# 150mA Voltage Regulator (Wide Input Voltage Range)

NO.EA-100-151027

## OUTLINE

The R1154x series are CMOS-based voltage regulator (VR) ICs. The R1154x 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 ±2.0%.

Since the packages for these ICs are DFN1616-6, SOT-23-5, and SOT-89-5, high density mounting of the ICs on boards is possible.

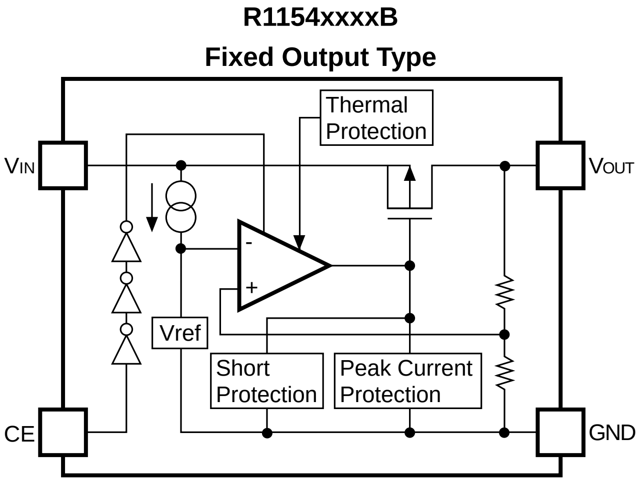
## FEATURES

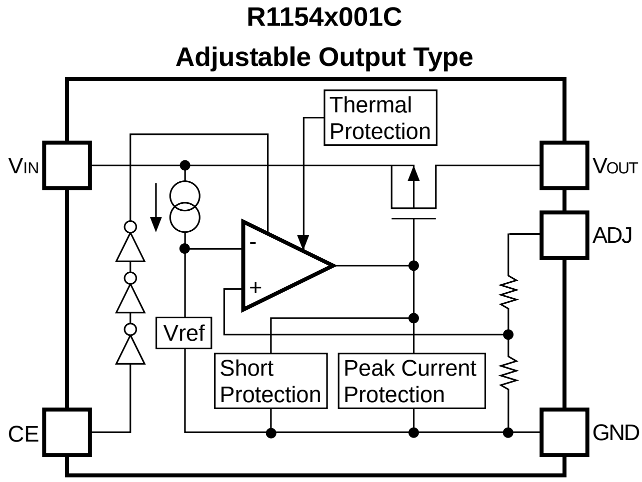
- Supply Current ................................................Typ. 5.0μA
- Standby Current ..............................................Typ. 0.1μA
- Output Voltage Accuracy.................................±2.0%
- Wide Output Voltage Range ...........................2.5V to 12.0V (0.1V steps) (xxxB)
  adjustable in the range of 2.5V to $V_{IN}$ or 24.0V (001C)
  (For other voltages, please refer to MARK INFORMATIONS.)
- Input Voltage ....................................................Max. 24.0V
- Output Current ................................................Min. 140mA ($V_{IN}=V_{OUT}+2.0V$, 2.5V Output type)
  Min. 150mA ($V_{IN}=V_{OUT}+2.0V$, 3.0V Output type)
- Package ..........................................................DFN1616-6, SOT-23-5, SOT-89-5
- Built-in Peak Current Limit Circuit
- Built-in Short Current Limit Circuit
- Built-in 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

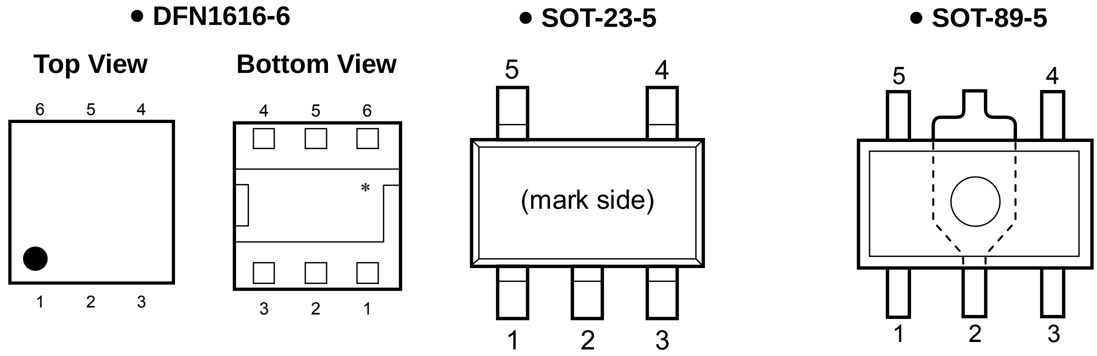
The output voltage can be selected at the user's request.

| Product Name | Package | Quantity per Reel | Pb Free | Halogen Free |
|---|---|---|---|---|
| R1154Lxxx∗-TR | DFN1616-6 | 5,000 pcs | Yes | Yes |
| R1154Nxxx∗-TR-FE | SOT-23-5 | 3,000 pcs | Yes | Yes |
| R1154Hxxx∗-T1-FE | SOT-89-5 | 1,000 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.)
The output voltage adjustable type is fixed at 001 (Reference voltage=2.5V)

∗ : (B) Fixed Output Type
(C) Adjustable Output Type

# PIN CONFIGURATION




# PIN DESCRIPTION

- **DFN1616-6**

| Pin No | Symbol | Description | |
|---|---|---|---|
| 1 | $V_{DD}$ | Input Pin | |
| 2 | NC | No Connection | |
| 3 | $V_{OUT}$ | Voltage Regulator Output Pin | |
| 4 | CE | Chip Enable Pin | |
| 5 | NC | R1154LxxxB (B version) | No Connection |
| | ADJ | R1154L001C (C version) | Reference Voltage of Adjustable Output Pin |
| 6 | GND | Ground Pin | |

*) Tab is GND level. (They are connected to the reverse side of this IC.)
The tab is better to be connected to the GND, but leaving it open is also acceptable.

- **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 | R1154NxxxB (B version) | No Connection |
| | ADJ | R1154N001C (C version) | Reference Voltage of Adjustable Output Pin |
| 5 | CE | Chip Enable Pin | |

- **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 | R1154HxxxB (B version) | No Connection |
| | ADJ | R1154H001C (C version) | Reference Voltage of Adjustable Output Pin |
| 5 | $V_{DD}$ | Input 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 (DFN1616-6)* | 640 | mW |
| | Power Dissipation (SOT-23-5)* | 420 | |
| | Power Dissipation (SOT-89-5)* | 900 | |
| $T_{opt}$ | Operating Temperature | –40 to +105 | °C |
| $T_{stg}$ | Storage Temperature | –55 to +125 | °C |

*) For Power Dissipation please refer to PACKAGE INFORMATION.

**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.

# POWER DISSIPATION (DFN1616-6)

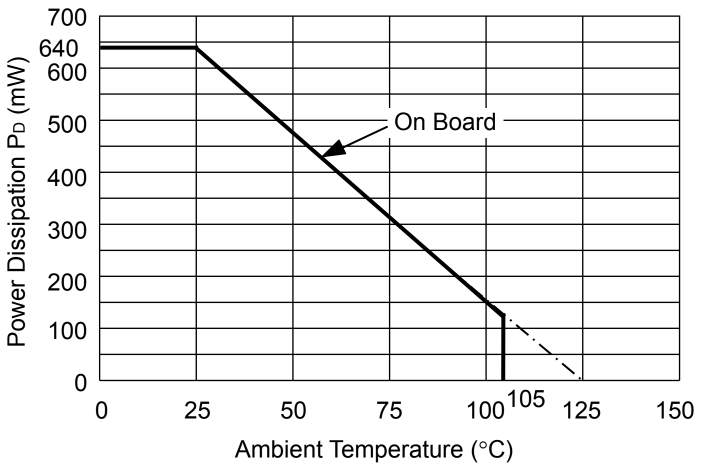
This specification is at mounted on board. Power Dissipation ($P_D$) depends on conditions of mounting on board. This specification is based on the measurement at the condition below:

Measurement Conditions

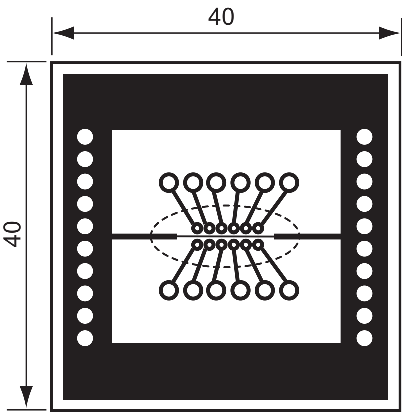
| | Standard Land Pattern |
|---|---|
| Environment | Mounting on Board (Wind velocity=0m/s) |
| Board Material | Glass cloth epoxy plastic (Double sided) |
| Board Dimensions | 40mm × 40mm × 1.6mm |
| Copper Ratio | Top side : Approx. 50% , Back side : Approx. 50% |
| Through-holes | φ0.5mm × 32pcs |

Measurement Results (Topt=25°C, Tjmax=125°C)

| | Standard Land Pattern |
|---|---|
| Power Dissipation | 640mW |
| Thermal Resistance | θja=(125−25°C)/0.64W=156°C/W |
| Thermal Resistance | θjc=23°C/W |



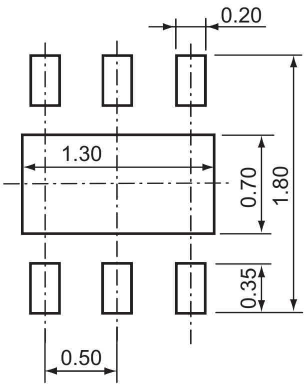

**Power Dissipation**




**Measurement Board Pattern**

IC Mount Area (Unit: mm)

# RECOMMENDED LAND PATTERN




(Unit: mm)

# POWER DISSIPATION (SOT-23-5)

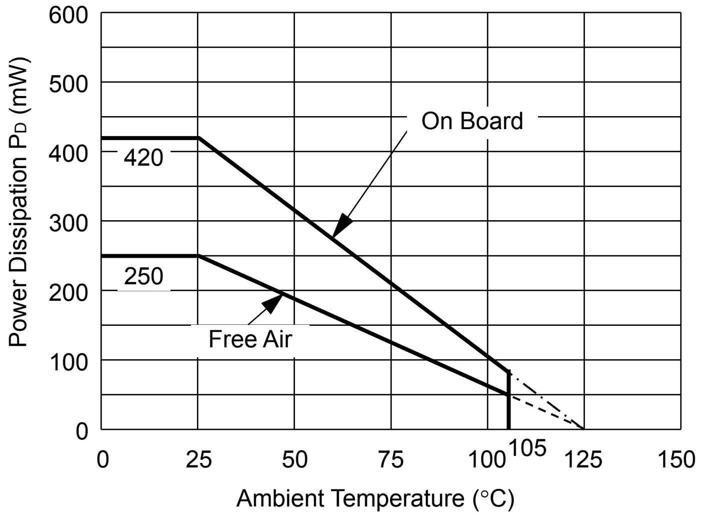
This specification is at mounted on board. Power Dissipation ($P_D$) depends on conditions of mounting on board. This specification is based on the measurement at the condition below:
(Power Dissipation (SOT-23-5) is substitution of SOT-23-6.)

Measurement Conditions

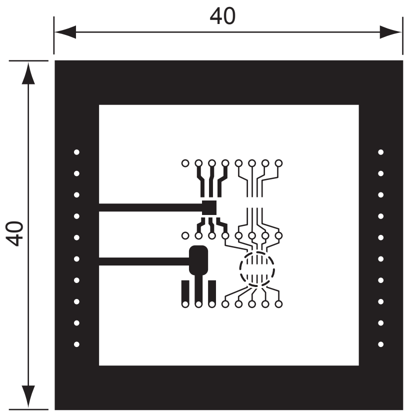
| | Standard Land Pattern |
|---|---|
| Environment | Mounting on Board (Wind velocity=0m/s) |
| Board Material | Glass cloth epoxy plastic (Double sided) |
| Board Dimensions | 40mm × 40mm × 1.6mm |
| Copper Ratio | Top side : Approx. 50% , Back side : Approx. 50% |
| Through-holes | ϕ0.5mm × 44pcs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

Measurement Results (Topt=25°C, Tjmax=125°C)

| | Standard Land Pattern | Free Air |
|---|---|---|
| Power Dissipation | 420mW | 250mW |
| Thermal Resistance | θja=(125−25°C)/0.42W=238°C/W | 400°C/W |



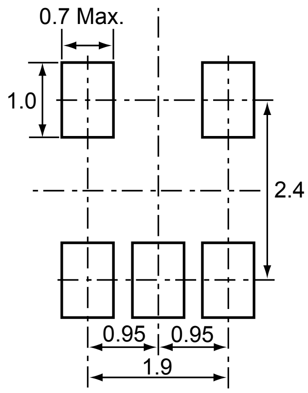

**Power Dissipation**




**Measurement Board Pattern**

IC Mount Area (Unit: mm)

# RECOMMENDED LAND PATTERN




(Unit: mm)

# POWER DISSIPATION (SOT-89-5)

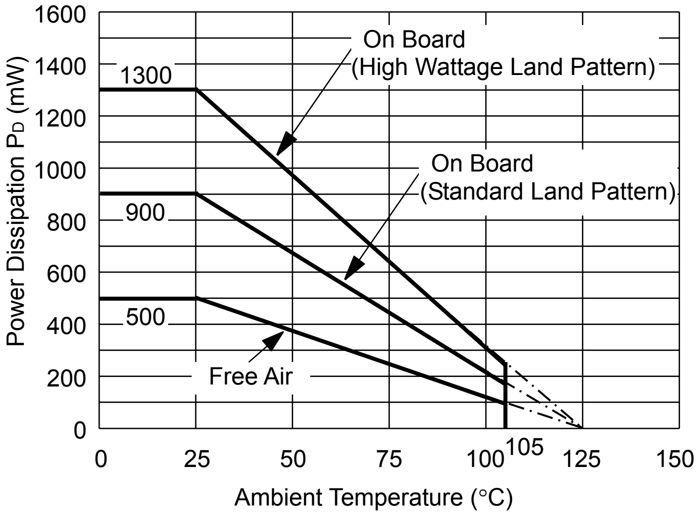
This specification is at mounted on board. Power Dissipation ($P_D$) depends on conditions of mounting on board. This specification is based on the measurement at the condition below:

Measurement Conditions

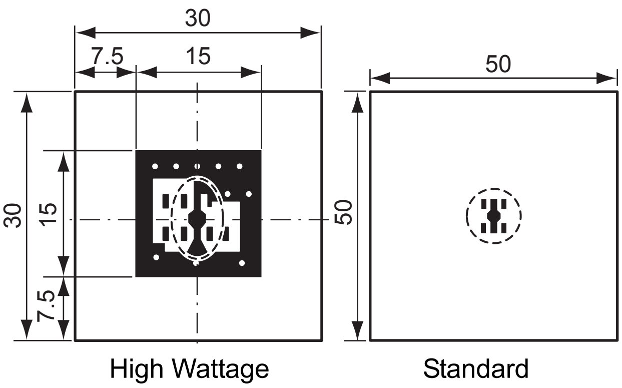
| | High Wattage Land Pattern | Standard Land Pattern |
|---|---|---|
| Environment | Mounting on Board (Wind velocity=0m/s) | Mounting on Board (Wind velocity=0m/s) |
| Board Material | Glass cloth epoxy plastic (Double sided) | Glass cloth epoxy plastic (Double sided) |
| Board Dimensions | 30mm × 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-holes | φ0.85mm × 10pcs | – |

Measurement Results (Topt=25°C,Tjmax=125°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 |



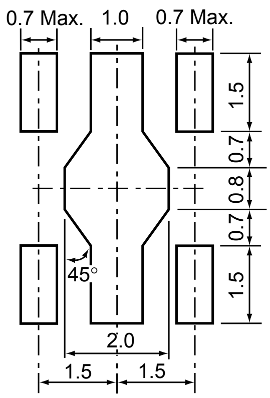

**Power Dissipation**




**Measurement Board Pattern**

IC Mount Area (Unit: mm)

# RECOMMENDED LAND PATTERN




(Unit: mm)

# ELECTRICAL CHARACTERISTICS

- **R1154xxxxB**

Topt=25°C

| Symbol | Item | Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $V_{IN}$ | Input Voltage | | | | 24 | V |
| $V_{OUT}$ | Output Voltage | $V_{IN}=V_{SET}+2.0V$, $I_{OUT}=20mA$ | ×0.98 | | ×1.02 | V |
| $I_{OUT}$ | Output Current | $V_{IN}-V_{SET}=2.0V$ | Refer to the following table | | | |
| $I_{SS}$ | Supply Current | $V_{IN}=V_{CE}$, $V_{IN}-V_{SET}=2.0V$ | | 5 | 10 | μA |
| $I_{standby}$ | Standby Current | $V_{IN}=24V$, $V_{CE}=0V$ | | 0.1 | 1.0 | μA |
| $\Delta V_{OUT}/\Delta I_{OUT}$ | Load regulation | $V_{IN}-V_{SET}=2.0V$, $1mA \leq I_{OUT} \leq 40mA$ | Refer to the following table | | | |
| $\Delta V_{OUT}/\Delta V_{IN}$ | Line regulation | $I_{OUT}=20mA$ $V_{SET}+1V \leq V_{IN} \leq 24V$ | | 0.05 | 0.20 | %/V |
| $V_{DIF}$ | Dropout Voltage | $I_{OUT}=20mA$ | Refer to the following table | | | |
| $\Delta V_{OUT}/\Delta Topt$ | Output Voltage Temperature Coefficient | $V_{IN}-V_{SET}=2.0V$, $I_{OUT}=20mA$ $-40°C \leq Topt \leq 105°C$ | | ±100 | | ppm/°C |
| $I_{SC}$ | Short Current Limit | $V_{OUT}=0V$ | | 45 | | mA |
| $V_{CEH}$ | CE “H” Input Voltage | | 2.1 | | $V_{IN}$ | V |
| $V_{CEL}$ | CE “L” Input Voltage | | 0 | | 0.3 | V |
| $T_{SD}$ | Thermal Shutdown Temperature | Junction Temperature | | 150 | | °C |
| $T_{SR}$ | Thermal Shutdown Released Temperature | Junction Temperature | | 125 | | °C |

- **Output Current (Topt=25°C)**

| Set Output Voltage $V_{SET}$ (V) | Output Current (mA) |
|---|---|
| | Min. |
| $2.5 \leq V_{SET} \leq 2.9$ | 140 |
| $3.0 \leq V_{SET} \leq 12.0$ | 150 |

- **Load Regulation (Topt=25°C)**

| Set Output Voltage $V_{OUT}$ (V) | Load Regulation (mV) | |
|---|---|---|
| | Typ. | Max. |
| $2.5 \leq V_{SET} \leq 3.0$ | 20 | 50 |
| $3.1 \leq V_{SET} \leq 5.0$ | 30 | 75 |
| $5.1 \leq V_{SET} \leq 12.0$ | 40 | 115 |

- **Dropout Voltage (Topt=25°C)**

| Set Output Voltage $V_{OUT}$ (V) | Dropout Voltage (V) | |
|---|---|---|
| | Typ. | Max. |
| $2.5 \leq V_{SET} \leq 7.0$ | 0.20 | 0.40 |
| $7.1 \leq V_{SET} \leq 10.0$ | 0.25 | 0.50 |
| $10.1 \leq V_{SET} \leq 12.0$ | 0.30 | 0.55 |

- **R1154x001C**

Topt=25°C

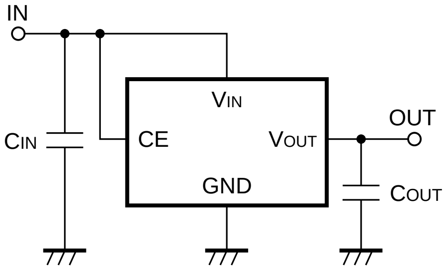
| Symbol | Item | Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $V_{IN}$ | Input Voltage | | | | 24 | V |
| $V_{OUT}$ | Output Voltage | $V_{IN}=V_{SET}+2.0V$, $I_{OUT}=20mA$ | 2.45 | 2.50 | 2.55 | V |
| $I_{OUT}$ | Output Current | $V_{IN}=V_{SET}+2.0V$ | 140 | | | mA |
| $I_{SS}$ | Supply Current | $V_{IN}=V_{SET}+2.0V$, $V_{CE}=V_{IN}$ | | 5 | 10 | μA |
| $I_{standby}$ | Standby Current | $V_{IN}=24V$, $V_{CE}=0V$ | | 0.1 | 1.0 | μA |
| $\Delta V_{OUT}/\Delta I_{OUT}$ | Load regulation | $V_{IN}=V_{SET}+2.0V$, $1mA \leq I_{OUT} \leq 40mA$ | | 20 | 50 | mV |
| $\Delta V_{OUT}/\Delta V_{IN}$ | Line regulation | $V_{SET}+1V \leq V_{IN} \leq 24V$, $I_{OUT}=20mA$ | | 0.05 | 0.20 | %/V |
| $V_{DIF}$ | Dropout Voltage | $I_{OUT}=20mA$ | | 0.20 | 0.40 | V |
| $\Delta V_{OUT}/\Delta Topt$ | Output Voltage Temperature Coefficient | $V_{IN}=V_{SET}+2.0V$, $I_{OUT}=20mA$, $-40°C \leq Topt \leq 105°C$ | | ±100 | | ppm/°C |
| $I_{SC}$ | Short Current Limit | $V_{OUT}=0V$ | | 45 | | mA |
| $V_{CEH}$ | CE "H" Input Voltage | | 2.1 | | $V_{IN}$ | V |
| $V_{CEL}$ | CE "L" Input Voltage | | 0 | | 0.3 | V |
| $T_{SD}$ | Thermal Shutdown Temperature | Junction Temperature | | 150 | | °C |
| $T_{SR}$ | Thermal Shutdown Released Temperature | Junction Temperature | | 125 | | °C |

The above specifications measured at the condition of $V_{OUT}=V_{ADJ}$.

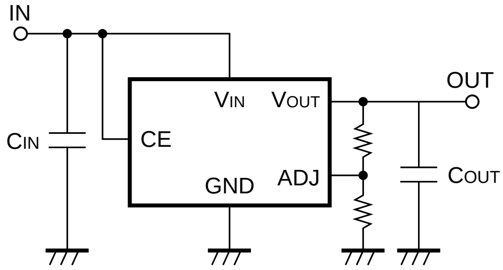
**RECOMMENDED OPERATING CONDITIONS (ELECTRICAL CHARACTERISTICS)**

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.

# TYPICAL APPLICATIONS

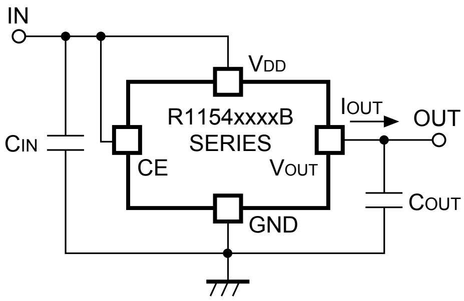



Fixed Output Voltage Type

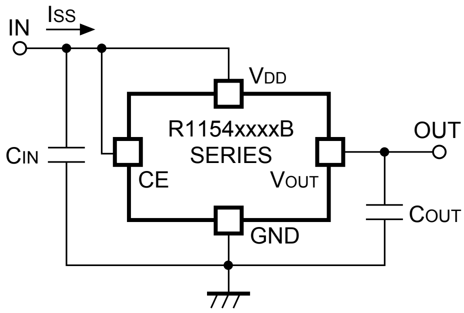



Adjustable Type

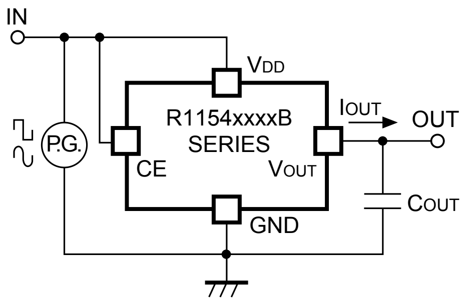
# TEST CIRCUITS



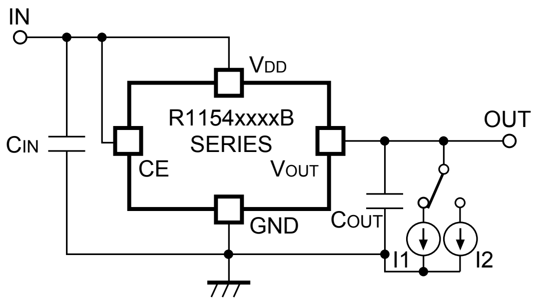

R1154xxxxB Standard Test Circuit



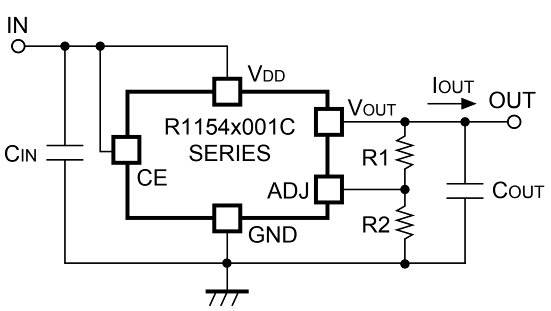

R1154xxxxB Supply Current Test Circuit



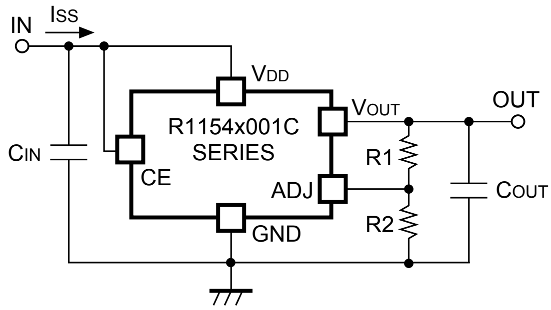

R1154xxxxB Input Transient Response Test Circuit



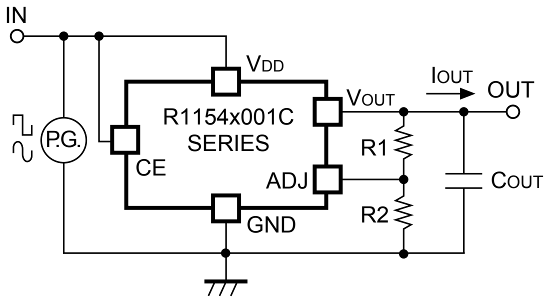

R1154xxxxB Load Regulation Test Circuit



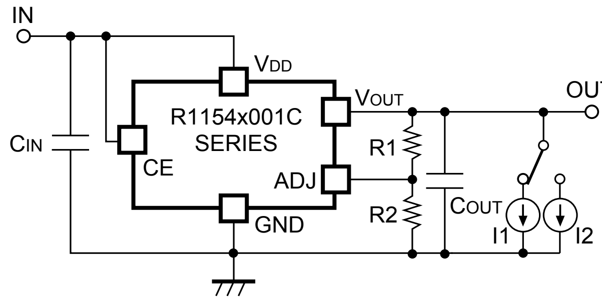

**R1154x001C Standard Test Circuit**




**R1154x001C Supply Current Test Circuit**




**R1154x001C Input Transient Response Test Circuit**

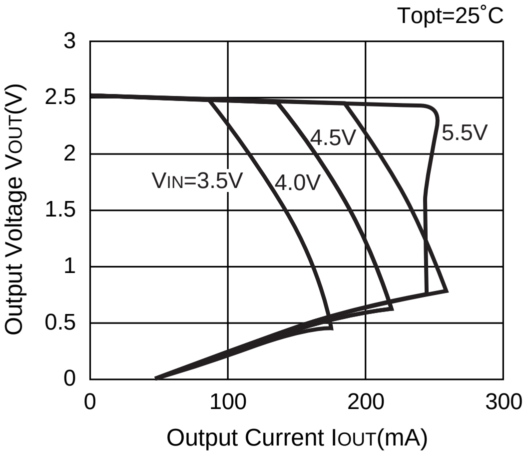



**R1154x001C Load Transient Response Test Circuit**

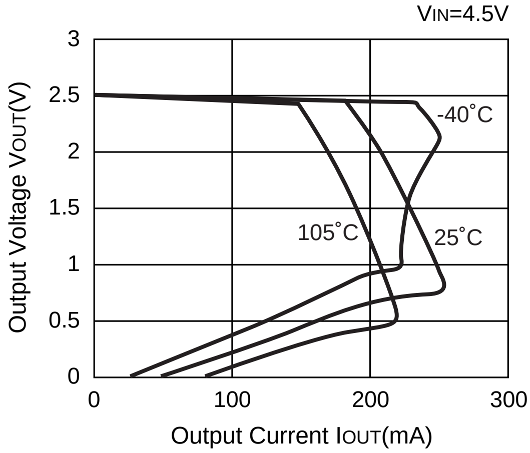
# TYPICAL CHARACTERISTICS

## 1) Output Voltage vs. Output Current

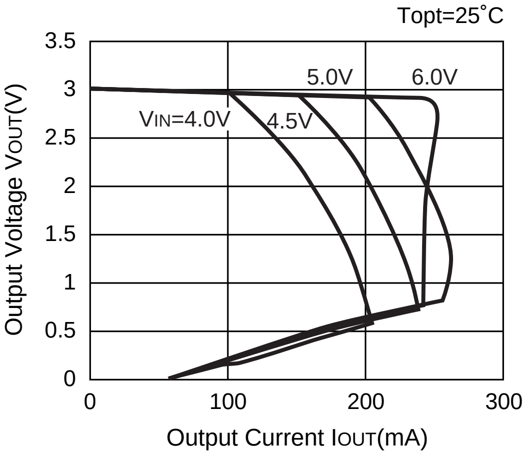
**R1154x025B**



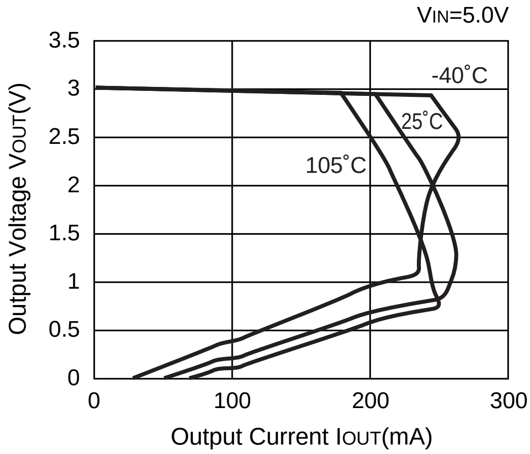

**R1154x025B**



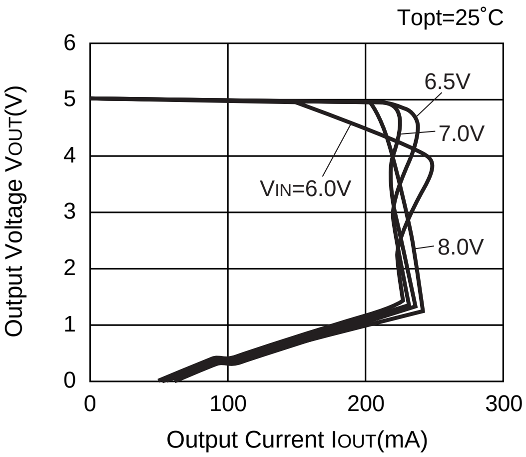

**R1154x030B**



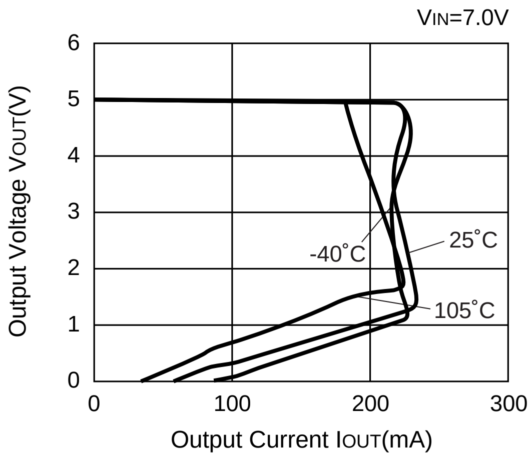

**R1154x030B**



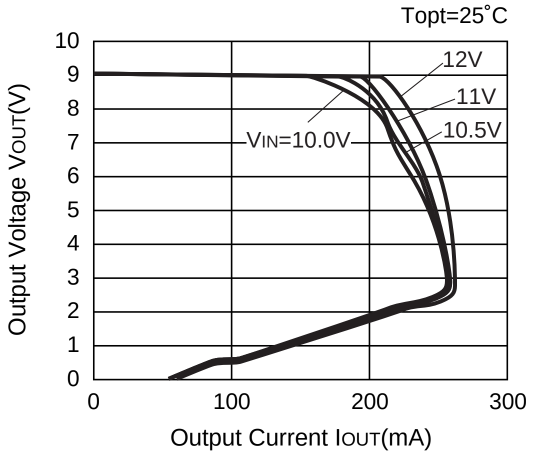

**R1154x050B**



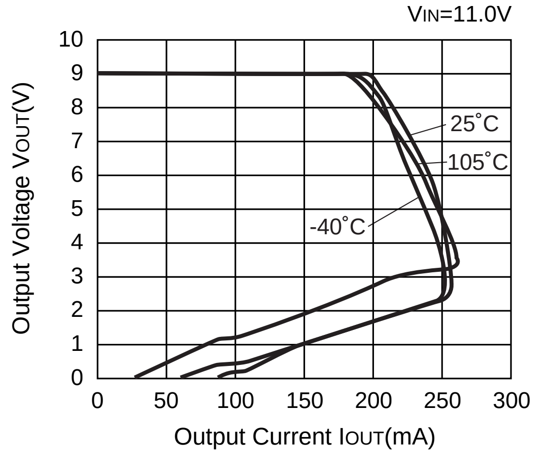

**R1154x050B**



**R1154x090B**

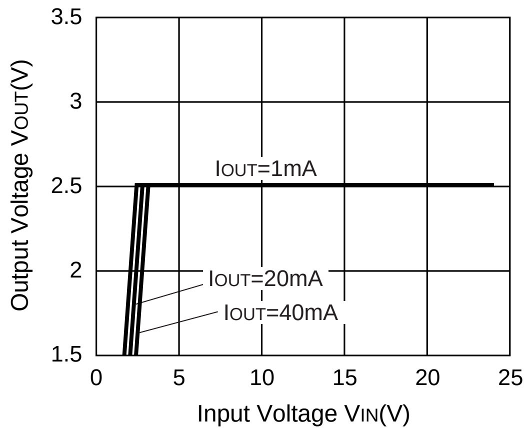



**R1154x090B**

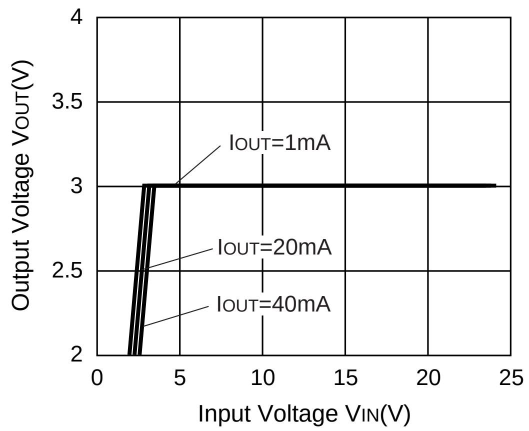



## 2) Input Voltage vs. Output Voltage (Topt=25°C)

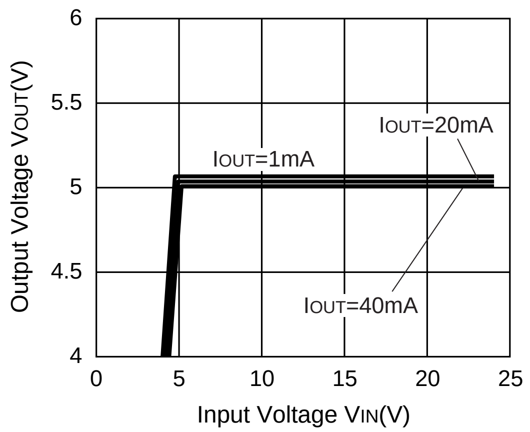
**R1154x025B**



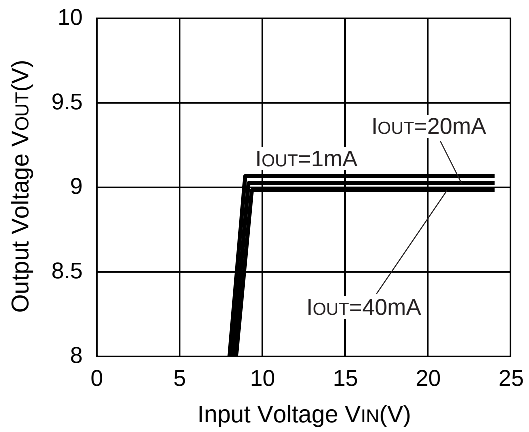

**R1154x030B**



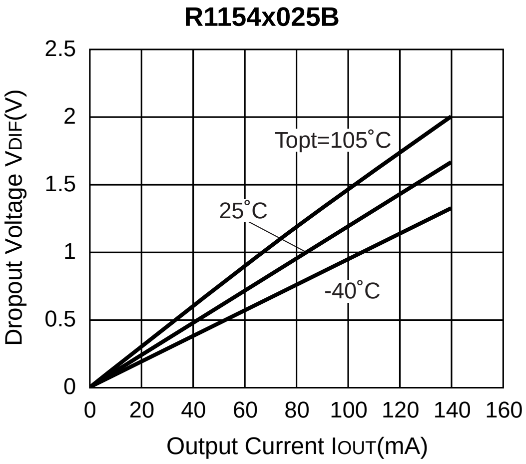

**R1154x050B**

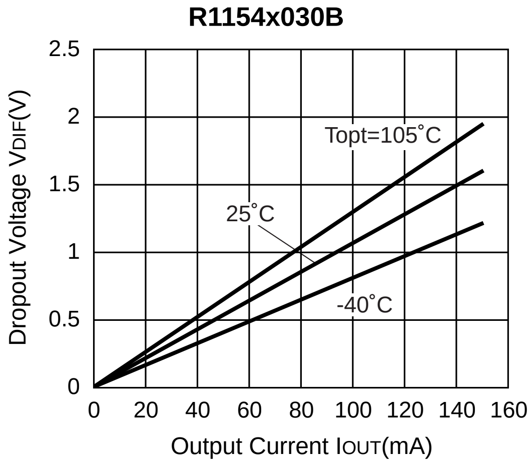


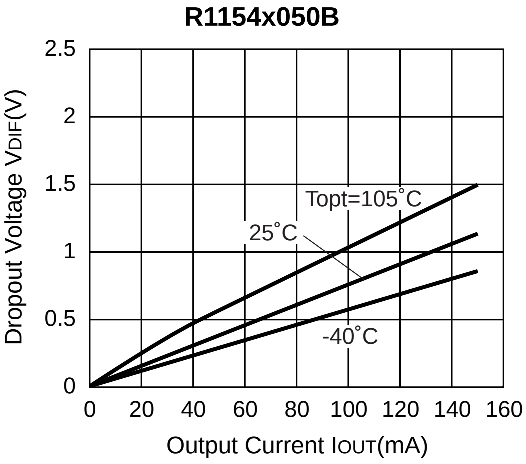

**R1154x090B**

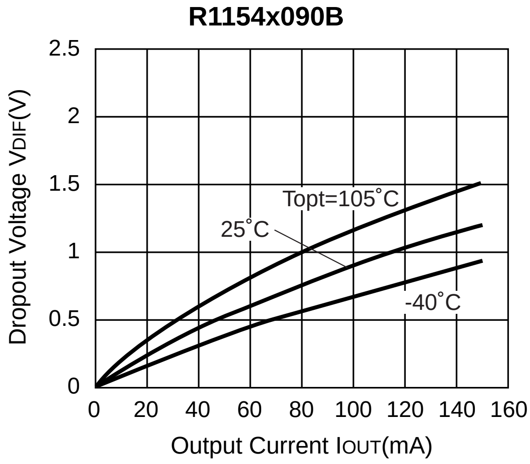


### 3) Dropout Voltage vs. Output Current

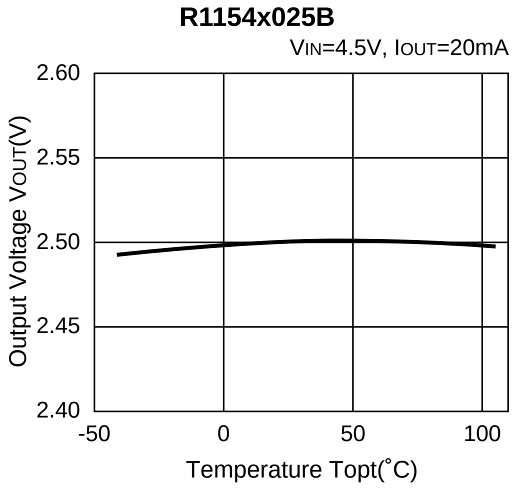


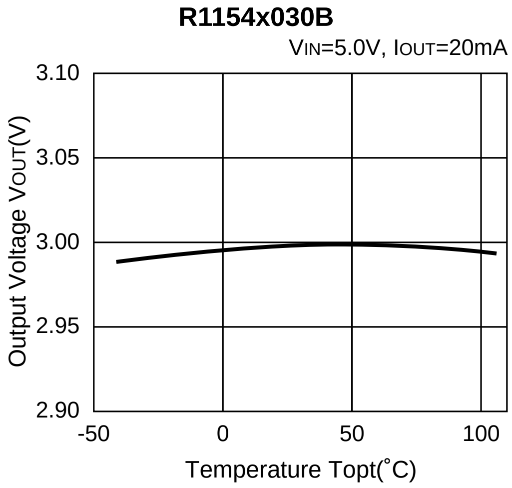



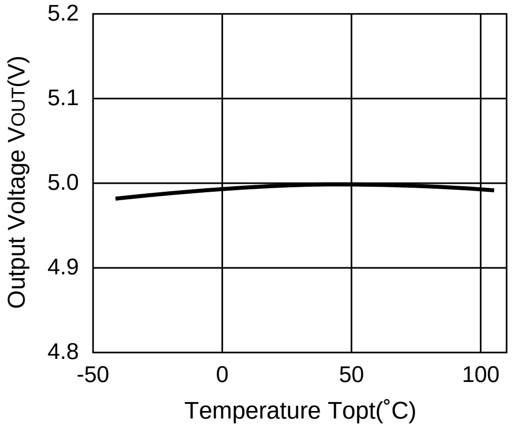

### 4) Output Voltage vs. Temperature



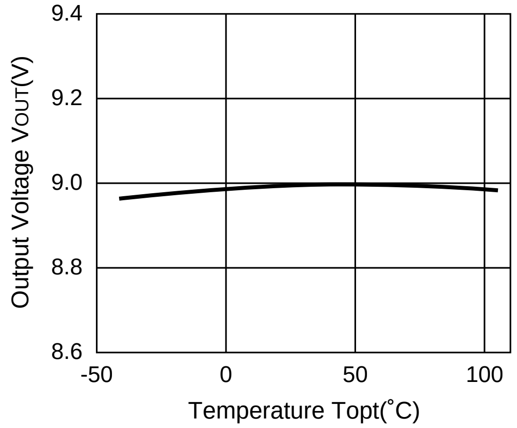
**R1154x050B**

$V_{IN}$=7.0V, $I_{OUT}$=20mA



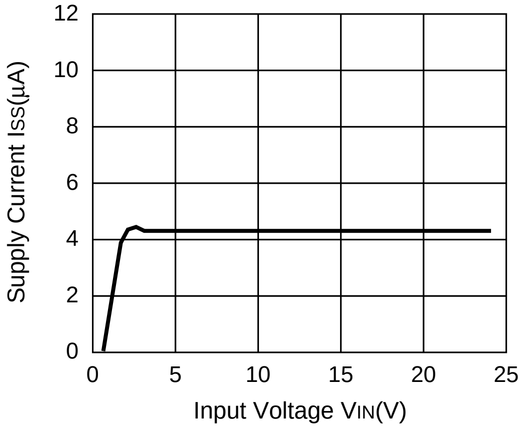

**R1154x090B**

$V_{IN}$=11.0V, $I_{OUT}$=20mA

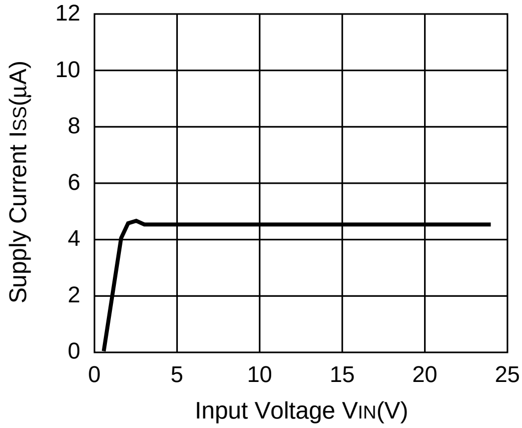



### 5) Supply Current vs. Input Voltage ($T_{opt}$=25°C)

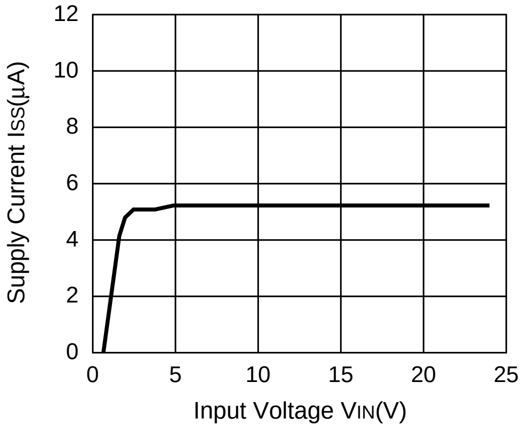
**R1154x025B**




**R1154x030B**




**R1154x050B**

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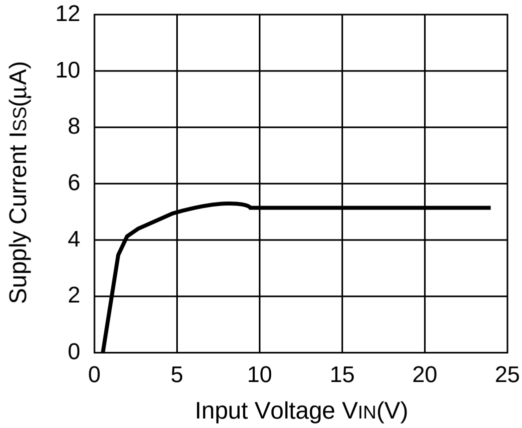
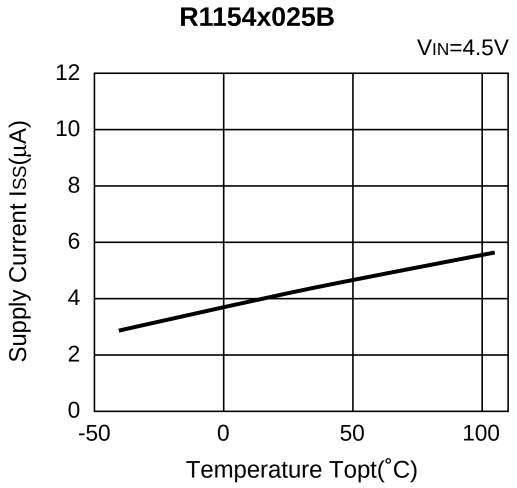
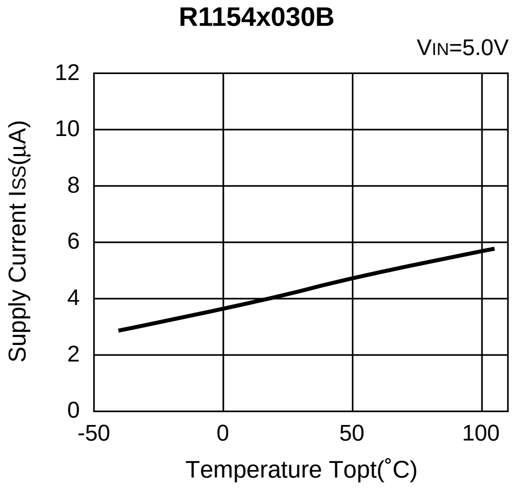
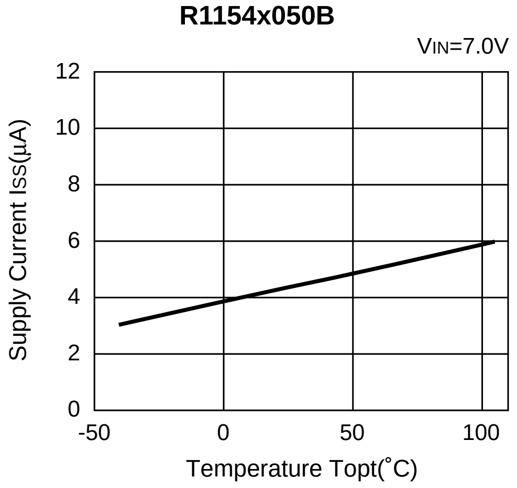
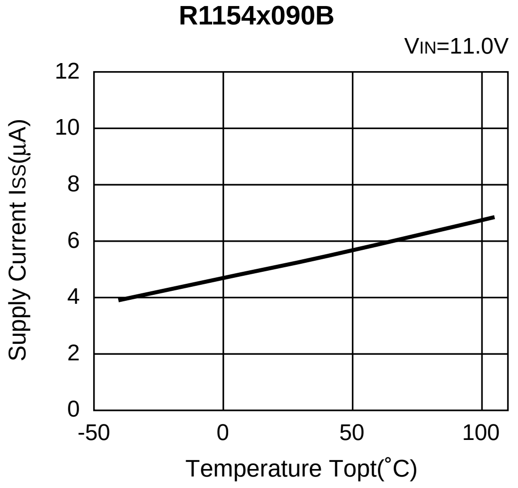


## 6) Supply Current vs. Temperature

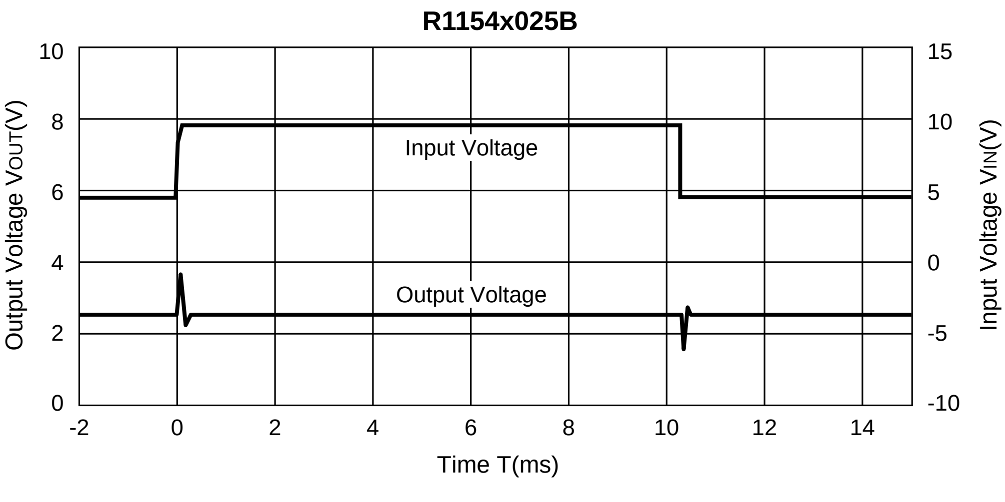


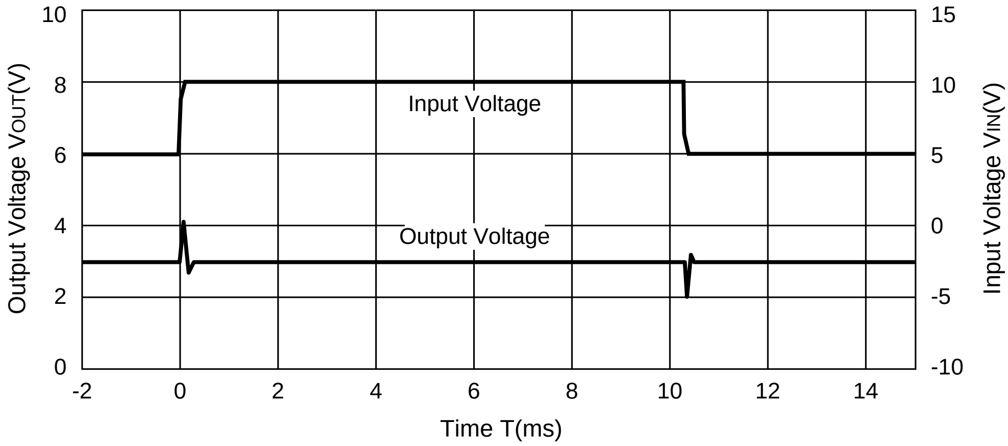



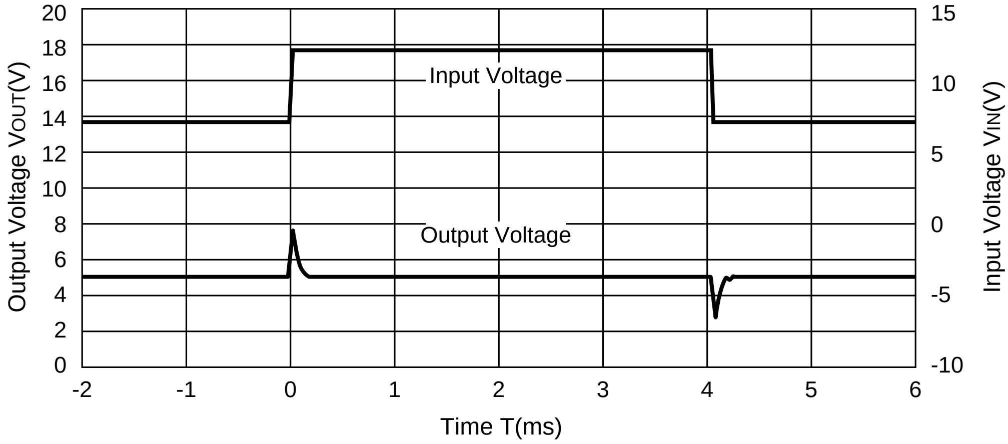

## 7) Input Transient Response ($I_{OUT}$=20mA, $C_{OUT}$=0.1μF, Topt=25°C)



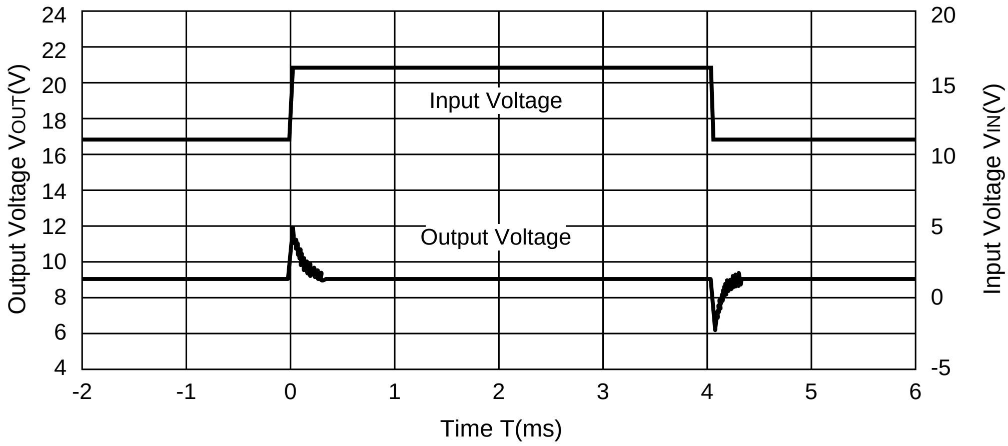
R1154x030B




R1154x050B

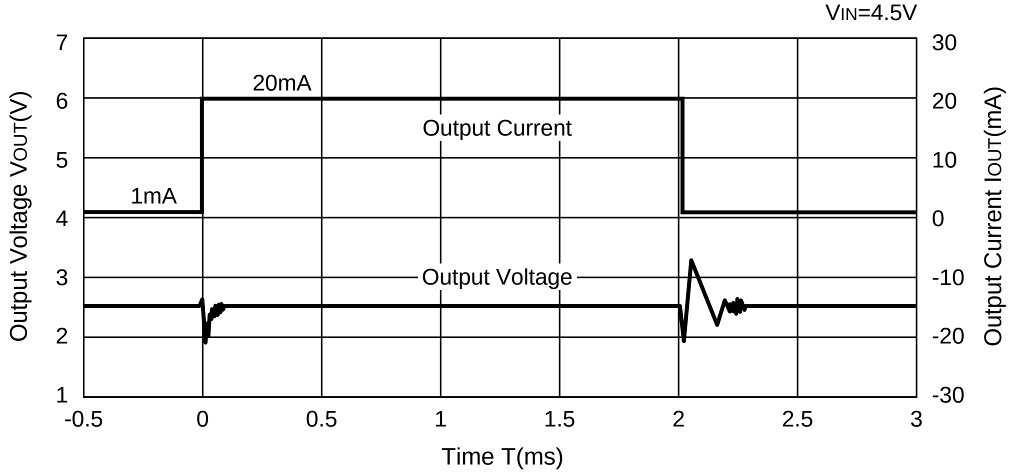



R1154x090B

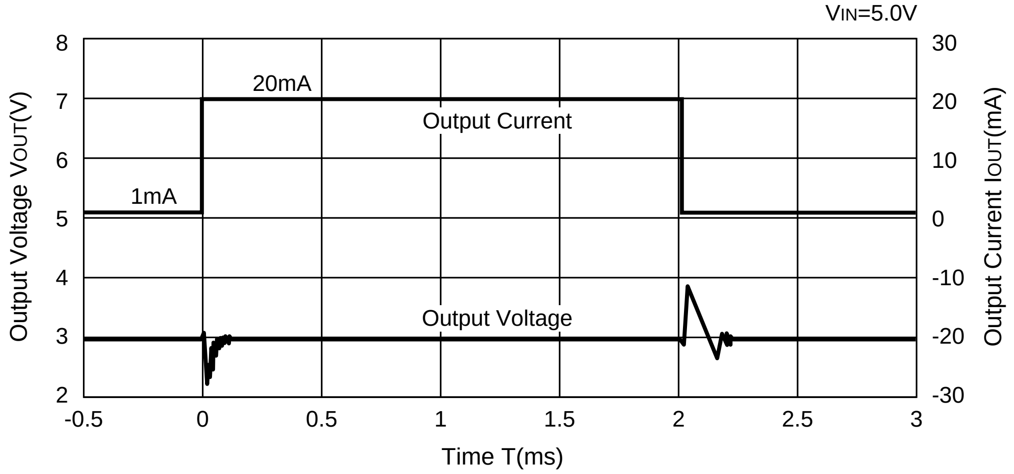


## 8) Load Transient Response ($C_{OUT}$=0.1μF, $T_{opt}$=25°C)

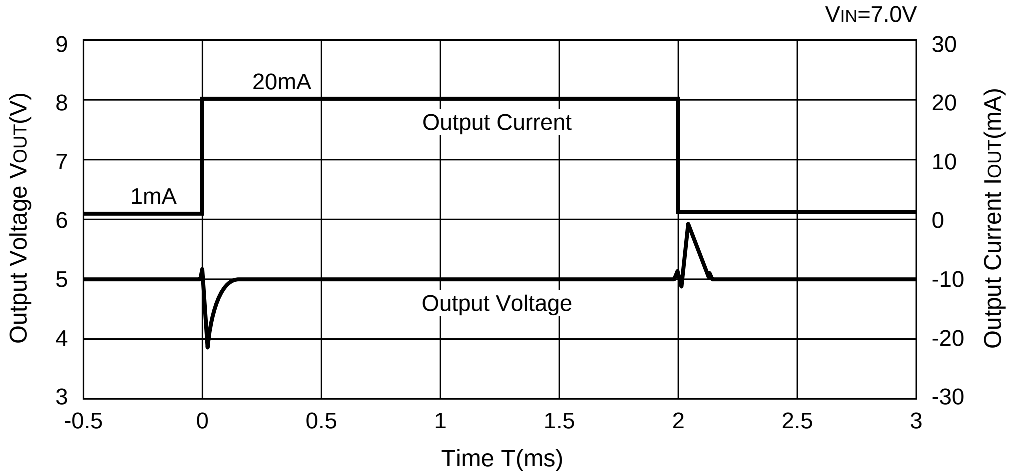
**R1154x025B**

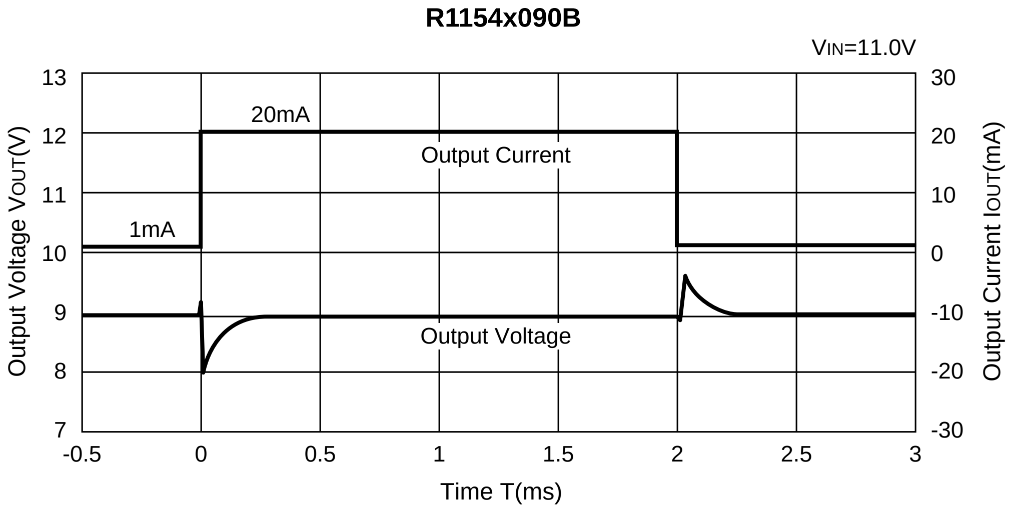



**R1154x030B**

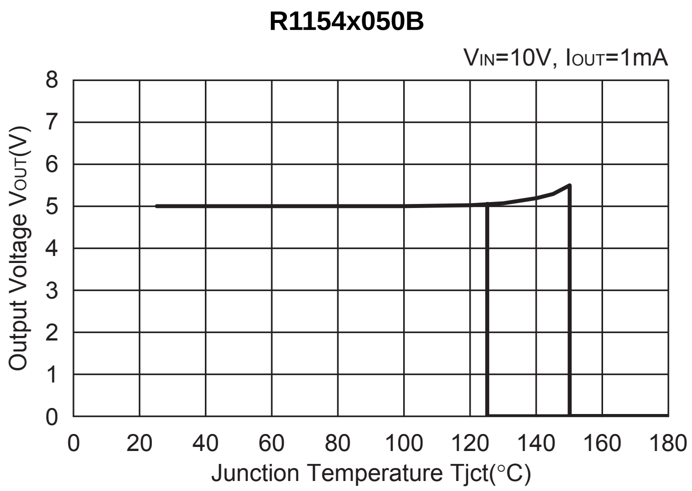



**R1154x050B**






## 9) Thermal Shutdown Characteristics

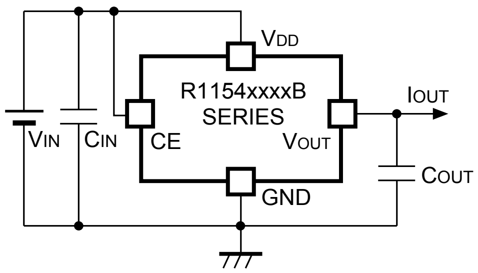


# TECHNICAL NOTES

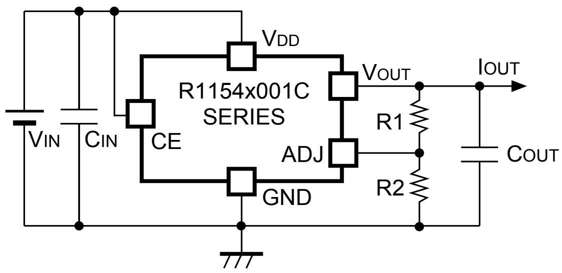
Phase Compensation

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 0.1μF to 2.2μF. 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

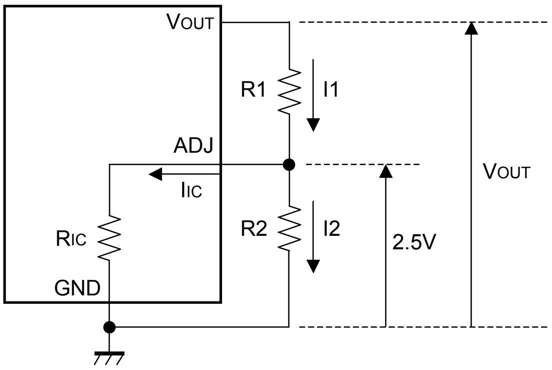
Thermal shutdown function is included in the R1154x Series, if the junction temperature is equal or more than +150°C(Typ.), the operation of regulator would stop. After that, when the junction temperature is equal or less than +125°C(Typ.), the operation of regulator would restart. Unless the cause of 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;

$I1=I_{IC}+I2$ ............................................................ (1)
$I2=2.5/R2$ ............................................................ (2)

Thus,
$I1=I_{IC}+2.5/R2$ ............................................................ (3)

Therefore,
$V_{OUT}=2.5+R1\times I1$ ............................................................ (4)

Put Equation (3) into Equation (4), then
$V_{OUT}=2.5+R1(I_{IC}+2.5/R2)$
$=2.5(1+R1/R2)+R1\times I_{IC}$ ............................................................ (5)

In 2nd term, or $R1\times I_{IC}$ will produce an error in $V_{OUT}$.
In Equation (5),
$I_{IC}=2.5/R_{IC}$ ............................................................ (6)
$R1\times I_{IC}=R1\times 2.5/R_{IC}$
$=2.5\times R1/R_{IC}$ ............................................................ (7)
For better accuracy, choosing R1 ($<<R_{IC}$) reduces this error.

$R_{IC}$ of the R1154x001C is approximately Typ.17MΩ (Ta=25°C, guaranteed by Design Engineering).
$R_{IC}$ could be affected by the temperature, therefore evaluate the circuit taking the actual conditions of use into account when deciding the resistance values for R1 and R2.

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