

## FAN5622 / FAN5624 / FAN5626 Linear LED Drivers with Single-Wire Digital Interface

### Features

- Family of Three Linear Current-Sink LED Drivers that Support 2, 4, or 6 LED Outputs
- Current Sink Driver for Each LED Output:
  - 30mA Maximum Output Current
  - 50mV Drop-out at 15mA I<sub>OUT</sub>
  - Better than 3% Matching between Channels
  - External R<sub>SET</sub>
- Single-Wire Digital Control Interface for Easy Programming
  - 32 Linear Steps of Dimming Control
- Less than 1µA Shut-Down Current
- Short-Circuit, Under-Voltage, and Thermal Protection
- Wide Input Voltage Range: 2.7 to 5.5V
- Small Form-Factor Packages:
  - FAN5622: 6-Pin Super SOT23
  - FAN5624: 10-Lead 1.4x1.8x0.55mm UMLP
  - FAN5626: 10-Lead 1.6x2.1x0.55mm MicroPak™ MLP

### Applications

- Mobile Handsets
- Mobile Internet Devices
- PMP and MP3 Players
- LCD Modules

### Description

The FAN5622, FAN5624, and FAN5626 are two-, four-, and six-channel current-sink linear LED drivers used to backlight the main LCD displays or keypads in mobile electronics, such as cellular phone handsets.

A very low dropout of 50mV allows driving LEDs without any inductors or switch capacitors. The brightness levels of the LED outputs are programmed through single-wire digital control interface. The user can program 32 linear dimming steps and turn on and off the LEDs through this interface by applying digital pulses.

The FAN562x family of linear LED drivers provides high efficiency due to the low drop-out voltage of the LED driver. Good matching between different channels of LED output is provided across the entire 32 dimming steps. These LED drivers also integrate short circuit, under-voltage, and thermal protection to ensure for a more robust solution.

The FAN5622, FAN5624, and FAN5626 are available in very small form-factor packages: 6-pin Super SOT23, 10-lead UMLP, and 10-lead MicroPak™ MLP, respectively.

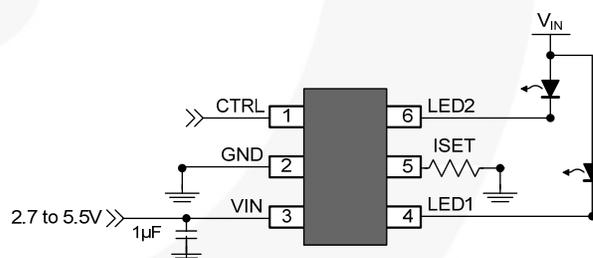


Figure 1. Typical Application of FAN5622

### Ordering Information

Part Number	# of Channels	Temperature Range	Package	Packing
FAN5622SX	2	-40 to 85°C	6-Lead, SUPERSOT6, JEDEC MO-193, 1.6mm Wide	Tape and Reel
FAN5624UMPX	4	-40 to 85°C	10-Lead, Ultrathin Molded Leadless Package (UMLP)	Tape and Reel
FAN5626LX	6	-40 to 85°C	10-Lead, Micropak, JEDEC MO255, 1.6 X 2.1mm	Tape and Reel

Applications Diagrams

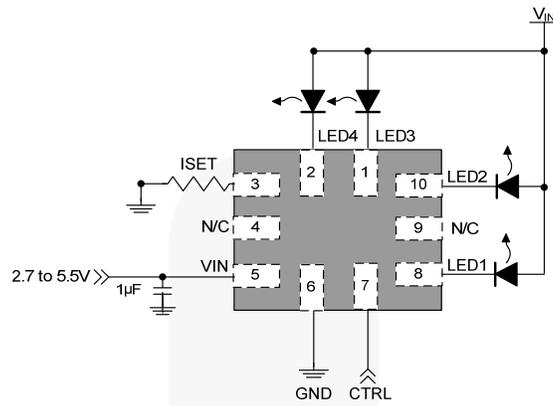


Figure 2. FAN5624 Typical Application for 4 LEDs

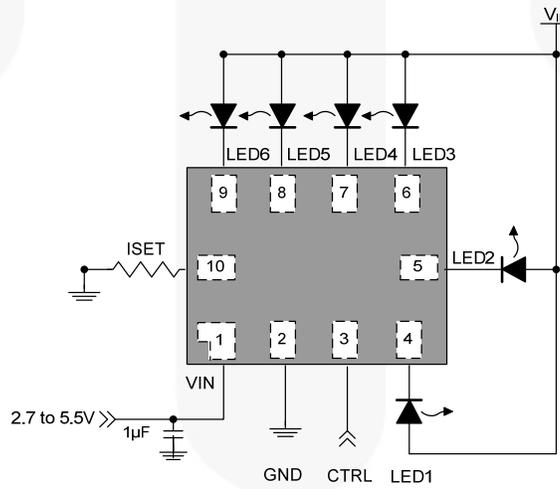


Figure 3. FAN5626 Typical Application for 6 LEDs

Block Diagram

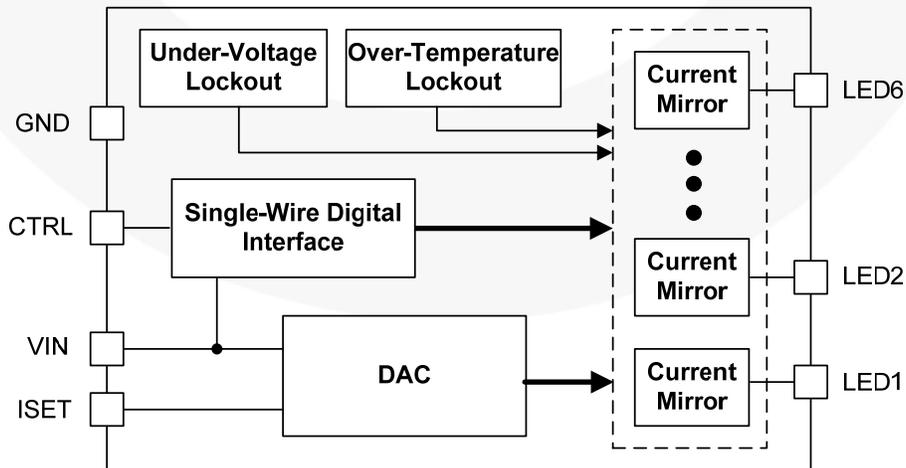


Figure 4. Block Diagram

## Pin Configuration

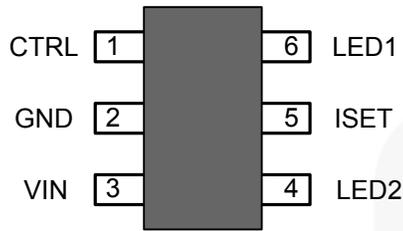


Figure 5. FAN5622: 6-Pin SSOT23, Top View

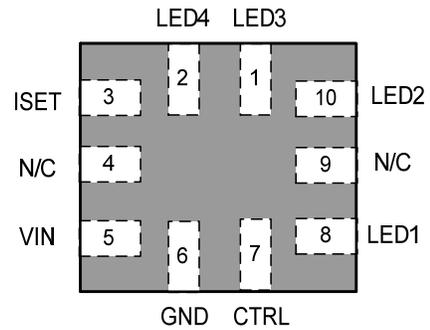


Figure 6. FAN5624: 10-Lead UMLP, Top View

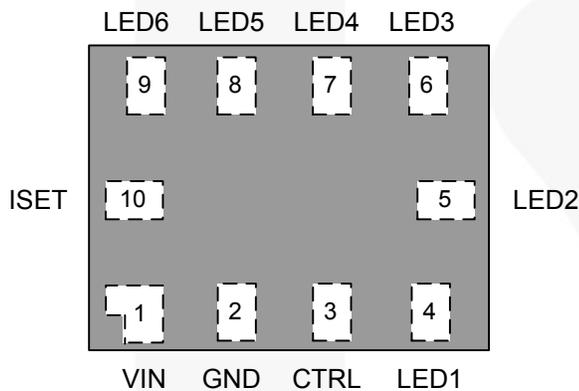


Figure 7. FAN5626: 10-Lead MicroPak™ MLP, Top View

## Pin Definitions

Pin #			Name	Description
FAN5622 SSOT23-6	FAN5624 UMLP10	FAN5626 MicroPak MLP10		
3	5	1	VIN	<b>Input Voltage.</b> Connect to 2.7-5.5V <sub>DC</sub> input power source.
2	6	2	GND	<b>Ground</b>
5	3	10	ISET	<b>LED Current Setting.</b> Full-scale LED current is set by tying this pin through a resistor (R <sub>SET</sub> ) to GND.
1	7	3	CTRL	<b>Control pin.</b> Program dimming levels by driving pin with digital pulses. This pin cannot be left floating.
6	8	4	LED1	<b>LED Cathode #1.</b> LED current sink output.
4	10	5	LED2	<b>LED Cathode #2.</b> LED current sink output.
	1	6	LED3	<b>LED Cathode #3.</b> LED current sink output.
	2	7	LED4	<b>LED Cathode #4.</b> LED current sink output.
		8	LED5	<b>LED Cathode #5.</b> LED current sink output.
		9	LED6	<b>LED Cathode #6.</b> LED current sink output.
	4, 9		N/C	<b>No Connect</b>

## Absolute Maximum Ratings

Stresses exceeding the absolute maximum ratings may damage the device. The device may not function or be operable above the recommended operating conditions and stressing the parts to these levels is not recommended. In addition, extended exposure to stresses above the recommended operating conditions may affect device reliability. The absolute maximum ratings are stress ratings only.

Symbol	Parameter	Min.	Max.	Unit
$V_{CC}$	VIN Pin	-0.3	6.0	V
	Other Pins <sup>(1)</sup>	-0.3	$V_{IN} + 0.3$	V
ESD	Electrostatic Discharge Protection Level	Human Body Model per JESD22-A114	3.0	kV
		Charged Device Model per JESD22-C101	1.5	kV
$T_J$	Junction Temperature	-40	+150	°C
$T_{STG}$	Storage Temperature	-65	+150	°C
$T_L$	Lead Soldering Temperature, 10 Seconds		+260	°C

### Note:

1. Lesser of 6.0V or  $V_{IN}+0.3V$ .

## Recommended Operating Conditions

The Recommended Operating Conditions table defines the conditions for actual device operation. Recommended operating conditions are specified to ensure optimal performance to the datasheet specifications. Fairchild does not recommend exceeding them or designing to absolute maximum ratings.

Symbol	Parameter	Min.	Max.	Unit
$V_{IN}$	Power Supply Voltage Range	2.7	5.5	V
$T_A$	Operating Ambient Temperature Range	-40	+85	°C
$T_J$	Operating Junction Temperature Range	-40	+125	°C
$I_{LED(FS)}$	Full-Scale LED Current	5	30	mA

## Thermal Properties

Junction-to-ambient thermal resistance is a function of application and board layout. This data is measured with boards in accordance to JEDEC standard JESD51. Special attention must be paid not to exceed junction temperature  $T_{J(max)}$  at a given ambient temperature  $T_A$ .

Symbol	Parameter	Typical	Unit
$\theta_{JA}$	Junction-to-Ambient Thermal Resistance, SSOT23-6 Package	235	°C/W
	Junction-to-Ambient Thermal Resistance, UMLP10 Package <sup>(2)</sup>	287	°C/W
	Junction-to-Ambient Thermal Resistance, MicroPak™ MLP10 package <sup>(3)</sup>	220	°C/W

### Notes:

2. Recommended not to exceed 132mW of maximum power dissipation.
3. Recommended not to exceed 198mW of maximum power dissipation.

## Electrical Specifications

$V_{IN} = 2.7V$  to  $5.5V$ ,  $R_{SET} = 19.10k\Omega$ ,  $T_A = -40^\circ C$  to  $+85^\circ C$ ,  $V_f = 2.5V$  to  $[3.5V$  or  $V_{IN} - 0.1V]$ , whichever is smaller. Typical values are at  $T_A = 25^\circ C$ ,  $V_{IN} = 3.6V$ , and  $V_f = 3.2V$ .

Symbol	Parameter	Condition	Min.	Typ.	Max.	Unit
<b>Power Supplies</b>						
$I_{SD}$	Shutdown Supply Current	$V_{IN} = 3.6V$ , CTRL = 0		0.3	1.0	$\mu A$
$I_{IN}$	Operating Supply Current	FAN5622: $V_{IN} = 3.6V$ , $I_{LED} = 0mA$		0.4	0.8	mA
		FAN5624: $V_{IN} = 3.6V$ , $I_{LED} = 0mA$		0.6	1.0	mA
		FAN5626: $V_{IN} = 3.6V$ , $I_{LED} = 0mA$		0.8	1.2	mA
$I_{IH}$	Control Pin Input Current	CTRL = 1.8V		1	250	nA
$V_{UVLO}$	Under-Voltage Lockout Threshold	$V_{IN}$ Rising		2.50	2.70	V
		$V_{IN}$ Falling	2.10	2.30	2.50	V
<b>Regulation</b>						
$I_{FS\_LEDx(MAX)}$	Full-Scale LED Output Current	$I_{LEDx} = 30mA$ ; x = 1 to 6	5		30	mA
$I_{LED}$	Absolute Current Accuracy	$V_{IN}=2.85V - 4.5V$ ; $V_{CATH}=0.15$ to $(1.2V$ or $V_{IN}=2.55V$ , Whichever is Smaller); Full-Scale Current 5-30mA, $T_A = 25^\circ C$	-10		+10	%
$I_{LED\ MATCH}$	LED Current Matching <sup>(4)</sup>	$I_{LEDx} = 15mA$ ; $V_{\_LEDx}=0.4V$ , $T_A = 25^\circ C$	-3		+3	%
$V_{ISET}$	ISET Drive Voltage	$9.53k\Omega \leq R_{SET} \leq 56.2k\Omega$		1.20		V
$I_{RATIO}$	Current Mirror Ratio from ISET Pin	$9.53k\Omega \leq R_{SET} \leq 56.2k\Omega$		240		
$\Delta I_{OUT\_LOAD}$	$I_{OUT}$ Load Regulation	$V_{IN} = 3.6V$ , $I_{LEDx} = 15mA$ , LED $V_f = 2.7$ to $3.5V$ ,	-3		+3	%
$\Delta I_{OUT\_LINE}$	$I_{OUT}$ Line Regulation	$V_{IN} = 2.7$ to $4.8V$ , $I_{LEDx} = 15mA$ , $V_{CATH} = 0.5V$	-4		+4	%
$V_{DROPOUT}$	Dropout Voltage	$V_{IN}=3.6V$ ; $I_{LED} = 15mA$ , -10% $I_{LED}$ Drop		50		mV
		$V_{IN}=3.6V$ ; $I_{LED} = 30mA$ , -10% $I_{LED}$ Drop		60		
TSD	Thermal Shutdown	Rising Temperature at Junction		150		$^\circ C$
		Hysteresis		20		
<b>Logic Input (CTRL)</b>						
$V_{IH}$	HIGH-Level Input Voltage		1.2			V
$V_{IL}$	LOW-Level Input Voltage				0.4	V
$T_{LO}$	CTRL LOW Time for Dimming	$V_{IN} = 3.6V$ ; See Figure 17	0.5		300	$\mu s$
$T_{HI}$	Time Delay between Steps	$V_{IN} = 3.6V$ ; See Figure 17	0.5			$\mu s$
$T_{ON}$	CTRL HIGH to Turn-On Delay	$V_{IN} = 3.6V$ ; See Figure 17		250		$\mu s$
$T_{SD}$	CTRL LOW, Shutdown Pulse Width	$V_{IN} = 3.6V$ ; from Falling Edge of CTRL	1			ms

### Note:

4. For the two, four, and six LED current sinks of FAN5622, FAN5624, and FAN5626 respectively; the following are determined: the maximum sink current of the two, four, and six LED outputs (MAX); the minimum sink current of the two, four, and six outputs (MIN); and the average sink current (AVG). For all of the LED outputs, two matching numbers are calculated:  $(MAX-AVG)/AVG$  and  $(AVG-MIN)/AVG$ . The largest number of the two (worst case) is considered the matching figure for the part. The matching figure for a given part is considered to be the highest matching figure of all LED outputs. The typical specification provided is the most likely norm of the matching figure for all parts.

### Typical Performance Characteristics

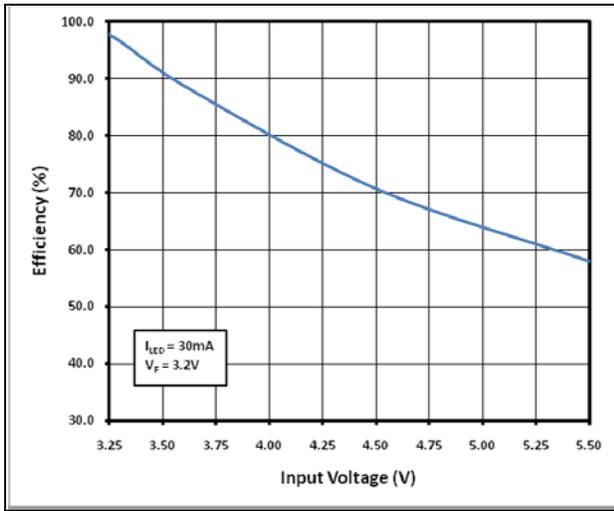


Figure 8. Efficiency vs. Input Voltage where LED  $V_F=3.2V$

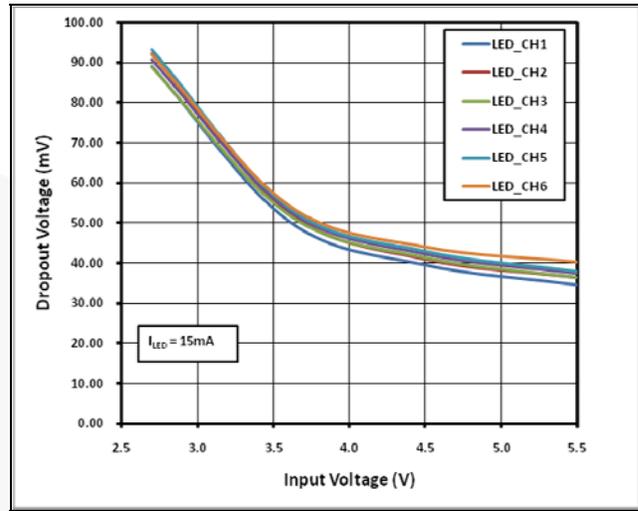


Figure 9. Dropout Voltage vs. Input Voltage

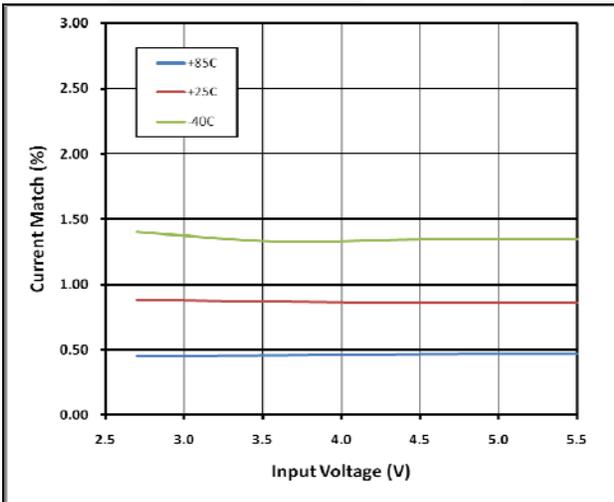


Figure 10. Current Match of Channels vs. Input Voltage

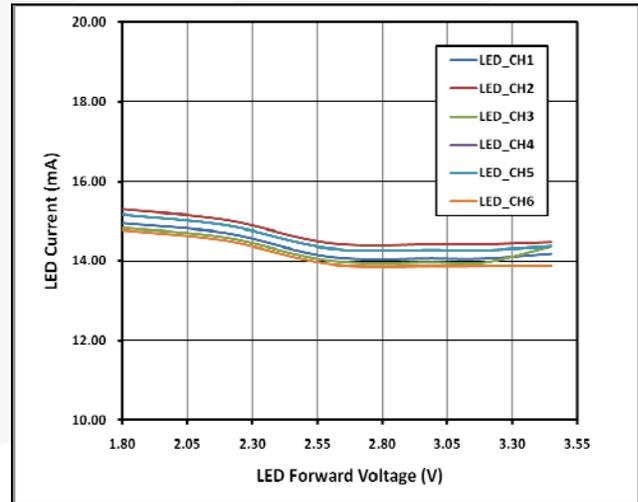


Figure 11. Load Regulation at 15mA/Output

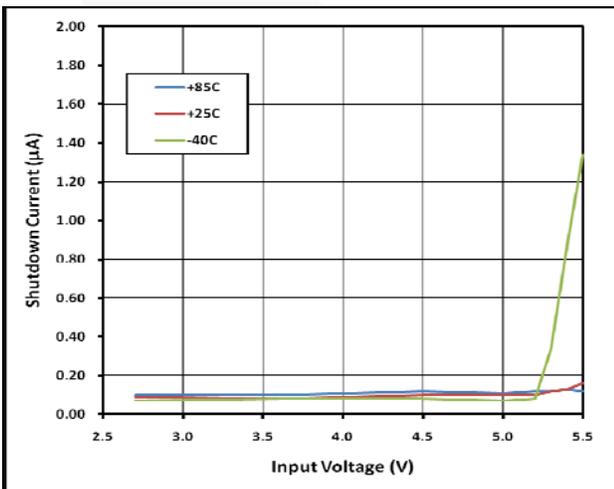


Figure 12. Shutdown Current vs. Input Voltage

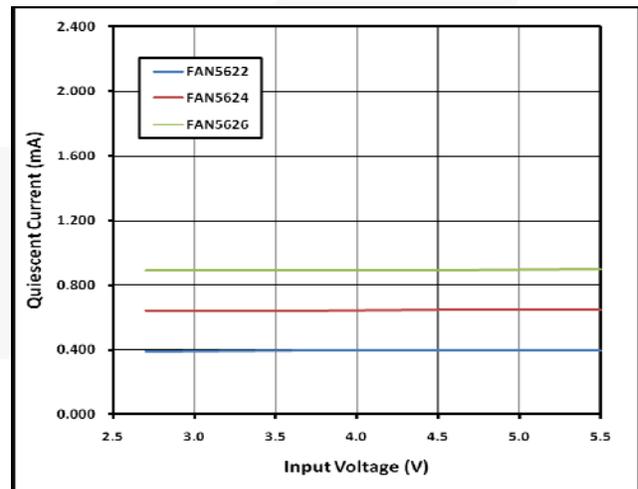


Figure 13. Quiescent Current vs. Input Voltage

### Typical Performance Characteristics

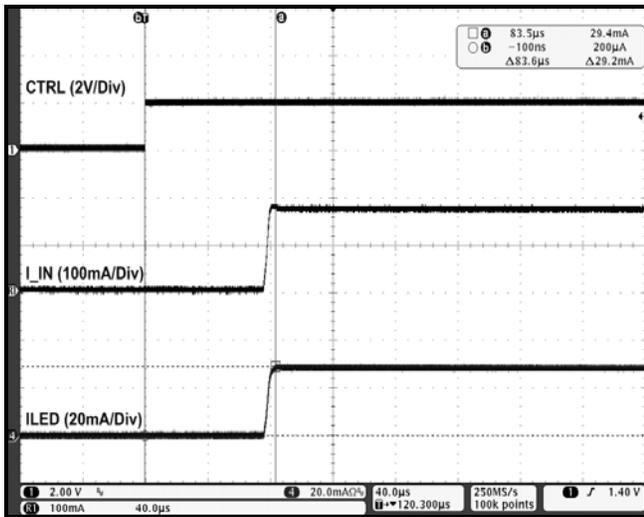


Figure 14. Startup Waveform for FAN5626

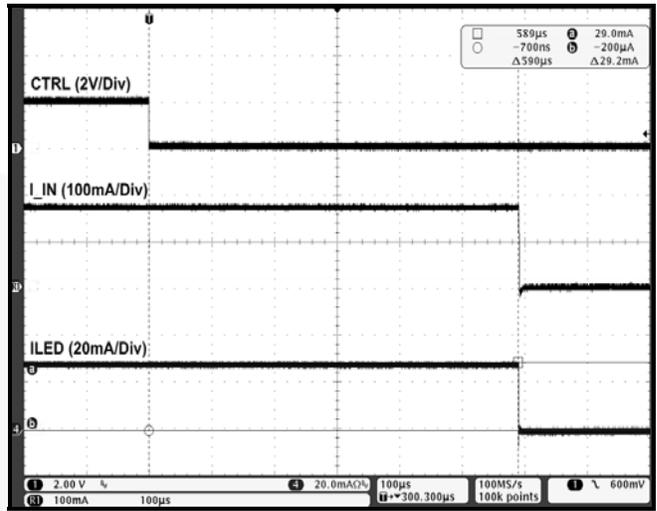


Figure 15. Shutdown Waveform for FAN5626

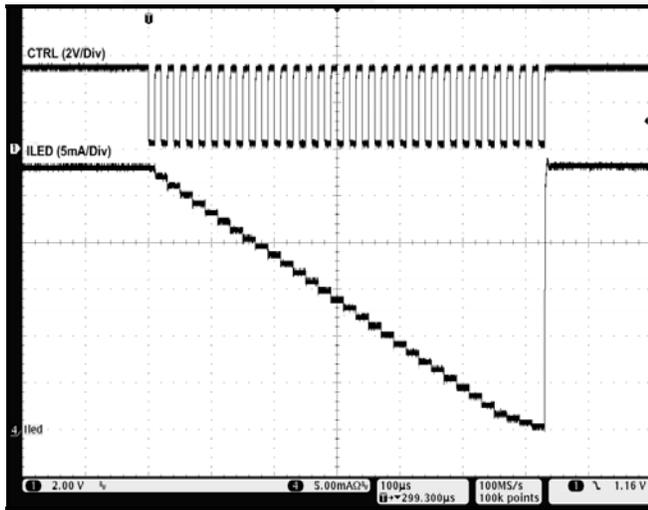


Figure 16. Dimming Operation

## Circuit Description

The FAN5622, FAN5624, and FAN5626 are a family of current-sink linear LED driver ICs able to drive two, four, and six LEDs respectively. These three devices are powered directly from 2.7V to 5.5V supply and all the channels are controlled via the integrated current sinks from the external power source. Designed with a very low drop-out voltage, the FAN562x products can operate close to the input supply voltage without the need for additional inductive boost or capacitive switching circuitry.

All three devices require only two additional discrete passive components: a single 1 $\mu$ F input ceramic capacitor and a resistor ( $R_{SET}$ ) to set the maximum current for the LEDs. Each current-sink output provides constant current and can drive the LEDs up to 30mA. Fairchild Semiconductor's TinyWire™ single-wire digital interface enables these LED drivers to program the brightness level of the LEDs in 32 linear steps.

## Setting Maximum Current

The maximum LED current of the FAN5622, FAN5624, and FAN5626 is programmed by an external resistor called  $R_{SET}$ . The maximum full-scale LED current for all three LED drivers is 30mA and it can go as low as 5mA. The FAN562x products also operate below 5mA full-scale LED current by using a larger  $R_{SET}$  value. However, the LED channel accuracy and matching specifications are guaranteed. Table 1 shows the  $R_{SET}$  resistor values for several full-scale current levels.

**Table 1. Maximum LED Current Settings by Resistor**

$I_{LED}$ (mA)	$R_{SET}$ (k $\Omega$ )
5	56.20
10	28.70
15	19.10
20	14.30
25	11.50
30	9.53

## Digital Interface & Dimming Control

The FAN5622, FAN5624, and FAN5626 implement a simple single-wire digital interface to program the LED brightness to one of thirty two (32) levels spaced in linear steps. To maintain the brightness of the LEDs at a specific dimming level, the digital pulse signal to the CTRL pin should be held HIGH for that last pulse. It is held HIGH for as long as desired to keep the LEDs illuminated at that specific brightness level.

Table 2 outlines the dimming levels while Figure 17 shows how to change the dimming levels.

**Table 2. Brightness Control Levels ( $R_{SET} = 19.10k\Omega$ )**

Dimming Level	Current Level	$I_{LED}$ (mA)
1	1.67%	0.25
2	3.33%	0.50
3	5.00%	0.75
4	6.67%	1.00
5	10.00%	1.50
6	13.33%	2.00
7	16.67%	2.50
8	20.00%	3.00
9	23.33%	3.50
10	26.67%	4.00
11	30.00%	4.50
12	33.33%	5.00
13	36.67%	5.50
14	40.00%	6.00
15	43.33%	6.50
16	46.67%	7.00
17	50.00%	7.50
18	53.33%	8.00
19	56.67%	8.50
20	60.00%	9.00
21	63.33%	9.50
22	66.67%	10.00
23	70.00%	10.50
24	73.33%	11.00
25	76.67%	11.50
26	80.00%	12.00
27	83.33%	12.50
28	86.67%	13.00
29	90.00%	13.50
30	93.33%	14.00
31	96.67%	14.50
32	100.00%	15.00

### Digital Dimming Control

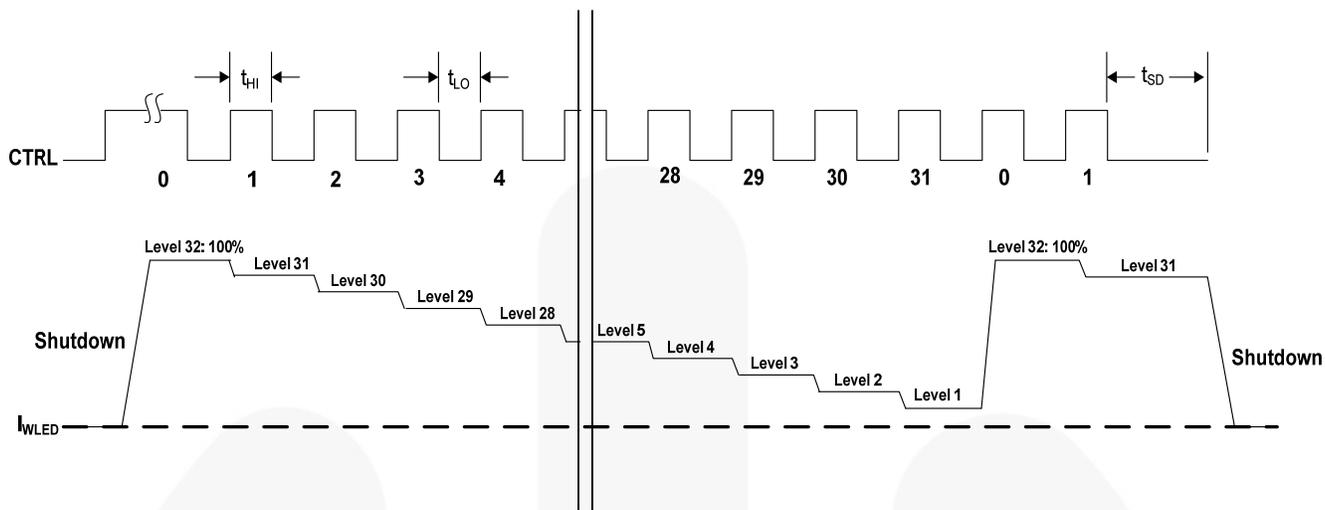


Figure 17. Digital Pulse Dimming Control Diagram



Physical Dimensions

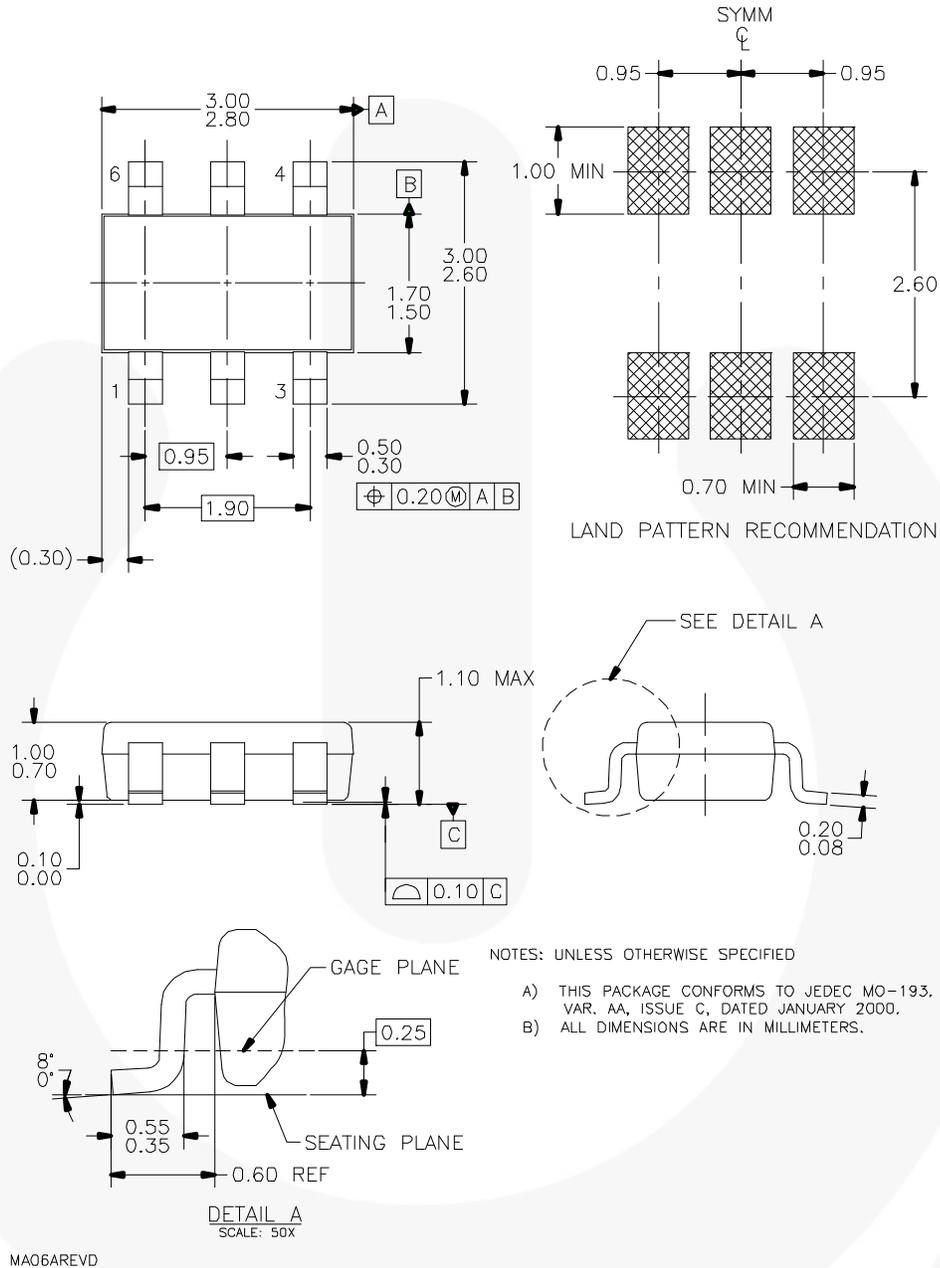
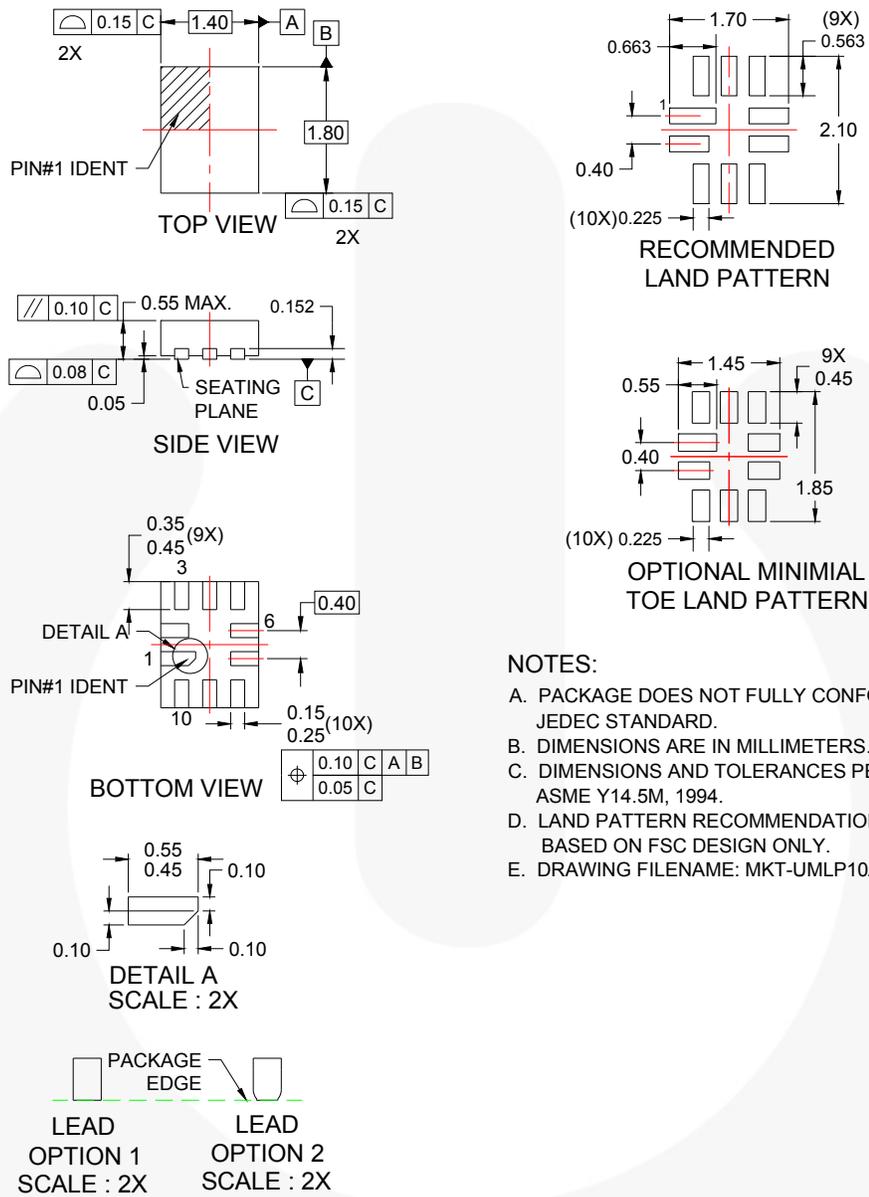


Figure 18. 6-Lead SSOT23

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Physical Dimensions (Continued)



- NOTES:**
- A. PACKAGE DOES NOT FULLY CONFORM TO JEDEC STANDARD.
  - B. DIMENSIONS ARE IN MILLIMETERS.
  - C. DIMENSIONS AND TOLERANCES PER ASME Y14.5M, 1994.
  - D. LAND PATTERN RECOMMENDATION IS BASED ON FSC DESIGN ONLY.
  - E. DRAWING FILENAME: MKT-UMLP10Arev3.

Figure 19. 10-Lead, Ultrathin Molded Leadless Package (UMLP)

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Physical Dimensions (Continued)

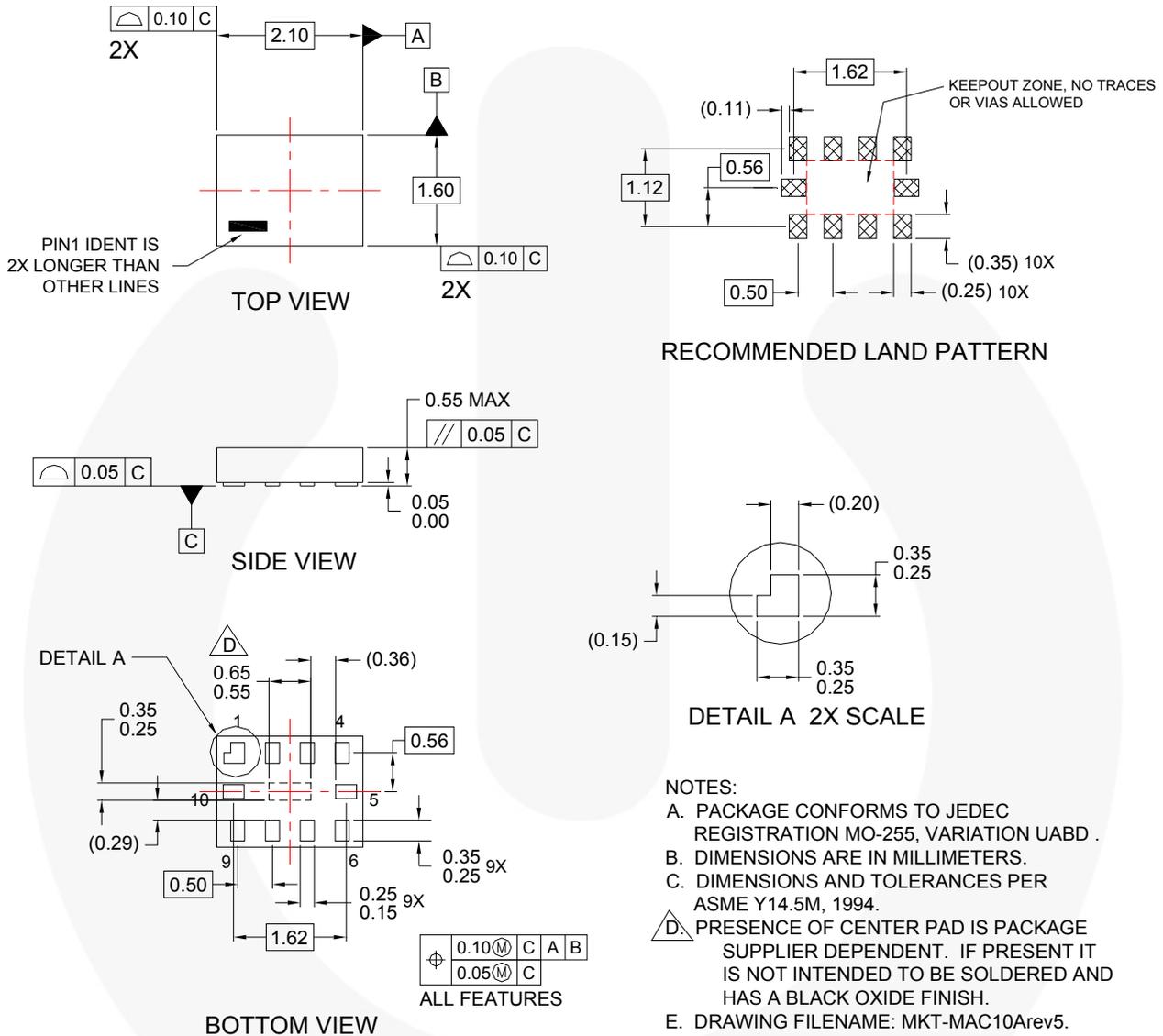


Figure 20. 10-Lead MicroPak™ MLP

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| BitSiC™                  | GreenBridge™                                   | QFET®                                | TinyBuck™            |
| Build it Now™            | Green FPS™                                     | QS™                                  | TinyCalc™            |
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| CROSSVOLT™               | GTO™   | ™                                    | TinyPower™           |
| CTL™                     | IntelliMAX™                                    | Saving our world, 1mW/WkW at a time™ | TinyPower™           |
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| EfficientMax™            | MicroFET™                                      | SPM®                                 | TRUECURRENT®*        |
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| ™                        | MicroPak2™                                     | SuperFET®                            | ™                    |
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| Fairchild Semiconductor® | MotionMax™                                     | SuperSOT™-6                          | Ultra FRFET™         |
| FACT Quiet Series™       | Motion-SPM™                                    | SuperSOT™-8                          | UniFET™              |
| FACT®                    | mWSaver™                                       | SupreMOS®                            | VCX™                 |
| FAST®                    | OptoHi™  | SyncFET™                             | VisualMax™           |
| FastvCore™               | OPTOLOGIC®                                     | Sync-Lock™                           | VoltagePlus™         |
| FETBench™                | OPTOPLANAR®                                    | ™                                    | XS™                  |
| FlashWriter®*            |  |                                      |                      |
| FPS™                     |  |                                      |                      |

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**PRODUCT STATUS DEFINITIONS**

**Definition of Terms**

Datasheet Identification	Product Status	Definition
Advance Information	Formative / In Design	Datasheet contains the design specifications for product development. Specifications may change in any manner without notice.
Preliminary	First Production	Datasheet contains preliminary data; supplementary data will be published at a later date. Fairchild Semiconductor reserves the right to make changes at any time without notice to improve design.
No Identification Needed	Full Production	Datasheet contains final specifications. Fairchild Semiconductor reserves the right to make changes at any time without notice to improve the design.
Obsolete	Not In Production	Datasheet contains specifications on a product that is discontinued by Fairchild Semiconductor. The datasheet is for reference information only.

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