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## 150mA 36V Input LDO Regulator

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NO.EA-258-140703

### OUTLINE

The R1516x Series are CMOS-based high-voltage resistant and low supply current voltage regulator ICs that provide the minimum 150mA of output voltage. Internally, the R1516x Series consists of a Foldback Protection Circuit, and a Thermal Shutdown Circuit in addition to the basic regulator circuits. The operating temperature range is between  $-40^{\circ}\text{C}$  to  $105^{\circ}\text{C}$ , and the maximum input voltage is 36V. All these features allow the R1516x Series to become an ideal power source of electric home appliances.

The R1516x Series are available in fixed output voltage options between 1.8V and 6.2V in 0.1V steps. The output voltage accuracy is  $\pm 1\%$ .

The R1516x Series are available in two types of packages: SOT-89-5 that is for high-density mounting and HSOP-6J that is for high wattage.

### FEATURES

- Input Voltage Range..... 4V to 36V
- Supply Current..... Typ. 29 $\mu\text{A}$
- Standby Current..... Typ. 0.1 $\mu\text{A}$
- Output Voltage Temperature Coefficient..... Typ.  $\pm 100\text{ppm}/^{\circ}\text{C}$
- Output Current ..... Min. 150mA ( $V_{\text{OUT}}=5.0\text{V}$ ,  $V_{\text{IN}}=8.0\text{V}$ )
- Line Regulation..... Typ. 0.1%/V
- Output Voltage Accuracy.....  $\pm 1\%$  ( $V_{\text{OUT}} \geq 3.2\text{V}$ ,  $T_{\text{opt}}=25^{\circ}\text{C}$ )
- Packages ..... SOT-89-5, HSOP-6J
- Output Voltage Range ..... 1.8V to 6.2V (0.1V steps)  
(For other voltages, please refer to MARK INFORMATIONS.)
- Built-in Foldback Protection Circuit..... 50mA (Current at short mode)
- Built-in Thermal Shutdown Circuit ..... Stops at  $160^{\circ}\text{C}$
- Operating Temperature .....  $-40$  to  $105^{\circ}\text{C}$

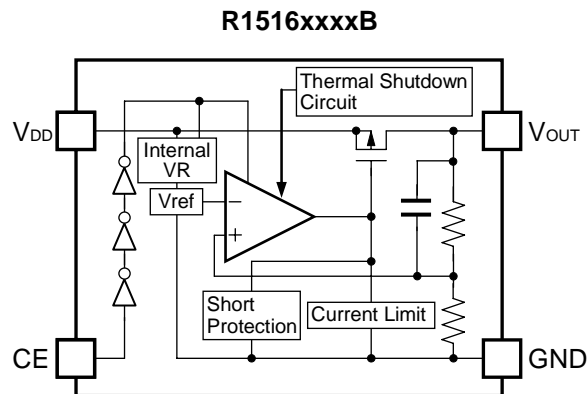
### APPLICATIONS

- Power source for home appliances such as refrigerators, rice cookers, electric hot-water pot.
- Power source for notebook PCs, digital TVs, cordless phones, and private LAN system.
- Power source for office equipment machines such as copiers, printers, facsimiles, scanners, projectors.

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**BLOCK DIAGRAMS****SELECTION GUIDE**

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

| Product Name     | Package  | Quantity per Reel | Pb Free | Halogen Free |
|------------------|----------|-------------------|---------|--------------|
| R1516HxxxB-T1-FE | SOT-89-5 | 1,000pcs          | Yes     | Yes          |
| R1516SxxxB-E2-FE | HSOP-6J  | 1,000pcs          | Yes     | Yes          |

xxx : The output voltage can be designated in the range of 1.8V (018) to 6.2V (062) in 0.1V steps.  
(For other voltages, please refer to MARK INFORMATIONS.)

## PIN CONFIGURATIONS



## PIN DESCRIPTIONS

### • SOT-89-5

| Pin No. | Symbol    | Description                  |
|---------|-----------|------------------------------|
| 1       | $V_{OUT}$ | Output Pin                   |
| 2       | GND*      | Ground Pin                   |
| 3       | CE        | Chip Enable Pin ("H" Active) |
| 4       | GND*      | Ground Pin                   |
| 5       | $V_{DD}$  | Input Pin                    |

\*) The GND pin must be wired together when it is mounted on board.

### • HSOP-6J

| Pin No. | Symbol    | Description                  |
|---------|-----------|------------------------------|
| 1       | $V_{OUT}$ | Output Pin                   |
| 2       | GND*      | Ground Pin                   |
| 3       | CE        | Chip Enable Pin ("H" Active) |
| 4       | GND*      | Ground Pin                   |
| 5       | GND*      | Ground Pin                   |
| 6       | $V_{DD}$  | Input Pin                    |

\*) The GND pin must be wired together when it is mounted on board.

**ABSOLUTE MAXIMUM RATINGS**

| Symbol    | Item                           | Rating                     | Unit |
|-----------|--------------------------------|----------------------------|------|
| $V_{IN}$  | Input Voltage                  | -0.3~50                    | V    |
| $V_{IN}$  | Peak Input Voltage*1           | 60                         | V    |
| $V_{CE}$  | Input Voltage (CE Pin)         | -0.3~ $V_{IN}+0.3 \leq 50$ | V    |
| $V_{OUT}$ | Output Voltage                 | -0.3~ $V_{IN}+0.3 \leq 50$ | V    |
| $I_{OUT}$ | Output Current                 | 250                        | mA   |
| $P_D$     | Power Dissipation (SOT-89-5)*2 | 900                        | mW   |
|           | Power Dissipation (HSOP-6J)*2  | 1700                       |      |
| $T_{opt}$ | Operating Temperature Range    | -40 to +105                | °C   |
| $T_{stg}$ | Storage Temperature Range      | -55 to +125                | °C   |

\*1) Duration time: 200ms

\*2) 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.

## ELECTRICAL CHARACTERISTICS

The specifications in   are applicable under the condition of  $-40^{\circ}\text{C} \leq T_{\text{opt}} \leq 105^{\circ}\text{C}$ .

### ● R1516xxxxB

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

| Symbol  | Item                                   | Conditions   | Min.   | Typ.                    | Max.                    | Unit                    |    |
|---|--|--|--|-------------------------|-------------------------|-------------------------|----|
| $V_{\text{IN}}$                               | Input Voltage                          |  | 4  |                         | 36                      | V                       |    |
| $I_{\text{SS}}$                               | Supply Current                         | $V_{\text{IN}}=V_{\text{OUT}}+3.0\text{V}$ , $I_{\text{OUT}}=0\text{mA}$   |  | 29                      | 45                      | $\mu\text{A}$           |    |
| $I_{\text{standby}}$                          | Standby Current                        | $V_{\text{IN}}=36\text{V}$ , $V_{\text{CE}}=0\text{V}$   |  | 0.1                     | 1.0                     | $\mu\text{A}$           |    |
| $V_{\text{OUT}}$                              | Output Voltage                         | $V_{\text{IN}}=V_{\text{OUT}}+3.0\text{V}$ ,<br>$I_{\text{OUT}}=1\text{mA}$  | $V_{\text{OUT}} \geq 3.2\text{V}$  | $\times 0.99$<br>0.98   | $\times 1.01$<br>1.02   | V                       |    |
|   |  |  | $V_{\text{OUT}} < 3.2\text{V}$   | $\times 0.985$<br>0.975 | $\times 1.015$<br>1.025 |                         |    |
| $I_{\text{OUT}}$                              | Output Current                         | Please refer to "Output Current by Output Voltage".  |  |                         |                         |                         |    |
| $\Delta V_{\text{OUT}}/\Delta I_{\text{OUT}}$ | Load Regulation                        | Please refer to "Load Regulation by Output Voltage".   |  |                         |                         |                         |    |
| $\Delta V_{\text{OUT}}/\Delta V_{\text{IN}}$  | Line Regulation                        | $I_{\text{OUT}}=1\text{mA}$  | $V_{\text{OUT}}+1.5\text{V} \leq V_{\text{IN}} \leq 36\text{V}$ ,<br>( $V_{\text{OUT}} \geq 2.5\text{V}$ ) |                         | 0.1                     | 0.7                     | %V |
|   |  |  | $4\text{V} \leq V_{\text{IN}} \leq 36\text{V}$ ,<br>( $V_{\text{OUT}} < 2.5\text{V}$ )                     |                         |                         |                         |    |
| $V_{\text{DIF}}$                              | Dropout Voltage                        | Please refer to "Dropout Voltage by Output Voltage".   |  |                         |                         |                         |    |
| $\Delta V_{\text{OUT}}/\Delta T_{\text{opt}}$ | Output Voltage Temperature Coefficient | $V_{\text{IN}}=V_{\text{OUT}}+3.0\text{V}$ , $I_{\text{OUT}}=1\text{mA}$<br>$-40^{\circ}\text{C} \leq T_{\text{opt}} \leq 105^{\circ}\text{C}$ |  | $\pm 100$               |                         | ppm/ $^{\circ}\text{C}$ |    |
| $I_{\text{SC}}$                               | Short Current Limit                    | $V_{\text{OUT}}=0\text{V}$   |  | 50                      |                         | mA                      |    |
| $V_{\text{CEH}}$                              | CE Input Voltage "H"                   |  | 1.3  |                         | $V_{\text{IN}}$         | V                       |    |
| $V_{\text{CEL}}$                              | CE Input Voltage "L"                   |  | 0  |                         | 0.35                    | V                       |    |
| $T_{\text{TSD}}$                              | Thermal Shutdown Temperature           | Junction Temperature   | 150  | 160                     |                         | $^{\circ}\text{C}$      |    |
| $T_{\text{TSR}}$                              | Thermal Shutdown Released Temperature  | Junction Temperature   |  | 125                     |                         | $^{\circ}\text{C}$      |    |

### ● Output Current by Output Voltage

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

| Output Voltage<br>$V_{\text{OUT}}$ (V) | Output Current $I_{\text{OUT}}$ (mA)       |      |
|--|--|------|
|  | Condition                                  | Min. |
| $1.8 \leq V_{\text{OUT}} < 3.0$        | $V_{\text{IN}}=V_{\text{OUT}}+5.0\text{V}$ | 150  |
| $3.0 \leq V_{\text{OUT}} < 5.0$        | $V_{\text{IN}}=V_{\text{OUT}}+4.0\text{V}$ |      |
| $5.0 \leq V_{\text{OUT}} \leq 6.2$     | $V_{\text{IN}}=V_{\text{OUT}}+3.0\text{V}$ |      |

### ● Load Regulation by Output Voltage

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

| Output Voltage<br>$V_{\text{OUT}}$ (V) | Load Regulation (mV)  |                                     |      |
|--|---|-------------------------------------|------|
|  | Condition   | Typ.                                | Max. |
| $1.8 \leq V_{\text{OUT}} \leq 3.0$     | $V_{\text{IN}}=V_{\text{OUT}}+3.0\text{V}$<br>$1\text{mA} \leq I_{\text{OUT}} \leq 40\text{mA}$ | 30 ( $V_{\text{OUT}}=3.0\text{V}$ ) | 70   |
| $3.0 < V_{\text{OUT}} \leq 5.0$        |   | 40 ( $V_{\text{OUT}}=5.0\text{V}$ ) | 105  |
| $5.0 < V_{\text{OUT}} \leq 6.2$        |   | 50 ( $V_{\text{OUT}}=6.2\text{V}$ ) | 125  |

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### ● Dropout Voltage by Output Voltage

( $I_{OUT}=20\text{mA}$ )

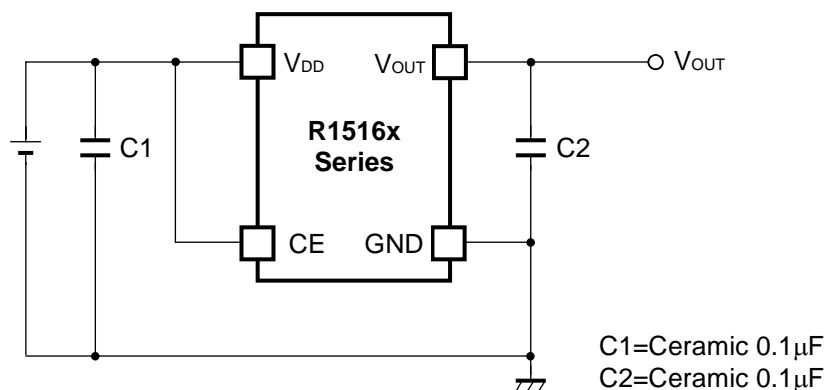
$T_{opt}=25^{\circ}\text{C}$

| Output Voltage<br>$V_{OUT}$ (V) | Dropout Voltage<br>$V_{DIF}$ (V) |
|---------------------------------|----------------------------------|
|                                 | Max.                             |
| $V_{OUT}=1.8$                   | 2.30                             |
| $V_{OUT}=1.9$                   | 2.20                             |
| $V_{OUT}=2.0$                   | 2.10                             |
| $V_{OUT}=2.1$                   | 2.00                             |
| $V_{OUT}=2.2$                   | 1.90                             |
| $V_{OUT}=2.3$                   | 1.80                             |
| $V_{OUT}=2.4$                   | 1.70                             |
| $V_{OUT}=2.5$                   | 1.60                             |
| $V_{OUT}=2.6$                   | 1.50                             |
| $V_{OUT}=2.7$                   | 1.40                             |
| $V_{OUT}=2.8$                   | 1.30                             |
| $V_{OUT}=2.9$                   | 1.20                             |
| $V_{OUT}=3.0$                   | 1.10                             |
| $V_{OUT}=3.1$                   | 1.06                             |
| $V_{OUT}=3.2$                   | 1.02                             |
| $V_{OUT}=3.3$                   | 0.98                             |
| $V_{OUT}=3.4$                   | 0.94                             |
| $V_{OUT}=3.5$                   | 0.90                             |
| $V_{OUT}=3.6$                   | 0.86                             |
| $V_{OUT}=3.7$                   | 0.82                             |
| $V_{OUT}=3.8$                   | 0.78                             |
| $V_{OUT}=3.9$                   | 0.74                             |
| $V_{OUT}=4.0$                   | 0.70                             |
| $V_{OUT}=4.1$                   | 0.69                             |
| $V_{OUT}=4.2$                   | 0.68                             |
| $V_{OUT}=4.3$                   | 0.67                             |
| $V_{OUT}=4.4$                   | 0.66                             |
| $V_{OUT}=4.5$                   | 0.65                             |
| $V_{OUT}=4.6$                   | 0.64                             |
| $V_{OUT}=4.7$                   | 0.63                             |
| $V_{OUT}=4.8$                   | 0.62                             |
| $V_{OUT}=4.9$                   | 0.61                             |
| $5.0 \leq V_{OUT} \leq 6.2$     | 0.60                             |

#### 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 APPLICATION



## TECHNICAL NOTES

When using the R1516x Series, please consider the following points.

### Phase Compensation

The R1516x Series provide the constant-voltage without using C1 and C2 capacitors. However, if the input line is too long, C1 should be connected. To minimize the input voltage fluctuation and the transient output voltage fluctuation that is caused by the load fluctuation, C2 size should be increased. Please refer to the Basic Test Circuit below when connecting a 0.1 $\mu$ F to 20 $\mu$ F C1 capacitor from V<sub>DD</sub> to GND, and also connecting a 0.1 $\mu$ F to 20 $\mu$ F C2 capacitor from V<sub>OUT</sub> to GND. The C1 and C2 capacitors, V<sub>DD</sub>, GND and V<sub>OUT</sub> should be connected as close as possible to each other.

### GND Wiring on Boards

For SOT-89-5 package, please connect the No.2 pin and the No.4 pin to the ground plane on the board.

For HSOP-6J package, please connect the No.2 pin, the No.4 pin and the No.5 pin to the ground plane on the board.

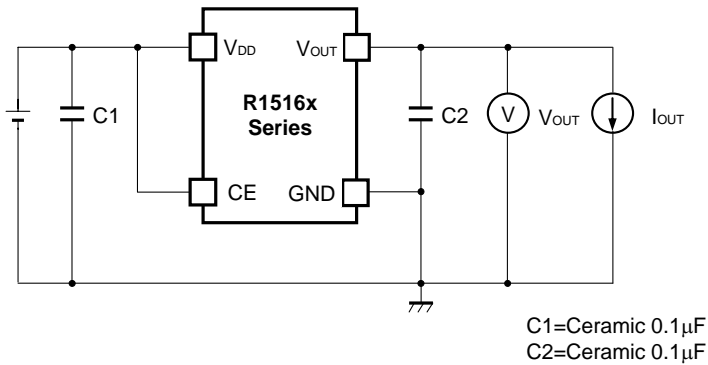
### Thermal Shutdown

The thermal shutdown is included, which limits the junction temperature to a maximum 160°C (Typ.). Under extreme conditions when the junction temperature begins to rise above 160°C, the output is turned off, reducing the output current to zero. When the junction temperature drops below +125°C (Typ.), the output is turned on again and the output current is restored to its nominal value. The output repeats turning on and off to form a pulse shaped output unless the causes of the temperature rise are removed.

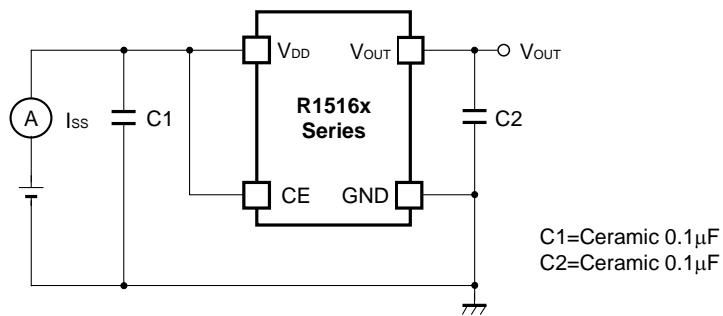
### Chip Enable (CE) Circuit

The electrical potential level of chip enable (CE) pin should not be set in between V<sub>CEH</sub> and V<sub>CEL</sub>. Using the electrical potentials in between V<sub>CEH</sub> and V<sub>CEL</sub> may cause the increase of supply current and may result in unstable output.

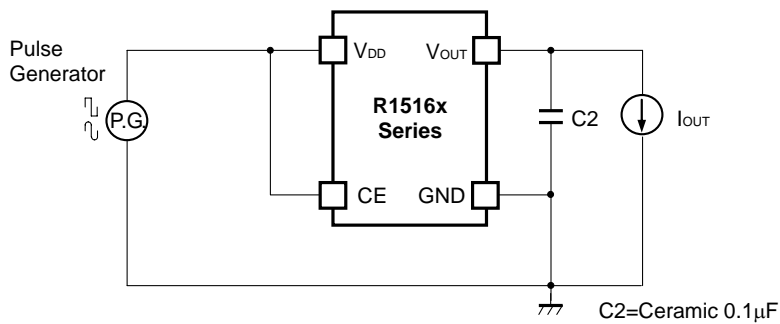
# TEST CIRCUITS



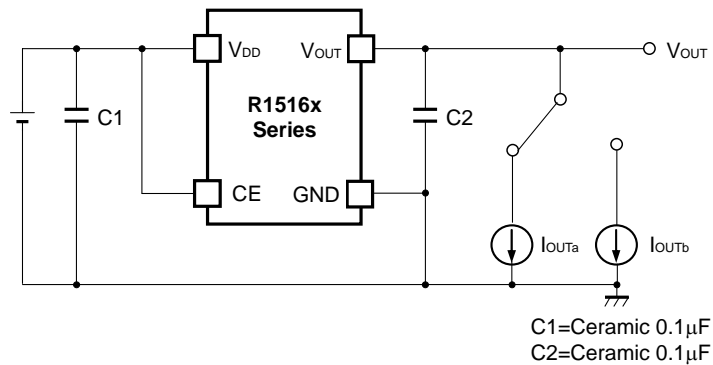
Basic Test Circuit



Test Circuit for Supply Current



Test Circuit for Line Transient Response

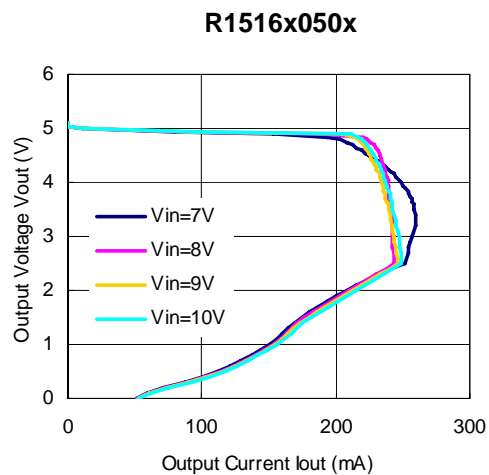
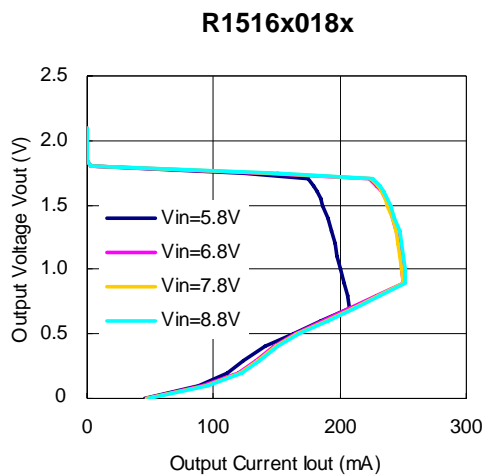


Test Circuit for Load Transient Response

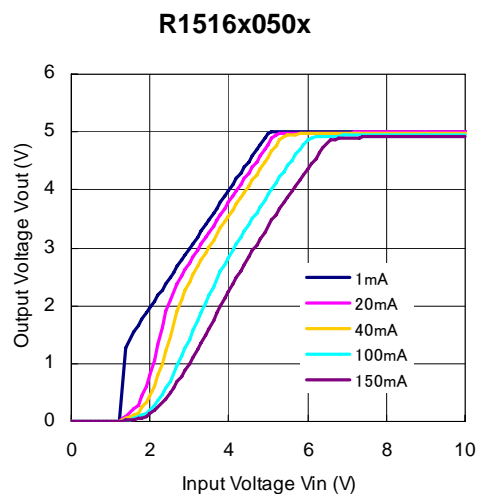
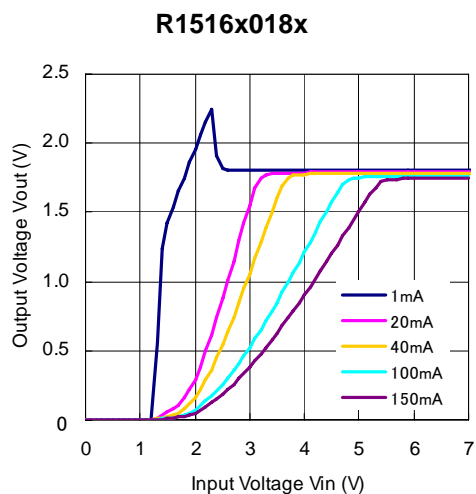


## Typical Characteristics

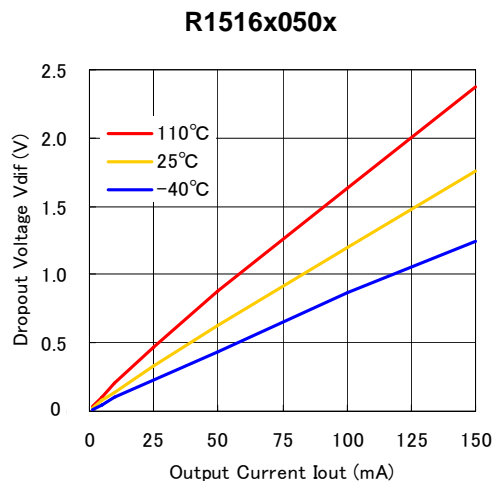
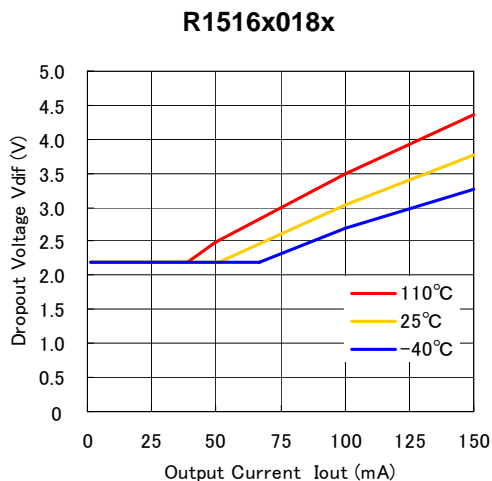
### 1) Output Voltage vs. Output Current (C1=0.1μF, C2=0.1μF, T<sub>opt</sub>=25°C)



### 2) Output Voltage vs. Input Voltage (C1=0.1μF, C2=0.1μF, T<sub>opt</sub>=25°C)



### 3) Dropout Voltage vs. Output Voltage (C1=0.1μF, C2=0.1μF, T<sub>opt</sub>=25°C)

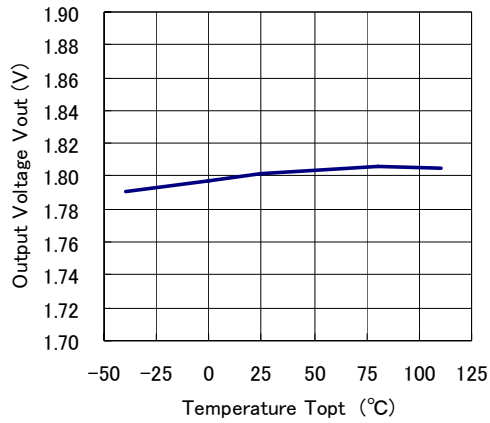


# R1516x

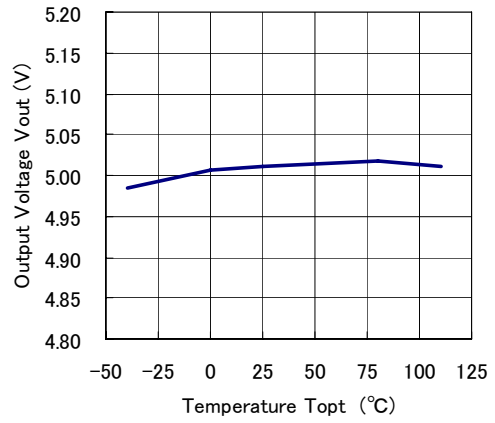
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## 4) Output Voltage vs. Temperature (C1=0.1μF, C2=0.1μF)

R1516x018x

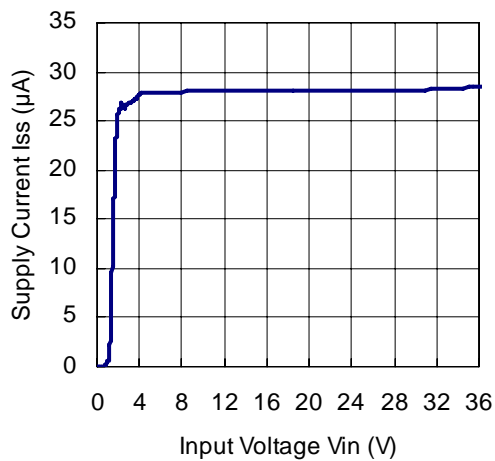


R1516x050x

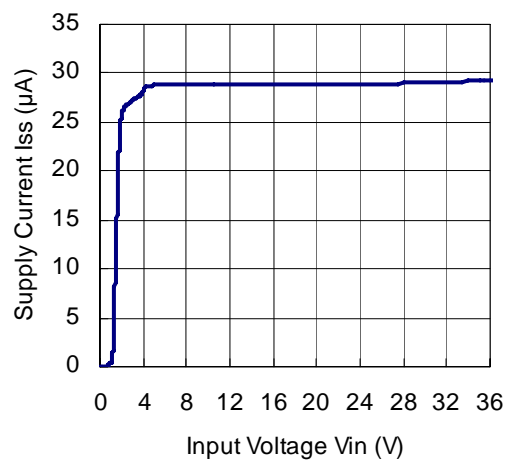


## 5) Supply Current vs. Input Voltage (C1=0.1μF, C2=0.1μF, T<sub>opt</sub>=25°C)

R1516x018x

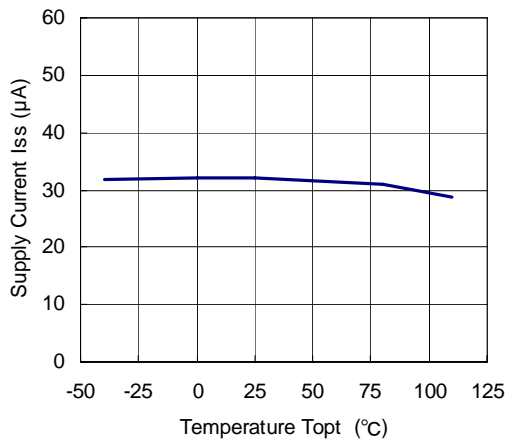


R1516x050x

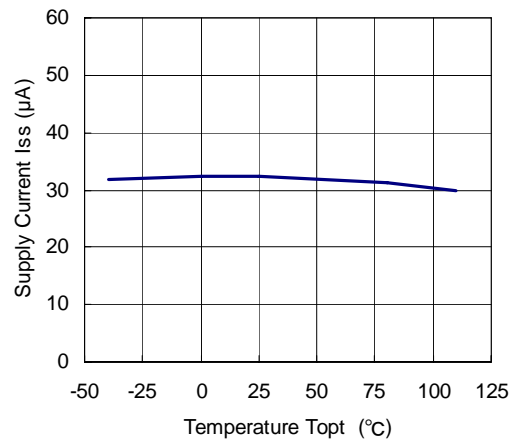


## 6) Supply Current vs. Temperature (C1=0.1μF, C2=0.1μF)

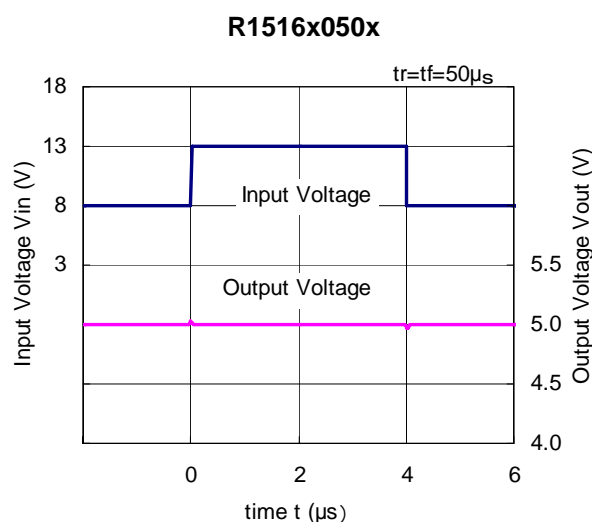
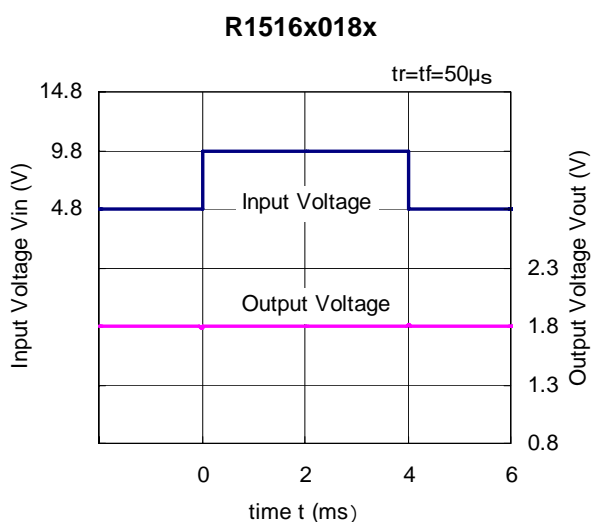
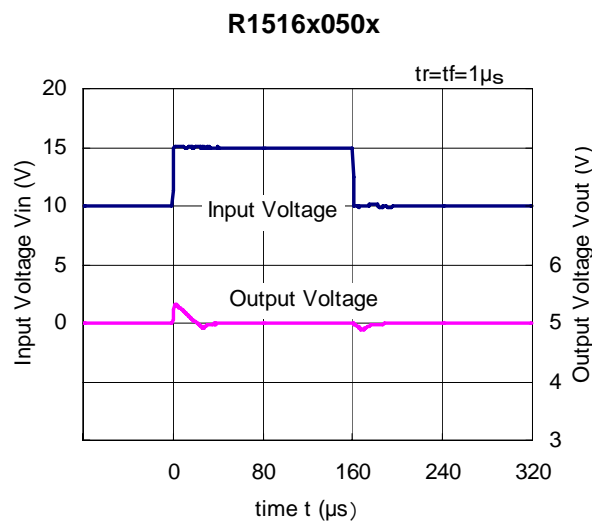
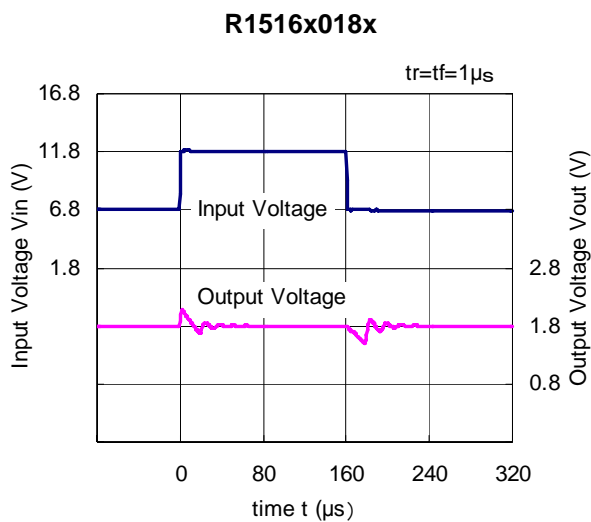
R1516x018x



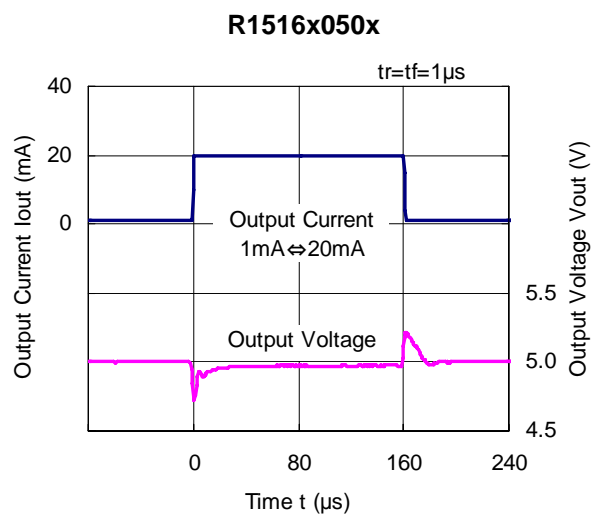
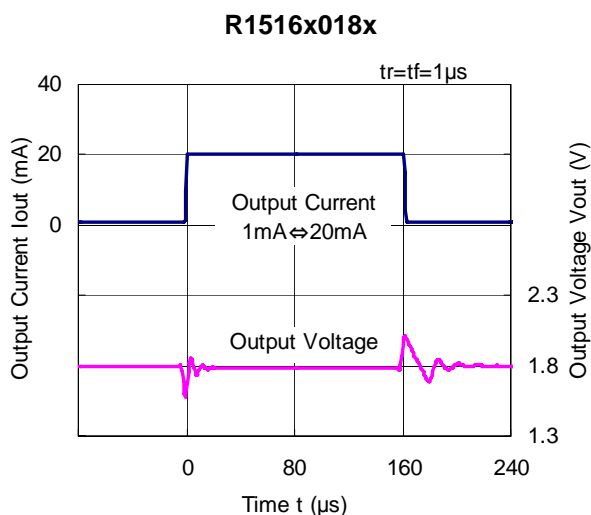
R1516x050x



7) Input Transient Response (C1=none, C2=Ceramic 0.1μF, I<sub>OUT</sub>=1mA, T<sub>opt</sub>=25°C)



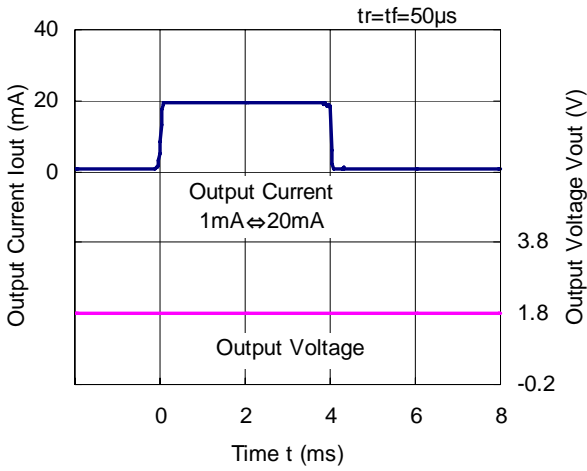
8) Load Transient Response (C<sub>1</sub>=Ceramic 0.1μF, C<sub>2</sub>=Ceramic 0.1μF, T<sub>opt</sub>=25°C)



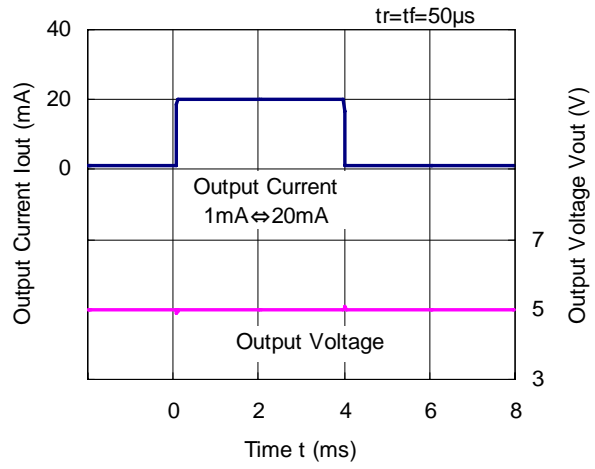
# R1516x

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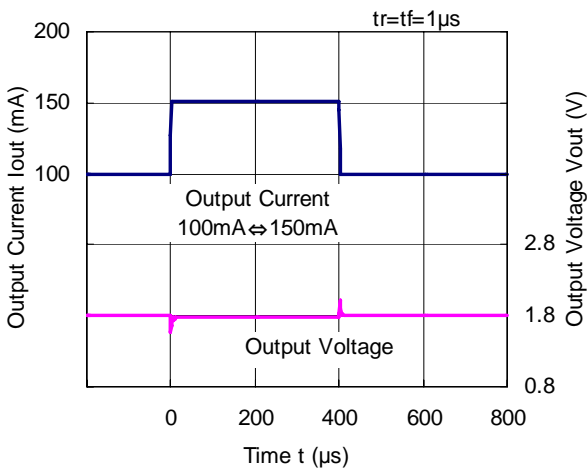
### R1516x018x



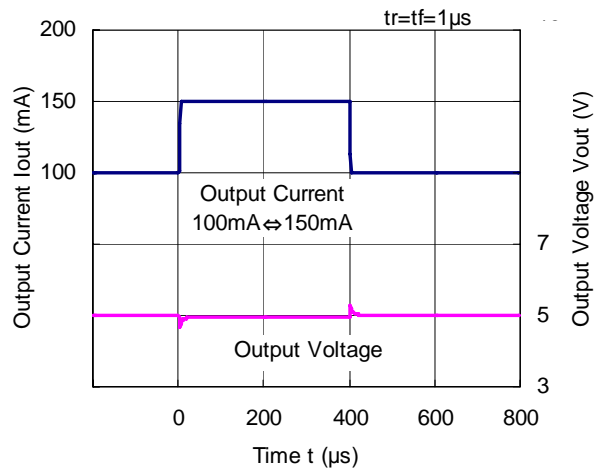
### R1516x050x



### R1516x018x

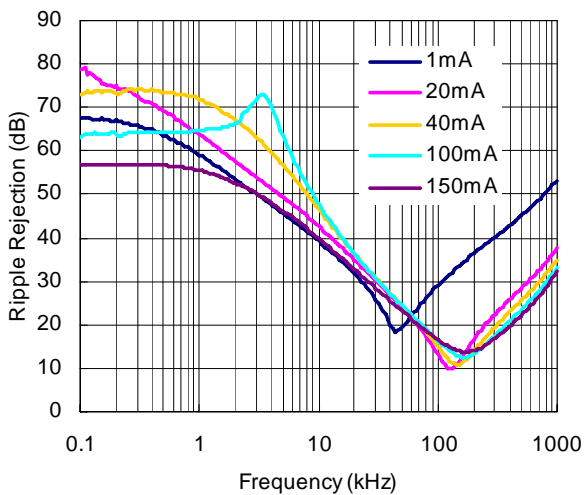


### R1516x050x

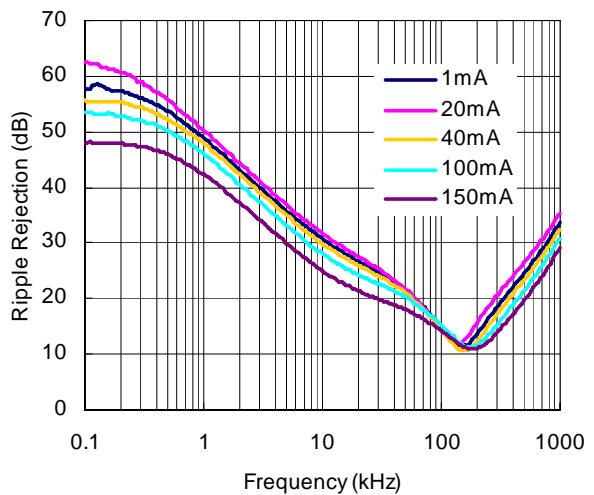


## 9) Ripple Rejection vs. Frequency (C1=none, C2=Ceramic 0.1μF, Ripple=0.5Vp-p, Topt=25°C)

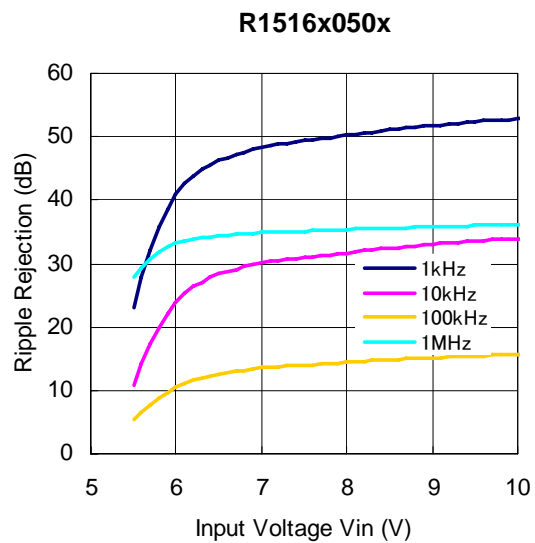
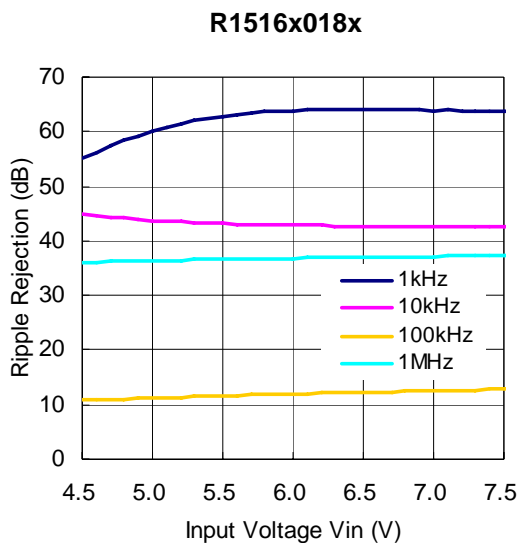
### R1516x018x



### R1516x050x



10) Ripple Rejection vs. Input Voltage (C1=none, C2=Ceramic 0.1μF, I<sub>OUT</sub>=20mA, Ripple=0.5Vp-p, T<sub>opt</sub>=25°C)





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