OUTLINE

The R1111N Series are CMOS-based voltage regulator ICs with high output voltage accuracy, extremely low supply current, low ON-resistance, and high Ripple Rejection. Each of these voltage regulator ICs consists of a voltage reference unit, an error amplifier, resistors, a current limit circuit, and a chip enable circuit.

These ICs perform with low dropout voltage and a chip enable function. The line transient response and load transient response of the R1111N Series are excellent, thus these ICs are very suitable for the power supply for hand-held communication equipment.

The output voltage of these ICs is fixed with high accuracy. Since the package for these ICs is SOT-23-5 (Mini-mold) package, high density mounting of the ICs on boards is possible.

FEATURES

- **Supply Current** ............................................................ Typ. 35μA
- **Standby Mode** ............................................................. Typ. 0.1μA
- **Dropout Voltage** .......................................................... Typ. 0.2V (Iout=100mA)
- **Ripple Rejection** ....................................................... Typ. 70dB(f=1kHz)
- **Output Voltage** ........................................................... 1.5V to 5.0V (0.1V steps)
  (For other voltages, please refer to MARK INFORMATIONS.)
- **Output Voltage Accuracy** ............................................. ±2.0%
- **Low Temperature-Drift Coefficient of Output Voltage**. Typ. ±100ppm/°C
- **Line Regulation** .......................................................... Typ. 0.05%/V
- **Package** .................................................................... SOT-23-5
- **Built-in chip enable circuit** (2 types; A: active "L", B: active "H")
- **Built-in Fold Back Protection Circuit** ............................. Typ. 50mA (Current at short mode)
- **Pin-out** ....................................................................... Similar to the LP2980

APPLICATIONS

- Power source for cellular phones such as GSM, CDMA and various kinds of PCSs.
- Power source for electrical appliances such as cameras, VCRs and camcorders.
- Power source for battery-powered equipment.
R1111N

BLOCK DIAGRAM

**R1111Nxx1A**

1. VDD
2. GND
3. CE
4. Vref
5. VOUT

**R1111Nxx1B**

1. VDD
2. GND
3. CE
4. Vref
5. VOUT

Current Limit

SELECTION GUIDE

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

<table>
<thead>
<tr>
<th>Product Name</th>
<th>Package</th>
<th>Quantity per Reel</th>
<th>Pb Free</th>
<th>Halogen Free</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1111Nxx1*-TR-FE</td>
<td>SOT-23-5</td>
<td>3,000 pcs</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

xx: The output voltage can be designated in the range from 1.5V(15) to 5.0V(50) in 0.1V steps.
(For other voltages, please refer to MARK INFORMATIONS.)

*: Designation of Active Type
  (A) "L" active
  (B) "H" active
PIN CONFIGURATION

- SOT-23-5

PIN DESCRIPTION

- SOT-23-5

<table>
<thead>
<tr>
<th>Pin No</th>
<th>Symbol</th>
<th>Pin Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>VDD</td>
<td>Input Pin</td>
</tr>
<tr>
<td>2</td>
<td>GND</td>
<td>Ground Pin</td>
</tr>
<tr>
<td>3</td>
<td>CE or CE</td>
<td>Chip Enable Pin</td>
</tr>
<tr>
<td>4</td>
<td>NC</td>
<td>No Connection</td>
</tr>
<tr>
<td>5</td>
<td>VOUT</td>
<td>Output pin</td>
</tr>
</tbody>
</table>

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Item</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>VIN</td>
<td>Input Voltage</td>
<td>9.0</td>
<td>V</td>
</tr>
<tr>
<td>VCE</td>
<td>Input Voltage(CE or CE Pin)</td>
<td>-0.3 ~ VIN+0.3</td>
<td>V</td>
</tr>
<tr>
<td>VOUT</td>
<td>Output Voltage</td>
<td>-0.3 ~ VIN+0.3</td>
<td>V</td>
</tr>
<tr>
<td>IOUT</td>
<td>Output Current</td>
<td>200</td>
<td>mA</td>
</tr>
<tr>
<td>PD</td>
<td>Power Dissipation *</td>
<td>420</td>
<td>mW</td>
</tr>
<tr>
<td>Topt</td>
<td>Operating Temperature Range</td>
<td>-40 ~ 85</td>
<td>°C</td>
</tr>
<tr>
<td>Tstg</td>
<td>Storage Temperature Range</td>
<td>-55 ~ 125</td>
<td>°C</td>
</tr>
</tbody>
</table>

*) 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

- **R1111Nxx1A**

  *(Topt=25°C)*

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Item</th>
<th>Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>V\text{OUT}</td>
<td>Output Voltage</td>
<td>$V_{IN}=V_{SET}+1V$, $1mA\leq I_{OUT}\leq 30mA$</td>
<td>$\times0.98$</td>
<td>$\times1.02$</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>I\text{OUT}</td>
<td>Output Current</td>
<td>Refer to ELECTRICAL CHARACTERISTICS BY OUTPUT VOLTAGE.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta V_{\text{OUT}} / \Delta I_{\text{OUT}}$</td>
<td>Load Regulation</td>
<td>$V_{IN}=V_{SET}+1V$, $1mA\leq I_{OUT}\leq 80mA$</td>
<td>12</td>
<td>40</td>
<td>mV</td>
<td></td>
</tr>
<tr>
<td>\text{VDIF}</td>
<td>Dropout Voltage</td>
<td>Refer to ELECTRICAL CHARACTERISTICS BY OUTPUT VOLTAGE.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_{\text{SS}}$</td>
<td>Supply Current</td>
<td>$V_{IN}=V_{SET}+1V$, $I_{OUT}=0A$</td>
<td>35</td>
<td>70</td>
<td>$\mu$A</td>
<td></td>
</tr>
<tr>
<td>$I_{\text{standby}}$</td>
<td>Standby Current</td>
<td>$V_{IN}=V_{CE}$, $V_{IN}=V_{SET}+1V$</td>
<td>0.1</td>
<td>1.0</td>
<td>$\mu$A</td>
<td></td>
</tr>
<tr>
<td>$\Delta V_{\text{OUT}} / \Delta V_{\text{IN}}$</td>
<td>Line Regulation</td>
<td>$V_{SET}+0.5V\leq V_{IN}\leq 8.0V$, $I_{OUT}=30mA$</td>
<td>0.05</td>
<td>0.20</td>
<td>%/V</td>
<td></td>
</tr>
<tr>
<td>\text{RR}</td>
<td>Ripple Rejection</td>
<td>$f=1kHz$, Ripple 0.5Vp-p, $V_{IN}=V_{SET}+1V$</td>
<td>70</td>
<td></td>
<td>dB</td>
<td></td>
</tr>
<tr>
<td>$V_{\text{IN}}$</td>
<td>Input Voltage</td>
<td></td>
<td>2.0</td>
<td>8.0</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>$\Delta V_{\text{OUT}} / \Delta T_{\text{opt}}$</td>
<td>Output Voltage Temperature Coefficient</td>
<td>$I_{OUT}=10mA$, $-40^\circ\text{C}\leq T_{\text{opt}}\leq 85^\circ\text{C}$</td>
<td>$\pm100$</td>
<td></td>
<td>Ppm/°C</td>
<td></td>
</tr>
<tr>
<td>$I_{\text{SC}}$</td>
<td>Short Current Limit</td>
<td>$V_{OUT}=0V$</td>
<td>50</td>
<td></td>
<td>mA</td>
<td></td>
</tr>
<tr>
<td>$R_{\text{PU}}$</td>
<td>$\bar{\text{CE}}$ Pull-up Resistance</td>
<td></td>
<td>2.5</td>
<td>5.0</td>
<td>10.0</td>
<td>M$\Omega$</td>
</tr>
<tr>
<td>$V_{\text{CEH}}$</td>
<td>$\bar{\text{CE}}$ Input Voltage “H”</td>
<td></td>
<td>1.5</td>
<td>$V_{IN}$</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>$V_{\text{CEL}}$</td>
<td>$\bar{\text{CE}}$ Input Voltage “L”</td>
<td></td>
<td>0</td>
<td>0.25</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>en</td>
<td>Output Noise</td>
<td>$BW=10Hz$ to $100kHz$</td>
<td>30</td>
<td></td>
<td>$\mu$Vrms</td>
<td></td>
</tr>
</tbody>
</table>

## 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.
### Symbol | Item | Conditions | Min. | Typ. | Max. | Unit
--- | --- | --- | --- | --- | --- | ---
$V_{OUT}$ | Output Voltage | $V_{IN}=V_{SET}+1V$, $1mA\leq I_{OUT}\leq 30mA$ | | $\times 0.98$ | | $V$
$I_{OUT}$ | Output Current | | | | | Refer to ELECTRICAL CHARACTERISTICS BY OUTPUT VOLTAGE.
$\frac{\Delta V_{OUT}}{\Delta I_{OUT}}$ | Load Regulation | $V_{IN}=V_{SET}+1V$, $1mA \leq I_{OUT} \leq 80mA$ | | 12 | 40 | mV
$V_{DIF}$ | Dropout Voltage | | | | | Refer to ELECTRICAL CHARACTERISTICS BY OUTPUT VOLTAGE.
$I_{SS}$ | Supply Current | $V_{IN}=V_{SET}+1V$, $I_{OUT}=0A$ | | 35 | 70 | μA
$I_{standby}$ | Standby Current | $V_{IN}=V_{SET}+1V$, $V_{CE}=GND$ | | 0.1 | 1.0 | μA
$\frac{\Delta V_{OUT}}{\Delta V_{IN}}$ | Line Regulation | $V_{SET}+0.5V \leq V_{IN} \leq 8.0V$, $I_{OUT}=30mA$ | | 0.05 | 0.20 | %/V
$RR$ | Ripple Rejection | $f=1KHz$, Ripple $0.5Vp-p$, $V_{IN}=V_{SET}+1V$ | | 70 | | dB
$V_{IN}$ | Input Voltage | | | 2.0 | 8.0 | V
$\frac{\Delta V_{OUT}}{\Delta T_{opt}}$ | Output Voltage Temperature Coefficient | $I_{OUT}=10mA$, $-40^\circ C \leq T_{opt} \leq 85^\circ C$ | | | $\pm 100$ | Ppm $^\circ C$
$I_{SC}$ | Short Current Limit | $V_{OUT}=0V$ | | 50 | | mA
$R_{PD}$ | CE Pull-up Resistance | | | 2.5 | 5.0 | 10.0 | MΩ
$V_{CEH}$ | CE Input Voltage “H” | | | 1.5 | | $V_{IN}$ | V
$V_{CEL}$ | CE Input Voltage “L” | | | 0 | 0.25 | | V
$en$ | Output Noise | BW=10Hz to 100kHz | | 30 | | μVrms

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**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.
### ELECTRICAL CHARACTERISTICS by OUTPUT VOLTAGE

<table>
<thead>
<tr>
<th>Output Voltage $V_{OUT} (V)$</th>
<th>Output Current $I_{OUT} (mA)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Condition</td>
<td>Min.</td>
</tr>
<tr>
<td>$1.5 \leq V_{SET} \leq 1.7$</td>
<td>$100$</td>
</tr>
<tr>
<td>$1.8 \leq V_{SET} \leq 5.0$</td>
<td>$150$</td>
</tr>
<tr>
<td>$V_{OUT} = V_{SET} + 1V$</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Dropout Voltage $V_{DIF} (V)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Condition</td>
</tr>
<tr>
<td>$1.5$</td>
</tr>
<tr>
<td>$1.6$</td>
</tr>
<tr>
<td>$1.7$</td>
</tr>
<tr>
<td>$1.8 \leq V_{SET} \leq 1.9$</td>
</tr>
<tr>
<td>$2.0 \leq V_{SET} \leq 2.4$</td>
</tr>
<tr>
<td>$2.5 \leq V_{SET} \leq 2.7$</td>
</tr>
<tr>
<td>$2.8 \leq V_{SET} \leq 3.3$</td>
</tr>
<tr>
<td>$3.4 \leq V_{SET} \leq 5.0$</td>
</tr>
</tbody>
</table>

### OPERATION

In these ICs, fluctuation of output voltage, $V_{OUT}$ is detected by feed-back registers $R1$, $R2$, and the result is compared with a reference voltage by the error amplifier, so that a constant voltage is output. A current limit circuit for protection at short mode and a chip enable circuit, are included.
TEST CIRCUITS

Fig.1 Standard test Circuit

Fig.2 Supply Current Test Circuit

Fig.3 Ripple Rejection, Line Transient Response Test Circuit

Fig.4 Load Transient Response Test Circuit
TYPICAL CHARACTERISTICS

1) Output Voltage vs. Output Current

**R1111N181B**

```
<table>
<thead>
<tr>
<th>Output Voltage VOUT (V)</th>
<th>3.8V</th>
<th>2.8V</th>
<th>2.3V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output Current IOUT (mA)</td>
<td>0</td>
<td>200</td>
<td>300</td>
</tr>
</tbody>
</table>
```

```
<table>
<thead>
<tr>
<th>Output Voltage VOUT (V)</th>
<th>5.0V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output Current IOUT (mA)</td>
<td>100</td>
</tr>
</tbody>
</table>
```

**R1111N301B**

```
<table>
<thead>
<tr>
<th>Output Voltage VOUT (V)</th>
<th>5.0V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output Current IOUT (mA)</td>
<td>100</td>
</tr>
</tbody>
</table>
```

2) Output Voltage vs. Input Voltage

**R1111N181B**

```
<table>
<thead>
<tr>
<th>Input Voltage VIN (V)</th>
<th>1.0</th>
<th>2.0</th>
<th>3.0</th>
<th>4.0</th>
<th>5.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output Voltage VOUT (V)</td>
<td>1.3</td>
<td>1.5</td>
<td>1.6</td>
<td>1.8</td>
<td>2.0</td>
</tr>
</tbody>
</table>
```

```
<table>
<thead>
<tr>
<th>Input Voltage VIN (V)</th>
<th>7.0</th>
<th>8.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output Voltage VOUT (V)</td>
<td>1.9</td>
<td>2.0</td>
</tr>
</tbody>
</table>
```

**R1111N301B**

```
<table>
<thead>
<tr>
<th>Input Voltage VIN (V)</th>
<th>2.0</th>
<th>3.0</th>
<th>4.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output Voltage VOUT (V)</td>
<td>2.5</td>
<td>2.7</td>
<td>2.9</td>
</tr>
</tbody>
</table>
```

```
<table>
<thead>
<tr>
<th>Input Voltage VIN (V)</th>
<th>5.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output Voltage VOUT (V)</td>
<td>3.1</td>
</tr>
</tbody>
</table>
```
3) Dropout Voltage vs. Output Current

**R1111N181B**

- Dropout Voltage $V_{DIF}$ vs. Output Current $I_{OUT}$
- Topt = 25°C
- Topt = 85°C
- Output Current $I_{OUT}$ (mA)
- Dropout Voltage $V_{DIF}$ (V)

**R1111N301B**

- Dropout Voltage $V_{DIF}$ vs. Output Current $I_{OUT}$
- Topt = 25°C
- Topt = 85°C
- Output Current $I_{OUT}$ (mA)
- Dropout Voltage $V_{DIF}$ (V)

**R1111N401B**

- Dropout Voltage $V_{DIF}$ vs. Output Current $I_{OUT}$
- Topt = 25°C
- Topt = 85°C
- Output Current $I_{OUT}$ (mA)
- Dropout Voltage $V_{DIF}$ (V)

**R1111N501B**

- Dropout Voltage $V_{DIF}$ vs. Output Current $I_{OUT}$
- Topt = 25°C
- Topt = 85°C
- Output Current $I_{OUT}$ (mA)
- Dropout Voltage $V_{DIF}$ (V)
4) Output Voltage vs. Temperature

**R1111N181B**

- VIN = 2.8V
- IOUT = 30mA

**R1111N301B**

- VIN = 4.0V
- IOUT = 30mA

**R1111N401B**

- VIN = 5.0V
- IOUT = 30mA

**R1111N501B**

- VIN = 6.0V
- IOUT = 30mA

5) Supply Current vs. Input Voltage

**R1111N181B**

- Topt = 25°C

**R1111N301B**

- Topt = 25°C
6) Supply Current vs. Temperature

**R1111N181B**

- **VIN = 2.8V**

**R1111N401B**

- **VIN = 5.0V**

**R1111N501B**

- **VIN = 6.0V**
7) Dropout Voltage vs. Set Output Voltage

**R1111Nxx1B**

![Graph showing Dropout Voltage vs. Set Output Voltage](image)

**TopT = 25 °C**

8) Ripple Rejection vs. Frequency

**R1111N181B**

- VIN = 2.8Vdc + 0.5Vp-p
- COUT = tantal 1.0μF

![Graph showing Ripple Rejection vs. Frequency](image)

**R1111N301B**

- VIN = 4Vdc + 0.5Vp-p
- COUT = tantal 1.0μF

![Graph showing Ripple Rejection vs. Frequency](image)
9) Ripple Rejection vs. Input Voltage (DC bias)

**R1111N401B**

VIN = 5.0Vdc + 0.5Vp-p
COUT = tantal 1.0μF

**R1111N301B**

IOUT = 1mA
COUT = 2.2μF

---

**R1111N401B**

VIN = 5.0Vdc + 0.5Vp-p
COUT = tantal 2.2μF

**R1111N301B**

IOUT = 10mA
COUT = 2.2μF

---

**R1111N301B**

IOUT = 50mA
COUT = 2.2μF
10) Input Transient Response

**R1111N301B**

- **IOUT**: 30mA
- **tr=tf**: 5 μs
- **COUT**: Tantalum 1.0 μF

**Graph 1:**
- **Input Voltage**
- **Output Voltage**

**Graph 2:**
- **Input Voltage**
- **Output Voltage**

**Graph 3:**
- **Input Voltage**
- **Output Voltage**
11) Load Transient Response

**R1111N301B**

VIN=4V
CIN=Tantalum 1μF
COUT=Tantalum 1.0μF

- **Output Voltage VOUT (V)**
- **Output Current IOUT (mA)**

<table>
<thead>
<tr>
<th>Time t (μs)</th>
<th>0</th>
<th>2</th>
<th>4</th>
<th>6</th>
<th>8</th>
<th>10</th>
<th>12</th>
<th>14</th>
<th>16</th>
<th>18</th>
<th>20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output Voltage</td>
<td>2.8</td>
<td>3.0</td>
<td>3.1</td>
<td>3.2</td>
<td>3.3</td>
<td>3.4</td>
<td>3.4</td>
<td>3.3</td>
<td>3.1</td>
<td>3.0</td>
<td>2.9</td>
</tr>
<tr>
<td>Output Current</td>
<td>-150</td>
<td>-100</td>
<td>0</td>
<td>50</td>
<td>100</td>
<td>150</td>
<td>150</td>
<td>100</td>
<td>50</td>
<td>0</td>
<td>-50</td>
</tr>
</tbody>
</table>

**R1111N301B**

VIN=4V
CIN=Tantalum 1μF
COUT=Tantalum 2.2μF

<table>
<thead>
<tr>
<th>Time t (μs)</th>
<th>0</th>
<th>2</th>
<th>4</th>
<th>6</th>
<th>8</th>
<th>10</th>
<th>12</th>
<th>14</th>
<th>16</th>
<th>18</th>
<th>20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output Voltage</td>
<td>2.8</td>
<td>3.0</td>
<td>3.1</td>
<td>3.2</td>
<td>3.3</td>
<td>3.4</td>
<td>3.4</td>
<td>3.3</td>
<td>3.1</td>
<td>3.0</td>
<td>2.9</td>
</tr>
<tr>
<td>Output Current</td>
<td>-150</td>
<td>-100</td>
<td>0</td>
<td>50</td>
<td>100</td>
<td>150</td>
<td>150</td>
<td>100</td>
<td>50</td>
<td>0</td>
<td>-50</td>
</tr>
</tbody>
</table>

**R1111N301B**

VIN=4V
CIN=Tantalum 1μF
COUT=Tantalum 4.7μF

<table>
<thead>
<tr>
<th>Time t (μs)</th>
<th>0</th>
<th>2</th>
<th>4</th>
<th>6</th>
<th>8</th>
<th>10</th>
<th>12</th>
<th>14</th>
<th>16</th>
<th>18</th>
<th>20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output Voltage</td>
<td>2.8</td>
<td>3.0</td>
<td>3.1</td>
<td>3.2</td>
<td>3.3</td>
<td>3.4</td>
<td>3.4</td>
<td>3.3</td>
<td>3.1</td>
<td>3.0</td>
<td>2.9</td>
</tr>
<tr>
<td>Output Current</td>
<td>-150</td>
<td>-100</td>
<td>0</td>
<td>50</td>
<td>100</td>
<td>150</td>
<td>150</td>
<td>100</td>
<td>50</td>
<td>0</td>
<td>-50</td>
</tr>
</tbody>
</table>
TECHNICAL NOTES

When using these ICs, consider the following points:

In these ICs, phase compensation is made for securing stable operation even if the load current is varied. For this purpose, be sure to use a capacitor $C_{\text{OUT}}$ with good frequency characteristics and ESR (Equivalent Series Resistance) of which is in the range described as follows:

The relationship between $I_{\text{OUT}}$ (output current) and ESR of output capacitor is shown in the graphs below. The conditions when the white noise level is under 40mV (Avg.) are indicated by the hatched area in the graph.

(note: When the additional ceramic capacitors are connected to the output pin with output capacitor for phase compensation, the operation might be unstable. Because of this, test these ICs with as the same external components as the ones to be used on the PCB.)

<Measurement conditions>

1. $V_{\text{IN}}=4V$
2. Frequency Band: 10Hz to 1MHz
3. Temperature: 25°C
· Make \( V_{DD} \) and GND lines sufficient. If their impedance is high, noise pick up or incorrect operation may result.
· Connect the capacitor with a capacitance of 1\( \mu \)F or more between \( V_{DD} \) and GND as close as possible.
· Set external components, especially the output capacitor, as close as possible to the ICs and make wiring as short as possible.

**TYPICAL APPLICATION**
1. The products and the product specifications described in this document are subject to change or discontinuation of production without notice for reasons such as improvement. Therefore, before deciding to use the products, please refer to Ricoh sales representatives for the latest information thereon.

2. The materials in this document may not be copied or otherwise reproduced in whole or in part without prior written consent of Ricoh.

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5. The products listed in this document are intended and designed for use as general electronic components in standard applications (office equipment, telecommunication equipment, measuring instruments, consumer electronic products, amusement equipment etc.). Those customers intending to use a product in an application requiring extreme quality and reliability, for example, in a highly specific application where the failure or misoperation of the product could result in human injury or death (aircraft, spacevehicle, nuclear reactor control system, traffic control system, automotive and transportation equipment, combustion equipment, safety devices, life support system etc.) should first contact us.

6. We are making our continuous effort to improve the quality and reliability of our products, but semiconductor products are likely to fail with certain probability. In order to prevent any injury to persons or damages to property resulting from such failure, customers should be careful enough to incorporate safety measures in their design, such as redundency feature, fire containment feature and fail-safe feature. We do not assume any liability or responsibility for any loss or damage arising from misuse or inappropriate use of the products.

7. Anti-radiation design is not implemented in the products described in this document.

8. The X-ray exposure can influence functions and characteristics of the products. Confirm the product functions and characteristics in the evaluation stage.

9. WL CSP products should be used in light shielded environments. The light exposure can influence functions and characteristics of the products under operation or storage.

10. There can be variation in the marking when different AOI (Automated Optical Inspection) equipment is used. In the case of recognizing the marking characteristic with AOI, please contact Ricoh sales or our distributor before attempting to use AOI.

11. Please contact Ricoh sales representatives should you have any questions or comments concerning the products or the technical information.

Ricoh is committed to reducing the environmental loading materials in electrical devices with a view to contributing to the protection of human health and the environment.

Ricoh has been providing RoHS compliant products since April 1, 2006 and Halogen-free products since April 1, 2012.

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