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## High Input Voltage Tolerant Boost Voltage Regulator

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NO.EA-108-130411

### OUTLINE

The R1152N Series are CMOS-based positive voltage regulator controller ICs with high output voltage accuracy, low supply current.

The high output current regulator can be composed with this IC, an external power transistor, and capacitors.

Each of these voltage regulator controllers consists of a voltage reference unit, an error amplifier, comparators, resistors for output voltage setting, a peak current limit protection circuit, a short current limit circuit, and a chip enable circuit. The output voltage of these ICs is internally fixed.

In addition to low supply current by the merit of CMOS process, the chip enable function prolongs the battery life.

Maximum operating input voltage is up to 18V, thus these ICs are very suitable for the power supply for hand-held equipment and other power management applications using various AC adapters.

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

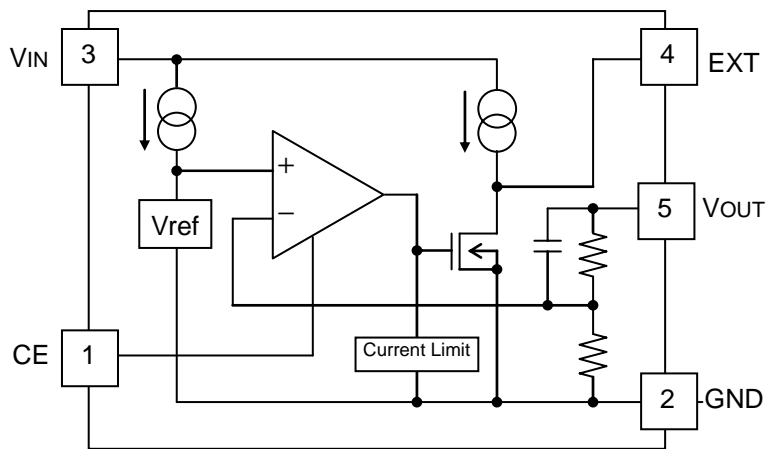
### FEATURES

- Supply Current ..... Typ.10 $\mu$ A
- Standby Mode ..... Typ.0.1 $\mu$ A
- Dropout Voltage ..... Typ.0.1V( $I_{OUT}=300mA, V_{OUT}=5.0V$ , Depends on External Transistor)
- Output Voltage Accuracy .....  $\pm 2.0\%$
- Output Voltage ..... Internally fixed output voltage : 2.5V to 12.0V (0.1V steps)  
Externally adjustable output voltage : the reference voltage is 2.5V  
(with external divider resistors can be set more than 12.1V)  
(For other voltages, please refer to MARK INFORMATIONS.)
- Operating Input Voltage ..... Max.18V
- Package ..... SOT-23-5
- Built-in Chip Enable Circuit ("H" active)
- Built-in Current Limit Circuit
- Built-in Output Short Current Limit Circuit

### APPLICATIONS

- Power source for home appliances such as refrigerators, rice cookers, etc.
- Power source for car audio equipment, car navigation system, and ETC system.
- Power source for notebook PCs, digital TVs, cordless phones, and LAN system.
- Power source for copiers, printers, facsimiles, and scanners.

## BLOCK DIAGRAMS



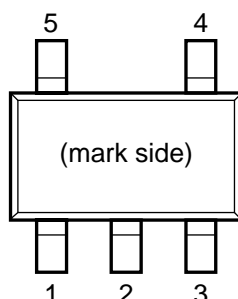
## SELECTION GUIDE

The output voltage for the ICs can be selected at the user's request.

Product Name	Package	Quantity per Reel	Pb Free	Halogen Free
R1152NxxxB*-TR-FE	SOT-23-5	3,000 pcs	Yes	Yes
xxx : The output voltage can be designated in the range from 2.5V(025) to 12.0V(120) in 0.1V steps. (For other voltages, please refer to MARK INFORMATIONS.)				

## PIN CONFIGURATION

### • SOT-23-5



## PIN DESCRIPTIONS

Pin No	Symbol	Pin Description
1	CE	Chip Enable Pin
2	GND	Ground Pin
3	V <sub>IN</sub>	Input pin
4	V <sub>DD</sub>	External Transistor Drive Pin
5	V <sub>OUT</sub>	Voltage Regulator Output Pin

## ABSOLUTE MAXIMUM RATINGS

Symbol	Item	Rating	Unit
V <sub>IN</sub>	Input Voltage	20	V
V <sub>SURGE</sub>	SURGE Input Voltage*2	26	V
V <sub>CE</sub>	Input Voltage (CE Pin)	-0.3 to V <sub>IN</sub> +0.3 ≤ 20	V
V <sub>OUT</sub>	Output Voltage (V <sub>OUT</sub> Pin)	-0.3 to V <sub>IN</sub> +0.3 ≤ 20	V
V <sub>EXT</sub>	Output Voltage (EXT Pin)	-0.3 to V <sub>IN</sub> +0.3 ≤ 20	V
I <sub>EXT</sub>	EXT Output Current	25	mA
P <sub>D</sub>	Power Dissipation (SOT-23-5*1)	420	mW
T <sub>opt</sub>	Operating Temperature Range	-40 to +105	°C
T <sub>stg</sub>	Storage Temperature Range	-55 to +125	°C

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

\*2) duration=200ms

### 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

### • R1152NxxxB

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> =100mA	×0.980		×1.020	V
I <sub>OUT</sub>	Output Current	Refer to the specification Table Note1	1			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 specification table by output voltage			
V <sub>DIF</sub>	Dropout Voltage	I <sub>OUT</sub> =300mA				
I <sub>SS</sub>	Supply Current	V <sub>IN</sub> =Set V <sub>OUT</sub> +1V, I <sub>OUT</sub> =0mA		10	24	μA
I <sub>standby</sub>	Supply Current (Standby)	V <sub>IN</sub> =18V, CE=0V		0.1	1.0	μA
I <sub>EXTleak</sub>	EXT Leakage Current				0.1	μA
ΔV <sub>OUT</sub> /ΔV <sub>IN</sub>	Line Regulation	Set V <sub>OUT</sub> +0.5V ≤ V <sub>IN</sub> ≤ 18.0V I <sub>OUT</sub> =100mA		0.01	0.10	%/V
V <sub>IN</sub>	Input Voltage				18	V
I <sub>SC</sub>	Current Limit	Refer to the specification Table Base Current I <sub>B</sub> of PNP Tr.	10		25	mA
I <sub>lim</sub>	Short Current Limit	Base Current I <sub>B</sub> of PNP Tr. V <sub>OUT</sub> =0V		600		μA
ΔV <sub>OUT</sub> /ΔT <sub>opt</sub>	Output Voltage Temperature Coefficient	I <sub>OUT</sub> =100mA -40°C ≤ T <sub>opt</sub> ≤ 105°C		±50		ppm/°C
V <sub>CEH</sub>	CE Input Voltage "H"		2.0		V <sub>IN</sub>	μA
V <sub>CEL</sub>	CE Input Voltage "L"		0		0.3	V

Note1: This item depends on the capability of external PNP transistor.

Use low saturation type transistor with h<sub>FE</sub> value range of 100 to 300.

#### 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.

- Load Regulation Table (T<sub>opt</sub>=25°C)

Output Voltage V <sub>OUT</sub> (V)	Load Regulation (mV)	
	Typ.	Max.
2.5 ≤ V <sub>OUT</sub> ≤ 5.0	4	10
5.1 ≤ V <sub>OUT</sub> ≤ 12.0	4	18

- Dropout Voltage Table (T<sub>opt</sub>=25°C)

Output Voltage V <sub>OUT</sub> (V)	Dropout Voltage (mV)	
	Typ.	Max.
2.5 ≤ V <sub>OUT</sub> ≤ 4.9	150	290
5.0 ≤ V <sub>OUT</sub> ≤ 12.0	100	180

\*This specification depends on an external transistor. ("2SB1642" is the reference item.)

- Output Current Limit Condition Table (T<sub>opt</sub>=25°C)

Output Voltage V <sub>OUT</sub> (V)	Condition
2.5V ≤ V <sub>OUT</sub> ≤ 3.9	V <sub>IN</sub> =CE=EXT=5.0V
4.0 ≤ V <sub>OUT</sub> ≤ 12.0	V <sub>IN</sub> =CE=EXT=V <sub>OUT</sub> +1.0V

- Output Current Condition Table (T<sub>opt</sub>=25°C)

Output Voltage V <sub>OUT</sub> (V)	Condition
2.5V ≤ V <sub>OUT</sub> ≤ 3.9	V <sub>IN</sub> =CE=5.0V
4.0 ≤ V <sub>OUT</sub> ≤ 12.0	V <sub>IN</sub> =CE=V <sub>OUT</sub> +1.0V

## OPERATION

In these ICs, fluctuation of Output Voltage,  $V_{OUT}$  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.

## TECHNICAL NOTES

When using these ICs, consider the following points:

Make  $V_{DD}$  and GND lines sufficient. When their impedance is high, noise pickup or unstable operation may result.

When you choose an external transistor, select with considering output current, input voltage, and power dissipation. Generally, low  $V_{CE}$  (SAT) and  $h_{FE}$  range from 100 to 300 are the appropriate characteristics.

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 a  $10\mu\text{F}$  or more output capacitor, as close as possible to the ICs.

If you choose an electrolytic capacitor, ESR shift by temperature should be small. If you choose a ceramic capacitor, add an appropriate series resistor.

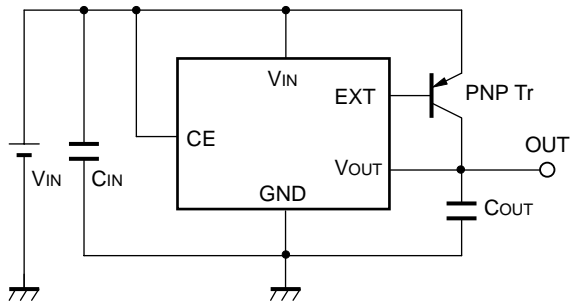
If the set output voltage is less than 4.0V, and  $I_{OUT} > 1\text{A}$  must be obtained, at least  $V_{IN} \geq 5.0\text{V}$  is the appropriate condition. (Supposed as  $h_{FE} = 100$ )

Voltage level for CE should not be floating, or middle range voltage. If the CE voltage is not appropriate, output voltage may be unstable or conduction current may flow.

All external components should be located as close as possible to the IC, and wiring should be as short as possible.

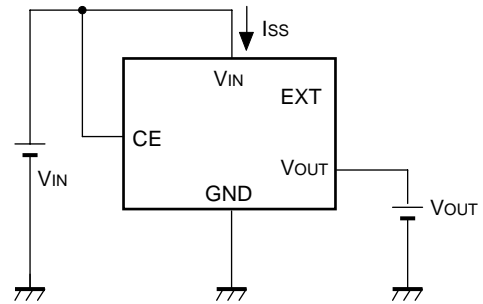
If  $h_{FE}$  value of the PNP transistor is too high, output voltage may rise at low load current (less than 1mA).

**TEST CIRCUITS**



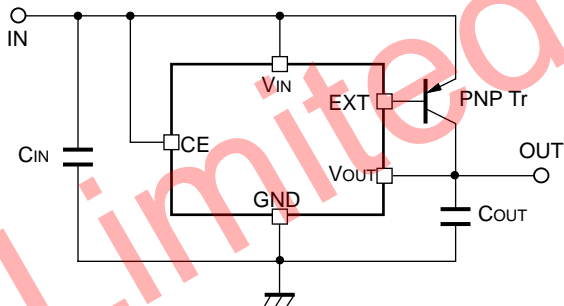
$C_{IN}=0.1\mu F, C_{OUT}=10\mu F$

**Fig.1 Standard test Circuit**



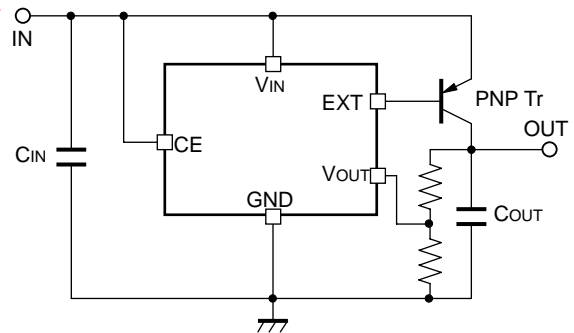
**Fig.2 Supply Current Test Circuit**

**TYPICAL APPLICATIONS**



$C_{IN}=0.1\mu F, C_{OUT}=10\mu F$

**Fixed Type Output**



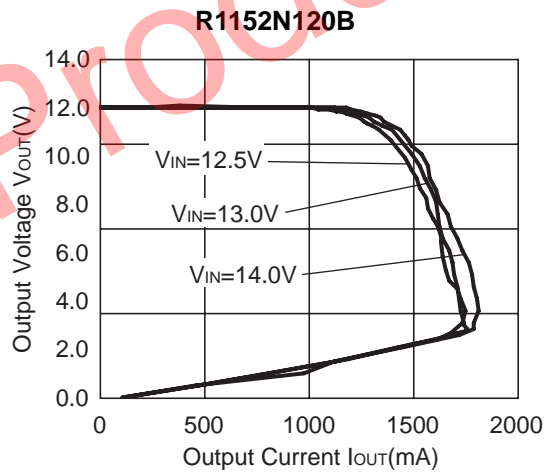
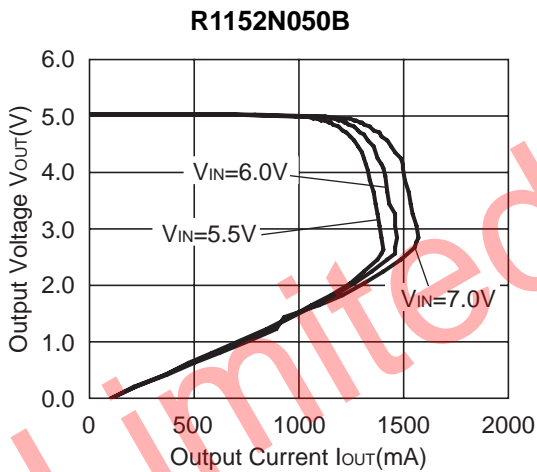
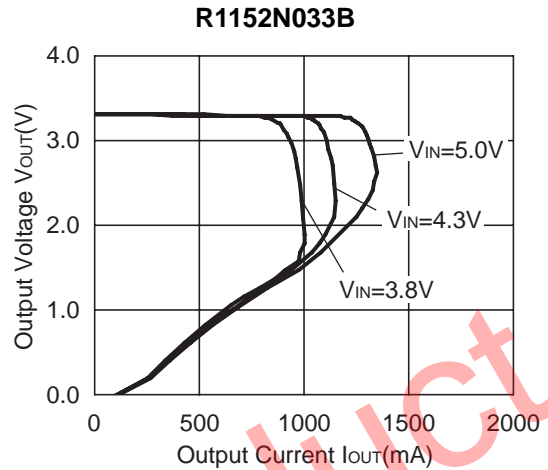
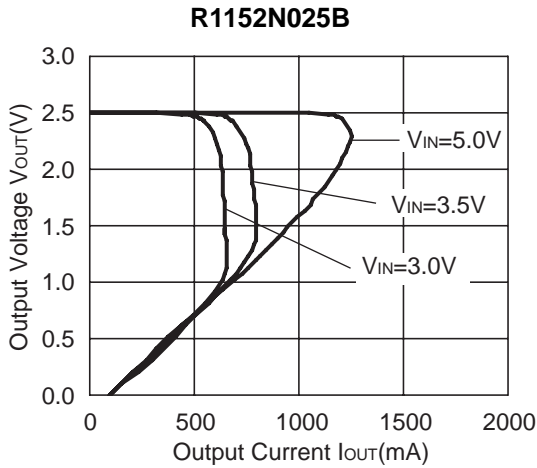
$C_{IN}=0.1\mu F, C_{OUT}=10\mu F$

**Adjustable Output**

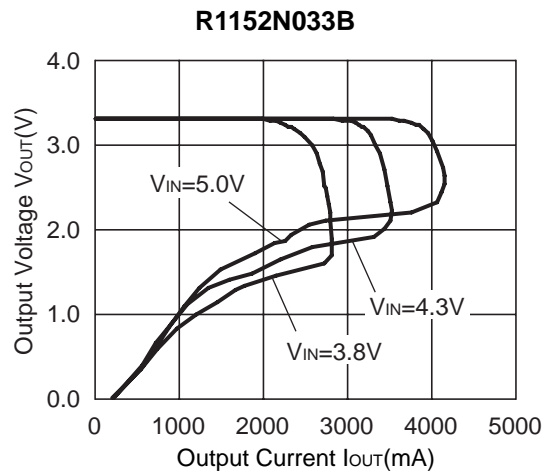
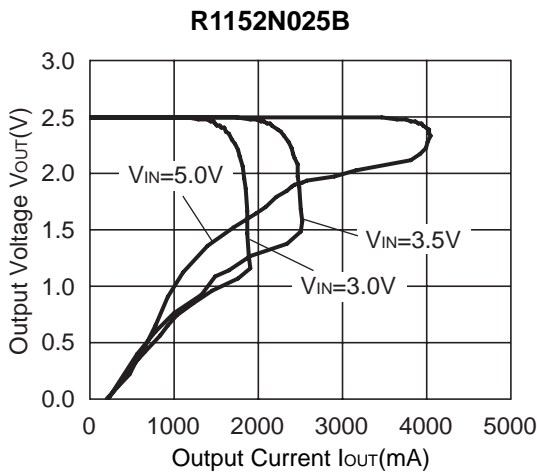
**TYPICAL CHARACTERISTICS**

1) Output Voltage vs. Output Current (Topt=25°C)

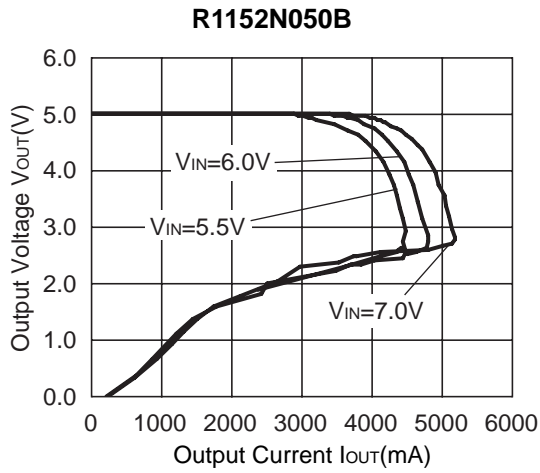
a. External Tr.: 2SB1642



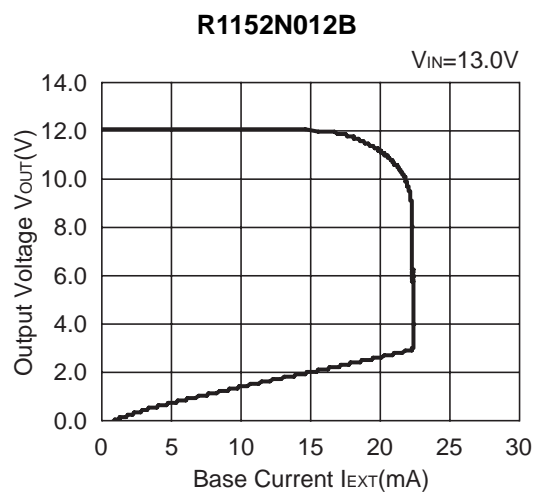
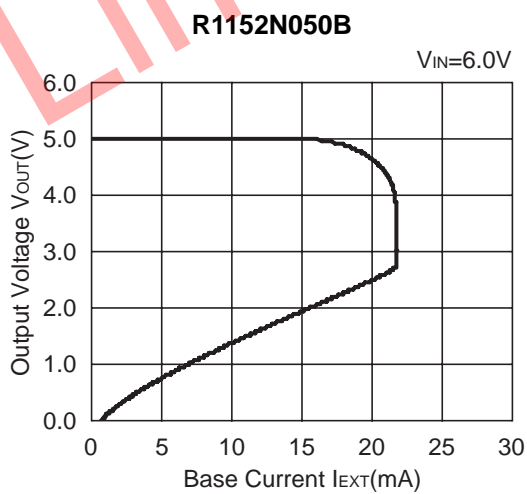
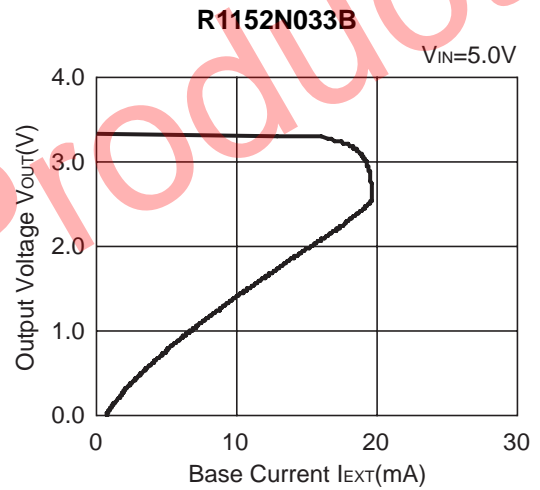
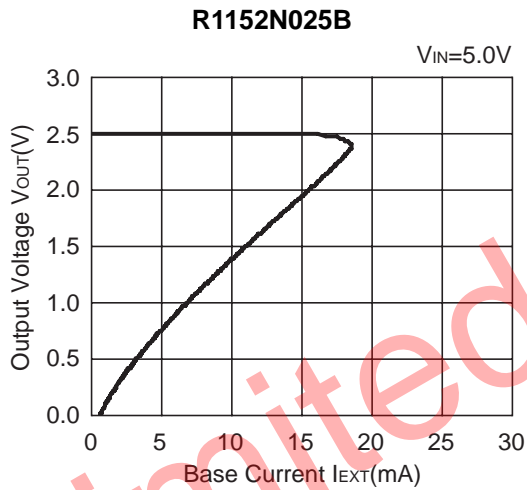
b. External Tr.: 2SA1645







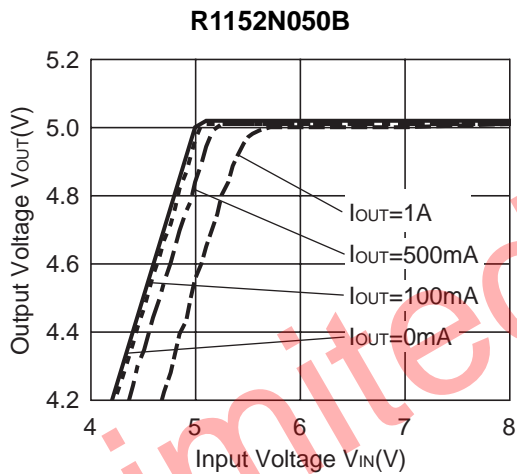
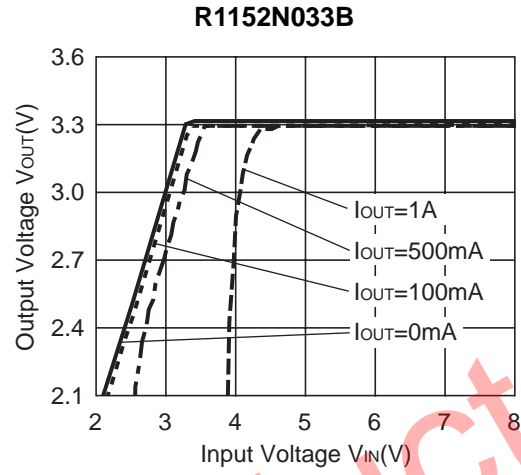
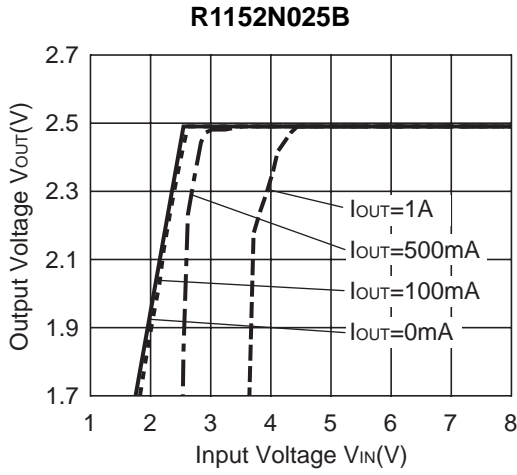
c. Output Voltage vs. Base Current (Topt=25°C)



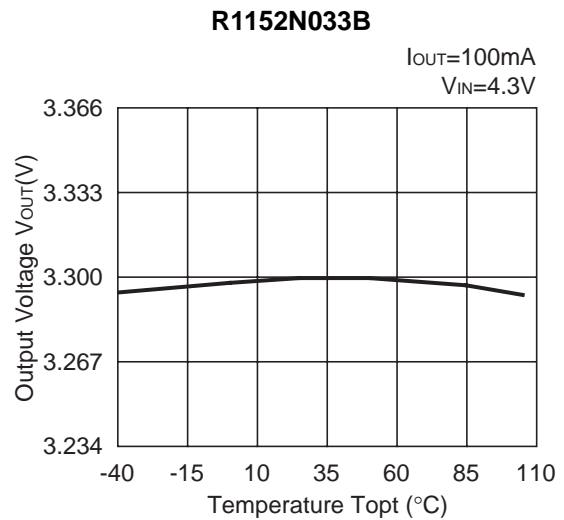
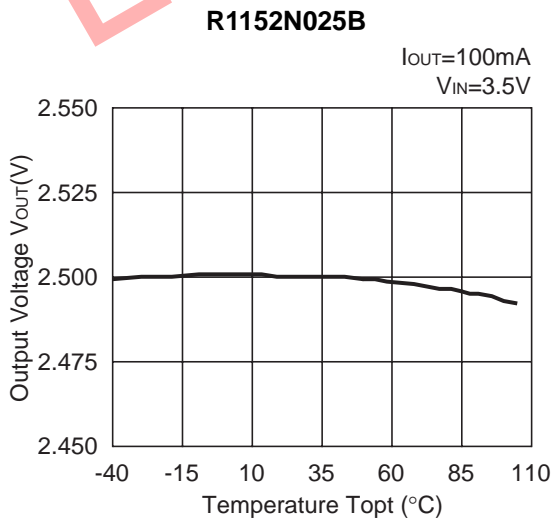
# R1152N

## 2) Output Voltage vs. Input Voltage (T<sub>opt</sub>=25°C)

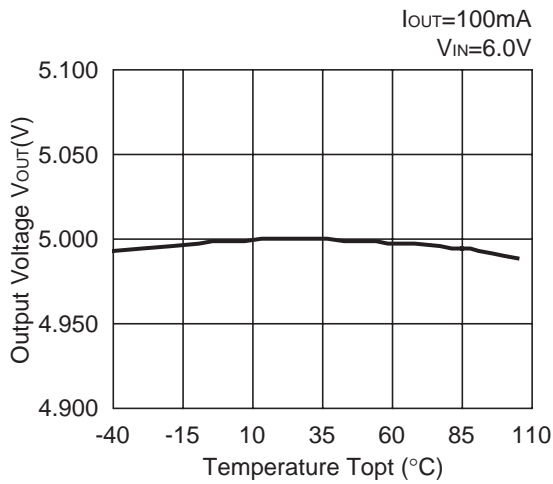
External Transistor: 2SB1642



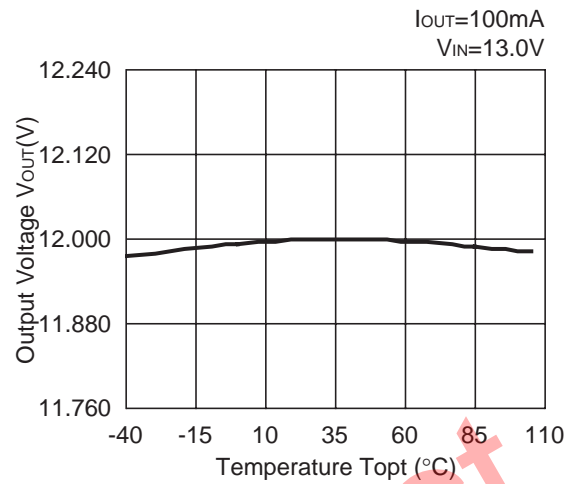
## 3) Output Voltage vs. Temperature



**R1152N050B**

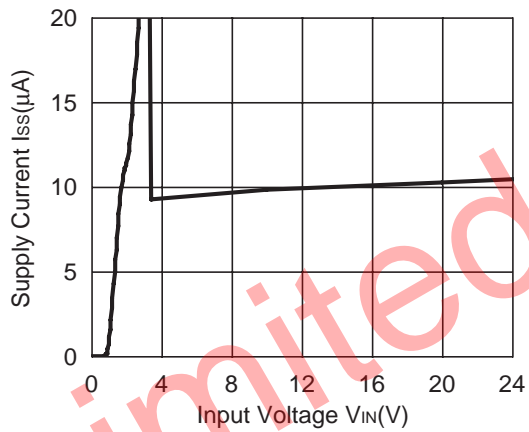


**R1152N120B**

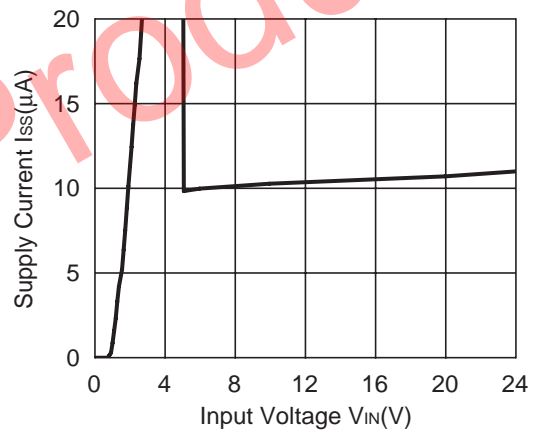


4) Supply Current vs. Input Voltage ( $T_{opt}=25^{\circ}C$ )

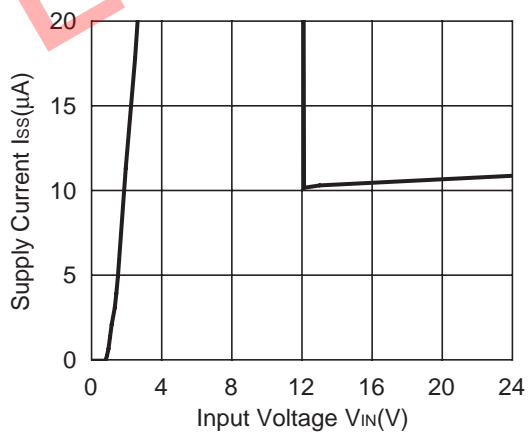
**R1152N033B**



**R1152N050B**



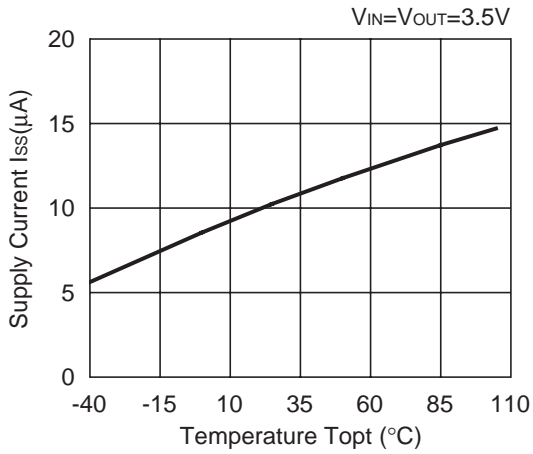
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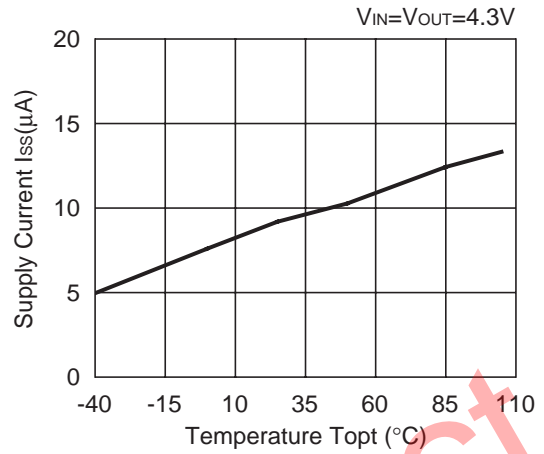
# R1152N

## 5) Supply Current vs. Temperature

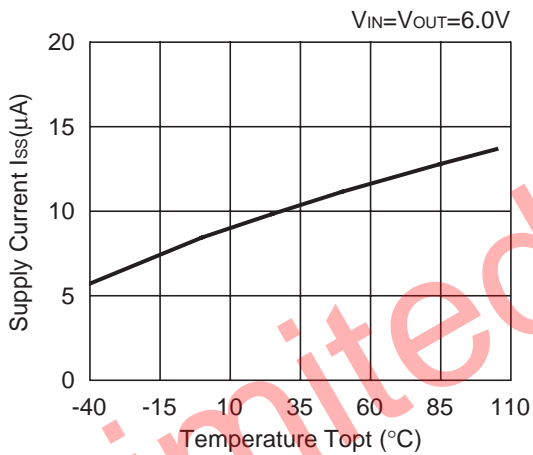
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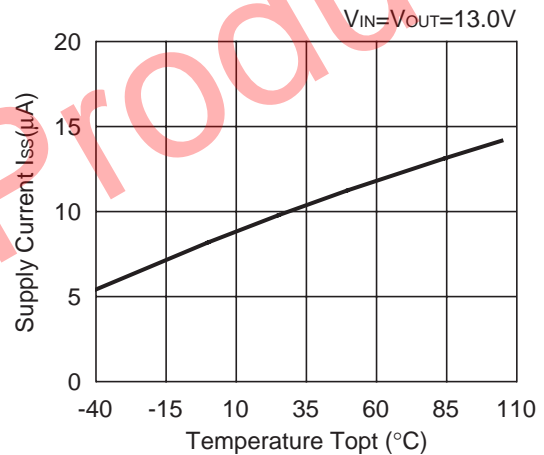
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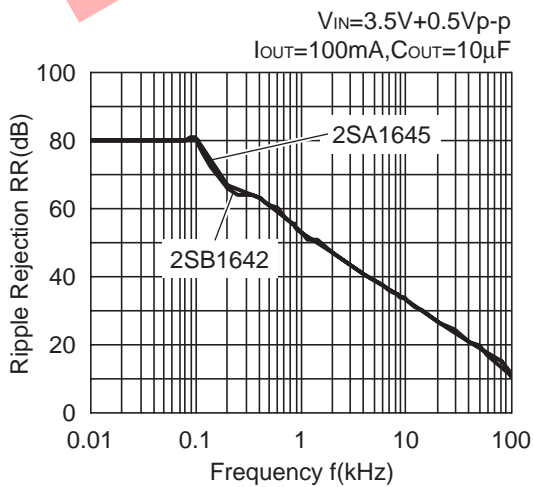


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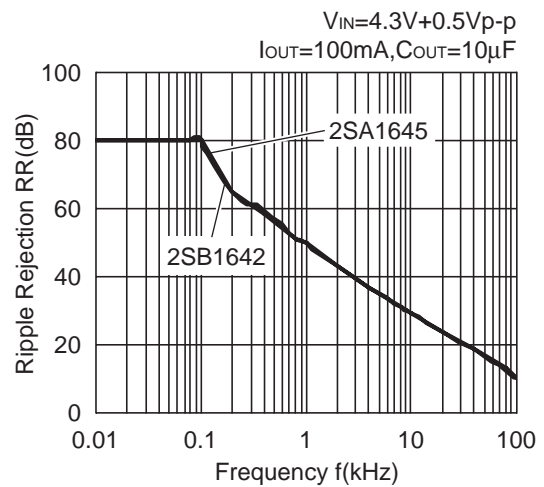


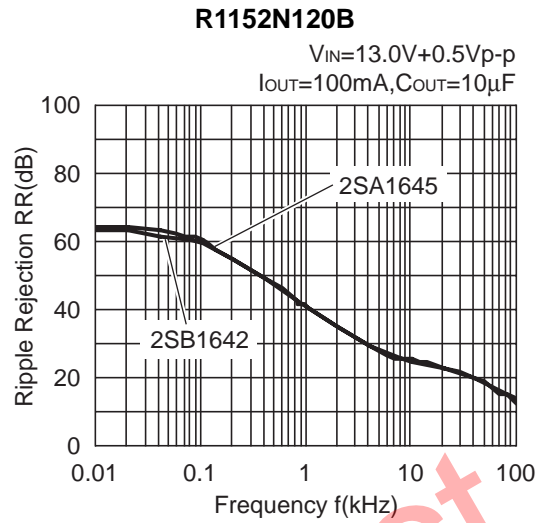
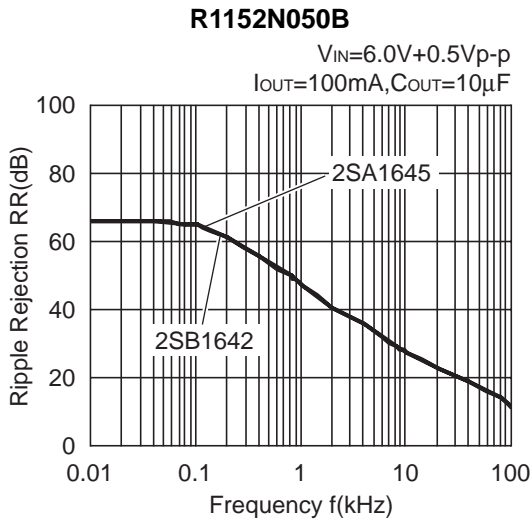
## 6) Ripple Rejection vs. Ripple Frequency ( $T_{opt}=25^{\circ}C$ )

**R1152N025B**



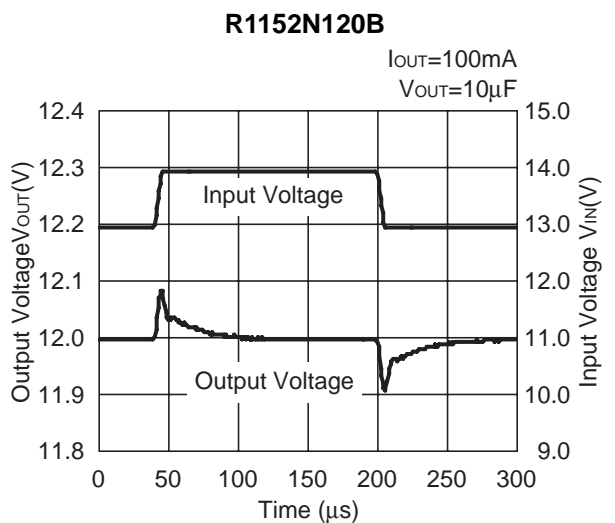
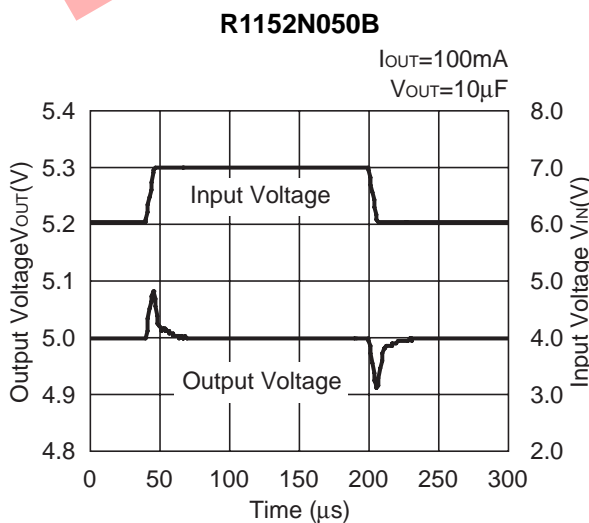
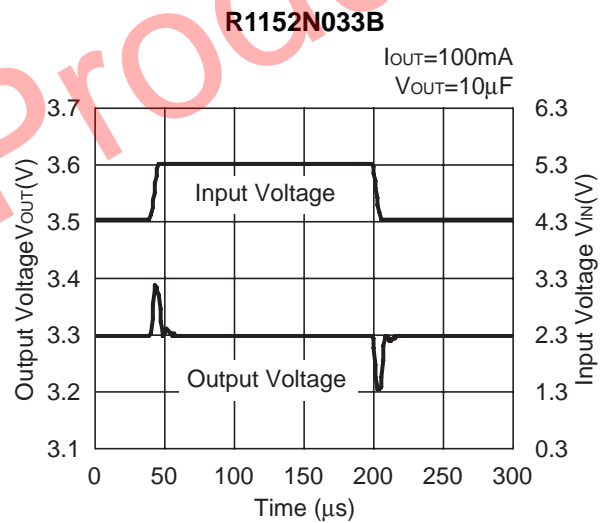
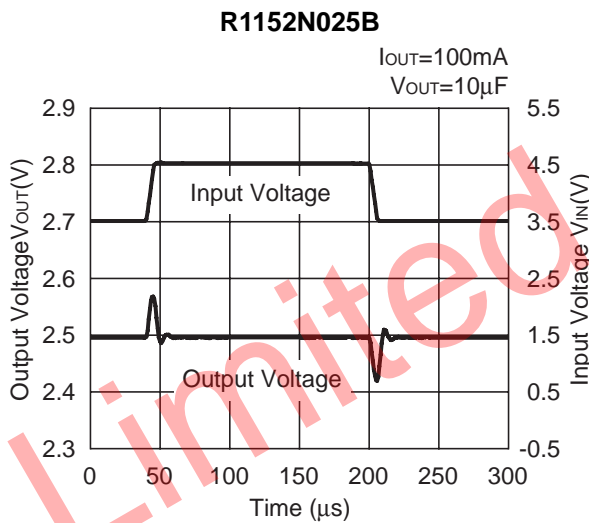
**R1152N033B**





7) Input Transient Response ( $T_{opt}=25^{\circ}C$ )

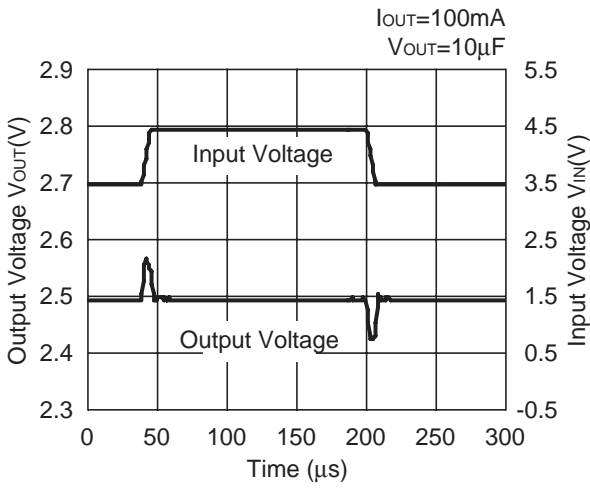
a. External Tr.: 2SB1642



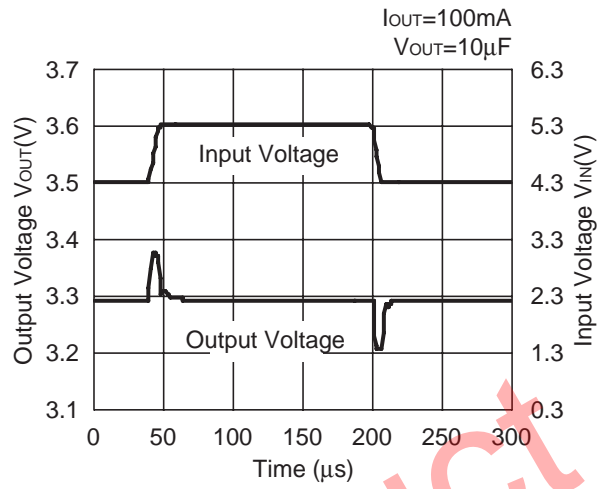
# R1152N

b. External Tr.: 2SA1645

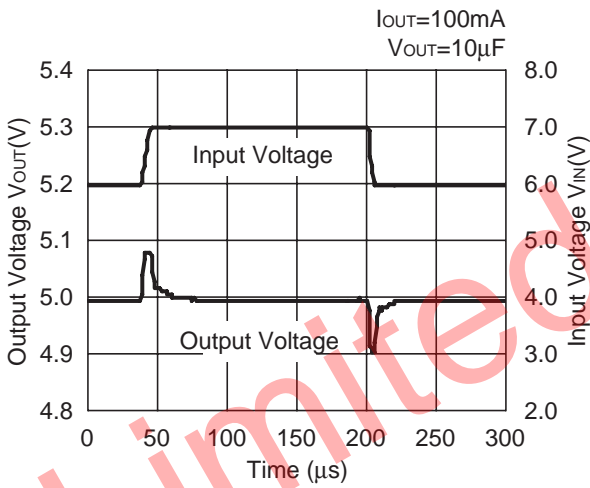
**R1152N025B**



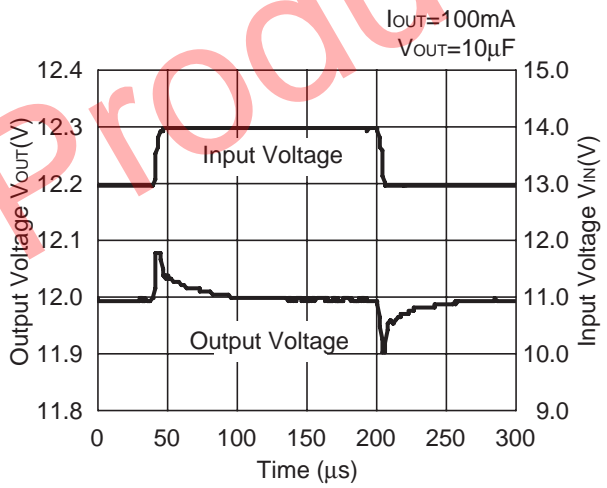
**R1152N033B**



**R1152N050B**



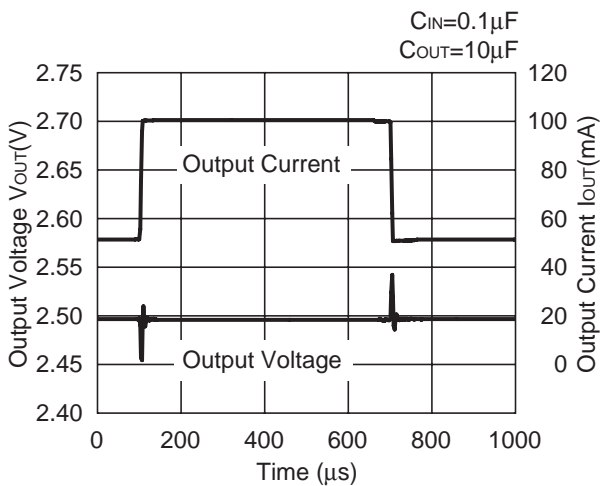
**R1152N120B**



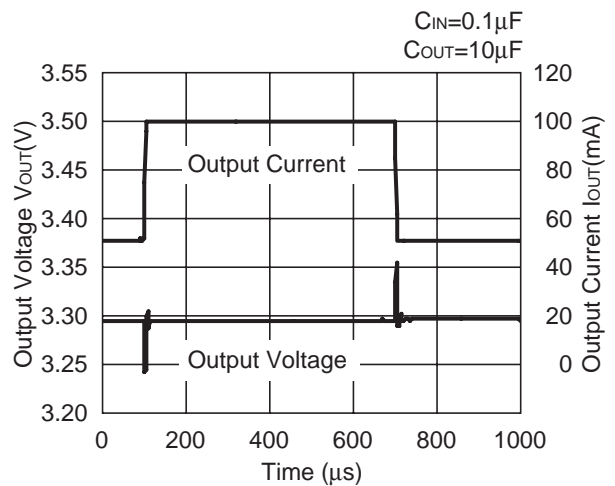
## 8) Load Transient Response ( $T_{opt}=25^{\circ}\text{C}$ )

a: External Tr.: 2SB1642

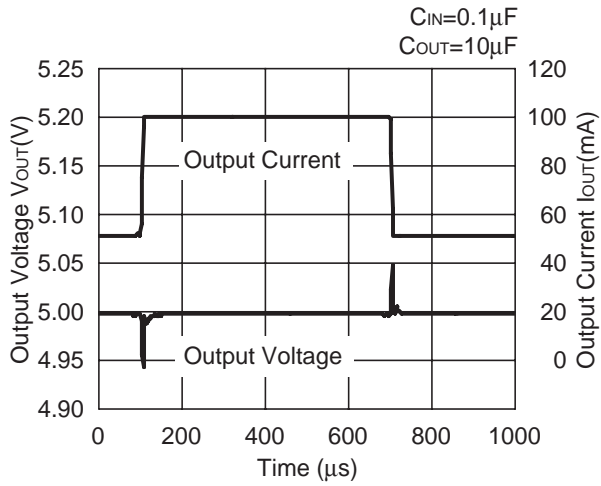
**R1152N025B**



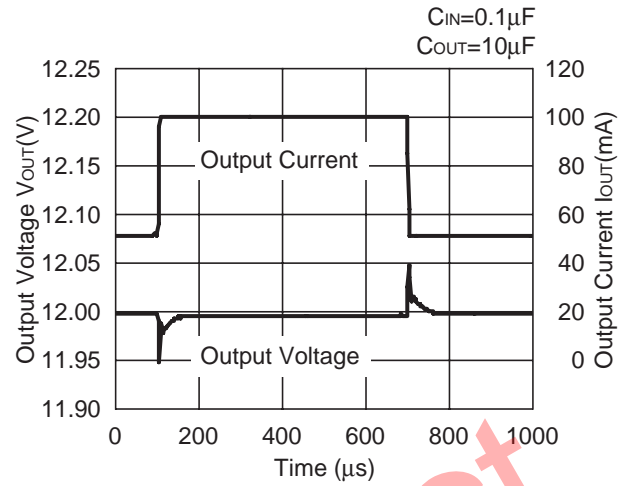
**R1152N033B**



**R1152N050B**

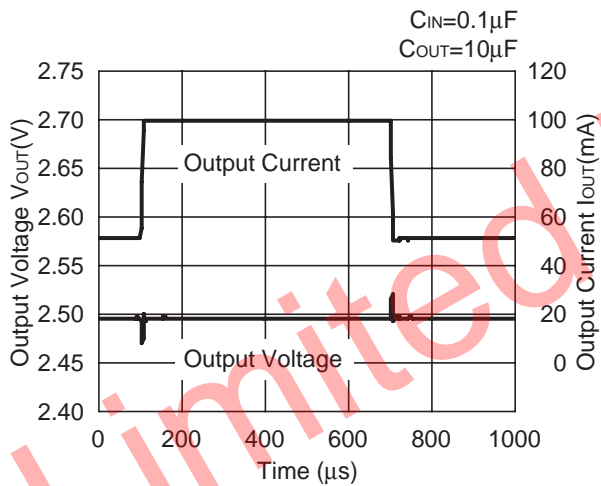


**R1152N120B**

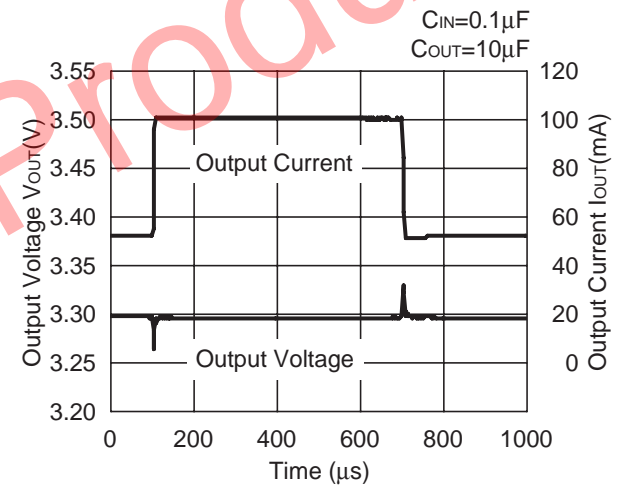


b. External Tr.: 2SA1645

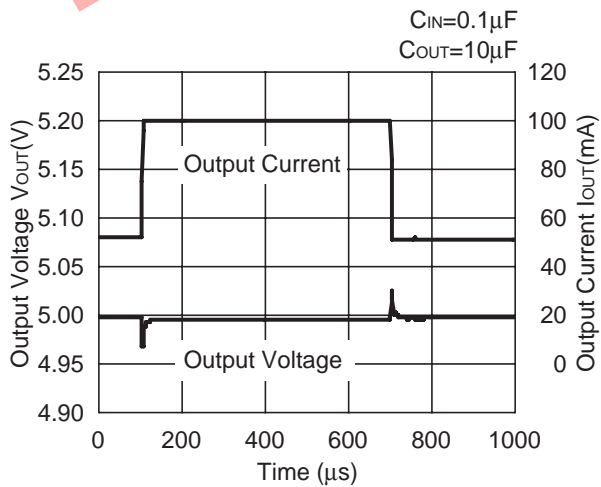
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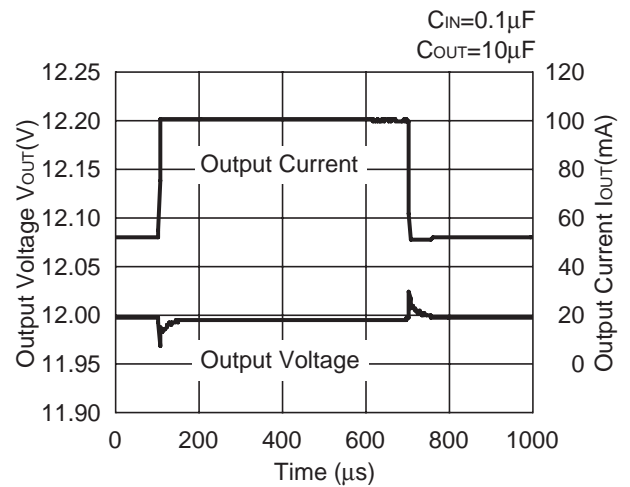
**R1152N033B**



**R1152N050B**

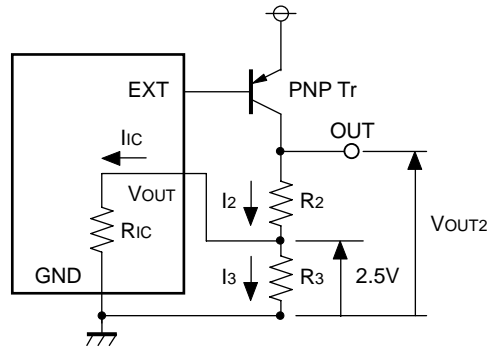


**R1152N120B**



**APPENDIX**

• **Technical Notes on Output Voltage Setting**



The output voltage of regulator with R1152N025x may be adjustable for any output voltage between its 2.5V reference and V<sub>DD</sub> setting level. An external pair of resistors is required, as shown above figure.

The complete equation for the output voltage is described step by step as follows;

$$I_2 = I_{1C} + I_3 \dots\dots\dots (1)$$

$$I_3 = 2.5/R_3 \dots\dots\dots (2)$$

Thus,

$$I_2 = I_{1C} + 2.5/R_3 \dots\dots\dots (3)$$

Therefore,

$$V_{OUT} = 2.5 + R_2 \times I_2 \dots\dots\dots (4)$$

Put Equation (3) into Equation (4), then

$$\begin{aligned} V_{OUT} &= 2.5 + R_2 \times (I_{1C} + 2.5/R_3) \\ &= 2.5 \times (1 + R_2/R_3) + R_2 \times I_{1C} \dots\dots\dots (5) \end{aligned}$$

In 2nd term, or  $R_2 \times I_{1C}$  will produce an error in  $V_{OUT}$ .

In Equation(5),

$$I_{1C} = 2.5/R_{1C} \dots\dots\dots (6)$$

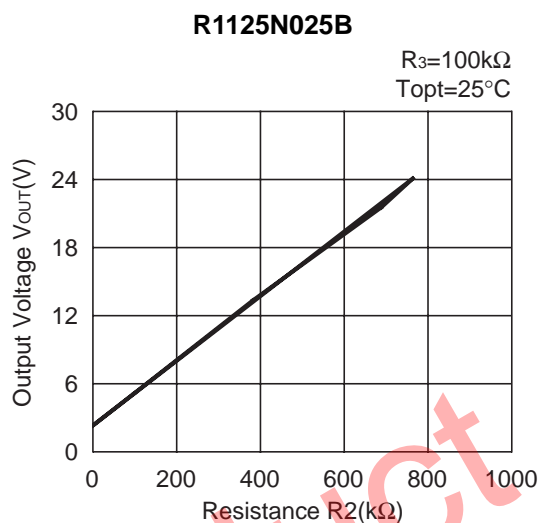
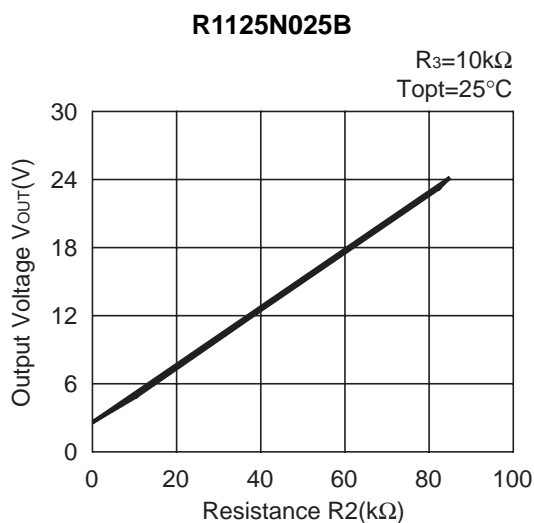
$$\begin{aligned} R_2 \times I_{1C} &= R_2 \times 2.5/R_{1C} \\ &= 2.5 \times R_2/R_{1C} \dots\dots\dots (7) \end{aligned}$$

For better accuracy, choosing  $R_2 \ll R_{1C}$  reduces this error.

\* $R_{1C}$  is approximately 1.1M $\Omega$ .



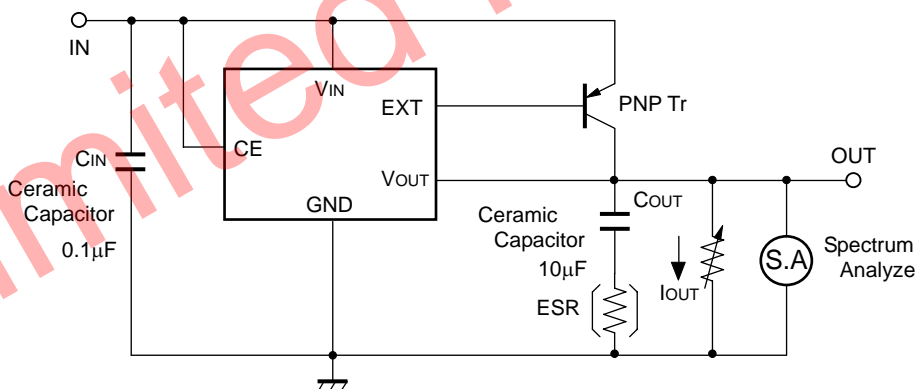
• Adjustable Resister vs. Output Voltage (Topt=25°C)



## 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; R1152NxxxB

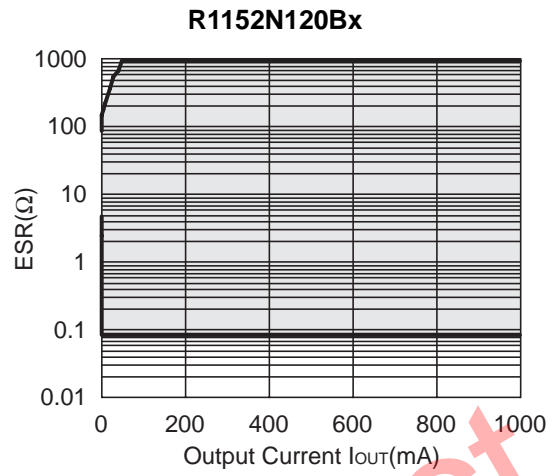
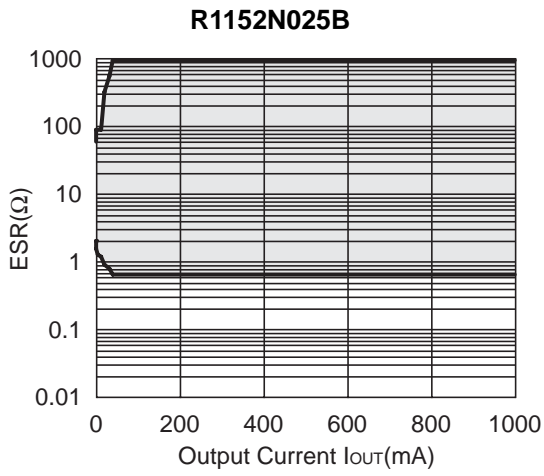
The relations between  $I_{OUT}$  (Output Current) and ESR of Output Capacitor are shown below. The conditions when the white noise level is under  $40\mu V$  (Avg.) are marked as the hatched area in the graph.

<Measurement conditions>

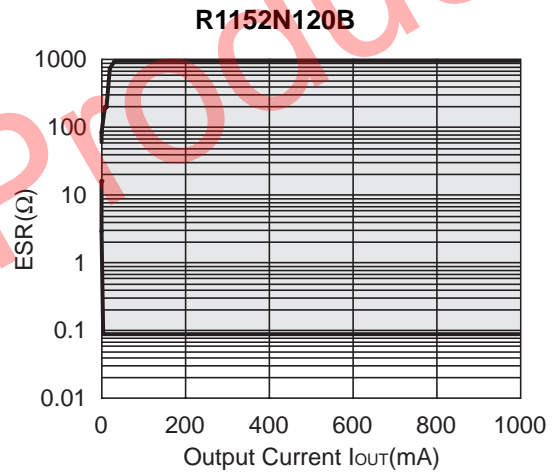
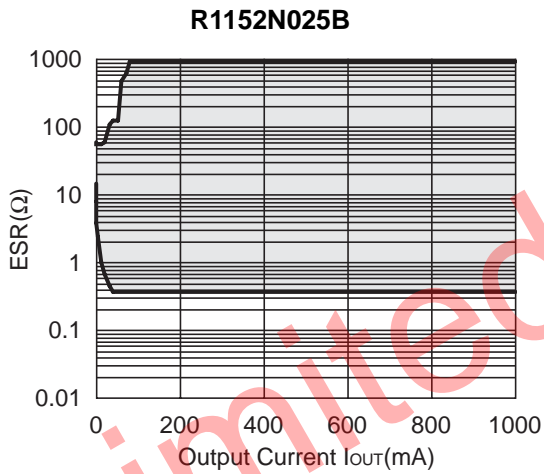
- (1)  $V_{IN}=V_{OUT}+1V$
- (2) Frequency band: 10Hz to 1MHz
- (3) Temperature: 25°C
- (4)  $C_{OUT}$ : Ceramic  $10\mu F$ ;  $ESR=0.075\Omega(10kHz)$

# R1152N

a) Tr.: 2SB1642



b) Tr.: 2SA1645





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