
SOT-23-5 PWM Step-up DC/DC CONVERTER

R1210N××2× SERIES

APPLICATION MANUAL

NO. EA-064-0006

R1210N××2× SERIES

OUTLINE

The R1210NXX2C/XX2D Series are PWM step-up DC/DC Converter controllers, with high accuracy, low supply current by CMOS process.

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.

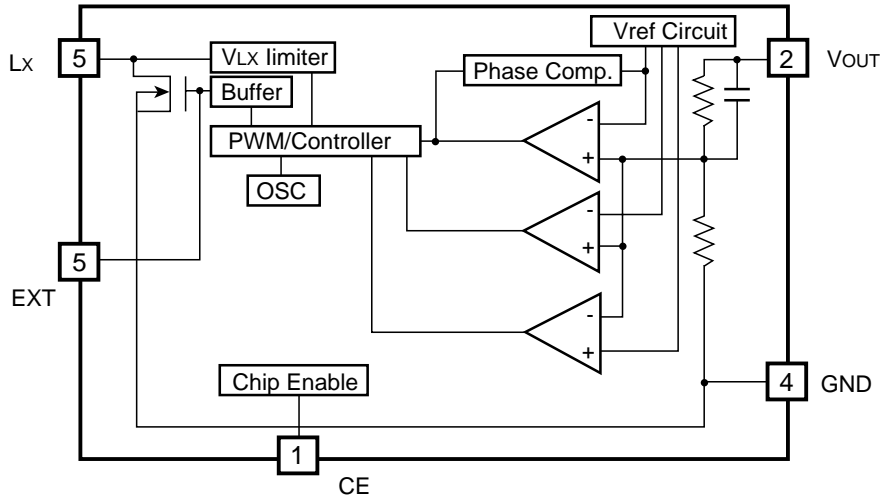
FEATURES

- External Components Only an inductor, a diode, a capacitor, and a transistor
- Standby Current TYP. 0 μ A
- Low Temperature-Drift Coefficient of Output Voltage..... TYP. \pm 100ppm/ $^{\circ}$ 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)
- Small Package SOT-23-5 (Mini-mold)
- 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 which require higher voltage than battery voltage.

BLOCK DIAGRAM



SELECTION GUIDE

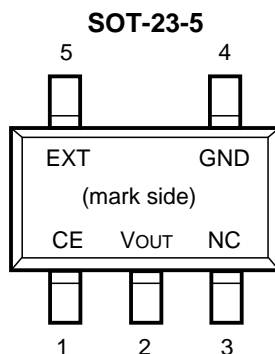
In the R1210N Series, the output voltage, the oscillator frequency, the optional function, and the taping type for the ICs can be selected at the user's request.

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

R1210NXXXX-XX
 ↑ ↑↑ ↑
 a bc d

| Code | Contents |
|------|---|
| a | Setting Output Voltage(V _{OUT}): Stepwise setting with a step of 0.1V in the range of 2.2V to 6.0V |
| b | Designation of Driver 2: External Tr. Driver |
| c | Designation of Oscillator Frequency C: 100kHz D: 180kHz |
| d | Designation of Taping Type; Ex.: TR, TL (refer to Taping Specification) "TR" is prescribed as a standard. |

PIN CONFIGURATION



PIN DESCRIPTION

| Pin No. | Symbol | 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 | 9 | V |
| V _{EXT} | EXT Pin Output Voltage | -0.3~V _{OUT} +0.3 | V |
| V _{CE} | CE Pin Input Voltage | 9 | V |
| I _{EXT} | EXT Pin Inductor Drive Output Current | ±40 | mA |
| PD | Power Dissipation | 250 | mW |
| T _{opt} | Operating Temperature Range | -40~+85 | °C |
| T _{stg} | Storage Temperature Range | -55~+125 | °C |

ELECTRICAL CHARACTERISTICS

• R1210NXX2

(T_{opt} = 25°C)

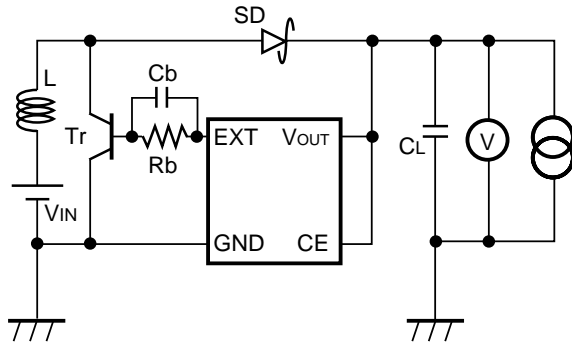
| Symbol | Item | Conditions | MIN. | TYP. | MAX. | Unit |
|-----------------------|--|---|--------|------|--------|-----------|
| V _{OUT} | Output Voltage | V _{IN} = V _{SET} × 0.6, I _{OUT} = 1mA | ×0.975 | | ×1.025 | V |
| V _{IN} | Maximum Input Voltage | | | | 8 | V |
| ΔV _{OUT} /ΔT | Step-up Output Voltage Temperature Coefficient | -40°C ≤ T _{opt} ≤ 85°C | | ±100 | | ppm/°C |
| V _{START} | Start-up Voltage | V _{IN} = 0V → 2V | | | 0.8 | V |
| I _{DD2} | Supply Current 2 | V _{OUT} = V _{CE} = V _{SET} + 0.5V | | 10 | 15 | μA (xx2C) |
| | | | | 15 | 22 | μA (xx2D) |
| I _{standby} | Supply Current 3(Standby) | V _{OUT} = 6.5V V _{CE} = 0V | | | 0.5 | μA |
| I _{DD1} | Supply Current1 | 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 4V ≤ 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) |

| Symbol | Item | Conditions | MIN. | TYP. | MAX. | Unit |
|-------------------|------------------------------|---|------|------|------|---------------|
| I _{DD1} | Supply Current1 | V _{OUT} =V _{SET} ×0.96 EXT at no load 5V ≤ 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 Current2 | V _{OUT} =V _{CE} =V _{SET} +0.5V | | 10 | 15 | μA (xx2C) |
| | | | | 15 | 22 | μA (xx2D) |
| 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 | |
| | | 3.1V ≤ V _{SET} ≤ 3.5V, V _{EXT} =V _{OUT} -0.4V | | | -2.5 | |
| | | 3.6V ≤ V _{SET} ≤ 4.0V, V _{EXT} =V _{OUT} -0.4V | | | -3.0 | |
| | | 4.1V ≤ V _{SET} ≤ 4.5V, V _{EXT} =V _{OUT} -0.4V | | | -3.5 | |
| | | 4.6V ≤ V _{SET} ≤ 5.0V, V _{EXT} =V _{OUT} -0.4V | | | -4.0 | |
| | | 5.1V ≤ V _{SET} ≤ 5.5V, V _{EXT} =V _{OUT} -0.4V | | | -4.5 | |
| | | 5.6V ≤ V _{SET} ≤ 6.0V, V _{EXT} =V _{OUT} -0.4V | | | -5.0 | |
| f _{osc} | Maximum Oscillator Frequency | V _{OUT} =V _{CE} =V _{SET} ×0.96 | 80 | 100 | 120 | kHz (xx2C) |
| | | | 144 | 180 | 216 | kHz (xx2D) |

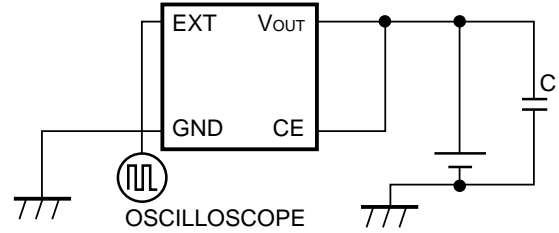
| Symbol | Item | Conditions | MIN. | TYP. | MAX. | Unit |
|---------------------------|--|---|------|------|------|-----------------------------------|
| $\Delta f_{osc}/\Delta T$ | Oscillator Frequency Temperature Coefficient | $-40^{\circ}\text{C} \leq T_{opt} \leq 85^{\circ}\text{C}$ | | 0.5 | | kHz/ $^{\circ}\text{C}$ (xx2C) |
| | | | | 0.6 | | kHz/ $^{\circ}\text{C}$ (xx2D) |
| Maxdty | Oscillator Maximum Duty Cycle | $V_{OUT} = V_{CE} = V_{SET} \times 0.96$, (V_{EXT} : "H" side) | 70 | 85 | 97 | % |
| I_{EXTL} | EXT "L" Output Current | $2.2\text{V} \leq V_{SET} \leq 2.5\text{V}, V_{EXT} = 0.4\text{V}$ | 1.0 | | | mA |
| | | $2.6\text{V} \leq V_{SET} \leq 3.0\text{V}, V_{EXT} = 0.4\text{V}$ | 2.0 | | | |
| | | $3.1\text{V} \leq V_{SET} \leq 3.5\text{V}, V_{EXT} = 0.4\text{V}$ | 2.5 | | | |
| | | $3.6\text{V} \leq V_{SET} \leq 4.0\text{V}, V_{EXT} = 0.4\text{V}$ | 3.0 | | | |
| | | $4.1\text{V} \leq V_{SET} \leq 4.5\text{V}, V_{EXT} = 0.4\text{V}$ | 3.5 | | | |
| | | $4.6\text{V} \leq V_{SET} \leq 5.0\text{V}, V_{EXT} = 0.4\text{V}$ | 4.0 | | | |
| | | $5.1\text{V} \leq V_{SET} \leq 5.5\text{V}, V_{EXT} = 0.4\text{V}$ | 4.5 | | | |
| | | $5.6\text{V} \leq V_{SET} \leq 6.0\text{V}, V_{EXT} = 0.4\text{V}$ | 5.0 | | | |
| V_{CEH} | CE "H" Input Voltage | $V_{OUT} = V_{SET} \times 0.96$ | 0.9 | | | V |
| V_{CEL} | CE "L" Input Voltage | $V_{OUT} = V_{SET} \times 0.96$ | | | 0.3 | V |
| I_{CEH} | CE "H" Input Current | $V_{OUT} = V_{CE} = 6.5\text{V}$ | -0.1 | 0 | 0.1 | μA |
| I_{CEL} | CE "L" Input Current | $V_{OUT} = 6.5\text{V}, V_{CE} = 0\text{V}$ | -0.1 | 0 | 0.1 | μA |

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

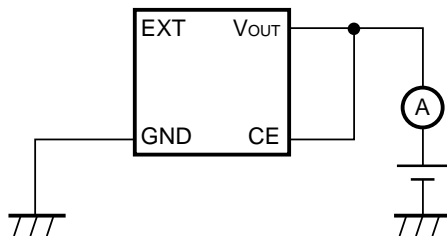
TEST CIRCUITS



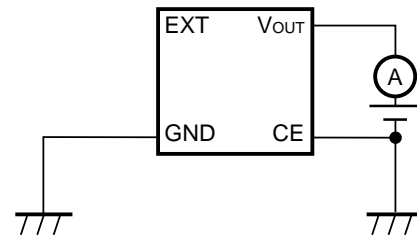
Test Circuit 1



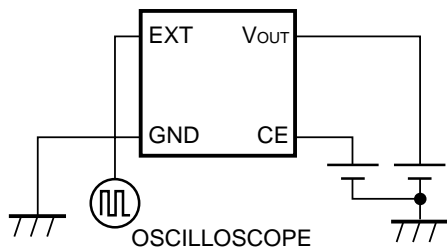
Test Circuit 2



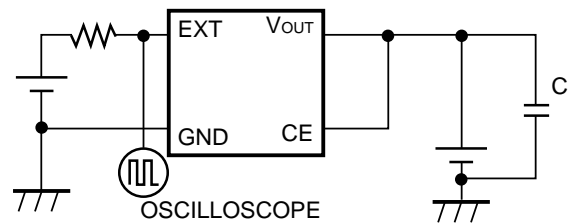
Test Circuit 3



Test Circuit 4



Test Circuit 5

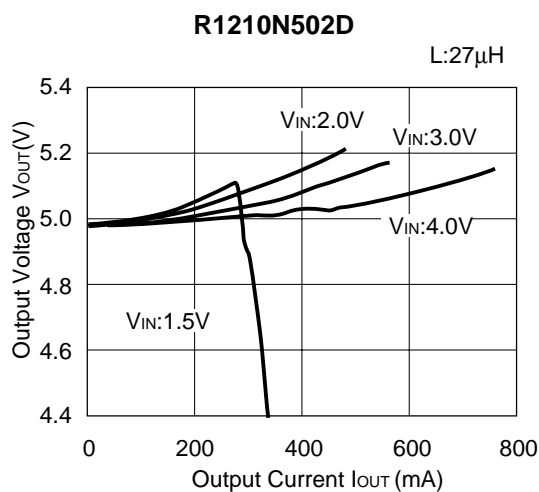
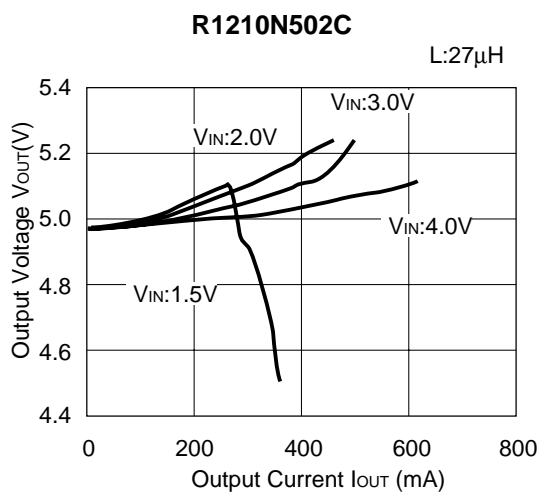
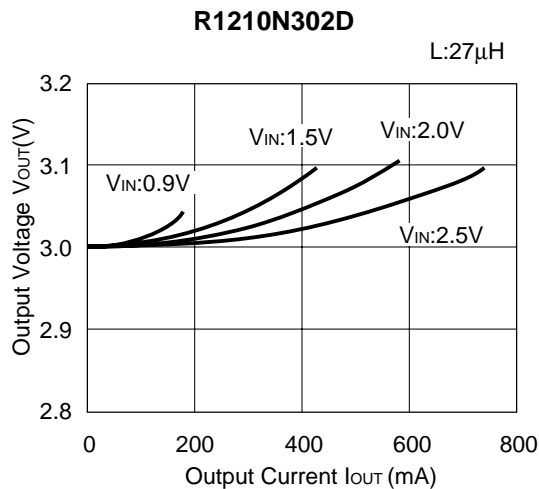
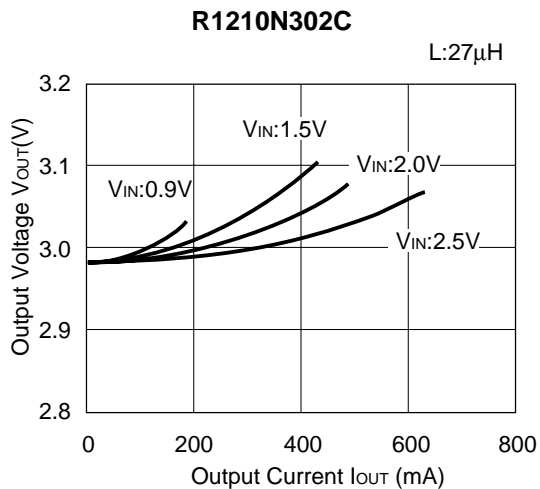


Test Circuit 6

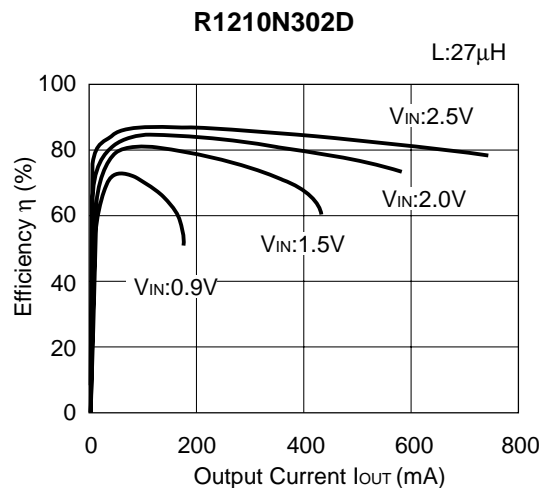
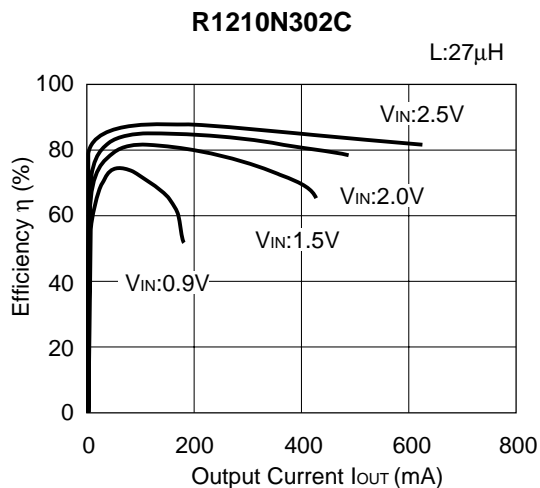
| | |
|---------------------|--|
| Inductor (L) | : 27 μ H (Sumida Electric Co., Ltd. CD104) |
| Diode (SD) | : RB491D (Rohm, Schottky Type) |
| Capacitor (CL) | : 47 μ F \times 2 (Tantalum Type) |
| Transistor (Tr) | : 2SD1628G |
| Base Resistor (Rb) | : 300 Ω |
| Base Capacitor (Cb) | : 0.01 μ F (Ceramic Type) |

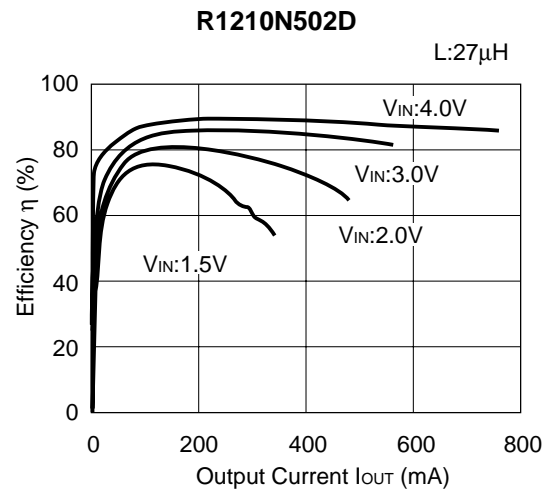
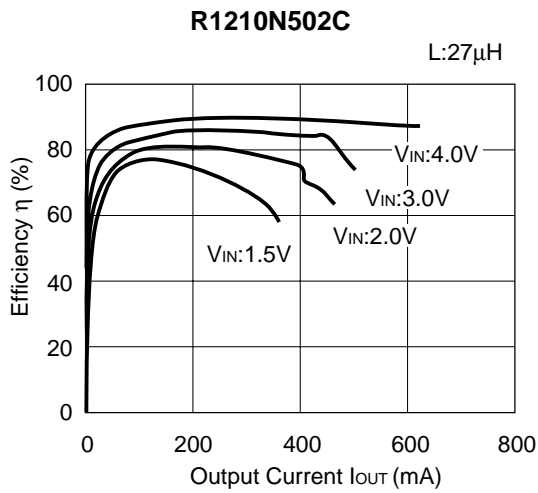
TYPICAL CHARACTERISTICS

1) Output Voltage vs. Output Current

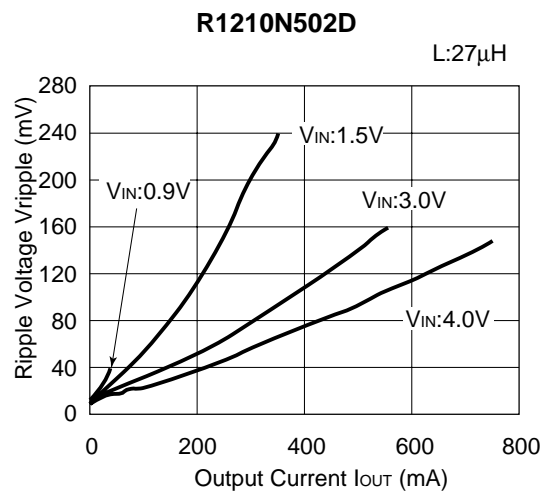
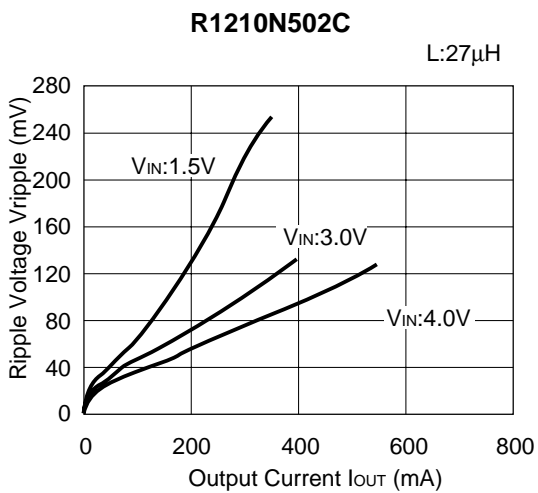
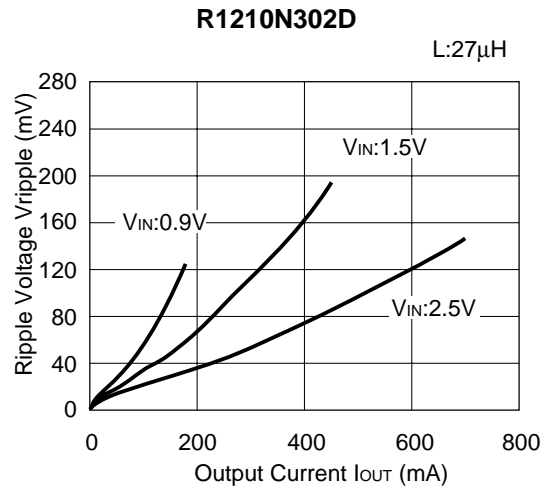
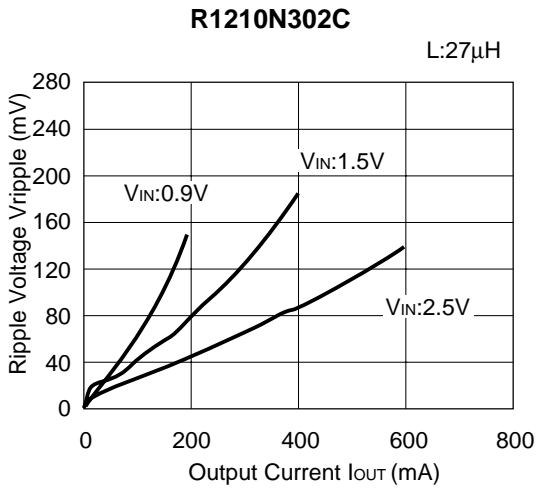


2) Efficiency vs. Output Current

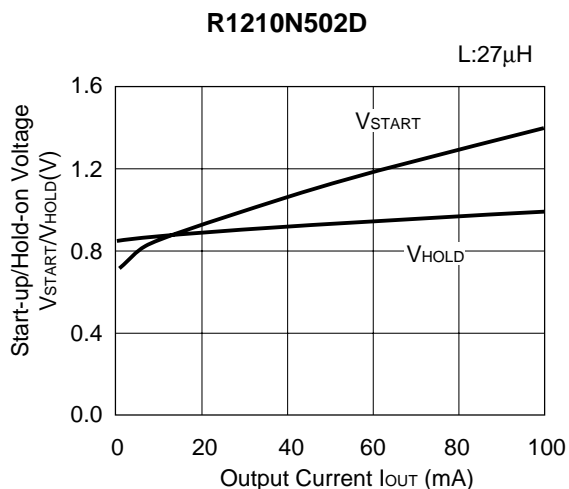
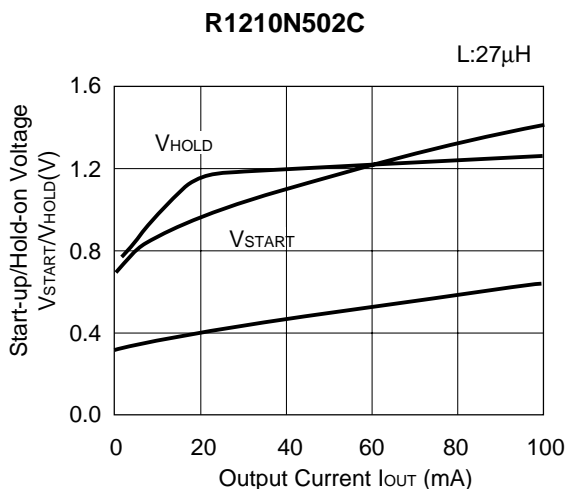
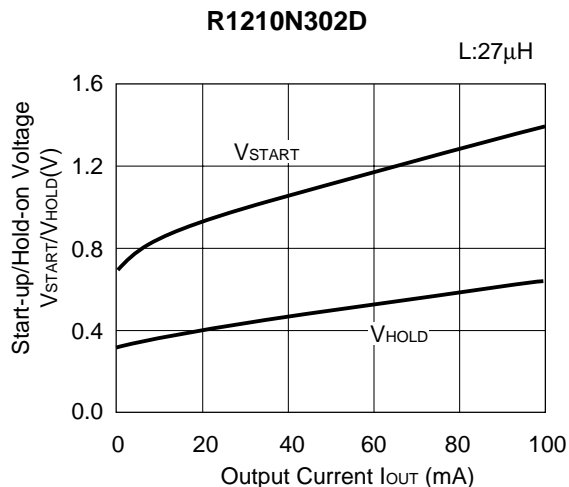
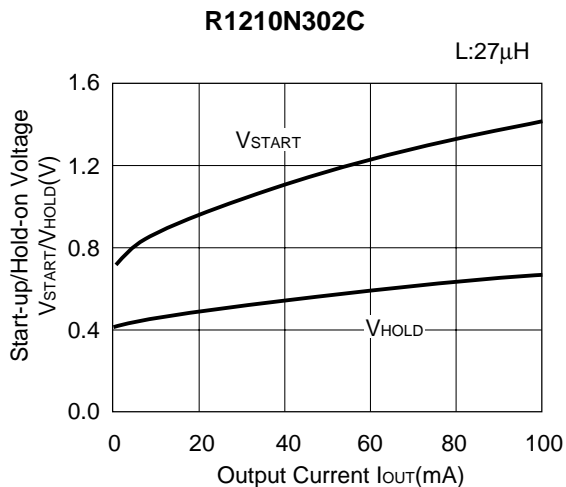




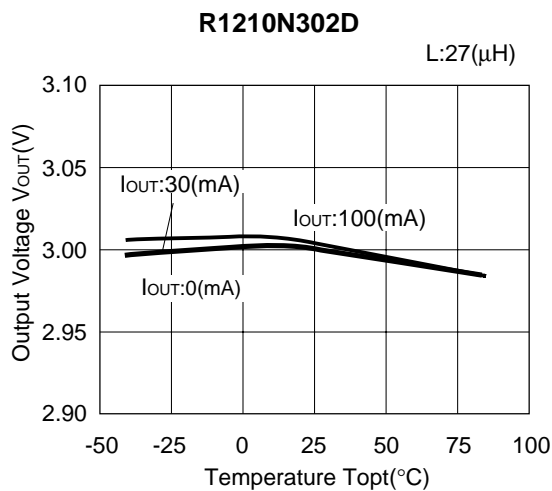
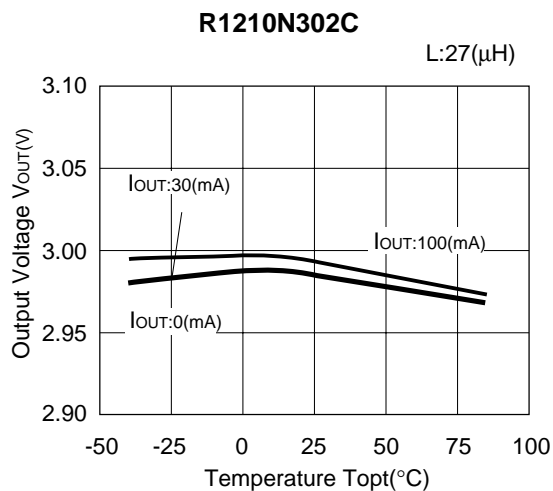
3) Ripple Voltage vs. Output Current

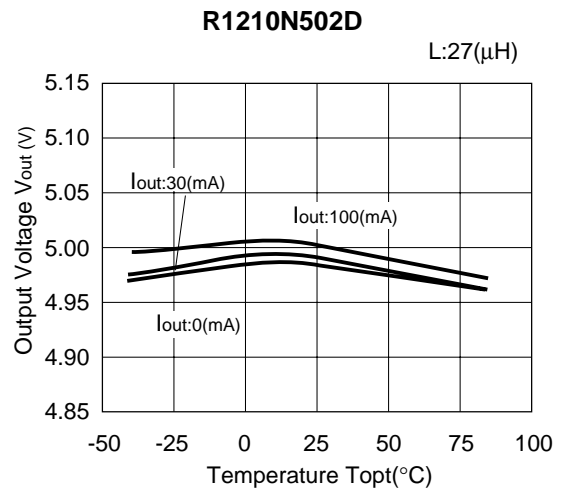
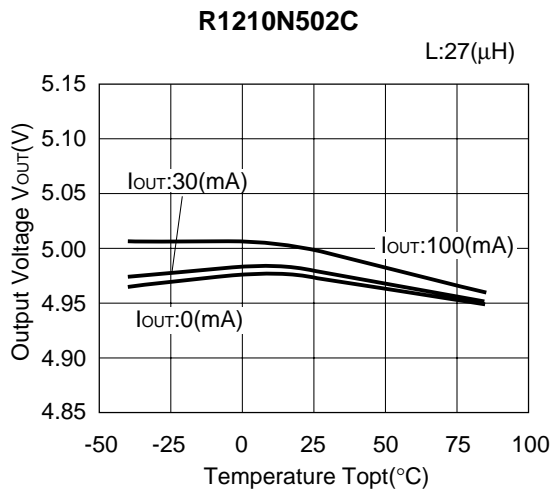


4) Start-up Voltage/ Hold-on Voltage vs. Output Current (Topt=25°C)

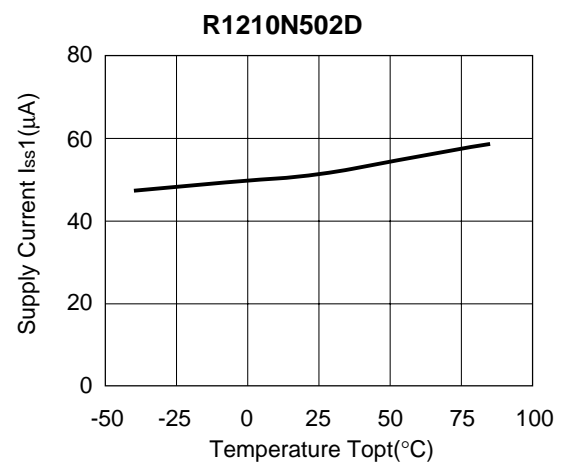
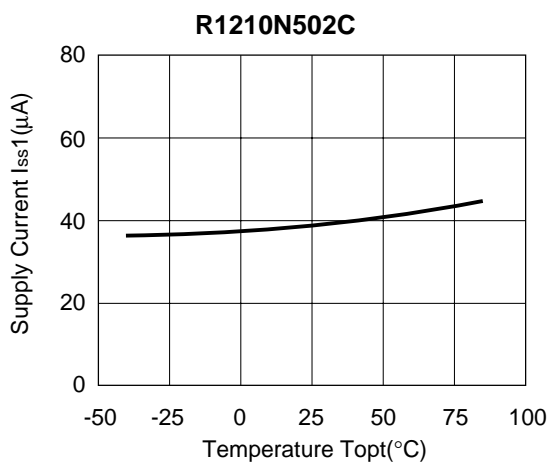
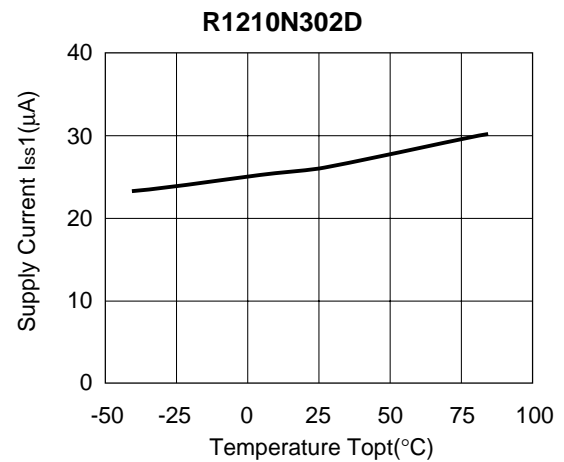
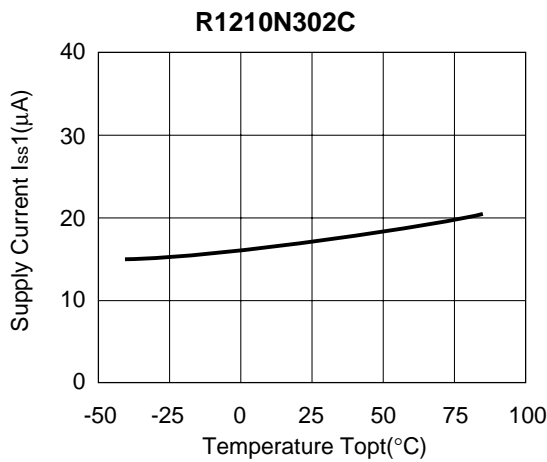


5) Output Voltage vs. Temperature

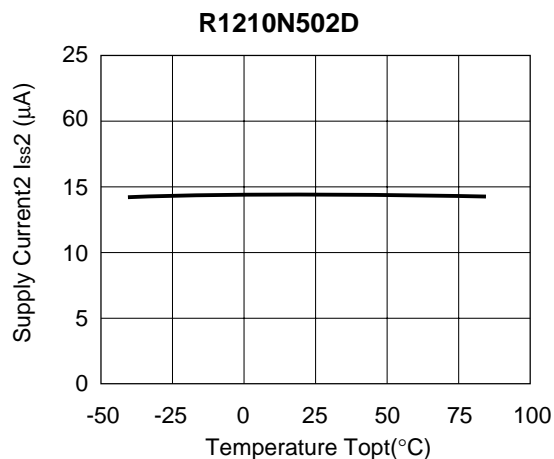
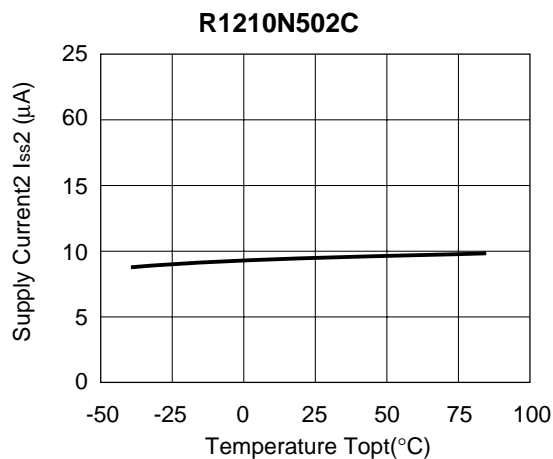
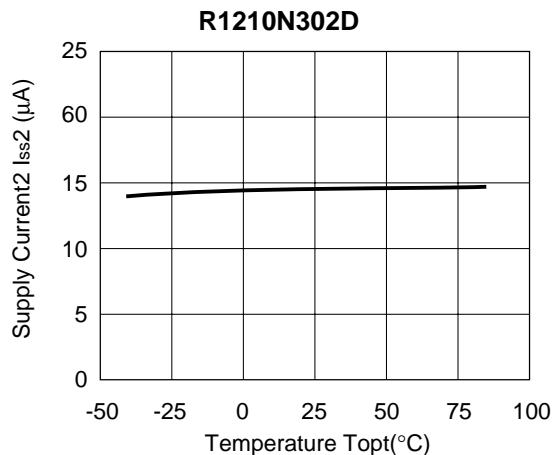
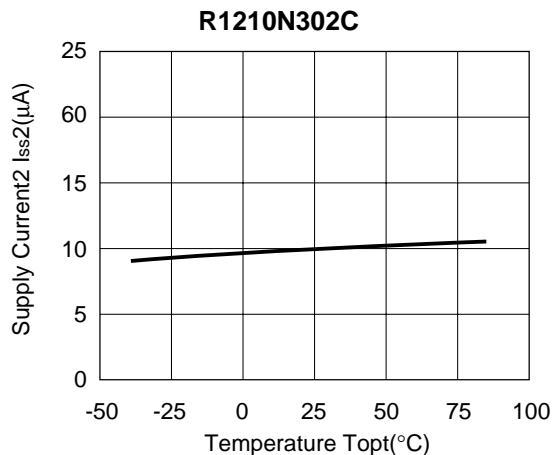




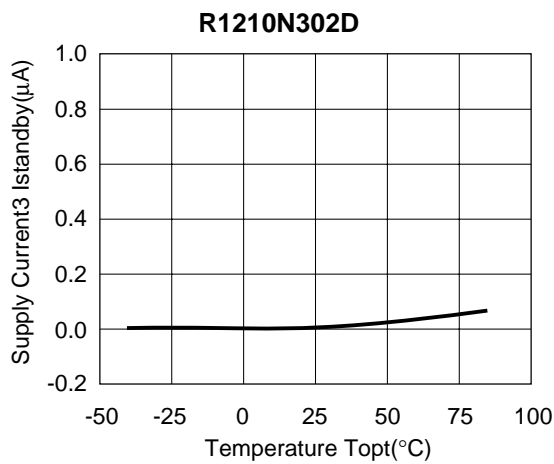
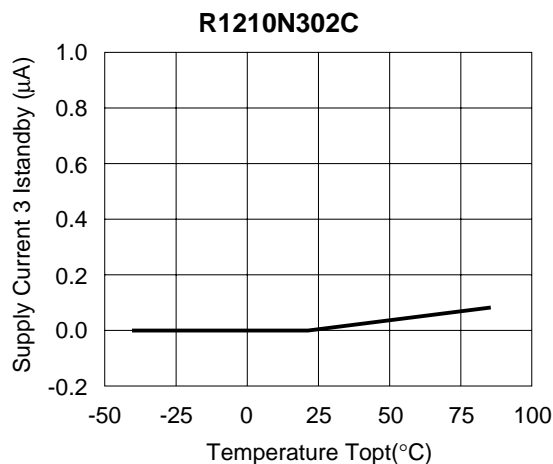
6) Supply Current I_{ss1} vs. Temperature

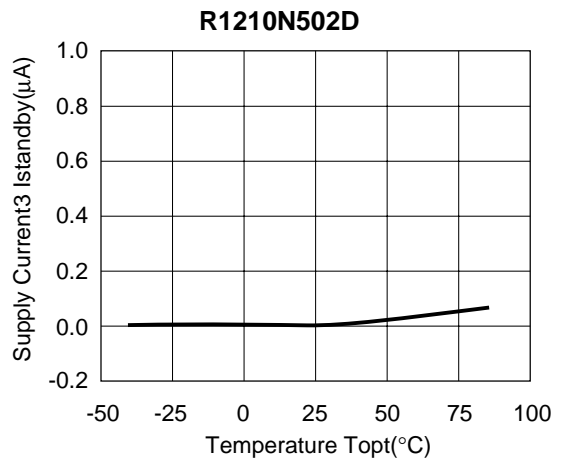
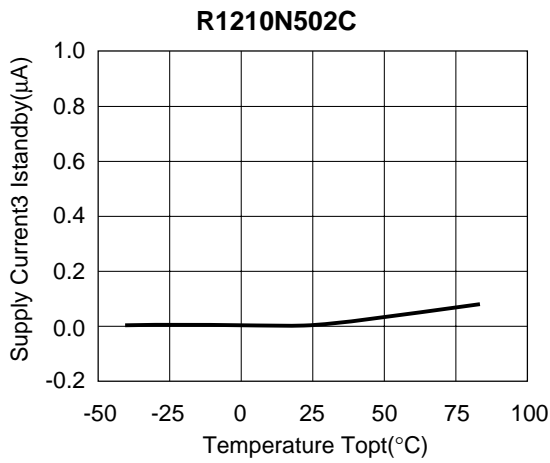


7) Supply Current 2 vs. Temperature

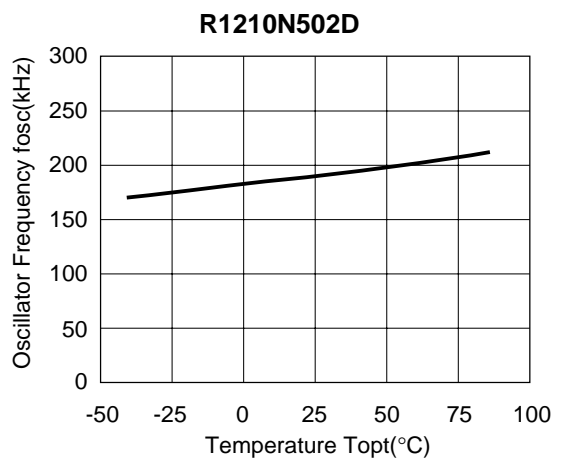
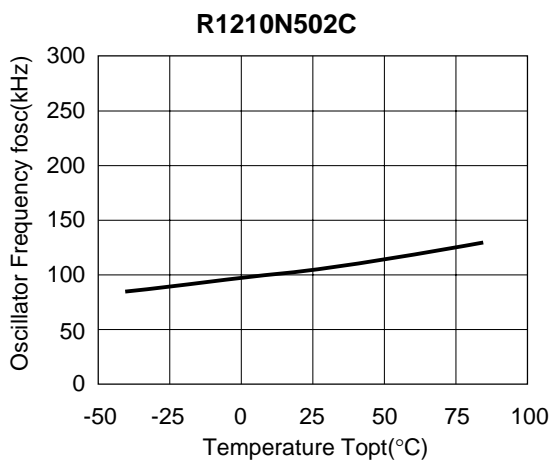
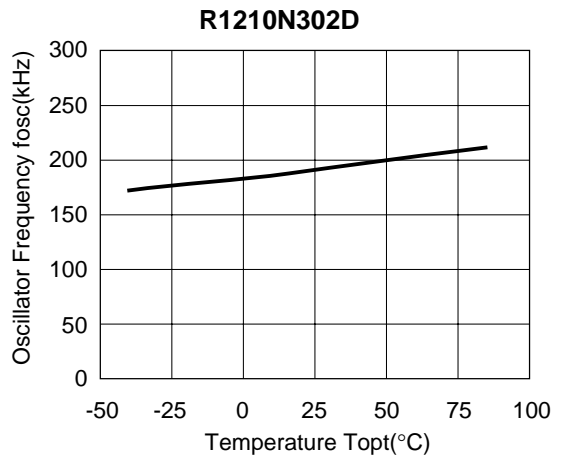
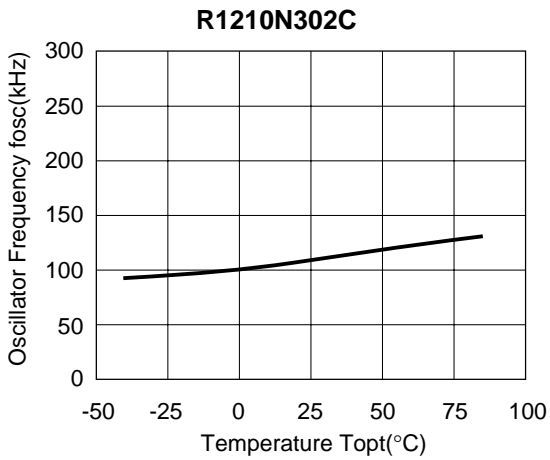


8) Supply Current 3 vs. Temperature

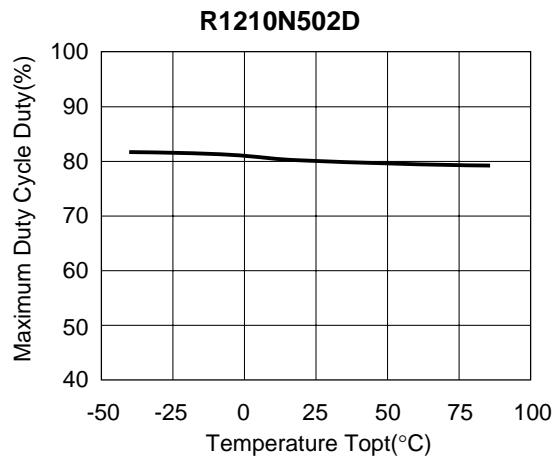
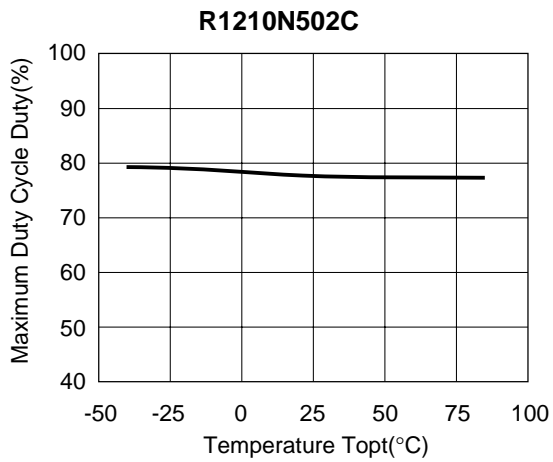
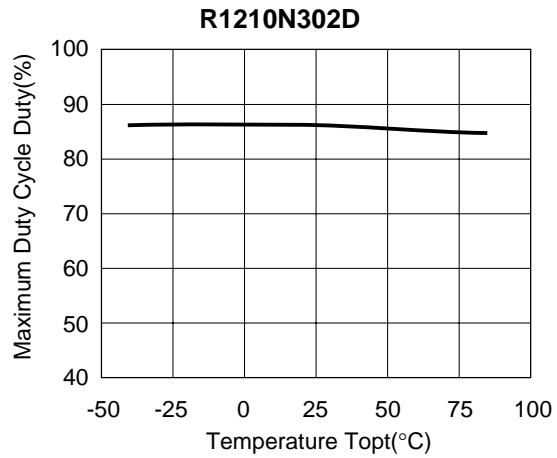
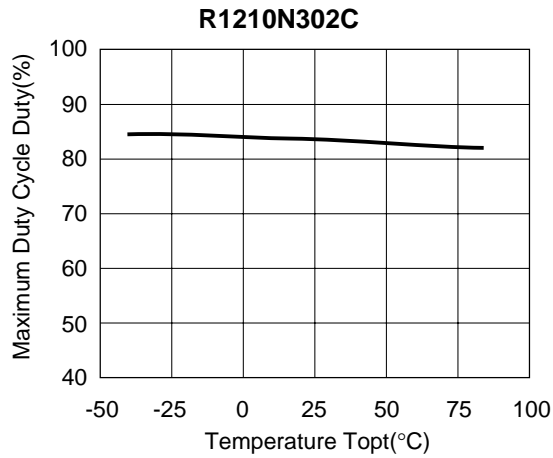




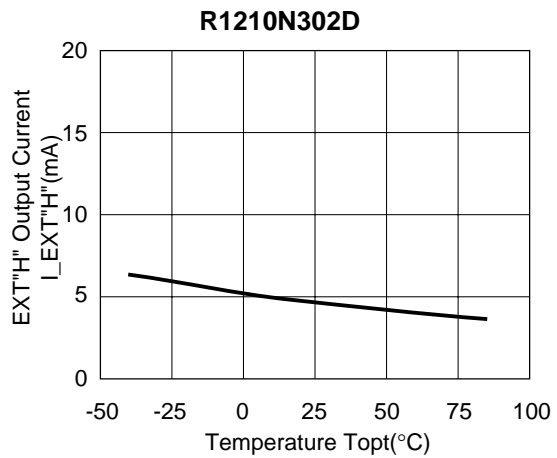
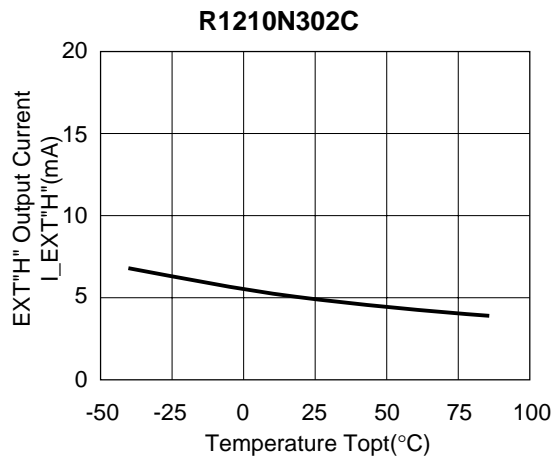
9) Oscillator Frequency vs. Temperature

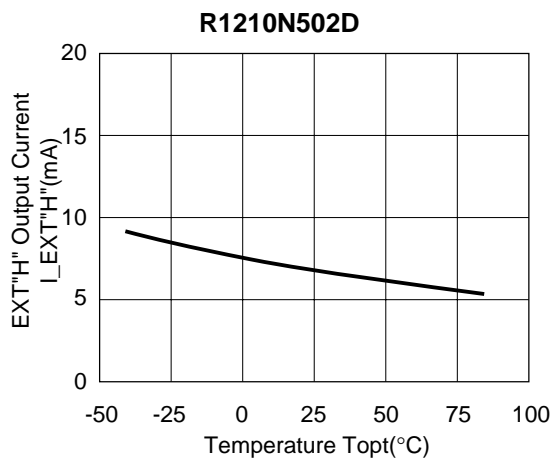
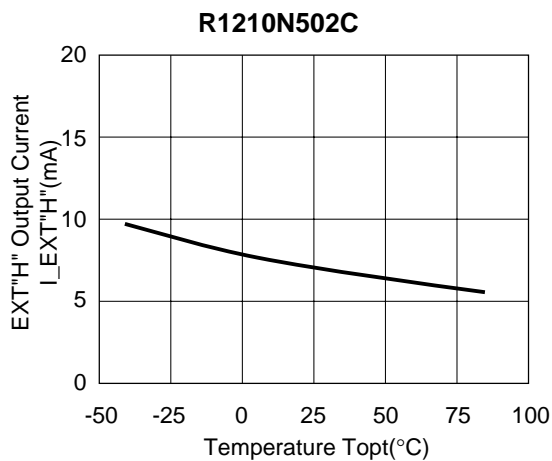


10) Maximum Duty Cycle vs. Temperature

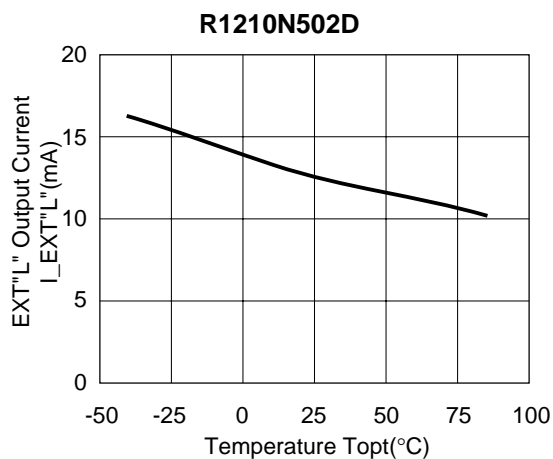
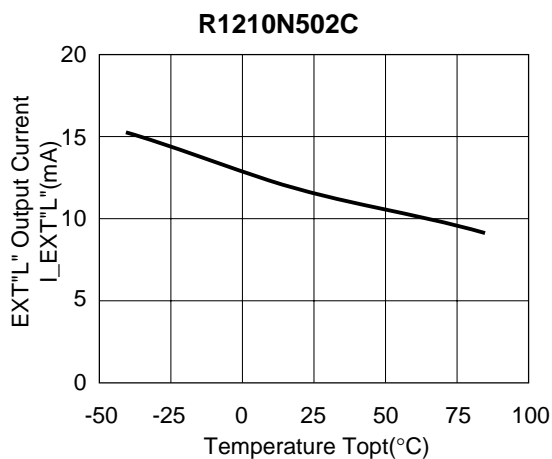
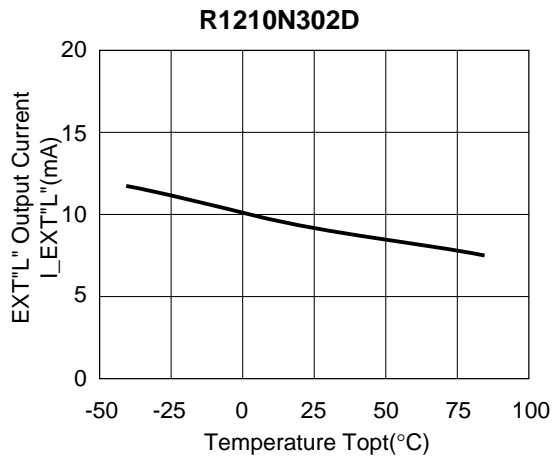
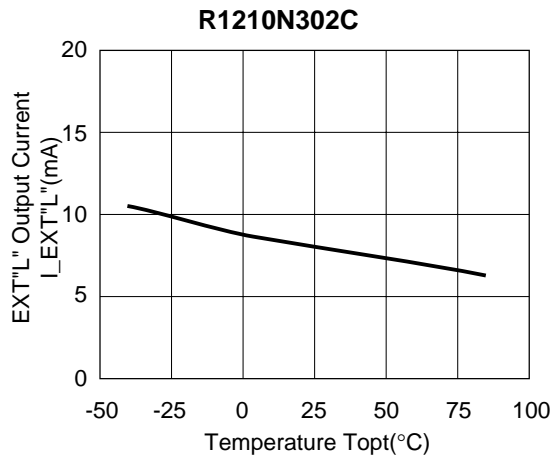


11) EXT "H" Output Current vs. Temperature

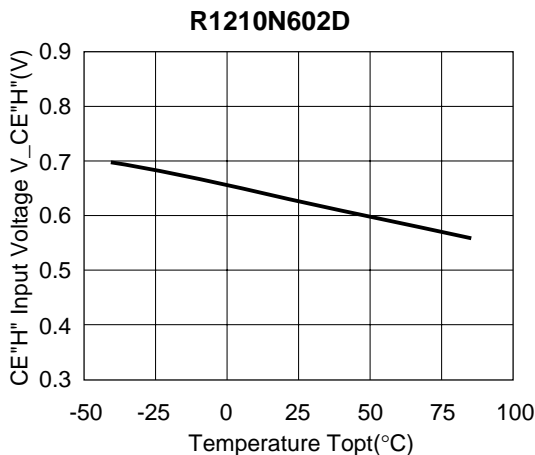
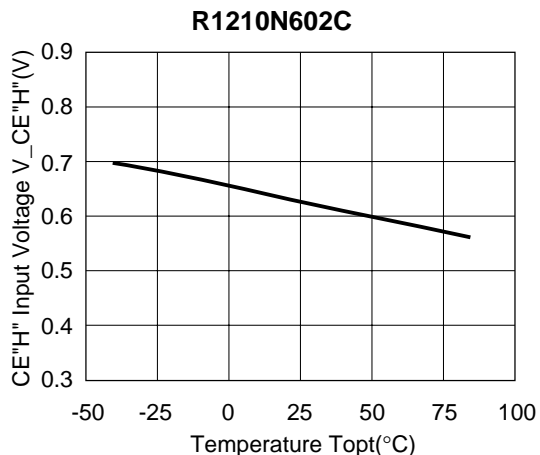




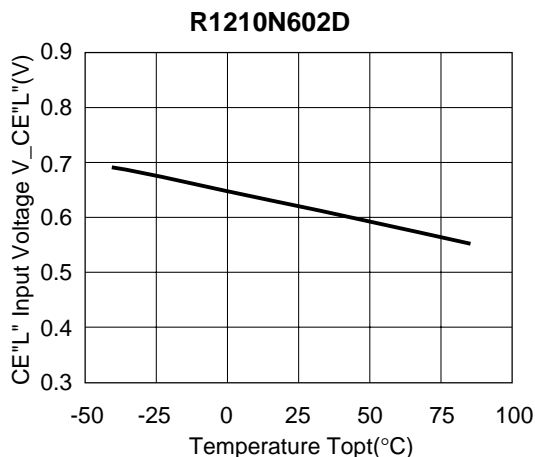
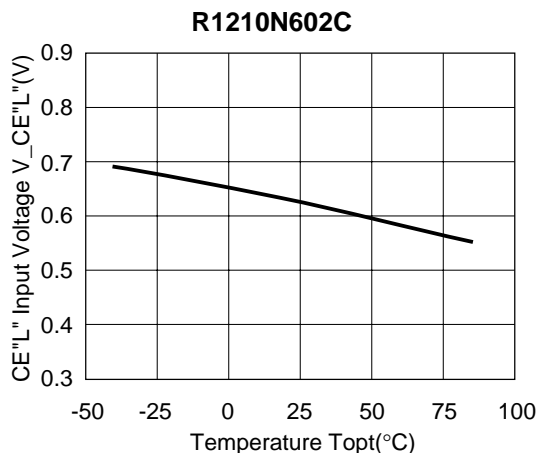
12) EXT "L" Output Current vs. Temperature



13) CE "H" Input Voltage vs. Temperature



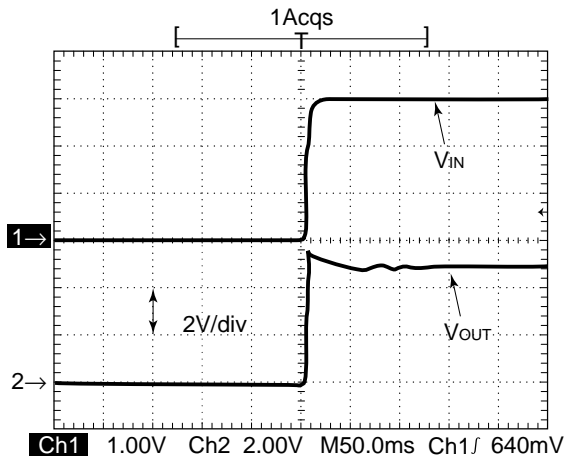
14) CE "L" Input Voltage vs. Temperature



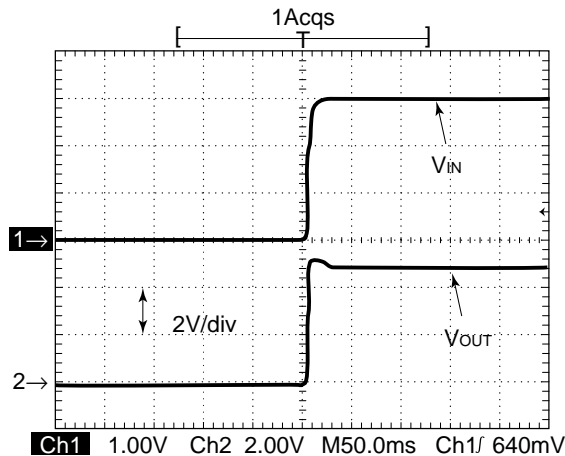
15) Output Waveform at Power-on (T_{opt}: 25°C)

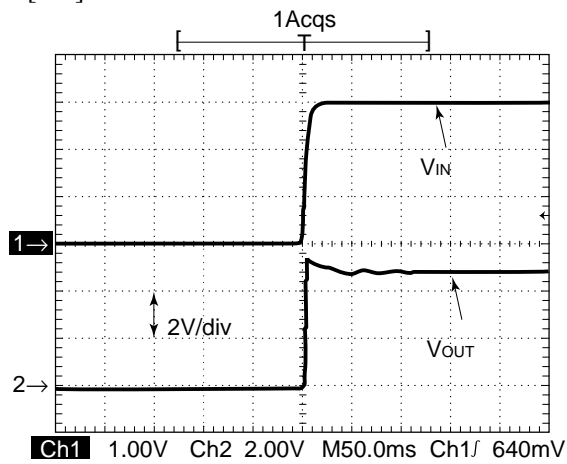
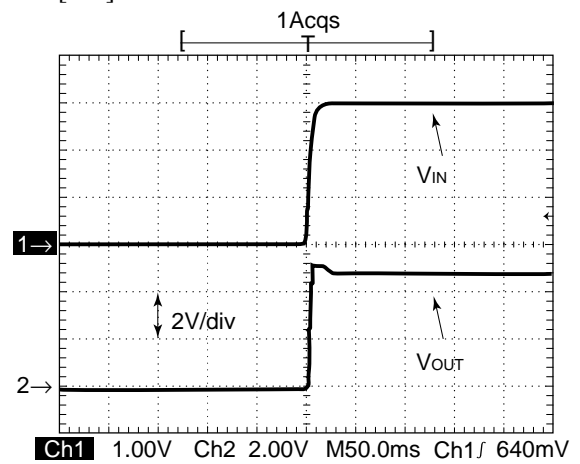
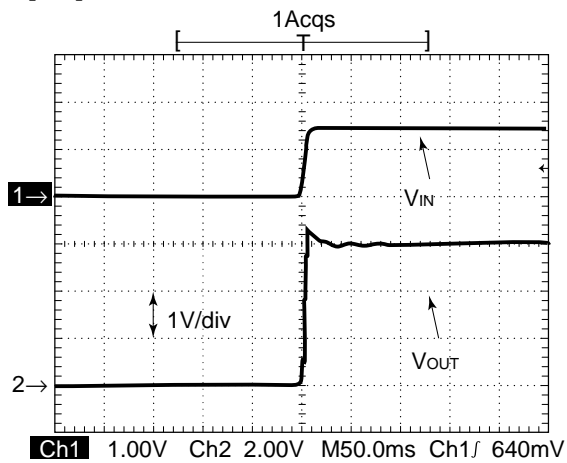
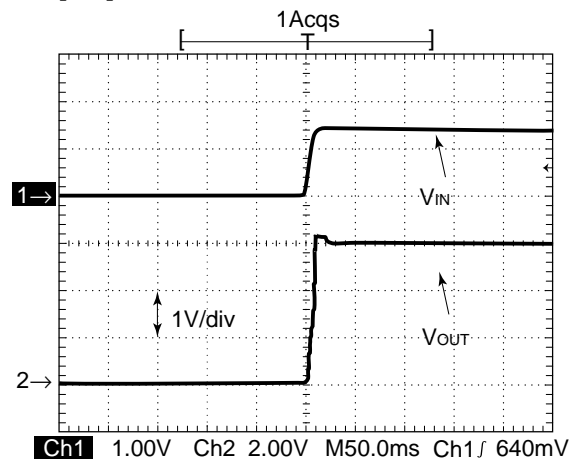
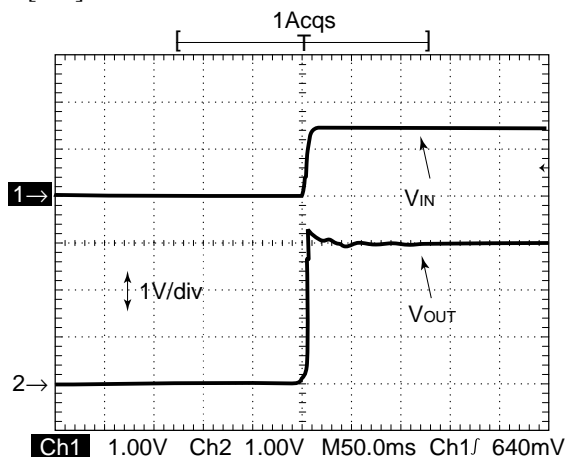
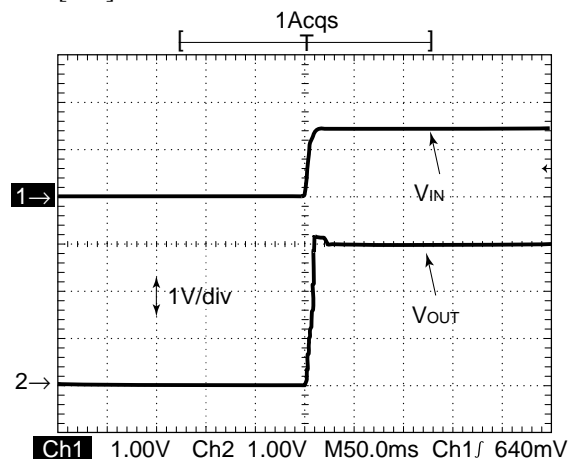
((R1210N502C)) (V_{IN}: 0[V]→3.0[V])

I_{OUT}: 1[mA]



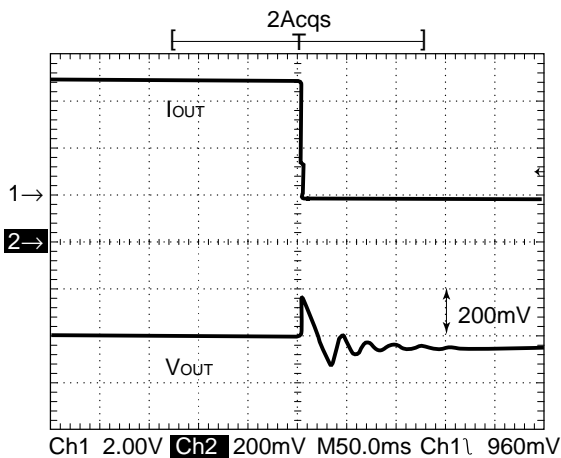
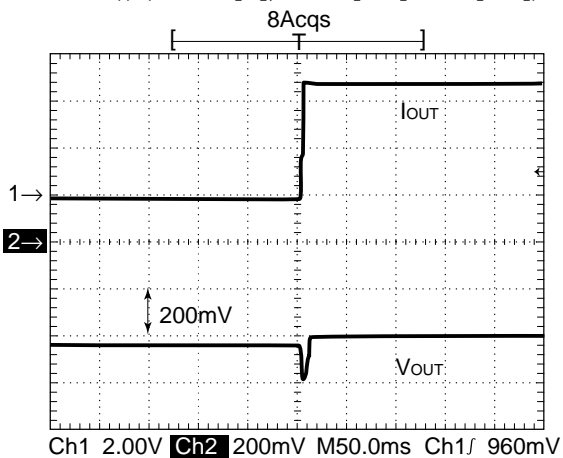
I_{OUT}: 100[mA]



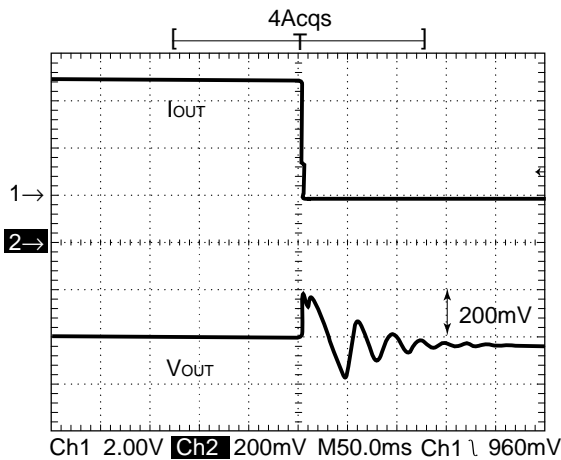
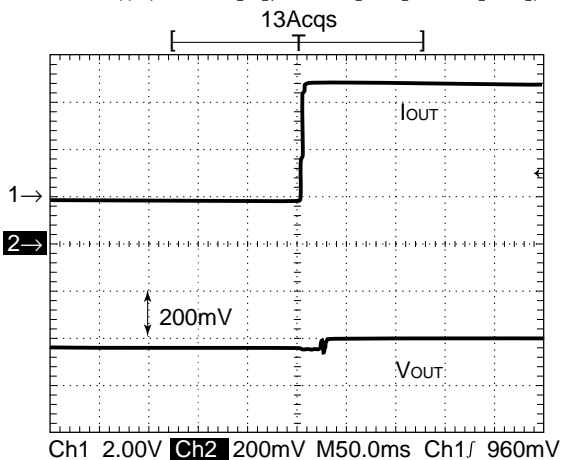
((R1210N502D)) (V_{IN} : 0[V]→3.0[V]) I_{OUT} : 1[mA] I_{OUT} : 100[mA]((R1210N302C)) (V_{IN} : 0[V]→1.5[V]) I_{OUT} : 1[mA] I_{OUT} : 100[mA]((R1210N302D)) (V_{IN} : 0[V]→1.5[V]) I_{OUT} : 1[mA] I_{OUT} : 100[mA]

16) Load Transient Response (T_{opt}: 25°C)

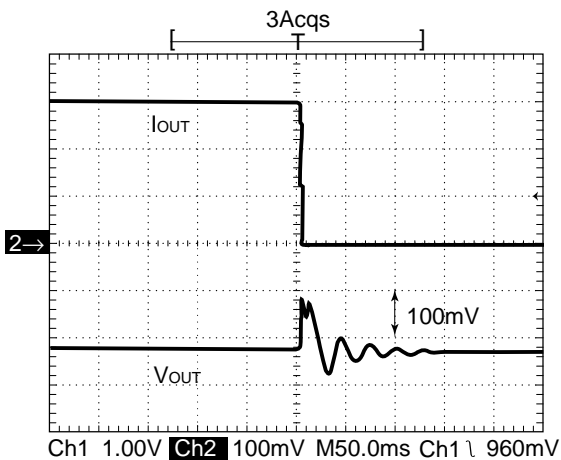
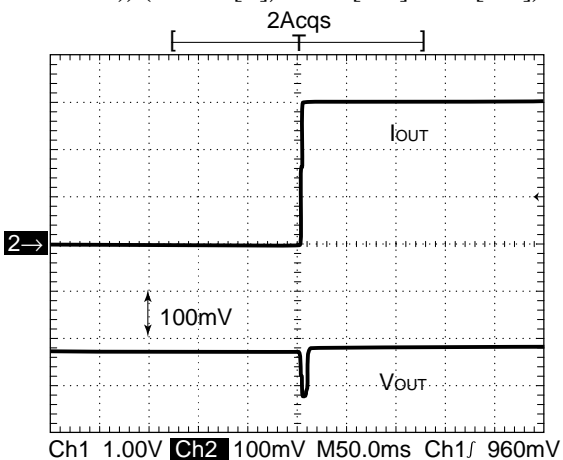
((R1210N502C)) (V_{IN}: 3.0[V], I_{OUT}: 1[mA]→200[mA])



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



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



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

