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AN-9743

FAN5345 and FAN5346 in LED Applications

Programming LED Current

The FAN5345 and FAN5346 are inductive current-mode boost serial LED drivers that achieve LED current regulation by maintaining 0.25V across the R_{SET} resistor. The current through the LED string (I_{LED}) is given by:

$$I_{LED} = \frac{0.250}{R_{SET}} \quad (1)$$

The voltage V_{OUT} is determined by the sum of the forward voltages across each LED, plus the voltage across R_{SET}, which is always 250mV.

Figure 1 illustrates an application of four white LEDs driven in series with I_{LED} = 20mA. The V_F of the white LEDs is 3.2V. The R_{SET} is set to 12.4Ω with L = 10.0µH and C_{OUT} = 1.0µF. For an I_{LED} of 25mA, change the R_{SET} to 10.0Ω.

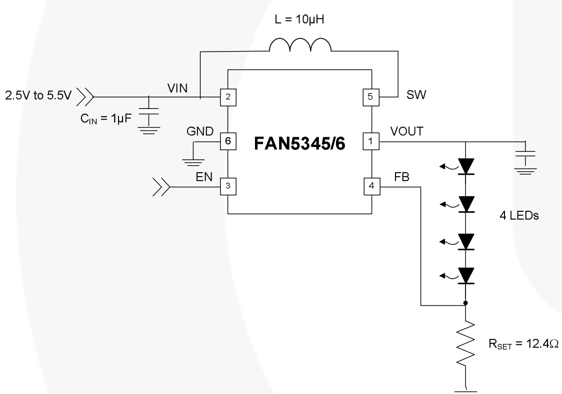

Figure 1. Driving 4 White LEDs at 20mA

Driving Eight LEDs in Series

FAN5345/6 can drive up to eight (8) white LEDs in series, but the input voltage MUST be ≥2.9V for stable operation.

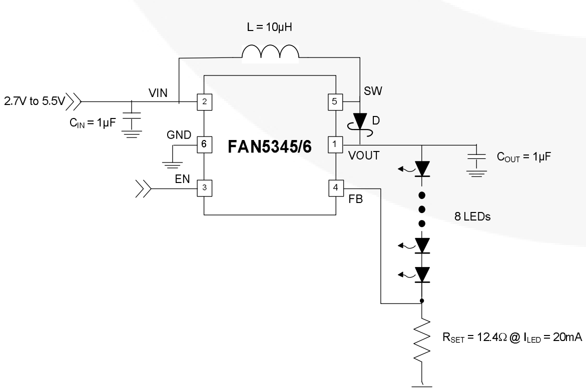

Figure 2. Configured for 8 White LEDs at 20mA

Figure 2 shows eight white LEDs driven in series with I_{LED} of 20mA and R_{SET} of 12.4Ω.

Setting the Output Voltage

The FAN5345/6 can be utilized as a voltage regulator by using up a voltage divider network with R1 on the top and R2 on the bottom (*see Figure 3*). The output voltage range for FAN5345/6(30V version) is 6.5V to 30V. For applications where the load current is greater than or equal to 5mA, select a value for R2 in the range of several KΩs, then calculate R1 using the following equation:

$$R_1 = \left(\frac{V_O}{0.25} - 1 \right) \times R_2 \quad (2)$$

where $I_{OUT} \geq 5$mA.

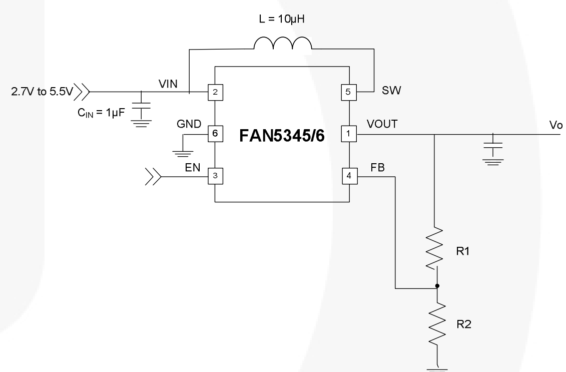

Figure 3. Configured as a Voltage Regulator

One application that can use the FAN5345/6 in the configuration above is passive matrix OLED (PMOLED) displays. These displays need a supply of 12V to 14V and 30mA to 40mA of load current. It is important to note that the FAN5345/6 can support a maximum output power of 500mW, so care must be taken in setting the output voltage and current.

In applications where the load current is less than 5mA, R2 should be determined using the equation below:

$$R_2 = \left(\frac{0.25}{0.005 - I_{OUT\_MIN}} \right) \quad (3)$$

where $I_{OUT} < 5$mA.

Once R2 has been set by the equation above; use Equation 2 to determine R1.

Procedure to Design FAN5345/6 in Application

To design FAN5345/6 for LED driver or boost applications, the design must meet the following conditions:

- The maximum output power that FAN5345/6 can support is 500mW, which is V_{OUT} x $I_{OUT} \leq$ 500mW.
- The FB voltage is fixed at 0.25V
- The maximum V_{OUT} is 20V or 30V, depending on the version of the product.

By applying the following equations, either the number of LEDs (N) or the boost voltage can be obtained.

- V_{OUT} = N x V_F + 0.25, LED driver application
- $V_{OUT} = I_{OUT}$ x (R_1 +R_2), Boost application
- $P_{OUT} = V_{OUT}$ x $I_{OUT} \leq$ 500mW
- $R_{EST} = 0.25/I_{OUT}$

Failure to meet the above requirements yields unstable operation or damage to FAN5345/6.

PCB Layout Consideration

FAN5345/6 switches at 1.2MHz to boost the output voltage. Component placement and PCB layout need to be carefully considered to ensure stable output and to prevent generation of noise. Figure 4 is a portion of the evaluation board layout. The critical layout elements are the L1, C_{IN}, C_{IN} return trace, C_{OUT}, and the C_{OUT} return trace.

Input Capacitor and Return Trace

The input capacitor is the first priority in a switching buck or boost regulator PCB layout. A stable input source (V_{IN}) enables a switching regulator to deliver its best performance. During the regulator's operation, it is switching at a high frequency, which makes the load of C_{IN} change dynamically since it is trying to make the input source vary at the same switching frequency as the regulator. To ensure a stable input source, C_{IN} needs to hold enough energy to minimize the variation right at the input pin of the regulator. In order for C_{IN} to have a fast response of charge/discharge, the trace from C_{IN} to the input pin of the regulator and the return trace from GND of the regulator to C_{IN} should be as short and as wide as possible to minimize trace resistance, inductance, and capacitance.

During operation, current flow from C_{IN} through the regulator to the load and back to C_{IN} contains high-frequency variation due to switching. Trace resistance reduces the overall efficiency due to I^2R loss. Even a small trace inductance could yield ground variation and add noise on V_{OUT}. The input capacitor should be placed close to the VIN and GND pins of the regulator and traces should be as short as possible. Avoid routing the return trace through different layers because vias have strong inductance effect at high frequencies. If routing to other PCB layers is unavoidable, place vias next to the VIN and GND pins of the regulator to minimize the trace distance.

Output Capacitor and Return Trace

The output capacitor serves the same purpose as the input capacitor but it also maintains a stable output voltage. As explained above, the current travels to the load and back to C_{OUT} GND terminal. C_{OUT} should be placed as close to the VOUT pin and the traces of C_{OUT} to L1, V_{OUT}, and return trace from load to C_{OUT} should be as short and wide as possible to minimize trace resistance and inductance. To minimize noise coupling to load, a small value capacitor can be placed between V_{OUT} and C_{OUT} to route high-frequency noise back to GND before it gets to the load.

Inductor

Inductor (L1) should be placed as close to the regulator as possible to minimize trace resistance and inductance for the reason explained above.

Sense Resistor

The sense resistor provides a feedback signal for the regulator to regulate an output voltage. A long trace from the sense resistor to the FB pin couples noise into the FB pin, which can cause unstable operation of the switching regulator, which affects application performance. The return trace from the sense resistor to the FB pin should be short and away from any fast-switching signal traces. The ground plane under the return trace is not necessary. If the ground plane under the return trace is noisy, but not the same ground plane as the regulator; the noise could be coupled into the FB pin through PCB parasitic capacitance, yielding a noisy output.

As shown in Figure 4; C_{IN}, C_{OUT}, and L1 are all placed next to the regulator. All traces are on the same layer to minimize trace resistance and inductance. Total PCB area, not including the sense resistor, is 67.2mm2 (7.47mm x 8.99mm).

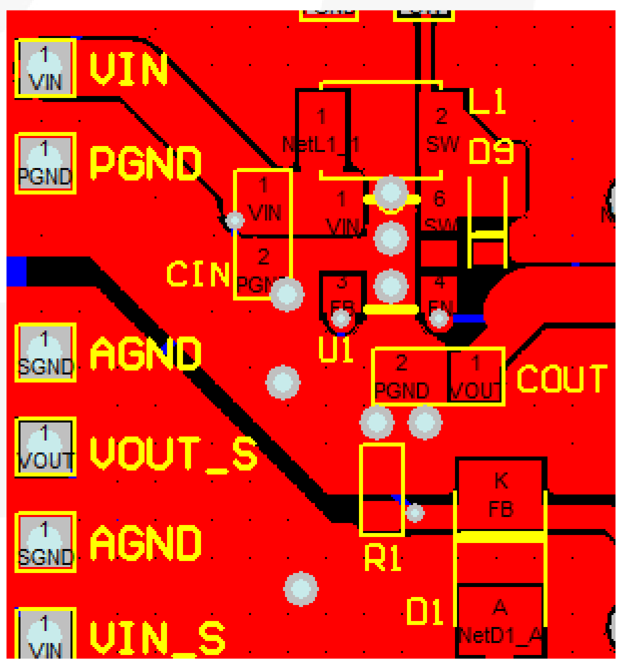

Figure 4. Recommended Component Placement

Inductor & Output Capacitor Selection

Table 1. Recommended External Components

Inductor (L)	Part Number	Manufacturer
10.0µH	LQH43MN100K03	Murata
	NLCV32T-100K-PFR	TDK
	VLF3010AT-100MR49-1	TDK
	DEM2810C 1224-AS-H-100M	TOKO
Minimum C_{OUT}		
1.0µF	CV105X5R105K25AT	AVX/Kyocera
Minimum C_{IN}		
10.0µF	GRM21BR71A106KE51L	Murata
Schottky Diode		
N/A	RBS520S30	Fairchild Semiconductor
N/A	RB520S-30	RΩ

Input Capacitance

In a typical application, the input and output capacitors should be placed as close to the IC as possible; no additional capacitance is needed to ensure proper functionality. However, in a testing environment, where the FAN5345/6 is typically powered by a power supply with relatively long cables, an additional input capacitor (10µF) may be needed to ensure stable functioning. This capacitor should be placed close to the power supply cables attachment to the FAN5345/6 evaluation board.

Related Datasheets

FAN5345 — Series Boost LED Driver with Single-Wire Digital Interface

FAN5346 — Series Boost LED Driver with PWM Dimming Interface

PUBLICATION ORDERING INFORMATION

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