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FAIRCHILD SEMICONDUCTOR®

June 2013

FAN5340
PWM亮度控制并可断开负载的同步恒流升压串联LED驱动器

产品特性

- 同步电流模式升压变换器
- 输出功率可达500mW
- 支持2, 3, 或 4 个 LED 串联
- 输入电压范围：2.7V－4.8V
- 1.2MHz 固定开关频率
- 1mA 最大静态电流
- 软启动
- 输入欠压锁定(UVLO)
- 输出过压保护 (OVP)
- 短路检测
- 热关闭保护（）TSD
- 8-引脚, 3.00 x 3.00mm UMLP
- 8-引脚 (焊球), 1.57 x 1.57mm WLCSP

适用范围

- 手机，智能电话
- 便携式电脑
- WLAN DC-DC 变换器模块
- PDA、DSC、PMP 以及 MP3 播放器

说明

FAN5340 为同步恒流LED驱动器，可以向最多4个串联的LED提供最高可达500mW的功率。优化设计更适用于小型装置，1.2MHz的固定开关频率从而允许使用较小的芯片电感和电容。

安全方面，器件整合了短路检测、过压和热关断保护功能。此外，若电池电压过低将触发输入欠压闭锁保护。

亮度（调光）控制通过在EN引脚上施加 300Hz 至 1kHz 的 PWM 信号来实现。关断期间，FAN5340 将 LED节点从保持升压稳压器电压C_{OUT}的升压稳压器输出端上断开，从而减少PWM调光的音频噪声，并断开 LED 串的电源。

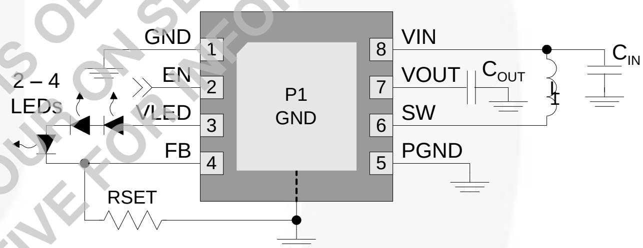


Figure 1. 典型应用

订购信息

器件型号	工作温度范围	封装	包装
FAN5340UCX	-40 至 +85°C	8 球型，1.57 x 1.57mm 晶圆级芯片封装（WLCSP）	卷带
FAN5340MPX (初级)	-40 至 +85°C	8-管脚，3.00 x 3.00mm 超薄模塑无铅封装(MLP)	卷带

框图

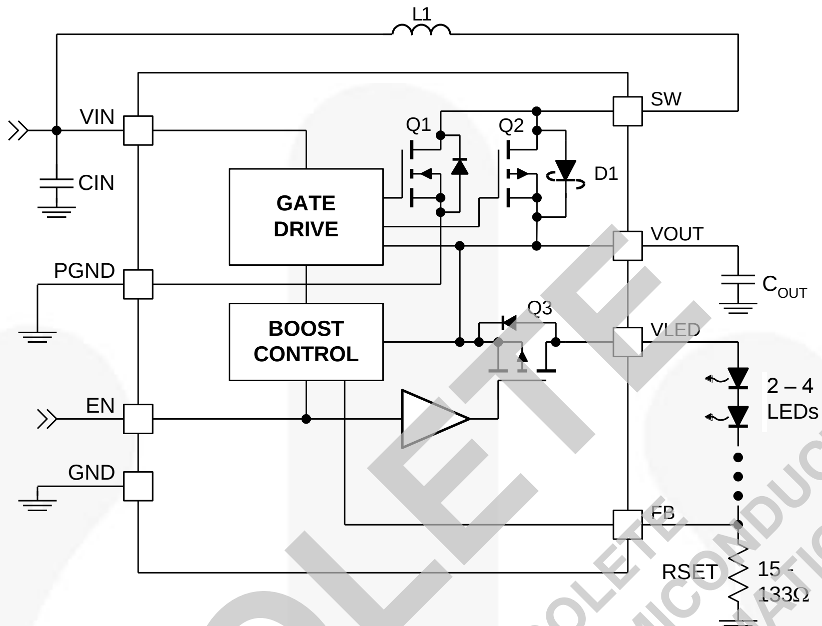


Figure 2. 框图

Table 1. 建议使用的外部器件

组件	说明	厂商	参数	最小值	典型值	最大值	单位
L1	22µH 标称	Murata LQH3NPN220MGOK	L[(1)]		22		µH
			DCR (系列 R)		1100		mΩ
C_{OUT}	4.7µF X5R 或更好		C		4.7		µF
C_{IN}	4.7µF X5R 或更好		C		4.7		µF

说明:

1. 最小 L (电感) 涉及容限、温度和直流偏压的影响(L随电流升高而降低)。

引脚布局

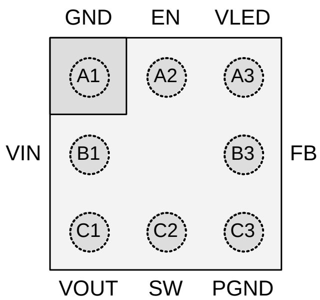


Figure 3. WLCSP 封装，顶视图

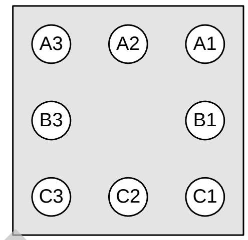


Figure 4. WLCSP 封装，底视图

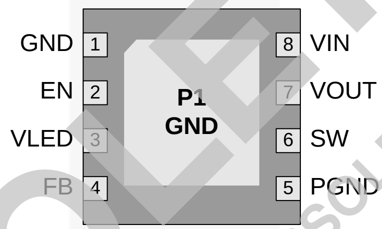


Figure 5. 8-引脚, 3 x 3mm 顶视图MLP,

引脚说明

引脚号		名称	说明
CSP	**MLP**		
A1	1	GND	**模拟地**。所有信号均以该引脚为参照。
A2	2	EN	**启用 / PWM亮度控制**。该引脚上的逻辑低电平可关断芯片，将LED与 VOUT断开，并降低芯片的功耗。该管脚上存在一只内部 300kΩ的下拉电阻。
A3	3	VLED	**LED串输出**。连接至两个至四个LED组成的串节点。
B3	4	FB	**电流反馈**。升压稳压器可将该引脚的电压调至0.5V，以控制LED的串行电流。将该引脚连接GND和LED串阴极之间的电流设置电阻（R_{SET}）。
C3	5	PGND	**电源地**。升压开关和栅极驱动在此引脚接地。
C2	6	SW	**开关节点**。电感L1连接在V_{IN}和该引脚之间。
C1	7	VOUT	**升压输出电压**。升压稳压器的输出。
B1	8	VIN	**输入电压**。

绝对最大额定值

如果应力超过绝对最大额定值，器件就会毁损。在推荐的工作条件之上，该器件可能无法正常运行或操作，且不建议让器件在这些条件下长期工作。此外，过度暴露在高于推荐的工作条件下，会影响器件的可靠性。绝对最大额定值仅是额定应力值。

符号	参数		最小值	最大值	单位
V_{IN}	VIN		–0.3	6.0	V
V_{FB}、V_{EN}	FB、EN引脚		–0.3	V_{IN} + 0.3	V
V_{SW}	SW 引脚		–0.3	24.0	V
V_{OUT}	VOUT 引脚		–0.3	24.0	V
ESD	静电放电防护等级	人体模型满足JESD22-A114	4.0		kV
		充电器件模型满足JESD22-C101	1.5		
T_J	结温		–40	+150	°C
T_{STG}	存储温度		–65	+150	°C
T_L	引线焊接温度，10秒			+260	°C

推荐工作条件

推荐的操作条件表定义了真实器件的工作条件。指定推荐的工作条件，以确保设备的最佳性能达到数据表中的规格。飞兆半导体建议不要超过推荐工作条件，也不能按照绝对最大额定值进行设计。

符号	参数	最小值	典型值	最大值	单位
V_{IN}	VIN 电源电压	2.7		4.8	V
V_{OUT}	VOUT 电压	6.2		16.0	V
I_{OUT}	VOUT 负载电流	5		40	mA
f_{EN_PWM}	EN 引脚 PWM 调光频率	100	300	1000	Hz
T_A	环境温度	–40		+85	°C
T_J	结温	–40		+125	°C

热性能

结-环境之间热阻与具体应用和电路板布局有关。该数据由2s2p四层板测得，符合JESD51-JEDEC标准。特别注意的是，不要超过给定环境温度T_A时的结温 $T_{J(max)}$ 。

符号	参数		典型值	单位
θ_{JA}	结-环境之间热阻	WLCSP 封装	110	°C/W
		MLP 封装	49	°C/W

电气规格

V_{IN} = 2.7V 至 4.8V, T_A = -40°C至 +85°C，除非另有说明。典型值测量条件为 T_A = 25°C 且 V_{IN} = 3.6V。

符号	参数	工作条件	最小值	典型值	最大值	单位
电源						
I_Q	静态电流	EN = V_{IN}, 器件未开关			1	mA
I_{SD}	停机电源电流	EN = GND, V_{IN} = 3.6V		0.3	1.0	µA
V_{UVLO}	欠压锁定	V_{IN} 升	2.30	2.40	2.50	V
		V_{IN} 降	2.00	2.15	2.25	V
V_{UVHYST}	欠压锁定滞环宽度			250		mV
EN:启用引脚						
V_{IH}	输入电压高电平		1.2			V
V_{IL}	输入电压低电平				0.4	V
R_{EN}	EN 下拉电阻		200	300	400	kΩ
t_{SD}	EN 低电平，关断延迟	自 EN 的下降沿	20		80	ms
反馈和参考						
V_{FB}	反馈电压		480	500	520	mV
I_{FB}	反馈输入电流	V_{FB} = 500mV		0.1	1.0	µA
电源输出						
$R_{DS(ON)\_Q1}$	升压开关接通电阻	V_{IN} = 3.6V, V_{OUT} = 10V, I_{SW} = 100mA		600		mΩ
		V_{IN} = 2.7V, V_{OUT} = 10V, I_{SW} = 100mA		850		mΩ
$R_{DS(ON)\_Q2}$	同步整流导通电阻	V_{OUT} = 10V, I_{SW} = 100mA		2.0		Ω
$R_{DS(ON)\_Q3}$	负载开关导通电阻	V_{OUT} = 10V, I_{LED} = 10mA		2.8		Ω
$I_{SW(OFF)}$	SW 节点漏电流(2)	EN = 0, V_{IN} = V_{SW} = V_{OUT} = 5.5V, V_{LED} = 0		0.1	1.0	µA
$I_{LIM\text{-}PK}$	升压开关峰值电流限值	V_{IN} = 3.6V	325	400	475	mA
振荡器						
f_{SW}	升压稳压器开关频率		1.0	1.2	1.4	MHz
PWM 调光						
D_{PWM}	PWM 占空比(3)	PWM调光频率≤1kHz	1.0		100	%
输出和保护						
V_{OVP}	升压输出过压保护 (OVP)		18.0	19.0	20.0	V
$V_{OVPHYST}$	OVP 滞环			0.8		V
V_{THSC}	V_{LED} 短路检测阈值	V_{OUT} 降		V_{IN} – 1.5		V
		V_{OUT} 升		V_{IN} – 1.3		V
D_{MAX}	最大升压占空比(3)		85			%
D_{MIN}	最小升压占空比(3)				20	%
T_{SD}	热关闭			150		°C
T_{HYS}	热关闭滞环宽度			25		°C

说明:

2. SW 漏电流包括三个内部开关的漏电流； SW 至 GND, V_{OUT} 至 V_{LED}, 以及 SW 至 V_{OUT}.
3. 设计保证。

典型特性

V_{IN} = 3.6V, T_A = 25°C, I_{LED} = 20mA, L = 22µH, C_{OUT} = 4.7µF.

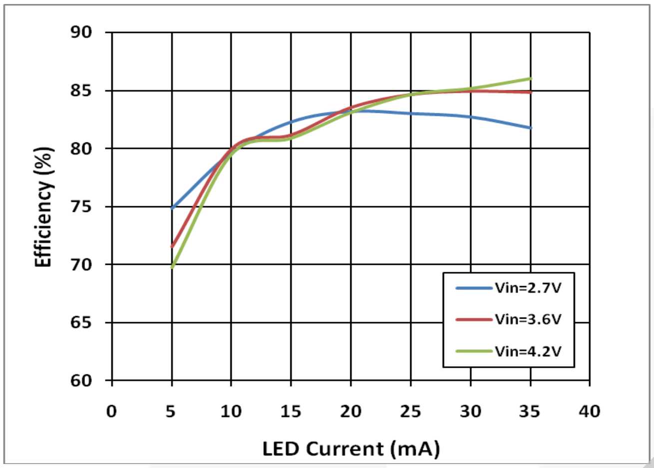


Figure 6. 效率 vs. LED 电流：2 LED

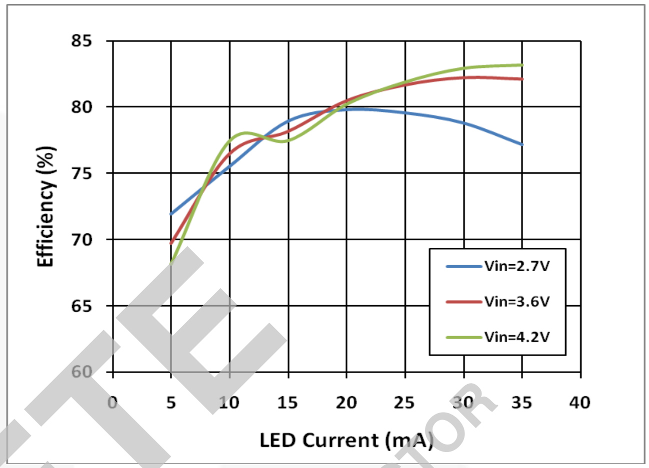


Figure 7. 效率 vs. LED 电流：3 LED

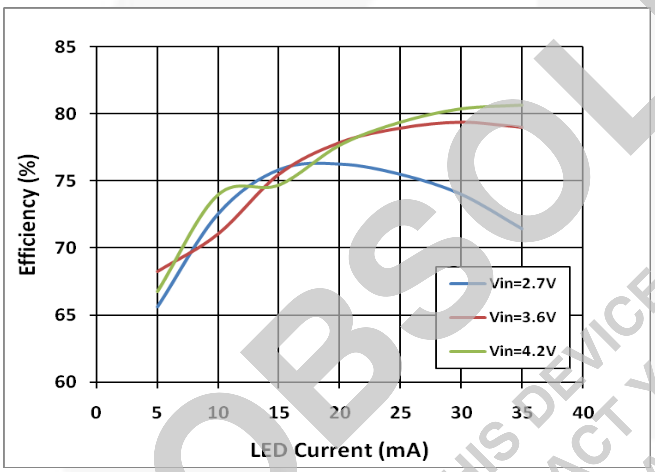


Figure 8. 效率 vs. LED 电流：4 LED

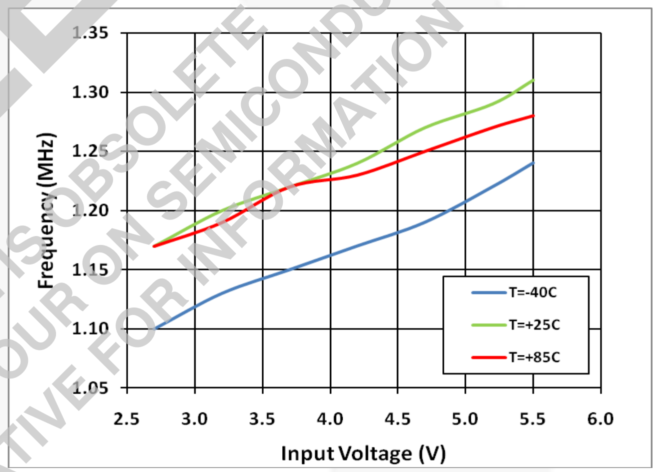


Figure 9. f_{SW} vs.输入电压 vs.温度

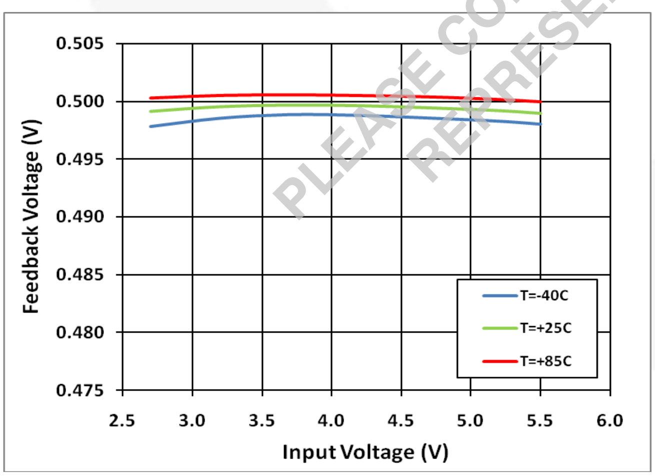


Figure 10. FB 电压 vs.输入电压 vs.温度

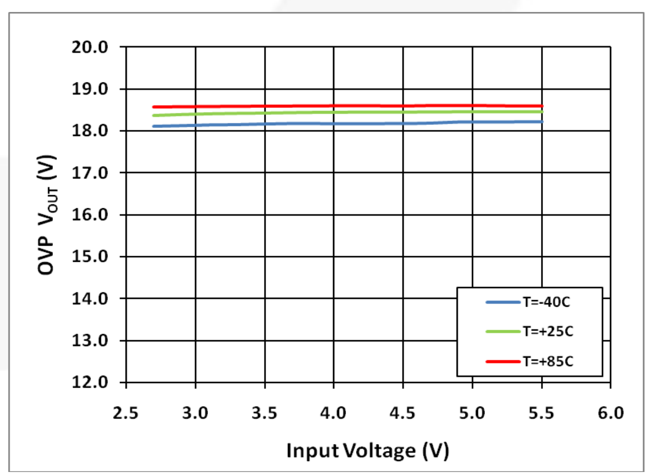


Figure 11. OVP vs.输入电压vs.温度

典型特性(续)

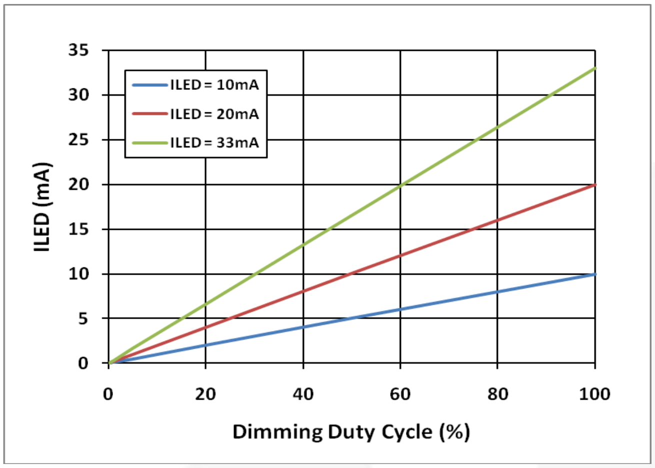


Figure 12. PWM 线性化，超过调光占空比全程，4 LED

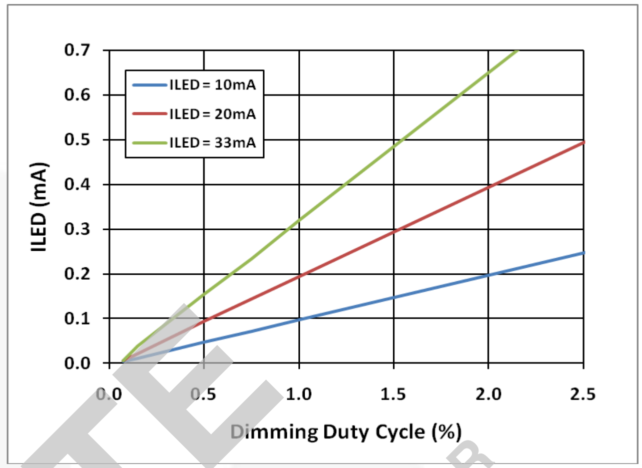


Figure 13. PWM 线性化，调光占空比<2.5%，4 LED

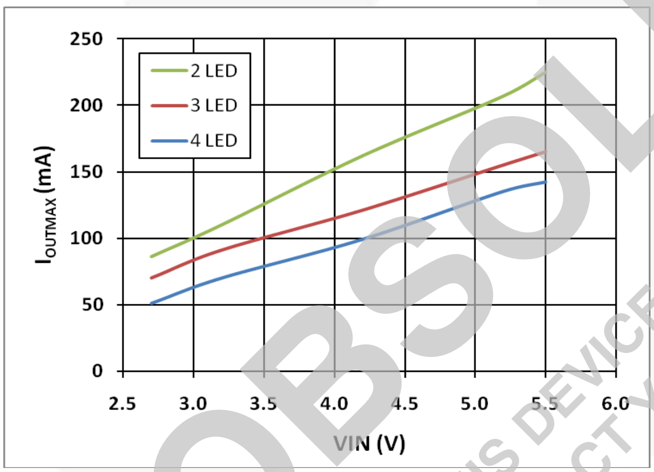


Figure 14. V_{OUT}上的最大输出电流

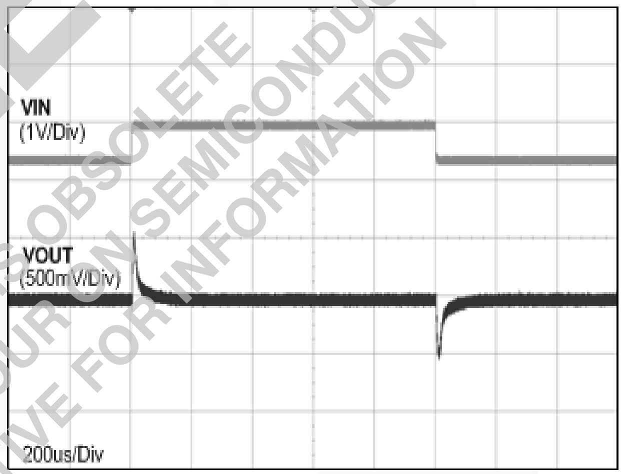


Figure 15. 电源瞬态，步进10µs 4 LED

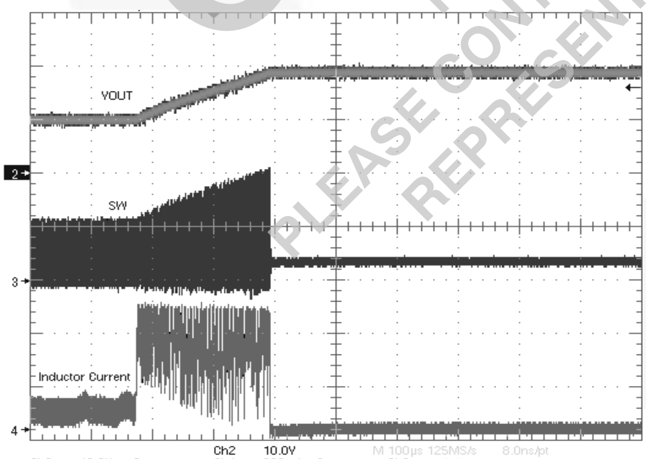


Figure 16. 过压保护：软起动，打开LED串

典型特性(续)

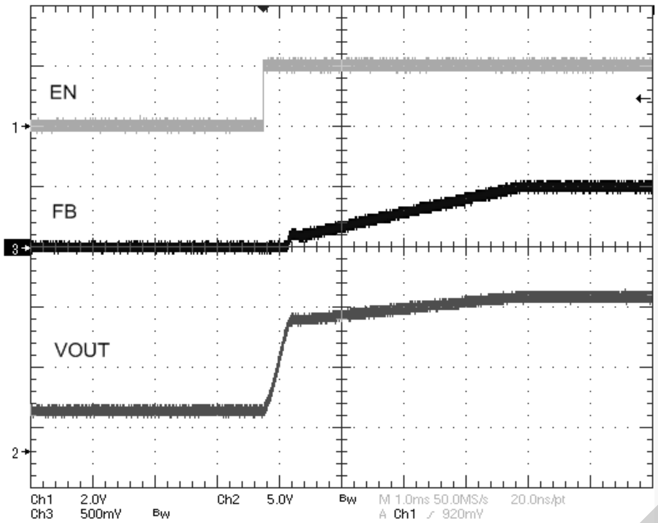


Figure 17. 1ms/Div，100%占空比的冷启动波形

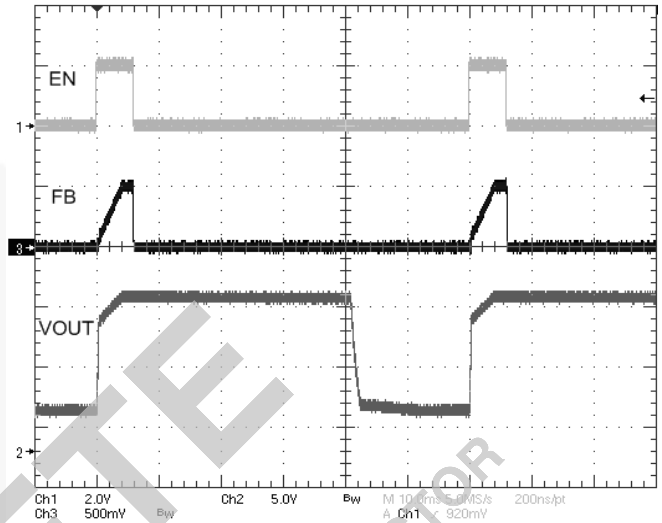


Figure 18. 100%占空比的冷启动波形以10ms/Div显示启动、关断再启动。

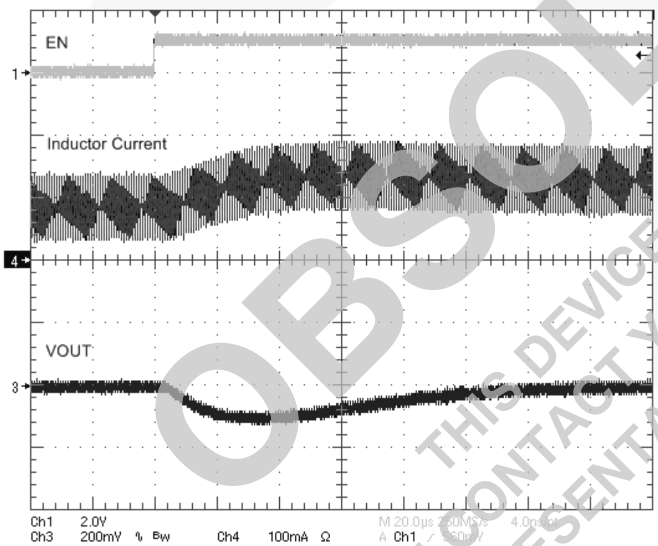


Figure 19. FAN5340 I_{LOAD} 从 20mA 步进至 30mA，通过在10mA 启用 FAN5640 3 LED

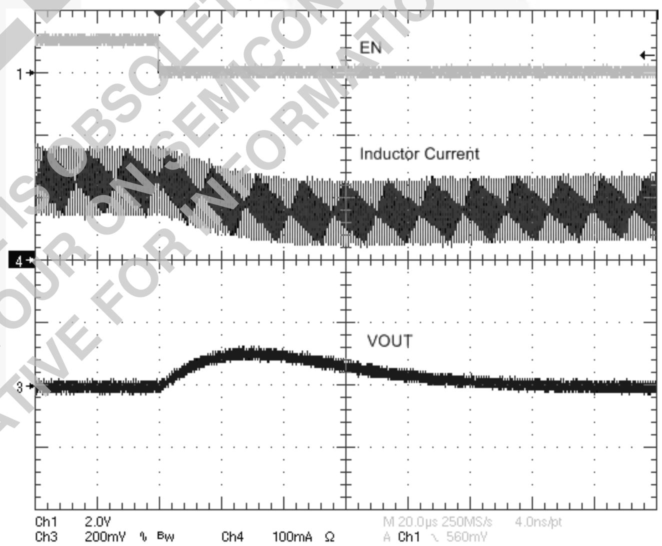


Figure 20. FAN5340 I_{LOAD} 从 30mA 步进至 20mA，通过在10mA 禁用 FAN5640 3 LED

电路说明

概述

FAN5340 是一款电感电流模式升压的串联 LED 驱动器，通过保持R_{SET}电阻 0.5V 的电压实现LED电流的调节。LED 串的电流（I_{LED}）的计算公式为：

$$I_{LED} = \frac{0.5}{R_{SET}} \qquad (1)$$

LED上的正向电压可决定 V_{OUT}，FAN5340 的升压稳压器输出也可以支持V_{OUT} *(参见图 21)* 上的其他负载，前提是不超过输入电流限制。

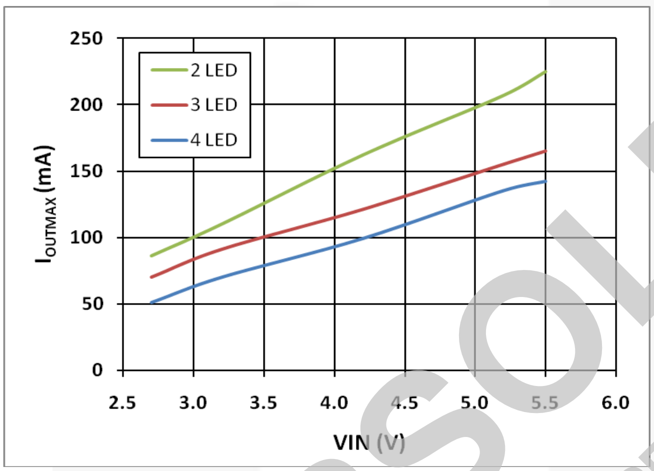


Figure 21. 最大输出电流 vs. 输入电压

UVLO 和软启动

若 EN 低电平超过 20ms，芯片在EN 升高时将进行"冷启动"的软起动周期，前提是 V_{IN} 超过 UVLO 阈值。软起动电路将参考电压输入误差放大器，从而控制冲击电流。

PWM 调光

EN 低电平时，芯片关断一个 MOSFET (Q3 图2)，其断开LED 负载，防止EN引脚低电平时 C_{OUT} 放电。只要 EN 低电平的时间不超过 20ms，稳压器的主回路将在 EN 恢复高电平时迅速恢复控制。

短路检测

V_{OUT} 降至 V_{IN} – 1.5V 以下时，Q3 关断直至 V_{OUT} 至少恢复至 V_{IN} – 1.3V 方可导通。

过压保护

若 LED 串采用开路，FB 保持为 0V，且输出电压在没有过压保护（OVP）电路的情况下持续升高。当 V_{OUT} 超过19.0V时，FAN5340 的 OVP电路将禁用升压稳压器，并持续到V_{OUT}降至18.2V以下方可启用。

热关闭

晶圆温度超过150°C时，发生复位并保持，直至晶圆冷却至125°C；此时允许电路开始软起动序列。

适用范围

使用 VOUT 驱动附加的 LED 串

VOUT 引脚可用作简单电流源（如图22使用FAN5640所示）或分离电流槽。为避免 EN 引脚在低电平时下拉 V_{OUT}，应启用辅助串，除非 EN 引脚处于高电平。因而辅助串可使用与 EN 相同线路进行 PWM 调光，如图所示，或单独启用，但应在 FAN5340 的导通期间。

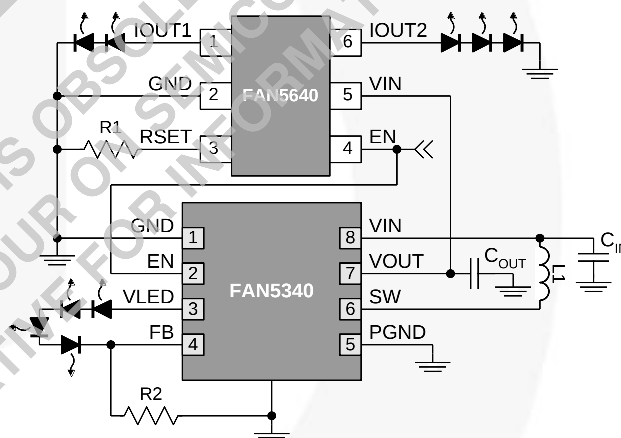
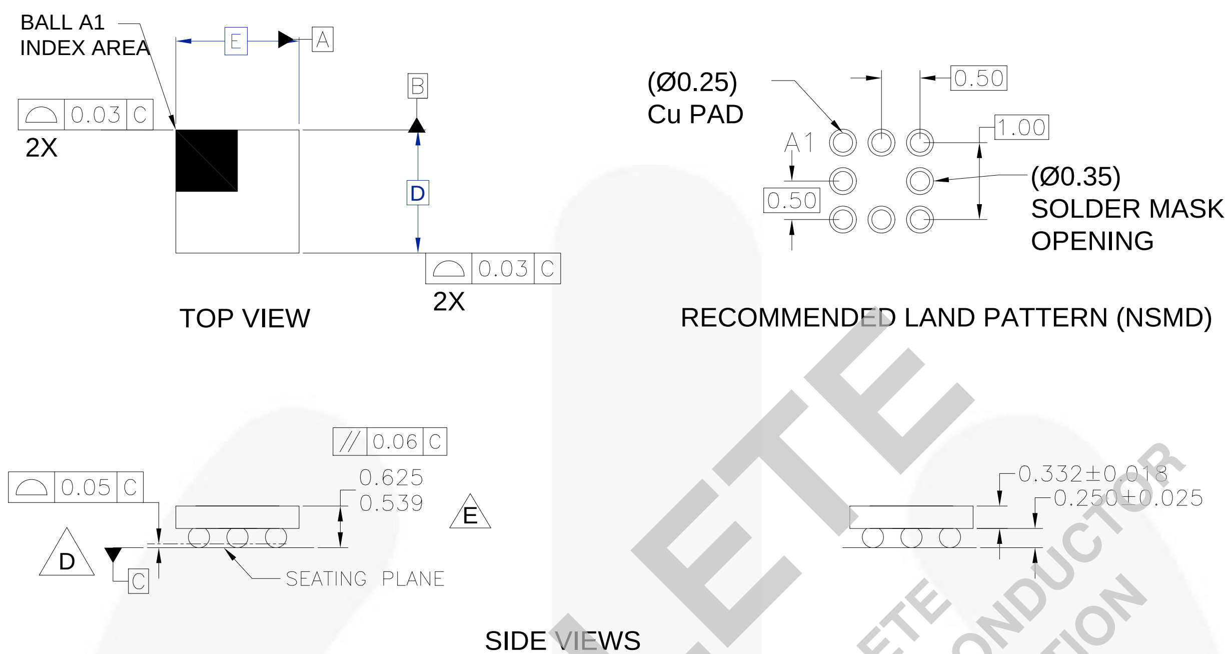
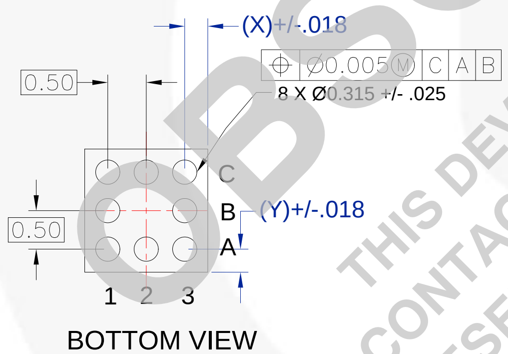


Figure 22. 驱动附加的 LED 串

若使用 VOUT 驱动附加负载，应注意不要超过输入电流限制。图21 给出了典型芯片的限制。总负载($I_{OUT}1$ + $I_{OUT}2$ + I_{LED})应保持低于图21值的 70%。

物理尺寸





NOTES:

A. NO JEDEC REGISTRATION APPLIES.

B. DIMENSIONS ARE IN MILLIMETERS.

C. DIMENSIONS AND TOLERANCES PER ASME Y14.5M, 1994

D. DATUM C, THE SEATING PLANE, IS DEFINED BY THE SPHERICAL CROWNS OF THE BALLS.

E. PACKAGE TYPICAL HEIGHT IS 582 MICRONS ± 43 MICRONS (539-625 MICRONS).

F. FOR DIMENSIONS D, E, X, AND Y SEE PRODUCT DATASHEET.

G. BALL COMPOSITION: Sn95.5-Ag3.9-Cu0.6

I. DRAWING FILENAME: MKT-UC008ABrev2.

产品规格尺寸

产品	D	E	X	Y
FAN5340UC	1.570	1.570	0.285	0.285

Figure 23. 8 球型，1.57 x 1.57mm 晶圆级芯片封装（WLCSP）

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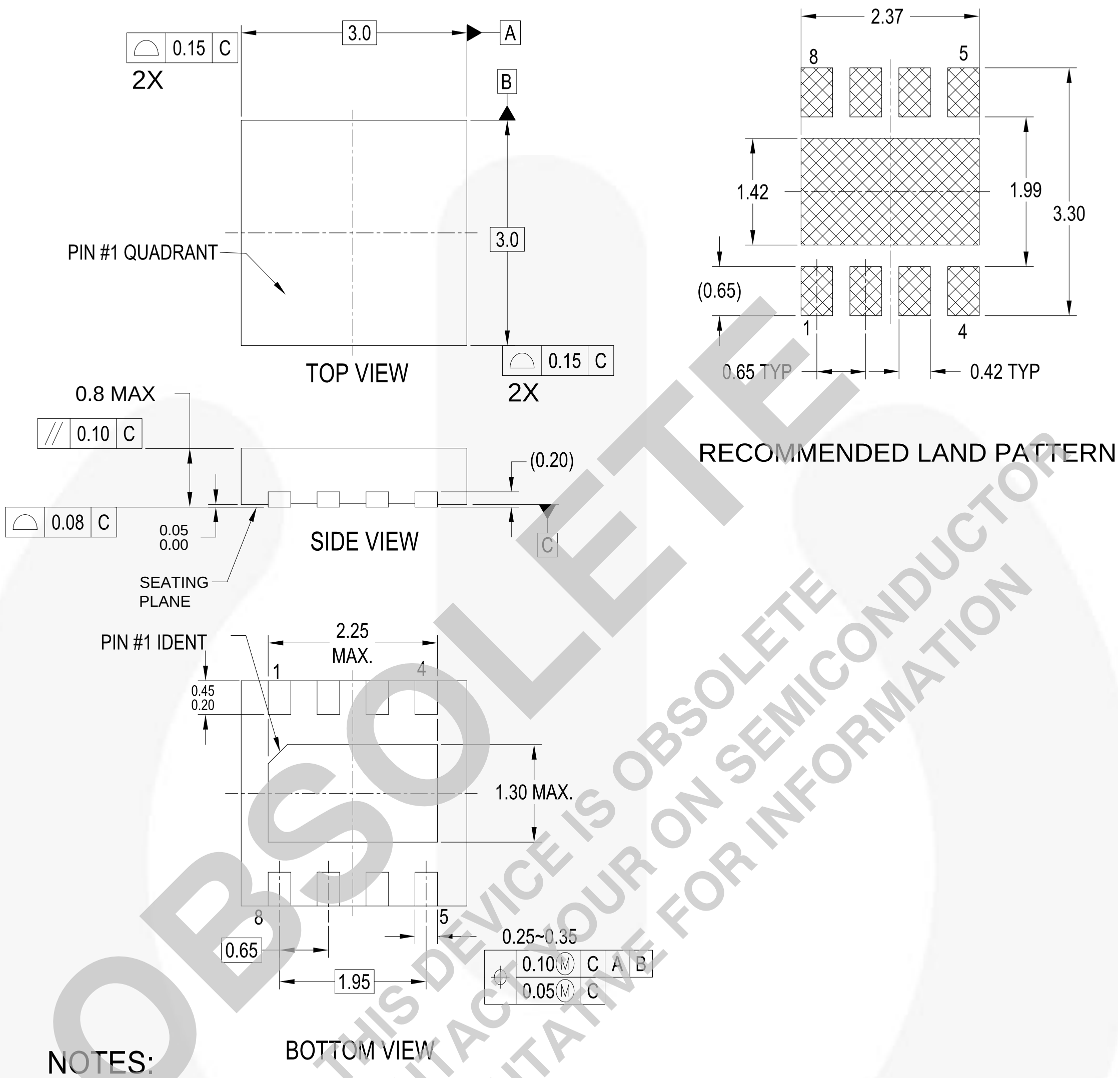
物理尺寸(续)



NOTES:

A. CONFORMS TO JEDEC REGISTRATION MO-229, VARIATION VEEC, DATED 11/2001

B. DIMENSIONS ARE IN MILLIMETERS.

C. DIMENSIONS AND TOLERANCES PER ASME Y14.5M, 1994

D. FILENAME: MKT-MLP08Drev2

Figure 24. 8-管脚，3 x 3mm 超薄模塑无铅封装(MLP)

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