# LM3423

Application Note 2011 LM3423 Boost 2 Layer Evaluation Board



Literature Number: SNVA416

# LM3423 Boost 2 Layer **Evaluation Board**

### National Semiconductor Application Note 2011 James Patterson September 23, 2010



# Introduction

This evaluation board showcases the LM3423 NFET controller used with a boost current regulator. It is designed to drive 9 to 12 LEDs at a maximum average LED current of 700mA from a DC input voltage of 10 to 26V.

The evaluation board showcases most features of the LM3423 including PWM dimming, overvoltage protection and input under-voltage lockout. It also has a connector footprint (J7) which can mate with an external LED load board allowing for the LEDs to be mounted close to the driver. Alternatively, the LED+ and LED- banana jacks can be used to connect the LED load.

The boost circuit can be easily redesigned for different specifications by changing only a few components (see the Alternate Designs section found at the end of this application note). Note that design modifications can change the system efficiency. See the LM3423 datasheet for a comprehensive explanation of the device and application information.

# **Schematic**



TP1 0 D1 ∨<sub>IN</sub>⊚ LM3423 HSN /161 C2, C3 C12 R20 **R8** TP10 HSF ΕN R10 ≶ LED+@ CB 02 18 GND (O) RPD RPD COMP Θ R1 cs⊦ 15 C4. C6 ່ວວ່ J7 0 0 RCT vcc C9 C7 AGNE GATE  $\mathbf{z}$ R17 🗲 R6 R13 OVP PGND LED- O nDIM DDR Q2 R14 R5 ≶ FLT DPOL DAP TP4 RPD Θ C11 R1 R15 C10 10 TIMR LRD TP5 Ŧ RPD BNC PWM 03 • ппп 30107802

**EFFICIENCY WITH 9 SERIES LEDS AT 700mA** 

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# **Pin Descriptions**

		Name	Description	Function
1	1	V <sub>IN</sub>	Input Voltage	Bypass with 100 nF capacitor to AGND as close to the device as possible in the circuit board layout.
2	2	EN	Enable	Connect to AGND for zero current shutdown or apply > 2.4V to enable device.
3	3	COMP	Compensation	Connect a capacitor to AGND to set the compensation.
4	4	CSH	Current Sense High	Connect a resistor to AGND to set the signal current. For analog dimming, connect a controlled current source or a potentiometer to AGND as detailed in the <i>Analog Dimming</i> section.
5	5	RCT	Resistor Capacitor Timing	External RC network sets the predictive "off-time" and thus the switching frequency.
6	6	AGND	Analog Ground	Connect to PGND through the DAP copper pad to provide ground return for CSH, COMP, RCT, and TIMR.
7	7	OVP	Over-Voltage Protection	Connect to a resistor divider from $V_0$ to program output over-voltage lockout (OVLO). Turn-off threshold is 1.24V and hysteresis for turn-on is provided by 23 $\mu$ A current source.
8	8	nDIM	Dimming Input / Under-Voltage Protection	Connect a PWM signal for dimming as detailed in the <i>PWM Dimming</i> section and/or a resistor divider from $V_{\rm IN}$ to program input under-voltage lockout (UVLO). Turn-on threshold is 1.24V and hysteresis for turn-off is provided by 23 $\mu$ A current source.
9	-	FLT	Fault Flag	Connect to pull-up resistor from VIN and N-channel MosFET open drain output is high when a fault condition is latched by the timer.
10	-	TIMR	Fault Timer	Connect a capacitor to AGND to set the time delay before a sensed fault condition is latched.
11	-	LRDY	LED Ready Flag	Connect to pull-up resistor from VIN and N-channel MosFET open drain output pulls down when the LED current is not in regulation.
12	-	DPOL	Dim Polarity	Connect to AGND if dimming with a series P-channel MosFET or leave open when dimming with series N- channel MosFET.
13	9	DDRV	Dim Gate Drive Output	Connect to the gate of the dimming MosFET.
14	10	PGND	Power Ground	Connect to AGND through the DAP copper pad to provide ground return for GATE and DDRV.
15	11	GATE	Main Gate Drive Output	Connect to the gate of the main switching MosFET.
16	12	V <sub>cc</sub>	Internal Regulator Output	Bypass with 2.2 $\mu$ F–3.3 $\mu$ F ceramic capacitor to PGND.
17	13	IS	Main Switch Current Sense	$\begin{array}{c} \mbox{Connect to the drain of the main N-channel MosFET} \\ \mbox{switch for } R_{DS-ON} \mbox{ sensing or to a sense resistor installed} \\ \mbox{in the source of the same device.} \end{array}$
18	14	RPD	Resistor Pull Down	Connect the low side of all external resistor dividers $(V_{IN} UVLO, OVP)$ to implement "zero-current" shutdown.
19	15	HSP	LED Current Sense Positive	Connect through a series resistor to the positive side of the LED current sense resistor.
20	16	HSN	LED Current Sense Negative	Connect through a series resistor to the negative side of the LED current sense resistor.
	DAP (17)	DAP	Thermal PAD on bottom of IC	Star ground, connecting AGND and PGND.

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# **Bill of Materials**

Qty	Part ID	Part Value	Manufacturer	Part Number
2	C1, C12	0.1 µF X7R 10% 50V	TDK	C1608X5R1H104K
2	C2, C8	1.0 μF X7R 10% 50V	MURATA	GRM21BR71H105KA12L KA01L
1	C3	100 µF 20% 50V	PANASONIC	EEV-FK1H101GP
1	C4	0.1 μF X7R 10% 100V	TDK	C2012X7R2A104M
1	C5	DNP		
4	C6	10 $\mu$ F X7R 10% 50V (4 installed for a total of 40 $\mu$ F)	ТDК	C5750X7R1H106
1	C7	1000 pF X5R 5% 100V	MURATA	C2012X5R2E102K
1	C9	2.2 μF X7R 10% 16V	MURATA	GRM21BR71C225KA01L
1	C10	10 nF X7R 10% 50V	PANASONIC	ECJ2VB1H103 KA12L
1	C11	47 pF COG/NPO 5% 50V	PANASONIC	ECJ2VG1H470 KA01L
1	D1	Schottky 100V 7A	VISHAY	6CWQ10FNPBF
4	J1, J2, J4, J5	banana jack	KEYSTONE	575-8
1	J3	1x2 male header (with shunt tab)	SAMTEC	TSW-102-07-T-S
1	J6	BNC connector	AMPHENOL	112536
1	J7	DNP		
1	L1	22 µH 20% 6.3A	COILCRAFT	DO5040H
2	Q1, Q2	NMOS 100V 40A	VISHAY	SUD40N10-25
1	Q3	NMOS 60V 260 mA	ON-SEMI	2N7002ET1G
2	R1, R11	12.4 kΩ 1%	VISHAY	CRCW080512k4FKEA
1	R2	0Ω 1%	VISHAY	CRCW08050000Z0EA
2	R3, R20	10Ω 1%	VISHAY	CRCW080510R0FKEA
1	R4	5.76 kΩ 1%	VISHAY	CRCW08055k76FKEA
1	R5	14.0 kΩ 1%	VISHAY	CRCW080514k0FKEA
2	R7, R8	1.40 kΩ 1%	VISHAY	CRCW08051k40FKEA
1	R6	0.06Ω 1% 1W	VISHAY	WSL2512R0600FEA
1	R9	0.2Ω 1% 1W	PANASONIC	ERJ12RSFR20U
1	R10	35.7 kΩ 1%	VISHAY	CRCW080535k7FKEA
1	R12	10.0 kΩ 1%	VISHAY	CRCW080510k0FKEA
3	R13, R14, R15	100 kΩ 1%	VISHAY	CRCW0805100kFKEA
2	R16, R21	DNP		
1	R17	432 kΩ 1%	VISHAY	CRCW0805432kFKEA
5	TP1, TP4, TP5, TP7, TP10	turret	KEYSTONE	1502-2
1	U1	Buck-boost controller	NSC	LM3423MH

# PCB Layout



Top Layer

**Bottom Layer** 

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# **Design Procedure**

Refer to LM3429 datasheet for design considerations.

### **SPECIFICATIONS**

$$\begin{split} N &= 9 \\ V_{LED} &= 3.5V \\ r_{LED} &= 325 \ \text{m}\Omega \\ V_{IN} &= 24V \\ V_{IN-MIN} &= 10V; \ V_{IN-MAX} &= 26V \\ f_{SW} &= 700 \ \text{kHz} \\ V_{SNS} &= 150 \ \text{m}V \\ I_{LED} &= 700 \text{m}A \\ \Delta i_{L-PP} &= 350 \ \text{m}A \\ \Delta i_{LED-PP} &= 25 \ \text{m}A \\ \Delta v_{IN-PP} &= 100 \ \text{m}V \\ I_{LIM} &= 4A \\ V_{TURN-ON} &= 10V; \ V_{HYS} &= 3V \\ V_{TURN-OFF} &= 44V; \ V_{HYSO} &= 10V \end{split}$$

### **1. OPERATING POINT**

Solve for  $V_O$  and  $r_D$ :

$$V_{\rm O} = N \times V_{\rm LED} = 9 \times 3.5 \text{V} = 31.5 \text{V}$$

$$r_{D} = N x r_{LED} = 9 x 325 m\Omega = 2.925 \Omega$$

Solve for D, D',  $\mathrm{D}_{\mathrm{MAX}},$  and  $\mathrm{D}_{\mathrm{MIN}}\!\!:$ 

$$D = \frac{V_{\rm O} - V_{\rm IN}}{V_{\rm O}} = \frac{31.5V - 24V}{31.5V} = 0.238$$

$$D' = 1 - D = 1 - 0.238 = 0.762$$

$$D_{MIN} = \frac{V_{O} - V_{IN-MAX}}{V_{O}} = \frac{31.5V - 26V}{31.5V} = 0.175$$

$$D_{MAX} = \frac{V_{O} - V_{IN-MIN}}{V_{O}} = \frac{31.5V - 10V}{31.5V} = 0.683$$

### 2. SWITCHING FREQUENCY

Assume C7 = 1 nF and solve for R10:

$$R10 = \frac{25}{f_{SW} \times C7} = \frac{25}{700 \text{ kHz } \times 1 \text{ nF}} = 35.7 \text{ k}\Omega$$

The closest standard resistor is actually 35.7 k $\Omega$  therefore the  $f_{\text{SW}}$  is:

$$f_{SW} = \frac{25}{R10 \text{ x C7}} = \frac{25}{35.7 \text{ } k\Omega \text{ x 1 nF}} = 700 \text{ kHz}$$

The chosen components from step 2 are:

# 3. AVERAGE LED CURRENT

Solve for R9:

$$R9 = \frac{V_{SNS}}{I_{LED}} = \frac{150 \text{ mV}}{700 \text{ mA}} = 0.214\Omega$$

Assume R1 = 12.4 k $\Omega$  and solve for R8:

$$R8 = \frac{I_{LED} \times R1 \times R9}{1.24V} = \frac{700 \text{ mA} \times 12.4 \text{ k}\Omega \times 0.2\Omega}{1.24V} = 1.4 \text{ k}\Omega$$

The closest standard resistor for R9 is 0.2 $\Omega$  and the closest for R8 (and R7) is actually 1.4 k $\Omega$  therefore I<sub>LED</sub> is:

$$I_{LED} = \frac{1.24V \text{ x } \text{R8}}{\text{R9 x R1}} = \frac{1.24V \text{ x } 1.4 \text{ k}\Omega}{0.2\Omega \text{ x } 12.4 \text{ k}\Omega} = 700 \text{ mA}$$

The chosen components from step 3 are:

R9 = 0.2Ω
R1 = 12.4 kΩ
R8 = R7 = 1.4 kΩ

4. INDUCTOR RIPPLE CURRENT

Solve for L1:

$$L1 = \frac{V_{\text{IN}} \times D}{\Delta i_{\text{L-PP}} \times f_{\text{SW}}} = \frac{24 \text{V} \times 0.238}{350 \text{ mA} \times 700 \text{ kHz}} = 23.3 \,\mu\text{H}$$

The closest standard inductor is 22  $\mu H$  therefore the actual  $\Delta i_{L\text{-PP}}$  is:

$$\Delta i_{L-PP} = \frac{V_{IN} \times D}{L1 \times f_{SW}} = \frac{24V \times 0.238}{22 \,\mu H \times 700 \,\text{kHz}} = 371 \,\text{mA}$$

Determine minimum allowable RMS current rating:

$$I_{L-RMS} = \frac{I_{LED}}{D'} \times \sqrt{1 + \frac{1}{12} \times \left(\frac{\Delta i_{L-PP} \times D'}{I_{LED}}\right)^2}$$
$$I_{L-RMS} = \frac{700 \text{ mA}}{0.762} \times \sqrt{1 + \frac{1}{12} \times \left(\frac{371 \text{ mA} \times 0.762}{700 \text{ mA}}\right)^2}$$
$$I_{L-RMS} = 925 \text{ mA}$$

The chosen component from step 4 is:

L1 = 22 μH
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# **5. OUTPUT CAPACITANCE** Solve for $C_0$ :

$$C_{O} = \frac{I_{LED} \times D}{r_{D} \times \Delta i_{LED-PP} \times f_{SW}}$$

$$C_{\rm O} = \frac{700 \,\text{mAx}\, 0.238}{2.925 \,\Omega \, x \, 25 \,\text{mA} \, x \, 700 \,\text{kHz}} = 3.25 \,\mu\text{F}$$

A total value of 40  $\mu F$  (using 4 10  $\mu F$  ceramic capacitors) is chosen to improve PWM dimming response therefore the actual  $\Delta i_{LED-PP}$  is:

$$\Delta i_{\text{LED-PP}} = \frac{I_{\text{LED}} \times D}{r_{\text{D}} \times C_{\text{O}} \times f_{\text{SW}}}$$
$$\Delta i_{\text{LED-PP}} = \frac{700 \text{ mA} \times 0.238}{2.925\Omega \times 40 \text{ µF} \times 700 \text{ kHz}} = 2 \text{ mA}$$

Determine minimum allowable RMS current rating:

$$I_{\text{CO-RMS}} = I_{\text{LED}} \times \sqrt{\frac{D_{\text{MAX}}}{1 - D_{\text{MAX}}}} = 700 \text{ mA} \times \sqrt{\frac{0.683}{1 - 0.683}} = 1.03\text{ A}$$

The chosen components from step 5 are:

# 6. PEAK CURRENT LIMIT

Solve for R6:

$$R6 = \frac{245 \text{ mV}}{I_{\text{LIM}}} = \frac{245 \text{ mV}}{4\text{A}} = 0.061\Omega$$

The closest standard resistor is 0.06  $\Omega$  therefore  ${\rm I}_{\rm LIM}$  is:

$$I_{\text{LIM}} = \frac{245 \text{ mV}}{\text{R6}} = \frac{245 \text{ mV}}{0.06\Omega} = 4.1\text{A}$$

The chosen component from step 6 is:

#### 7. LOOP COMPENSATION

 $\omega_{P1}$  is approximated:

$$ω_{P1} = \frac{2}{r_D x C_O} = \frac{2}{2.925\Omega x 40\mu F} = 17 k \frac{rad}{sec}$$

 $\omega_{Z1}$  is approximated:

$$\omega_{z1} = \frac{r_{D} \times D'^{2}}{L1} = \frac{2.925 \Omega \times 0.762^{2}}{22 \,\mu H} = 77 k \frac{rad}{sec}$$

T<sub>U0</sub> is approximated:

$$T_{U0} = \frac{D'x 310V}{I_{LED} x R_{LIM}} = \frac{0.762 x 310V}{700 \text{ mAx } 0.06\Omega} = 5620$$

To ensure stability, calculate  $\omega_{P2}$ :

$$\omega_{P2} = \frac{\min(\omega_{P1}, \omega_{Z1})}{5 x T_{U0}} = \frac{\omega_{P1}}{5 x 5620} = \frac{17k \frac{rad}{sec}}{5 x 5620} = 0.60 \frac{rad}{sec}$$

Solve for C8:

$$C8 = \frac{1}{\omega_{P2} \times 5e^{6}\Omega} = \frac{1}{0.60 \frac{\text{rad}}{\text{sec}} \times 5e^{6}\Omega} = 0.33 \,\mu\text{F}$$

To attenuate switching noise, calculate  $\omega_{P3}$ :

$$\omega_{P3} = \max(\omega_{P1}, \omega_{Z1}) \times 10 = \omega_{Z1} \times 10$$
$$\omega_{P3} = 77 \text{ k} \frac{\text{rad}}{\text{sec}} \times 10 = 770 \text{ k} \frac{\text{rad}}{\text{sec}}$$

Assume R20 =  $10\Omega$  and solve for C12:

$$C12 = \frac{1}{10\Omega x \omega_{P3}} = \frac{1}{10\Omega x 770 k \frac{rad}{sec}} = 0.130 \,\mu\text{F}$$

Since PWM dimming can be evaluated with this board, a much larger compensation capacitor C8 = 1.0  $\mu F$  is chosen and a smaller high frequency capacitor C12 = 0.1  $\mu F$  is chosen.

The chosen components from step 7 are:

#### 8. INPUT CAPACITANCE

Solve for the minimum C<sub>IN</sub>:

$$C_{IN} = \frac{\Delta i_{L-PP}}{8 \, x \, \Delta v_{IN-PP} \, x \, f_{SW}} = \frac{371 \text{ mA}}{8 \, x \, 100 \text{ mV} \, x \, 700 \text{ kHz}} = 0.66 \, \mu\text{F}$$

To minimize power supply interaction a much larger capacitance of 100  $\mu F$  is used, therefore the actual  $\Delta v_{IN-PP}$  is much lower.

Determine minimum allowable RMS current rating:

$$I_{\text{IN-RMS}} = \frac{\Delta i_{\text{L-PP}}}{\sqrt{12}} = \frac{371 \text{ mA}}{\sqrt{12}} = 107 \text{ mA}$$

The chosen components from step 8 are:

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# 9. NFET

Determine minimum Q1 voltage rating and current rating:

$$V_{T-MAX} = V_0 = 31.5V$$

$$I_{T-MAX} = \frac{0.683}{1 - 0.683} \times 700 \text{ mA} = 1.5\text{A}$$

A 100V NFET is chosen with a current rating of 40A due to the low  $R_{DS-ON}$  = 50 m $\Omega$ . Determine  $I_{T-RMS}$  and  $P_T$ :

$$I_{T-RMS} = \frac{I_{LED}}{D'} \times \sqrt{D} = \frac{700 \text{ mA}}{0.762} \times \sqrt{0.238} = 448 \text{ mA}$$

$$P_{T} = I_{T-RMS}^{2} x R_{DSON} = 448 \text{ mA}^{2} x 50 \text{ m}\Omega = 10 \text{ mW}$$

The chosen component from step 9 is:

$$\text{Q1} \rightarrow \text{40A}, \, \text{100V}, \, \text{DPAK}$$

10. DIODE

Determine minimum D1 voltage rating and current rating:

$$V_{RD-MAX} = V_0 = 31.5V$$
  
 $I_{D-MAX} = I_{LED} = 700 \text{ mA}$ 

A 100V diode is chosen with a current rating of 12A and  $V_D = 600 \text{ mV}$ . Determine  $P_D$ :

$$P_{D} = I_{D} \times V_{FD} = 700 \text{ mA} \times 600 \text{ mV} = 420 \text{ mW}$$

The chosen component from step 10 is:

$$D1 \rightarrow 12A$$
, 100V, DPAK

# **11. INPUT UVLO**

Since PWM dimming will be evaluated a three resistor network will be used. Assume R13 = 100 k $\Omega$  and solve for R5:

$$R5 = \frac{1.24V \text{ x R13}}{V_{\text{TURN-ON}} - 1.24V} = \frac{1.24V \text{ x 100 } \text{k}\Omega}{10V - 1.24V} = 14.2 \text{ k}\Omega$$

The closest standard resistor is 14  $k\Omega$  therefore  $V_{TURN\text{-}ON}$  is:

$$V_{\text{TURN-ON}} = \frac{1.24\text{V x } (\text{R5} + \text{R13})}{\text{R5}}$$
$$V_{\text{TURN-ON}} = \frac{1.24\text{V x } (14 \text{ k}\Omega + 100 \text{ k}\Omega)}{14 \text{ k}\Omega} = 10.1\text{V}$$

Solve for R4:

R4 = 
$$\frac{\text{R5 x (V_{HYS} - 23 \mu A x R13)}}{23 \mu A x (\text{R5 + R13})}$$

$$R4 = \frac{14 \text{ } \text{k}\Omega \text{ } \text{x} (3.4 \text{V} - 23 \text{ } \mu\text{A} \text{ x} 100 \text{ } \text{k}\Omega)}{23 \text{ } \mu\text{A} \text{ x} (14 \text{ } \text{k}\Omega + 100 \text{ } \text{k}\Omega)} = 5.87 \text{ } \text{k}\Omega$$

The closest standard resistor is 5.76 k $\Omega$  making V<sub>HYS</sub>:

$$V_{HYS} = \frac{23 \ \mu A \ x \ R4 \ x \ (R5 + R13)}{R5} + 23 \ \mu A \ x \ R13$$
$$V_{HYS} = \frac{23 \ \mu A \ x \ 5.76 \ k\Omega \ x \ (14 \ k\Omega + 100 \ k\Omega)}{14 \ k\Omega} + 23 \ \mu A \ x \ 100 \ k\Omega = 3.4V$$

The chosen components from step 11 are:

R5 = 14 kΩ	
R13 = 100 kΩ	
R4 = 5.76 kΩ	

# 12. OUTPUT OVLO

Solve for R17:

$$R18 = \frac{V_{HYSO}}{23 \ \mu A} = \frac{10V}{23 \ \mu A} = 435 \ k\Omega$$

The closest standard resistor is 432 k $\Omega$  therefore  $V_{HYSO}$  is:

Solve for R11:

R11 = 
$$\frac{1.24V \times R18}{V_{\text{TURN-OFF}} - 1.24V} = \frac{1.24V \times 432 \text{ k}\Omega}{44V - 1.24V} = 12.5 \text{ k}\Omega$$

The closest standard resistor is 12.4 k $\Omega$  making V\_{TURN-OFF}:

$$V_{\text{TURN-OFF}} = \frac{1.24\text{V x } (\text{R11 + R18})}{\text{R11}}$$
$$V_{\text{TURN-OFF}} = \frac{1.24\text{V x } (12.4 \text{ k}\Omega + 432 \text{ k}\Omega)}{12.4 \text{ k}\Omega} = 44\text{V}$$

The chosen components from step 12 are:

R11 = 12.4 kΩ
R18 = 432 k $\Omega$

# 13. PWM DIMMING

The LM3423 Boost Evaluation board is configured to demonstrate PWM dimming of the LEDs. For best operation, use a PWM signal that has greater than 3V amplitude at a frequency between 120Hz and 25kHz. Apply the PWM signal to the BNC connector (J6) and the inverted signal (seen by the nDIM pin) can be monitored at TP5.

The output DDRV signal is connected directly to the series dimming FET (Q2) to open and close the LED load. Achievable contrast ratios are dependant on the dimming frequency and operating point. The minimum pulse width is limited by the internal delays of the LM3423 and the slew time of the LED current from zero to its nominal value. This can be several microseconds in duration.

Using the evaluation board (24V input, 31.5V output), at 25kHz dimming frequency the best case contrast ratio is approximately 20:1, but at 200Hz the same system is more like 2500:1 ratio. In general, contrast ratios much above 4000:1 are not possible for any operating point using the LM3423 boost evaluation board.

# **Typical Waveforms**

 $T_A = +25^{\circ}C$ ,  $V_{IN} = 24V$  and  $V_O = 31.5V$ .



1kHz 50% PWM DIMMING TP5 dim voltage (V<sub>DIM</sub>) LED current (I<sub>LED</sub>)

## **13. FAULT AND LED CURRENT MONITORING**

The LM3423 has a fault detection flag in the form of an opendrain NFET at the FLT pin. Using the external pull-up resistor (R14) to VIN, the fault status can be monitored at the FLT pin (high = fault). The fault timer interval is set with the capacitor (C10) from TIMR to GND (10nF yields roughly 1ms). If a fault is detected that exceeds the programmed timer interval, such as an output over-voltage condition, the FLT pin transitions from high to low and internally GATE and DDRV are latched off. To reset the device once the fault is removed, either the input power must be cycled or the EN pin must be toggled.

This can be tested directly with the evaluation board by opening the LED load. An OVP fault will occur which disables GATE and DDRV. Then if the LEDs are reconnected, the EN pin jumper (J3) can be removed and reinserted to restart normal operation of the LM3423.

The LED status flag (LRDY) can be seen by monitoring TP4. LRDY is also an open-drain NFET connection which has an external pull-up resistor (R15) to  $V_{\rm IN}$ . If the LED current is in regulation the voltage at TP4 will be high, but when it falls out of regulation the NFET turns on and pulls TP4 low. The LM3423 datasheet lists all of the conditions that affect LRDY, FLT, and TIMR.



1kHz 50% PWM DIMMING (Rising Edge) TP5 dim voltage (V<sub>DIM</sub>) LED current (I<sub>LED</sub>)

# **Alternate Designs**

Alternate designs with the LM3423 evaluation board are possible with very few changes to the existing hardware. The evaluation board FETs and diodes are already rated higher than necessary for design flexibility. The input UVLO, output OVP, input and output capacitance can remain the same for the designs shown below. These alternate designs can be evaluated by changing only R9, R10, and L1.

The table below gives the main specifications for four different designs and the corresponding values for R9, R10, and L1. PWM dimming can be evaluated with any of these designs.

Specification /	Design 1	Design 2	Design 3	Design 4
V	10V	15V	20V	25V
V <sub>O</sub>	14V	21V	28V	35V
f <sub>sw</sub>	600kHz	700kHz	500kHz	700kHz
I <sub>LED</sub>	2A	500mA	2.5A	1.25A
R9	0.05Ω	0.2Ω	0.04Ω	0.08Ω
R10	41.2 kΩ	35.7 kΩ	49.9 kΩ	35.7 kΩ
L1	22µH	68µH	15µH	33µН

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LDOs	www.national.com/ldo	Quality and Reliability	www.national.com/quality
LED Lighting	www.national.com/led	Feedback/Support	www.national.com/feedback
Voltage References	www.national.com/vref	Design Made Easy	www.national.com/easy
PowerWise® Solutions	www.national.com/powerwise	Applications & Markets	www.national.com/solutions
Serial Digital Interface (SDI)	www.national.com/sdi	Mil/Aero	www.national.com/milaero
Temperature Sensors	www.national.com/tempsensors	SolarMagic™	www.national.com/solarmagic
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