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## 150mA Voltage Regulator (Wide Input Voltage Range)

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NO.EA-100-061107

### OUTLINE

The R1154x series are CMOS-based voltage regulator (VR) ICs. The R1154xxxxxx has features of high output voltage accuracy and ultra-low supply current. A peak current limit circuit, a short current limit circuit, and a thermal shutdown circuit are built in the R1154x series.

The regulator output voltage is fixed in the R1154xxxxB, while adjustable type is the R1154x001C. Output voltage accuracy is  $\pm 2.0\%$ .

Since the packages for these ICs are the SOT-89-5 and SOT-23-5, high density mounting of the ICs on boards is possible.

### FEATURES

- Supply Current ..... Typ.  $5.0\mu\text{A}$
- Standby Current ..... Typ.  $0.1\mu\text{A}$
- Output Voltage Accuracy .....  $\pm 2.0\%$
- Wide Output Voltage Range ..... 2.5V to 12.0V(xxxxB)  
adjustable in the range of 2.5V to  $V_{\text{IN}}$  or 24.0V (001C)
- Input Voltage ..... Max. 24.0V
- Output Current ..... Min. 140mA ( $V_{\text{IN}}=V_{\text{OUT}}+2.0\text{V}$ , 2.5V Output type)  
Min. 150mA ( $V_{\text{IN}}=V_{\text{OUT}}+2.0\text{V}$ , 3.0V Output type)
- Package ..... SOT-89-5, SOT-23-5
- Built-in Peak Current Limit Circuit
- Short Current Limit Circuit
- Thermal Shutdown Circuit

### APPLICATIONS

- Power source for home appliances such as refrigerators, rice cookers, Electronic water warmers, 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

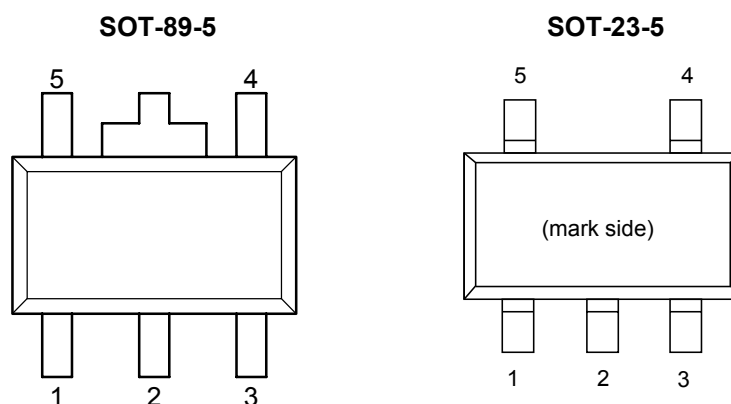
The output voltage can be selected at the user's request.

The selection can be made with designating the part number as follows;

R1154xxxx-xx-x ←Part Number  
 ↑ ↑ ↑ ↑ ↑  
 a b c d e

Code	Contents
a	Designation of package type; H: SOT-89-5 N: SOT-23-5
b	Designation of output voltage: Adjustable: 001 (Reference voltage=2.5V) Fixed: Stepwise Setting in the range from 2.5V to 12.0V
c	Designation of Output Type; B: Fixed Output Type C: Adjustable Output Type
d	Designation of Taping Type; T1, T2 (SOT-89-5), TR (SOT-23-5) (Refer to Taping Specifications)
e	Designation of composition of plating: -F: Lead free plating (SOT-23-5,SOT-89-5)

## PIN CONFIGURATION



## PIN DESCRIPTION

### • SOT-89-5

Pin No	Symbol	Description
1	$V_{OUT}$	Voltage Regulator Output Pin
2	GND	Ground Pin
3	CE	Chip Enable Pin
4	NC/ADJ	B version: No Connection C version: Reference Voltage of Adjustable Output Pin
5	$V_{DD}$	Input Pin

### • SOT-23-5

Pin No	Symbol	Description
1	$V_{OUT}$	Voltage Regulator Output Pin
2	GND	Ground Pin
3	$V_{DD}$	Input Pin
4	NC/ADJ	B version: No Connection C version: Reference Voltage of Adjustable Output Pin
5	CE	Chip Enable Pin

## ABSOLUTE MAXIMUM RATINGS

Symbol	Item	Rating	Unit
$V_{IN}$	Input Voltage	26.0	V
$V_{CE}$	Input Voltage (CE Input Pin)	-0.3 to $V_{IN}+0.3$	V
$V_{OUT}$	Output Voltage	-0.3 to $V_{IN}+0.3$	V
$V_{ADJ}$	Output Voltage (ADJ Pin)	-0.3 to $V_{IN}+0.3$	V
$I_{OUT}$	Output Current	250	mA
$P_D$	Power Dissipation (SOT-23-5) <sup>*Note1</sup>	420	mV
	Power Dissipation (SOT-89-5) <sup>*Note1</sup>	900	
$T_{opt}$	Operating Temperature	-40 to +105	°C
$T_{stg}$	Storage Temperature	-55 to +125	°C

\*Note1) For Power Dissipation please refer to PACKAGE INFORMATION to be described.

## ELECTRICAL CHARACTERISTICS

### • R1154xxxxB

$T_{opt}=25^{\circ}\text{C}$

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit
$V_{IN}$	Input Voltage				24	V
$V_{OUT}$	Output Voltage	$V_{IN}=V_{OUT}+2.0\text{V}$	$\times 0.98$		$\times 1.02$	V
$I_{OUT}$	Output Current	$V_{IN}-V_{OUT}=2.0\text{V}$	Refer to the Output Current Table			
$I_{SS}$	Supply Current	$V_{IN}=V_{CE}$ $V_{IN}-V_{OUT}=2.0\text{V}$		5	10	$\mu\text{A}$
$I_{standby}$	Standby Current	$V_{IN}=24\text{V}$ , $V_{CE}=0\text{V}$		0.1	1.0	$\mu\text{A}$
$\frac{\Delta V_{OUT}}{\Delta I_{OUT}}$	Load regulation	$V_{IN}-V_{OUT}=2.0\text{V}$ $1\text{mA} \leq I_{OUT} \leq 40\text{mA}$	Refer to the Load Regulation Table			
$\frac{\Delta V_{OUT}}{\Delta V_{IN}}$	Line regulation	$I_{OUT}=20\text{mA}$ $V_{OUT}+1\text{V} \leq V_{IN} \leq 24\text{V}$		0.05	0.20	%/V
$V_{DIF}$	Dropout Voltage	$I_{OUT}=20\text{mA}$	Refer to the Dropout Voltage Table			
$\frac{\Delta V_{OUT}}{\Delta T_{opt}}$	Output Voltage Temperature Coefficient	$V_{IN}-V_{OUT}=2.0\text{V}$ $I_{OUT}=20\text{mA}$ $-40^{\circ}\text{C} \leq T_{opt} \leq 105^{\circ}\text{C}$		$\pm 100$		ppm/°C
$I_{lim}$	Short Current Limit	$V_{OUT}=0\text{V}$		45		mA
$V_{CEH}$	CE "H" Input Voltage		2.1		$V_{IN}$	V
$V_{CEL}$	CE "L" Input Voltage		0.0		0.3	V
$T_{SD}$	Thermal Shutdown Temperature	Junction Temperature		150		°C
$T_{SR}$	Thermal Shutdown Released Temperature	Junction Temperature		125		°C

## • R1154xxxxC

T<sub>opt</sub>=25°C

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit
V <sub>IN</sub>	Input Voltage				24	V
V <sub>OUT</sub>	Output Voltage	V <sub>IN</sub> =V <sub>OUT</sub> +2.0V, V <sub>OUT</sub> =V <sub>ADJ</sub> I <sub>OUT</sub> =20mA	2.45	2.50	2.55	V
I <sub>OUT</sub>	Output Current	V <sub>IN</sub> =V <sub>OUT</sub> +2.0V, V <sub>OUT</sub> =V <sub>ADJ</sub>	140			mA
I <sub>SS</sub>	Supply Current	V <sub>IN</sub> =V <sub>OUT</sub> +2.0V, V <sub>OUT</sub> =V <sub>ADJ</sub> V <sub>CE</sub> =V <sub>IN</sub>		5	10	μA
I <sub>standby</sub>	Standby Current	V <sub>IN</sub> =24V, V <sub>OUT</sub> =V <sub>ADJ</sub> V <sub>CE</sub> =0V		0.1	1.0	μA
ΔV <sub>OUT</sub> /ΔI <sub>OUT</sub>	Load regulation	V <sub>IN</sub> =V <sub>OUT</sub> +2.0V, V <sub>OUT</sub> =V <sub>ADJ</sub> 1mA ≤ I <sub>OUT</sub> ≤ 40mA		20	50	mV
ΔV <sub>OUT</sub> /ΔV <sub>IN</sub>	Line regulation	V <sub>OUT</sub> +1V ≤ V <sub>IN</sub> ≤ 24V V <sub>OUT</sub> =V <sub>ADJ</sub> , I <sub>OUT</sub> =20mA		0.05	0.20	%/V
V <sub>DIF</sub>	Dropout Voltage	V <sub>OUT</sub> =V <sub>ADJ</sub> , I <sub>OUT</sub> =20mA		0.20	0.40	V
ΔV <sub>OUT</sub> /ΔT <sub>opt</sub>	Output Voltage Temperature Coefficient	V <sub>IN</sub> =V <sub>OUT</sub> +2.0V, V <sub>OUT</sub> =V <sub>ADJ</sub> I <sub>OUT</sub> =20mA -40°C ≤ T <sub>opt</sub> ≤ 105°C		±100		ppm/°C
I <sub>lim</sub>	Short Current Limit	V <sub>OUT</sub> =V <sub>ADJ</sub> =0V		45		mA
V <sub>CEH</sub>	CE "H" Input Voltage		2.1		V <sub>IN</sub>	V
V <sub>CEL</sub>	CE "L" Input Voltage		0.0		0.3	V
T <sub>SD</sub>	Thermal Shutdown Temperature	Junction Temperature		150		°C
T <sub>SR</sub>	Thermal Shutdown Released Temperature	Junction Temperature		125		°C

• Output Current (T<sub>opt</sub>=25°C)

Output Voltage V <sub>OUT</sub> (V)	Output Current (mA)
	Min.
2.5 ≤ V <sub>OUT</sub> ≤ 2.9	140
3.0 ≤ V <sub>OUT</sub> ≤ 12.0	150

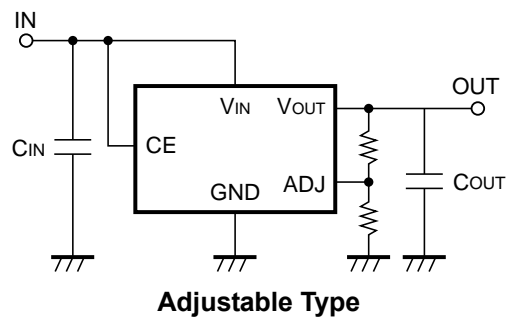
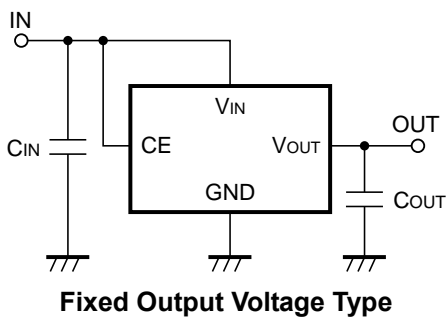
• Load Regulation (T<sub>opt</sub>=25°C)

Output Voltage V <sub>OUT</sub> (V)	Load Regulation (mV)	
	Typ.	Max.
2.5 ≤ V <sub>OUT</sub> ≤ 3.0	20	50
3.1 ≤ V <sub>OUT</sub> ≤ 5.0	30	75
5.1 ≤ V <sub>OUT</sub> ≤ 12.0	40	115

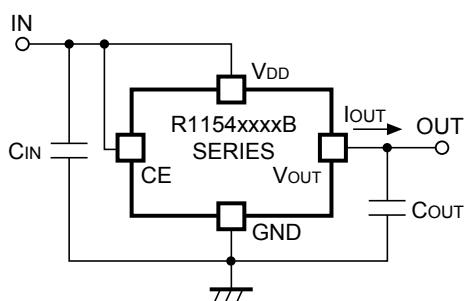
• Dropout Voltage (T<sub>opt</sub>=25°C)

Output Voltage V <sub>OUT</sub> (V)	Dropout Voltage (V)	
	Typ.	Max.
2.5 ≤ V <sub>OUT</sub> ≤ 7.0	0.20	0.40
7.1 ≤ V <sub>OUT</sub> ≤ 10.0	0.25	0.50
10.1 ≤ V <sub>OUT</sub> ≤ 12.0	0.30	0.55

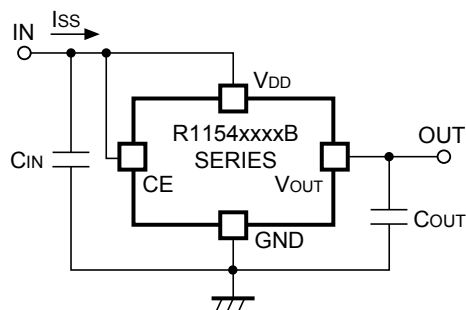
TYPICAL APPLICATIONS



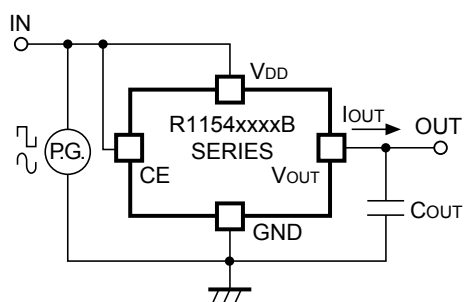
## TEST CIRCUITS



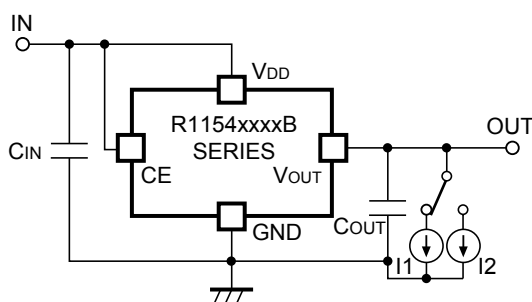
**R1154xxxxB Standard Test Circuit**



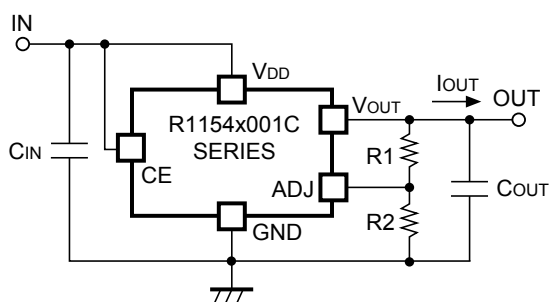
**R1154xxxxB Supply Current Test Circuit**



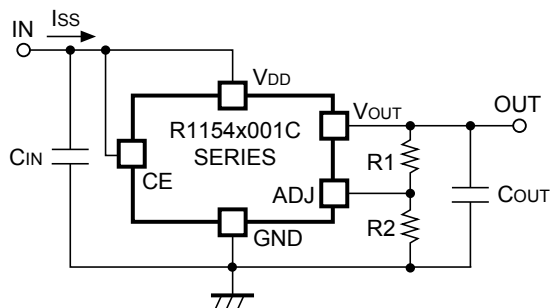
**R1154xxxxB Input Transient Response Test Circuit**



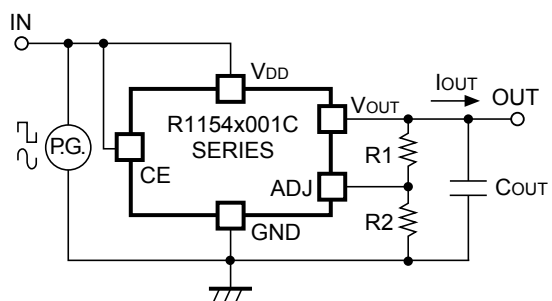
**R1154xxxxB Load Regulation Test Circuit**



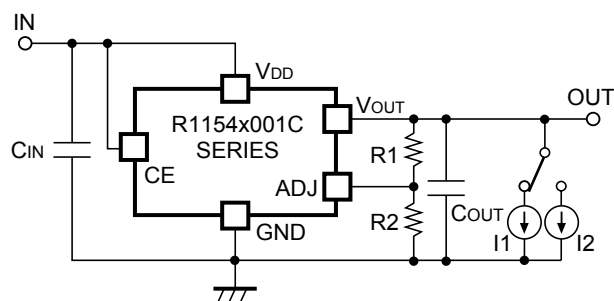
**R1154x001C Standard Test Circuit**



**R1154x001C Supply Current Test Circuit**



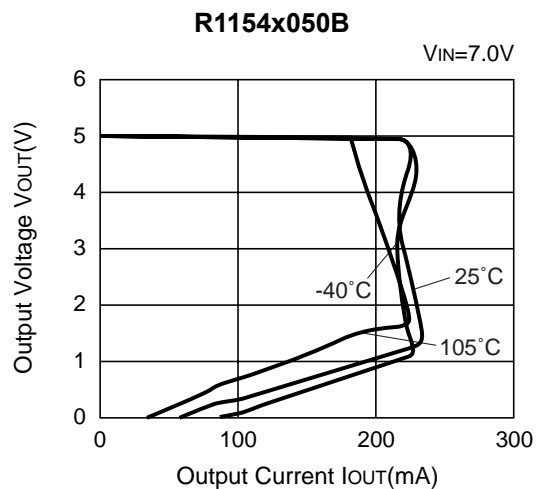
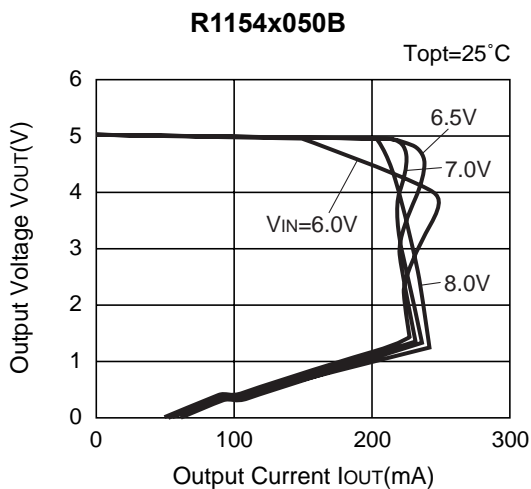
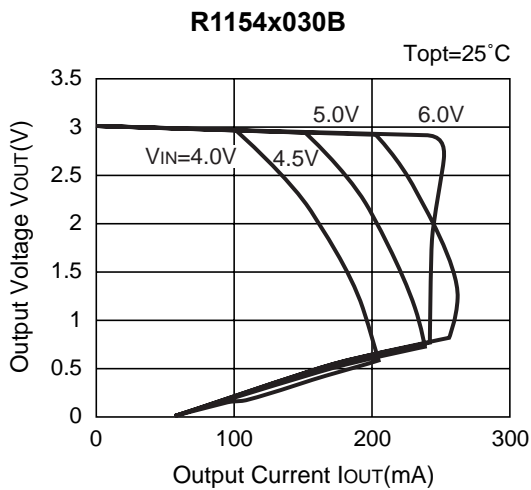
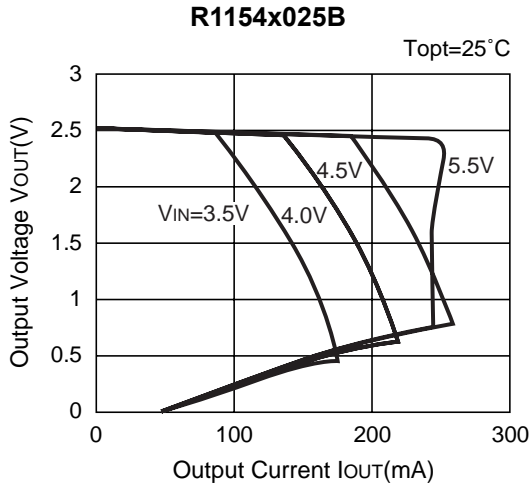
**R1154x001C Input Transient Response Test Circuit**



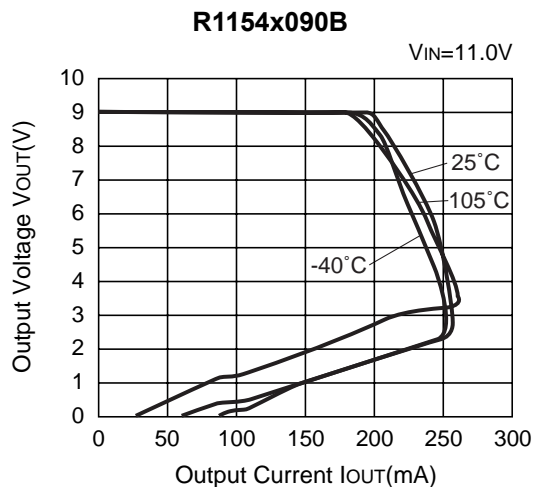
**R1154x001C Load Transient Response Test Circuit**

## TYPICAL CHARACTERISTICS

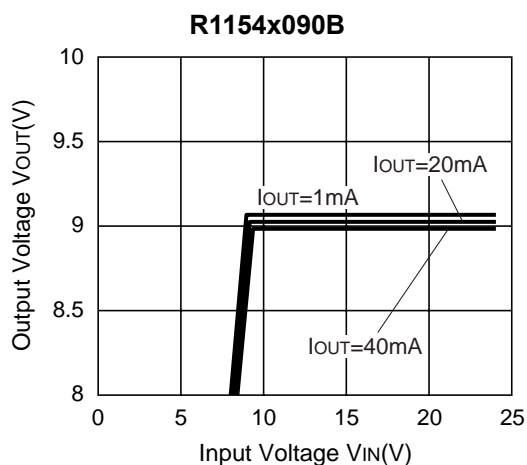
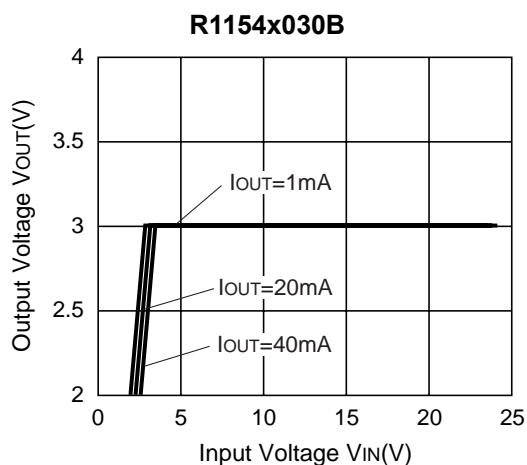
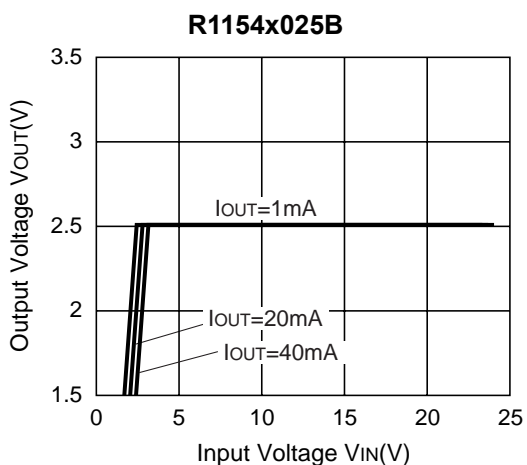
### 1) Output Voltage vs. Output Current







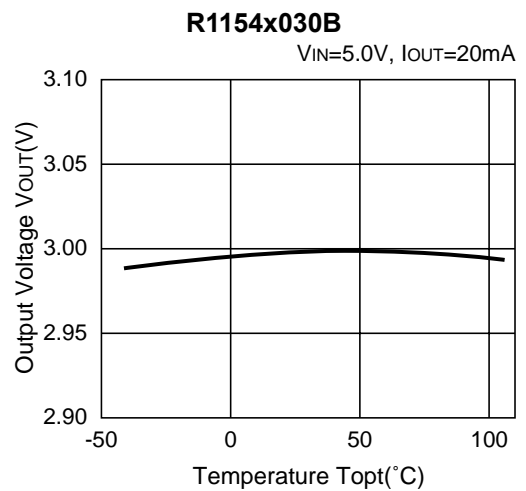
2) Input Voltage vs. Output Voltage ( $T_{opt}=25^{\circ}\text{C}$ )



3) Dropout Voltage vs. Output Current



4) Output Voltage vs. Temperature

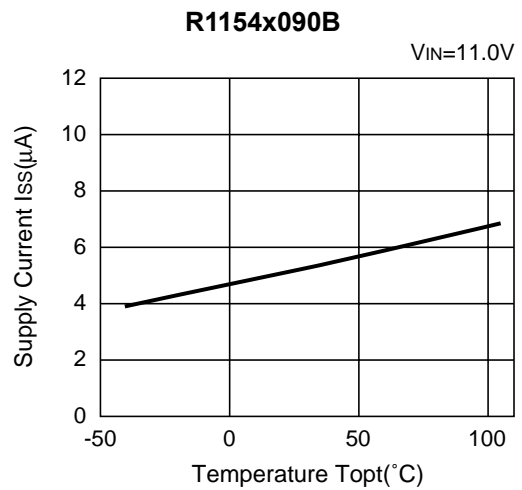
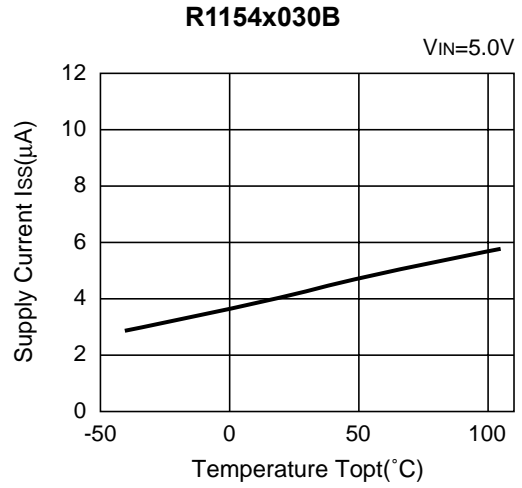




**5) Supply Current vs. Input Voltage ( $T_{opt}=25^{\circ}C$ )**



6) Supply Current vs. Temperature



7) Input Transient Response ( $I_{OUT}=20mA$ ,  $C_{OUT}=0.1\mu F$ ,  $T_{opt}=25^\circ C$ )





8) Load Transient Response ( $C_{OUT}=0.1\mu F$ ,  $T_{opt}=25^{\circ}C$ )

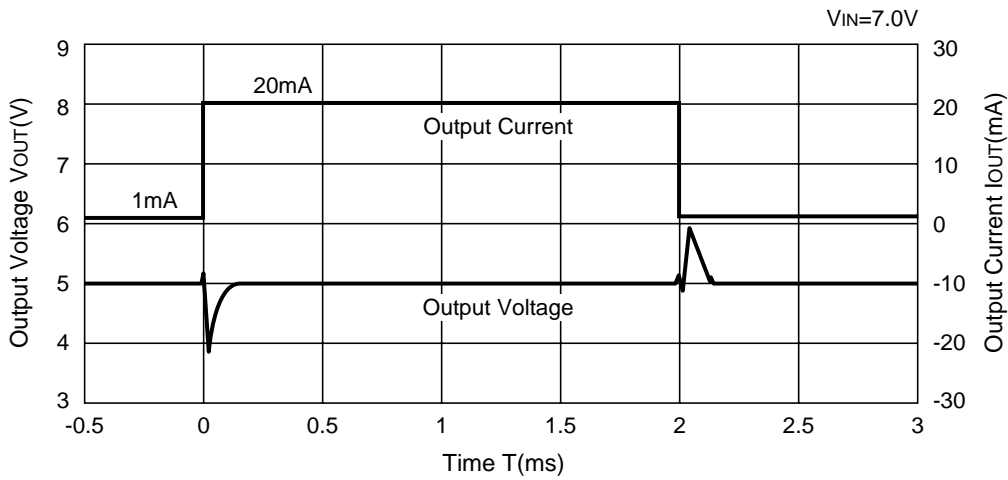
R1154x025B



R1154x030B

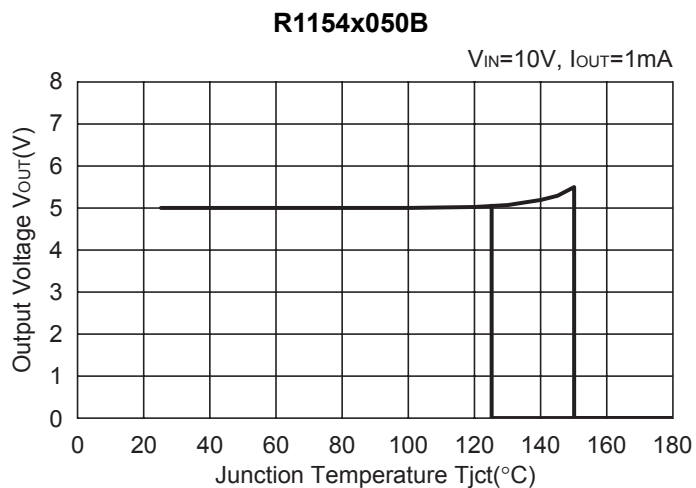


R1154x050B





**9) Thermal Shutdown Characteristics**



## TECHNICAL NOTES

### Phase Compensation

Phase Compensation of the R1154x Series has been made internally for stable operation even though the load current would vary. Therefore, without the capacitors,  $C_{IN}$  and  $C_{OUT}$ , the output voltage is regulated, however, for more stable operation, use capacitors as  $C_{IN}$  and  $C_{OUT}$ . Especially, if the input line is long and impedance is high,  $C_{IN}$  is necessary, moreover, if you use  $C_{OUT}$ , transient response will be improved. Recommended value is in the range from  $0.1\mu\text{F}$  to  $2.2\mu\text{F}$ . Wiring should be made as short as possible.

Connect the capacitor,  $C_{IN}$  between  $V_{DD}$  pin and GND pin and  $C_{OUT}$  between  $V_{OUT}$  and GND as close as possible.



R1154xxxxB Typical Application



R1154xxxxC Typical Application

### Thermal Shutdown

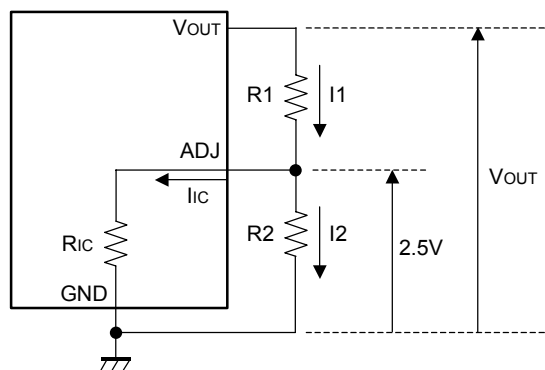
Thermal shutdown function is included in the R1154x Series, if the junction temperature is equal or more than  $+150^{\circ}\text{C}$  (Typ.), the operation of regulator would stop. After that, when the junction temperature is equal or less than  $+125^{\circ}\text{C}$  (Typ.), the operation of regulator would restart. Unless the cause of rising temperature would remove, the regulator repeats on and off, and output waveform would be like consecutive pulses.

### Chip Enable Circuit

Do not make voltage level of chip enable pin keep floating level, or in between  $V_{IH}$  and  $V_{IL}$ . Unless otherwise, Output voltage would be unstable or indefinite, or unexpected current would flow internally.

\* Technical Notes on Output Voltage Setting of C type

Figure 1. Adjustable Regulator (C type)





The Output Voltage of Regulator in R1154xxxxC may be adjustable for any output voltage between its 2.5V reference and its  $V_{DD}$  setting level. An external pair of resistors is required, as shown in Figure 1. The complete equation for the output voltage is described step by step as follows;

$$I_1 = I_{IC} + I_2 \dots\dots\dots (1)$$

$$I_2 = 2.5/R_2 \dots\dots\dots (2)$$

Thus,

$$I_1 = I_{IC} + 2.5/R_2 \dots\dots\dots (3)$$

Therefore,

$$V_{OUT} = 2.5 + R_1 \times I_1 \dots\dots\dots (4)$$

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

$$\begin{aligned} V_{OUT} &= 2.5 + R_1(I_{IC} + 2.5/R_2) \\ &= 2.5(1 + R_1/R_2) + R_1 \times I_{IC} \dots\dots\dots (5) \end{aligned}$$

In 2nd term, or  $R_1 \times I_{IC}$  will produce an error in  $V_{OUT}$ .

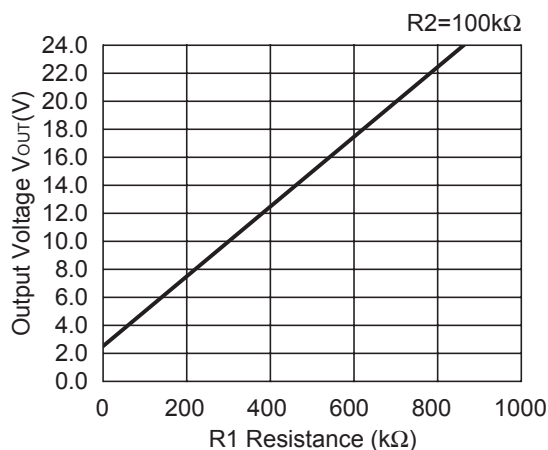
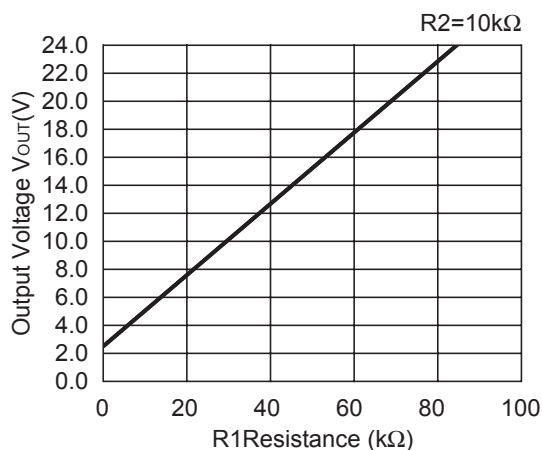
In Equation (5),

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

$$\begin{aligned} R_1 \times I_{IC} &= R_1 \times 2.5/R_{IC} \\ &= 2.5 \times R_1/R_{IC} \dots\dots\dots (7) \end{aligned}$$

For better accuracy, choosing  $R_1 \ll R_{IC}$  reduces this error.

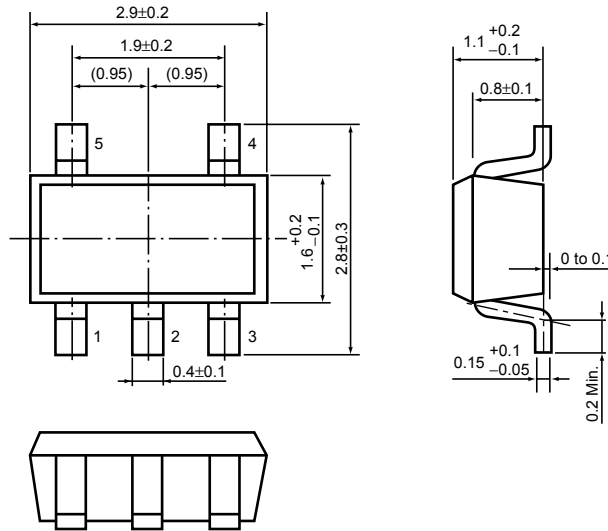
**Adjustable Resister Dependence of Output Voltage (Topt=25°C)**



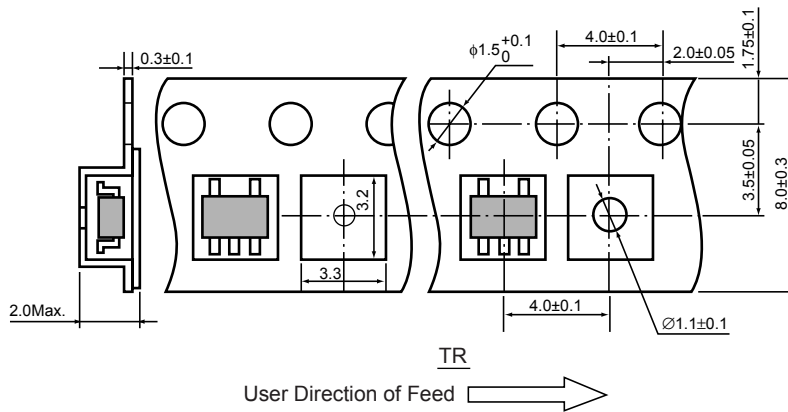
- SOT-23-5 (SC-74A)

Unit: mm

**PACKAGE DIMENSIONS**

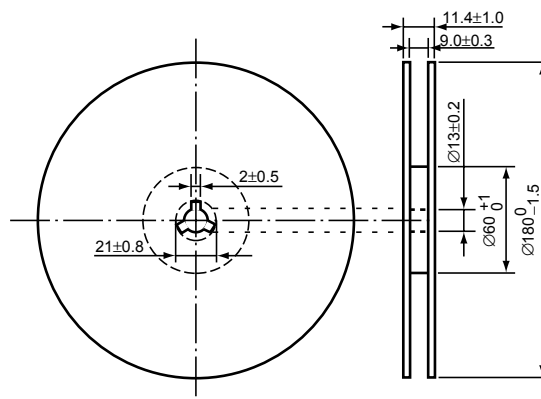


**TAPING SPECIFICATION**



**TAPING REEL DIMENSIONS REUSE REEL (EIAJ-RRM-08Bc)**

(1reel=3000pcs)



### POWER DISSIPATION (SOT-23-5)

This specification is at mounted on board. Power Dissipation ( $P_D$ ) depends on conditions of mounting on board.

This specification is based on the measurement at the condition below:

(Power Dissipation (SOT-23-5) is substitution of SOT-23-6.)

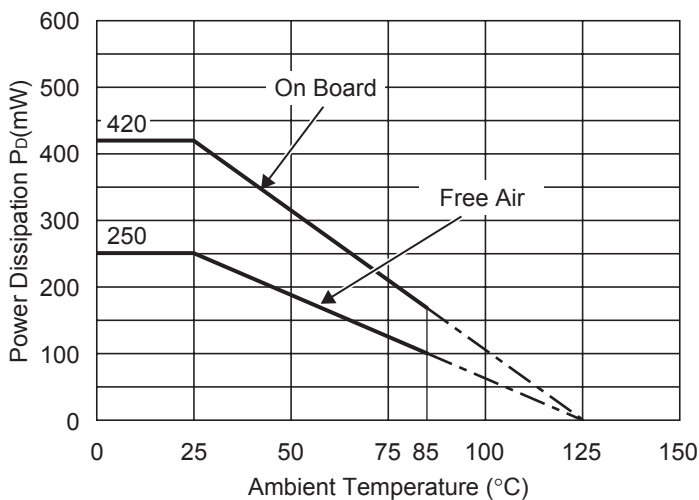
Measurement Conditions

	Standard Land Pattern
Environment	Mounting on Board (Wind velocity=0m/s)
Board Material	Glass cloth epoxy plactic (Double sided)
Board Dimensions	40mm × 40mm × 1.6mm
Copper Ratio	Top side : Approx. 50% , Back side : Approx. 50%
Through-hole	φ0.5mm × 44pcs

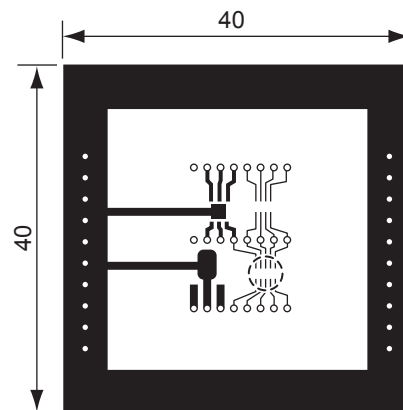
Measurement Result

( $T_{opt}=25^{\circ}C, T_{jmax}=125^{\circ}C$ )

	Standard Land Pattern	Free Air
Power Dissipation	420mW	250mW
Thermal Resistance	$\theta_{ja}=(125-25^{\circ}C)/0.42W=263^{\circ}C/W$	400 $^{\circ}C/W$



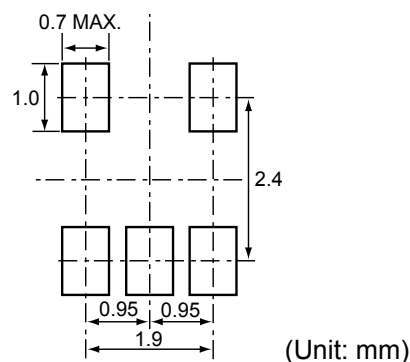
Power Dissipation



Measurement Board Pattern

○ IC Mount Area Unit : mm

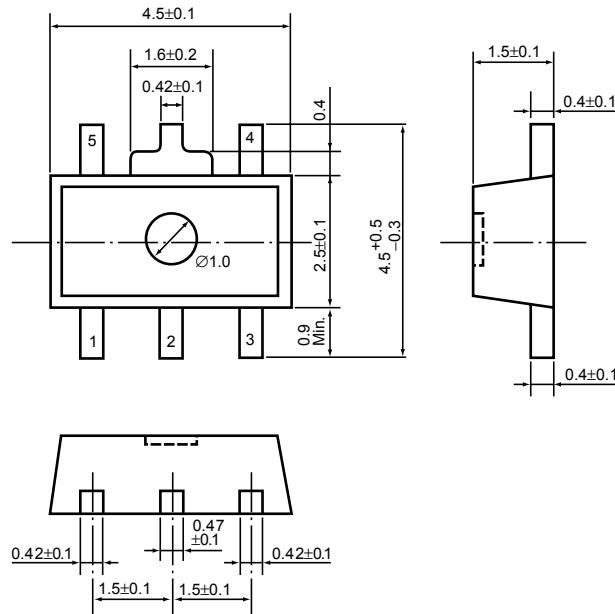
### RECOMMENDED LAND PATTERN



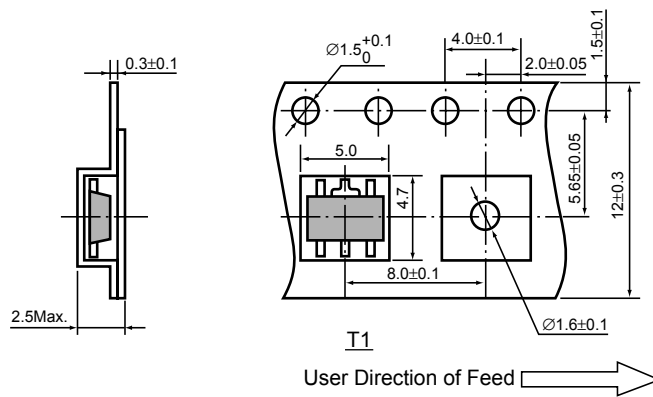
• SOT-89-5

Unit: mm

PACKAGE DIMENSIONS

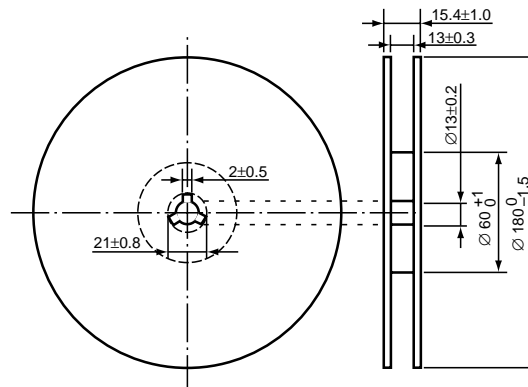


TAPING SPECIFICATION (T1: Standard Type)



TAPING REEL DIMENSIONS REUSE REEL (EIAJ-RRM-12Bc)

(1reel=1000pcs)



### POWER DISSIPATION (SOT-89-5)

This specification is at mounted on board. Power Dissipation ( $P_D$ ) depends on conditions of mounting on board. This specification is based on the measurement at the condition below:

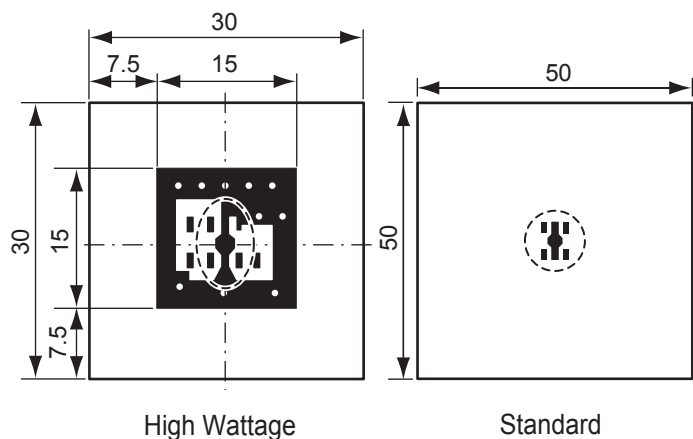
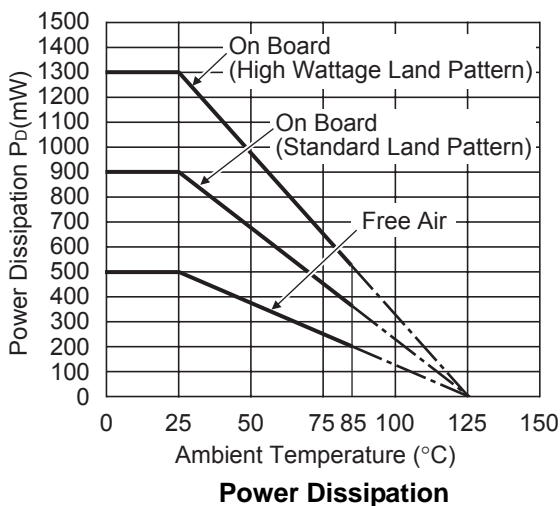
Measurement Conditions

	High Wattage Land Pattern	Standard Land Pattern
Environment	Mounting on Board (Wind velocity=0m/s)	Mounting on Board (Wind velocity=0m/s)
Board Material	Glass cloth epoxy plastic (Double sided)	Glass cloth epoxy plastic (Double sided)
Board Dimensions	30mm × 30mm × 1.6mm	50mm × 50mm × 1.6mm
Copper Ratio	Top side : Approx. 20% , Back side : Approx. 100%	Top side : Approx. 10% , Back side : Approx. 100%
Through-hole	φ0.85mm × 10pcs	-

Measurement Result

( $T_{opt}=25^{\circ}C, T_{jmax}=125^{\circ}C$ )

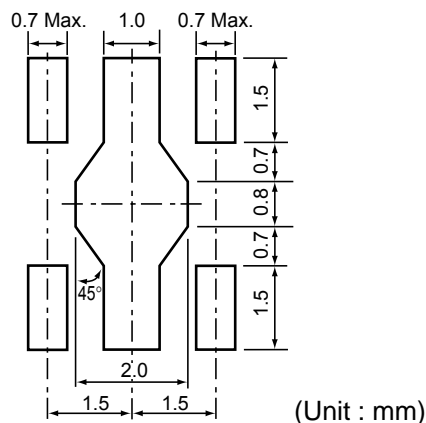
	High Wattage Land Pattern	Standard Land Pattern	Free Air
Power Dissipation	1300mW	900mW	500mW
Thermal Resistance	77°C/W	111°C/W	200°C/W



Measurement Board Pattern

○ IC Mount Area (Unit : mm)

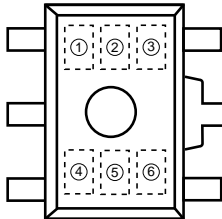
### RECOMMENDED LAND PATTERN (SOT-89-5)





R1154H SERIES MARK SPECIFICATION

• SOT-89-5



- ① : G (fixed)
- ②, ③, ④ : Product Code } (refer to Part Number vs. Product Code)
- ⑤, ⑥ : Lot Number

• Part Number vs. Product Code

Part Number	Product Code			
	①	②	③	④
R1154H025B	G	0	2	5
R1154H026B	G	0	2	6
R1154H027B	G	0	2	7
R1154H028B	G	0	2	8
R1154H029B	G	0	2	9
R1154H030B	G	0	3	0
R1154H031B	G	0	3	1
R1154H032B	G	0	3	2
R1154H033B	G	0	3	3
R1154H034B	G	0	3	4
R1154H035B	G	0	3	5
R1154H036B	G	0	3	6
R1154H037B	G	0	3	7
R1154H038B	G	0	3	8
R1154H039B	G	0	3	9
R1154H040B	G	0	4	0
R1154H041B	G	0	4	1
R1154H042B	G	0	4	2
R1154H043B	G	0	4	3
R1154H044B	G	0	4	4
R1154H045B	G	0	4	5
R1154H046B	G	0	4	6
R1154H047B	G	0	4	7
R1154H048B	G	0	4	8
R1154H049B	G	0	4	9
R1154H050B	G	0	5	0
R1154H051B	G	0	5	1
R1154H052B	G	0	5	2
R1154H053B	G	0	5	3
R1154H054B	G	0	5	4

Part Number	Product Code			
	①	②	③	④
R1154H055B	G	0	5	5
R1154H056B	G	0	5	6
R1154H057B	G	0	5	7
R1154H058B	G	0	5	8
R1154H059B	G	0	5	9
R1154H060B	G	0	6	0
R1154H061B	G	0	6	1
R1154H062B	G	0	6	2
R1154H063B	G	0	6	3
R1154H064B	G	0	6	4
R1154H065B	G	0	6	5
R1154H066B	G	0	6	6
R1154H067B	G	0	6	7
R1154H068B	G	0	6	8
R1154H069B	G	0	6	9
R1154H070B	G	0	7	0
R1154H071B	G	0	7	1
R1154H072B	G	0	7	2
R1154H073B	G	0	7	3
R1154H074B	G	0	7	4
R1154H075B	G	0	7	5
R1154H076B	G	0	7	6
R1154H077B	G	0	7	7
R1154H078B	G	0	7	8
R1154H079B	G	0	7	9
R1154H080B	G	0	8	0
R1154H081B	G	0	8	1
R1154H082B	G	0	8	2
R1154H083B	G	0	8	3
R1154H084B	G	0	8	4

Part Number	Product Code			
	①	②	③	④
R1154H085B	G	0	8	5
R1154H086B	G	0	8	6
R1154H087B	G	0	8	7
R1154H088B	G	0	8	8
R1154H089B	G	0	8	9
R1154H090B	G	0	9	0
R1154H091B	G	0	9	1
R1154H092B	G	0	9	2
R1154H093B	G	0	9	3
R1154H094B	G	0	9	4
R1154H095B	G	0	9	5
R1154H096B	G	0	9	6
R1154H097B	G	0	9	7
R1154H098B	G	0	9	8
R1154H099B	G	0	9	9
R1154H100B	G	1	0	0
R1154H101B	G	1	0	1
R1154H102B	G	1	0	2
R1154H103B	G	1	0	3
R1154H104B	G	1	0	4
R1154H105B	G	1	0	5
R1154H106B	G	1	0	6
R1154H107B	G	1	0	7
R1154H108B	G	1	0	8
R1154H109B	G	1	0	9
R1154H110B	G	1	1	0
R1154H111B	G	1	1	1
R1154H112B	G	1	1	2
R1154H113B	G	1	1	3
R1154H114B	G	1	1	4

Part Number	Product Code			
	①	②	③	④
R1154H115B	G	1	1	5
R1154H116B	G	1	1	6
R1154H117B	G	1	1	7
R1154H118B	G	1	1	8
R1154H119B	G	1	1	9
R1154H120B	G	1	2	0
R1154H001C	G	0	0	1

Компания «Океан Электроники» предлагает заключение долгосрочных отношений при поставках импортных электронных компонентов на взаимовыгодных условиях!

Наши преимущества:

- Поставка оригинальных импортных электронных компонентов напрямую с производств Америки, Европы и Азии, а так же с крупнейших складов мира;
- Широкая линейка поставок активных и пассивных импортных электронных компонентов (более 30 млн. наименований);
- Поставка сложных, дефицитных, либо снятых с производства позиций;
- Оперативные сроки поставки под заказ (от 5 рабочих дней);
- Экспресс доставка в любую точку России;
- Помощь Конструкторского Отдела и консультации квалифицированных инженеров;
- Техническая поддержка проекта, помощь в подборе аналогов, поставка прототипов;
- Поставка электронных компонентов под контролем ВП;
- Система менеджмента качества сертифицирована по Международному стандарту ISO 9001;
- При необходимости вся продукция военного и аэрокосмического назначения проходит испытания и сертификацию в лаборатории (по согласованию с заказчиком);
- Поставка специализированных компонентов военного и аэрокосмического уровня качества (Xilinx, Altera, Analog Devices, Intersil, Interpoint, Microsemi, Actel, Aeroflex, Peregrine, VPT, Syfer, Eurofarad, Texas Instruments, MS Kennedy, Miteq, Cobham, E2V, MA-COM, Hittite, Mini-Circuits, General Dynamics и др.);

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## JONHON

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Разъемы специального, военного и аэрокосмического назначения:

(Применяются в военной, авиационной, аэрокосмической, морской, железнодорожной, горно- и нефтедобывающей отраслях промышленности)

«FORSTAR» (основан в 1998 г.)

ВЧ соединители, коаксиальные кабели,  
кабельные сборки и микроволновые компоненты:

(Применяются в телекоммуникациях гражданского и специального назначения, в средствах связи, РЛС, а так же военной, авиационной и аэрокосмической отраслях промышленности).



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