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FAN5701 — 紧凑型移动平台用的 6-LED 驱动器

产品特性

- 6只LED并联（每只电流高达30mA）
- 整体封装的载流能力：180mA LED默认分为四只（4）和两只（2）两组，分别用于主次显示的背光，分别带有独立的PWM调光控制，最高操作可达20kHz
- ，PWM频率为100Hz时，调光比大于600:1
- 效率高达92%
- 内置带有低压差旁路开关的1.5X电荷泵
- 输入范围广：2.7V 至 5.5V
- V_{OUT} 过压和短路保护
- 过温保护
- 1.2MHz的开关频率，缩减电容体积
- 16-焊点 1.61mm x 1.61mm WLCSP（高0.6mm）
- 16-引线 3.0mm x 3.0mm UMLP（高0.55mm）

适用范围

- LCD 背光
- 键盘背光
- 手机
- 便携式媒体播放器

说明

FAN5701是一个高度集成，并基于高效电荷泵的多LED驱动器。该装置可以驱动多达六个并联LED，总输出电流为180mA。

FAN5701可用于驱动需要四至六只LED的主显示背光。背光需要四只以上LED时，可连接FAN5701的PWM调光输入，从而为六个LCD提供正常的调光控制。若有主次显示的不同需求时，FAN5701可以分别控制其各自的调光。直板手机需要有主显示屏和键盘背光，FAN5701可提供简单紧凑的背光解决方案。

调节其内部电流槽，可以为六个LED提供精确电流和亮度匹配。该器件具有很高的效率，无需电感，可以调节电荷泵，使之工作在1.5x 模式或直通模式。

可订购的FAN5701其I_{SET} 值可以为30mA、20mA、15mA或8mA，并且可采用 WLCSP或超薄的UMLP封装。默认I_{SET}值取决于订购时器件型号（参考订购信息）。

订购信息

器件型号	LED 电流(I _{SET})	温度范围	封装	包装
FAN5701UC30X	30mA	-40°C 至 85°C	WLCSP-16, 0.4mm 间距	卷带
FAN5701UC20X	20mA	-40°C 至 85°C	WLCSP-16, 0.4mm 间距	卷带
FAN5701UC15X	15mA	-40°C 至 85°C	WLCSP-16, 0.4mm 间距	卷带
FAN5701UC08X	8mA	-40°C 至 85°C	WLCSP-16, 0.4mm 间距	卷带
FAN5701UMP30X	30mA	-40°C 至 85°C	UMLP-16, 3.0 x 3.0 x 0.55mm	卷带
FAN5701UMP20X	20mA	-40°C 至 85°C	UMLP-16, 3.0 x 3.0 x 0.55mm	卷带
FAN5701UMP15X	15mA	-40°C 至 85°C	UMLP-16, 3.0 x 3.0 x 0.55mm	卷带
FAN5701UMP08X	8mA	-40°C 至 85°C	UMLP-16, 3.0 x 3.0 x 0.55mm	卷带

框图

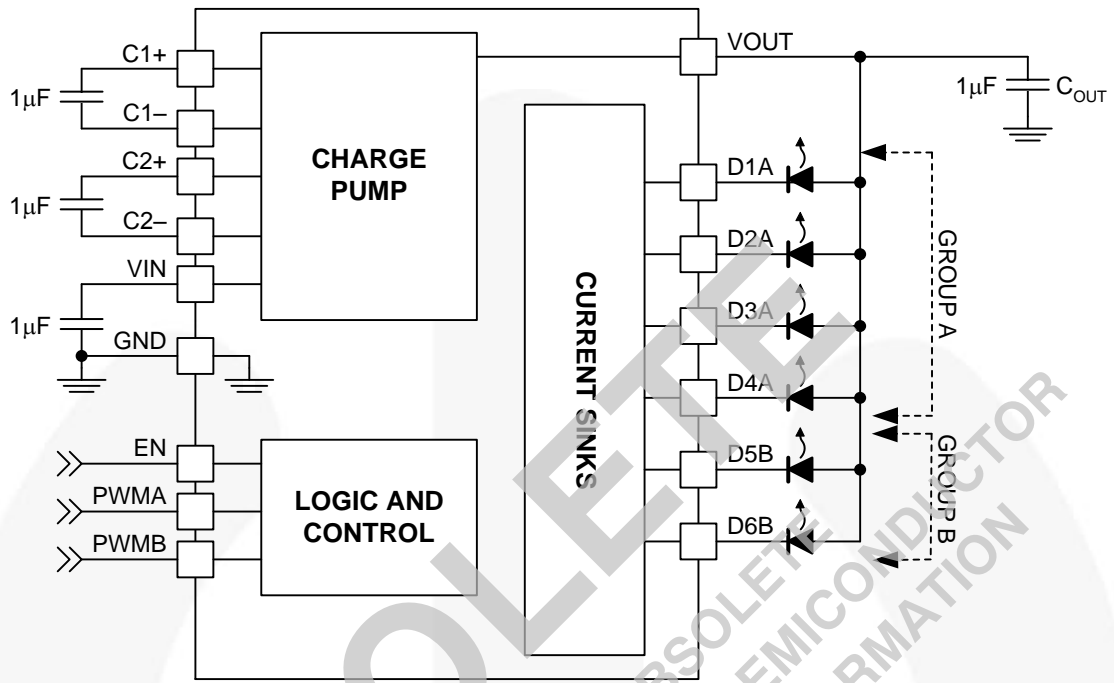


图1. 典型应用

OBSOLETE

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WLCSP 引脚布局

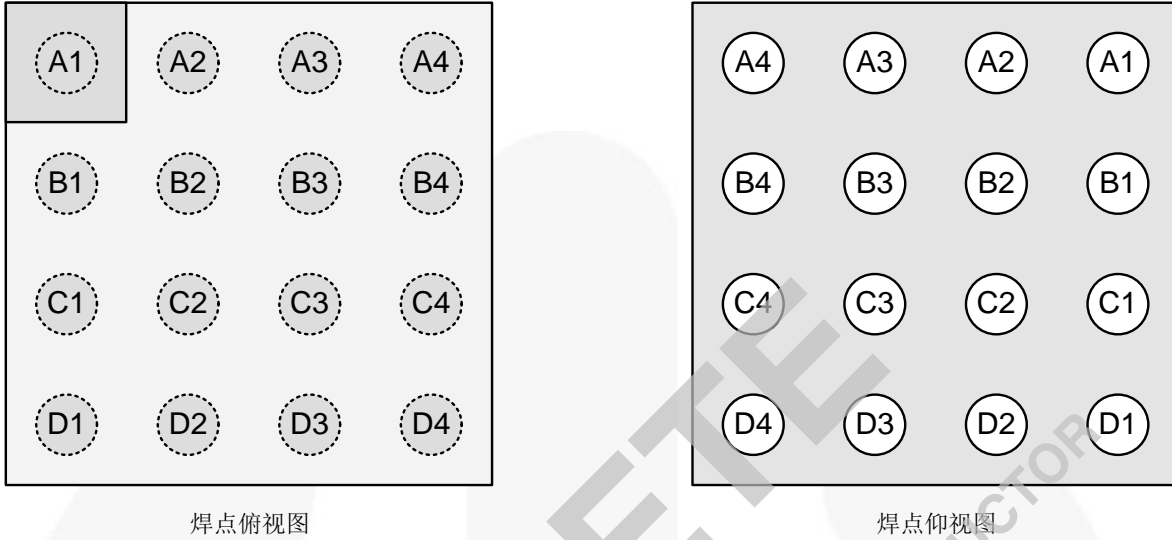


图2. WLCSP-16, 0.4mm 间距, 1.61mm x 1.61mm

引脚说明

引脚号	名称	说明
D2	VIN	输入电压。连接2.7-5.5 V _{DC} 输入电源。
B4	GND	接地
D1	VOUT	电荷泵输出电压。连接LED阳极。
D3,D4	C1+, C1-	C1.电荷泵飞跨#1电容。
C3,C4	C2+, C2-	C2.电荷泵飞跨#2电容。
A1, A2, B1, B2, C1, C2	D2A, D1A, D4A, D3A, D6B, D5B	LED输出
A4	EN	启用。该引脚为高电平时, 启用常规工作模式。该引脚为低电平时, IC被复位, 并禁用所有功能。
B3	PWMA	A组PWM调光输入
A3	PWMB	B组PWM调光输入

UMLP 引脚布局

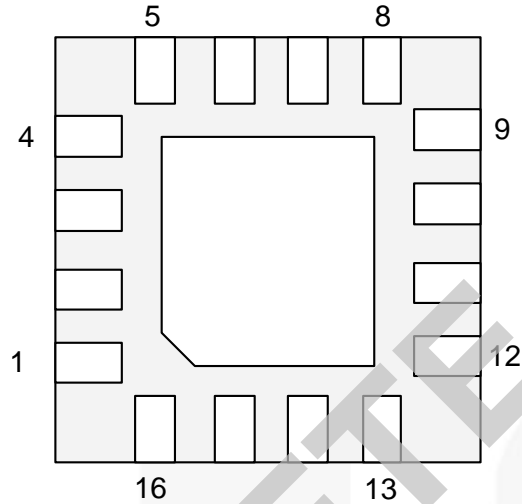


图3. UMLP-16, 0.5mm 间距, 3mm x 3mm (底视图)

引脚说明

引脚号	名称	说明
11	VIN	输入电压。连接至2.7 – 5.5V _{DC} 输入电源。
6	GND	接地。
12	VOUT	电荷泵输出电压。连接LED阳极。
10,9	C1+, C1-	C1. 电荷泵飞跨#1电容。
8,7	C2+, C2-	C2. 电荷泵飞跨#2电容。
1,2, 15, 16, 13, 14	D2A, D1A, D4A, D3A, D6B, D5B	LED 输入
4	EN	启用。该引脚为高电平时，启用常规工作模式。启用。该引脚为高电平时，启用常规工作模式。
5	PWMA	A组PWM调光输入
3	PWMB	B组PWM调光输入

绝对最大额定值

如果应力超过绝对最大额定值，设备就会毁损。在推荐的工作条件之上，该设备可能无法正常运行或操作，且不建议让设备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 _{CC}	VIN, VOUT 引脚		-0.3	6.0	V
	其他引脚 ⁽⁰⁾		-0.3	AV _{IN} + 0.3	V
ESD	静电放电防护等级	人体模式, JESD22-A114	3		kV
		带电设备模式, JESD22-C101	UMLP16	2	
		带电设备模式, JESD22-C101	WLCSP-16	1	
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

说明：

1. 选取V_{IN}+0.3与6.0V中的较小值。

推荐工作条件

推荐的操作条件定义了真实设备的工作条件。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	最大值	单位
V _{IN}	电源电压	2.7	5.5	V
V _{LED}	LED正向电压	2	4	V
T _A	环境温度	-40	+85	°C
T _J	结温	-40	+125	°C

热性能

符号	参数		最小值	典型值	最大值	单位
Θ _{JA}	结-环境之间热阻 ⁽²⁾	WLCSP		80		°C/W
		UMLP		49		°C/W

说明：

2. 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)}。

电气规格

若无其他特定要求, $V_{IN} = 2.7V$ 至 $5.5V$, $T_A = -40^{\circ}C$ 至 $+85^{\circ}C$, 且 $EN = V_{IN}$ 。典型值为 $V_{IN} = 3.6V$ 、 $T_A = 25^{\circ}C$ 、 $I_{LED} = 20mA$ 且 LED 负极端子 = $0.4V$ 。根据图1设计电路与器件。

符号	参数	工作条件	最小值	典型值	最大值	单位
电源与热保护						
I_Q	静态电源电流	1.5x 模式, 无 LED		4.4		mA
		1x 模式, 无 LED		0.7		mA
I_{SD}	停机电源电流	$EN = 0$ 、 $V_{IN} = 4.5V$ 、 $T_A = -40^{\circ}C$ 至 $+85^{\circ}C$		1.5	4.0	μA
V_{UVLO}	欠压闭锁阈值	V_{IN} 升		2.55	2.70	V
		V_{IN} 降	2.20	2.40		
V_{UVHYST}	欠压锁定滞环宽度			150		mV
OVP	过压保护			6		V
T_{LIMIT}	热关闭			150		$^{\circ}C$
T_{HYST}	热关闭滞环宽度			20		$^{\circ}C$
LED 灌电流						
I_{LED}	绝对电流精度	$V_{CATHODE} = 0.4V$; 参见 I_{SET} 的选项	-10%	I_{SET}	+10%	mA
$I_{LED(MAX)}$	最大二极管电流 ⁽³⁾	$I_{LED} = I_{SET}$		30		mA
I_{LED_MATCH}	LED 电流匹配 ⁽⁴⁾	$V_{CATHODE} = 0.4V$, $I_{LED} = I_{SET}$		0.4	3.0	%
V_{DTH}	1x 到 1.5x 增益转换阈值	LED 阴极电压降		100		mV
V_{HR}	灌电流余量 ⁽⁴⁾	$I_{LED} = 90\% I_{LED(额定值)}$		65		mV
电荷泵						
R_{OUT}	输出电阻	1.5x 模式		2.4		Ω
		1x 模式		0.9		Ω
f_{SW}	开关频率		0.9	1.2	1.5	MHz
t_{START}	启动时间	$V_{OUT} =$ 稳态的 90%		250		μs
PWM 调光						
f_{PWM}	PWM 调光频率	$t_{ON_LED} = 15\mu s$ (Minimum)			20	kHz
D_{PWM}	PWM 占空比	$f_{PWM} = 100Hz$	0.15		100.00	%
逻辑输入 (EN, PWMA, PWMB)						
V_{IH}	输入电压高电平		1.2			V
V_{IL}	输入电压低电平				0.4	V
V_{IMAX}	最大输入电压			1.8	5.5	V
I_{IN}	输入偏置电流	输入连接到 GND 或 V_{IN}		0.01	1.00	μA

注意:

- I_C 的最大总输出电流为 180mA。总输出电流可分为 2 个组 ($IDxA = IDxB = 30mA$ 最大值)。在最大输出电流条件下, 需特别注意输入电压和 LED 的正向电压, 以确保适当的电流调节。参见产品说明书中最大输出电流的章节。
- 对于器件中的这两组 (A 组和 B 组) 灌电流, 如果以下是确定的: 每组中最大灌电流 (MAX)、每组中最小灌电流 (MIN)、每组中平均灌电流 (AVG), 则对于每一组, 定义两个匹配数值, 计算如下: $(MAX-AVG)/AVG$ 和 $(AVG-MIN)/AVG$ 。选择二者中较大的数 (最坏情况), 作为该组的匹配值。既定部分的匹配值应为两组中匹配度最高的。提供的典型规格就是所有部分的最大可能匹配基准。
- 对于每一个 D_{xx} 引脚, 净空电压指内部回流槽与该引脚之间的电压。 $V_{HRx} = V_{OUT} - V_{LED}$ 。如果净空电压不满足要求, LED 电流调节效果会大大折扣。

典型特性

$V_{IN} = 3.6V$ 、 $T_A = 25^\circ C$ 、 $I_{LED} = 20mA$ 以及 LED 负极端子 = 0.4V。

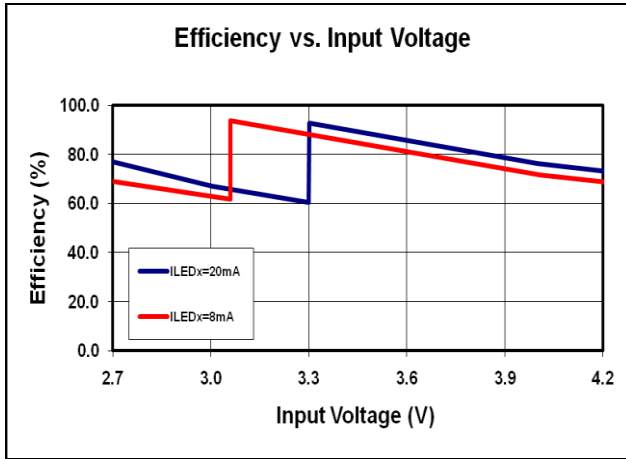


图4. LED 电流为 8mA 和 20mA 时的效率

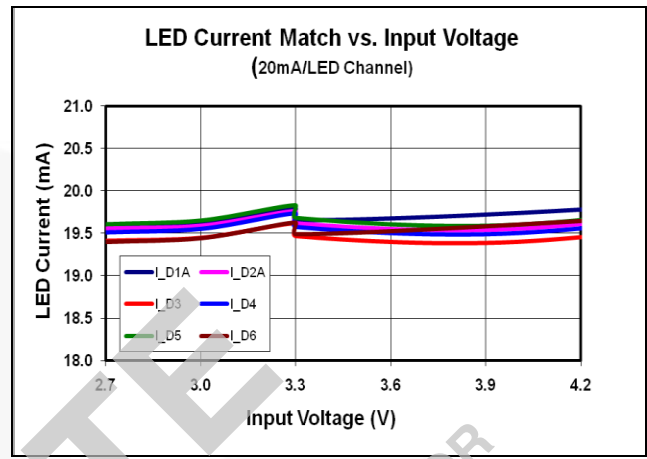


图5. $I_{LED}=20mA$ 时6个LED通道的电流匹配

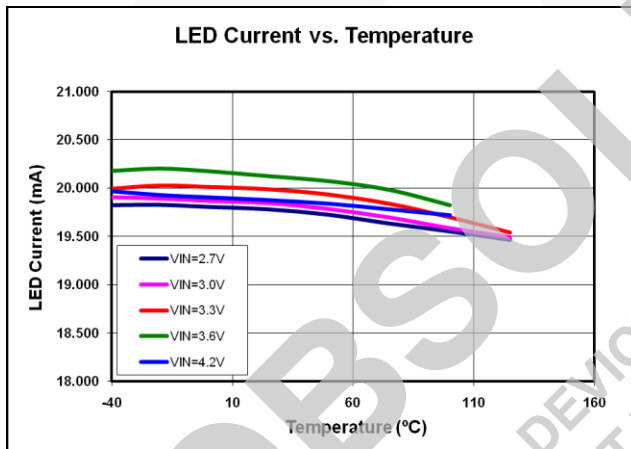


图6. LED 电流变化相对温度的曲线

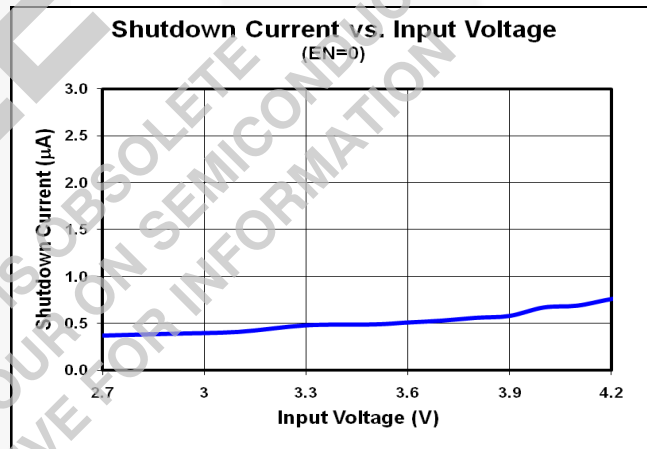


图7. 待机电流与输入电压的关系

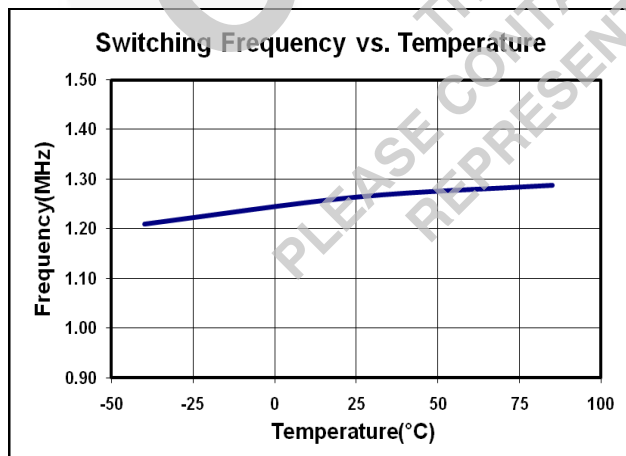


图8. LED 电流为 20mA 时开关频率和温度的关系

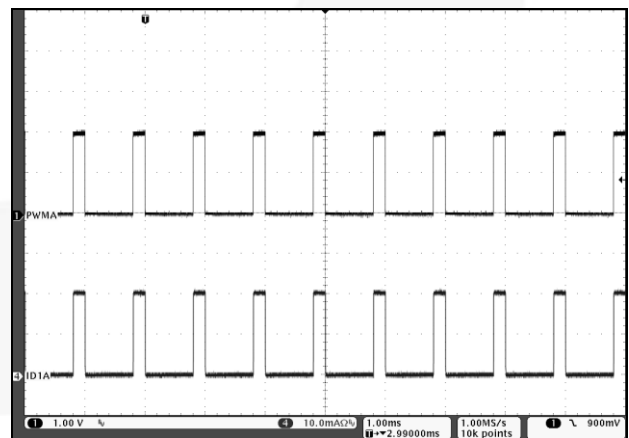


图9. PWM 调光、 $V_{IN}=3.6V$ 、 $I_{LEDx}=20mA$ 、且 $EN=1kHz$ 、占空比为 20%

典型特性(续)

$V_{IN} = 3.6V$ 、 $T_A = 25^\circ C$ 、 $I_{LED} = 20mA$ 以及 LED 负极端子 = $0.4V$ 。

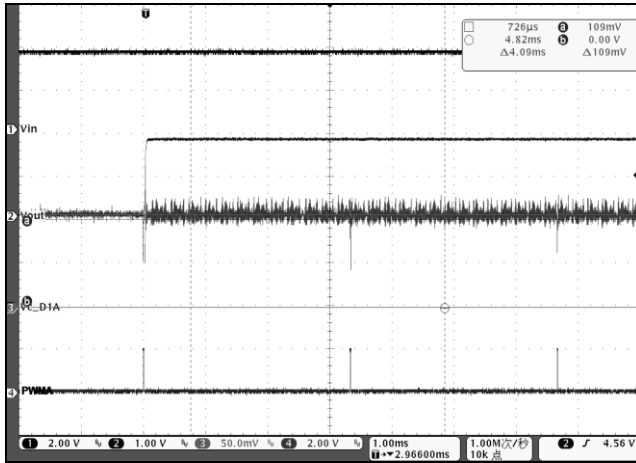


图10. 1x到1.5x模式切换、 $V_{IN}=3.6V$ ($V_{CATHODE}$ 斜升)

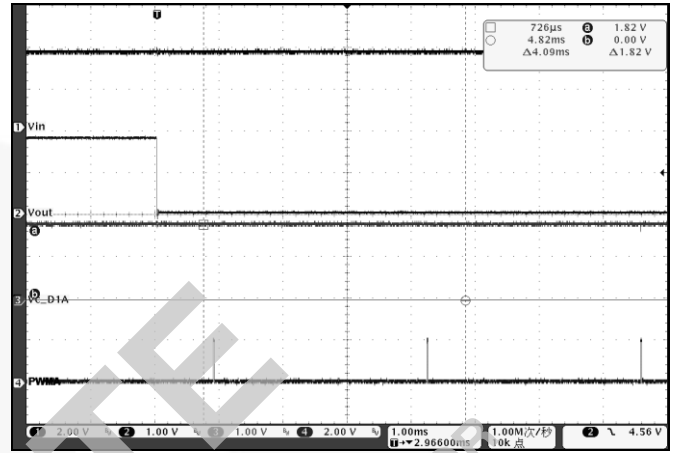


图11. 1x到1.5x模式切换、 $V_{IN}=3.6V$ ($V_{CATHODE}$ 斜降)

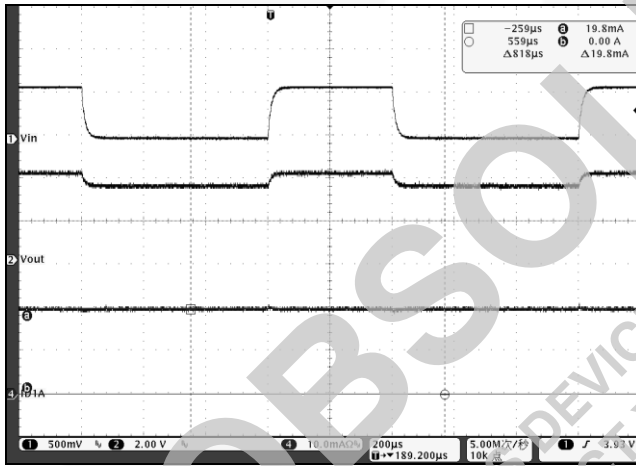


图12. 1x模式下的线路瞬态响应、 $V_{IN}=3.6V - 4.2V$, $I_{LEDx}=20mA$

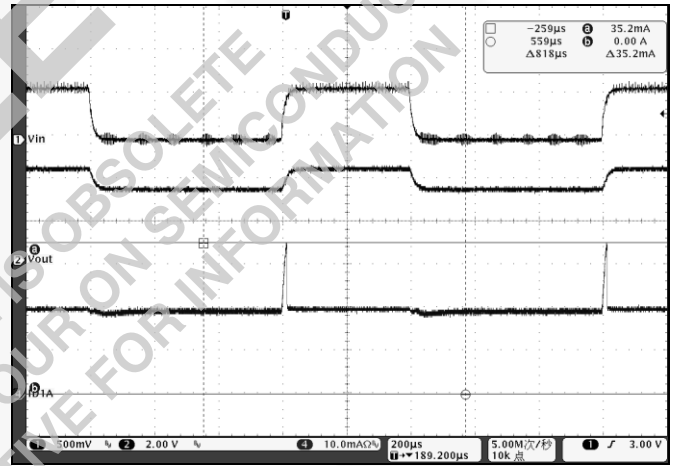


图13. 1.5x模式下的线路瞬态响应、 $V_{IN}=2.7V - 3.3V$, $I_{LED}=20mA$

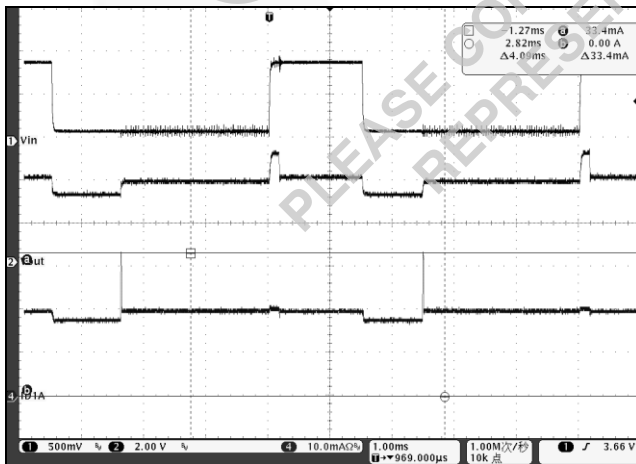


图14. 1x到1.5x模式切换时线路瞬态响应、 $V_{IN}=3.2V - 4.1V$, $I_{LEDx}=20mA$

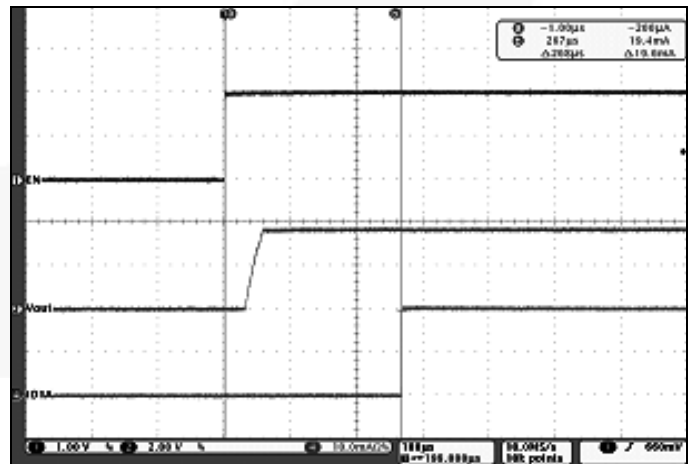


图15. $V_{IN}=3.6V$, $I_{LEDx}=20mA$ 时带EN软起动

电路说明

FAN5701是一个白色LED的驱动系统，基于一个自适应1.5x/1x电荷泵，能够提供达到180mA的总输出电流。严格匹配的电流槽能确保各个LED的亮度均匀。LED采用共阳极配置，在制造过程中设置峰值驱动电流（参见订购信息和 I_{SET} ）。

电荷泵

电荷泵可工作于1.5x模式，也可工作于1x模式，其中 V_{OUT} 通过一个旁路开关与 V_{IN} 相连。正向电压最大（ $V_{LED(MAX)}$ ）的LED不能再维持电流调节之前，该电路工作在1 x模式。之后，开始切换到1.5x模式。如果最低的有效阴极电压大于1.8V，电荷泵恢复1x模式。

此外为应对滞环，提供1ms的转换延迟，从而让设备忽略决定模式转换时短暂的输入电压跌落。

IC 启用

当EN引脚为低电平时，禁用所有的电路功能。当EN引脚为高电平时，启用整个芯片。两个PWM的输入都有效。

PWM 调光

外部PWM输入（A组和B组）直接调制对应LED通道的输出电流，从而调整LED亮度。有两个PWM输入，分别单独控制两组LED，如主显示面板和次面板。也可连接两者组成一个单一输入，对六个LED输出进行同步调光。

V_{OUT} 的短路保护

FAN5701内置有集成保护电路，当输出电压跌落到2V以下时，防止设备遭受短路危害。如果发生短路，FAN5701将关闭电荷泵和LED驱动输出，但是一个小型旁路开关继续保持导通。该器件通过监测输出电压，判断是否仍处于短路状态，一旦短路消失，软启动后回到正常工作状态。

V_{OUT} 的过电压保护

如果输出电压高于6V，FAN5701将停机，直至该状态消失。电荷泵和LED驱动器输出关闭。一旦该状态消失，FAN5701软启动后进入正常工作状态。

物理尺寸

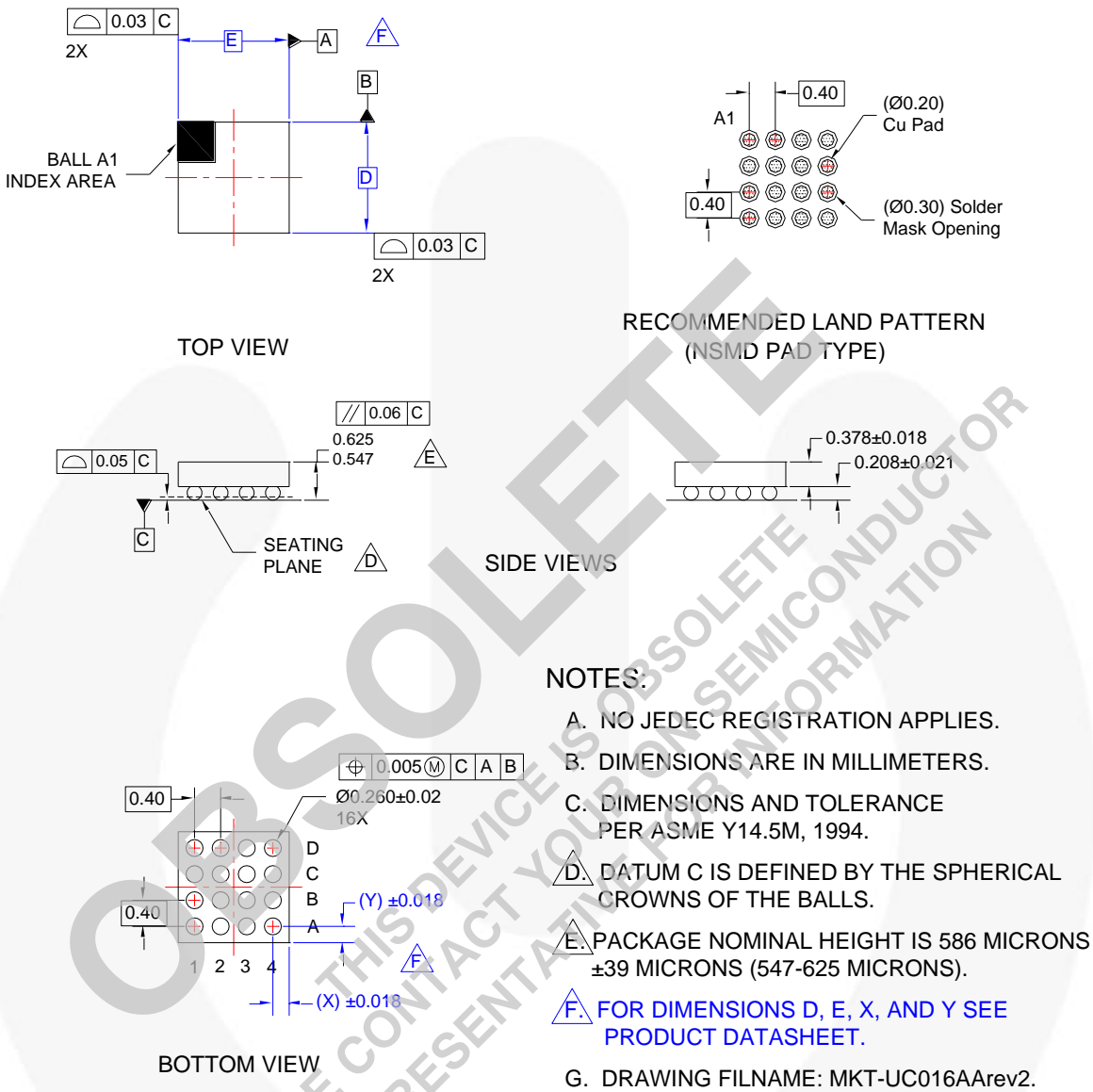


图16. 晶圆级芯片封装 (WLCSP)

产品规格尺寸

产品	D	E	X	Y
FAN5701UCxx	1.610mm	1.610mm	0.205mm	0.205mm

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物理尺寸 (续)

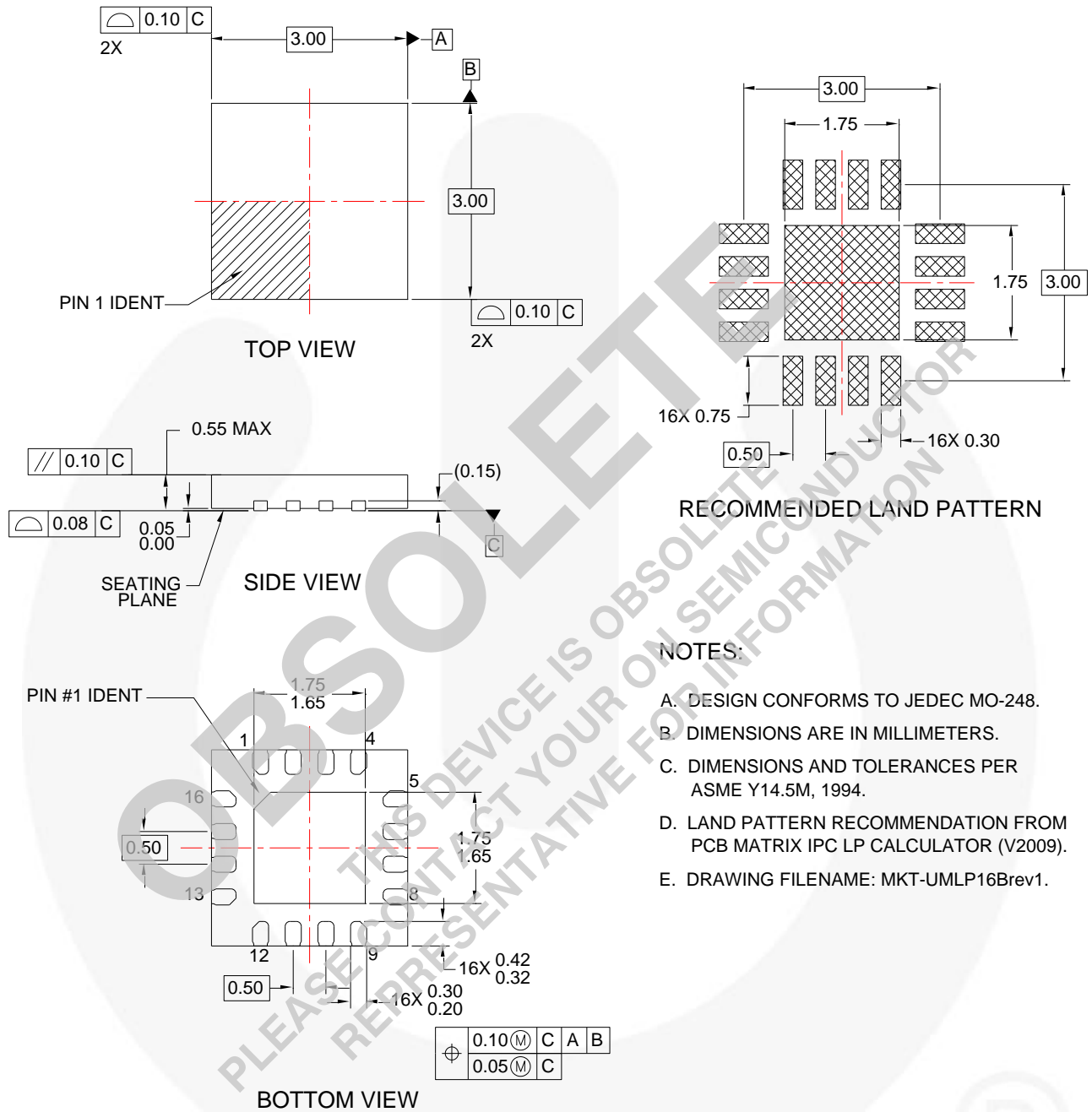


图17. UMLP-16尺寸

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