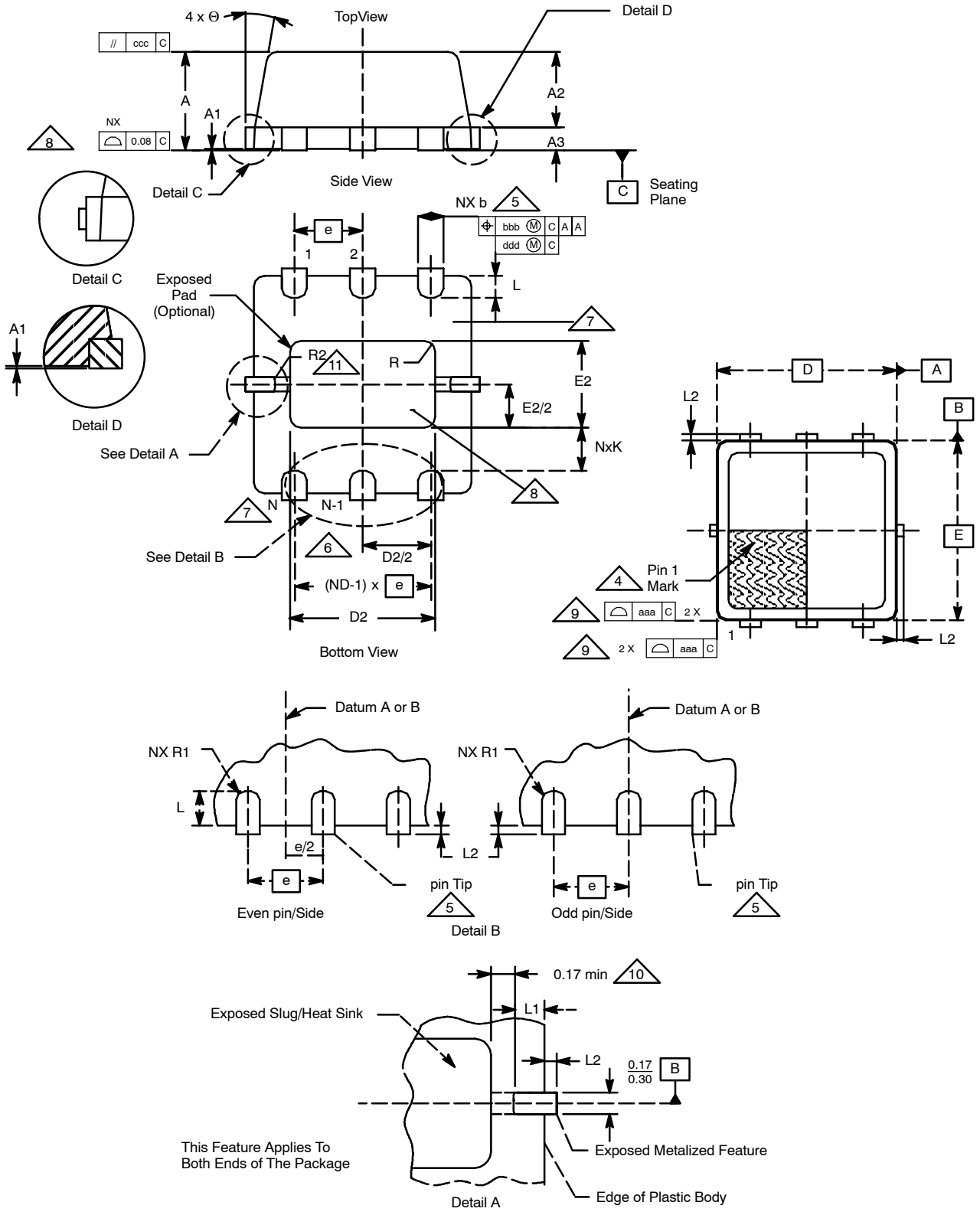


Figure 3. Switching Waveforms: V_{IN}, V_{OUT} and V_{EXT}
V_{IN} = 3.6 V, L = 22 µH, C_{OUT} = 4.7 µF, Four LEDs in Series

Vishay Siliconix maintains worldwide manufacturing capability. Products may be manufactured at one of several qualified locations. Reliability data for Silicon Technology and Package Reliability represent a composite of all qualified locations. For related documents such as package/tape drawings, part marking, and reliability data, see http://www.vishay.com/ppg?73193.

PowerPAK® MLP33-6, 8 and 10 (POWER IC ONLY)



PowerPAK® MLP33-6, 8, 10

N = 6 PITCH: 0.95 mm
N = 8 PITCH: 0.65 mm
N = 10 PITCH: 0.50 mm

Dim	MILLIMETERS*				INCHES				Notes
	Basic	Min	Nom	Max	Basic	Min	Nom	Max	
A	–	0.80	0.90	1.00	–	0.031	0.035	0.039	1, 2
A1	–	0.00	0.025	0.05	–	0.000	0.001	0.002	1, 2
A2	–	0.65	0.70	0.75	–	0.026	0.028	0.030	1, 2
A3	–	0.15	0.20	0.25	–	0.006	0.008	0.010	1, 2
aaa	–	–	0.10	–	–	–	0.004	–	1, 2
b-6	–	0.33	0.35	0.43	–	0.013	0.014	0.017	1, 2, 8
b-8	–	0.285	0.305	0.385	–	0.011	0.012	0.015	1, 2, 8
b-10	–	0.18	0.20	0.28	–	0.007	0.008	0.011	1, 2, 8
bbb	–	–	0.10	–	–	–	0.004	–	1, 2
ccc	–	–	0.10	–	–	–	0.004	–	1, 2
D	3.00	–	–	–	0.118	–	–	–	1, 2, 8
D2	–	1.92	2.02	2.12	–	0.076	0.080	0.083	1, 2, 8
ddd	–	–	0.05	–	–		0.002		1, 2
E	3.00	–	–	–	0.118	–	–	–	1, 2, 8
E2	–	1.10	1.20	1.30	–	0.043	0.047	0.051	1, 2, 8
e-6	–	–	0.95	–	–	–	0.037	–	1, 2
e-8	–	–	0.65	–	–	–	0.026	–	1, 2
e-10	–	–	0.50	–	–	–	0.020	–	1, 2
K	–	0.20	–	–	–	0.008	–	–	5, 11
L	–	0.20	0.29	0.45	–	0.008	0.011	0.018	1, 2, 8
L1-6	–	0.16	0.24	0.40	–	0.006	0.009	0.016	1, 2, 8
L1-8	–	0.16	0.24	0.40	–	0.006	0.009	0.016	1, 2, 8
L1-10	–	–	–	–	–	–	–	–	1, 2, 8
L2	–	–	–	0.125	–	–	–	0.005	5, 11
R Ref	–	–	0.15	–	–	–	0.006	–	1, 2, 8
R1 Ref-6	–	–	0.127	–	–	–	0.005	–	1, 2, 8
R1 Ref-8	–	–	0.15	–	–	–	0.006	–	1, 2, 8
R1 Ref-10	–	–	0.075	–	–	–	0.003	–	1, 2, 8
Θ	–	0°	10°	12°	–	0°	10°	12°	1, 2

* Use millimeters as the primary measurement.

ECN: S-40082—Rev. A, 02-Feb-04
DWG: 5925

NOTES:

1. Dimensioning and tolerancing conform to ASME Y14.5M-1994.
2. All dimensions are in millimeters. All angels are in degrees.
3. N is the total number of pins.
4. The pin #1 identifier and pin numbering convention shall conform to JESD 95-1 SPP-012. Details of pin #1 identifier is located within the zone indicated. The pin #1 identifier is marked.
5. Dimension b applies to metallized pin and is measured between 0.15 mm and 0.20 mm from the pin tip.
6. ND refers to the maximum number of pins on the D side.
7. Depopulation of pins is allowed and will be called out on the individual variation.
8. Coplanarity applies to the exposed heat sink slug as well as the pins.
9. Profile tolerance (aaa) will be applicable only to the plastic body and not to the metallized features (such as the pin tips and tie bars.) Metallized features may protrude a maximum of L2 from the plastic body profile.
10. L1 max is not called out, the metallized feature will extend to the exposed pad. Thus, the 0.17-mm gap does not apply.
11. The corner will be sharp unless otherwise specified with radius dimensions.

Disclaimer

ALL PRODUCT, PRODUCT SPECIFICATIONS AND DATA ARE SUBJECT TO CHANGE WITHOUT NOTICE TO IMPROVE RELIABILITY, FUNCTION OR DESIGN OR OTHERWISE.

Vishay Intertechnology, Inc., its affiliates, agents, and employees, and all persons acting on its or their behalf (collectively, “Vishay”), disclaim any and all liability for any errors, inaccuracies or incompleteness contained in any datasheet or in any other disclosure relating to any product.

Vishay makes no warranty, representation or guarantee regarding the suitability of the products for any particular purpose or the continuing production of any product. To the maximum extent permitted by applicable law, Vishay disclaims (i) any and all liability arising out of the application or use of any product, (ii) any and all liability, including without limitation special, consequential or incidental damages, and (iii) any and all implied warranties, including warranties of fitness for particular purpose, non-infringement and merchantability.

Statements regarding the suitability of products for certain types of applications are based on Vishay's knowledge of typical requirements that are often placed on Vishay products in generic applications. Such statements are not binding statements about the suitability of products for a particular application. It is the customer's responsibility to validate that a particular product with the properties described in the product specification is suitable for use in a particular application. Parameters provided in datasheets and / or specifications may vary in different applications and performance may vary over time. All operating parameters, including typical parameters, must be validated for each customer application by the customer's technical experts. Product specifications do not expand or otherwise modify Vishay's terms and conditions of purchase, including but not limited to the warranty expressed therein.

Hyperlinks included in this datasheet may direct users to third-party websites. These links are provided as a convenience and for informational purposes only. Inclusion of these hyperlinks does not constitute an endorsement or an approval by Vishay of any of the products, services or opinions of the corporation, organization or individual associated with the third-party website. Vishay disclaims any and all liability and bears no responsibility for the accuracy, legality or content of the third-party website or for that of subsequent links.

Except as expressly indicated in writing, Vishay products are not designed for use in medical, life-saving, or life-sustaining applications or for any other application in which the failure of the Vishay product could result in personal injury or death. Customers using or selling Vishay products not expressly indicated for use in such applications do so at their own risk. Please contact authorized Vishay personnel to obtain written terms and conditions regarding products designed for such applications.

No license, express or implied, by estoppel or otherwise, to any intellectual property rights is granted by this document or by any conduct of Vishay. Product names and markings noted herein may be trademarks of their respective owners.

© 2022 VISHAY INTERTECHNOLOGY, INC. ALL RIGHTS RESERVED