

## OUTLINE

The R1151N Series are CMOS-based boost type voltage regulator ICs with high output voltage accuracy, low supply current, and high ripple rejection. Each of these voltage regulator controllers consists of a voltage reference unit, an error amplifier, comparators, resistors for output and reset voltage setting, a current limit protection circuit, and a chip enable circuit.

In addition to low consumption current by CMOS process, the chip enable function prolongs the battery life. Dynamic response and ripple rejection of the R1151N Series are excellent, further these are low noise type, plus maximum operating input voltage tolerance is up to 18.5V, thus these ICs are very suitable for the power supply for handheld equipment and other power management applications using AC adapter input voltage.

The output voltage of these ICs is internally fixed with high accuracy. Since the package for these ICs is SOT-23-6 (Mini-mold) package, high density mounting of the ICs on boards is possible.

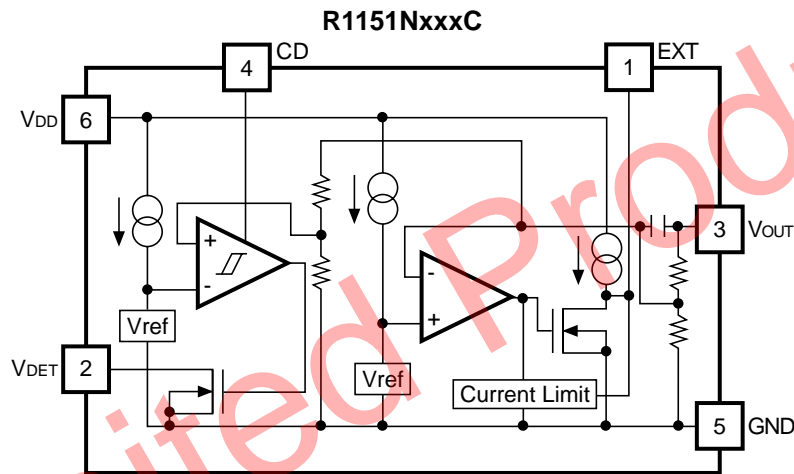
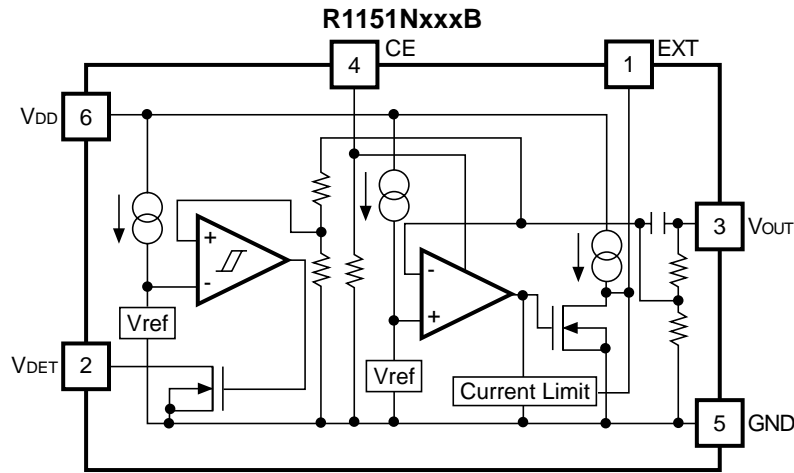
## FEATURES

- Ultra-Low Supply Current ..... Typ. 70 $\mu$ A ( $I_{OUT}=0$ mA)
- Standby Mode ..... Typ. 0.1 $\mu$ A
- Low Dropout Voltage ..... Typ. 0.1V ( $I_{OUT}=100$ mA \*Depends on External Transistor)
- High Ripple Rejection ..... Typ. 60dB (f=1kHz)
- Low Temperature-Drift Coefficient of Output Voltage ..... Typ.  $\pm 100$ ppm/ $^{\circ}$ C
- High Output Voltage Accuracy .....  $\pm 2.0\%$
- Excellent Dynamic Response
- Small Package ..... SOT-23-6 (Mini-mold)
- Output Voltage ..... Stepwise setting with a step of 0.1V in the range of 2.5V to 9.0V
- Built-in chip enable circuit (2 types; A: active low, B: active high)
- Output Capacitor ..... Tantalum type recommendation (or Ceramic+Series Resistor)
- Built-in output voltage detector ..... with delay (C version)
- Detector Threshold Tolerance .....  $\pm 2.5\%$
- Detector Threshold Voltage ..... Stepwise setting with a step of 0.1V in the range of 1.7V to 8.0V
- Operating Input Voltage ..... Max. 18.5V

## APPLICATIONS

- Power source for handheld equipment such as cameras and videos.
- Power source for home appliances.
- Power source for battery-powered equipment.

## BLOCK DIAGRAMS



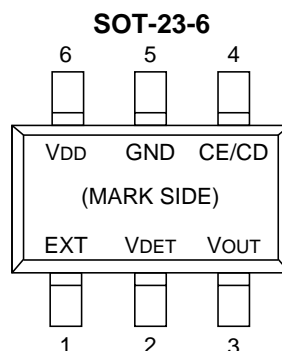
## SELECTION GUIDE

The output voltage, mask option code, and the taping type for the ICs can be selected at the user's request. The selection can be made with designating the part number as shown below;

R1151Nxxxx-xx ← Part Number  
 ↑ ↑ ↑  
 a b c

Code	Contents
a	Code Number for Voltage Setting
b	Setting mask option : A: with $\overline{CE}$ (active at "L" type) B: with CE (active at "H" type) C: with the pin for external capacitor to set the output delay of voltage detector
c	Designation of Taping Type : Ex. TR (Refer to Taping Specifications.)

## PIN CONFIGURATION



## PIN DESCRIPTIONS

Pin No.	Symbol	Description
1	EXT	External Transistor Drive Pin
2	V <sub>DET</sub>	Voltage Detector Output Pin
3	V <sub>OUT</sub>	Voltage Regulator Output pin
4	$\overline{\text{CE}}$ or CE	Chip Enable Pin (A/B version)
4	CD	Pin for External capacitor to set Output Delay of Voltage Detector (C version)
5	GND	Ground Pin
6	V <sub>DD</sub>	Input Pin

## ABSOLUTE MAXIMUM RATINGS

Symbol	Item	Rating	Unit
V <sub>IN</sub>	Input Voltage	20	V
V <sub>CE/CD</sub>	Input Voltage ( $\overline{\text{CE}}$ /CE/CD Pin)	-0.3 ~ V <sub>IN</sub> +0.3	V
V <sub>OUT</sub>	Output Voltage (V <sub>OUT</sub> Pin)	-0.3 ~ V <sub>IN</sub> +0.3	V
V <sub>EXT</sub>	Output Voltage (EXT Pin)	-0.3 ~ V <sub>IN</sub> +0.3	V
V <sub>DET</sub>	Output Voltage (V <sub>DET</sub> Pin)	-0.3 ~ V <sub>IN</sub> +0.3	V
I <sub>EXT</sub>	EXT Output Current	30	mA
P <sub>D</sub>	Power Dissipation	150	mW
T <sub>opt</sub>	Operating Temperature Range	-40 ~ 85	°C
T <sub>stg</sub>	Storage Temperature Range	-55 ~ 125	°C

## ELECTRICAL CHARACTERISTICS

## • R1151NxxxA/B

Topt=25°C

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit
V <sub>OUT</sub>	Output Voltage	V <sub>IN</sub> = Set V <sub>OUT</sub> +1V I <sub>OUT</sub> = 50mA	V <sub>OUT</sub> ×0.98		V <sub>OUT</sub> ×1.02	V
I <sub>OUT</sub>	Output Current	V <sub>IN</sub> - V <sub>OUT</sub> = 1.0V		1 <sup>Note</sup>		A
ΔV <sub>OUT</sub> /ΔI <sub>OUT</sub>	Load Regulation	V <sub>IN</sub> = Set V <sub>OUT</sub> +1V 1mA ≤ I <sub>OUT</sub> ≤ 100mA	Refer to the Load Regulation Table			
V <sub>DIF</sub>	Dropout Voltage	I <sub>OUT</sub> = 100mA		0.1 <sup>Note</sup>	0.2	V
I <sub>SS</sub>	Supply Current	V <sub>IN</sub> = Set V <sub>OUT</sub> +1V, I <sub>OUT</sub> = 0mA		70	100	μA
I <sub>standby</sub>	Supply Current (Standby)	V <sub>IN</sub> = 18.5V		15		μA
I <sub>EXTleak</sub>	EXT Leakage Current				0.5	μA
ΔV <sub>OUT</sub> /ΔV <sub>IN</sub>	Line Regulation	Set V <sub>OUT</sub> +0.5V ≤ V <sub>IN</sub> ≤ 18.5V I <sub>OUT</sub> = 50mA	0.00	0.02	0.10	%/V
RR	Ripple Rejection	f = 1kHz, Ripple 0.5V <sub>p-p</sub> V <sub>IN</sub> = Set V <sub>OUT</sub> +1V		60		dB
V <sub>IN</sub>	Input Voltage				18.5	V
ΔV <sub>OUT</sub> /ΔT	Output Voltage Temperature Coefficient	I <sub>OUT</sub> = 10mA -40°C ≤ Topt ≤ 85°C		±100		ppm /°C
I <sub>lim</sub>	Current Limit	Base Current I <sub>B</sub> of PNP Tr. V <sub>IN</sub> - V <sub>OUT</sub> = 1.0V	8		27	mA
I <sub>RPT</sub>	Short Current Limit	Base Current I <sub>B</sub> of PNP Tr. V <sub>OUT</sub> = 0V		0.7		mA
R <sub>UD</sub>	CE/CE Pull-up/down Resistance			2		MΩ
V <sub>CEH</sub>	CE/CE Input Voltage "H"		1.5		V <sub>IN</sub>	V
V <sub>CEL</sub>	CE/CE Input Voltage "L"		0.00		0.25	V
-V <sub>DET</sub>	Detector Threshold		-V <sub>DET</sub> ×0.975		-V <sub>DET</sub> ×1.025	V
V <sub>HYS</sub>	Detector Threshold Hysteresis Range		-V <sub>DET</sub> ×0.03	-V <sub>DET</sub> ×0.05	-V <sub>DET</sub> ×0.07	V
I <sub>OUT2</sub>	Output Current 2	V <sub>DD</sub> = 1.5V, V <sub>DS</sub> = 0.5V	2.0	5.0	10.0	mA
ΔV <sub>DET</sub> /ΔT	Detector Threshold Temperature Coefficient	-40°C ≤ Topt ≤ 85°C		±100		ppm /°C
t <sub>PLH</sub>	Output Delay Time				0.1	ms
V <sub>DDL</sub>	Minimum Operating Voltage			0.9	1.1	V

Note: This item depends on the capability of external PNP transistor. Use low saturation type transistor with hFE value range of 100 to 300.

## • R1151NxxxC

T<sub>opt</sub> = 25°C

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit
V <sub>OUT</sub>	Output Voltage	V <sub>IN</sub> = Set V <sub>OUT</sub> +1V I <sub>OUT</sub> = 50mA	V <sub>OUT</sub> ×0.98		V <sub>OUT</sub> ×1.02	V
I <sub>OUT</sub>	Output Current	V <sub>IN</sub> - V <sub>OUT</sub> = 1.0V		1* <sup>Note1</sup>		A
ΔV <sub>OUT</sub> /ΔI <sub>OUT</sub>	Load Regulation	V <sub>IN</sub> = Set V <sub>OUT</sub> +1V 1mA ≤ I <sub>OUT</sub> ≤ 100mA	Refer to the Load Regulation Table			
V <sub>DIF</sub>	Dropout Voltage	I <sub>OUT</sub> = 100mA		0.1* <sup>Note1</sup>		V
I <sub>SS</sub>	Supply Current	V <sub>IN</sub> = Set V <sub>OUT</sub> +1V, I <sub>OUT</sub> = 0mA		70	100	μA
I <sub>EXTleak</sub>	EXT Leakage Current				0.5	μA
ΔV <sub>OUT</sub> /ΔV <sub>IN</sub>	Line Regulation	Set V <sub>OUT</sub> +0.5V ≤ V <sub>IN</sub> ≤ 18.5V I <sub>OUT</sub> = 50mA	0.00	0.02	0.10	%/V
RR	Ripple Rejection	f = 1kHz, Ripple 0.5Vp-p V <sub>IN</sub> = Set V <sub>OUT</sub> +1V		60		dB
V <sub>IN</sub>	Input Voltage				18.5	V
ΔV <sub>OUT</sub> /ΔT	Output Voltage Temperature Coefficient	I <sub>OUT</sub> = 10mA -40°C ≤ T <sub>opt</sub> ≤ 85°C		±100		ppm /°C
I <sub>lim</sub>	Current Limit	Base Current I <sub>B</sub> of PNP Tr. V <sub>IN</sub> - V <sub>OUT</sub> = 1.0V	8		27	mA
I <sub>RPT</sub>	Short Current Limit	Base Current I <sub>B</sub> of PNP Tr. V <sub>OUT</sub> = 0V		0.7		mA
-V <sub>DET</sub>	Detector Threshold		-V <sub>DET</sub> ×0.975		-V <sub>DET</sub> ×1.025	V
V <sub>HYS</sub>	Detector Threshold Hysteresis Range		-V <sub>DET</sub> ×0.03	-V <sub>DET</sub> ×0.05	-V <sub>DET</sub> ×0.07	V
I <sub>OUT2</sub>	Output Current 2	V <sub>DD</sub> = 1.5V, V <sub>DS</sub> = 0.5V	2.0	5.0	10.0	mA
ΔV <sub>DET</sub> /ΔT	Detector Threshold Temperature Coefficient	-40°C ≤ T <sub>opt</sub> ≤ 85°C		±100		ppm /°C
t <sub>PLH</sub>	Output Delay Time	CD=220pF* <sup>Note2</sup>	0.9	1.6	2.7	ms
V <sub>DDL</sub>	Minimum Operating Voltage			0.9	1.1	V

Note1: This item depends on the capability of external PNP transistor. Use low saturation type transistor with hFE value range of 100 to 300.

Note2: V<sub>DET</sub> pin is pulled-up to V<sub>DD</sub> via 470kΩ resistance. The time is between the rising edge of V<sub>OUT</sub> level from 0.9V to (+V<sub>DET</sub>)+2.0V and the reaching point to ((+V<sub>DET</sub>)+2.0V)/2 of the V<sub>DET</sub> output voltage.

• Load Regulation Table

Output Voltage V <sub>OUT</sub> (V)	Load Regulation ΔV <sub>OUT</sub> /ΔI <sub>OUT</sub> (mV)	
	Typ.	Max.
2.5 to 3.3	20	60
3.4 to 5.0	30	90
5.1 to 7.0	40	130
7.1 to 9.0	50	160

**OPERATION**

In these ICs, fluctuation of Output Voltage, V<sub>OUT</sub> is detected by the feed-back registers, and the result is compared with a reference voltage with the error amplifier and control the base current of an external PNP transistor so that a constant voltage is output. The base current is monitored with the base current limit circuit. If the base current may be too large, the protection circuit works, further, output voltage is monitored with the built-in voltage detector. If the set detector threshold voltage is detected, reset signal will be output.

**TECHNICAL NOTES**

When using these ICs, consider the following points:

In these ICs, phase compensation is made for securing stable operation even if the load current is varied. For this purpose, be sure to use as much as 10μF capacitor as CL with good frequency characteristics and ESR (Equivalent Series Resistance).

The best suitable equivalent series resistor value (ESR) is approximately 1Ω.

If the ESR of the output capacitor is too large, output may be unstable, therefore fully evaluation is necessary.

Make V<sub>DD</sub> and GND lines sufficient. When their impedance of these is high, noise pickup or unstable operation may be the result. Connect a capacitor with a capacitance value of as much as 10μF between V<sub>DD</sub> and GND as close as possible to these pins.

Set external components, especially output capacitor, as close as possible to the ICs.

Refer to the next equation to calculate the output delay time of C version and decide the capacitance value for the delay time.

$$t_{PLH} = 1.83 \times C / (300 \times 10^{-9})$$

C: Capacitance value (F)

Recommended pull-up resistance (R1) value is 470kΩ. If the value is too small, released voltage may shift, therefore, use 10kΩ or more value resistor.

## TEST CIRCUITS

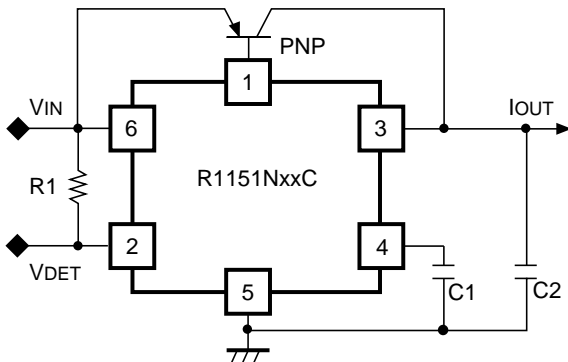


Fig.1 Standard test Circuit

R1=470kΩ C1=220pF, C2=10μF

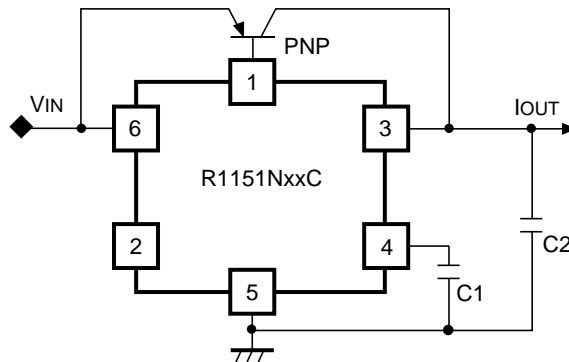


Fig.2 Supply Current Test Circuit

C1=220pF, C2=10μF

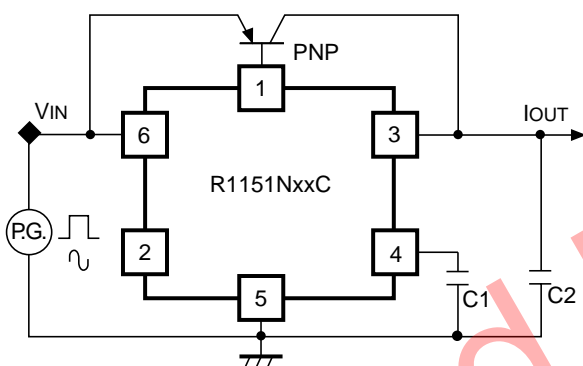


Fig.3 Ripple Rejection, Line Transient Response Test Circuit

C1=220pF, C2=10μF

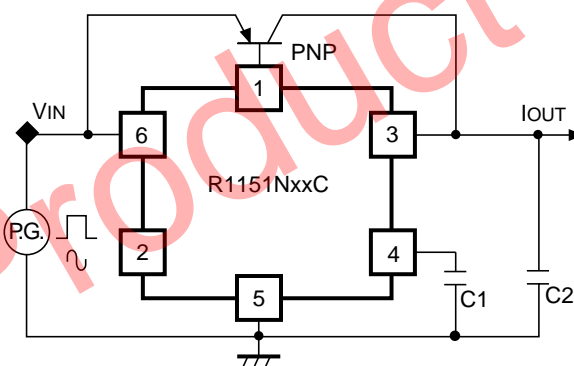
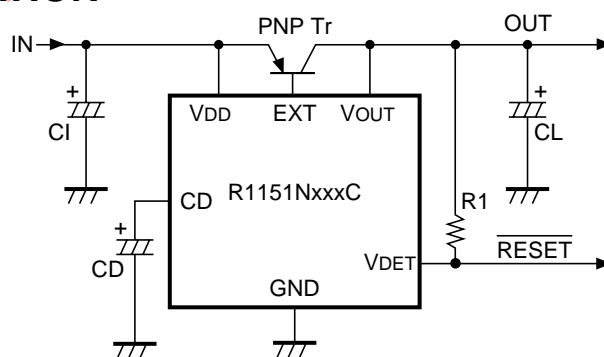


Fig.4 Load Transient Response Test Circuit

C1=220pF, C2=10μF

## TYPICAL APPLICATION



(External Components)

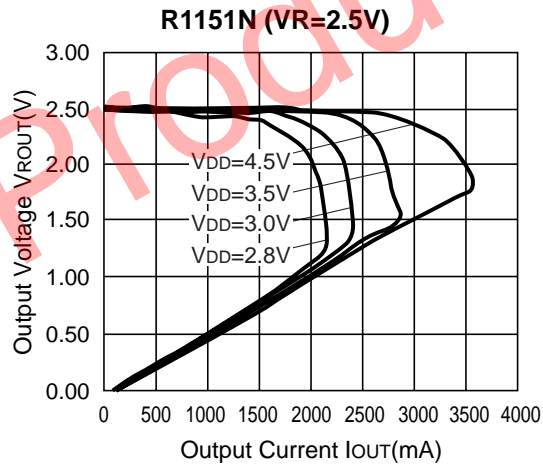
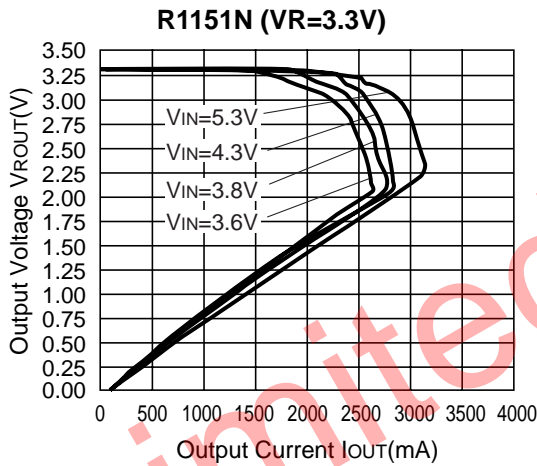
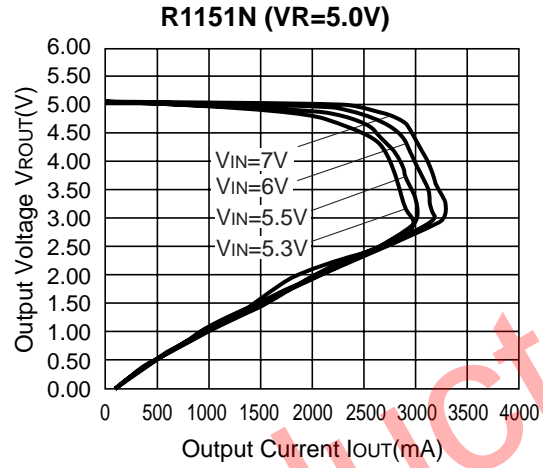
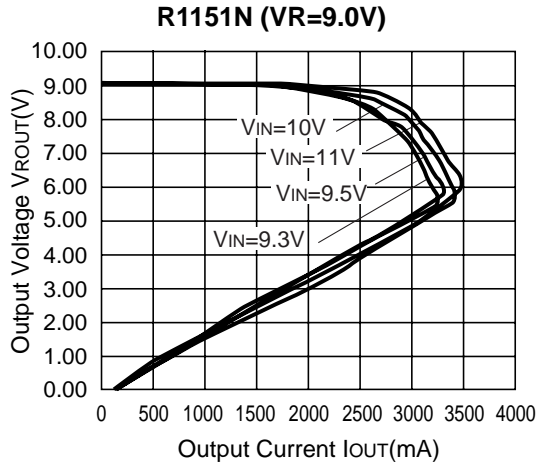
C1 10μF R1=470kΩ PNP Tr.: 2SA1441, 2SB940, 2SB703

CL 10μF

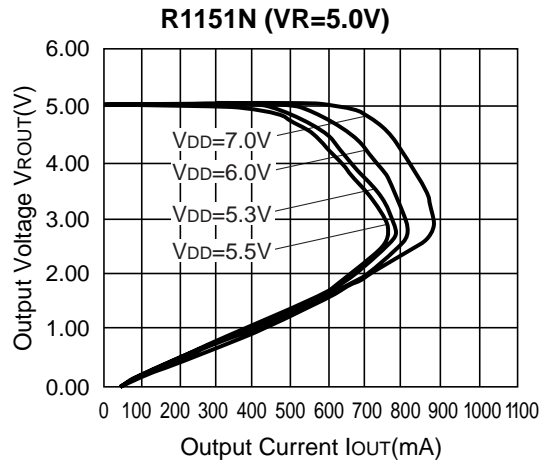
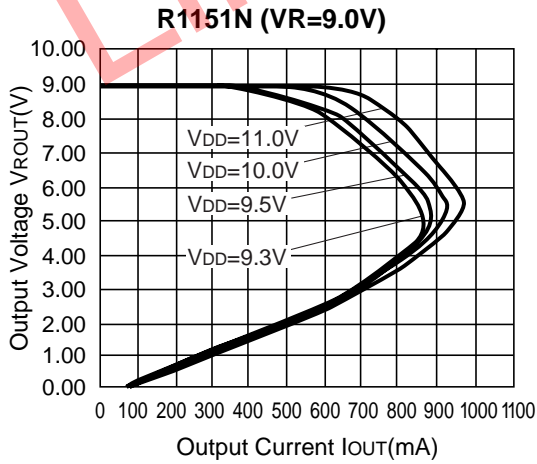
## TYPICAL CHARACTERISTICS

1) Output Voltage vs. Output Current ( $T_{opt}=25^{\circ}C$ )

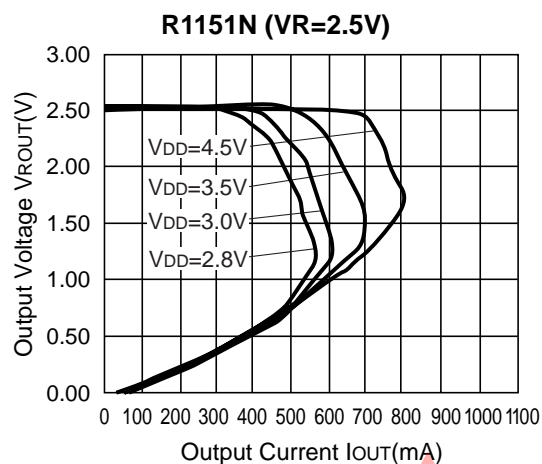
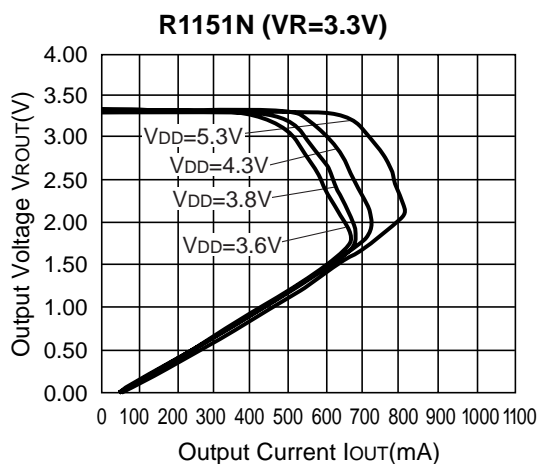
a. External Tr.: 2SA1441



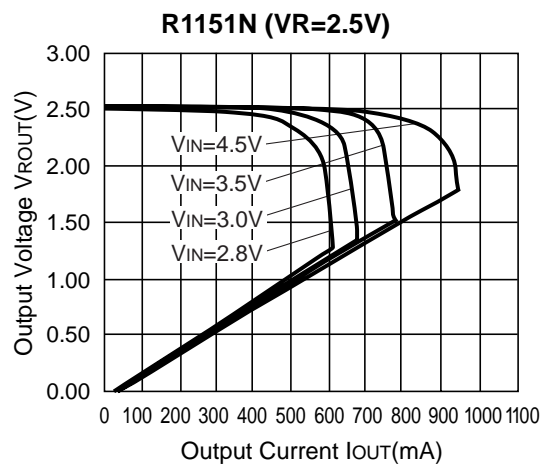
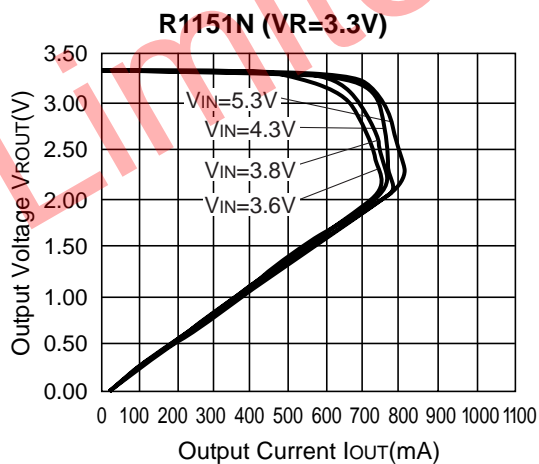
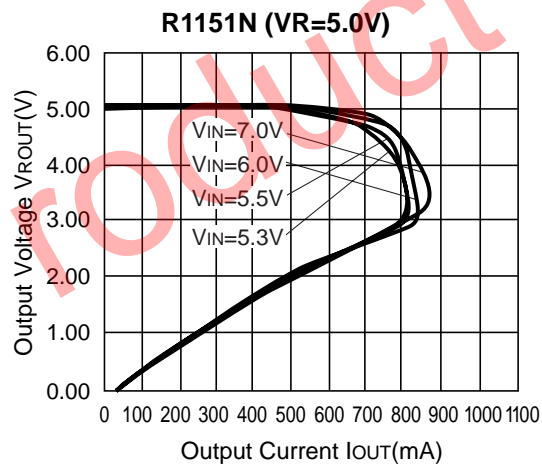
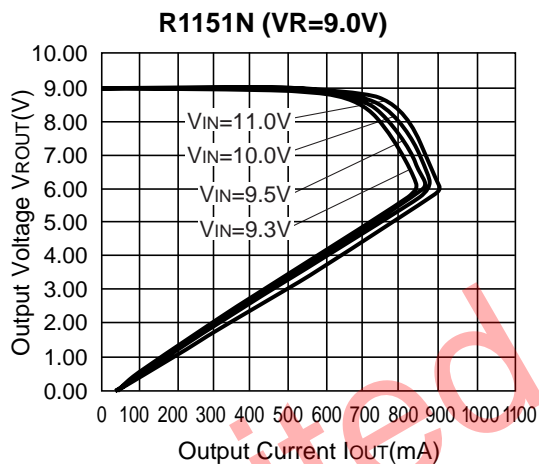
b. External Tr.: 2SB940



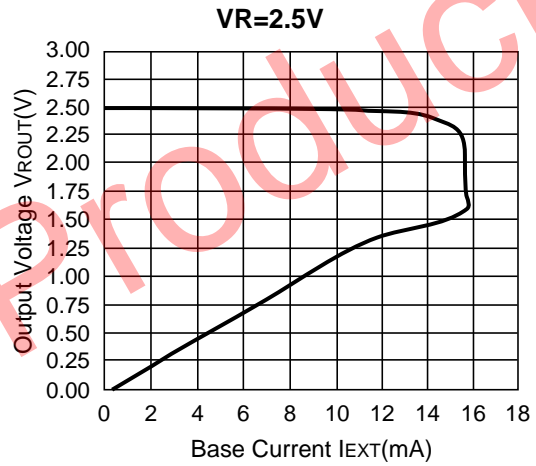
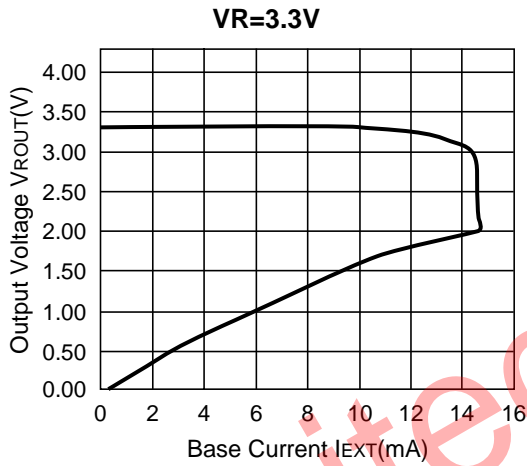
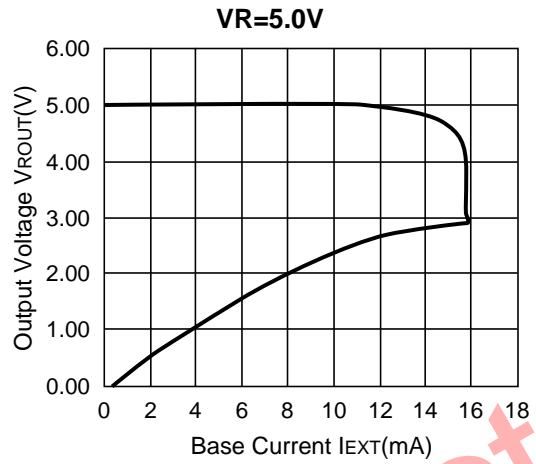
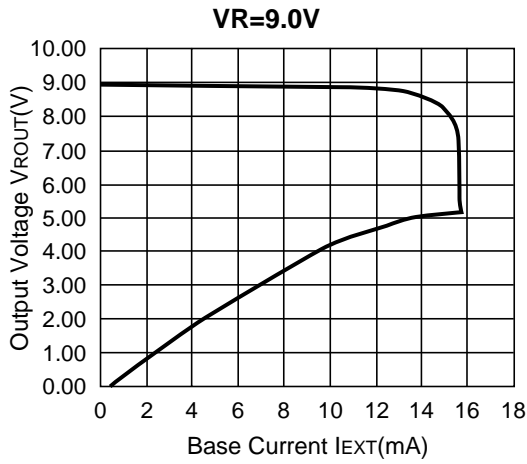




c. External Tr.:2SB703

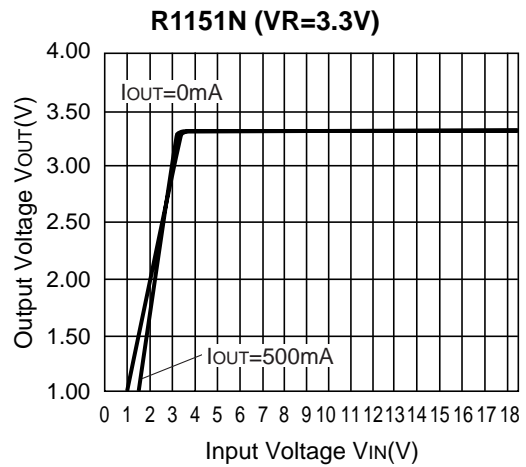
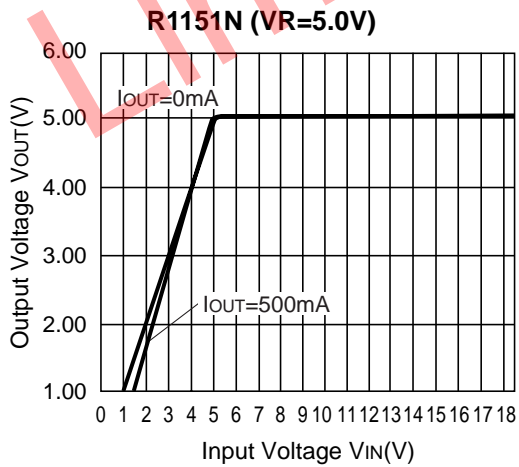


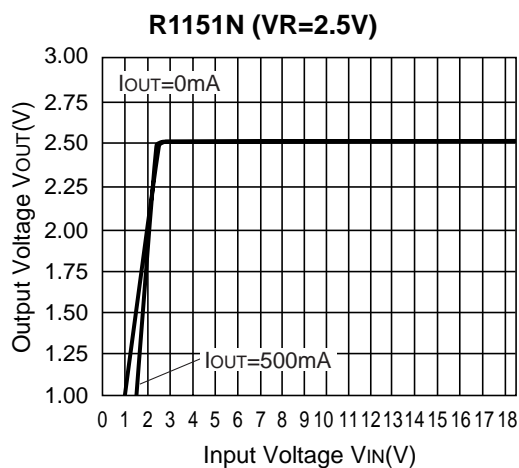
d. Output Voltage vs. Base Current ( $T_{opt}=25^{\circ}C$ )



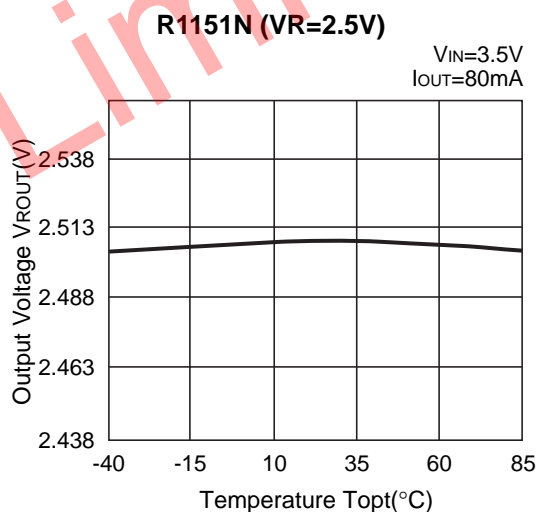
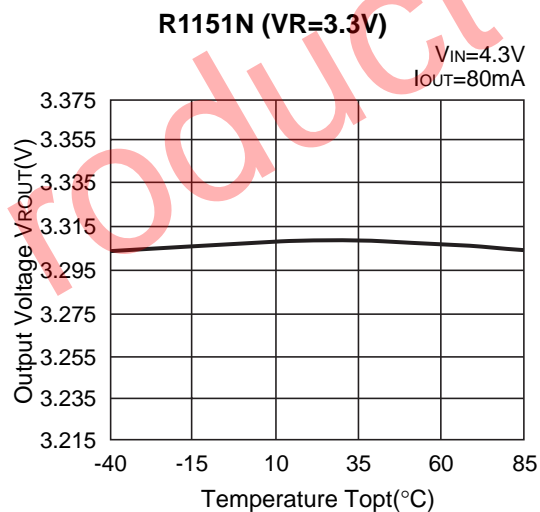
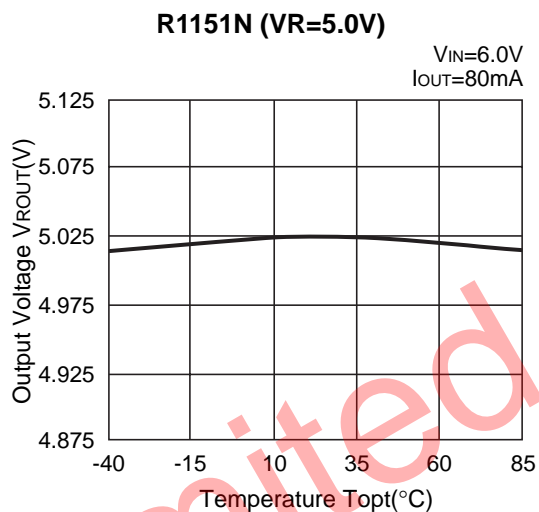
2) Output Voltage vs. Input Voltage ( $T_{opt}=25^{\circ}C$ )

External Transistor: 2SA1441



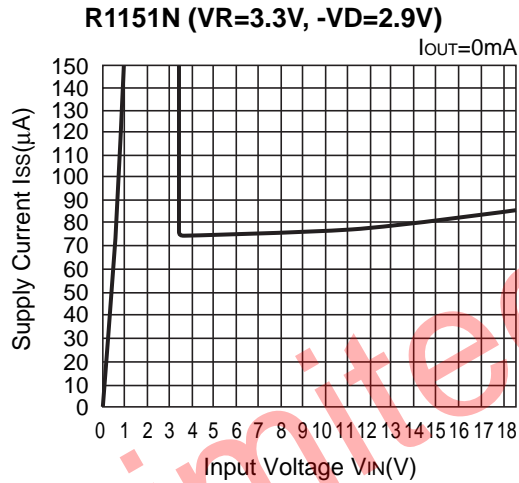
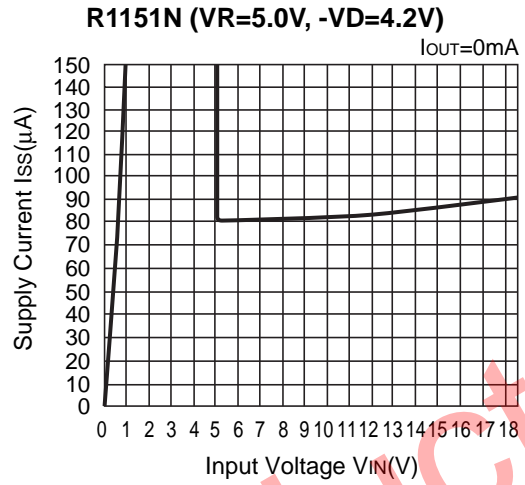
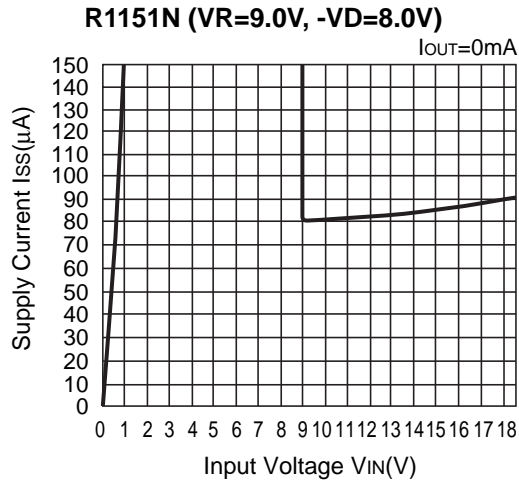


## 3) Output Voltage vs. Temperature



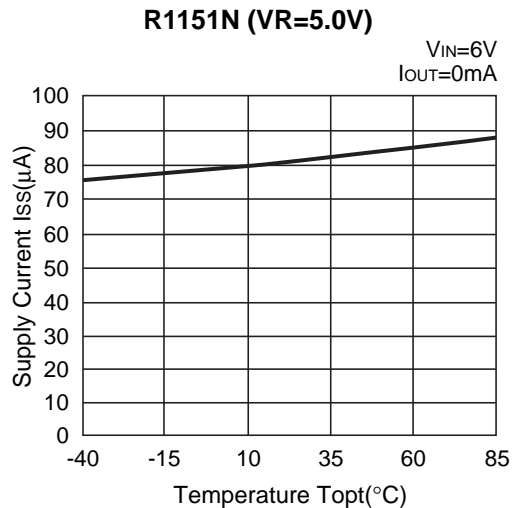
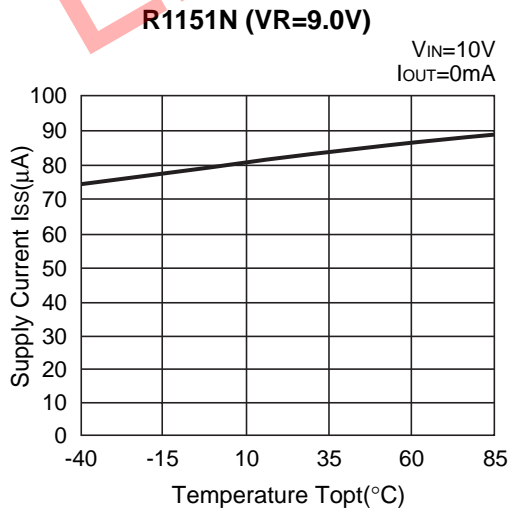
4) Supply Current vs. Input Voltage

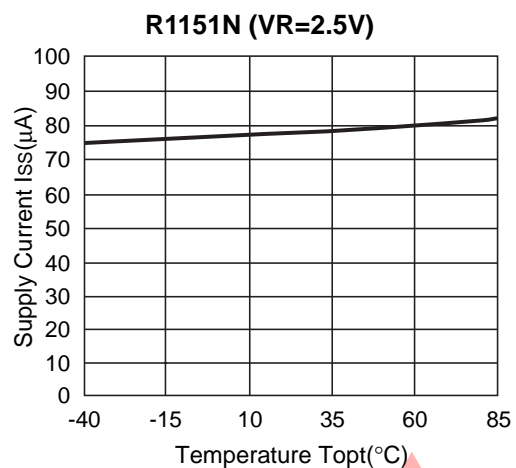
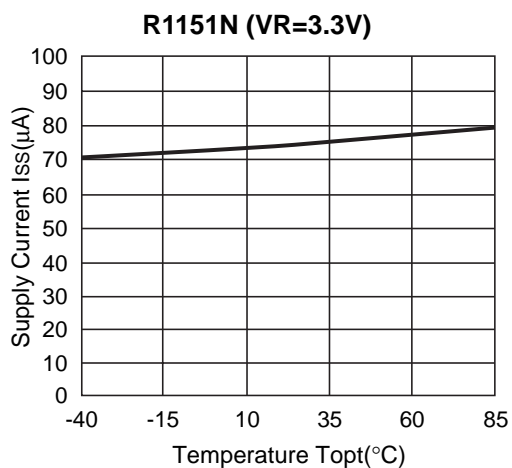
External Tr.:2SA1441



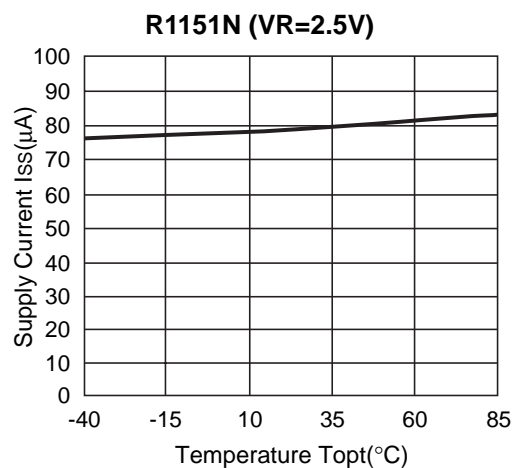
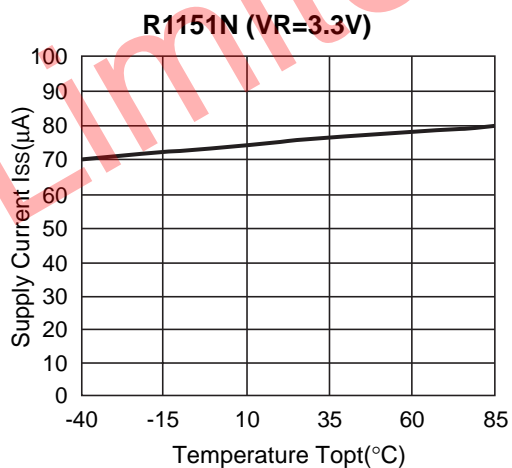
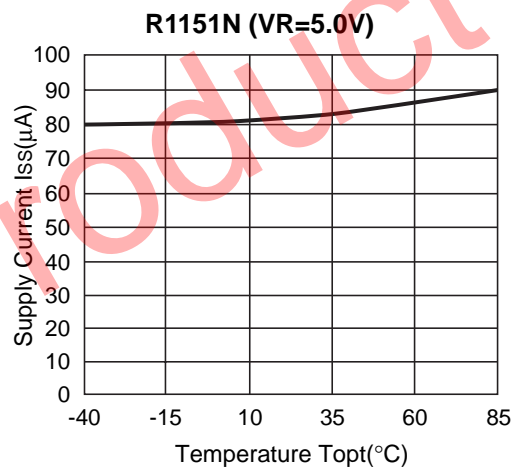
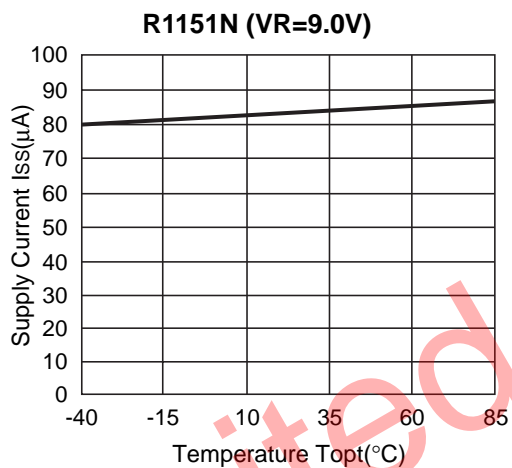
5) Supply Current vs. Temperature

a. External Tr.:2SA1441



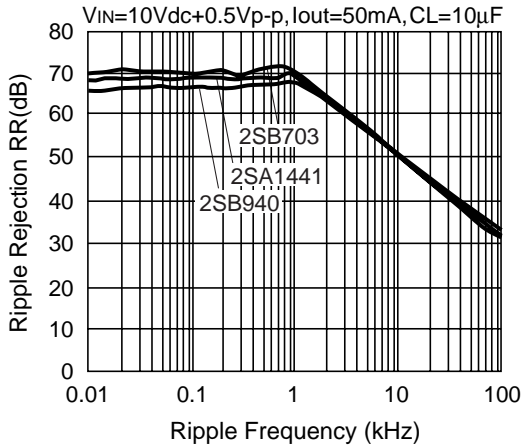


b. External Tr.:2SB703

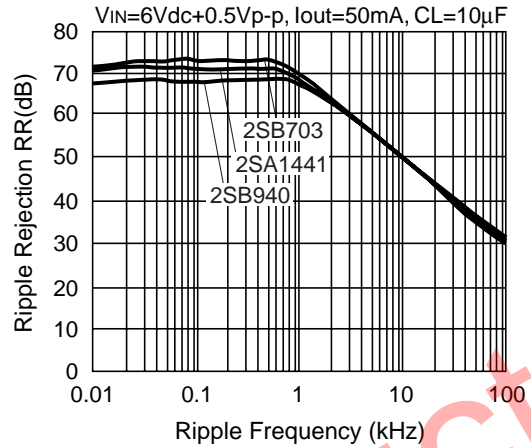


6) Ripple Rejection vs. Ripple Frequency (Topt=25°C)

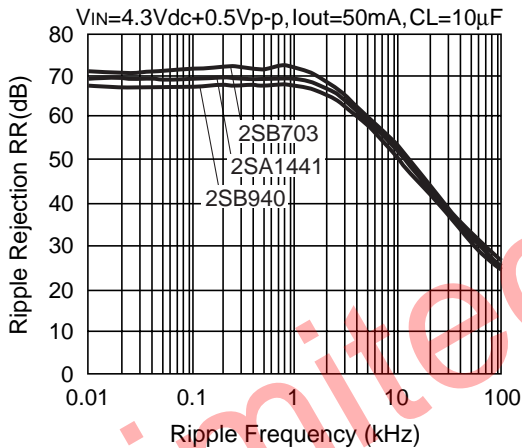
**R1151N (VR=9.0V)**



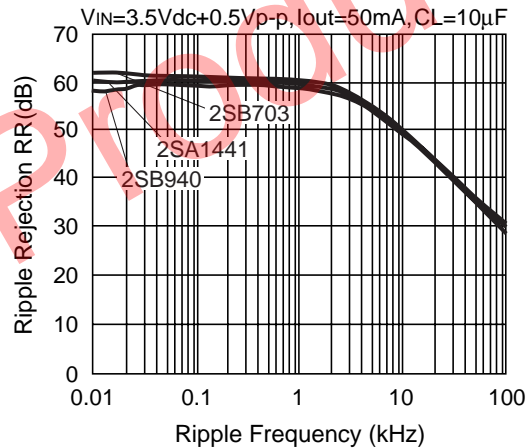
**R1151N (VR=5.0V)**



**R1151N (VR=3.3V)**

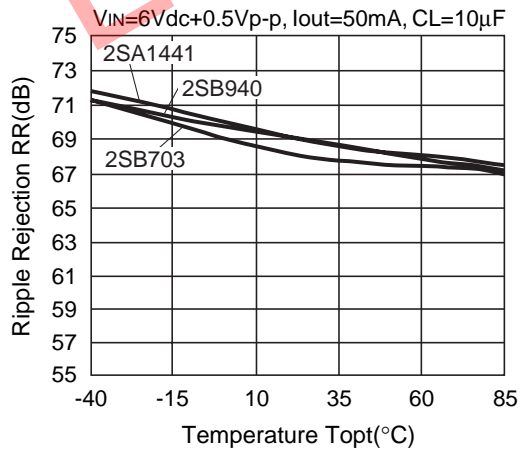


**R1151N (VR=2.5V)**

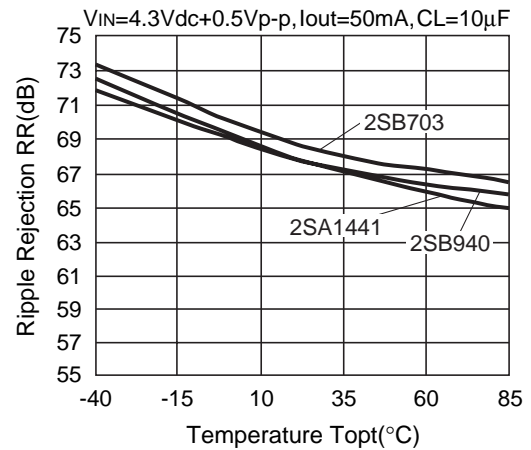


7) Ripple Rejection vs. Temperature

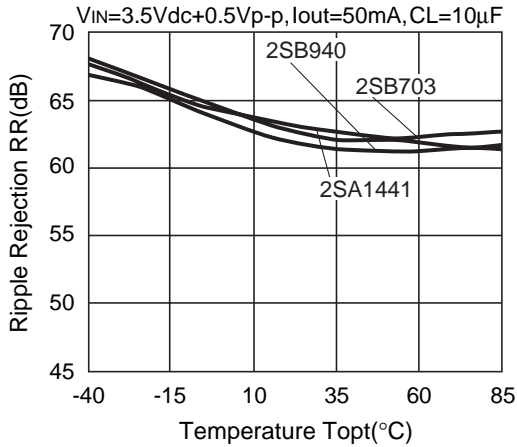
**R1151N (VR=5.0V)**



**R1151N (VR=3.3V)**



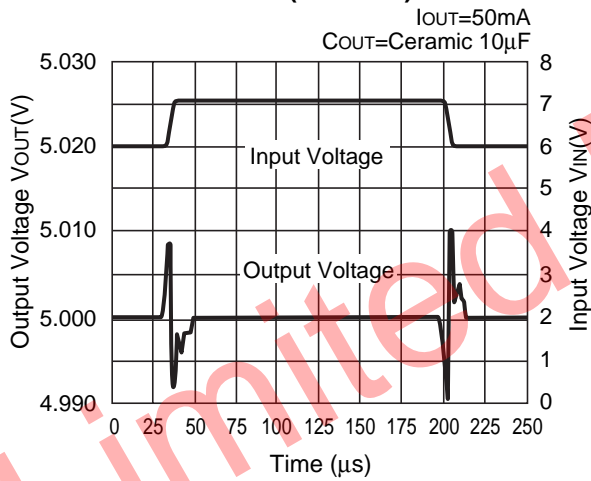
**R1151N (VR=2.5V)**



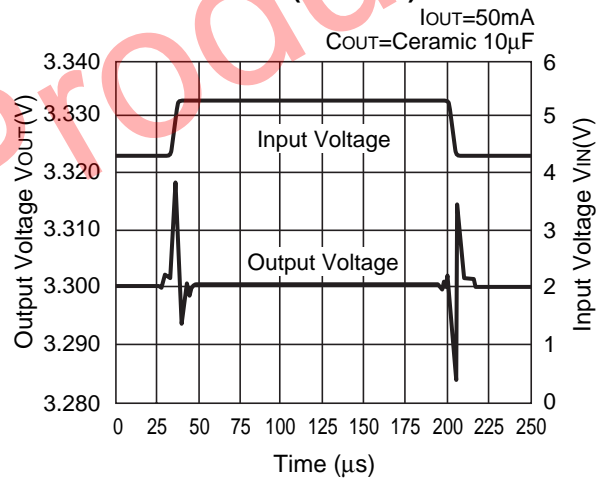
8) Input Transient Response (T<sub>opt</sub>=25°C)

a. External Tr.:2SA1441

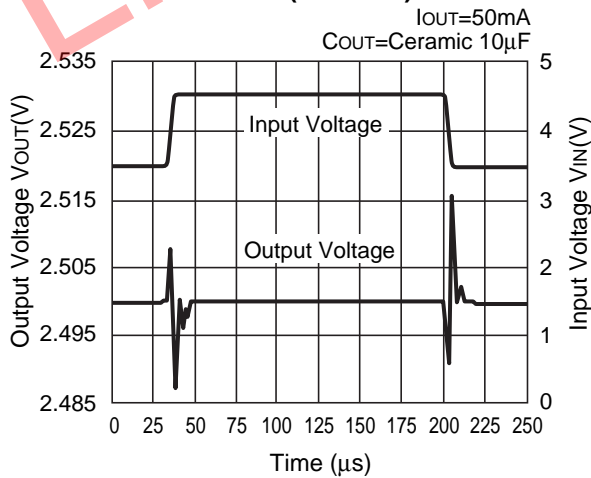
**R1151N (VR=5.0V)**



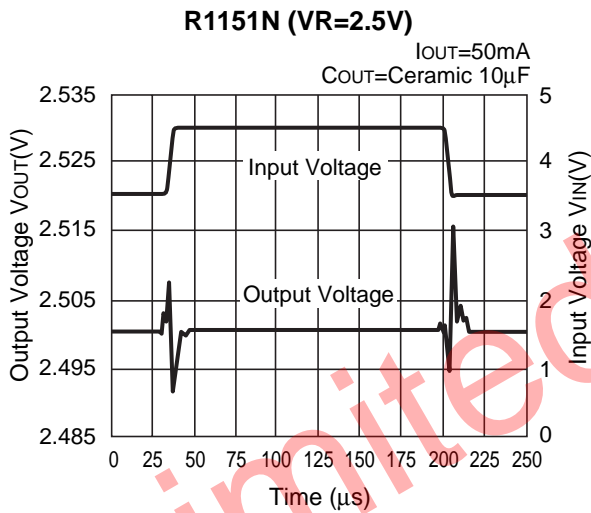
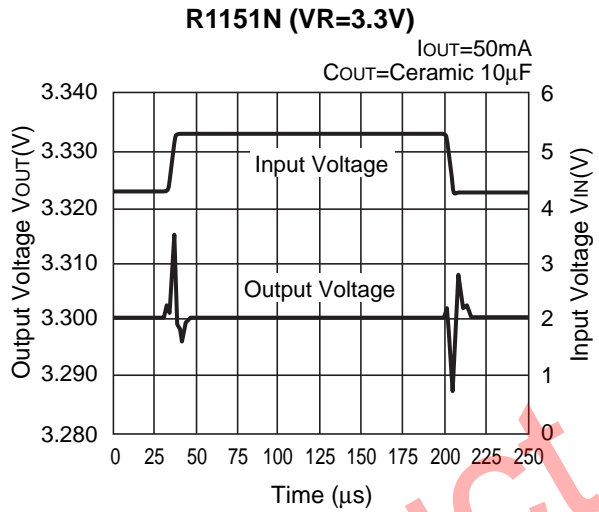
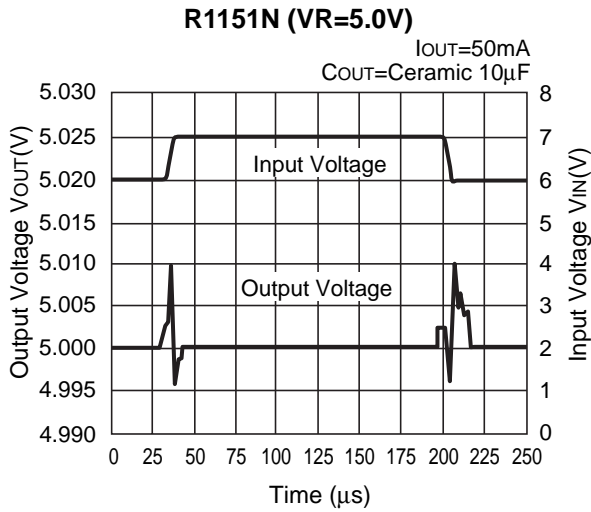
**R1151N (VR=3.3V)**



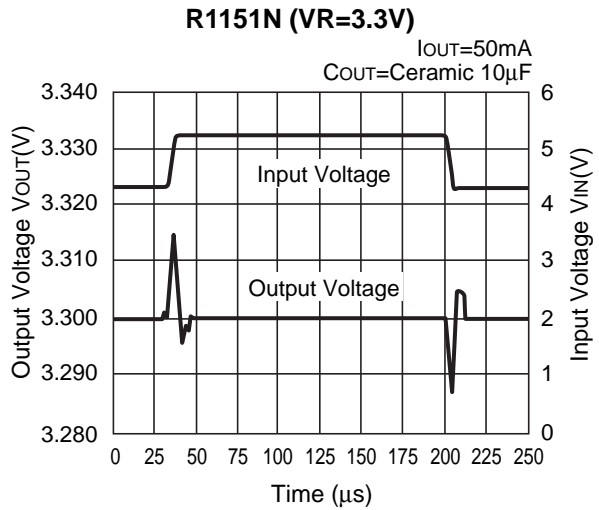
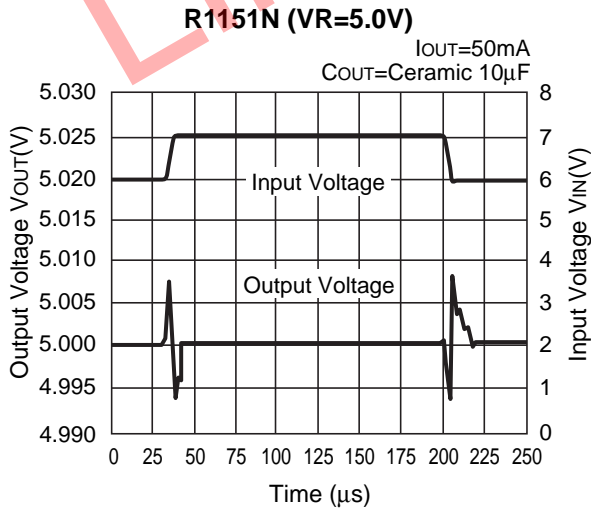
**R1151N (VR=2.5V)**



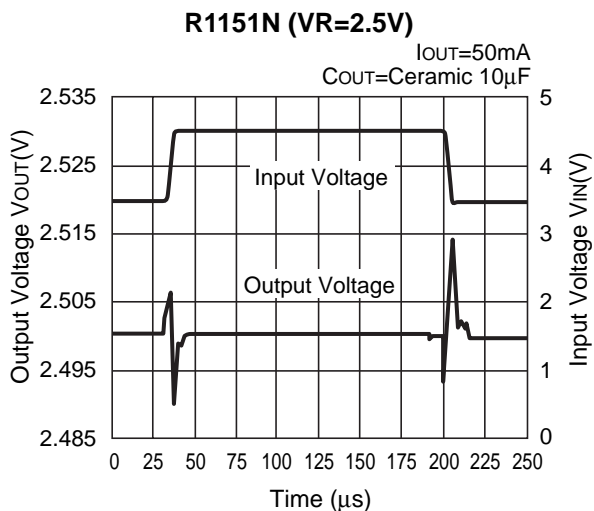
b. External Tr.: 2SB703



c. External Tr. : 2SB940

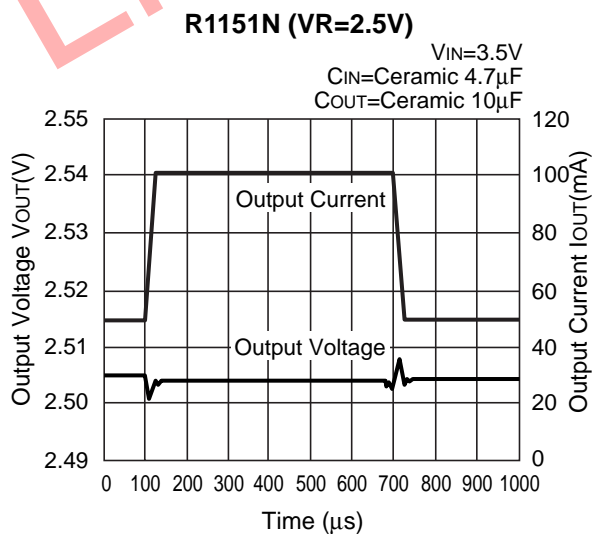
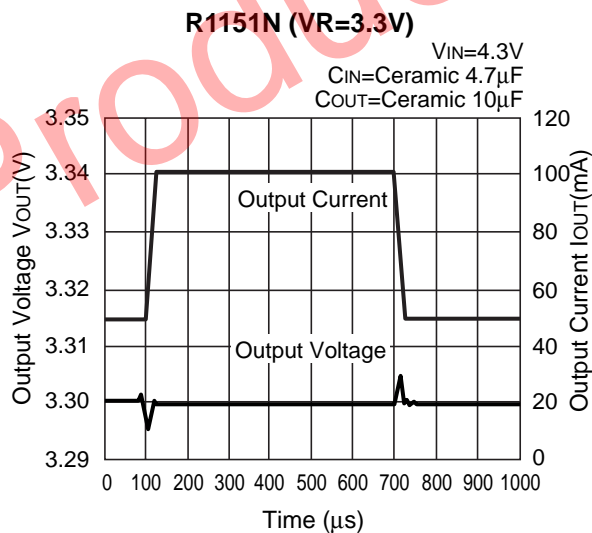
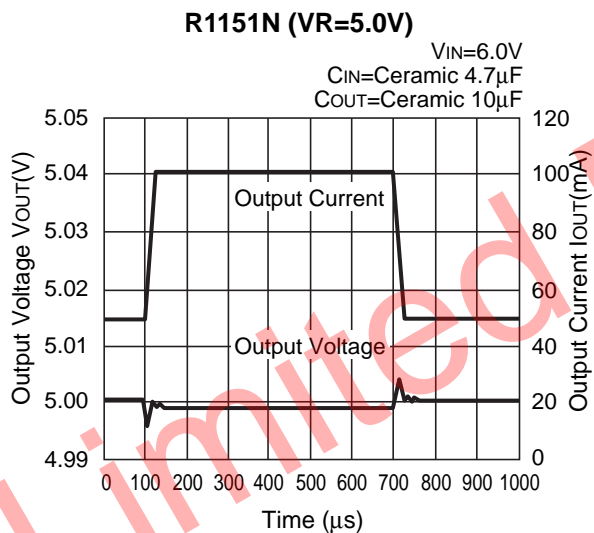






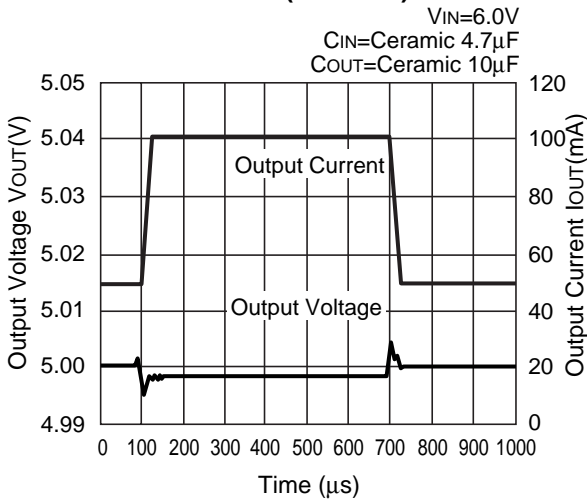
9) Load Transient Response ( $T_{opt}=25^{\circ}\text{C}$ )

a: External Tr.: 2SA1441

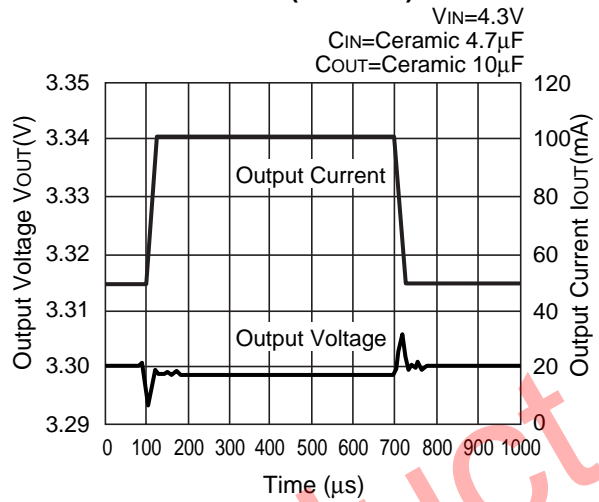


b. External Tr.: 2SB703

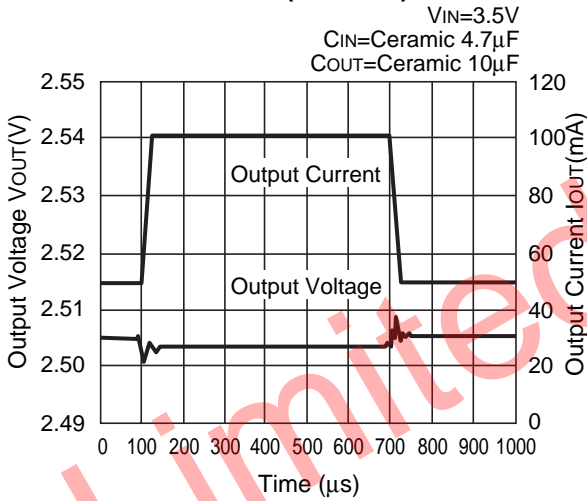
**R1151N (VR=5.0V)**



**R1151N (VR=3.3V)**

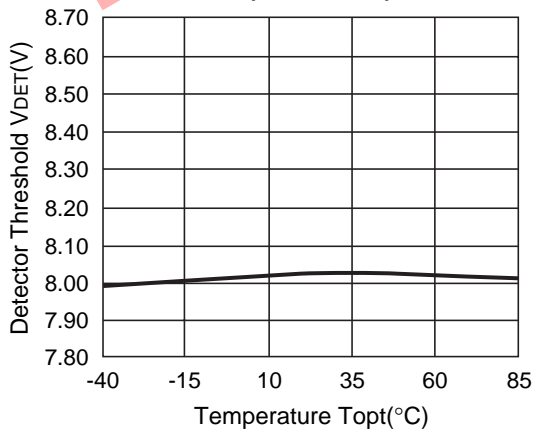


**R1151N (VR=2.5V)**

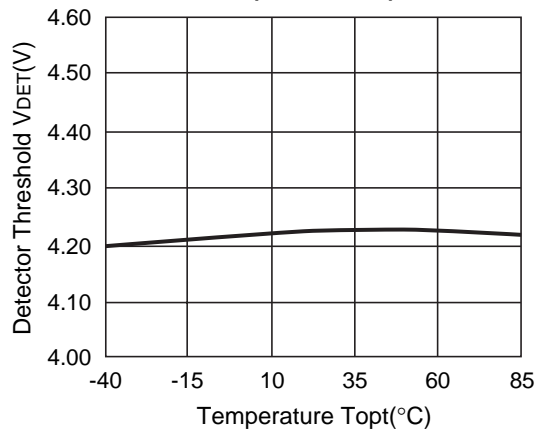


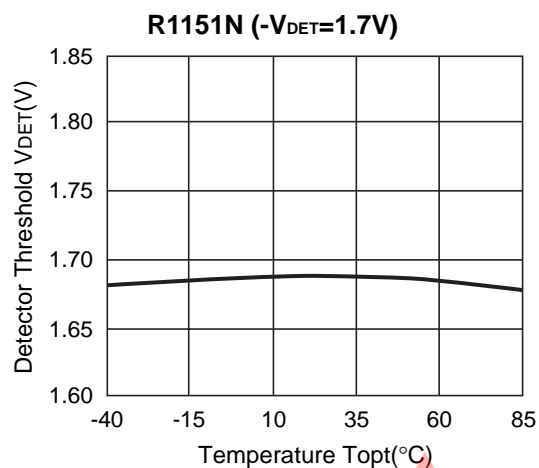
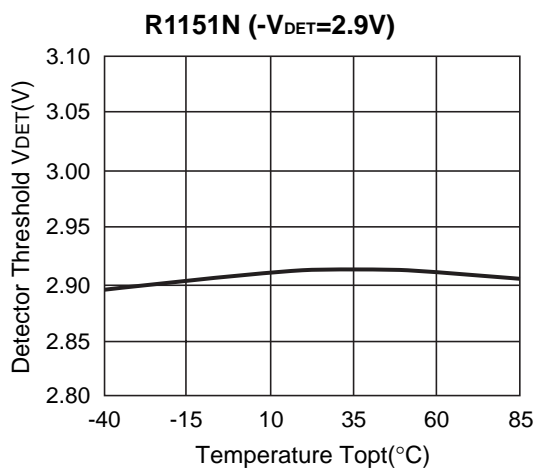
10) Detector Threshold vs. Temperature

**R1151N ( $-V_{DET}=8.0V$ )**

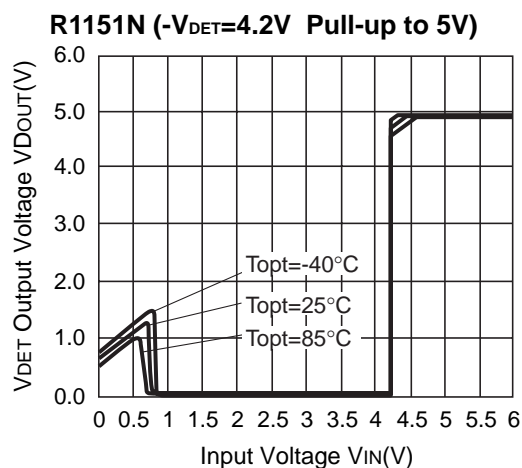
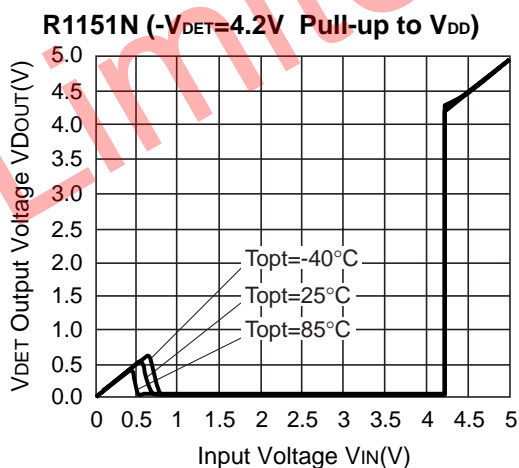
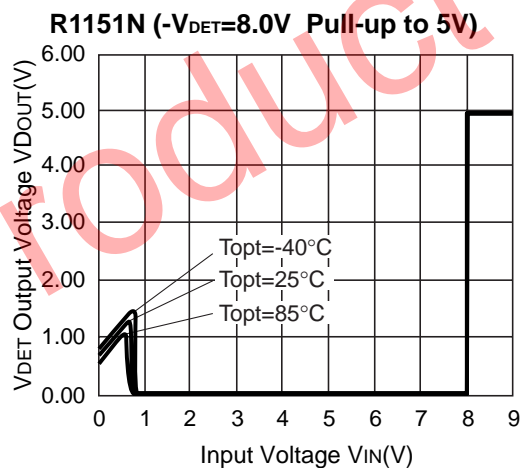
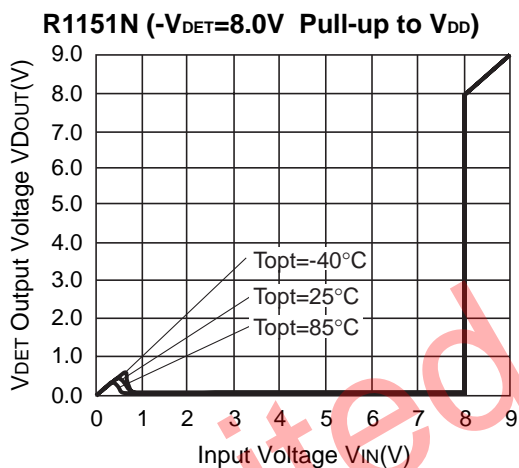


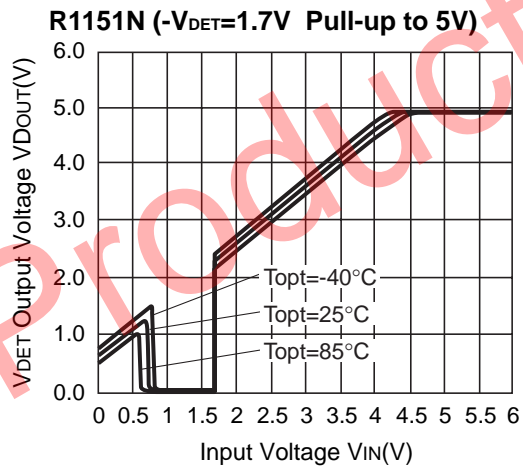
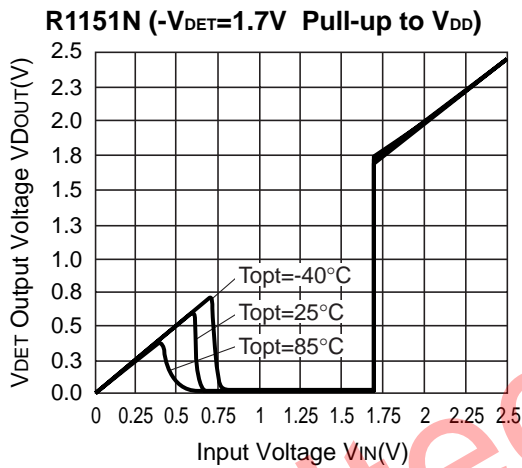
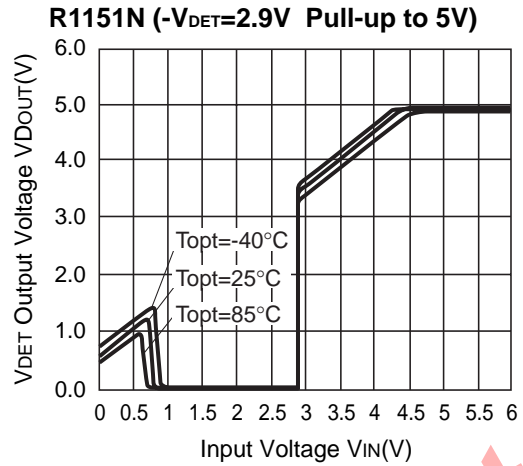
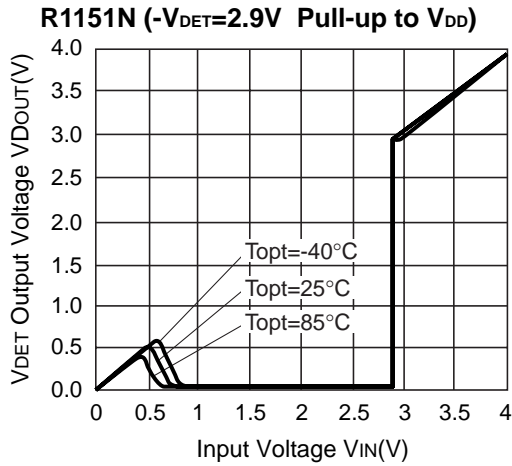
**R1151N ( $-V_{DET}=4.2V$ )**



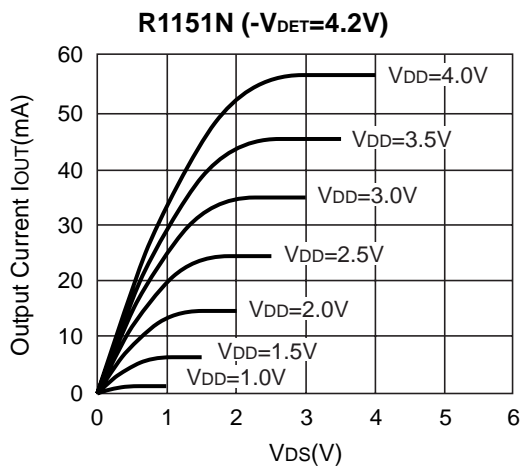
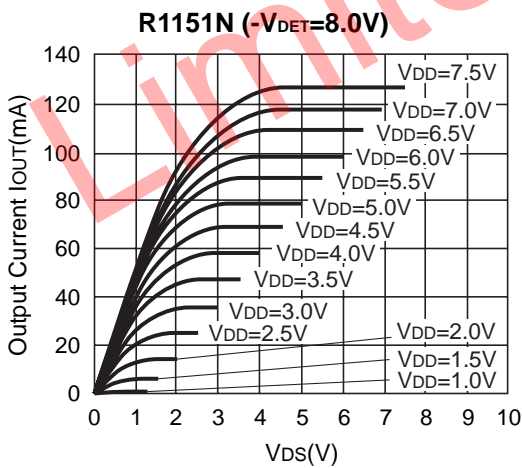


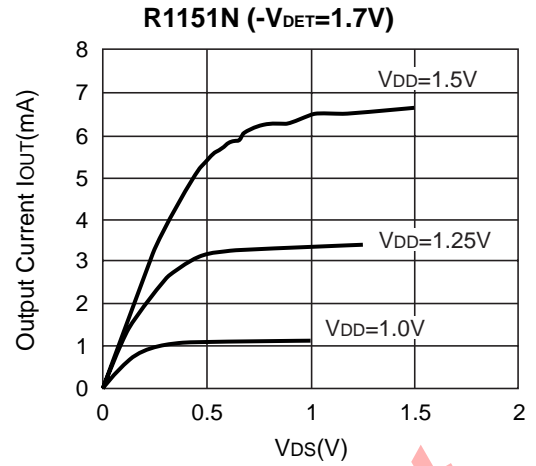
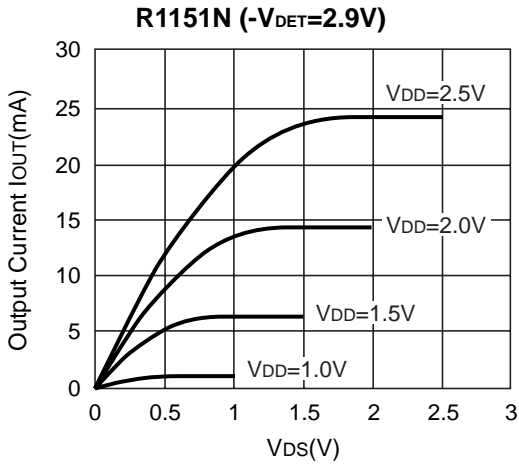
11) V<sub>DET</sub> Output Voltage vs. Input Voltage



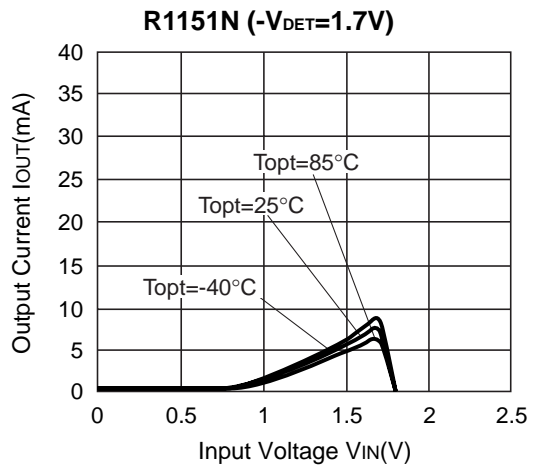
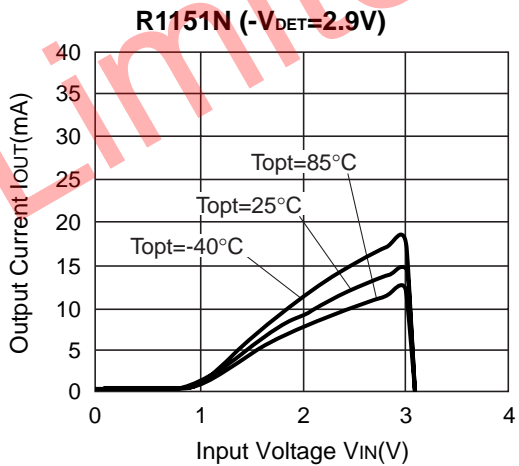
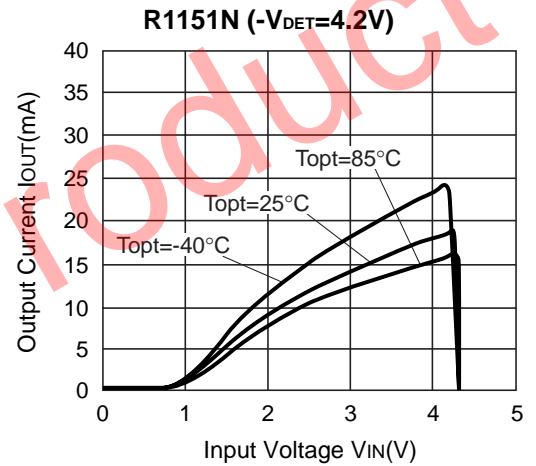
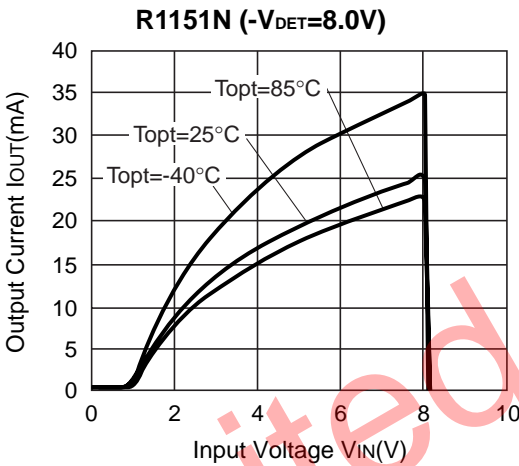


12) Nch Driver Output Current vs. V<sub>DS</sub> (T<sub>opt</sub>=25°C)

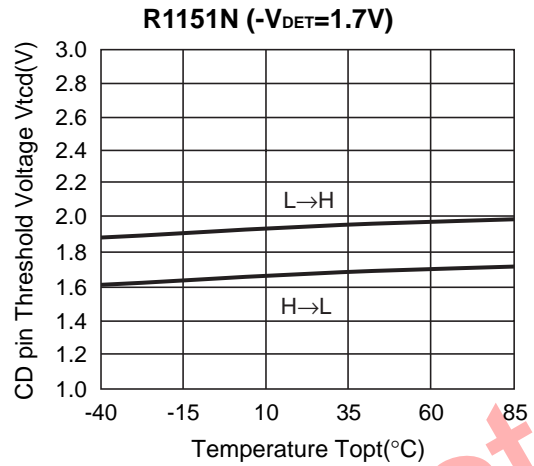
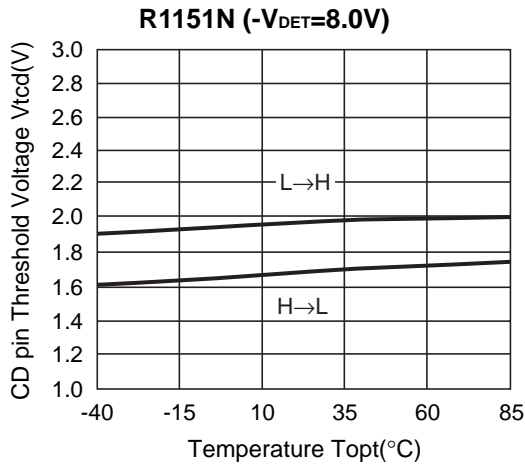




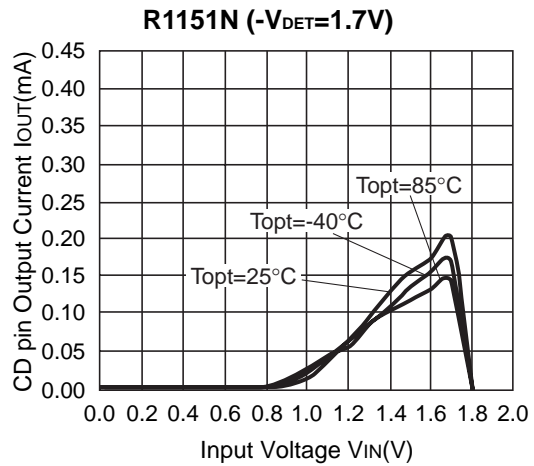
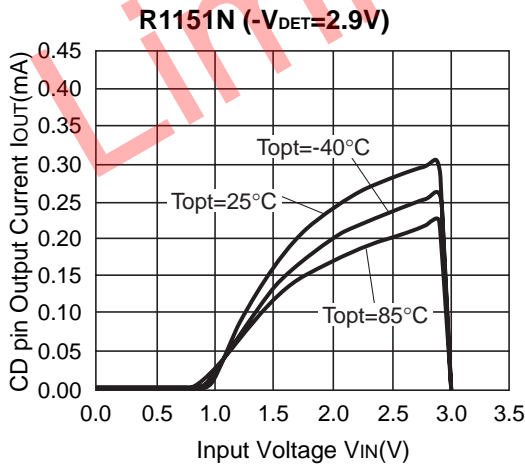
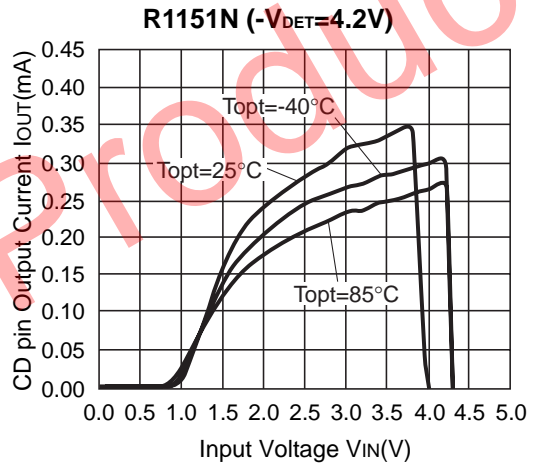
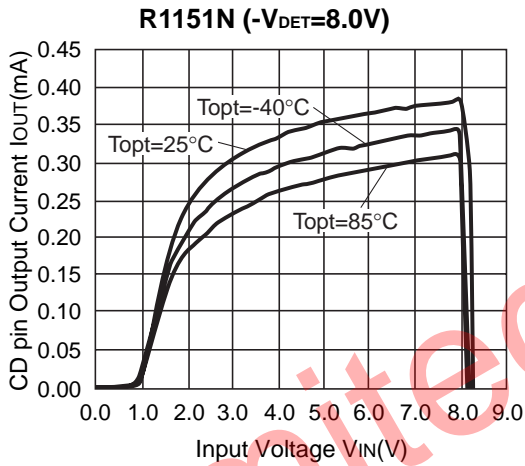
13) Nch Driver Output Current vs. Input Voltage



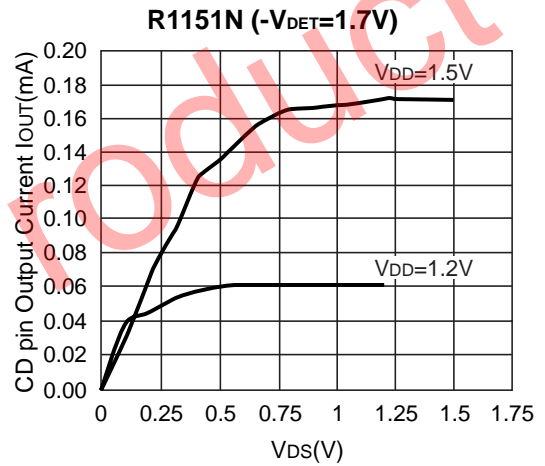
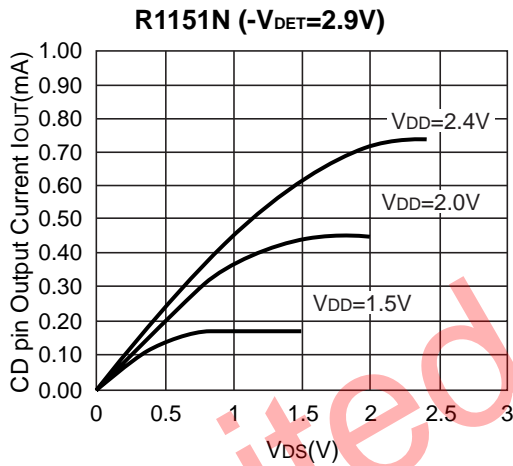
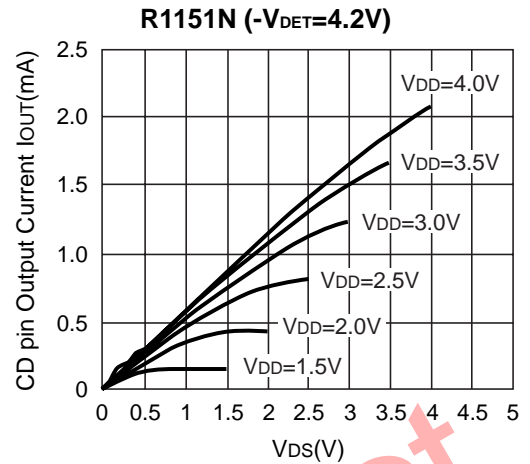
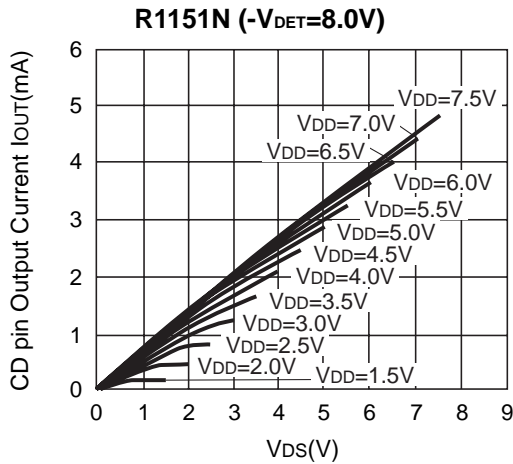
14) CD pin Threshold Voltage vs. Temperature



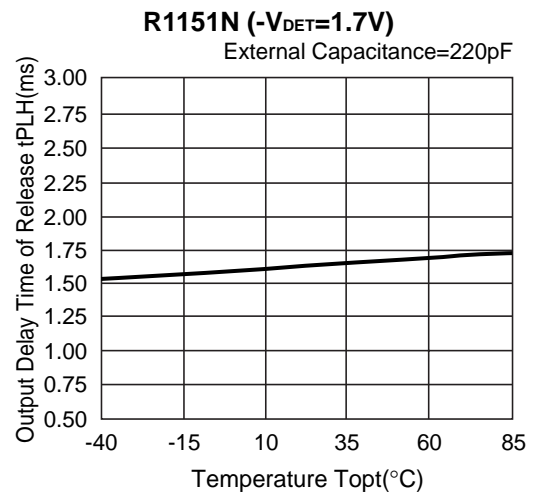
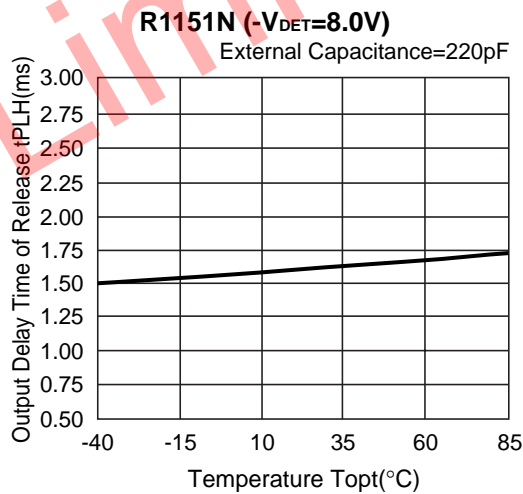
15) CD Pin Output Current vs. Input Voltage



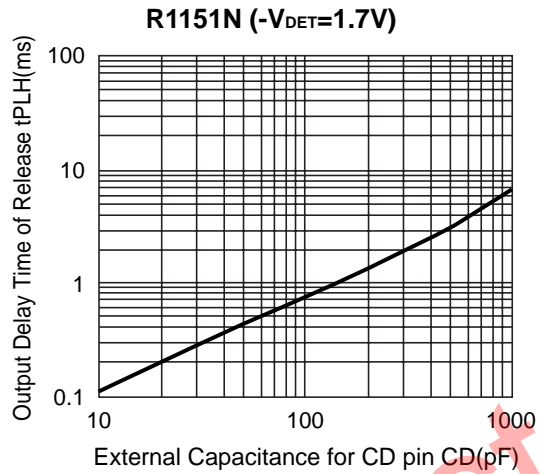
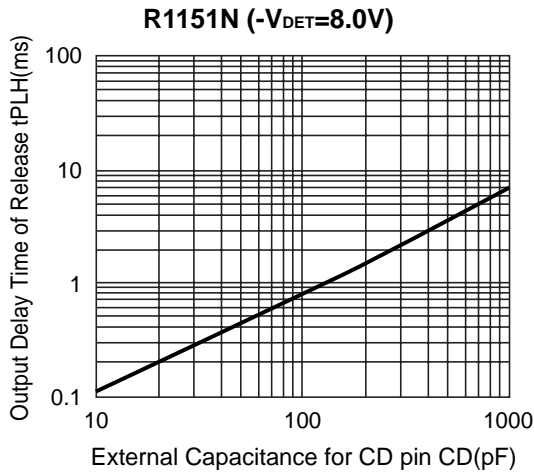
16) CD Pin Output Current vs.  $V_{DS}$  ( $T_{opt}=25^{\circ}C$ )



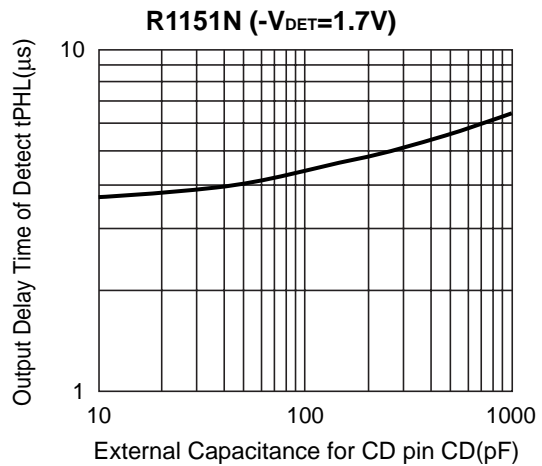
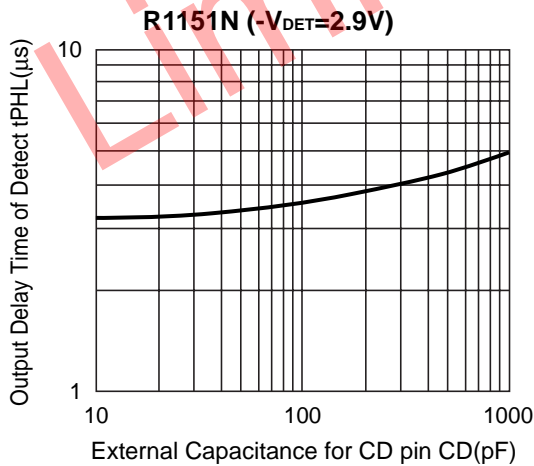
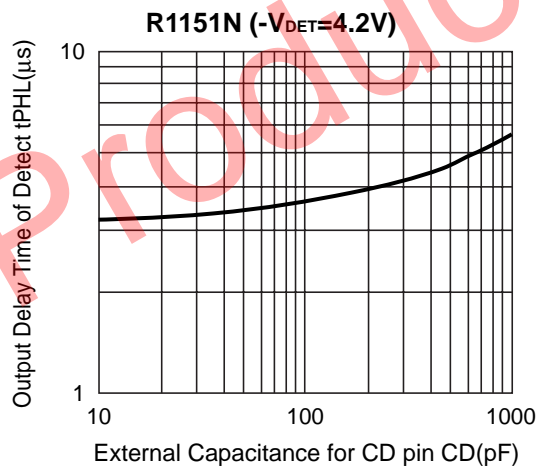
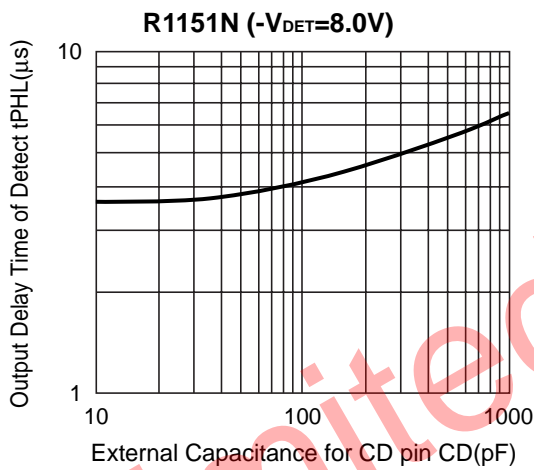
17) Output Delay Time of Release vs. Temperature



18) Output Delay Time of Release vs. External Capacitance for CD pin ( $T_{opt}=25^{\circ}\text{C}$ )



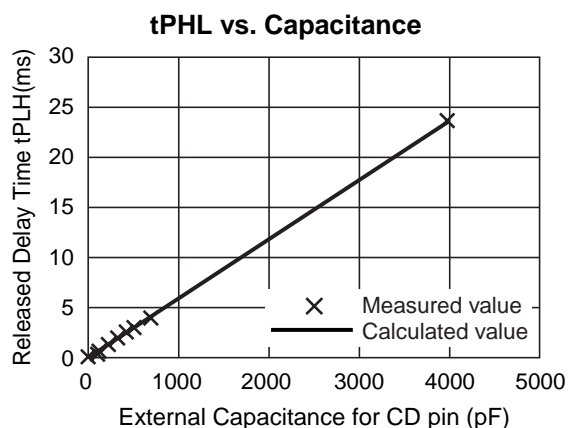
19) Output Delay Time of Detect vs. External Capacitance for CD pin ( $T_{opt}=25^{\circ}\text{C}$ )





## Calculation of Output Delay Time of Release

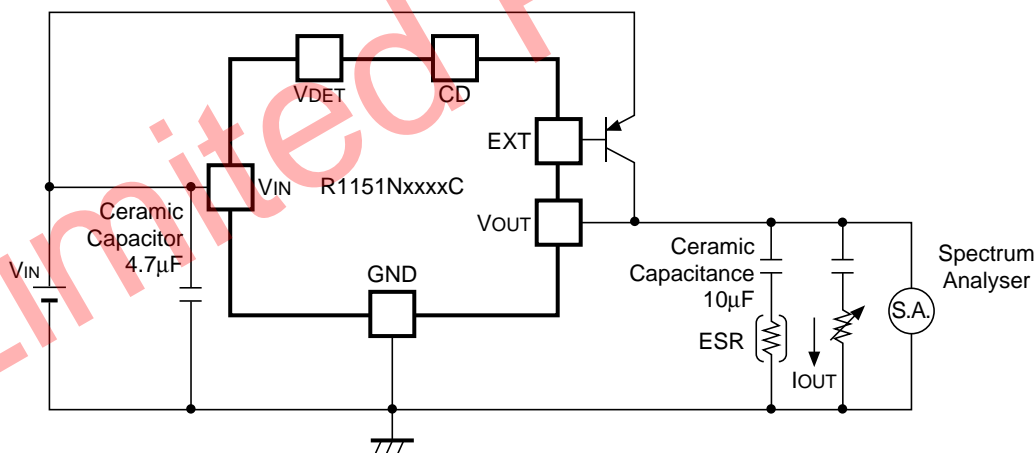
$$t_{PLH}(s) = 1.83 \times C / (300 \times 10^{-9})$$



## For Stable Operation

### Phase Compensation

In these ICs, phase compensation is externally made for securing stable operation even if the load current is varied. For this purpose, be sure to use a capacitor for the output pin with good frequency characteristics and ESR (Equivalent Series Resistance) of which is in the range described as follows:

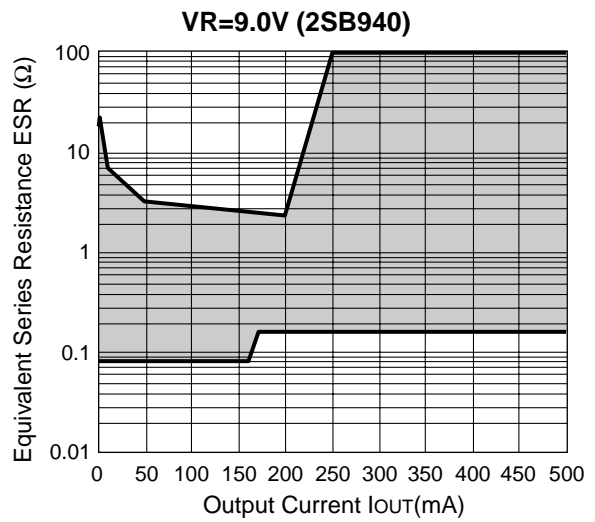
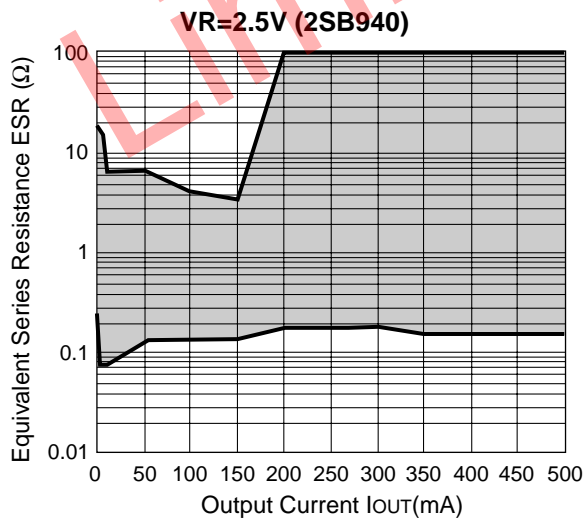
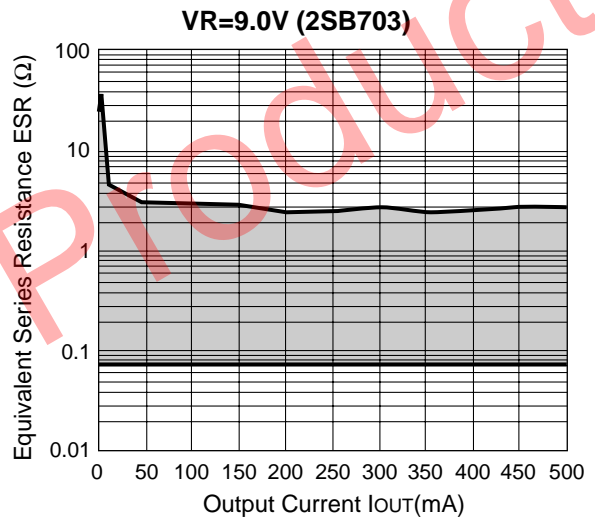
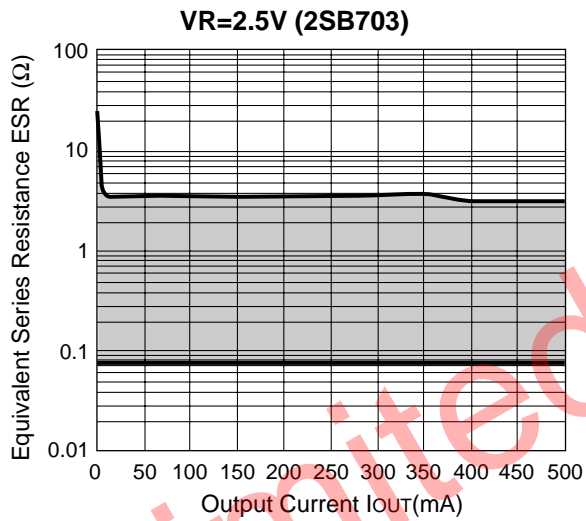
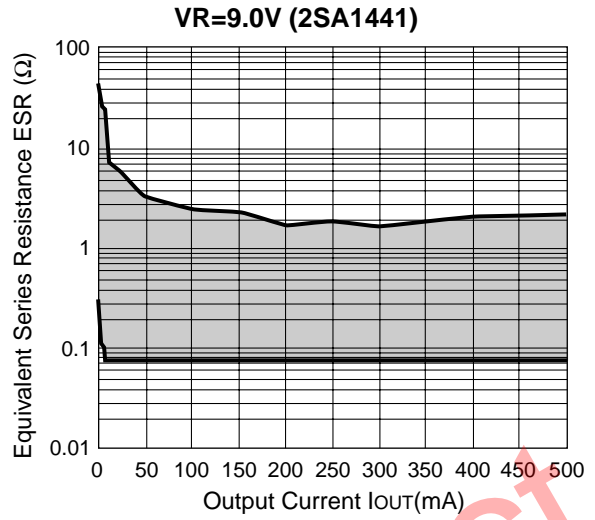
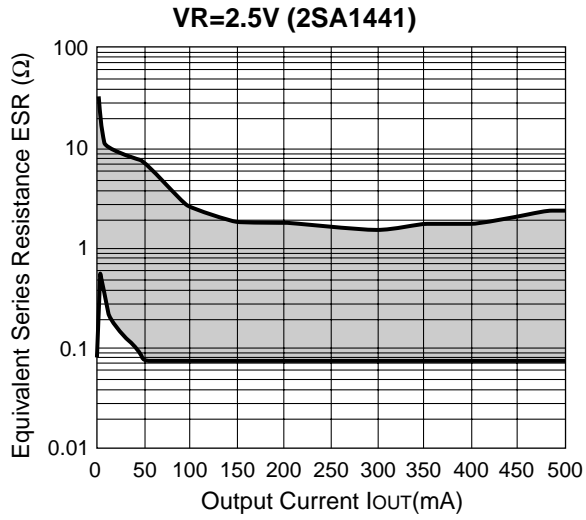


**Measuring Circuit for white noise; R1151NxxxC**

The relations between  $I_{OUT}$  (Output Current) and ESR of Output Capacitor are shown below. The conditions when the white noise level is under  $40\mu V$  (Avg.) are marked as the hatched area in the graph.

<Measurement conditions>

- (1)  $V_{IN} = V_{OUT} + 1V$
- (2) Frequency band: 10Hz to 1MHz
- (3) Temperature: 25°C
- (4)  $C_{OUT}$ : Ceramic 10µF; ESR=0.075Ω (10kHz)





1. The products and the product specifications described in this document are subject to change or discontinuation of production without notice for reasons such as improvement. Therefore, before deciding to use the products, please refer to Ricoh sales representatives for the latest information thereon.
2. The materials in this document may not be copied or otherwise reproduced in whole or in part without prior written consent of Ricoh.
3. Please be sure to take any necessary formalities under relevant laws or regulations before exporting or otherwise taking out of your country the products or the technical information described herein.
4. The technical information described in this document shows typical characteristics of and example application circuits for the products. The release of such information is not to be construed as a warranty of or a grant of license under Ricoh's or any third party's intellectual property rights or any other rights.
5. The products listed in this document are intended and designed for use as general electronic components in standard applications (office equipment, telecommunication equipment, measuring instruments, consumer electronic products, amusement equipment etc.). Those customers intending to use a product in an application requiring extreme quality and reliability, for example, in a highly specific application where the failure or misoperation of the product could result in human injury or death (aircraft, spacevehicle, nuclear reactor control system, traffic control system, automotive and transportation equipment, combustion equipment, safety devices, life support system etc.) should first contact us.
6. We are making our continuous effort to improve the quality and reliability of our products, but semiconductor products are likely to fail with certain probability. In order to prevent any injury to persons or damages to property resulting from such failure, customers should be careful enough to incorporate safety measures in their design, such as redundancy feature, fire containment feature and fail-safe feature. We do not assume any liability or responsibility for any loss or damage arising from misuse or inappropriate use of the products.
7. Anti-radiation design is not implemented in the products described in this document.
8. The X-ray exposure can influence functions and characteristics of the products. Confirm the product functions and characteristics in the evaluation stage.
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 Ricoh sales or our distributor before attempting to use AOI.
11. Please contact Ricoh sales representatives should you have any questions or comments concerning the products or the technical information.



**Ricoh is committed to reducing the environmental loading materials in electrical devices with a view to contributing to the protection of human health and the environment.**

Ricoh has been providing RoHS compliant products since April 1, 2006 and Halogen-free products since April 1, 2012.

**RICOH** RICOH ELECTRONIC DEVICES CO., LTD.

<http://www.e-devices.ricoh.co.jp/en/>

**Sales & Support Offices**

**RICOH ELECTRONIC DEVICES CO., LTD.**

**Higashi-Shinagawa Office (International Sales)**  
3-32-3, Higashi-Shinagawa, Shinagawa-ku, Tokyo 140-8655, Japan  
Phone: +81-3-5479-2857 Fax: +81-3-5479-0502

**RICOH EUROPE (NETHERLANDS) B.V.**

**Semiconductor Support Centre**  
Prof. W.H. Keesomlaan 1, 1183 DJ Amstelveen, The Netherlands  
Phone: +31-20-5474-309

**RICOH INTERNATIONAL B.V. - German Branch**

**Semiconductor Sales and Support Centre**  
Oberrather Strasse 6, 40472 Düsseldorf, Germany  
Phone: +49-211-6546-0

**RICOH ELECTRONIC DEVICES KOREA CO., LTD.**

3F, Haesung Bldg, 504, Teheran-ro, Gangnam-gu, Seoul, 135-725, Korea  
Phone: +82-2-2135-5700 Fax: +82-2-2051-5713

**RICOH ELECTRONIC DEVICES SHANGHAI CO., LTD.**

Room 403, No.2 Building, No.690 Bibo Road, Pu Dong New District, Shanghai 201203, People's Republic of China  
Phone: +86-21-5027-3200 Fax: +86-21-5027-3299

**RICOH ELECTRONIC DEVICES CO., LTD.**

**Taipei office**  
Room 109, 10F-1, No.51, Hengyang Rd., Taipei City, Taiwan (R.O.C.)  
Phone: +886-2-2313-1621/1622 Fax: +886-2-2313-1623