PWM Step-up DC/DC Controller

NO.EA-064-181214

OUTLINE

The R1210Nxx2C/xx2D Series are CMOS-based PWM step-up DC/DC Converter controllers, with high accuracy, low supply current.

Each of the R1210Nxx2x Series consists of an oscillator, a PWM circuit, a reference voltage unit, an error amplifier, phase compensation circuit, resistors for voltage detection, a chip enable circuit, a controller against drastic load transient and an output voltage detector. A low ripple, high efficiency step-up DC/DC converter can be composed of this IC with only four external components, or an inductor, a diode, a transistor and a capacitor.

The R1210Nxx2x Series can detect drastic change of output voltage with a circuit controller, the load transient response is improved.

Each of the R1210Nxx2x Series has a driver pin, or 'EXT' pin for external transistor. By connecting a power transistor with low ON-resistance to EXT pin, a large current flows through an inductor, thus, large output current can be supplied.

The built-in chip enable circuit can make the standby mode with ultra low quiescent current.

Since the package for these ICs is small SOT-23-5, high density mounting of the ICs on board is possible.

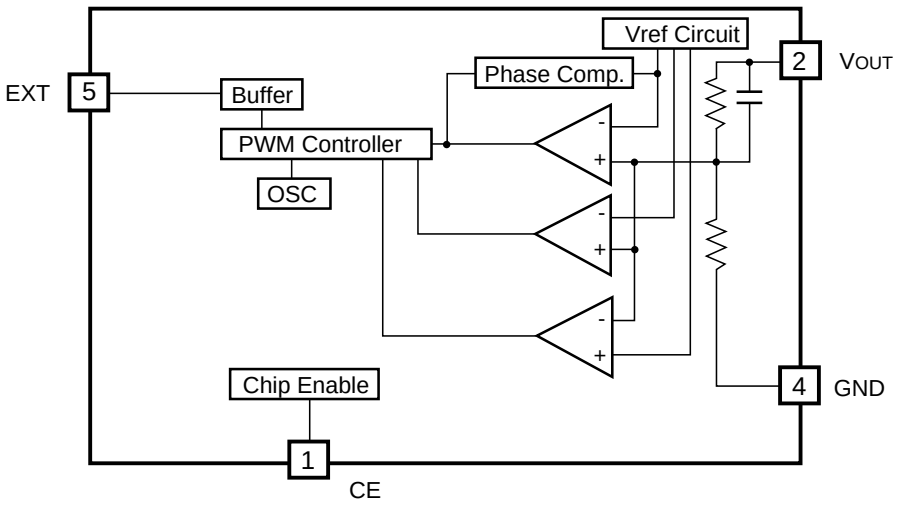
FEATURES

- External Components .....Only an inductor, a diode, a capacitor, and a transistor
- Standby Current .....Max. 0.5μA
- Low Temperature-Drift Coefficient of Output Voltage Typ. ±100ppm/°C
- Output Voltage .....Stepwise Setting with a step of 0.1V in the range of 2.2V to 6.0V
- Two choices of Basic Oscillator Frequency 100kHz (xx2C), 180kHz (xx2D)
- Output Voltage Accuracy.....±2.5%
- Small Package SOT-23-5
- Low Ripple, Low Noise
- Oscillator Start-up Voltage .....Max. 0.8V

APPLICATIONS

- Power source for battery-powered equipment.
- Power source for portable communication appliances, cameras, VCRs
- Power source for appliances of which require higher voltage than battery voltage.

BLOCK DIAGRAMS



SELECTION GUIDE

In the R1210N Series, the output voltage, the oscillator frequency for the ICs can be selected at the user's request.

The selection can be made by designating the part number as shown below;

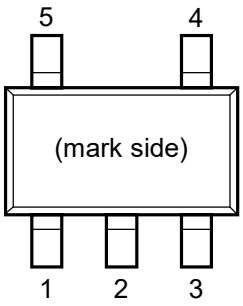
Product Name	Package	Quantity per Reel	Pb Free	Halogen Free
R1210Nxx2∗-TR-FE	SOT-23-5	3,000 pcs	Yes	Yes

xx : Setting Output Voltage(V_{OUT})
Stepwise setting with a step of 0.1V in the range of 2.2V（22）to 6.0V（60）

∗ : Designation of Oscillator Frequency
C : 100kHz
D : 180kHz

PIN CONFIGURATION

SOT-23-5



PIN DESCRIPTIONS

Pin No	Symbol	Pin Description
1	CE	Chip Enable Pin
2	V_{OUT}	Pin for Output Voltage
3	NC	No Connection
4	GND	Ground Pin
5	EXT	External Transistor Drive Pin

ABSOLUTE MAXIMUM RATINGS

Symbol	Item	Rating	Unit
V_{OUT}	V_{OUT} Pin Output Voltage	-0.3 to 9.0	V
V_{EXT}	EXT Pin Output Voltage	-0.3 to V_{OUT}+0.3	V
V_{CE}	CE Pin Input Voltage	-0.3 to 9.0	V
I_{EXT}	EXT Pin Output Current	±40	mA
P_D	Power Dissipation	420	mW
Topt	Operating Temperature Range	−40 to +85	°C
Tstg	Storage Temperature Range	−55 to +125	°C

*1) For Power Dissipation, please refer to PACKAGE 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.

ELECTRICAL CHARACTERISTICS

- **R1210Nxx2x**

Topt=25°C

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit
V_{OUT}	Output Voltage	V_{IN}=V_{SET}×0.6, I_{OUT}=1mA	×0.975		×1.025	V
V_{IN}	Maximum Input Voltage				8	V
$\Delta V_{OUT}/\Delta T$	Step-up Output Voltage Temperature Coefficient	−40°C ≦ Topt ≦ 85°C		±100		ppm/°C
Vstart	Start-up Voltage	V_{IN}=0V→2V			0.8	V
Istandby	Supply Current 3(Standby)	V_{OUT}=6.5V,V_{CE}=0V			0.5	μA
I_{DD1}	Supply Current 1	V_{OUT}= V_{SET}×0.96 EXT at no load 2.2V ≦ V_{SET} ≦ 2.4V		18	35	μA (xx2C)
				23	45	μA (xx2D)
		V_{OUT}= V_{SET}×0.96 EXT at no load 2.5V ≦ V_{SET} ≦ 3.0V		20	40	μA (xx2C)
				25	50	μA (xx2D)
		V_{OUT}= V_{SET}×0.96 EXT at no load 3.1V ≦ V_{SET} ≦ 3.9V		25	50	μA (xx2C)
				30	60	μA (xx2D)
		V_{OUT}= V_{SET}×0.96 EXT at no load 4.0V ≦ V_{SET} ≦ 4.4V		30	60	μA (xx2C)
				35	70	μA (xx2D)
		V_{OUT}= V_{SET}×0.96 EXT at no load 4.5V ≦ V_{SET} ≦ 4.9V		35	70	μA (xx2C)
				40	80	μA (xx2D)
		V_{OUT}= V_{SET}×0.96 EXT at no load 5.0V ≦ V_{SET} ≦ 5.4V		45	90	μA (xx2C)
				50	100	μA (xx2D)
		V_{OUT}= V_{SET}×0.96 EXT at no load 5.5V ≦ V_{SET} ≦ 6.0V		50	100	μA (xx2C)
				55	110	μA (xx2D)
I_{DD2}	Supply Current 2	V_{OUT}=V_{CE}=V_{SET}+0.5		10	15	μA (xx2C)
				15	22	μA (xx2D)

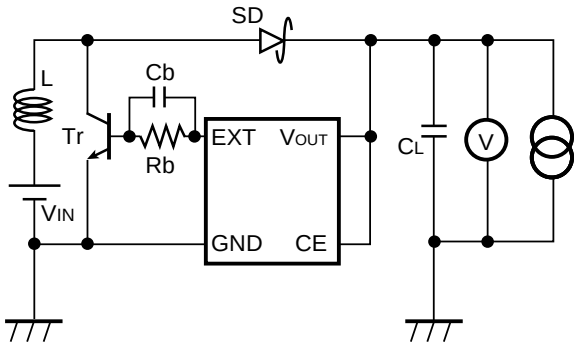
Symbol	Item	Conditions	Min.	Typ.	Max.	Unit
I_{EXTH}	EXT "H" Output Current	2.2V ≦ V_{SET} ≦ 2.5V V_{EXT}=V_{OUT}-0.4V			-1.0	mA
		2.6V ≦ V_{SET} ≦ 3.0V V_{EXT}=V_{OUT}-0.4V			-2.0	mA
		3.1V ≦ V_{SET} ≦ 3.5V V_{EXT}=V_{OUT}-0.4V			-2.5	mA
		3.6V ≦ V_{SET} ≦ 4.0V V_{EXT}=V_{OUT}-0.4V			-3.0	mA
		4.1V ≦ V_{SET} ≦ 4.5V V_{EXT}=V_{OUT}-0.4V			-3.5	mA
		4.6V ≦ V_{SET} ≦ 5.0V V_{EXT}=V_{OUT}-0.4V			-4.0	mA
		5.1V ≦ V_{SET} ≦ 5.5V V_{EXT}=V_{OUT}-0.4V			-4.5	mA
		5.6V ≦ V_{SET} ≦ 6.0V V_{EXT}=V_{OUT}-0.4V			-5.0	mA
fosc	Maximum Oscillator Frequency	V_{OUT}=V_{CE}=V_{SET}×0.96	80	100	120	kHz (xx2C)
			144	180	216	kHz (xx2D)
Δ fosc/ ΔT	Oscillator Frequency Temperature Coefficient	−40°C ≦ Topt ≦ 85°C		0.5		kHz/°C (xx2C)
				0.6		kHz/°C (xx2D)
Maxdty	Oscillator Maximum Duty Cycle	V_{OUT}=V_{CE}=V_{SET}×0.96, (V_{EXT} "H" Side)	70	85	97	%
I_{EXTL}	EXT "L" Output Current	2.2V ≦ V_{SET} ≦ 2.5V,V_{EXT}=0.4V	1.0			mA
		2.6V ≦ V_{SET} ≦ 3.0V,V_{EXT}=0.4V	2.0			mA
		3.1V ≦ V_{SET} ≦ 3.5V,V_{EXT}=0.4V	2.5			mA
		3.6V ≦ V_{SET} ≦ 4.0V,V_{EXT}=0.4V	3.0			mA
		4.1V ≦ V_{SET} ≦ 4.5V,V_{EXT}=0.4V	3.5			mA
		4.6V ≦ V_{SET} ≦ 5.0V,V_{EXT}=0.4V	4.0			mA
		5.1V ≦ V_{SET} ≦ 5.5V,V_{EXT}=0.4V	4.5			mA
		5.6V ≦ V_{SET} ≦ 6.0V,V_{EXT}=0.4V	5.0			mA
V_{CEH}	CE "H" Input Voltage	V_{OUT}=V_{SET}×0.96	0.9			V
V_{CEL}	CE "L" Input Voltage	V_{OUT}=V_{SET}×0.96			0.3	V
I_{CEH}	CE "H" Input Current	V_{OUT}=V_{CE}=6.5V	-0.1	0.0	0.1	μA
I_{CEL}	CE "L" Input Current	V_{IN}=6.5V, V_{CE}=0V	-0.1	0.0	0.1	μA

*Note: V_{SET} means setting Output Voltage.

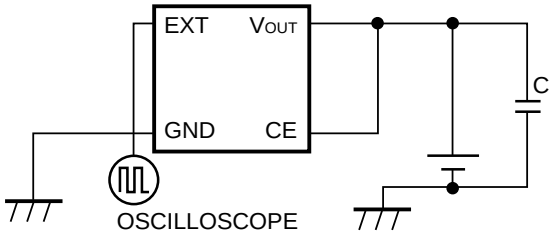
RECOMMENDED OPERATING CONDITIONS (ELECTRICAL CHARACTERISTICS)

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.

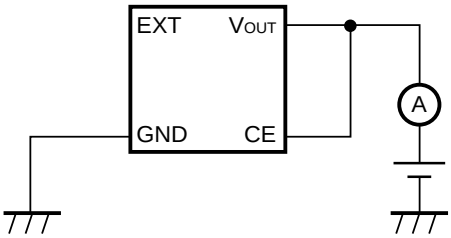
TEST CIRCUITS



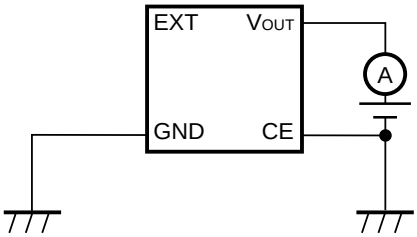
Test Circuit 1



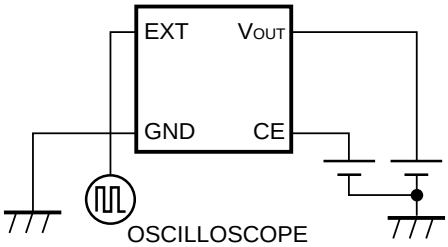
Test Circuit 2



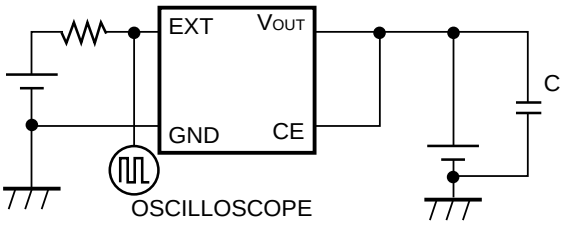
Test Circuit 3



Test Circuit 4



Test Circuit 5



Test Circuit 6

Inductor (L) : 27μH (Sumida Electric Co., Ltd. CD104NP)
Diode (SD) : RB491D (Rohm, Schottky Type)
Capacitor (CL) : 47μF×2 (Tantalum Type)
Transistor (Tr) : 2SD1628G
Base Resistor (Rb) : 300Ω
Base Capacitor (Cb) : 0.01μF(Ceramic Type)

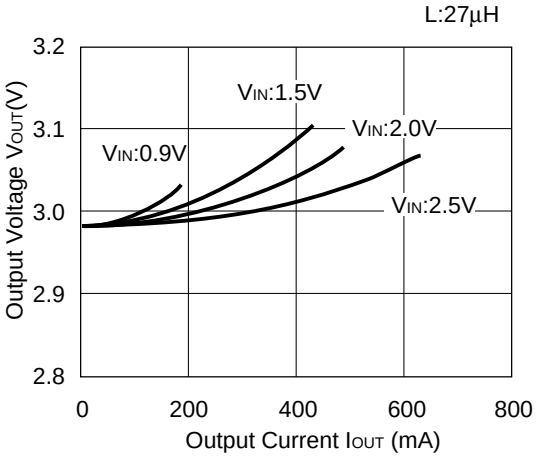
The typical characteristics were obtained by use of these test circuits.

Test Circuit 1 : Typical Characteristics 1) 2) 3) 4) 5)
Test Circuit 2 : Typical Characteristics 9) 10)
Test Circuit 3 : Typical Characteristics 6) 7)
Test Circuit 4 : Typical Characteristics 8)
Test Circuit 5 : Typical Characteristics 11)
Test Circuit 6 : Typical Characteristics 12)

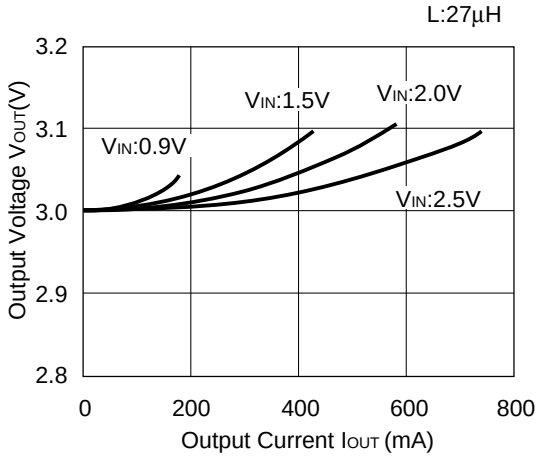
TYPICAL CHARACTERISTICS

1) Output Voltage vs. Output Current

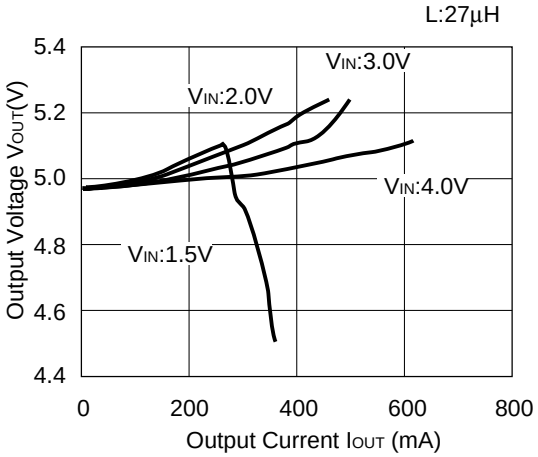
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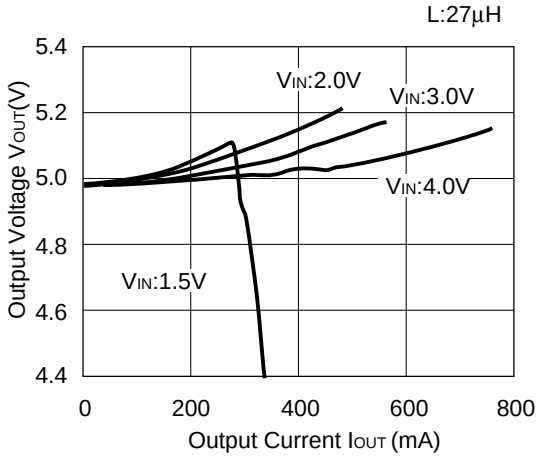
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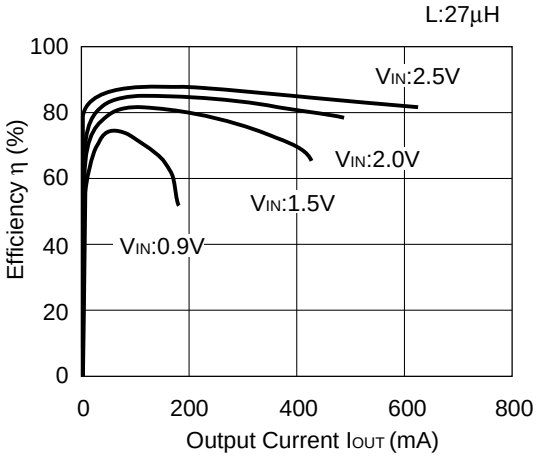


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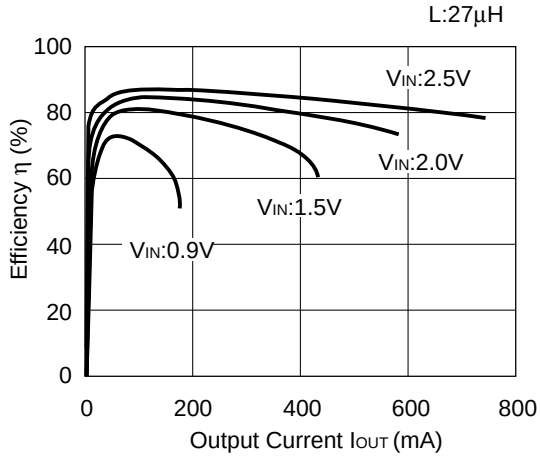


2) Efficiency vs. Output Current

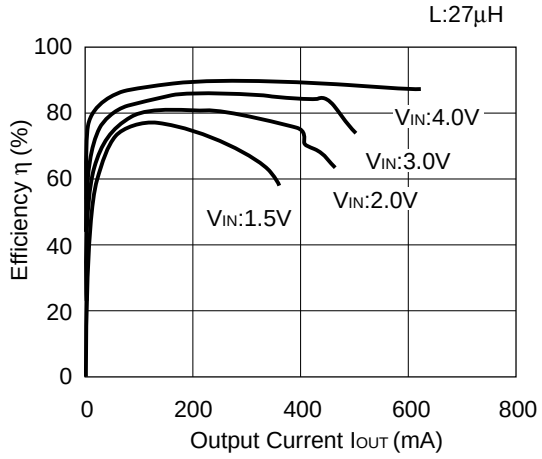
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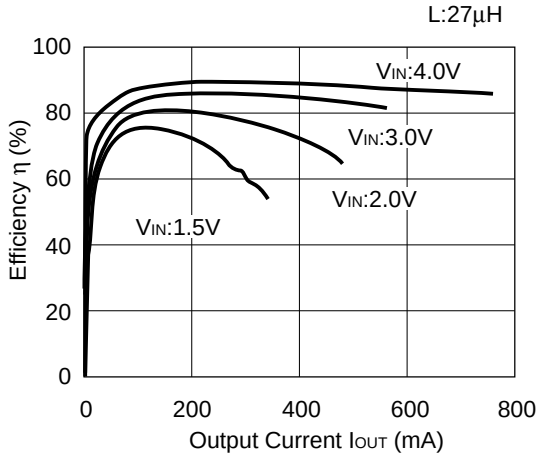
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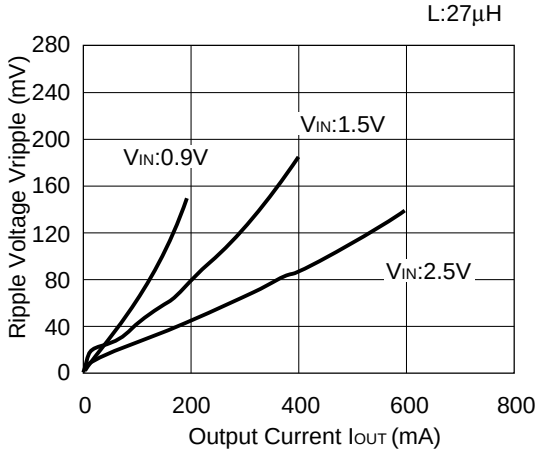


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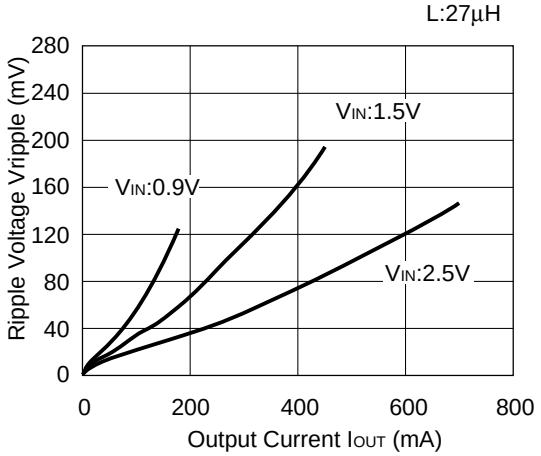


3) Ripple Voltage vs. Output Current

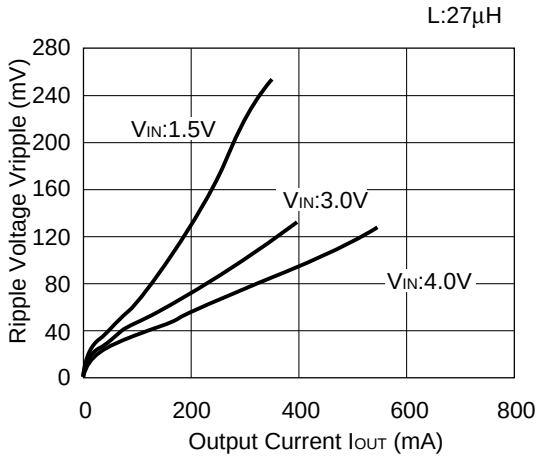
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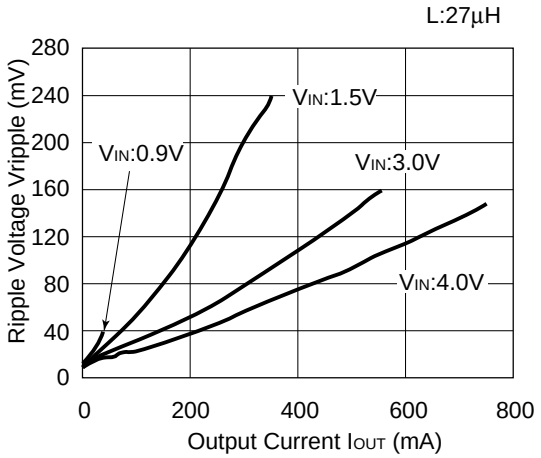
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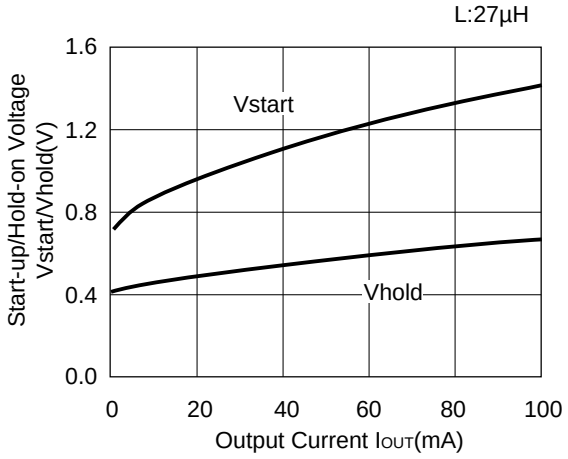


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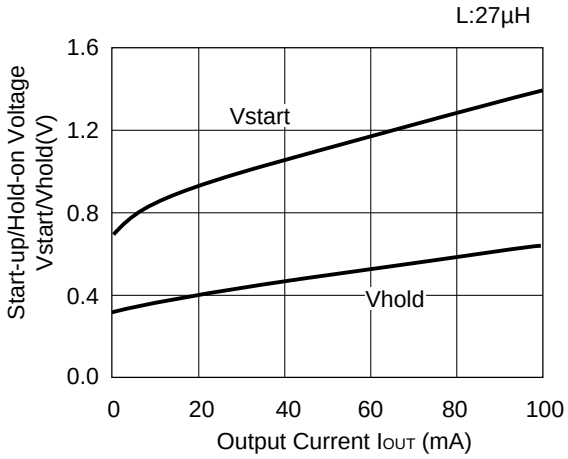


4) Start-up Voltage/ Hold-on Voltage vs. Output Current (Topt=25°C)

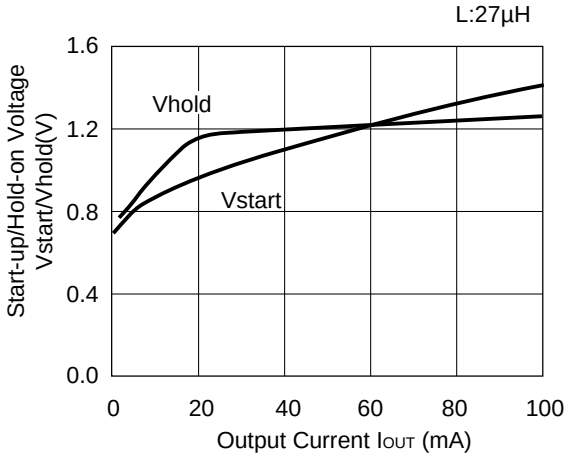
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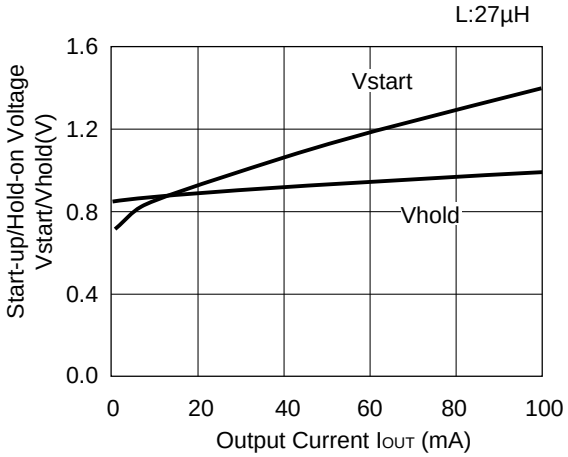
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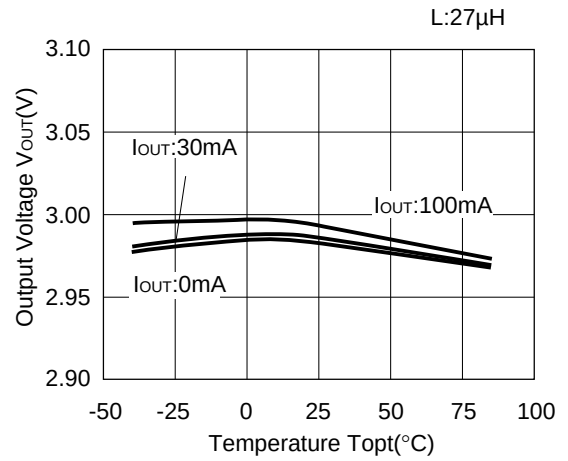


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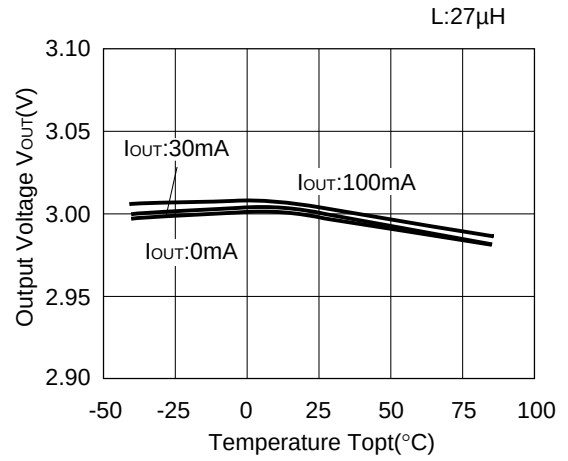


5) Output Voltage vs. Temperature

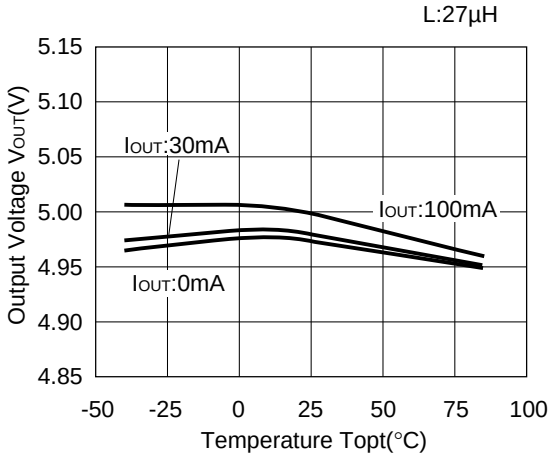
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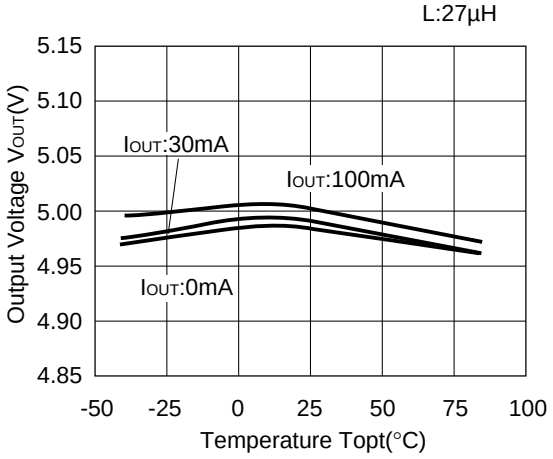
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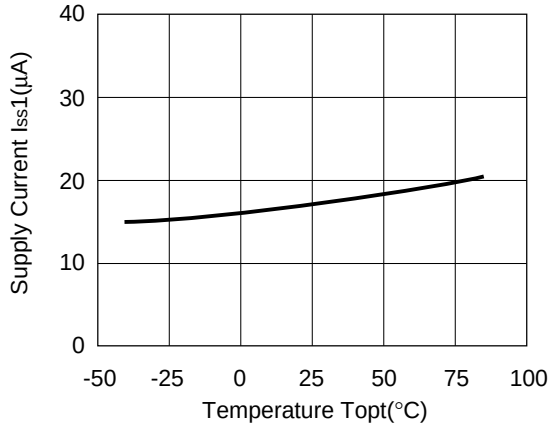


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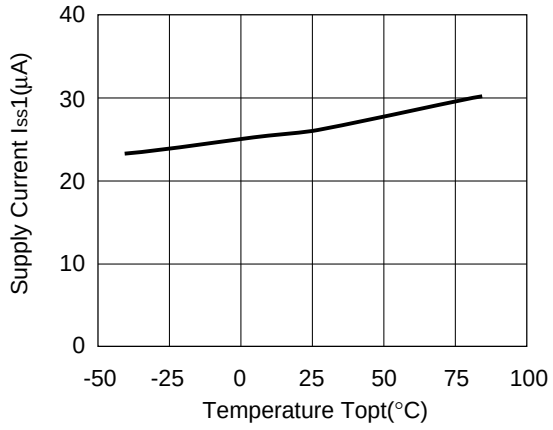


6) Supply Current 1 vs. Temperature

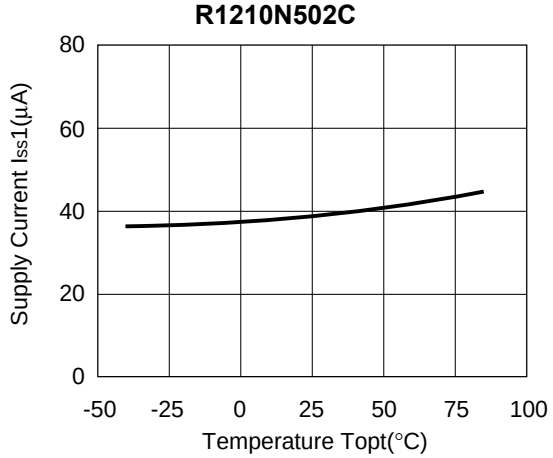
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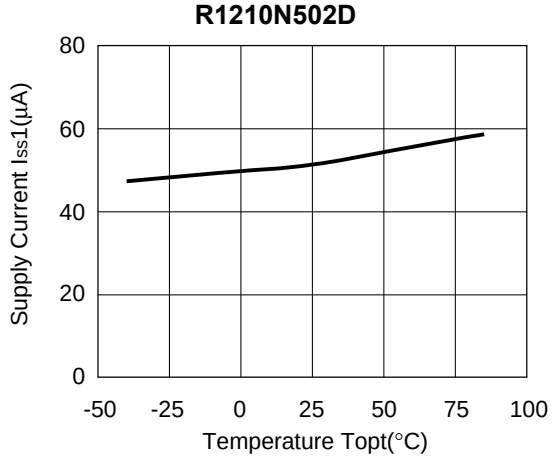
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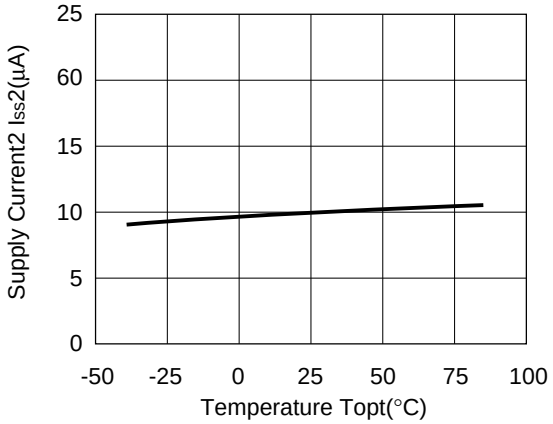


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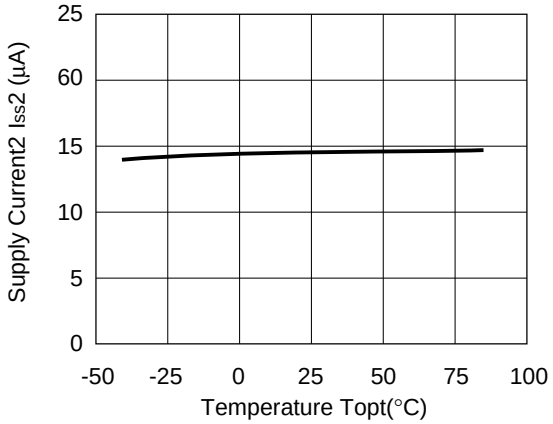


7) Supply Current 2 vs. Temperature

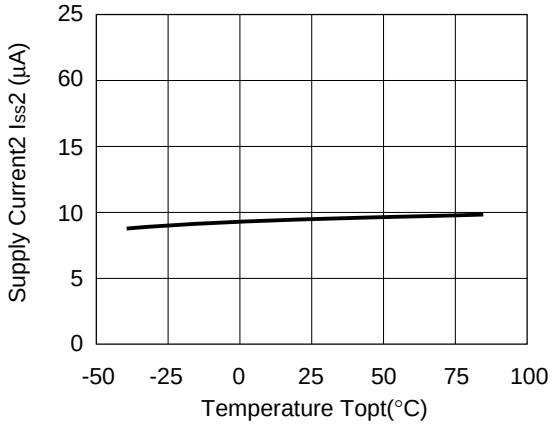
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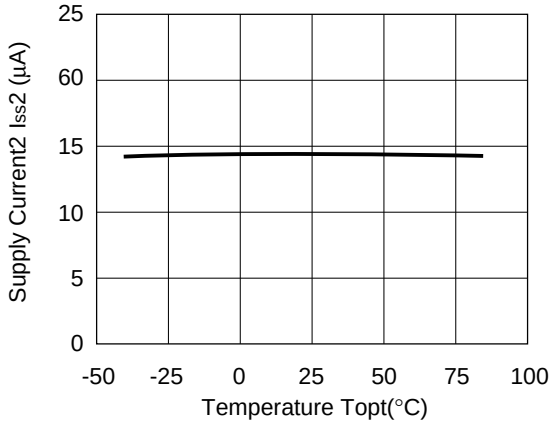
R1210N302D



R1210N502C

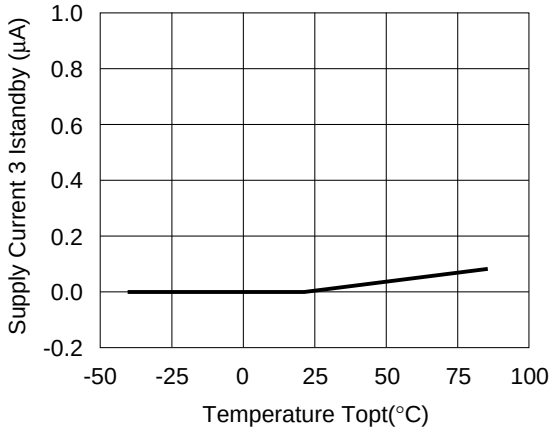


R1210N502D

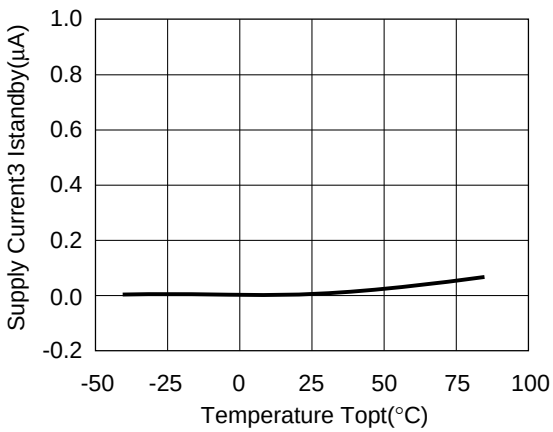


8) Supply Current 3 vs. Temperature

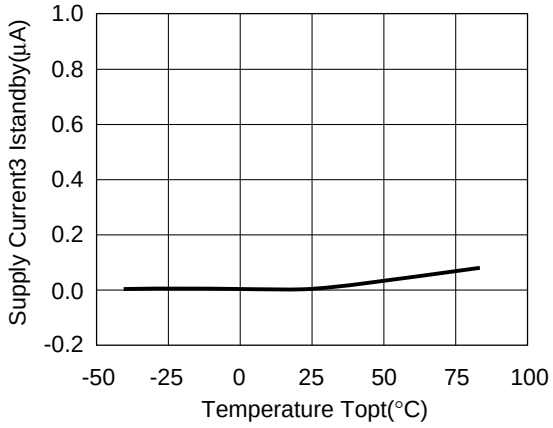
R1210N302C



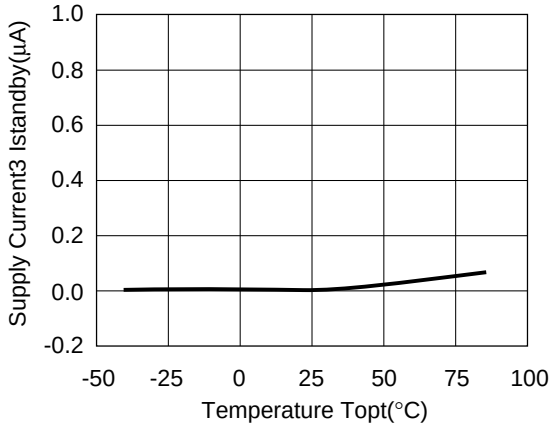
R1210N302D



R1210N502C

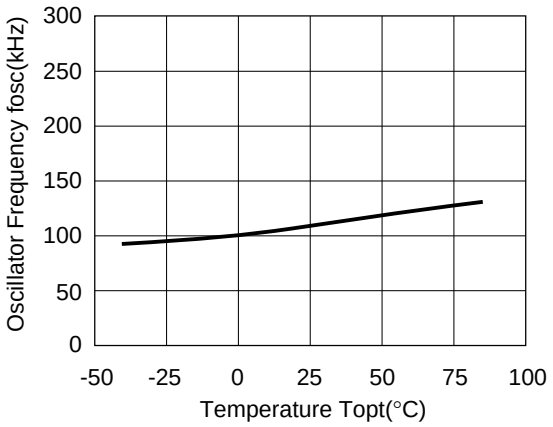


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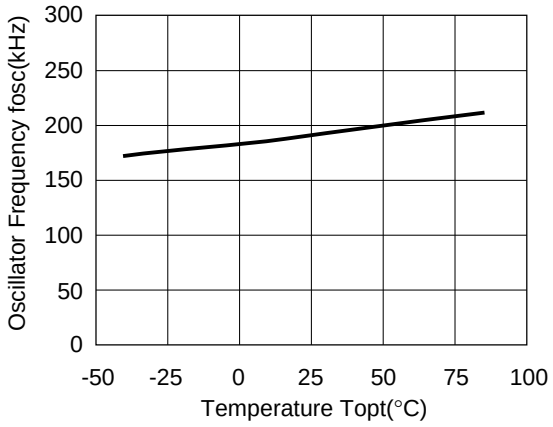


9) Oscillator Frequency vs. Temperature

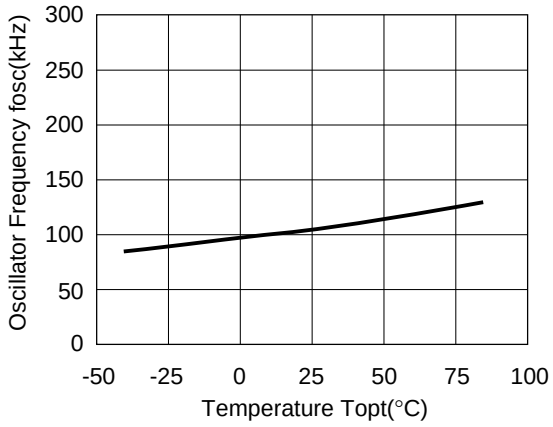
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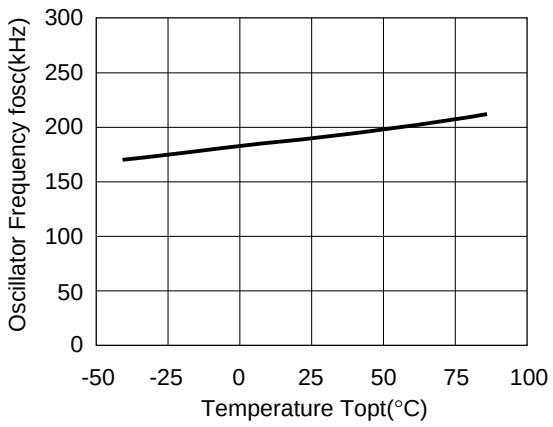
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R1210N502C

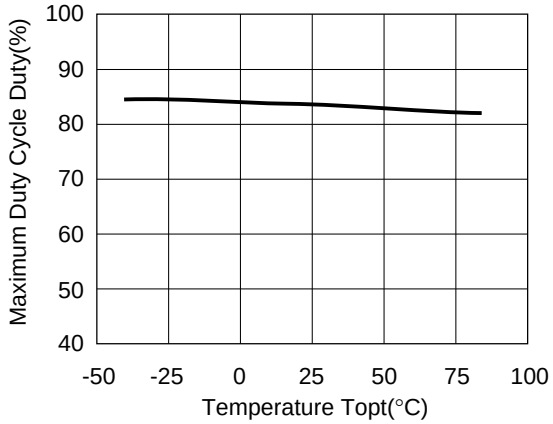


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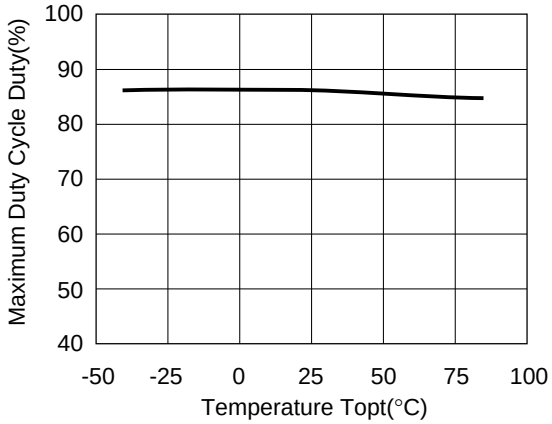


10) Maximum Duty Cycle vs. Temperature

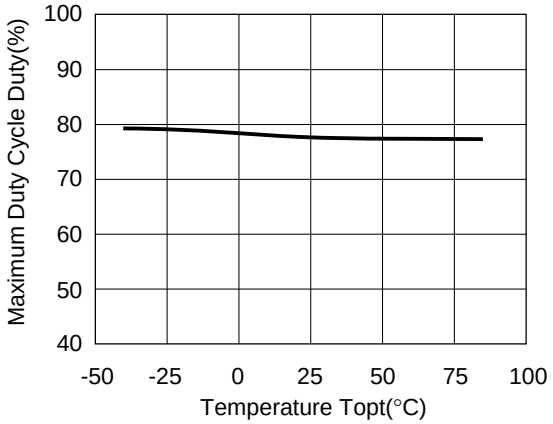
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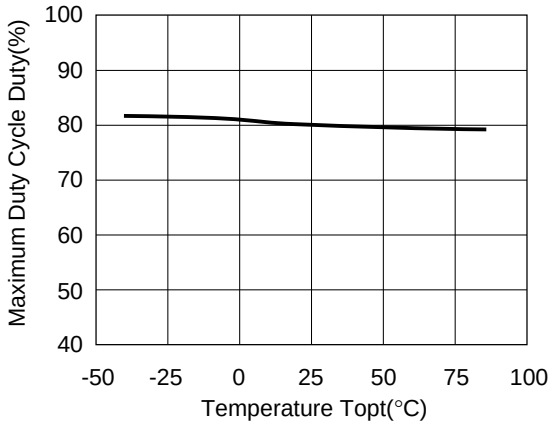
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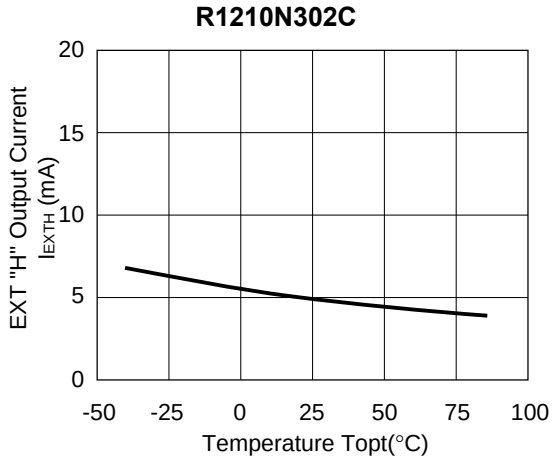


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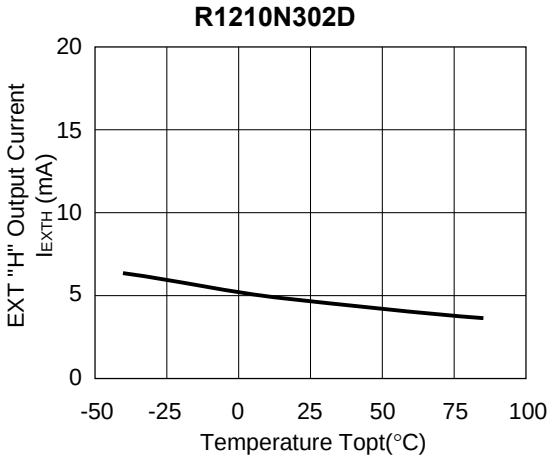


11) EXT "H" Output Current vs. Temperature

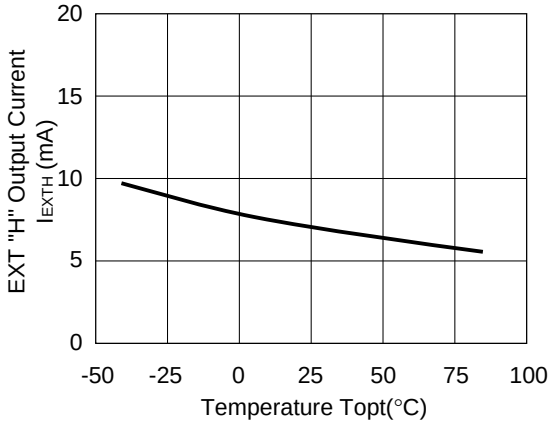
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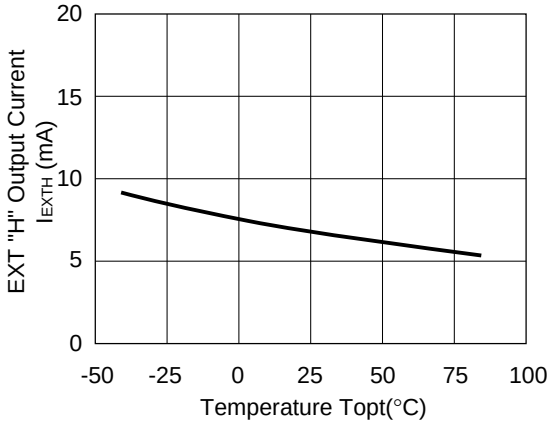
R1210N302D



R1210N502C

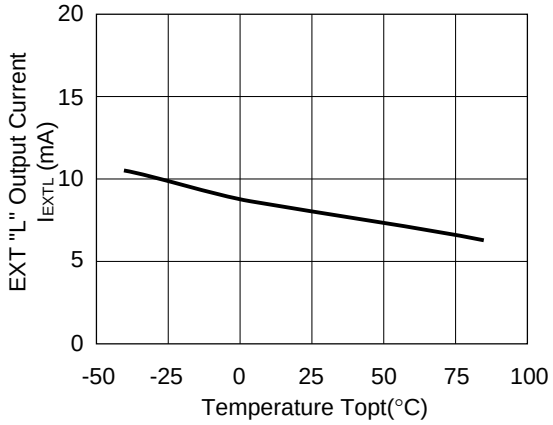


R1210N502D

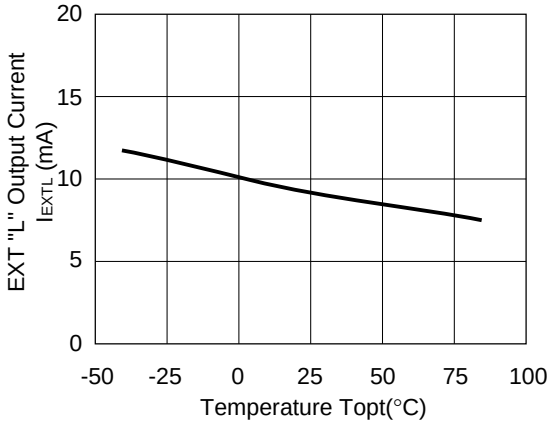


12) EXT "L" Output Current vs. Temperature

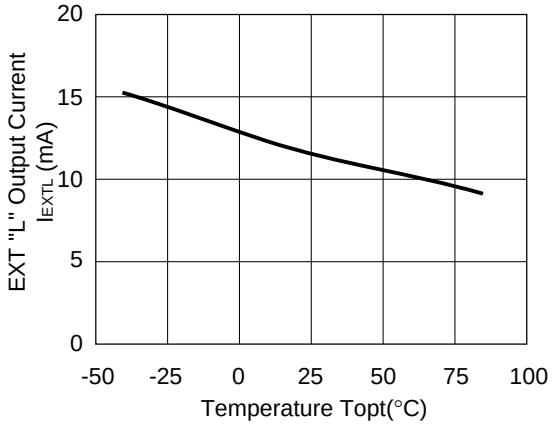
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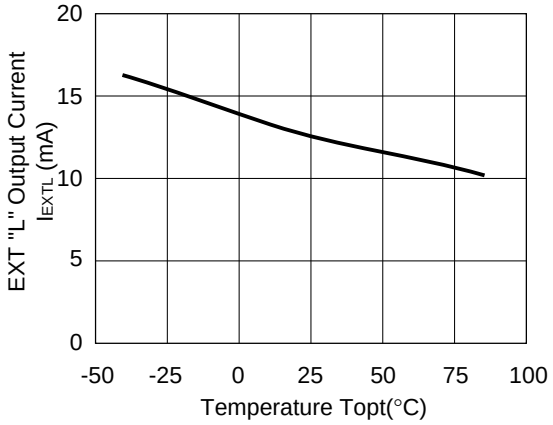
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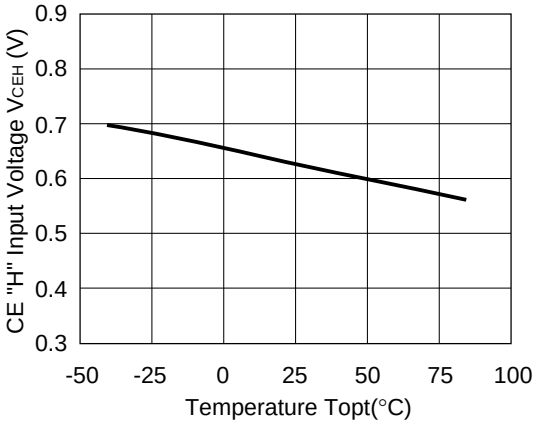


R1210N502D

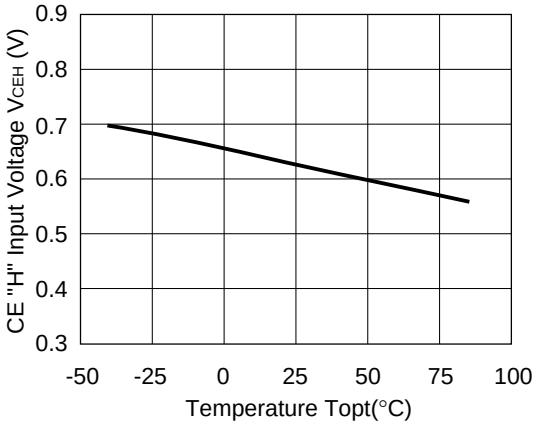


13) CE "H" Input Voltage vs. Temperature

R1210N602C

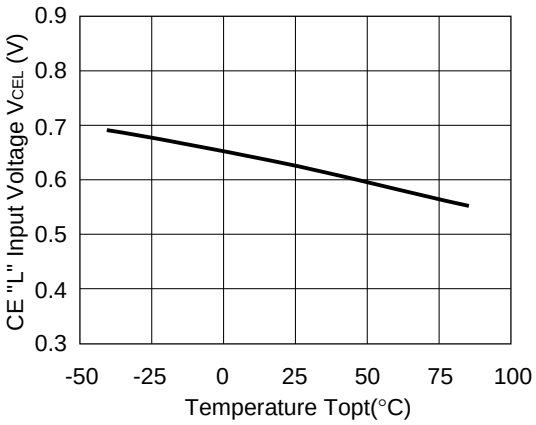


R1210N602D

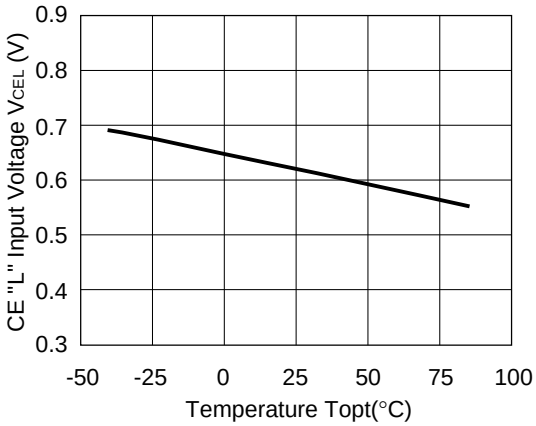


14) CE "L" Input Voltage vs. Temperature

R1210N602C

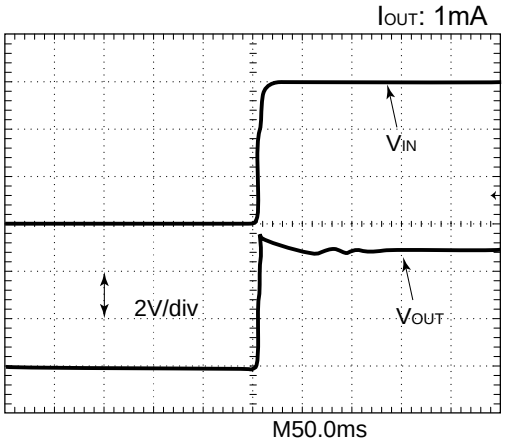


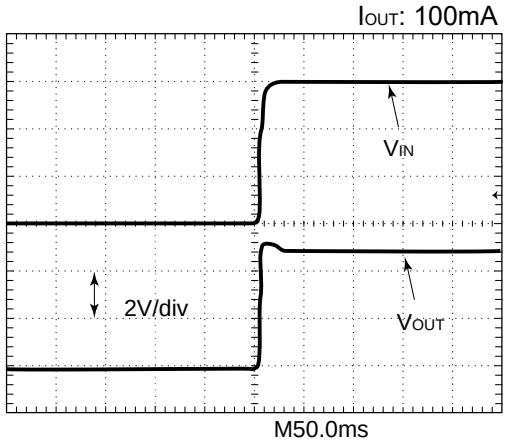
R1210N602D



15) Output Waveform at Power-on (Topt=25°C)

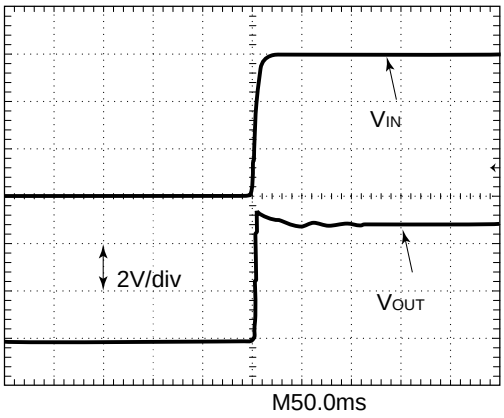
((R1210N502C)) (V_{IN}: 0V→3.0V)



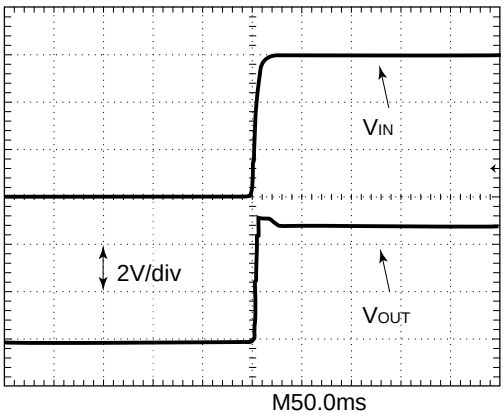


((R1210N502D)) (V_{IN}: 0V→3.0V)

I_{OUT}: 1mA

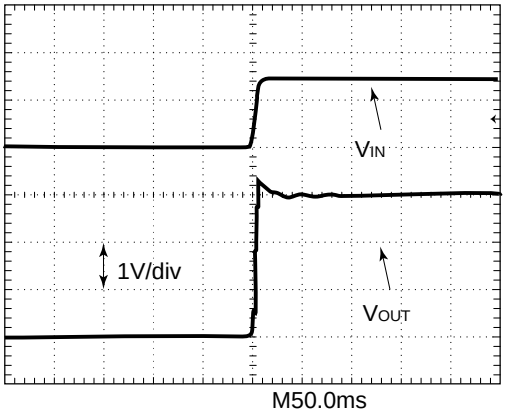


I_{OUT}: 100mA

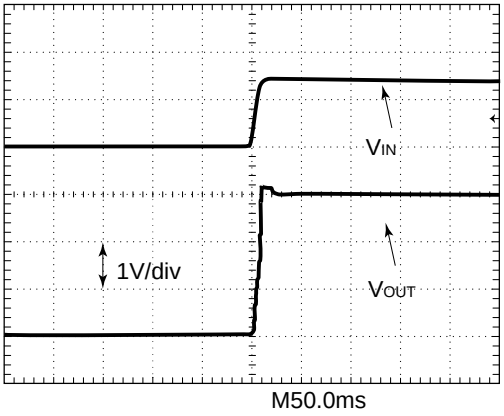


((R1210N302C)) (V_{IN}: 0V→1.5V)

I_{OUT}: 1mA

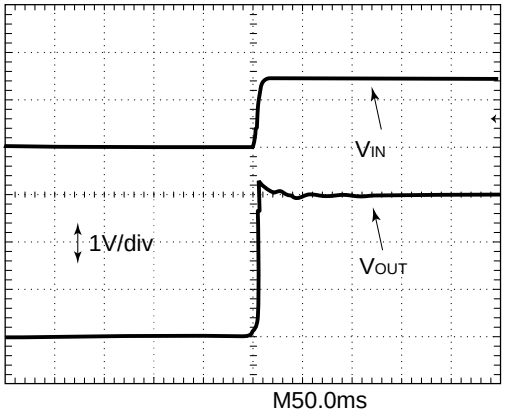


I_{OUT}: 100mA

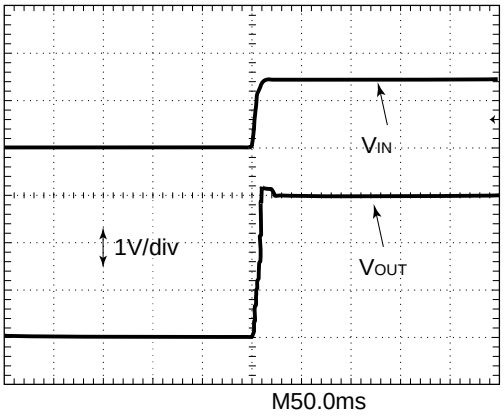


((R1210N302D)) (V_{IN}: 0V→1.5V)

I_{OUT}: 1mA

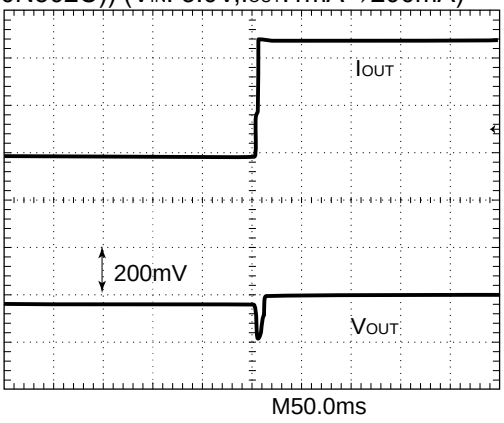


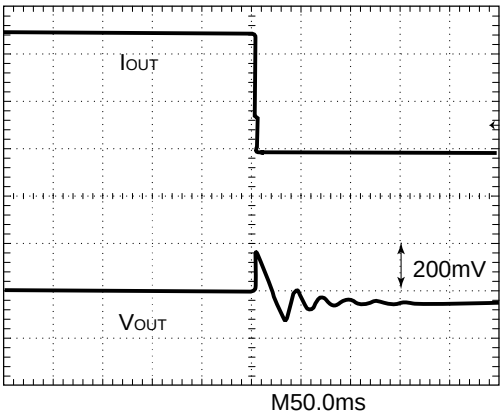
I_{OUT}: 100mA



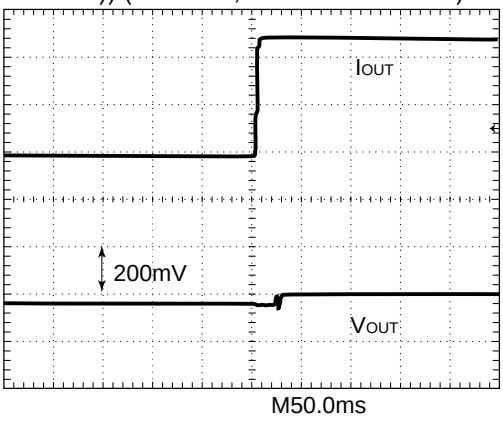
16) Load Transient Response (Topt=25°C)

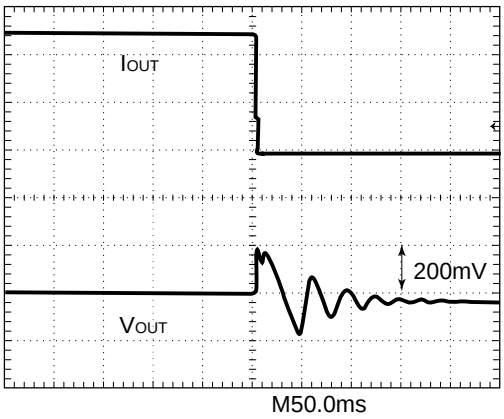
((R1210N502C)) (V_{IN}: 3.0V,I_{OUT}:1mA→200mA)



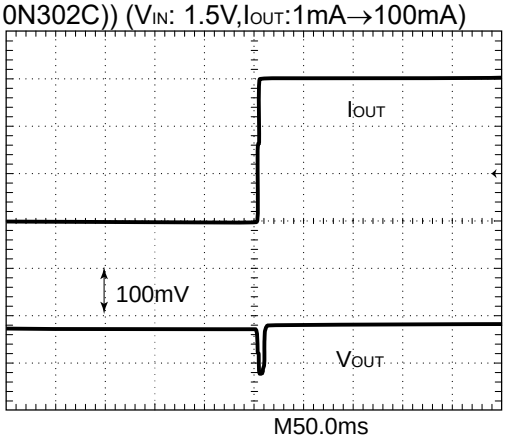


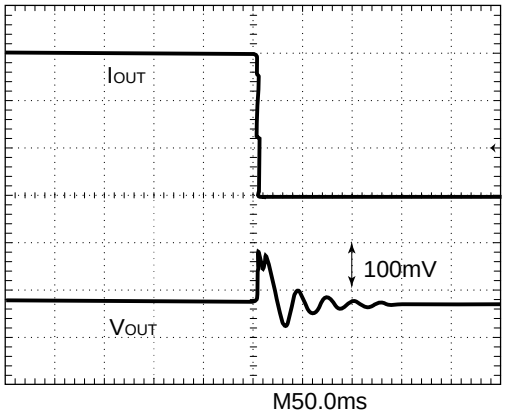
((R1210N502D)) (V_{IN}: 3.0V,I_{OUT}:1mA→200mA)



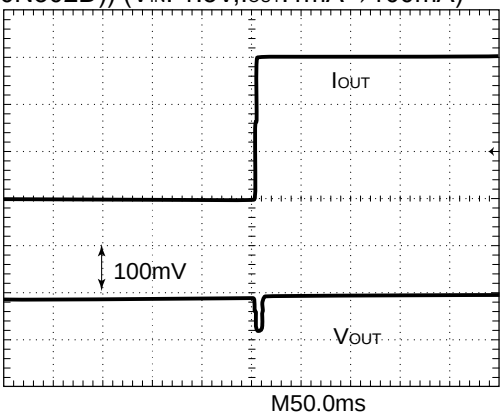


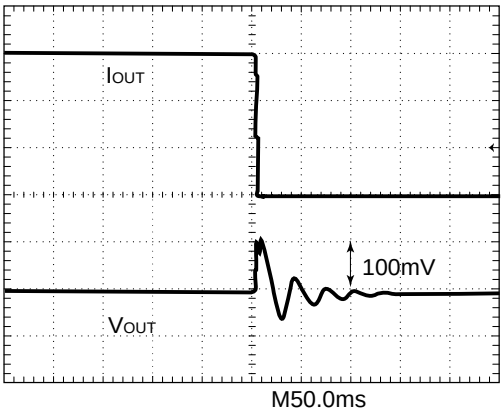
((R1210N302C)) (V_{IN}: 1.5V,I_{OUT}:1mA→100mA)





((R1210N302D)) (V_{IN}: 1.5V,I_{OUT}:1mA→100mA)





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9. WLCSP products should be used in light shielded environments. The light exposure can influence functions and characteristics of the products under operation or storage.
10. There can be variation in the marking when different AOI (Automated Optical Inspection) equipment is used. In the case of recognizing the marking characteristic with AOI, please contact our sales or our distributor before attempting to use AOI.
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