



*Analog Semiconductor IC*

# VRR Series

High speed, Low dropout,  $\pm 1\%$  High output accuracy  
CMOS Voltage Regulator with On/Off circuit

Rev. E09-08

*AnaSem Inc.*  
..... Future of the analog world



High speed, Low dropout,  $\pm 1\%$  High output accuracy with On/Off circuit CMOS Voltage Regulator

## VRR Series

### GENERAL DESCRIPTIONS

The VRR series are positive voltage regulators with high speed, low voltage dropout and high accuracy output achieved by low current consumption. The output voltage is guaranteed within  $\pm 1\%$  within the given temperature range by Vref controlling the temperature characteristics. It corresponds to the low ESR capacitor as an output stabilization capacitor. The charged ESR capacitor can be discharged with an internal switch by making the EN=Vss, as a result the VOUT quickly returns to the Vss level. To make the current capacity of the output transistor not exceeded, the over-current protection circuit is built in.



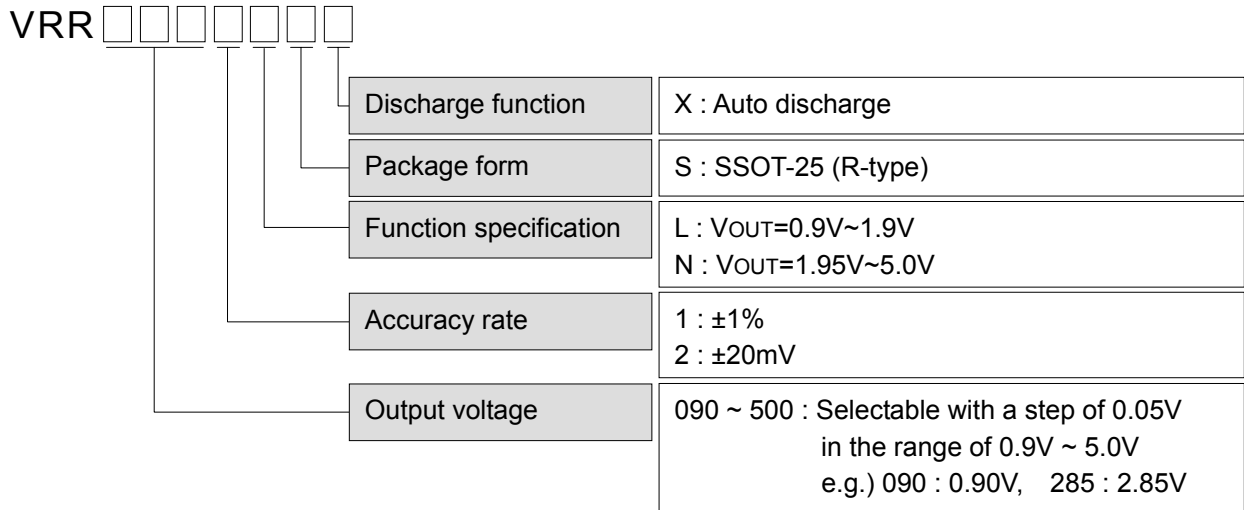
### FEATURES

- Output voltage range ..... 0.9V~5.0V (selectable with a step of 0.05V)
- Operating voltage range ..... 1.6V~6.0V
- High accuracy output voltage .....  $\pm 1\%$  (VOUT=1.95V ~ 5.0V) /  $\pm 20\text{mV}$  (VOUT=0.9V ~ 1.9V)
- Maximum output current ..... 250mA
- Dropout voltage ..... Typ. 90mV (output=3.0V, IOUT=100mA)
- Low current consumption ..... Typ. 25 $\mu\text{A}$
- High ripple rejection ..... Typ. 75dB at 1KHz
- Low ESR capacitor ..... 1.0  $\mu\text{F}$  ceramic capacitor
- Operating temperature range .....  $-40^{\circ}\text{C} \sim +85^{\circ}\text{C}$
- Built-in over-current protector ..... Limit current : 300mA
- CL high-speed auto-discharge
- Built-in On/Off circuit
- Small package ..... SSOT-25 : R-type (350mW)

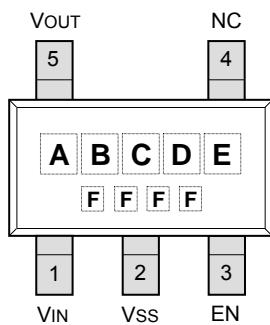
### APPLICATIONS

- Battery powered devices
- Cellular phone
- Digital / Video cameras
- Portable games
- Handheld instruments

## PRODUCTS NUMBERING GUIDE



## PIN CONFIGURATION / MARKING SPECIFICATION (SSOT-25 : R-TYPE)



(Top view)

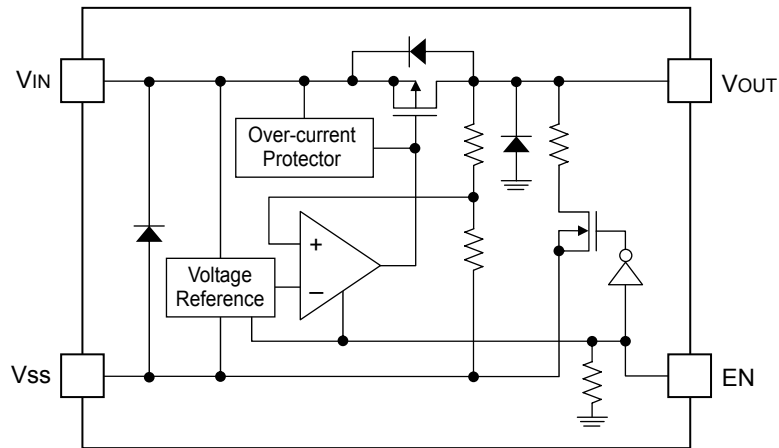
### ● Pin Configuration

No.	Symbol	Descriptions
1	VIN	Voltage input
2	VSS	Power ground
3	EN	Chip enable
4	NC	Non connection (open)
5	VOUT	Output

### ● Marking Specification

Code	Mark	Contents
A	R	Products series name
BCD	090~500	Output voltage
E	X	Discharge function
F	Internal rule	Lot number

## BLOCK DIAGRAM



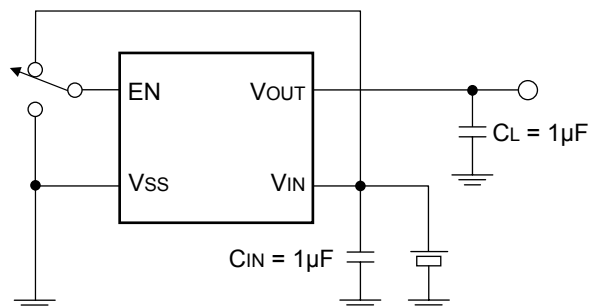
## ABSOLUTE MAXIMUM RATINGS

Items	Symbol	Ratings	Unit
Input voltage range	V <sub>IN</sub>	-0.3 ~ +7.0	V
Output current	I <sub>OUT</sub>	500	mA
Output voltage range	V <sub>OUT</sub>	V <sub>SS</sub> -0.3 ~ V <sub>IN</sub> +0.3	V
Power dissipation ※1)	SSOT-25 P <sub>D</sub>	350 (on PCB)	mW
Operating temperature range	T <sub>OPR</sub>	-40 ~ +85	°C
Storage temperature range	T <sub>STG</sub>	-55 ~ +125	°C

Note :

- ※1) Power dissipation depends on conditions of mounting on boards.  
PCB dimension is 50mm×50mm×1.6mm.

## TYPICAL APPLICATION CIRCUITS



## ELECTRICAL CHARACTERISTICS

(Ta=25°C unless otherwise specified)

Items	Symbol	Conditions		Min.	Typ.	Max.	Unit	Test circuit
Output voltage	V <sub>OUT</sub>	V <sub>OUT</sub> +1.0V ≤ V <sub>IN</sub> ≤ 6.0V I <sub>OUT</sub> =30mA Ta=-40°C ~ +85°C	V <sub>OUT</sub> ≥ 1.95V	V <sub>OUT</sub> × 0.99	V <sub>OUT</sub>	V <sub>OUT</sub> × 1.01	V	1
			V <sub>OUT</sub> ≤ 1.90V	-20	-	+20	mV	
Output current	I <sub>OUT</sub>	V <sub>IN</sub> ≥ V <sub>OUT</sub> +1.0V	0.9V ≤ V <sub>OUT</sub> ≤ 1.15V	-	250	-	mA	1
			1.2V ≤ V <sub>OUT</sub> ≤ 1.65V	-	250	-	mA	
			1.7V ≤ V <sub>OUT</sub> ≤ 2.25V	-	250	-	mA	
			2.3V ≤ V <sub>OUT</sub> ≤ 2.85V	-	250	-	mA	
			2.9V ≤ V <sub>OUT</sub> ≤ 3.45V	-	250	-	mA	
			3.5V ≤ V <sub>OUT</sub> ≤ 4.05V	-	250	-	mA	
			4.0V ≤ V <sub>OUT</sub> ≤ 5.00V	-	250	-	mA	
Dropout voltage	V <sub>DROP</sub>	I <sub>OUT</sub> =100mA	0.9V ≤ V <sub>OUT</sub> ≤ 1.15V	-	480	730	mV	1
			1.2V ≤ V <sub>OUT</sub> ≤ 1.65V	-	210	340	mV	
			1.7V ≤ V <sub>OUT</sub> ≤ 2.25V	-	130	205	mV	
			2.3V ≤ V <sub>OUT</sub> ≤ 2.85V	-	100	150	mV	
			2.9V ≤ V <sub>OUT</sub> ≤ 3.45V	-	90	137	mV	
			3.5V ≤ V <sub>OUT</sub> ≤ 4.05V	-	85	115	mV	
			4.0V ≤ V <sub>OUT</sub> ≤ 5.00V	-	80	85	mV	

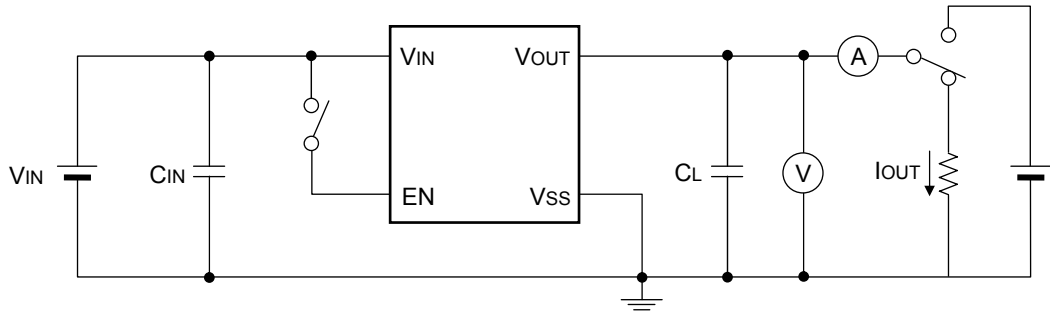
**ELECTRICAL CHARACTERISTICS** (continued)

(Ta=25°C unless otherwise specified)

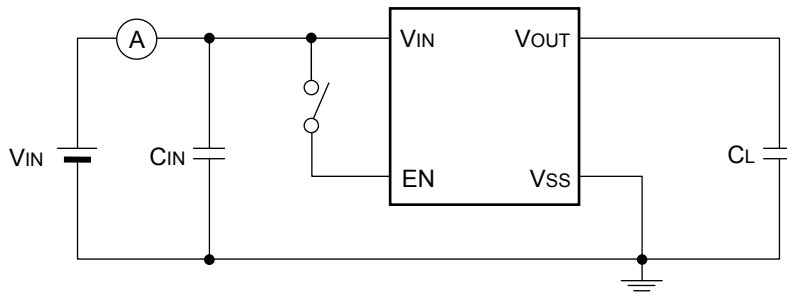
Items	Symbol	Conditions	Min.	Typ.	Max.	Unit	Test circuit
Current consumption	I <sub>DD</sub>	V <sub>IN</sub> =V <sub>OUT</sub> +1.0V, V <sub>OUT</sub> =Open, I <sub>OUT</sub> =0mA	-	25	40	$\mu$ A	2
Standby current	I <sub>STB</sub>	EN=V <sub>SS</sub>	-	0.01	0.1	$\mu$ A	2
Input voltage	V <sub>IN</sub>		1.6	-	6.0	V	1
Load regulation	$\Delta$ V <sub>OUT</sub>	V <sub>IN</sub> =V <sub>OUT</sub> +1.0V, I <sub>OUT</sub> =0.1mA ~ 100mA	-	10	40	mV	1
Line regulation	$\frac{\Delta V_{OUT}}{\Delta V_{IN} \cdot V_{OUT}}$	V <sub>OUT</sub> +1.0V $\leq$ V <sub>IN</sub> $\leq$ 6.0V, I <sub>OUT</sub> =30mA	-	0.01	0.1	%/V	1
Ripple rejection	R <sub>r</sub>	V <sub>IN</sub> =V <sub>OUT</sub> +1.0V, f=1KHz, $\Delta$ V <sub>RIP</sub> =0.5VP-P, I <sub>OUT</sub> =30mA	-	75	-	dB	3
Limit current	I <sub>LIMIT</sub>	EN=V <sub>IN</sub>	300	-	-	mA	1
Short circuit current	I <sub>SHORT</sub>	V <sub>IN</sub> =V <sub>OUT</sub> +1.0V, V <sub>OUT</sub> =0V	-	40	-	mA	1
Output voltage temperature coefficient	$\frac{\Delta V_{OUT}}{\Delta T_a \cdot V_{OUT}}$	V <sub>EN</sub> =V <sub>IN</sub> , I <sub>OUT</sub> =300mA Ta=-40°C ~ +85°C		$\pm 20$		ppm /°C	1
EN high level voltage	V <sub>ENH</sub>		1.2	-	6.0	V	4
EN low level voltage	V <sub>ENL</sub>		-	-	0.3	V	4
EN high level current	I <sub>ENH</sub>	V <sub>EN</sub> = V <sub>IN</sub>	-0.1	-	0.1	$\mu$ A	4
EN low level current	I <sub>ENL</sub>	V <sub>EN</sub> = V <sub>SS</sub>	-0.1	-	0.1	$\mu$ A	4
CL auto-discharge resistance	R <sub>DIS</sub>	V <sub>IN</sub> =6.0V, V <sub>OUT</sub> =4.0V, V <sub>EN</sub> = V <sub>SS</sub>	-	160	-	$\Omega$	1

## TEST CIRCUITS

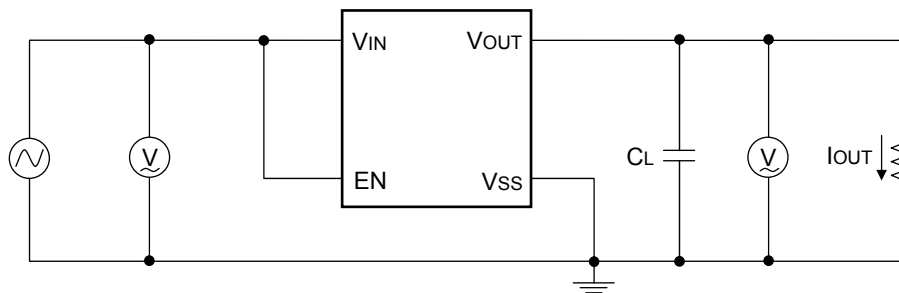
- **Circuit (1)** - Output voltage, Output current, Dropout voltage, Input voltage, Load regulation, Line regulation, Limit current, Short circuit current, Output voltage temperature coefficient, CL auto-discharge resistance



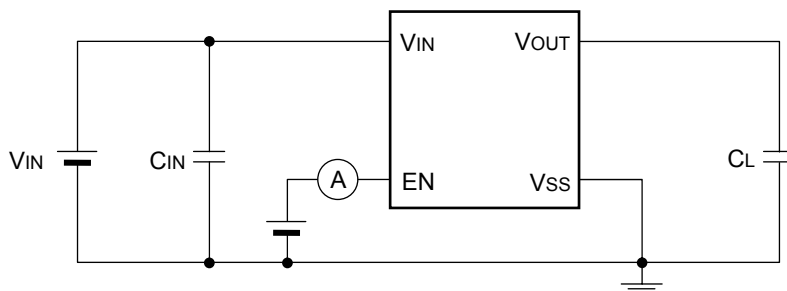
- **Circuit (2)** - Current consumption, Standby current



- **Circuit (3)** - Ripple rejection



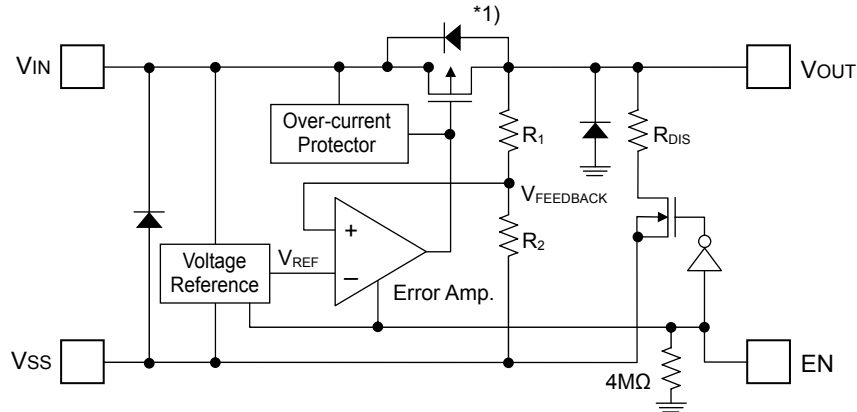
- **Circuit (4)** - EN high level voltage, EN low level voltage, EN high level current, EN low level current



## DESCRIPTION OF OPERATION

### ● General operation

In reference to following block diagram of the VRR series ;



By the error amplifier, the reference voltage ( $V_{REF}$ ) is compared with  $V_{FEEDBACK}$  which is divided by feedback resistors  $R_1$  and  $R_2$ . It supplies the output transistor (see note \*1) to keep a stabilized output voltage against with any fluctuation of input voltage by negative feedback system.

Note \*1)

The VRR series has P-channel MOSFET which is connected to the  $V_{OUT}$  terminal as the output transistor. To prevent the VRR series from being damaged due to inverse current from  $V_{OUT}$  terminal to  $V_{IN}$  terminal through a parasitic diode,  $V_{OUT}$  should not be exceeded  $V_{IN}+0.3V$ .

### ● EN terminal (shutdown function) & CL auto-discharge

The VRR series can be shutdown through EN terminal. The P-channel MOSFET is turned off and operation of all internal circuits stops to reduce the current consumption when the signal of EN terminal is set to the shutdown level. In shutdown mode, the VRR series enables the electric charge at the  $C_L$  to be discharged via the auto-discharge resistance ( $R_{DIS}$  ; 160 $\Omega$ ), and the  $V_{OUT}$  terminal can be rapidly returned to the  $V_{SS}$  level as a result.

### ● Output capacitor (CL)

For phase compensation, an output capacitor ( $C_L$ ) is required to connected between  $V_{OUT}$  terminal and  $V_{SS}$  terminal as close as possible. A ceramic capacitor with capacitance value of at least 1.0 $\mu F$  is recommended. Of course, the suitable capacitance value should be different by the condition of each application. In addition, an input capacitor ( $C_{IN}$ ) with capacitance value of at least 1.0 $\mu F$  is also recommended between  $V_{IN}$  terminal and  $V_{SS}$  terminal for stable input power.

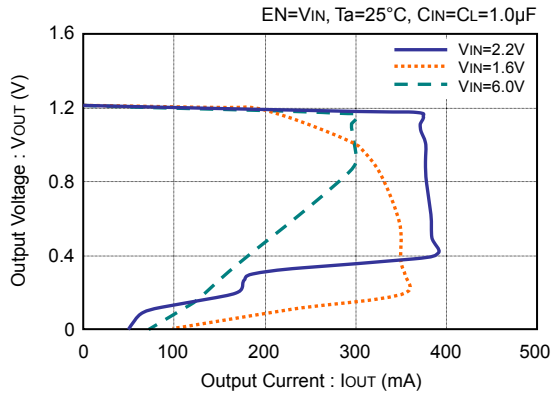
### ● Over current protection and short circuit protection

Built-in over current protection circuit performs circuit protection from over current as a current limiter. When the load current reaches the limit level, the output voltage drops and output current also decreases accordingly. A current of typ. 40mA will flow when output terminal is shorted.

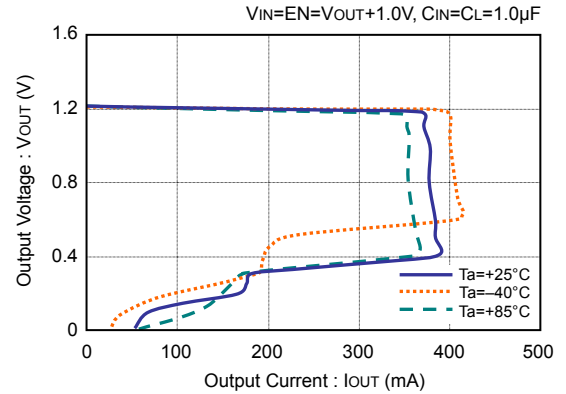


**TYPICAL CHARACTERISTICS – Output Voltage vs. Output Current**

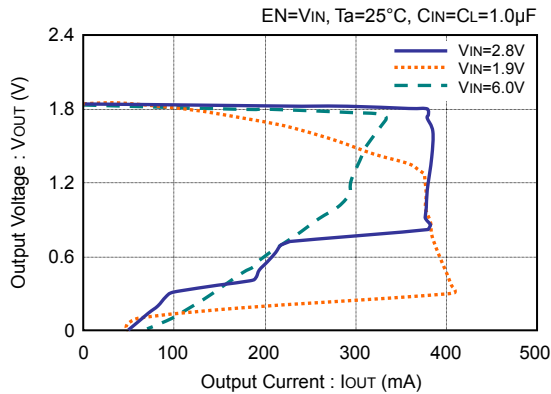
● **VRR1202xxx (VOUT=1.2V)**



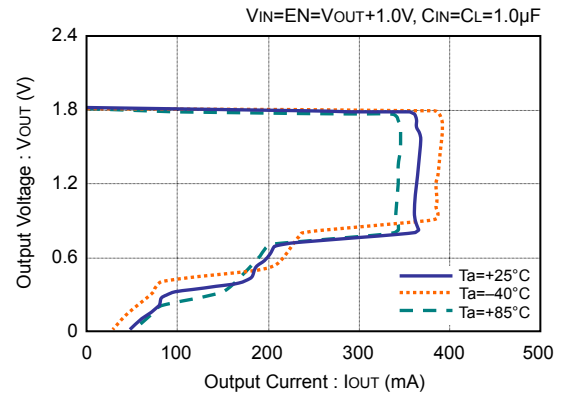
● **VRR1202xxx (VOUT=1.2V)**



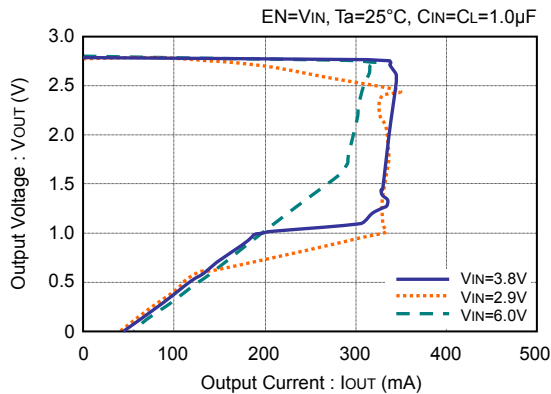
● **VRR1802xxx (VOUT=1.8V)**



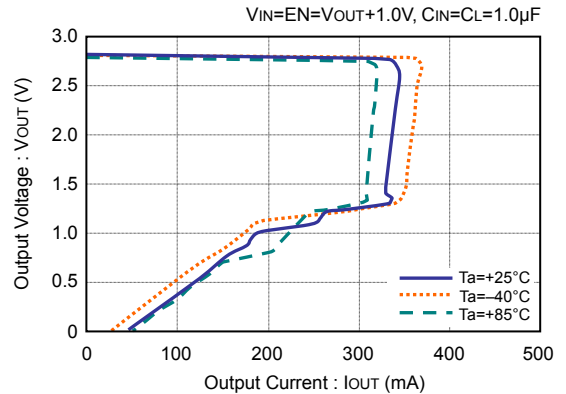
● **VRR1802xxx (VOUT=1.8V)**



● **VRR2801xxx (VOUT=2.8V)**

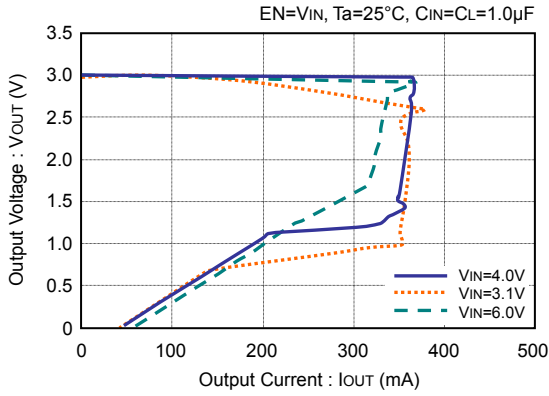


● **VRR2801xxx (VOUT=2.8V)**

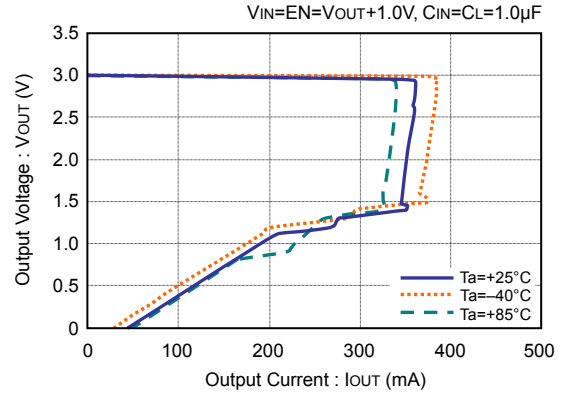


**TYPICAL CHARACTERISTICS – Output Voltage vs. Output Current (continued)**

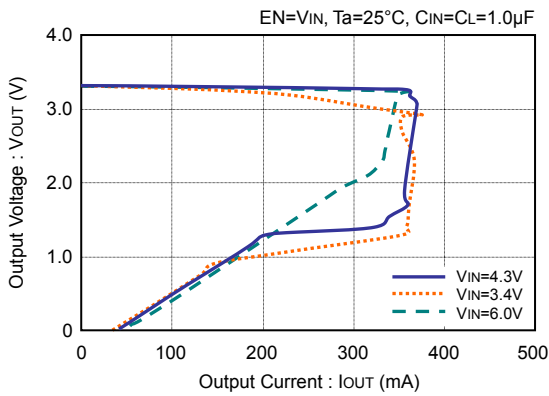
● **VRR3001xxx (V<sub>OUT</sub>=3.0V)**



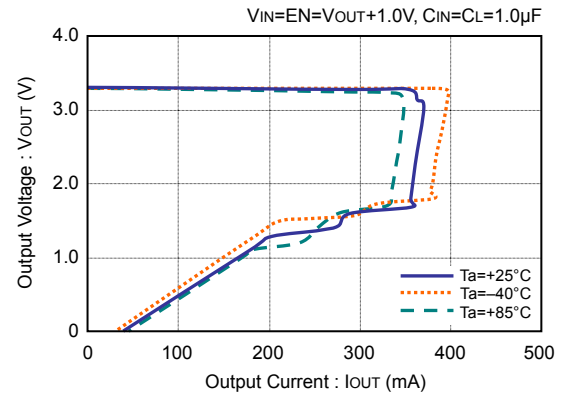
● **VRR3001xxx (V<sub>OUT</sub>=3.0V)**



● **VRR3301xxx (V<sub>OUT</sub>=3.3V)**

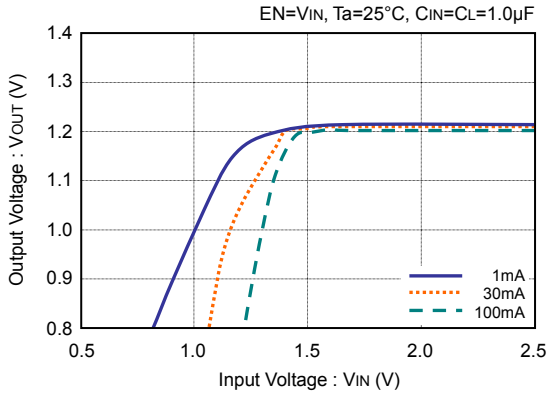


● **VRR3301xxx (V<sub>OUT</sub>=3.3V)**

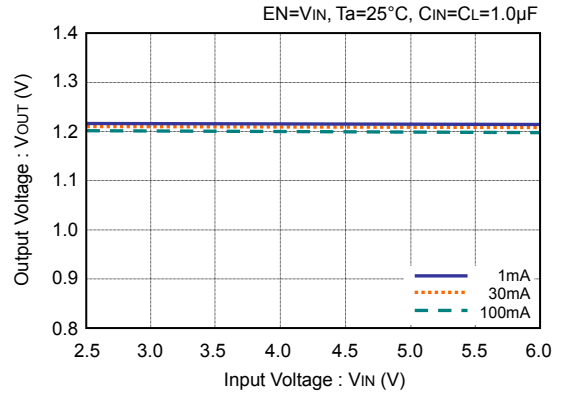


**TYPICAL CHARACTERISTICS – Output Voltage vs. Input Voltage**

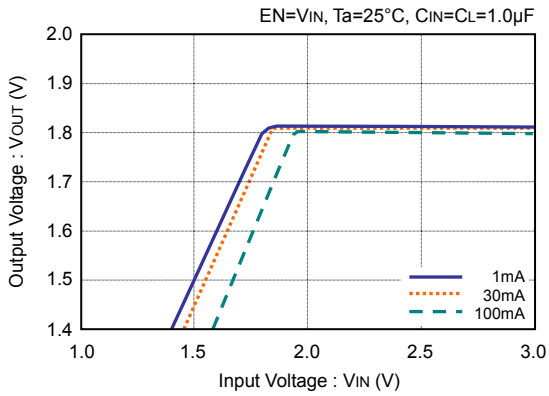
● **VRR1202xxx (VOUT=1.2V)**



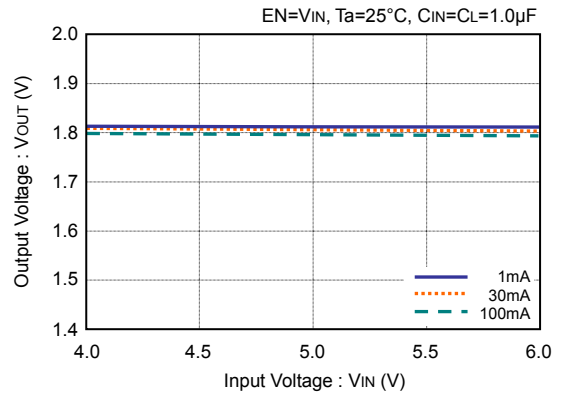
● **VRR1202xxx (VOUT=1.2V)**



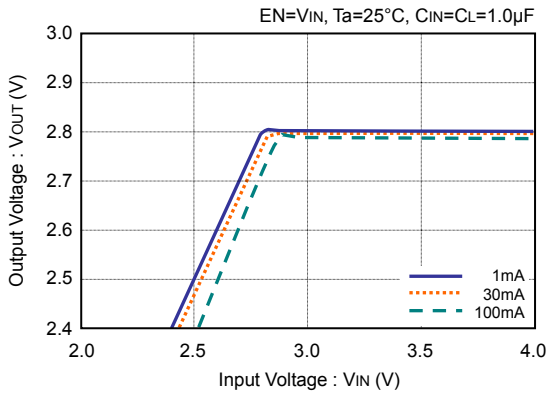
● **VRR1802xxx (VOUT=1.8V)**



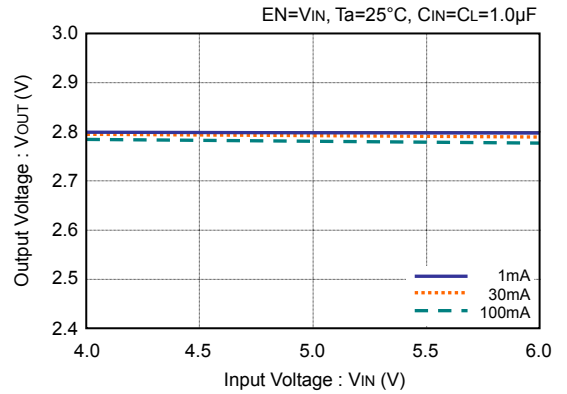
● **VRR1802xxx (VOUT=1.8V)**



● **VRR2801xxx (VOUT=2.8V)**

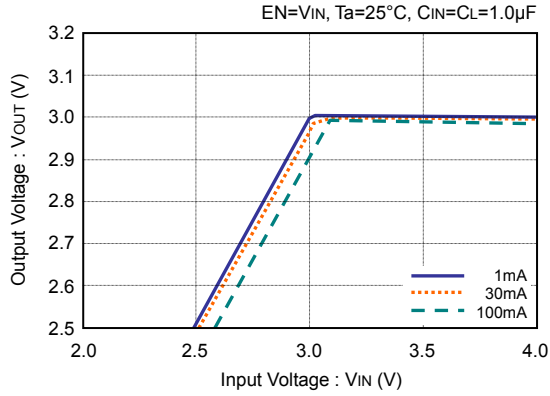


● **VRR2801xxx (VOUT=2.8V)**

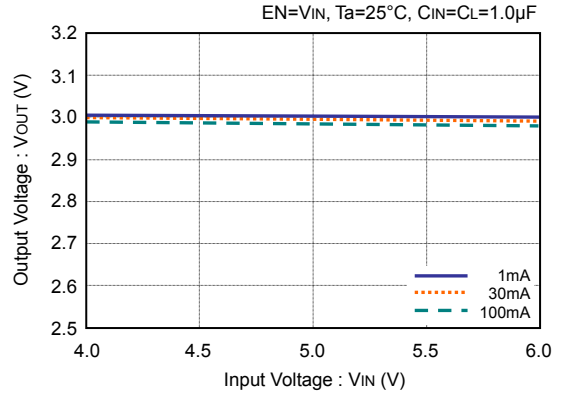


**TYPICAL CHARACTERISTICS – Output Voltage vs. Input Voltage (continued)**

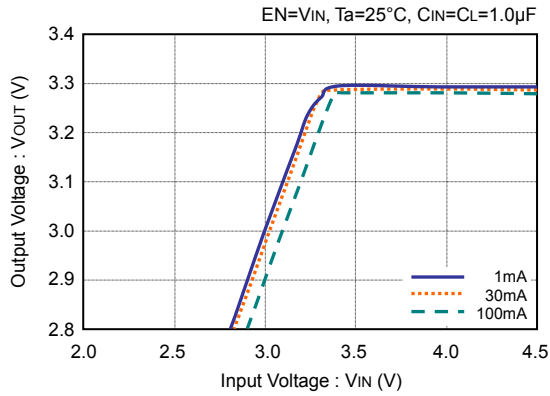
● **VRR3001xxx (V<sub>OUT</sub>=3.0V)**



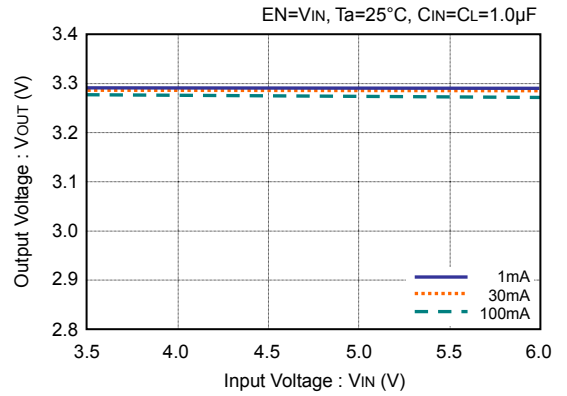
● **VRR3001xxx (V<sub>OUT</sub>=3.0V)**



● **VRR3301xxx (V<sub>OUT</sub>=3.3V)**

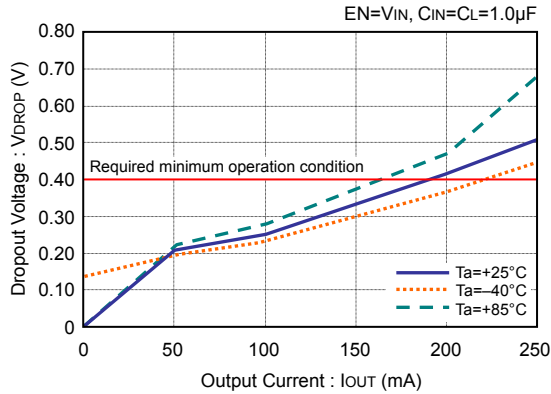


● **VRR3301xxx (V<sub>OUT</sub>=3.3V)**

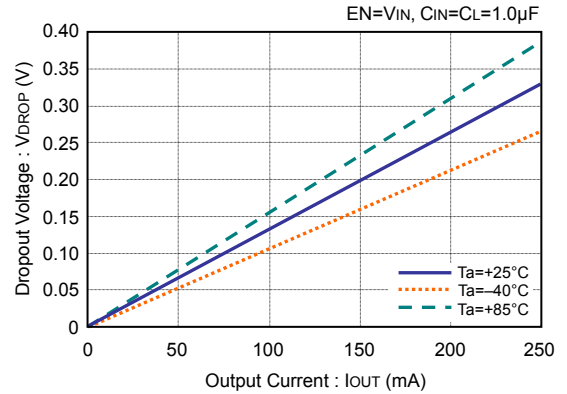


**TYPICAL CHARACTERISTICS – Dropout Voltage vs. Output Current**

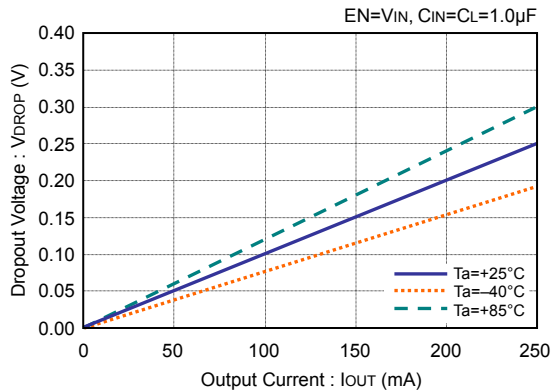
● **VRR1202xxx (V<sub>OUT</sub>=1.2V)**



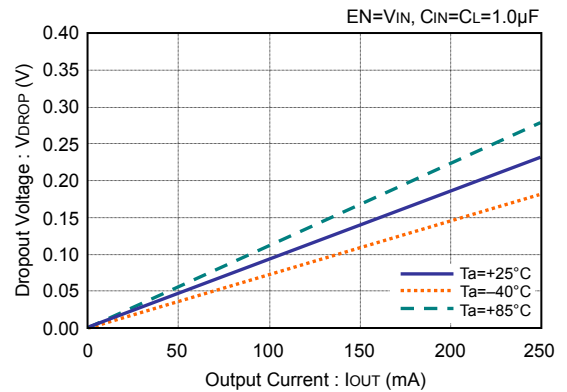
● **VRR1802xxx (V<sub>OUT</sub>=1.8V)**



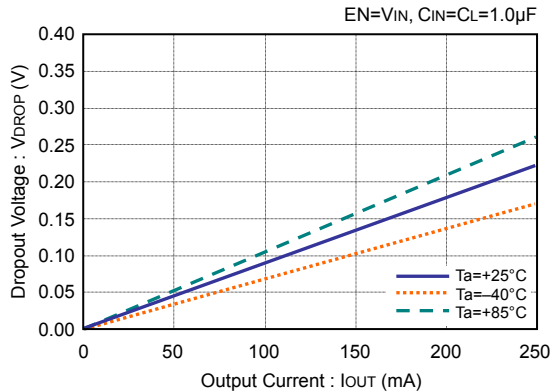
● **VRR2801xxx (V<sub>OUT</sub>=2.8V)**



● **VRR3001xxx (V<sub>OUT</sub>=3.0V)**

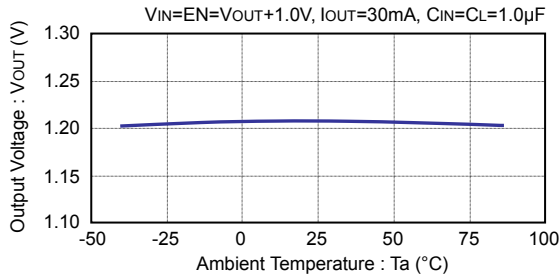


● **VRR3301xxx (V<sub>OUT</sub>=3.3V)**

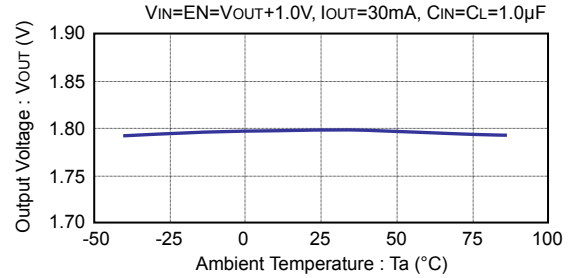


### TYPICAL CHARACTERISTICS – Output Voltage vs. Ambient Temperature

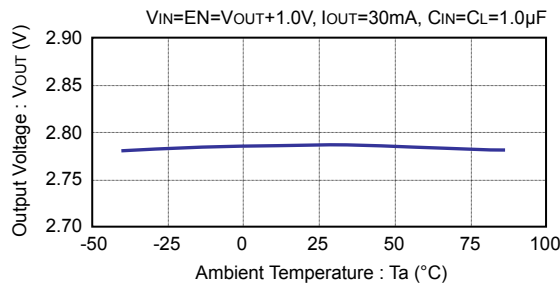
● **VRR1202xxx (VOUT=1.2V)**



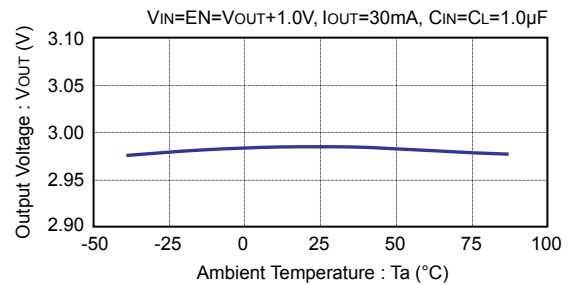
● **VRR1802xxx (VOUT=1.8V)**



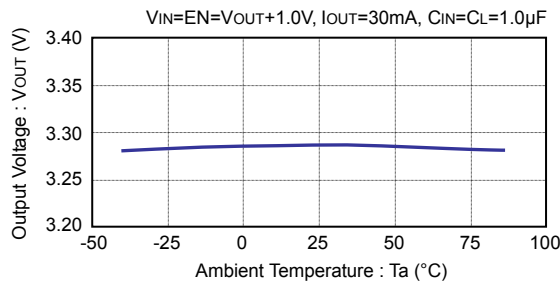
● **VRR2801xxx (VOUT=2.8V)**



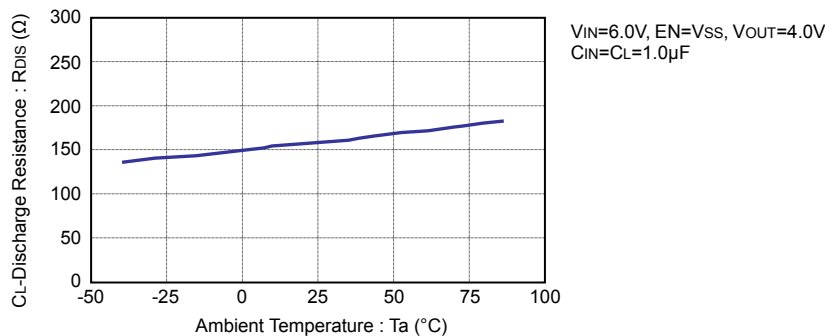
● **VRR3001xxx (VOUT=3.0V)**



● **VRR3301xxx (VOUT=3.3V)**

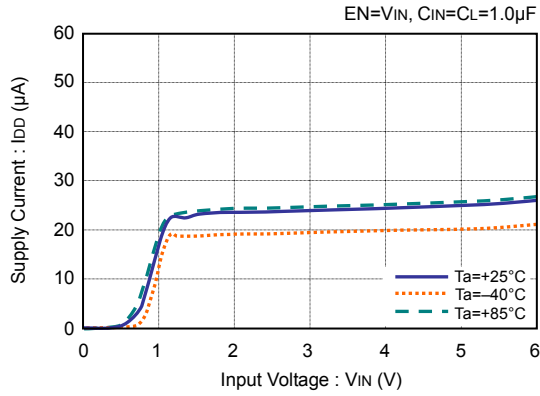


### TYPICAL CHARACTERISTICS – CL-Discharge Resistance vs. Ambient Temperature

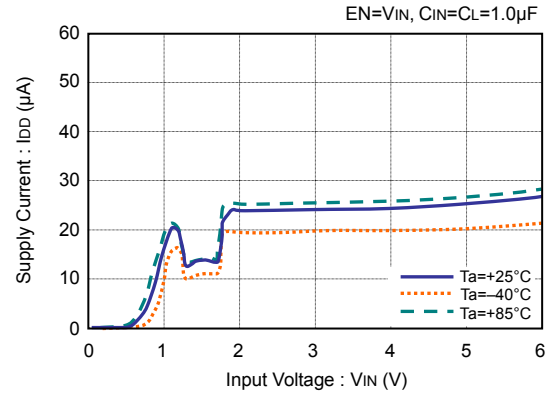


**TYPICAL CHARACTERISTICS – Supply Current vs. Input Voltage**

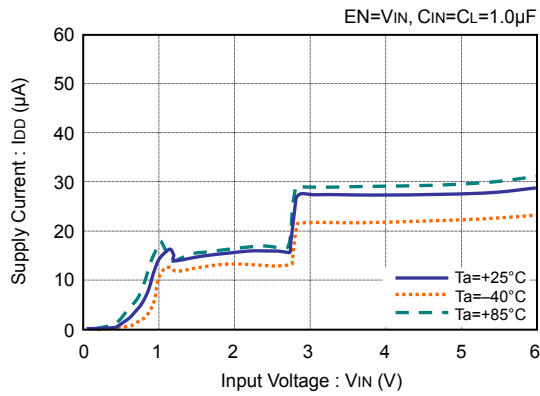
● **VRR1202xxx (VOUT=1.2V)**



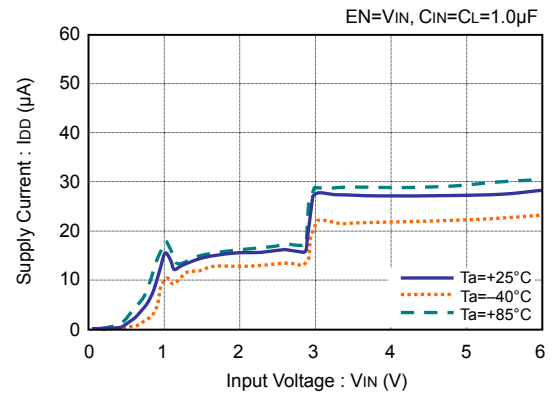
● **VRR1802xxx (VOUT=1.8V)**



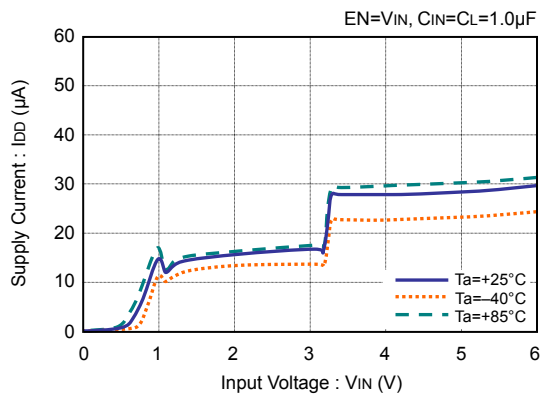
● **VRR2801xxx (VOUT=2.8V)**



● **VRR3001xxx (VOUT=3.0V)**

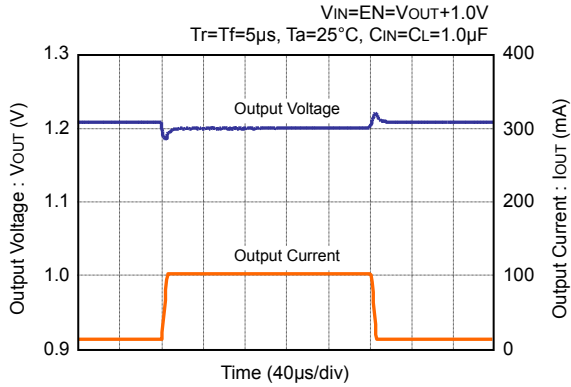


● **VRR3301xxx (VOUT=3.3V)**

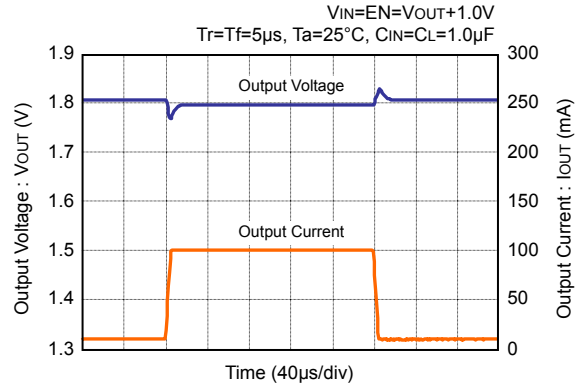


**TYPICAL CHARACTERISTICS – Load Transient Response**

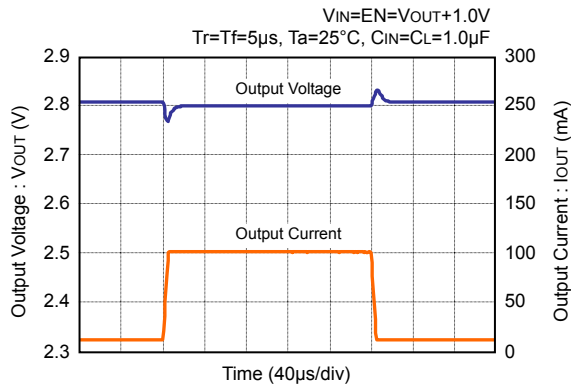
● **VRR1202xxx (VOUT=1.2V)**



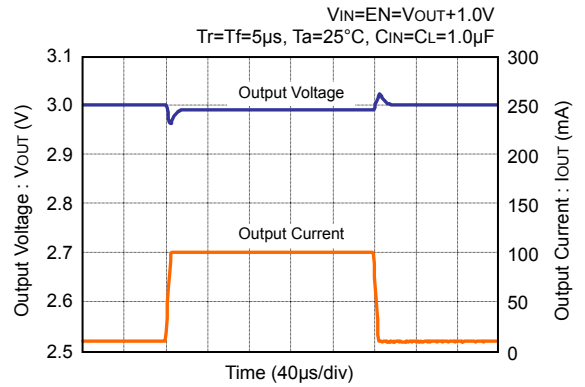
● **VRR1802xxx (VOUT=1.8V)**



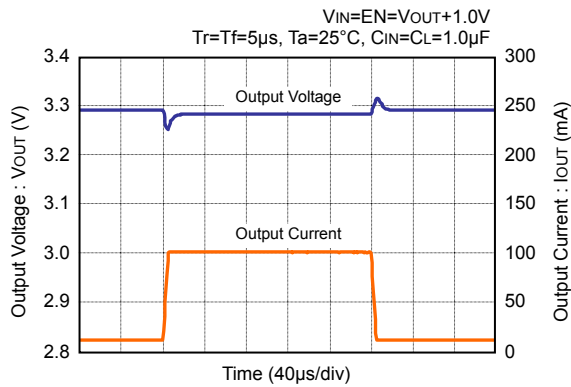
● **VRR2801xxx (VOUT=2.8V)**



● **VRR3001xxx (VOUT=3.0V)**



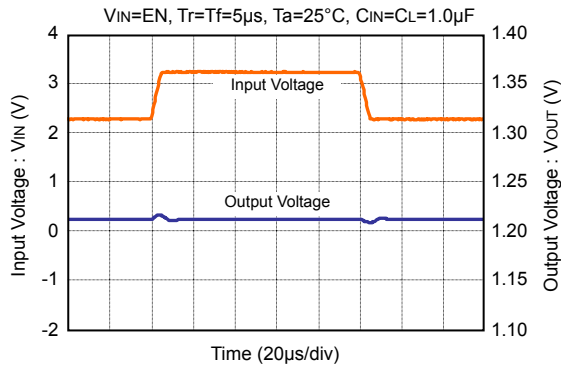
● **VRR3301xxx (VOUT=3.3V)**



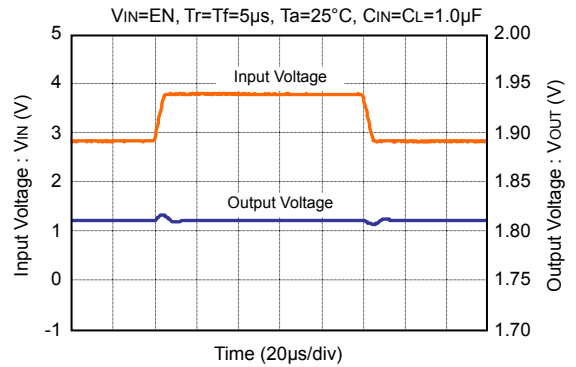


**TYPICAL CHARACTERISTICS – Input Transient Response ( $I_{OUT}=1mA$ )**

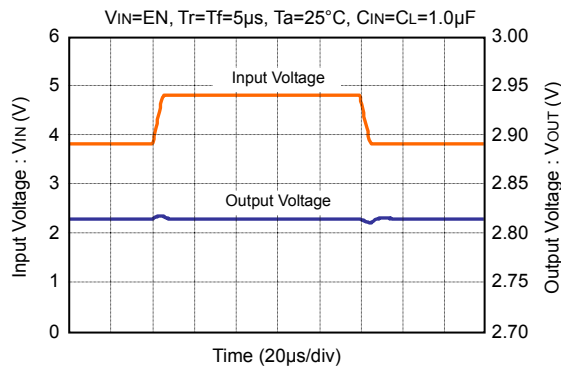
● **VRR1202xxx ( $V_{OUT}=1.2V$ )**



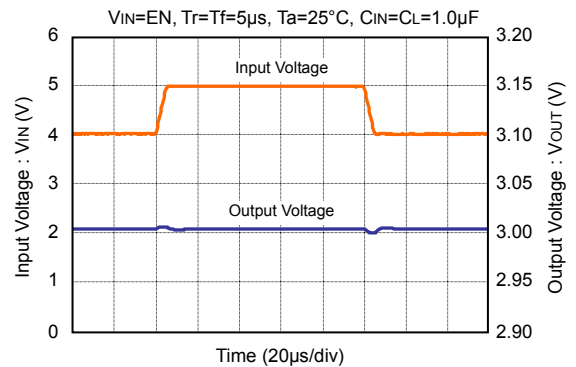
● **VRR1802xxx ( $V_{OUT}=1.8V$ )**



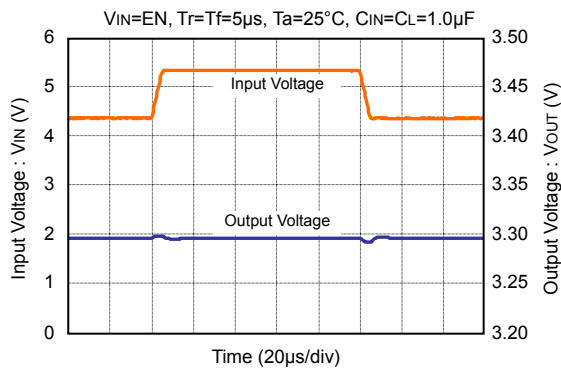
● **VRR2801xxx ( $V_{OUT}=2.8V$ )**



● **VRR3001xxx ( $V_{OUT}=3.0V$ )**

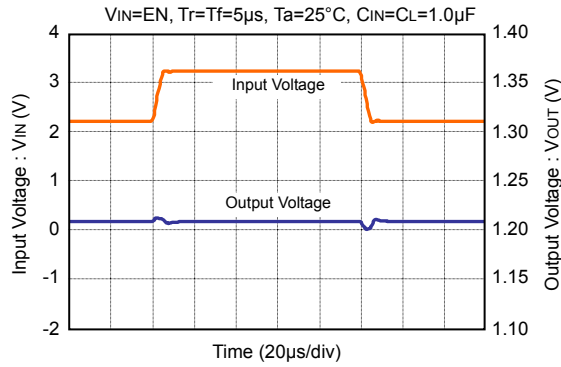


● **VRR3301xxx ( $V_{OUT}=3.3V$ )**

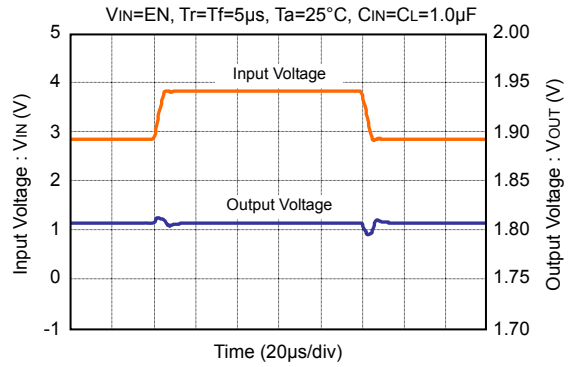


**TYPICAL CHARACTERISTICS – Input Transient Response ( $I_{OUT}=30mA$ )**

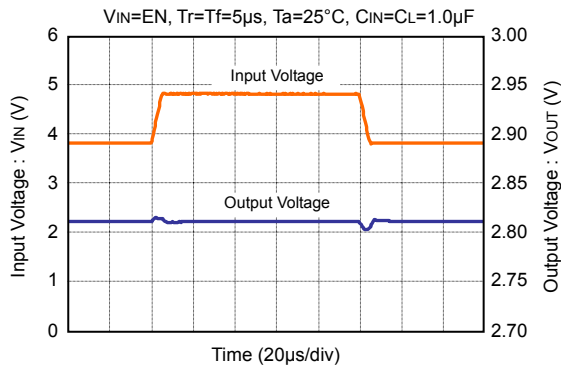
● **VRR1202xxx ( $V_{OUT}=1.2V$ )**



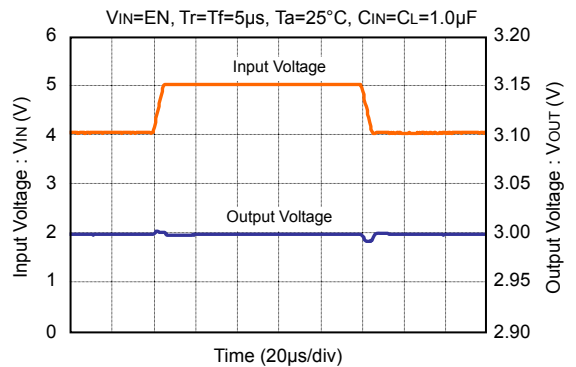
● **VRR1802xxx ( $V_{OUT}=1.8V$ )**



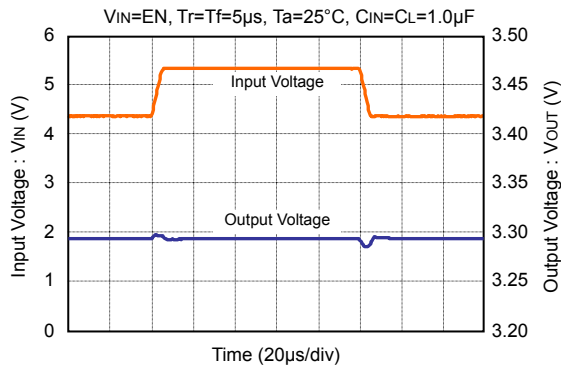
● **VRR2801xxx ( $V_{OUT}=2.8V$ )**



● **VRR3001xxx ( $V_{OUT}=3.0V$ )**

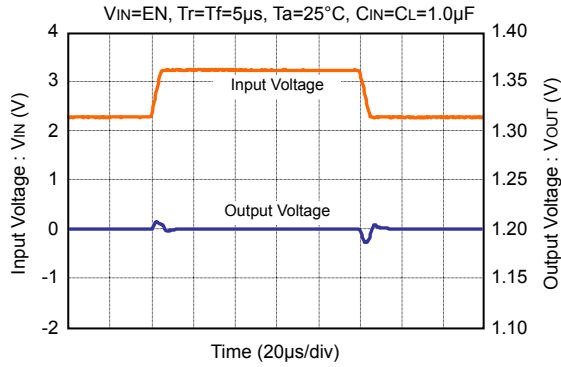


● **VRR3301xxx ( $V_{OUT}=3.3V$ )**

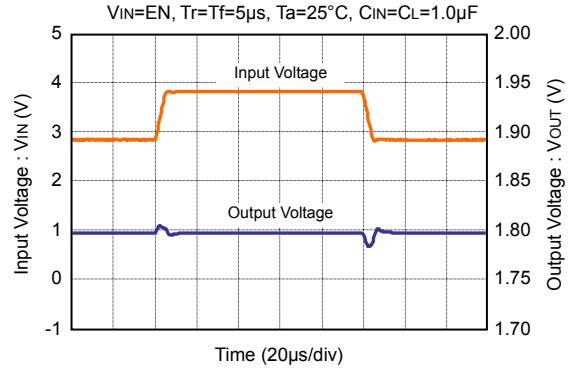


**TYPICAL CHARACTERISTICS – Input Transient Response ( $I_{OUT}=100mA$ )**

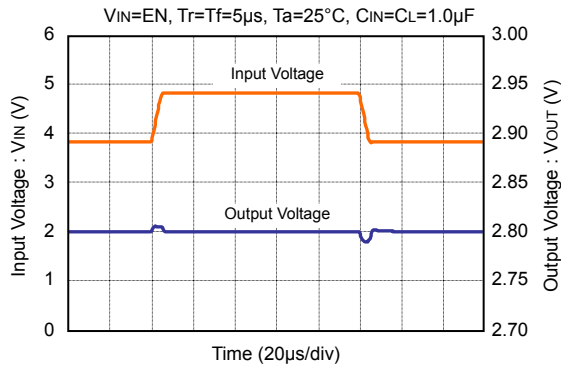
● **VRR1202xxx ( $V_{OUT}=1.2V$ )**



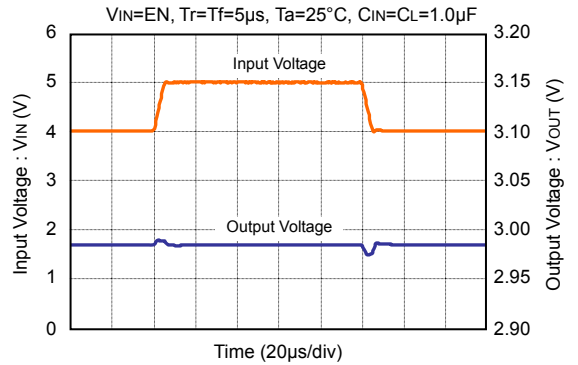
● **VRR1802xxx ( $V_{OUT}=1.8V$ )**



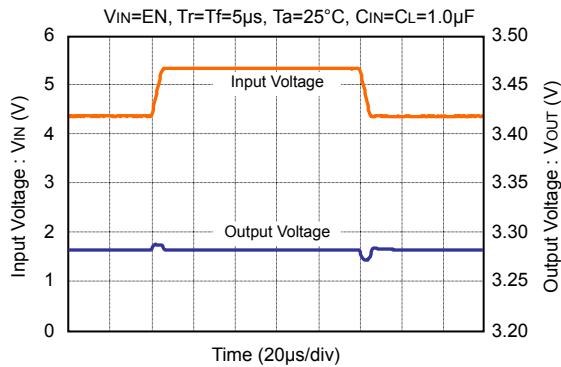
● **VRR2801xxx ( $V_{OUT}=2.8V$ )**



● **VRR3001xxx ( $V_{OUT}=3.0V$ )**

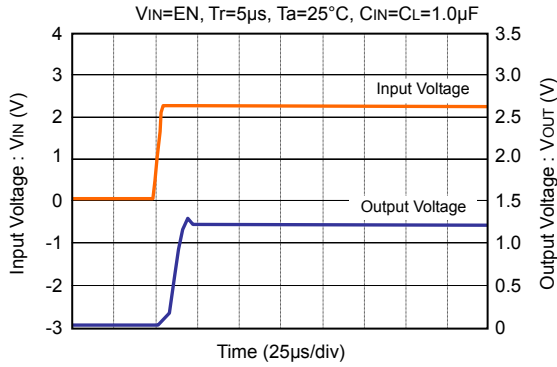


● **VRR3301xxx ( $V_{OUT}=3.3V$ )**

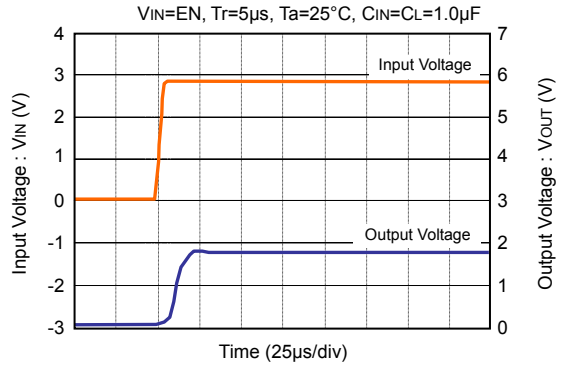


**TYPICAL CHARACTERISTICS – Input Rise Time ( $I_{OUT}=1mA$ )**

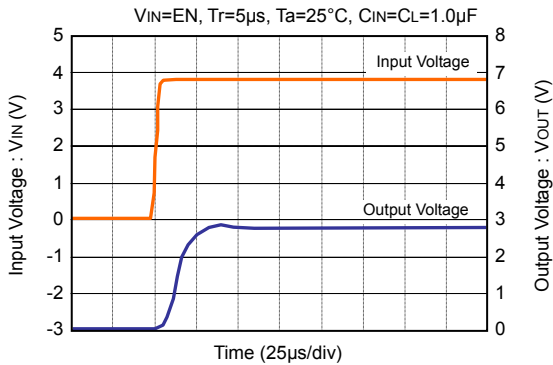
● **VRR1202xxx ( $V_{OUT}=1.2V$ )**



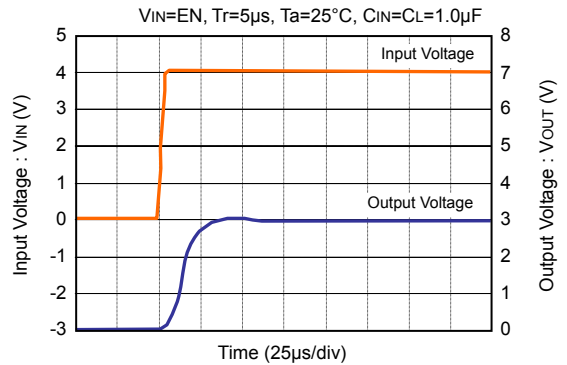
● **VRR1802xxx ( $V_{OUT}=1.8V$ )**



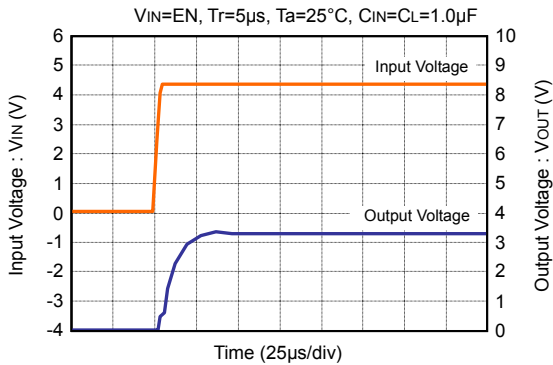
● **VRR2801xxx ( $V_{OUT}=2.8V$ )**



● **VRR3001xxx ( $V_{OUT}=3.0V$ )**

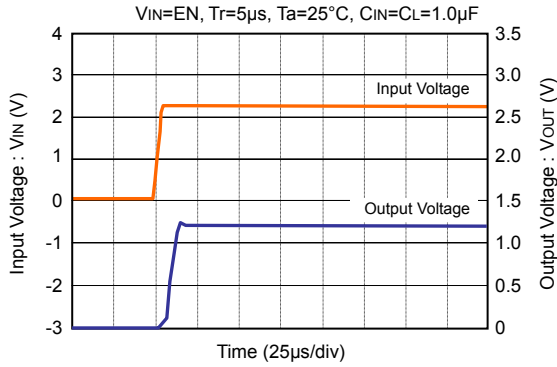


● **VRR3301xxx ( $V_{OUT}=3.3V$ )**

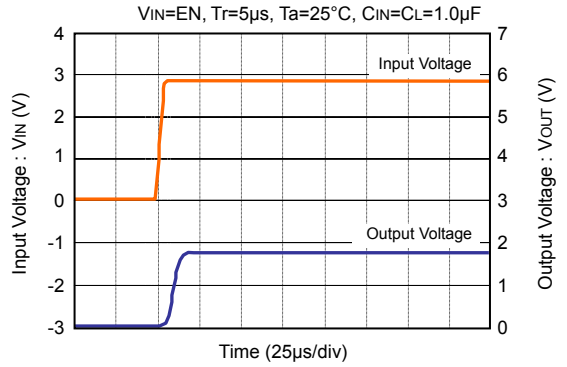


**TYPICAL CHARACTERISTICS – Input Rise Time ( $I_{OUT}=30mA$ )**

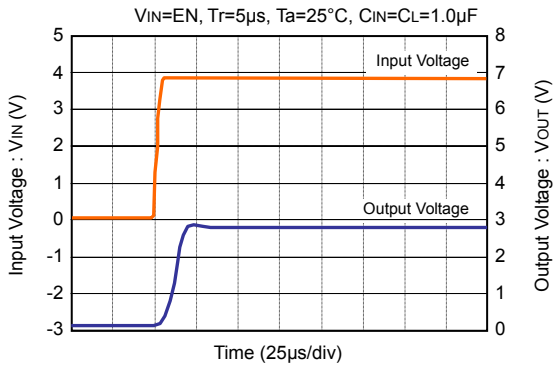
● **VRR1202xxx ( $V_{OUT}=1.2V$ )**



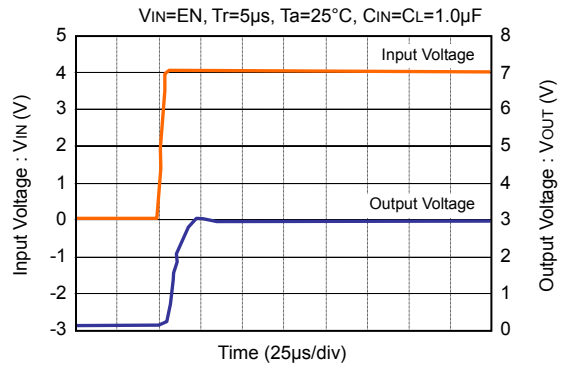
● **VRR1802xxx ( $V_{OUT}=1.8V$ )**



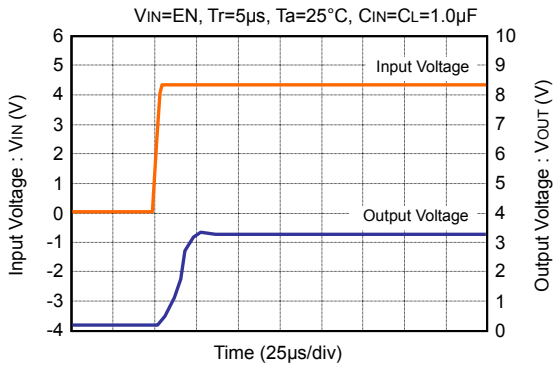
● **VRR2801xxx ( $V_{OUT}=2.8V$ )**



● **VRR3001xxx ( $V_{OUT}=3.0V$ )**

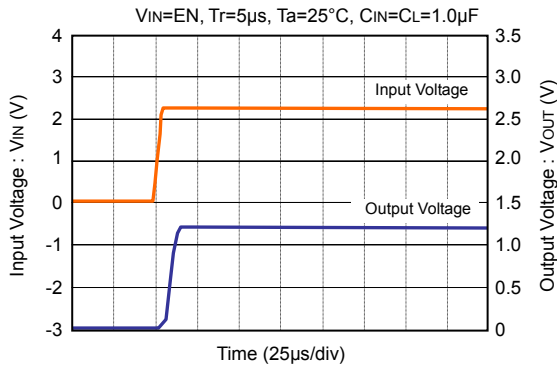


● **VRR3301xxx ( $V_{OUT}=3.3V$ )**

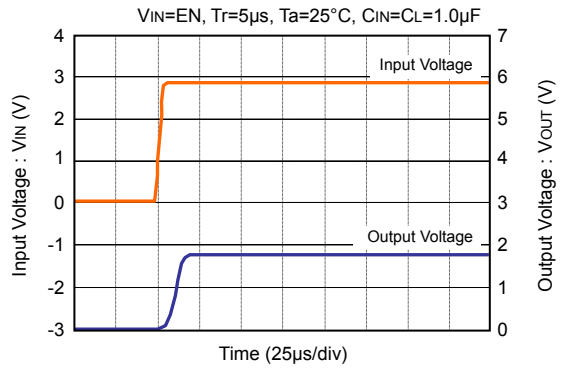


**TYPICAL CHARACTERISTICS – Input Rise Time ( $I_{OUT}=100mA$ )**

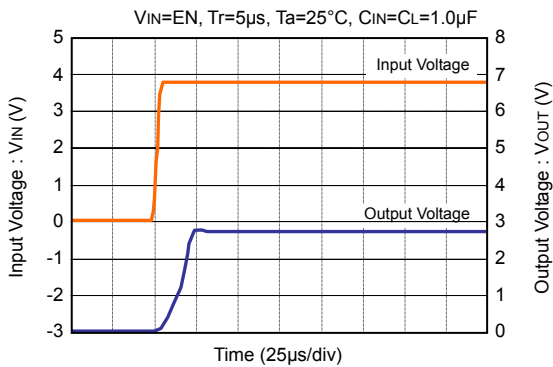
● **VRR1202xxx ( $V_{OUT}=1.2V$ )**



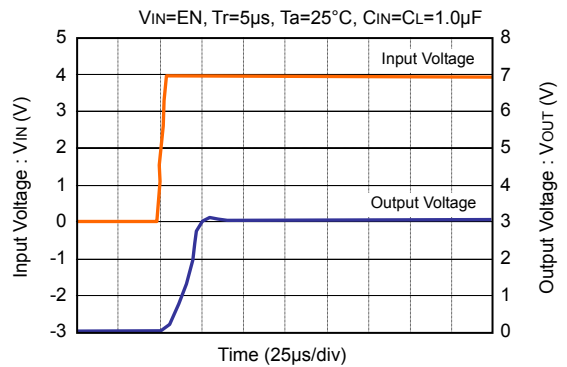
● **VRR1802xxx ( $V_{OUT}=1.8V$ )**



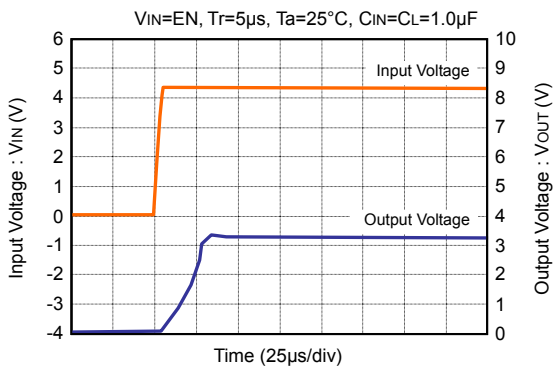
● **VRR2801xxx ( $V_{OUT}=2.8V$ )**



● **VRR3001xxx ( $V_{OUT}=3.0V$ )**

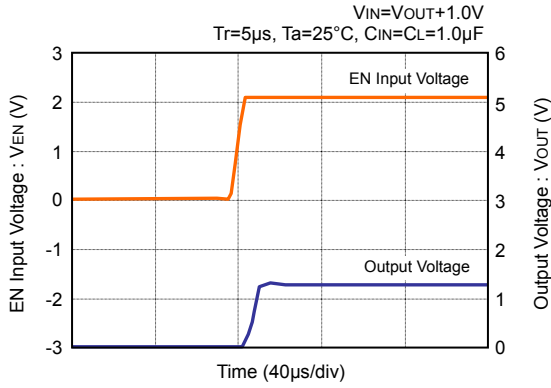


● **VRR3301xxx ( $V_{OUT}=3.3V$ )**

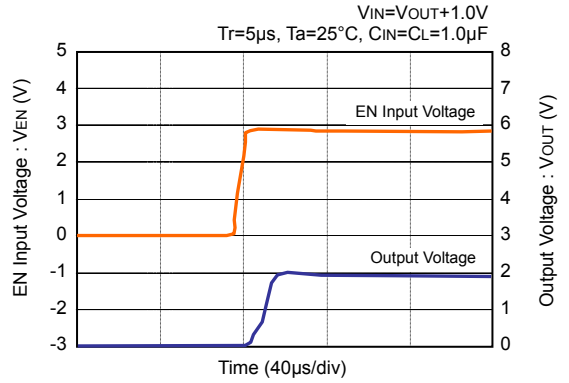


**TYPICAL CHARACTERISTICS – EN Rise Time ( $I_{OUT}=1mA$ )**

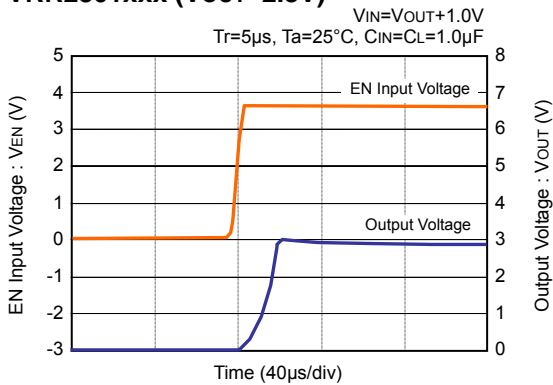
● **VRR1202xxx ( $V_{OUT}=1.2V$ )**



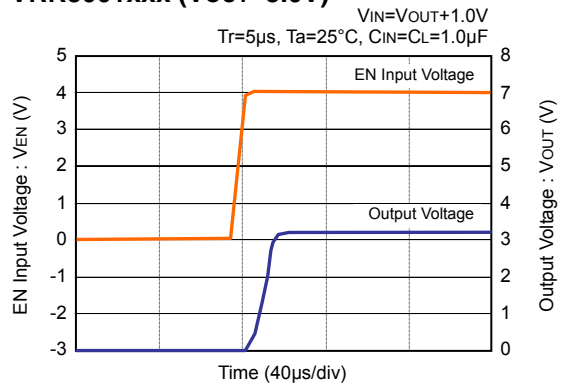
● **VRR1802xxx ( $V_{OUT}=1.8V$ )**



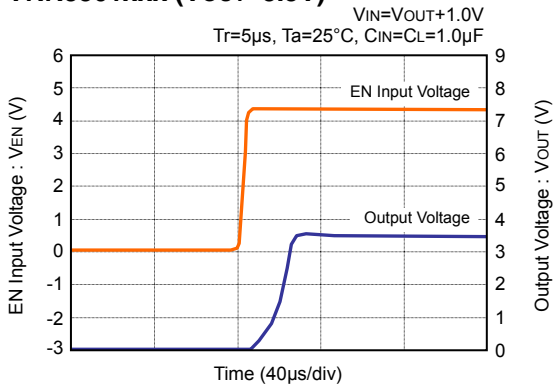
● **VRR2801xxx ( $V_{OUT}=2.8V$ )**



● **VRR3001xxx ( $V_{OUT}=3.0V$ )**

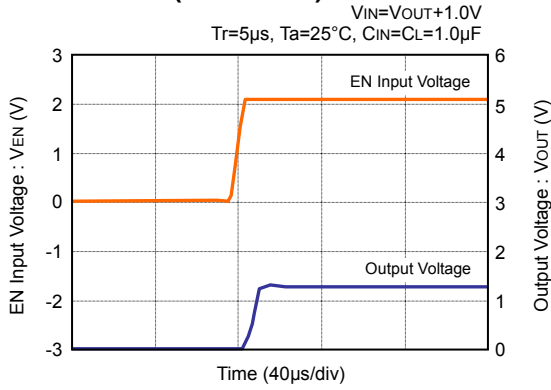


● **VRR3301xxx ( $V_{OUT}=3.3V$ )**

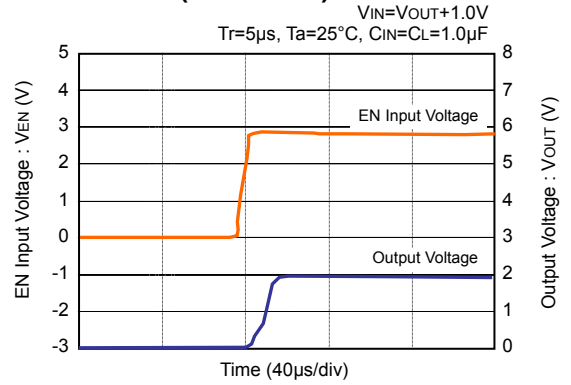


**TYPICAL CHARACTERISTICS – EN Rise Time ( $I_{OUT}=30mA$ )**

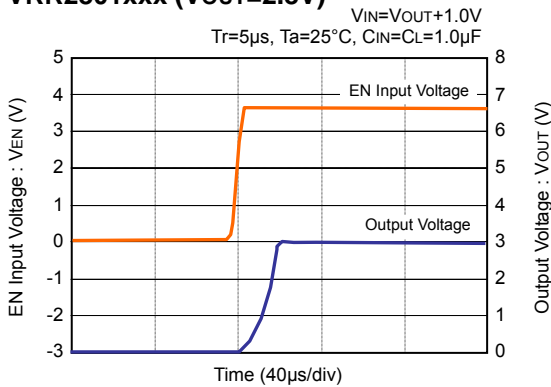
● **VRR1202xxx ( $V_{OUT}=1.2V$ )**



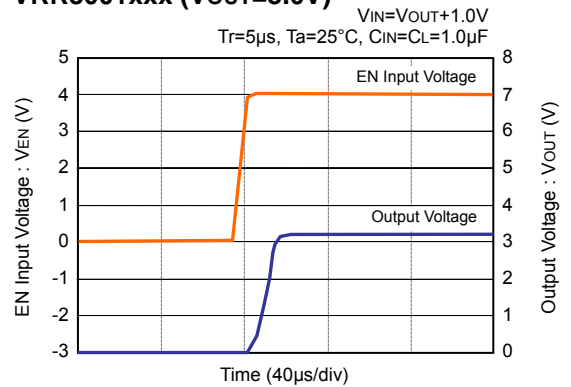
● **VRR1802xxx ( $V_{OUT}=1.8V$ )**



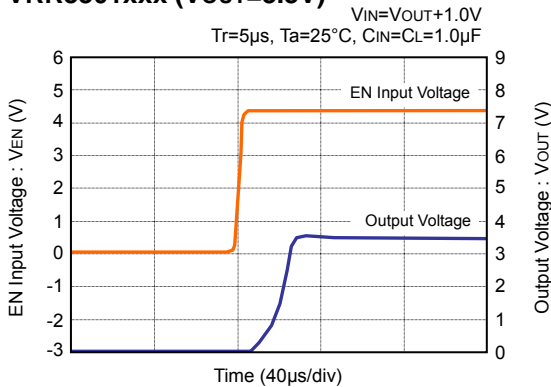
● **VRR2801xxx ( $V_{OUT}=2.8V$ )**



● **VRR3001xxx ( $V_{OUT}=3.0V$ )**



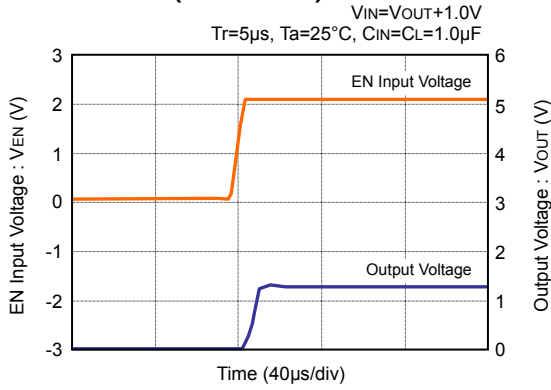
● **VRR3301xxx ( $V_{OUT}=3.3V$ )**



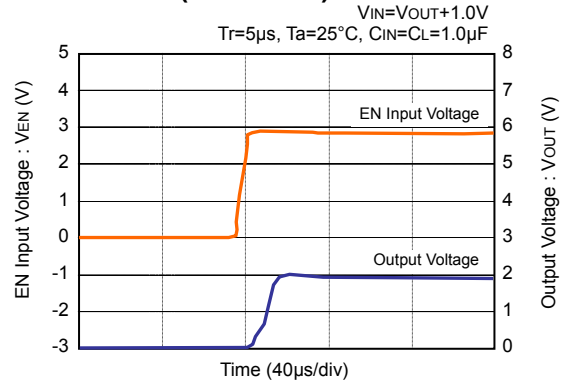


**TYPICAL CHARACTERISTICS – EN Rise Time ( $I_{OUT}=100mA$ )**

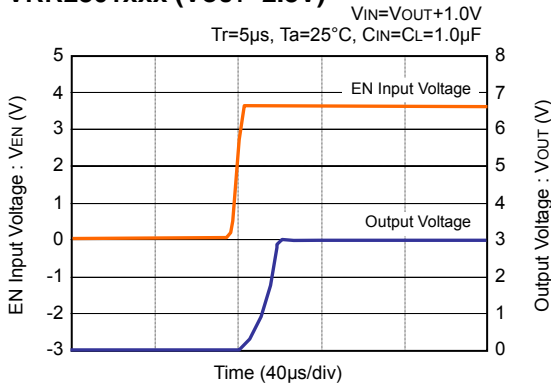
● **VRR1202xxx ( $V_{OUT}=1.2V$ )**



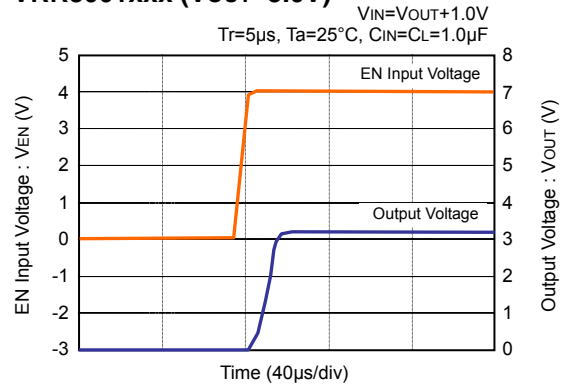
● **VRR1802xxx ( $V_{OUT}=1.8V$ )**



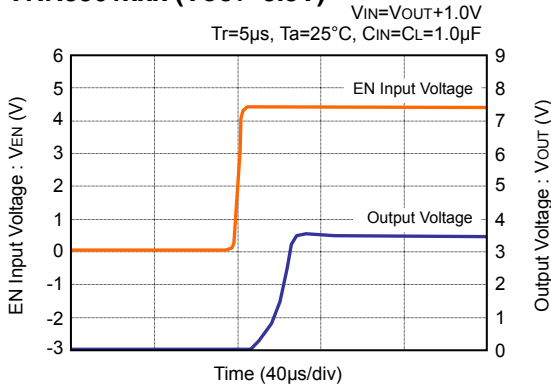
● **VRR2801xxx ( $V_{OUT}=2.8V$ )**



● **VRR3001xxx ( $V_{OUT}=3.0V$ )**

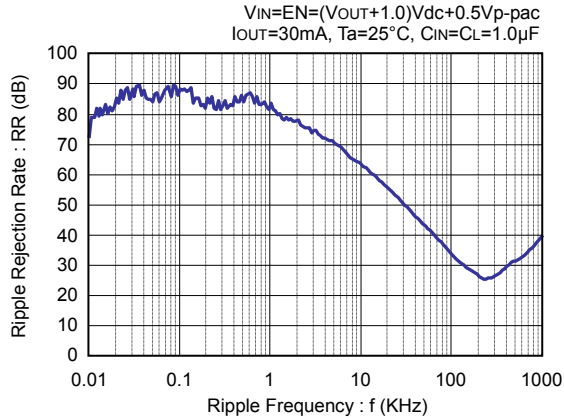


● **VRR3301xxx ( $V_{OUT}=3.3V$ )**

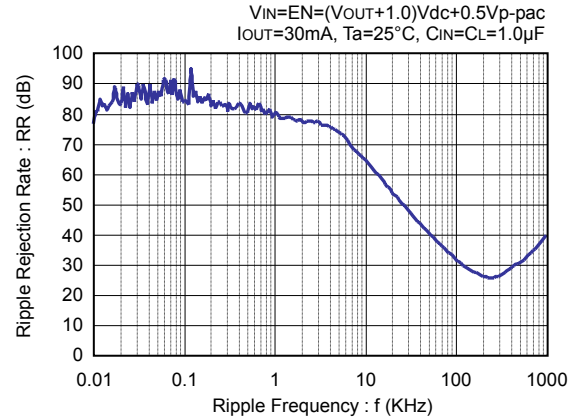


## TYPICAL CHARACTERISTICS – Ripple Rejection Rate

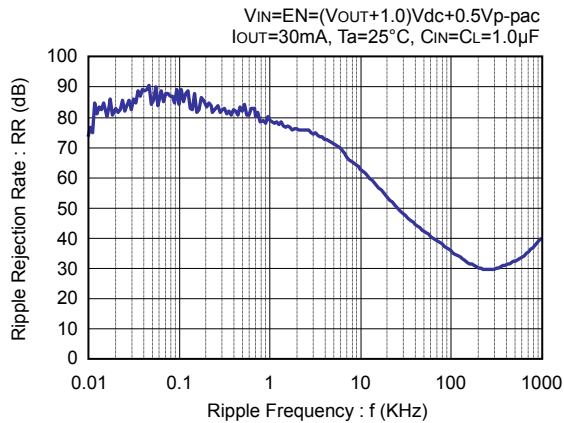
### ● VRR1202xxx (VOUT=1.2V)



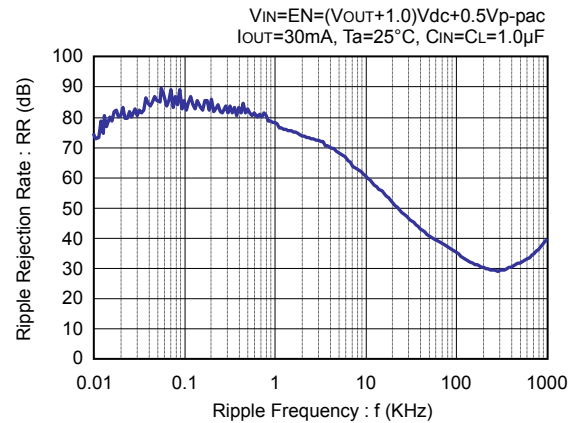
### ● VRR1802xxx (VOUT=1.8V)



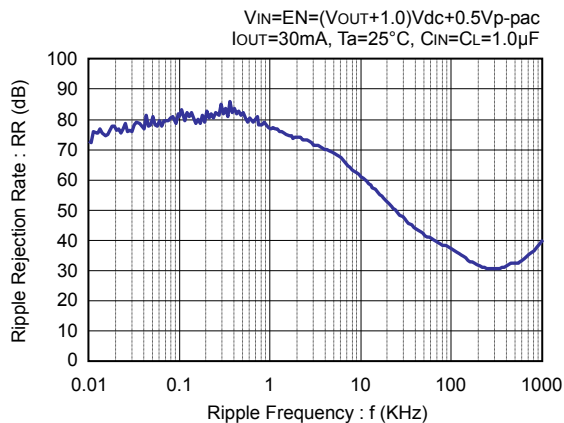
### ● VRR2801xxx (VOUT=2.8V)



### ● VRR3001xxx (VOUT=3.0V)

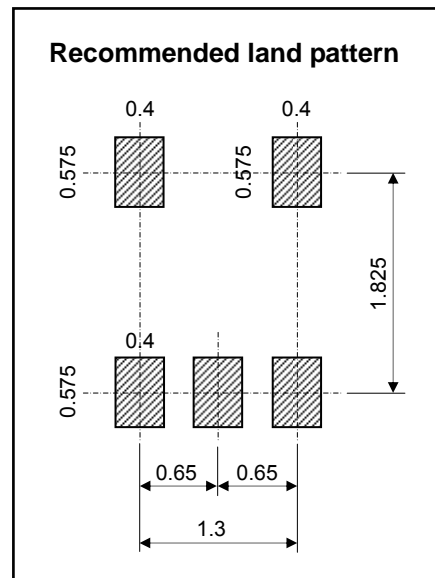
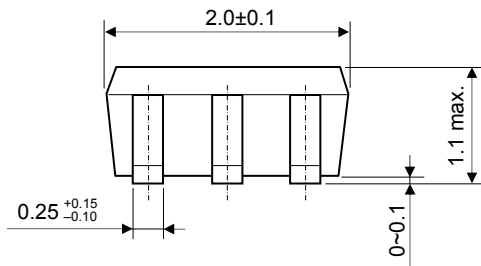
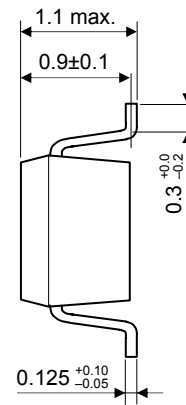
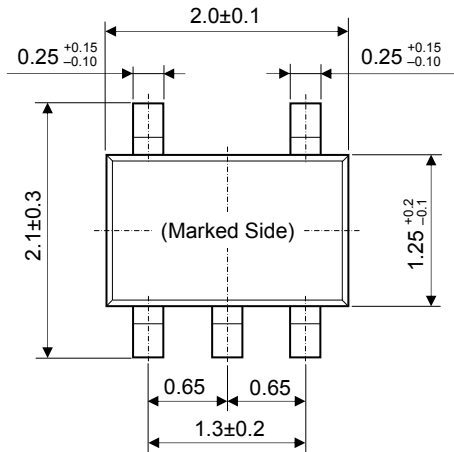


### ● VRR3301xxx (VOUT=3.3V)



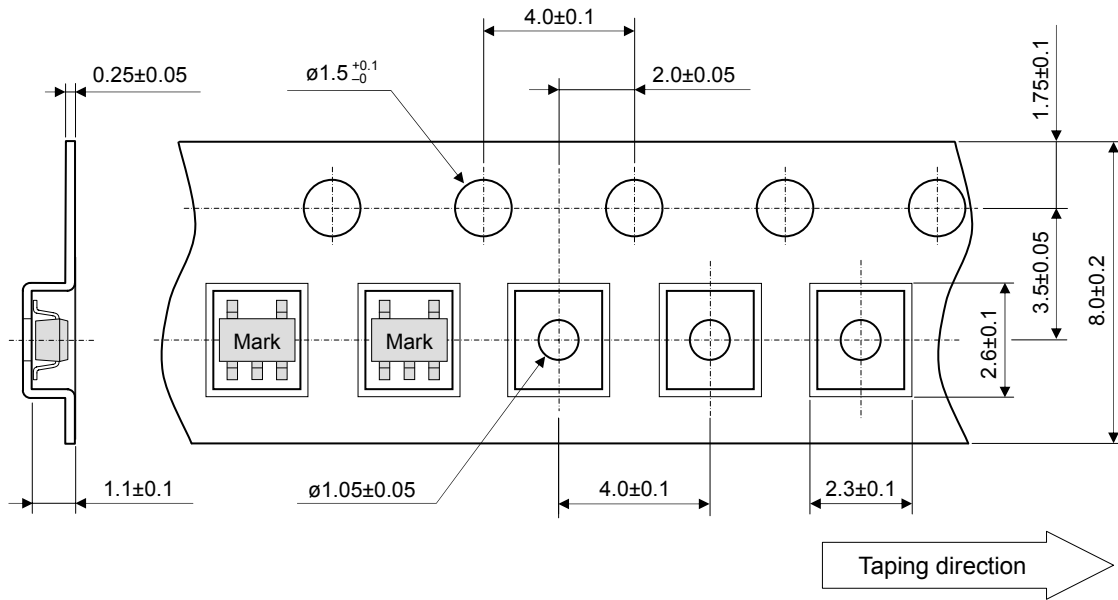
**PACKAGE DIMENSIONS (SSOT-25 : R-TYPE)**

(Unit : mm)



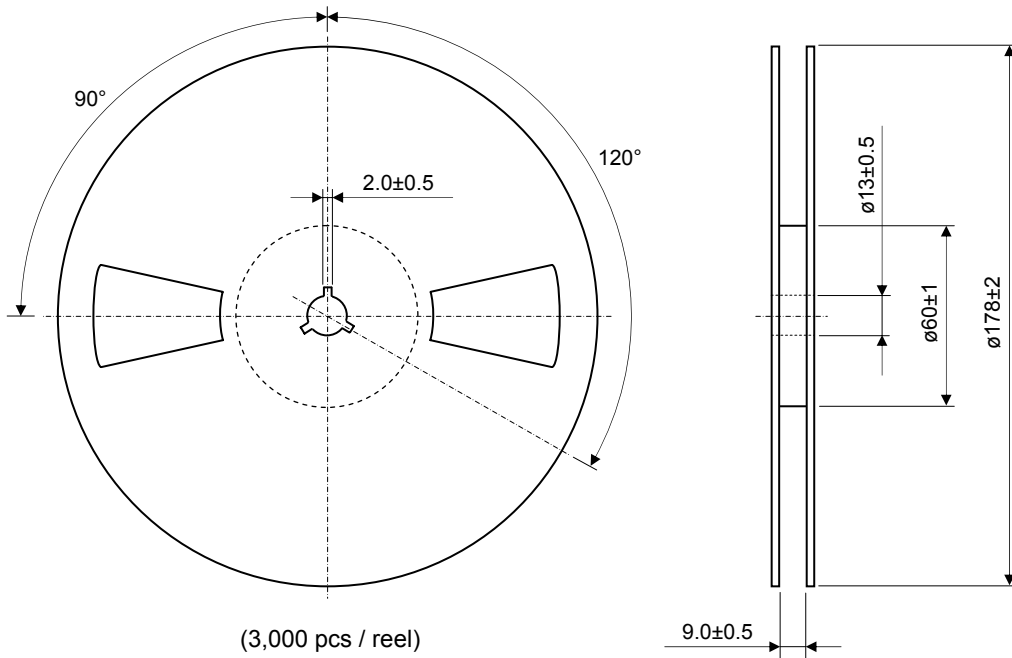
**TAPING AND LOADING SPECIFICATIONS (SSOT-25 : R-TYPE)**

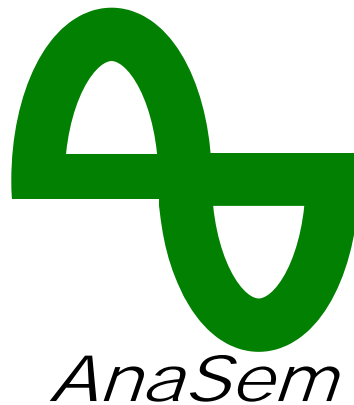
(Unit : mm)



**REEL DIMENSIONS (SSOT-25 : R-TYPE)**

(Unit : mm)





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