RICOH

R1208x Series

PWM Low Supply Current Step-up DC/DC Converter

NO.EA-314-170330

OUTLINE

The R1208x is a low supply current CMOS-based PWM control step-up DC/DC converter. Internally, a single converter consists of an NMOS FET, an oscillator, a PWM comparator, a voltage reference unit, an error amplifier, a current limit circuit, an under voltage lockout circuit (UVLO), an over-voltage protection circuit (OVP), a thermal shutdown protection circuit and current drivers for four white LED channels.

By simply using an inductor, a resistor, capacitors and a diode, white LEDs can be driven with constant current and high efficiency. The LED current can be determined by the value of current setting resistor. The brightness of the LEDs can be adjusted quickly by applying a PWM signal (200 Hz to 300 kHz) to the CE pin.

Protection circuits included in the R1208x are a current limit circuit which limits the L_X peak current, an UVLO circuit which prevents the malfunction of the device at low input voltage, an OVP circuit which monitors the excess output voltage and a thermal shutdown protection circuit which detects the overheating of the device and stops the operation to protect the device from damage.

The R1208x is offered in 12-pin DFN(PLP)2730-12 package.

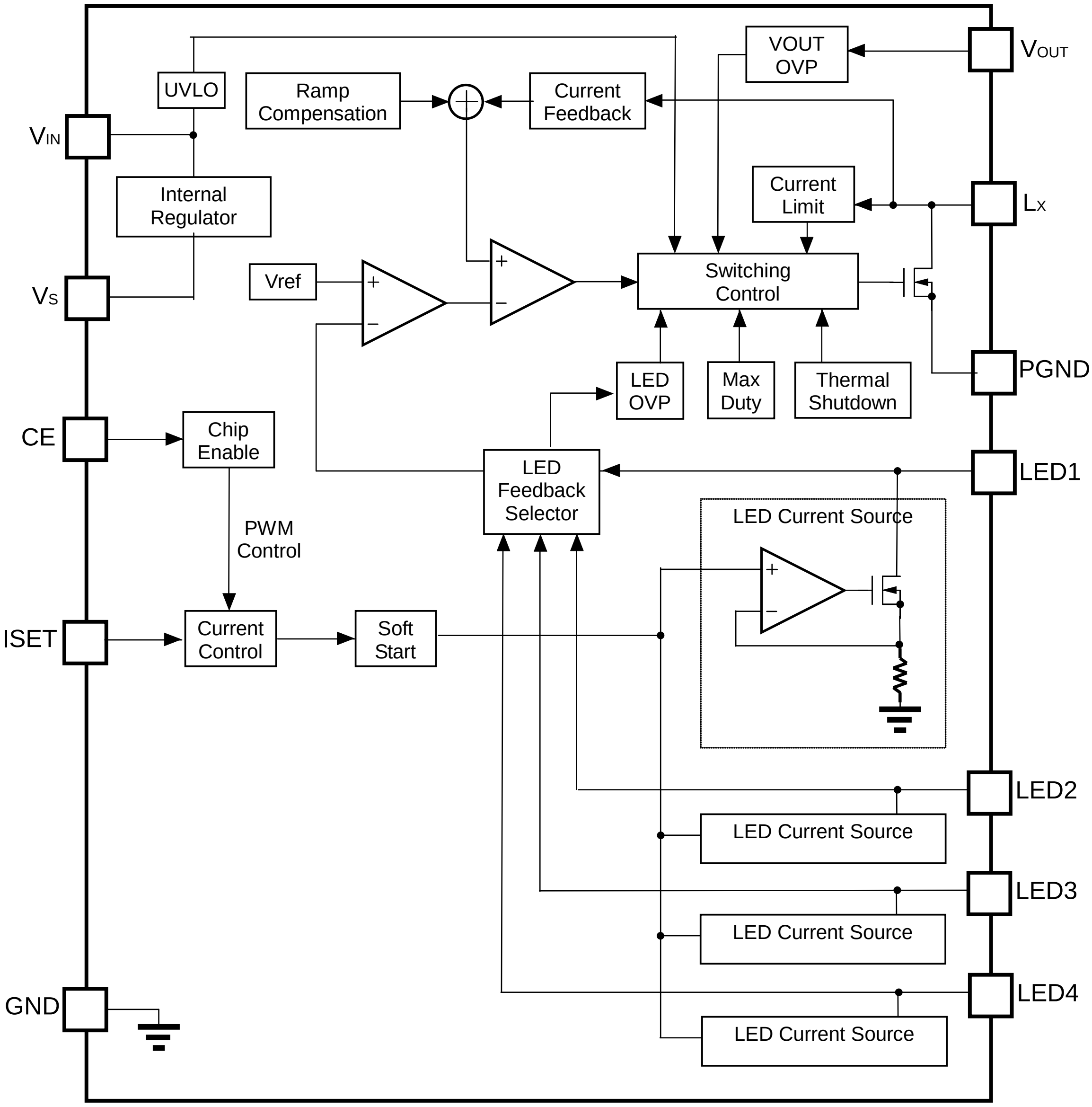
FEATURES

- Input Voltage Range .... 2.7 V to 22 V
- Supply Current .... Typ. 600 µA
- Standby Current .... Typ. 1.5 µA
- Lx Current Limit .... Typ. 2 A
- Overvoltage Protection (OVP) .... Typ. 23 V / 33 V / 43.5 V
- Oscillator Frequency .... Typ. 750 kHz / 450 kHz
- Maximum Duty Cycle .... 95% (750 kHz) / 97% (450 kHz)
- Nch MOSFET ON Resistance .... Typ. 0.28 Ω
- Undervoltage Lockout (UVLO) .... Typ. 2.4 V
- Thermal Shutdown .... Typ. 150°C
- LED Dimming Control .... By sending a PWM signal (200 Hz to 300 kHz) to the CE pin
- Package .... DFN(PLP)2730-12

APPLICATIONS

- LED backlight driver for LCD displays for portable equipment
- LED backlight driver for LCD displays for Tablets and Note PCs.

BLOCK DIAGRAMS



R1208x Block Diagram

SELECTION GUIDE

The OVP threshold voltage and the oscillator frequency are user-selectable options.

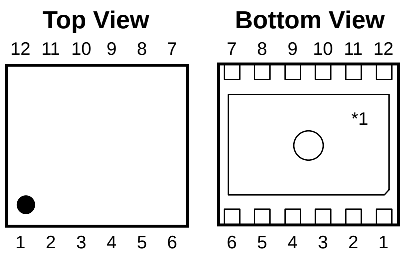
Selection Guide

Product Name	Package	Quantity per Reel	Pb Free	Halogen Free
R1208Kx12∗-TR	DFN(PLP)2730-12	5,000 pcs	Yes	Yes

x: Specify the OVP threshold voltage.
(1) 23 V
(2) 33 V
(3) 43.5 V

∗: Specify the oscillator frequency.
(A) 750 kHz
(B) 450 kHz

PIN DESCRIPTION



DFN(PLP)2730-12 Pin Configurations

DFN(PLP)2730-1 Pin Description

Pin No.	Symbol	Description
1	V_{IN}	Power Input Pin
2	LED1	LED1 pin
3	ISET	LED Current Control Pin
4	V_S	Power Input Pin (V_{IN} < 5 V), Internal Regulator Pin (V_{IN} > 5 V)
5	CE	Chip Enable Pin (Active-high)
6	PGND	Power GND Pin
7	L_X	Switching Pin
8	V_{OUT}	Output Pin
9	GND[*1]	Analog GND Pin
10	LED4	LED 4 Pin
11	LED3	LED 3 Pin
12	LED2	LED 2 Pin

[*1] The exposed tab is substrate level (GND). It is recommended that the exposed tab be connected to the ground plane on the board or otherwise be left floating.

ABSOLUTE MAXIMUM RATINGS

Absolute Maximum Ratings (GND / PGND = 0 V)

Symbol	Item	Rating		Unit
V_{IN}	V_{IN} Pin Voltage	−0.3 to 24		V
V_S	V_S Pin Voltage	−0.3 to 6.5		V
V_{CE}	CE Pin Voltage	−0.3 to 6.5		V
V_{ISET}	I_{SET} Pin Voltage	−0.3 to 6.5		V
V_{OUT}	V_{OUT} Pin Voltage	−0.3 to 48		V
V_{LX}	L_X Pin Voltage	−0.3 to 48		V
V_{LED}	LED1, LED2, LED3, LED4 Pin Voltage	−0.3 to 24		V
I_{LX}	L_X Pin Current	2500		mA
P_D	Power Dissipation*1	Standard Test Land Pattern	1000	mW
		JEDEC STD. 51-7 Test Land Pattern	1950	
Tj	Junction Temperature Range	−40 to 125		°C
Tstg	Storage Temperature Range	−55 to 125		°C

*1 Refer to *PACKAGE INFORMATION* for detailed information.

ABSOLUTE MAXIMUM RATINGS
Electronic and mechanical stress momentarily exceeded absolute maximum ratings may cause the permanent damages and may degrade the life time and safety for both device and system using the device in the field. The functional operation at or over these absolute maximum ratings is not assured.

RECOMMENDED OPERATING CONDITIONS (ELECTRICAL CHARACTERISTICS)
All of electronic equipment should be designed that the mounted semiconductor devices operate within the recommended operating conditions. The semiconductor devices cannot operate normally over the recommended operating conditions, even if when they are used over such conditions by momentary electronic noise or surge. And the semiconductor devices may receive serious damage when they continue to operate over the recommended operating conditions.

ELECTRICAL CHARACTERISTICS

The specifications surrounded by [box] are over −40°C ≤ Ta ≤ 85°C.and guaranteed by design but not tested in production.

Electrical Characteristics (Ta = 25°C)

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit
V_{IN}	Operating Input Voltage		2.7		22	V
I_{DD}	Supply Current	V_{IN} = 5.5 V, no load, no switching		0.6		mA
		V_{IN} = 5.5 V, no load, switching, R1208Kx12A		2.2		mA
		V_{IN} = 5.5 V, no load, switching, R1208Kx12B		1.5		mA
Istandby	Standby Current	V_{IN} = 22 V, V_{CE} = 0 V		1.5	10.0	µA
V_{UVLO1}	UVLO Detector Threshold	V_{IN} falling	2.3	2.4		V
V_{UVLO2}	UVLO Released Voltage	V_{IN} rising		V_{UVLO1} +0.1	2.6	V
V_{CEH}	CE Input Voltage "H"	V_{IN} = 22 V	1.5			V
V_{CEL}	CE Input Voltage "L"	V_{IN} = 2.7 V			0.4	V
R_{CE}	CE Pull-down Resistance	V_{IN} = 8 V		1200		kΩ
V_S	V_S Active Voltage	V_{IN} = 8 V		5		V
I_{LED}	LED1-4 Current Accuracy	R_{ISET} = 10 kΩ, 1 string = 20 mA, V_{IN} = 3.6 V,	−3%	20	+3%	mA
ΔI_{LED} /ΔTa	LED1-4 Current Temperature Coefficient	−40°C ≤ Ta ≤ 85°C, V_{IN} = 3.6 V		±100		ppm /°C
I_{LEDM}	LED1-4 Current Matching	(I_{MAX} − I_{AVE}) / I_{AVE}, 1 string = 20 mA, V_{IN} = 3.6 V,			2.5	%
I_{LEDM2}	LED1-4 Current Matching 2	(I_{MAX} − I_{AVE}) / I_{AVE}, 1 string = 2 mA			10	%
CEduty	CE Input Duty Range	V_{IN} = 3.6 V, R_{ISET} = 10 kΩ	2.3		100	%
I_{LEDMAX}	LED1-4 Max. Current Setting (100% dimming)	V_{IN} = 3.6 V	[80]	100		mA
V_{LED1}	LED1-4 Active Voltage	V_{IN} = 3.6 V, 1 string = 30 mA		0.75		V
$I_{LEDLEAK}$	LED1-4 Leakage Current	V_{IN} = V_{LED1-4} = 22 V, V_{CE} = 0 V		0	3.0	µA
R_{ON}	NMOS ON Resistance	I_{LX} = 100 mA , V_{IN} = 3.6 V		0.28		Ω
I_{LXLEAK}	NMOS Leakage Current	V_{IN} = V_{LED1-4} = 22 V, V_{CE} = 0 V		0	3.0	µA
I_{LXLIM}	NMOS Current Limit	V_{IN} = 3.6 V	1.5	2	2.5	A
fosc	Oscillator Frequency	V_{IN} = 3.6 V (R1208Kx12A)	675	750	825	kHz
		V_{IN} = 3.6 V (R1208Kx12B)	400	450	500	kHz

ELECTRICAL CHARACTERISTICS (continued)

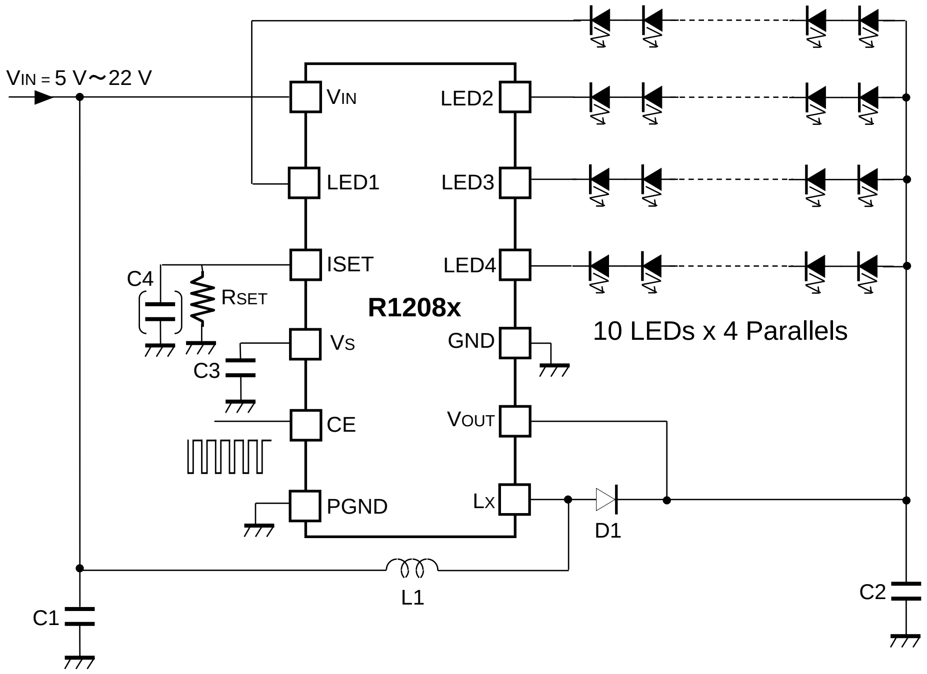
The specifications surrounded by [box] are over −40°C ≤ Ta ≤ 85°C.and guaranteed by design but not tested in production.

Electrical Characteristics (Ta = 25°C)

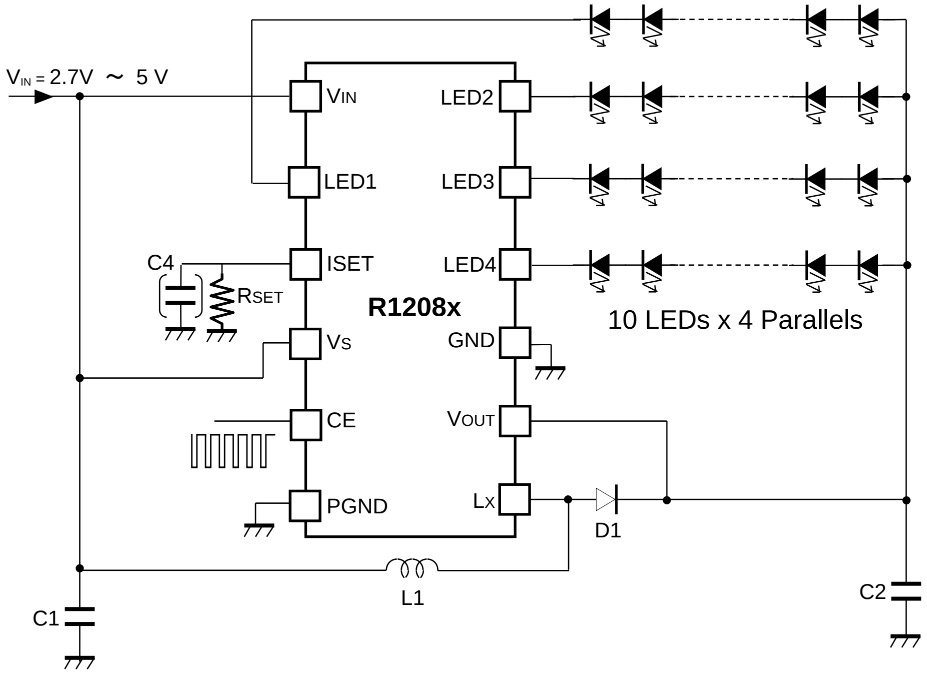
Symbol	Item	Conditions		Min.	Typ.	Max.	Unit
Maxduty	Maximum Duty Cycle	V_{IN} = 3.6 V		92			%
V_{OVP1}	V_{OUT} OVP Detector Threshold	V_{IN} = 3.6 V, V_{OUT} rising	R1208K112*	22	23	24	V
			R1208K212*	31.5	33	34.5	V
			R1208K312*	42	43.5	45	V
V_{OVP2}	V_{OUT} OVP Release Voltage	V_{IN} = 3.6 V, V_{OUT} falling	R1208K112*	21	V_{OVP1} −0.5		V
			R1208K212*	30.5	V_{OVP1} −1		V
			R1208K312*	39.5	V_{OVP1} −1.5		V
V_{OVP3}	LED OVP Detector Threshold	V_{IN} = 3.6 V, V_{LED1-4} rising			10	11.5	V
T_{SS}	Soft Start Time	V_{IN} = 3.6 V		10	15	32	ms
T_{TSD}	Thermal Shutdown Temperature	V_{IN} = 3.6 V			150		°C
T_{TSR}	Thermal Shutdown Release Temperature	V_{IN} = 3.6 V			120		°C

All test items listed under *ELECTRICAL CHARACTERISTICS* are done under the pulse load condition (Tj ≈ Ta = 25°C).

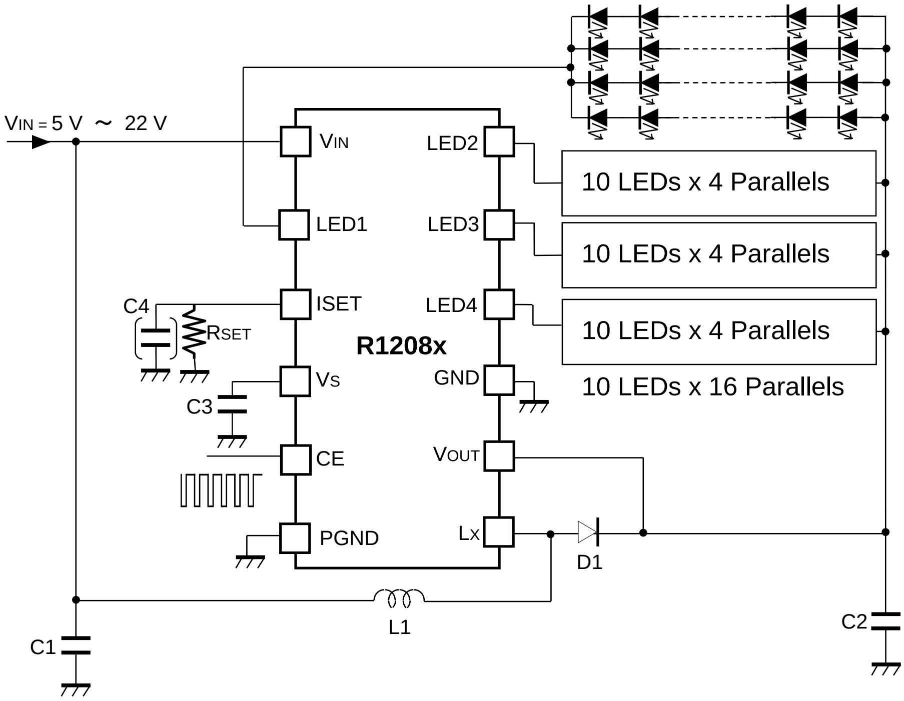
TYPICAL APPLICATIONS



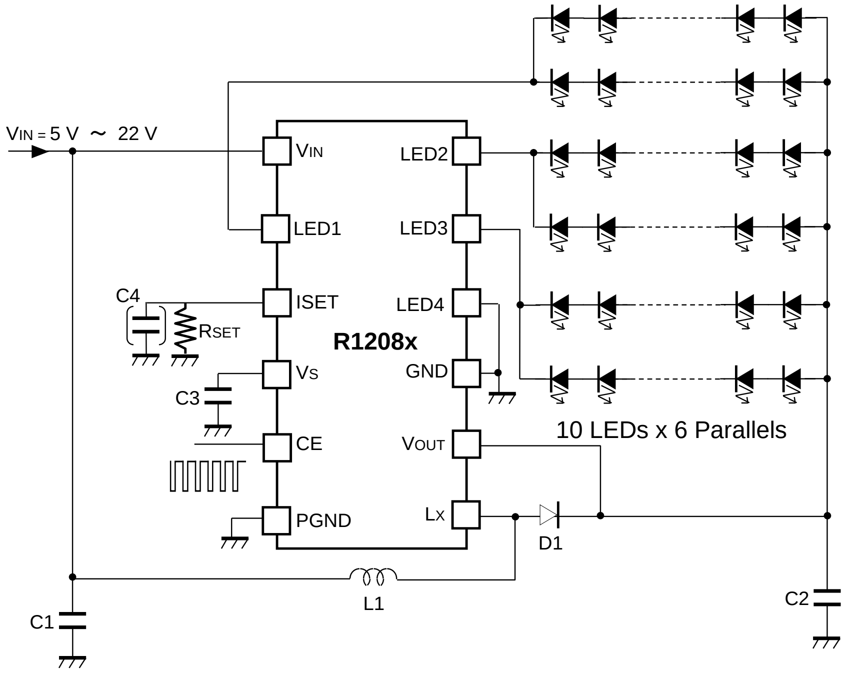
Typical Application 1. 10 LEDs in series x 4 parallels, up to 80 mA per LED, 5 V or higher power supply voltage, using 4 LED channels



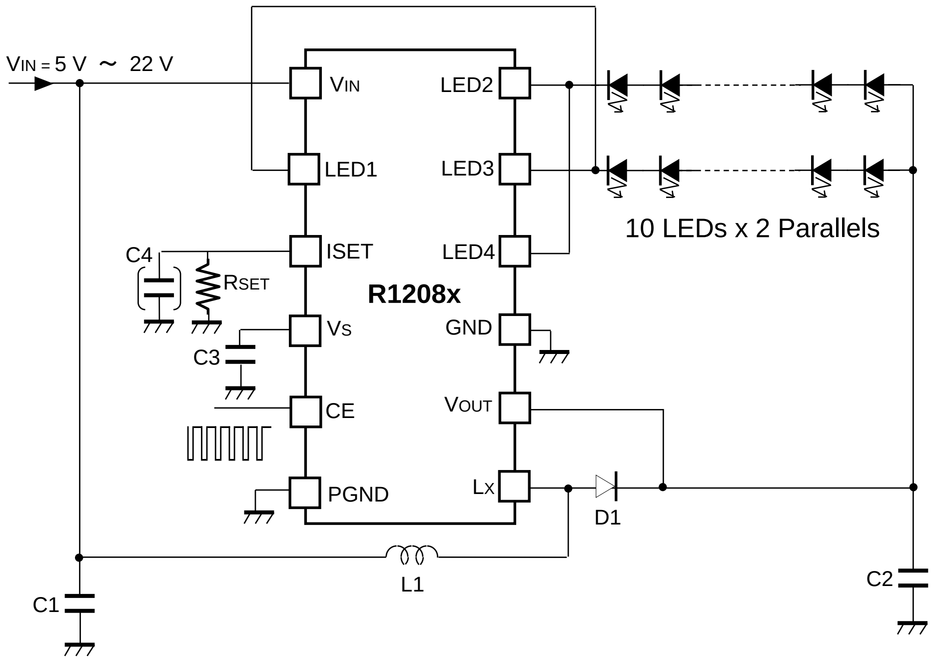
Typical Application 2. 10 LEDs in series x 4 parallels, up to 80 mA per LED, less than 5 V power supply voltage, using 4 LED channels



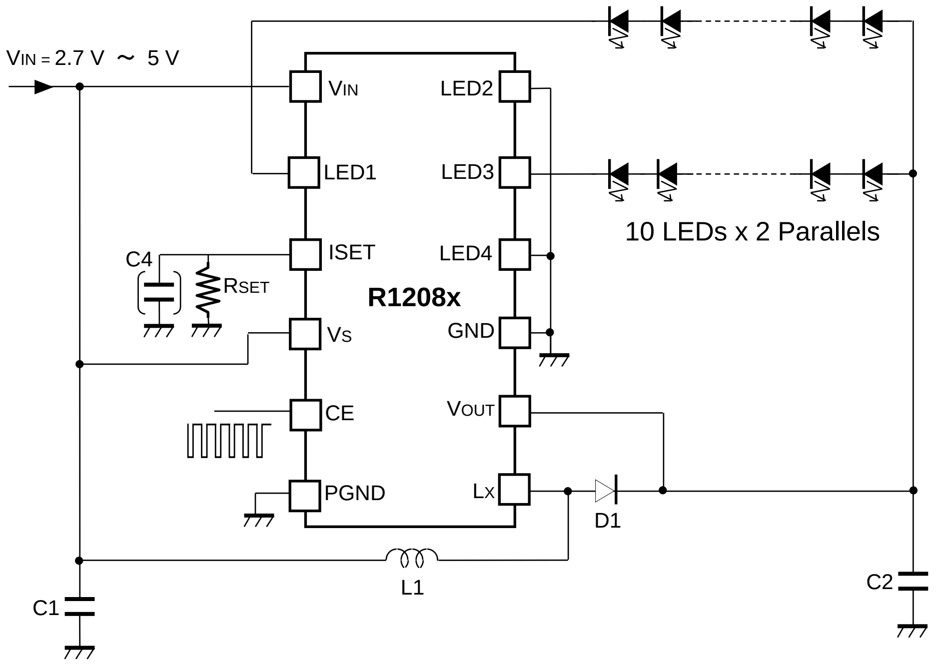
**Typical Application 3. 10 LEDs in series x 16 parallels, up to 20 mA per LED,
5 V or higher power supply voltage, using 4 LED channels**



**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 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

• 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 kΩ 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 kΩ (10 mA) to 143 kΩ (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 calculatable by the following formula.

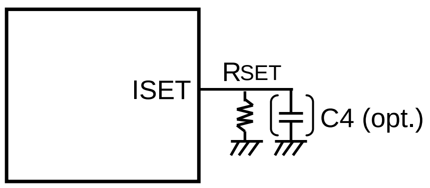
$$I_{LED} = \text{Hduty} \times I_{LEDSET}$$

The minimum High-duty of a PWM signal can be controlled up to 2.3% (Ta = 25°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 (IL) may generate noise in the audible band. In this case, connect a capacitor (C4) 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 Limit Function**

If the peak current of inductor (ILmax) exceeds the current limit, current limit function turns the driver off and turns it on in every switching cycle to continually monitor the driver current.

- **Soft-Start Function**

After power-on, soft-start forcibly switches L_X for a prescribed time to increase V_{OUT}. By gradually increasing the L_X limit, the rush current generated at start-up can be controlled. After V_{OUT} is increased, soft-start operation continues until the LED current reaches the set current.

- **Under Voltage Lockout (UVLO) Function**

UVLO function stops DC/DC operation to prevent malfunction when the supply voltage falls below the UVLO detector threshold.

- **Overvoltage Protection (OVP) Circuit**

OVP circuit monitors the V_{OUT} pin voltage and halts oscillation once it reaches the OVP detect voltage. Oscillation resumes when the V_{OUT} pin voltage decreases below 0.3 V. In case the cause of the excess V_{OUT} pin voltage is not removed the OVP circuit will stop and resume repeatedly in order to limit the V_{OUT} pin voltage.

- **Thermal Shutdown Function**

Thermal shutdown circuit detects overheating of the converter if the output pin is shorted to the ground pin (GND) etc. and stops the converter operation to protect it from damage. If the junction temperature of the device exceeds the specified temperature, the thermal shutdown stops the converter operation and resumes the converter operation if the junction temperature decreases below the thermal shutdown release temperature.

- **Selection of Capacitor**

Set a 1 µF or more input capacitor (C1) between the V_{IN} and GND pins as close as possible to the pins.
Set a 1 µF output capacitor (C2) between the V_{OUT} and GND pins if $I_{LED} \leq 80$ mA and an inductor is 10 µH.
In other cases, set a 2.2 µF 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.*

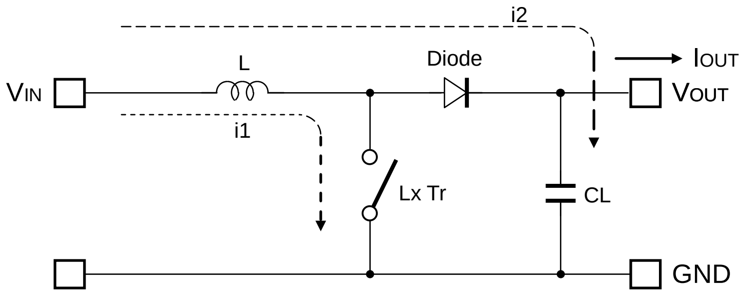
- **Selection of Inductor**

ILmax under steady operation can be calculated by the formula below.

$$ILmax = 1.25 \times I_{LED} \times V_{OUT} / V_{IN} + 0.5 \times V_{IN} \times (V_{OUT} - V_{IN}) / (L \times V_{OUT} \times fosc)$$

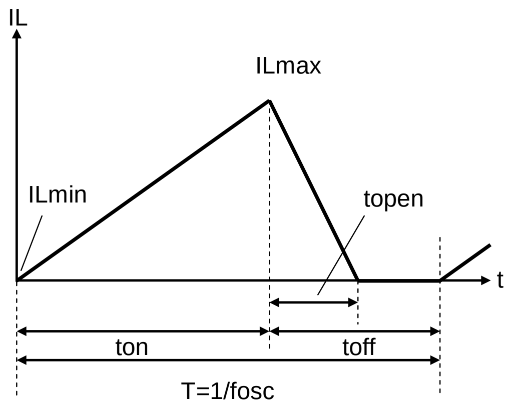
When starting up the device or adjusting the brightness of LED lights using the CE pin, a large transient current may flow into an inductor (L1). ILmax of L1 should be equal or smaller than the current limit of the device. It is recommended that a 10 µH to 22 µH L1 be used.

OPERATION OF STEP-UP DC/DC CONVERTER AND OUTPUT CURRENT

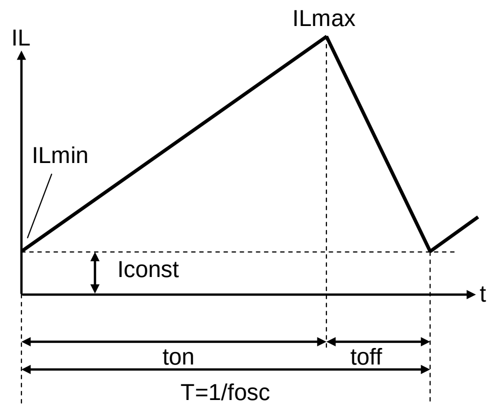


Basic Circuit

Current (IL) Flowing Through Inductor (L)



Discontinuous Mode



Continuous Mode

There are two operation modes in the PWM step-up DC/DC converter: continuous mode and discontinuous mode.

When a transistor is in the On-state, the voltage to be applied to L is described as V_{IN}. An increase in the inductor current (i1) can be written as follows:

$\Delta i1 = V_{IN} \times ton / L$ .... Formula 1

In the step-up circuit, the energy accumulated during the On-state is transferred into the capacitor even in the Off-state. A decrease in the inductor current (i2) can be written as follows:

$\Delta i2 = (V_{OUT} - V_{IN}) \times topen / L$ .... Formula 2

In the PWM switching control, i1 and i2 become continuous when topen = toff, which is called continuous mode.

When the IC is in the continuous mode and operates in steady-state conditions, the variations of i1 and i2 are same:

$V_{IN} \times ton / L = (V_{OUT} - V_{IN}) \times toff / L$ .... Formula 3

Therefore, the duty cycle in the continuous mode is:

$Duty = ton / (ton + toff) = (V_{OUT} - V_{IN}) / V_{OUT}$ .... Formula 4

When topen = toff, the average of IL is:

$IL\ (Ave.) = V_{IN} \times ton / (2 \times L)$ .... Formula 5

If the input power is equal to output power, the output current (I_{OUT}) is:

$I_{OUT} = V_{IN}^2 \times ton / (2 \times L \times V_{OUT})$ .... Formula 6

If I_{OUT} is larger than Formula 6, the IC switches to the continuous mode.

ILmax flowing through L is:

$ILmax = I_{OUT} \times V_{OUT} / V_{IN} + V_{IN} \times ton / (2 \times L)$ .... Formula 7

$ILmax = I_{OUT} \times V_{OUT} / V_{IN} + V_{IN} \times T \times (V_{OUT} - V_{IN}) / (2 \times L \times V_{OUT})$ .... Formula 8

As a result, ILmax becomes larger compared to I_{OUT}.

When considering the input and output conditions or selecting the external components, please pay attention to ILmax.

★ The above calculations are based on the ideal operation of the ICs in the continuous mode. They do not include the losses caused by the external components or L_X switch. The actual maximum output current will be 50% to 80% of the above calculation results. Especially, if IL is large or V_{IN} is low, it may cause the switching losses. As for V_{OUT}, please consider V_F of the diode (approximately 0.8V).

PACKAGE INFORMATION

Power Dissipation (DFN(PLP)2730-12)

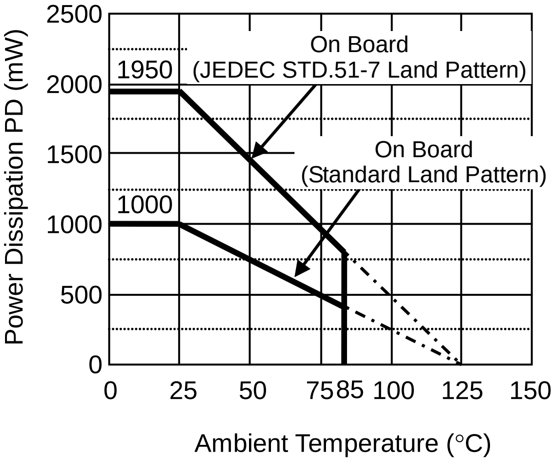
Power Dissipation (P_D) depends on conditions of mounting on board. This specification is based on the measurement at the condition below:

Measurement Conditions

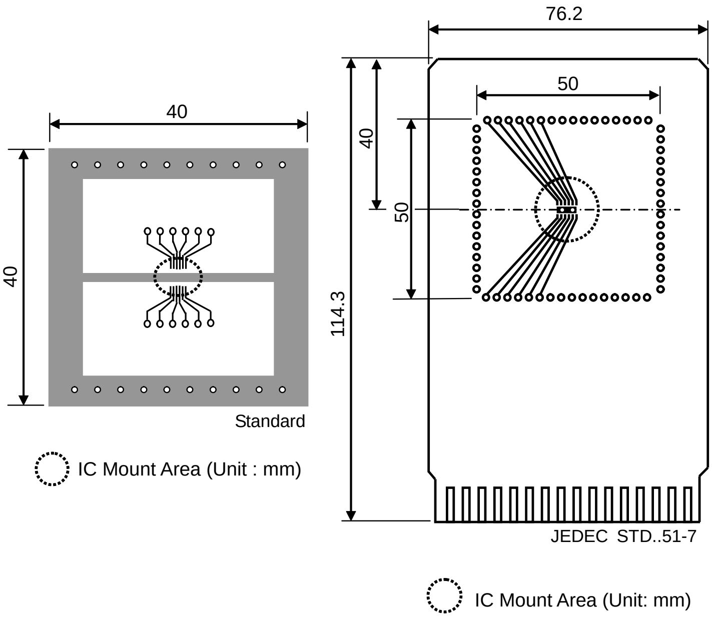
	Standard Test Land Pattern	**JEDEC STD. 51-7 Test Land Pattern**
Environment	Mounting on Board (Wind Velocity = 0 m/s)	Mounting on Board (Wind Velocity = 0 m/s)
Board Material	Glass Cloth Epoxy Plastic (Double-sided)	Glass Cloth Epoxy Plastic (Four-layers)
Board Dimensions	40 mm x 40 mm x 1.6 mm	76.2 mm x 114.3 mm x 1.6 mm
Copper Ratio	Topside: Approx. 50%, Backside: Approx. 50%	Top, Backside: Approx. 10%, 2nd, 3rd: Approx. 100%
Through-holes	ϕ 0.54 mm x 32 pcs	ϕ 0.85 mm x 64 pcs * The land pattern of Tab (Heat spreader), the inner layers and the backside pattern are connected by 0.3 mm through-hole.

Measurement Result (Ta = 25°C, Tjmax = 125°C)

	Standard Test Land Pattern	**JEDEC STD. 51-7 Test Land Pattern**
Power Dissipation	1000mW	1950mW
Thermal Resistance	θja = (125-25°C)/1.0W = 100°C/W	θja = (125-25°C)/1.95W = 51.2°C/W
	θjc = 18°C/W	θjc = 5.9°C/W

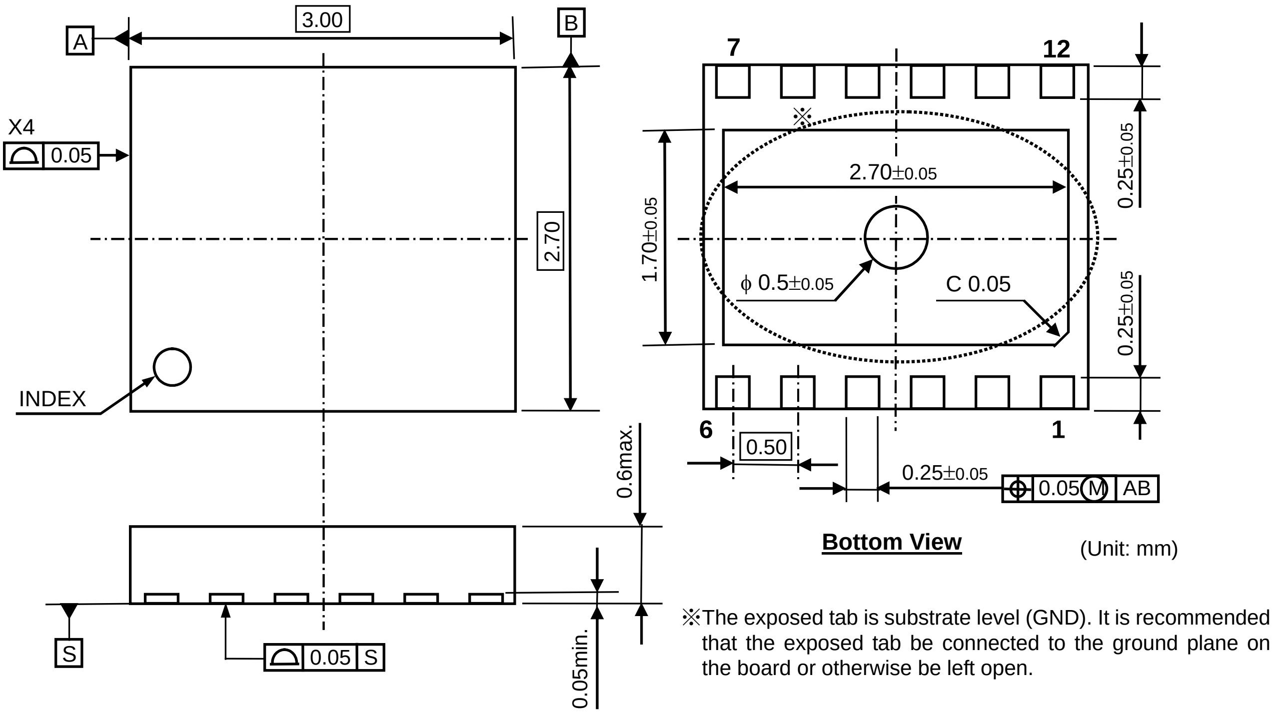


Power Dissipation vs. Ambient Temperature



Measurement Board Pattern

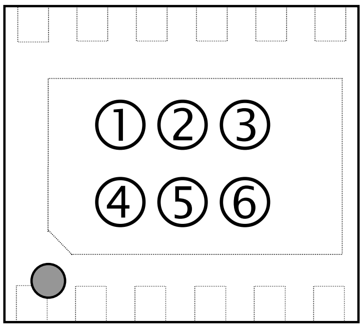
Package Dimensions (DFN(PLP)2730-12)



DFN(PLP)2730-12 Package Dimensions

Mark Specification (DFN(PLP)2730-12)

①②③④: Product Code … ***Refer to MARK SPECIFICATION TABLE(DFN(PLP)2730-12)***
⑤⑥: Lot Number … Alphanumeric Serial Number



DFN(PLP)2730-12 Mark Specification

Mark Specification Table (DFN(PLP)2730-12)

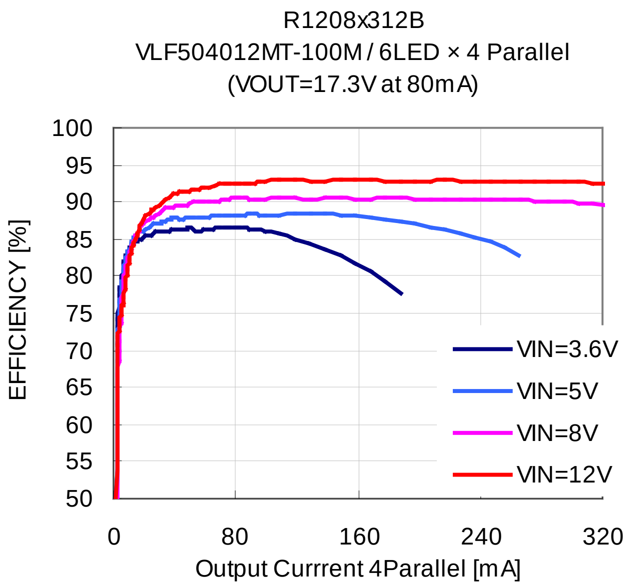
R1208x Mark Specification Table

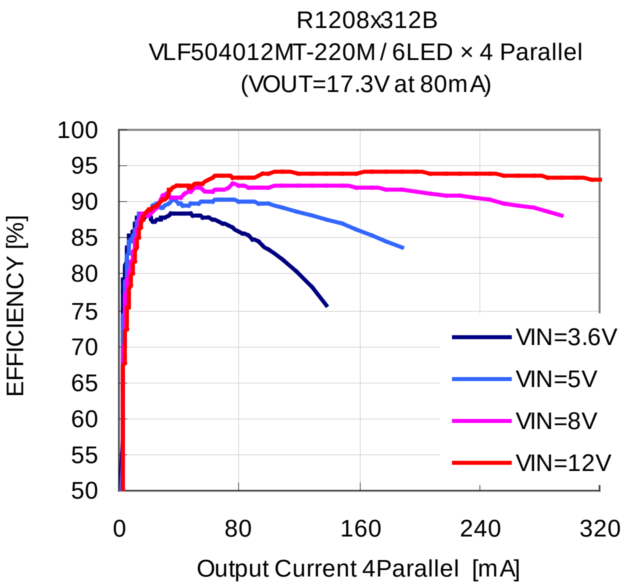
Product Name	①②③④
R1208K112A	D Y 0 0
R1208K212A	D Y 0 1
R1208K312A	D Y 0 2
R1208K112B	D Y 0 3
R1208K212B	D Y 0 4
R1208K312B	D Y 0 5

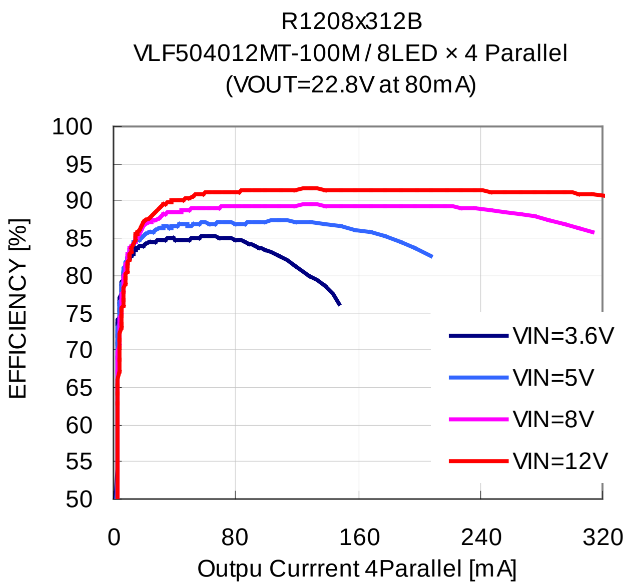
TYPICAL CHARACTERISTICS

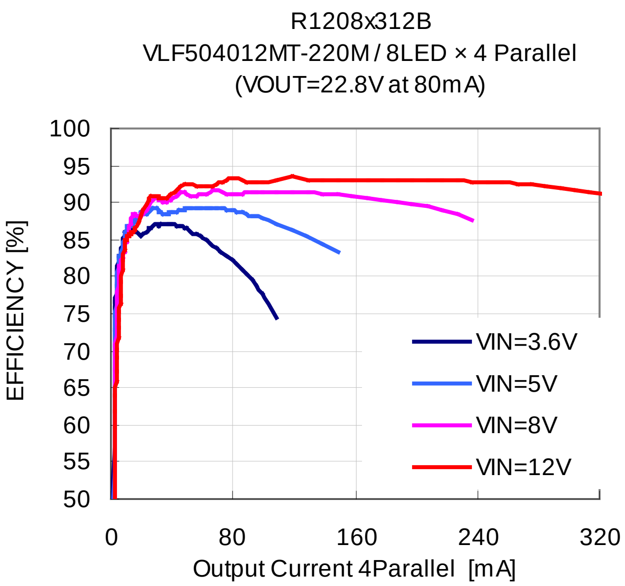
1) Efficiency vs. Output Current of R1208xx12A/B

1-1) Efficiency vs. Output Current with Different Input Voltages

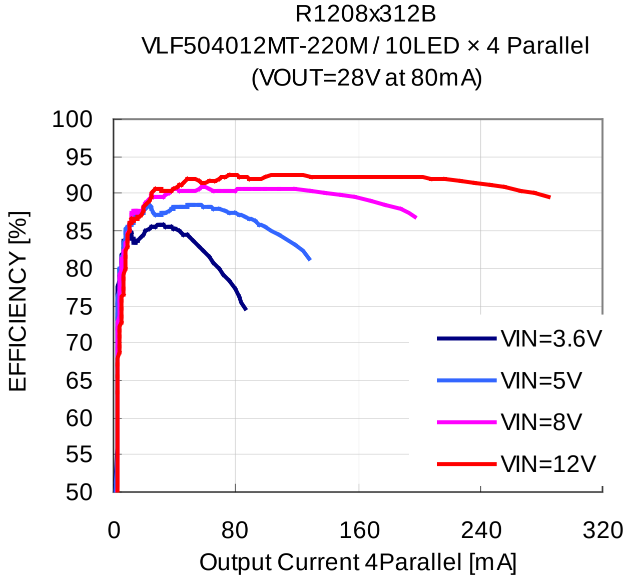


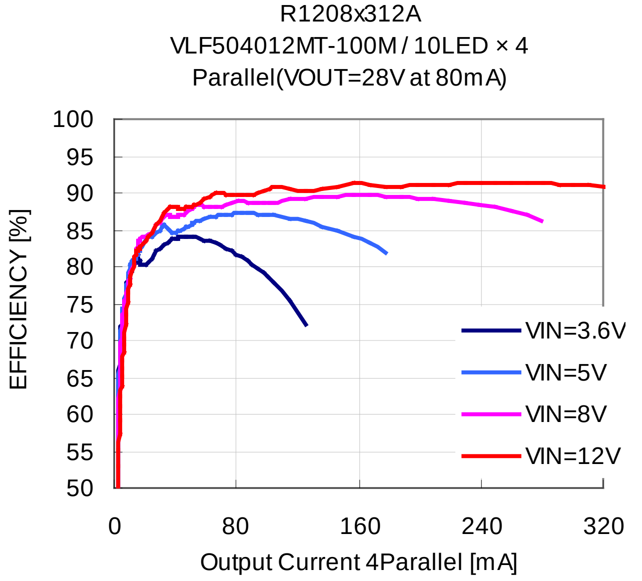


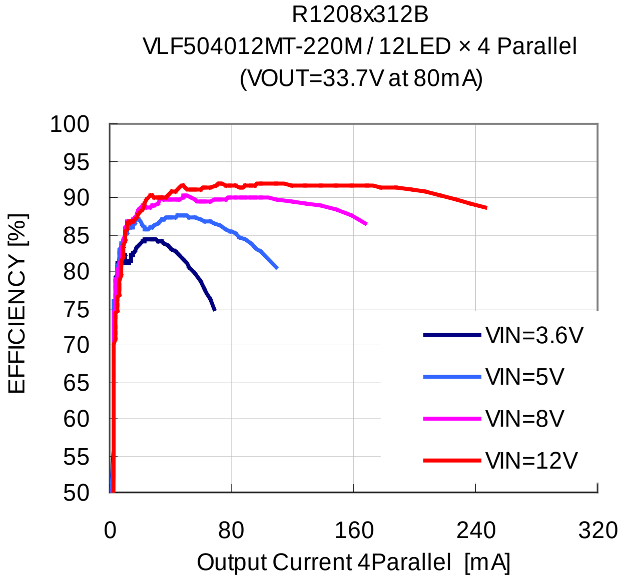


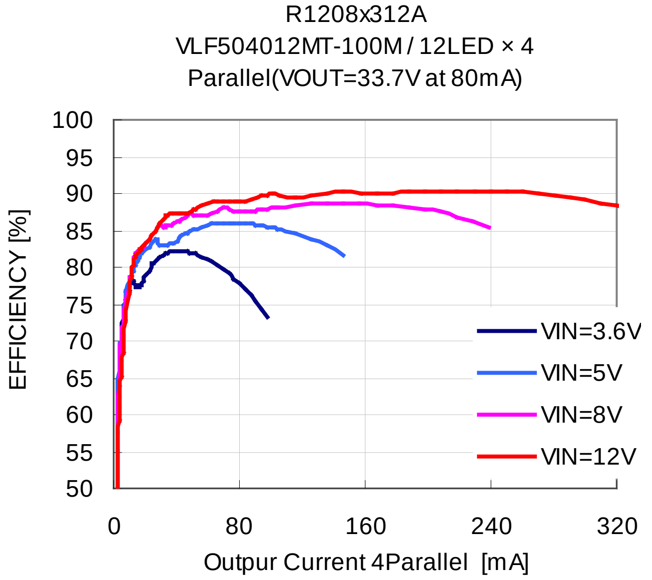


TYPICAL CHARACTERISTICS (continued)



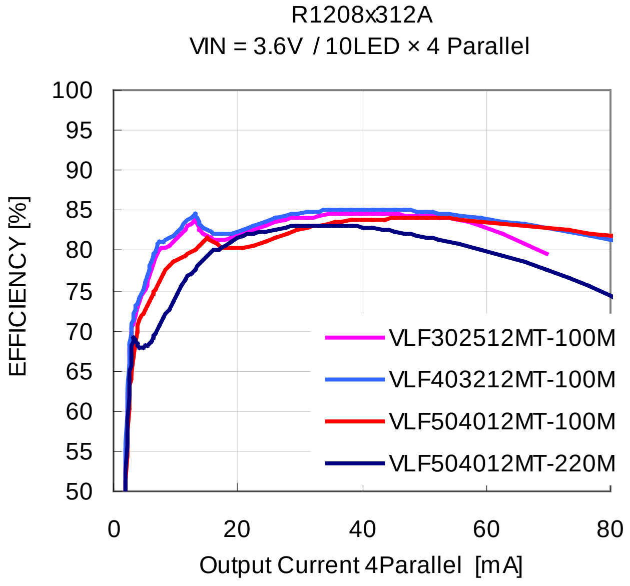


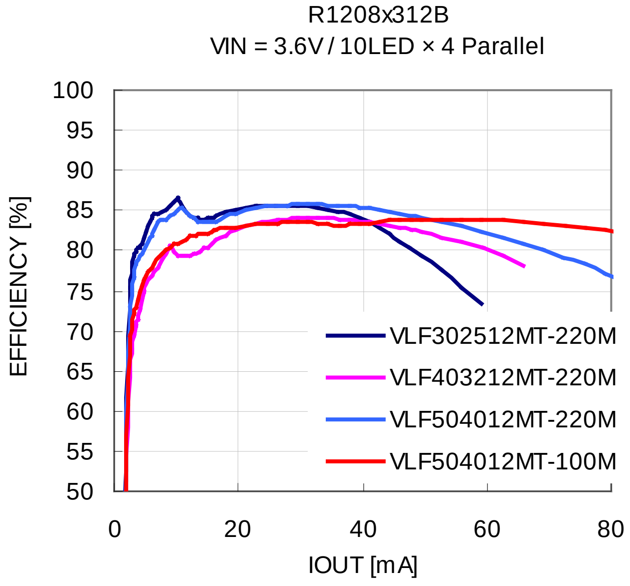


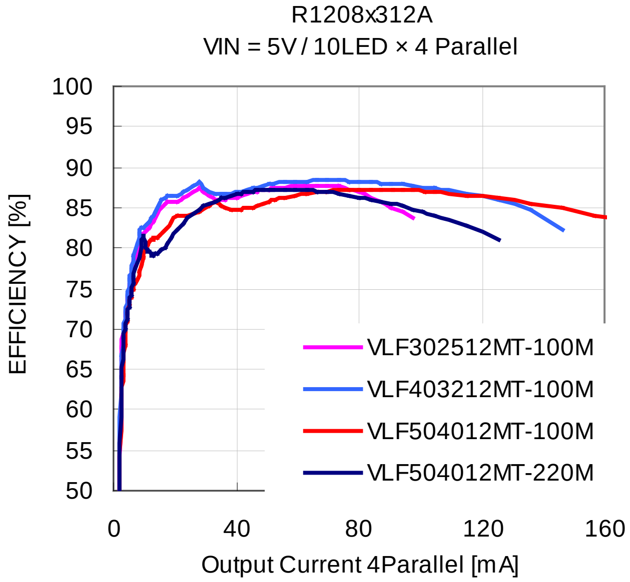


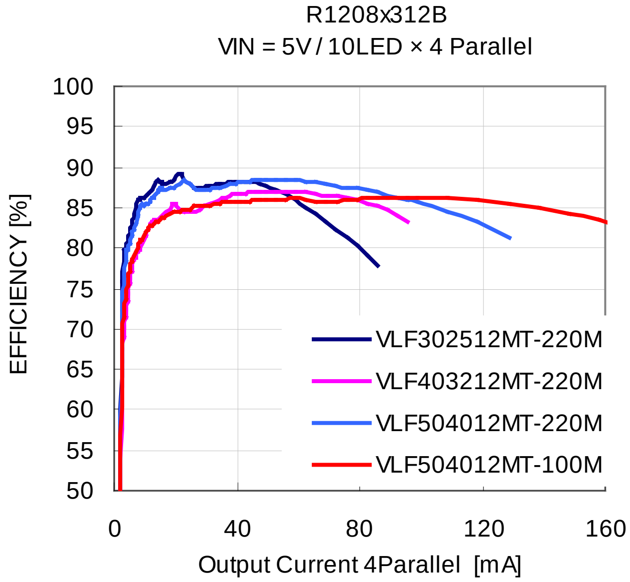
TYPICAL CHARACTERISTICS (continued)

1-2) Efficiency vs. Output Current with Different Inductors (V_{OUT} = 28 V at 80 mA)

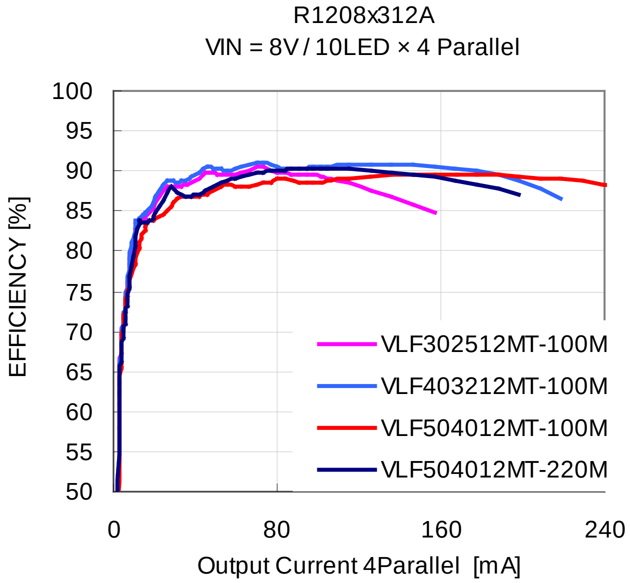


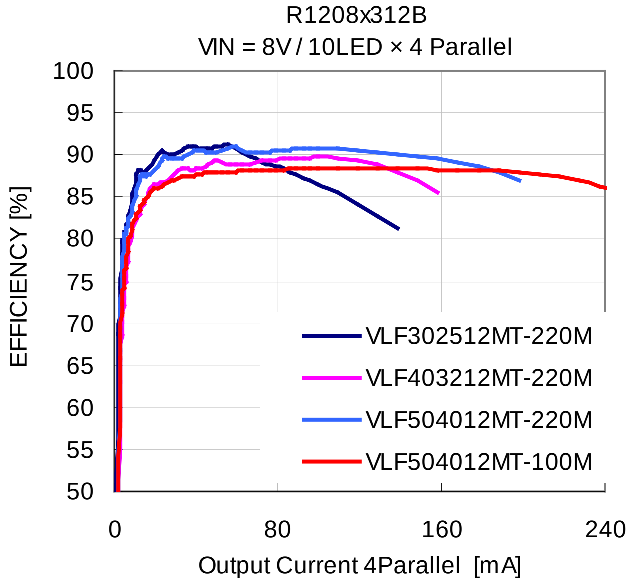


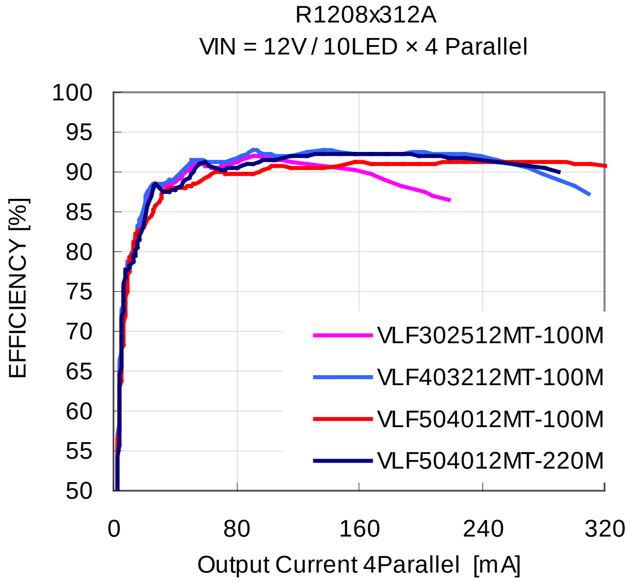


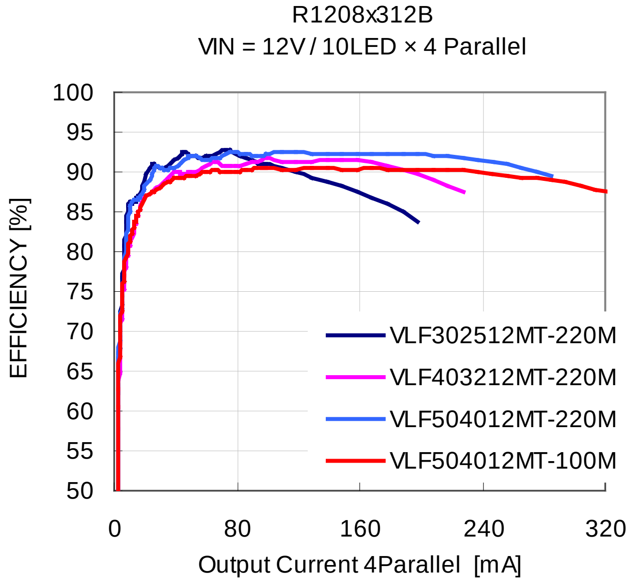


TYPICAL CHARACTERISTICS (continued)



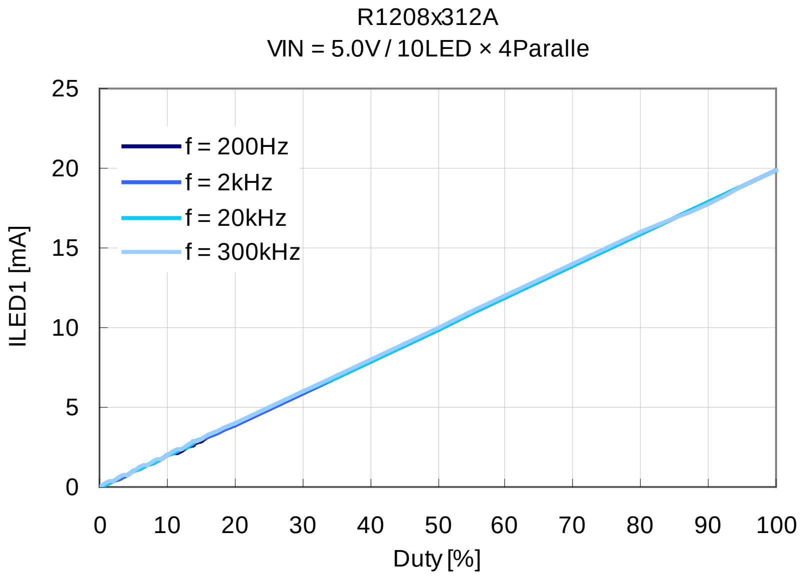






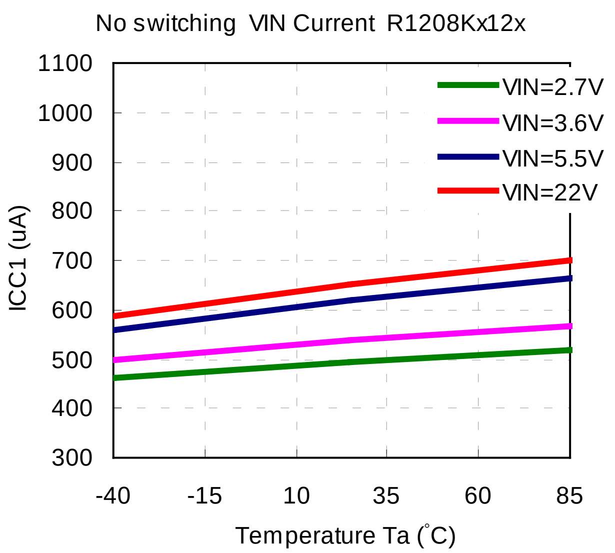
TYPICAL CHARACTERISTICS (continued)

2) Onduty vs. I_{LED} (I_{SET} = 10 kΩ)



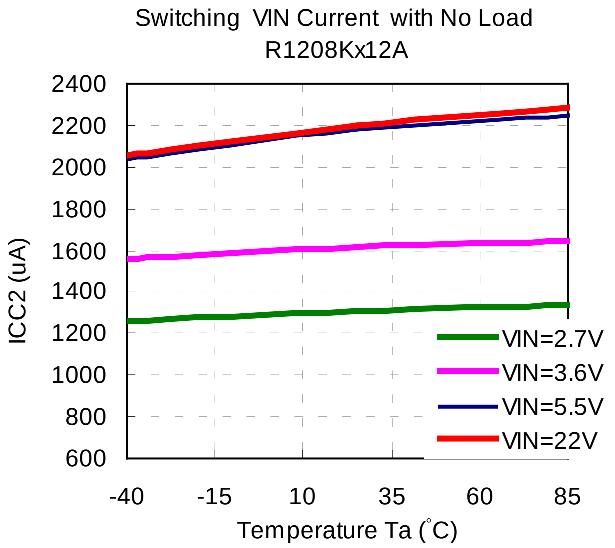
3) Electrical Characteristics

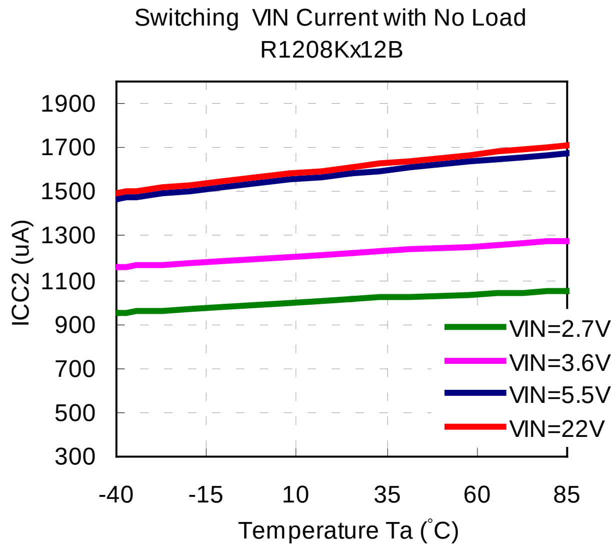
3-1) Supply Current (No switching) vs. Ambient Temperature



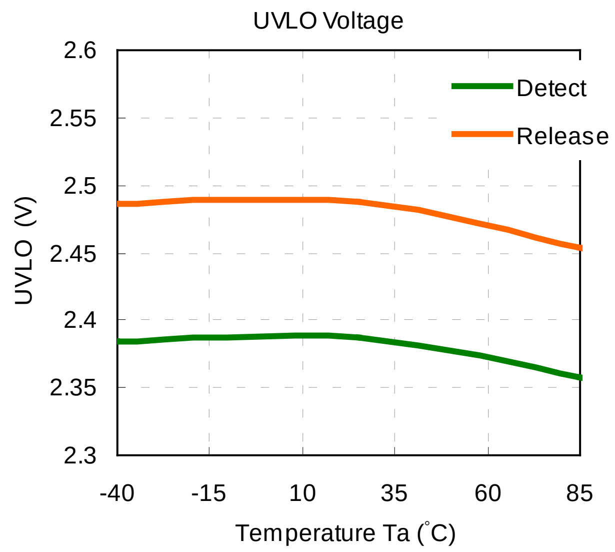
TYPICAL CHARACTERISTICS (continued)

3-2) Supply Current (Switching) vs. Ambient Temperature

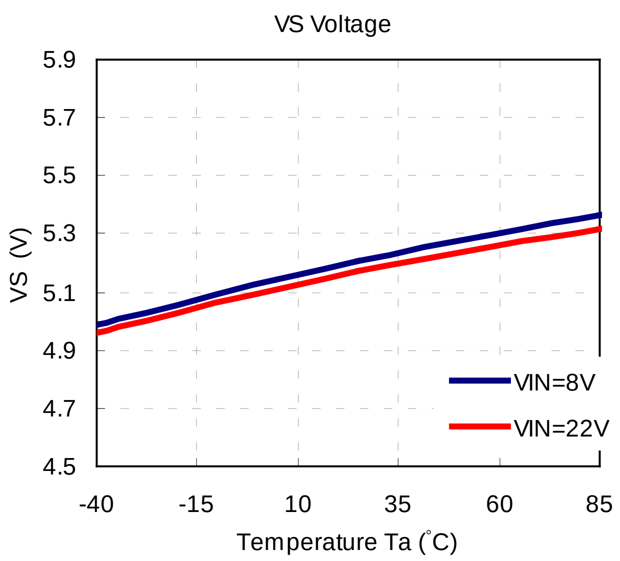




3-3) UVLO Voltage vs. Ambient Temperature

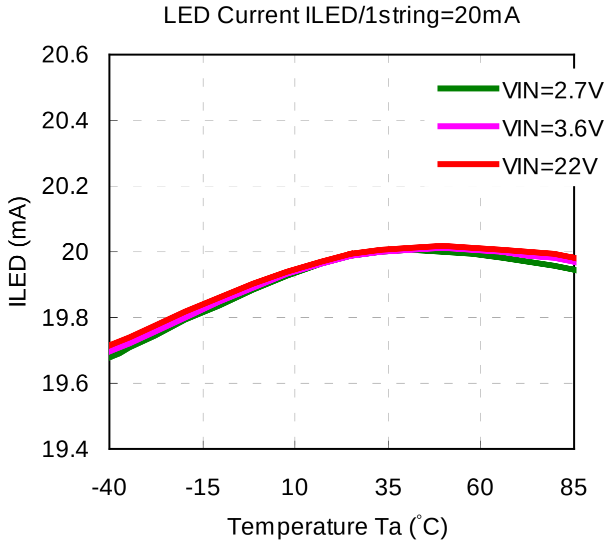


3-4) VS Voltage vs. Ambient Temperature

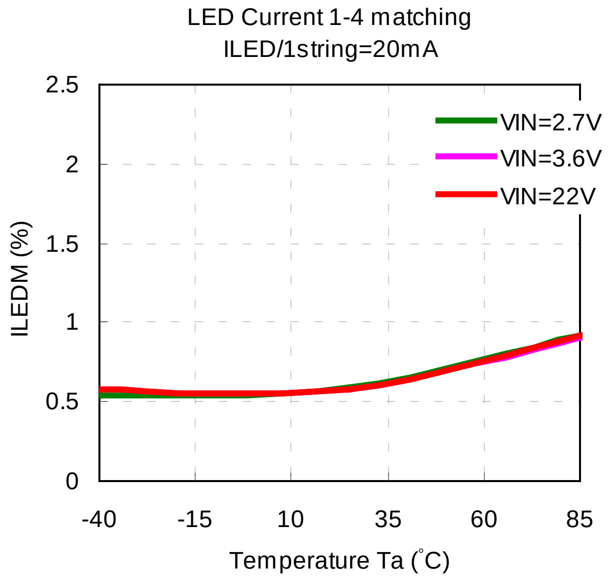


TYPICAL CHARACTERISTICS (continued)

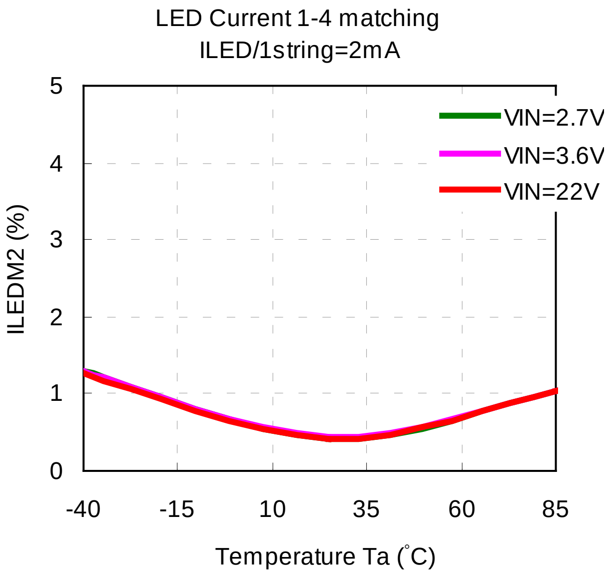
3-5) LED Current Accuracy vs. Ambient Temperature



3-6) Channnel Matching vs. Ambient Temperature 1 String: 20 mA

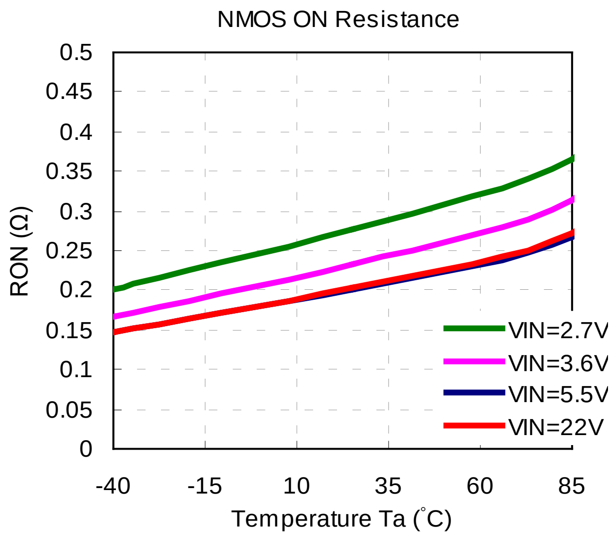


3-7) Channel Matching vs. Ambient Temperature 1 String: 2 mA

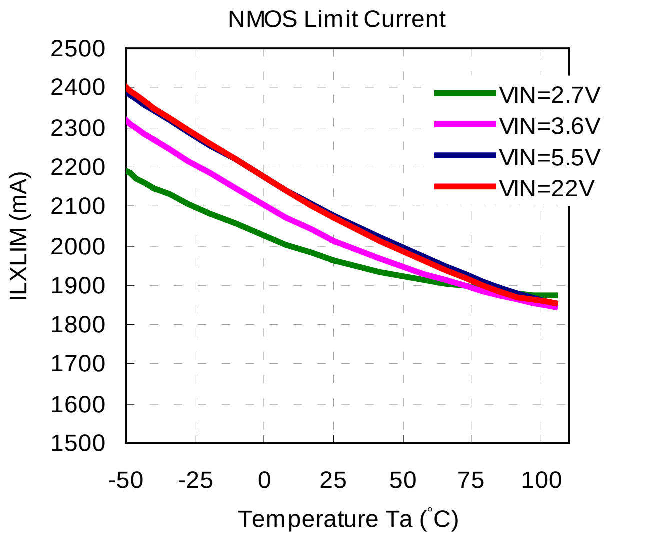


TYPICAL CHARACTERISTICS (continued)

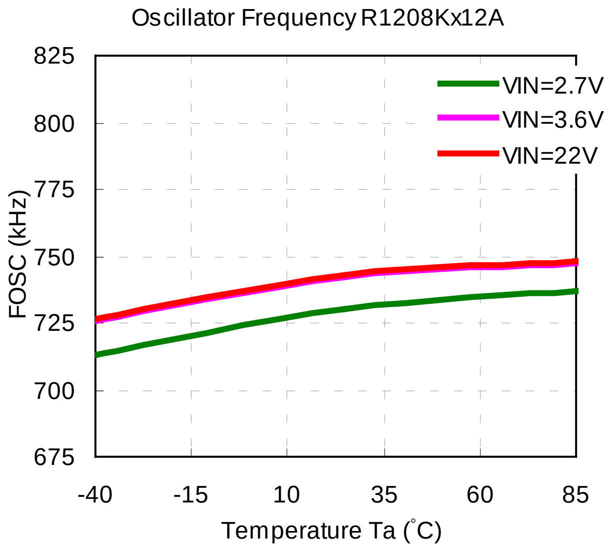
3-8) NMOS ON Resistance vs. Ambient Temperature

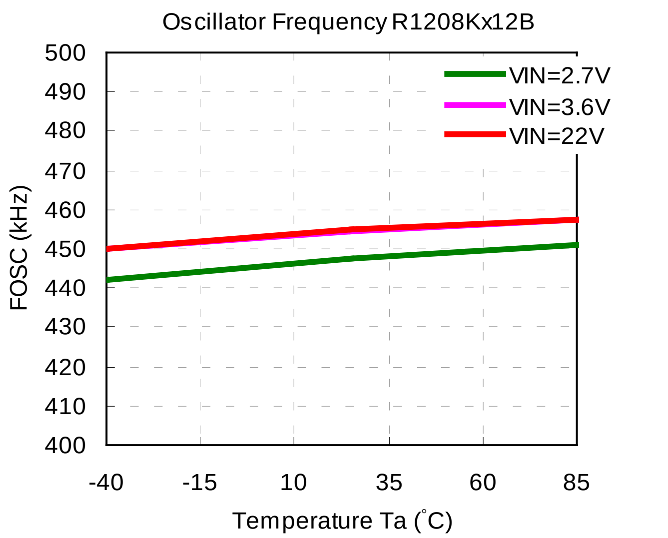


3-9) NMOS Limit Current vs. Ambient Temperature



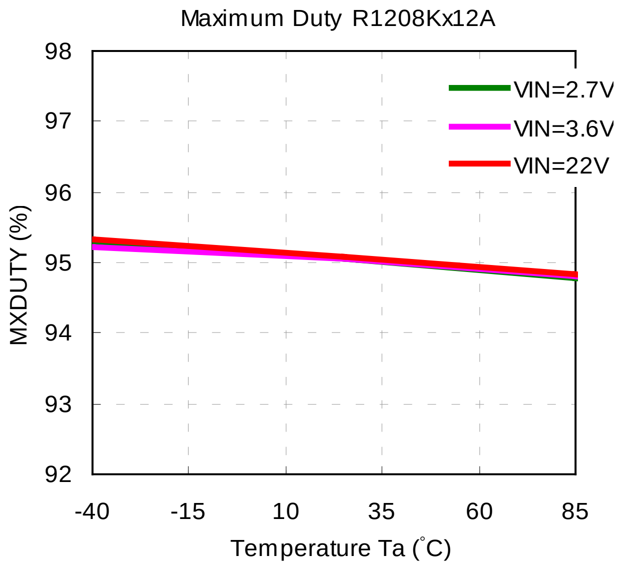
3-10) Operating Frequency vs. Ambient Temperature

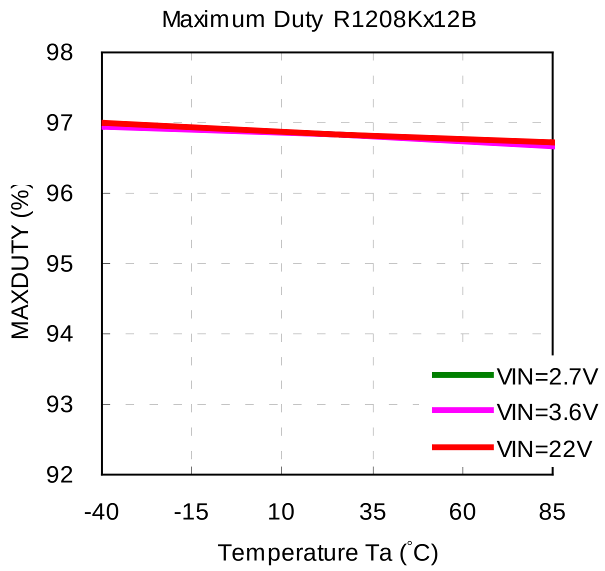




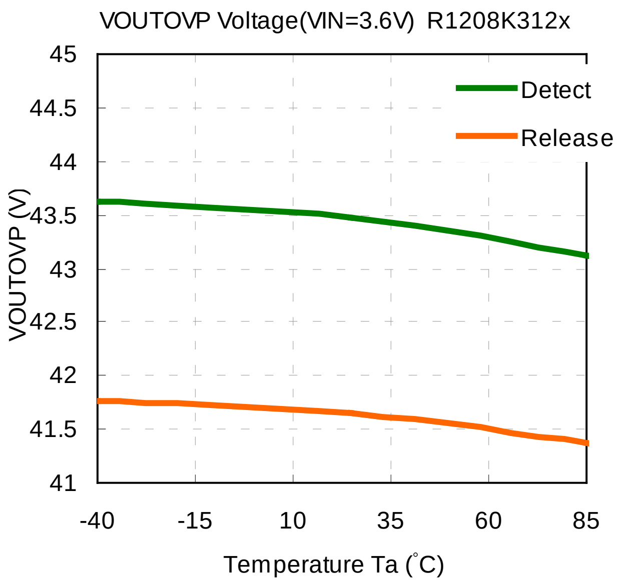
TYPICAL CHARACTERISTICS (continued)

3-11) Maxduty vs. Ambient Temperature

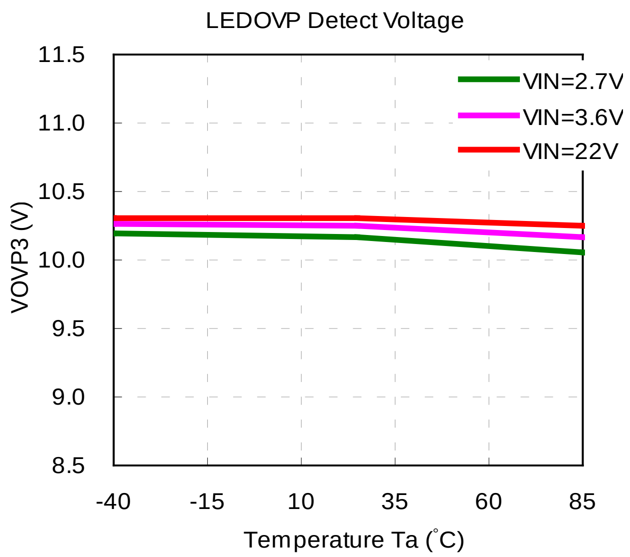




3-12) V_{OUT} OVP Detector Threshold vs. Ambient Temperature

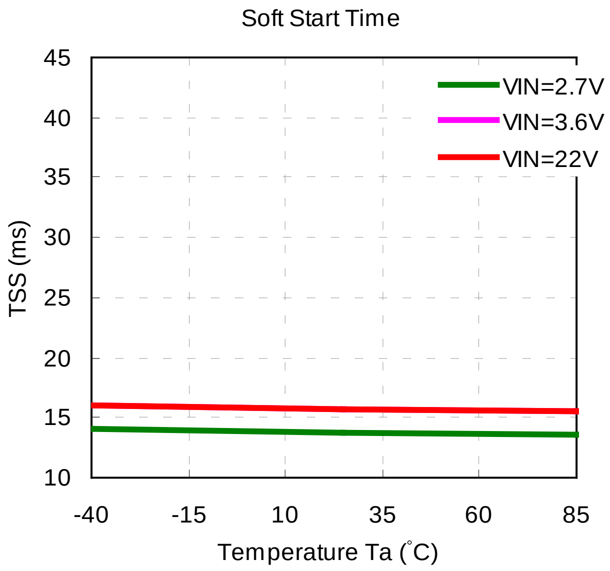


3-13) LED OVP Detector Threshold vs. Ambient Temperature



TYPICAL CHARACTERISTICS (continued)

3-14) Soft-start Time vs. Ambient Temperature



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