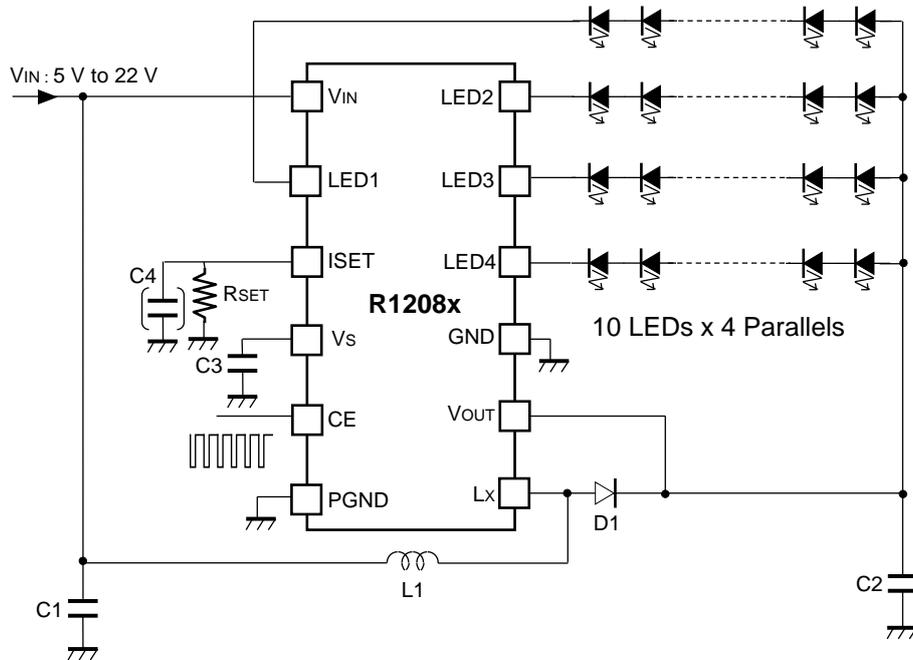


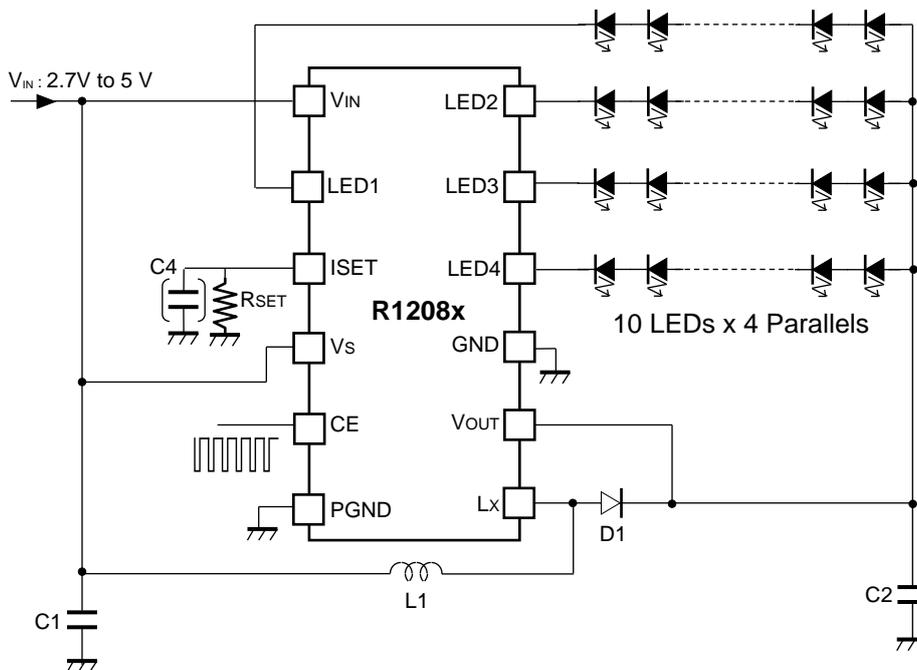
DESIGN GUIDE

NO.ED-314-170330

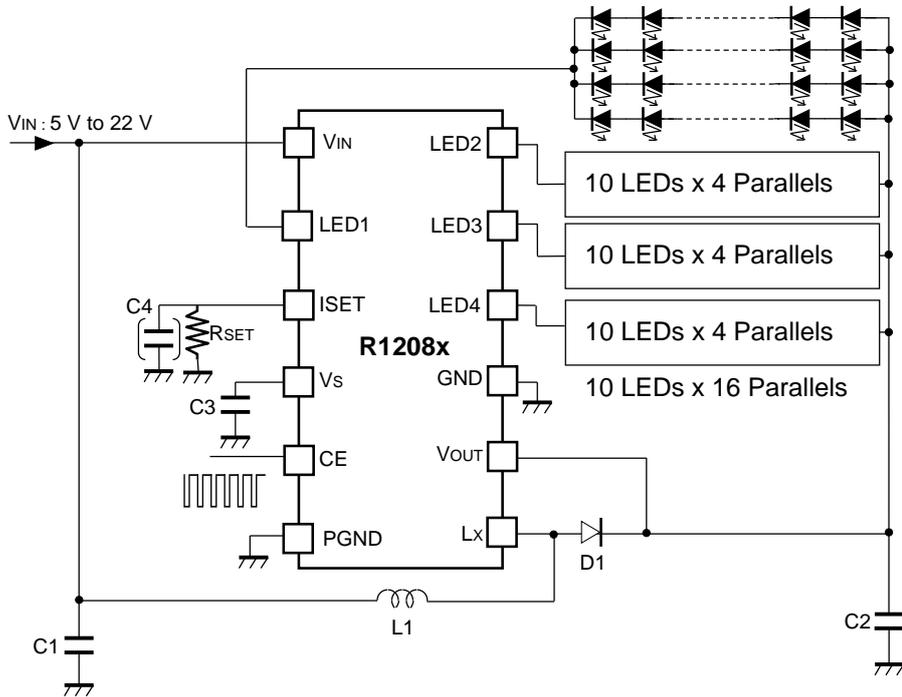
TYPICAL APPLICATION



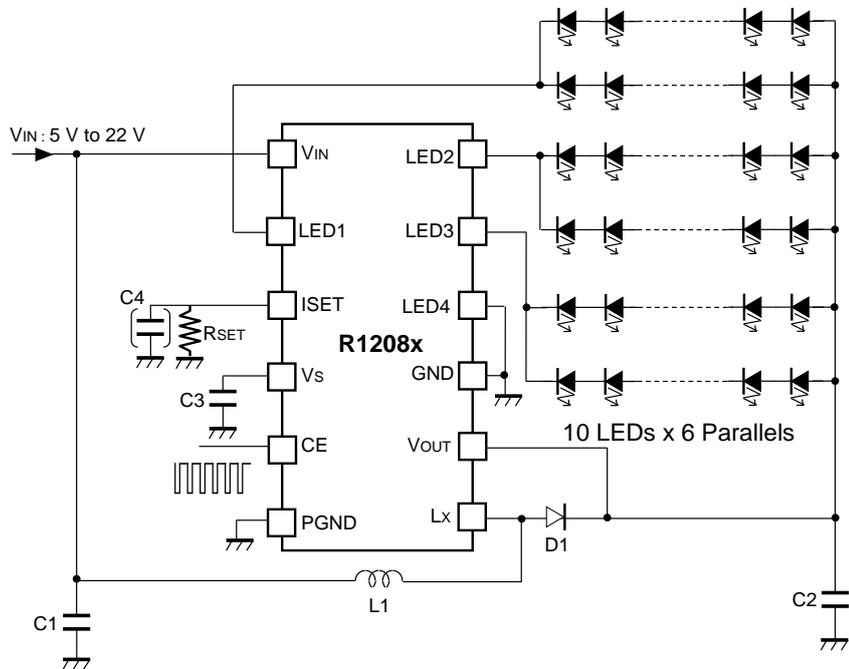
Typical Application 1. 10 LEDs in series x 4 parallels, up to 80 mA per LED, 5 V or higher power supply voltage, using 4 LED channels



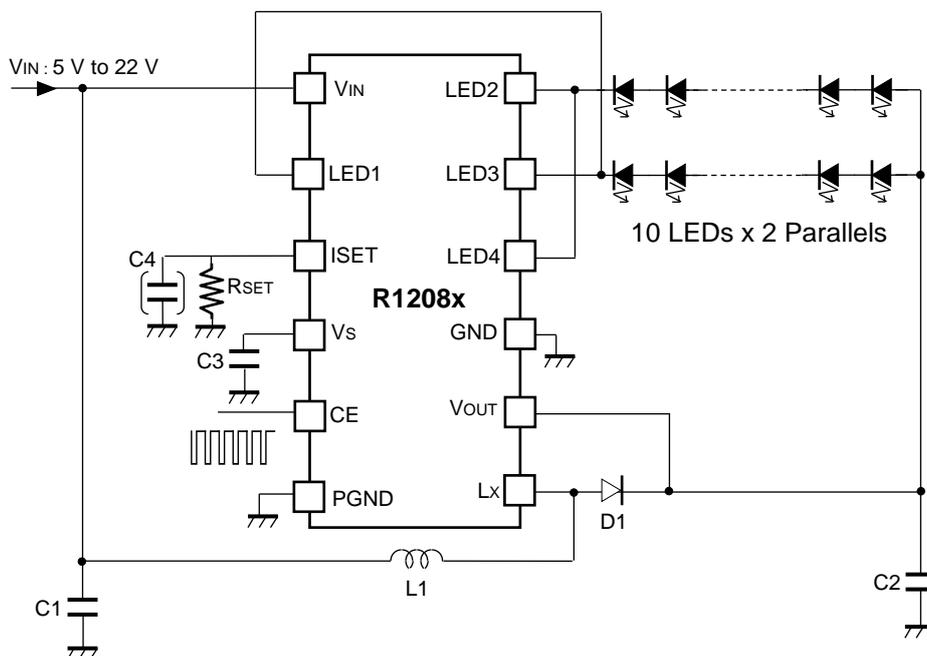
Typical Application 2. 10 LEDs in series x 4 parallels, up to 80 mA per LED, less than 5 V power supply voltage, using 4 LED channels



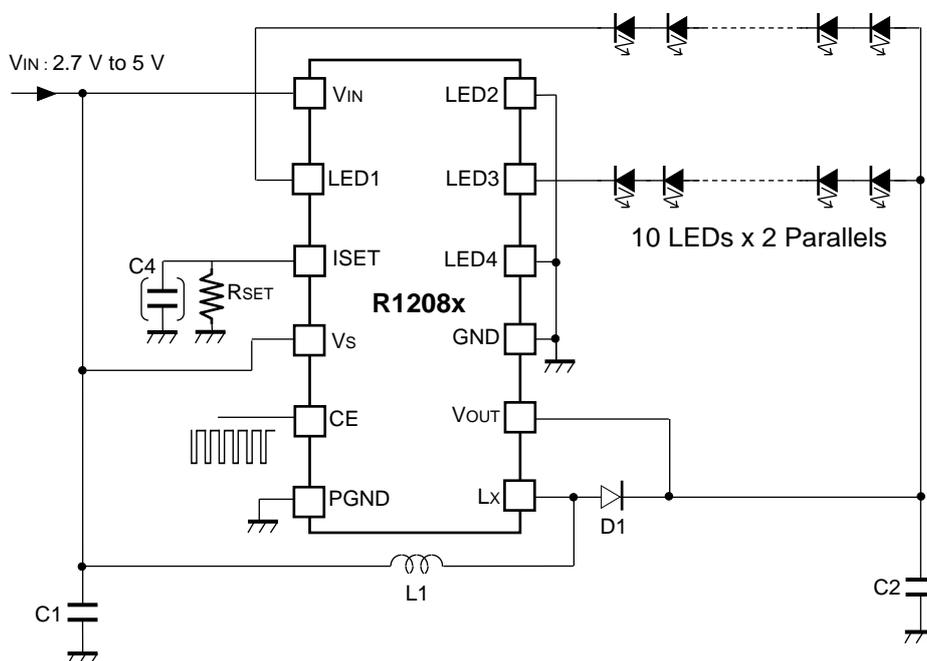
Typical Application 3. 10 LEDs in series x 16 parallels, up to 20 mA per LED, 5 V or higher power supply voltage, using 4 LED channels



Typical Application 4. 10 LEDs in series x 6 parallels, up to 40 mA per LED, 5 V or higher power supply voltage, using 3 LED channels



Typical Application 5. 10 LEDs in series x 2 parallels, up to 160 mA per LED, 5 V or higher power supply voltage, using 4 LED channels



Typical Application 6. 10 LEDs in series x 2 parallels, up to 80 mA per LED, less than 5 V power supply voltage, using 2 LED channels

RECOMMENDED COMPONENTS**Recommended Inductors**

Frequency (kHz)	L1 (μH)	Parts No.	Rated Current (mA)	Size (mm)
750	10	VLS252010ET-100M	550	2.5 × 2.0 × 1.0
		VLF302512MT-100M	620	3.0 × 2.5 × 1.2
		VLF403212MT-100M	900	4.0 × 3.2 × 1.2
		VLF504012MT-100M	1320	5.0 × 4.0 × 1.2
450	22	VLF302512MT-220M	430	3.0 × 2.5 × 1.2
		VLF403212MT-220M	540	4.0 × 3.2 × 1.2
		VLF504012MT-220M	890	5.0 × 4.0 × 1.2
		VLS5045EX-220M	1800	5.0 × 5.0 × 4.5

Recommended Components

Symbol	Rated Voltage (V)	Parts No.
D1	60	CRS12
	60	RB060M-60
C1	25	C3225JB1E475M
C2	50	C2012X5R1H225K
		C2012X5R1H105K ^{*1}
C3	25	C1608X5R1E224M
C4	6.3	CM105B105K06

^{*1} When ILED = 80 mA or lower at 750 kHz

TECHNICAL NOTES

The performance of power source circuits using this IC largely depends on the peripheral circuits. When selecting the peripheral components, consider the conditions of use. Do not allow each component, PCB pattern and the IC to exceed their respected rated values (voltage, current and power) when designing the peripheral circuits.

Selection of Inductor

Peak current of inductor (I_{Lmax}) in normal mode when the efficiency is 80% can be calculated by the following formula.

$$I_{Lmax} = 1.25 \times I_{LED} \times V_{OUT} / V_{IN} + 0.5 \times V_{IN} \times (V_{OUT} - V_{IN}) / (L1 \times V_{OUT} \times f_{osc})$$

- When starting up the IC or when adjusting the brightness of LEDs, a large transient current may flow into an inductor (L1).
- I_{Lmax} should be equal or smaller than the current limit of the IC.
- When deciding the rated current of inductor, I_{Lmax} should be considered.
- It is recommended that L1 with 10 μ H to 22 μ H be used.

Selection of Capacitor

Set a 1 μ F or more input capacitor (C1) between the V_{IN} and GND pins as close as possible to the pins.

Set a 1 μ F output capacitor (C2) between the V_{OUT} and GND pins if $I_{LED} \leq 80$ mA and an inductor is 10 μ H.

In other cases, set a 2.2 μ F or more output capacitor (C2) between the V_{OUT} and GND pins.

VS Pin Connection at $V_{IN} < 5$ V

When using the VS pin at $V_{IN} < 5$ V, it is recommended that the V_{IN} pin and the VS pin be short-circuited each other. Refer to *Typical Application 2* and *6*. There's no capacitor required between the VS pin and the GND pin.

If the V_{IN} pin and the VS pin are not shorted each other, a capacitor (C3) is required between the VS pin and the GND pin. Refer to *Typical Application 1, 3, 4, and 5*.

Selection of Diode

For a rectifier diode, use a schottky barrier diode that has low V_F .

It is recommended to select a schottky barrier diode that has low reverse current and low parasitic capacitance.

R1208x

NO.ED-314-170330

LED Current Setting

The LED current (I_{LEDSET}) when a "H" PWM signal is applied to the CE pin (Duty = 100%) can be determined by the value of feedback resistor (R_{SET}). If a 10 k Ω resistor (R_{SET}) is placed between the ISET pin and the GND pin, the LED pin current will be set to 20 mA.

$$I_{LEDSET} = 0.103 \times R_{SET} / (41.5 \text{ k} + R_{SET})$$

Choose 4.4 k Ω (10 mA) to 143 k Ω (80 mA) for R_{SET} .

By using the application example of *Typical Application 5*, the LED current can be set between 80 mA to 160 mA. The LED current can be set up to 320 mA by using the four LED pins.

LED Dimming Control

The brightness of the LEDs can be adjusted by applying a PWM signal to the CE pin. By inputting "L" voltage for a certain period of time (Typ. 12 ms for R1208KxxxA/ 18 ms for R1208KxxxB), the IC goes into standby mode and turns off LEDs. I_{LED} can be controlled by the duty of a PWM signal for the CE pin.

The relation between the high-duty of the CE pin (Hduty) and I_{LED} is calculable by the following formula.

$$I_{LED} = Hduty \times I_{LEDSET}$$

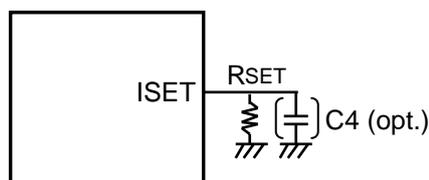
The minimum High-duty of a PWM signal can be controlled up to 2.3% ($T_a = 25^\circ\text{C}$).

PWM Dimming Adjustment Frequency

The frequency range of a PWM signal should be set within the range of 200 Hz to 300 kHz.

In the case of using a 20 kHz or less PWM signal for dimming the LEDs, the increasing or decreasing of the inductor current (I_L) may generate noise in the audible band. In this case, connect a capacitor (C_4) between the ISET pin and GND pin.

In the case of using a 20 kHz or more PWM signal, connecting a capacitor is not required. Refer to *Typical Application 2*, *Typical Application 5* and *Typical Application 6* for details.



Unused LED Current Source

Unused LED pin should be connected to GND. When using two or three LED pins, it is recommended that the rest of the LED pins should be connected as below.

Using two LED pins: LED 2 and LED 4 should be connected to GND. Refer to *Typical Application 6*.

Using three LED pins: LED 4 should be connected to GND. Refer to *Typical Application 4*.

Current Paths on PCB

Figure 1 and Figure 2 show flows of current paths of the application circuits when MOSFET is ON and when MOSFET is OFF, respectively.

Parasitic elements (impedance, inductance or capacitance) in the paths pointed with red arrows in Figure 1 and Figure 2 influence stability of the system and cause noise outbreak. It is recommended that these parasitic elements be minimized.

In addition, except for the paths of LED load, it is recommended that the all wirings of the current paths be made as short and wide as possible.

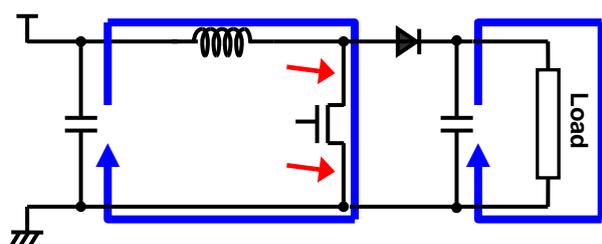


Figure 1. MOSFET-ON

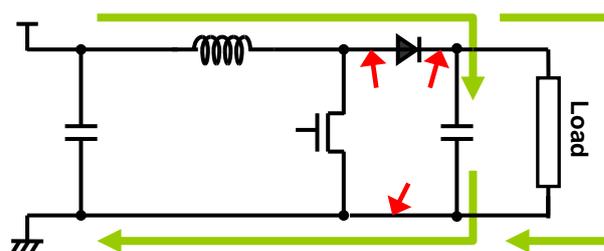
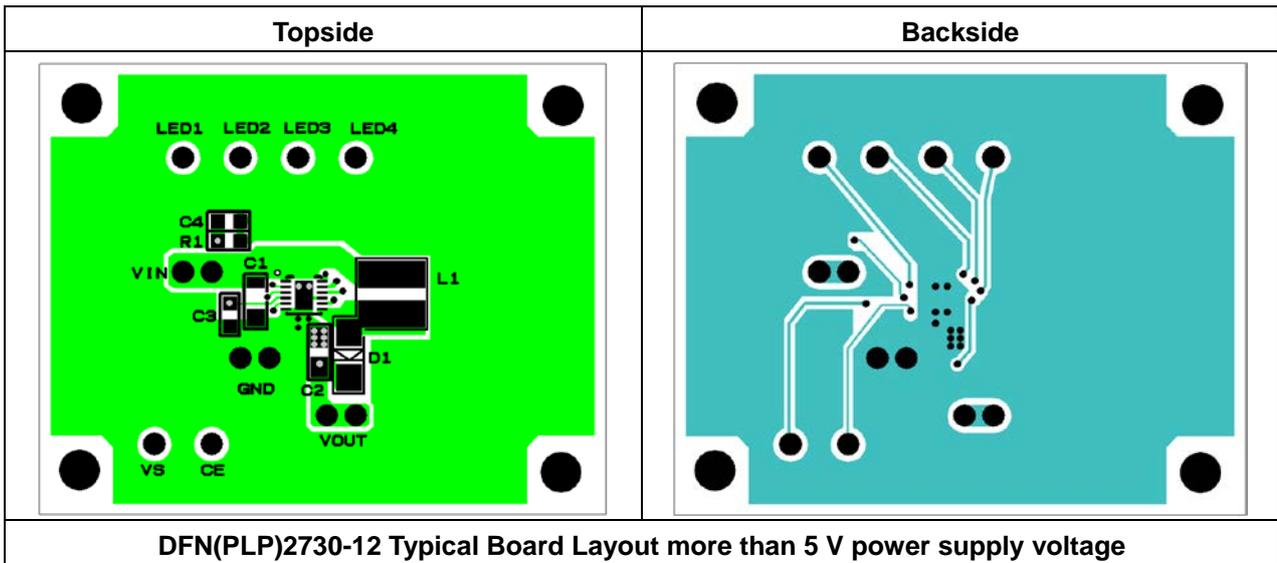
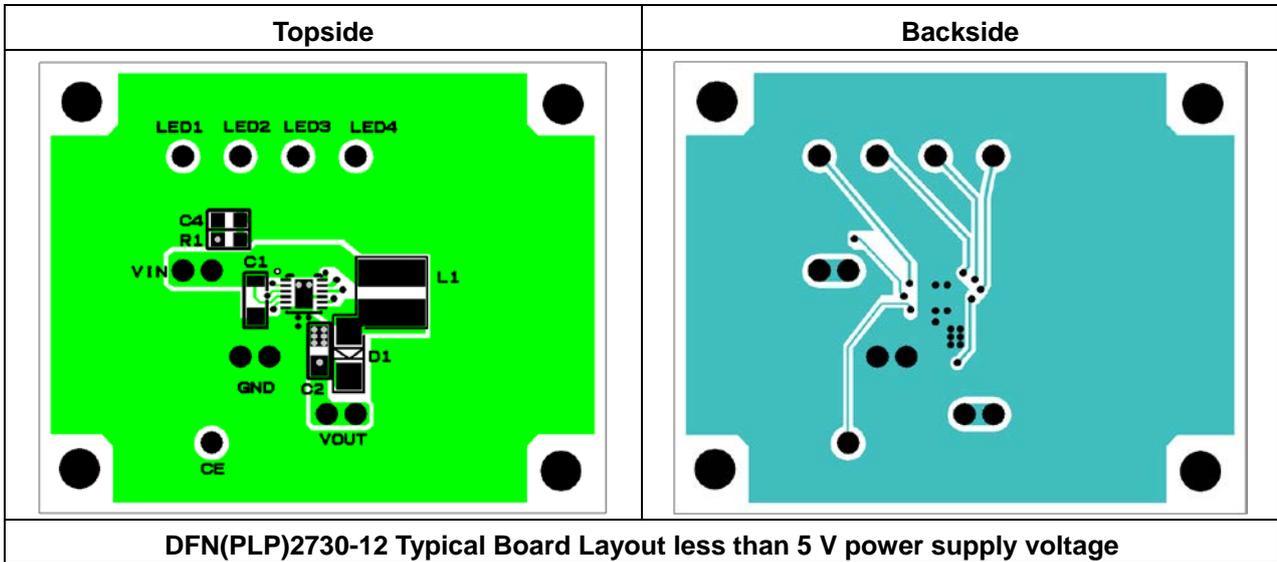


Figure 2. MOSFET-OFF

PCB Layout Recommendation

- Place C1 as close as possible to the V_{IN} and GND pins. Also, connect the GND pin to the wider GND plane.
- Make the L_x land pattern as small as possible.
- Make the wirings between the L_x pin, the inductor and the diode as short as possible. Also, connect C2 as close as possible to the cathode of the diode.
- Place C2 as close as possible to the GND pin.

TYPICAL BOARD LAYOUT





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