OUTLINE

The R1160x Series consist of CMOS-based voltage regulator ICs with high output voltage accuracy, low supply current, and low ON-resistance. Each of these voltage regulator ICs consists of a voltage reference unit, an error amplifier, resistors for setting Output Voltage, a current limit circuit, and a chip enable circuit.

These ICs perform with low dropout voltage and a chip enable function. To prevent the destruction by over current, current limit circuit is included. The R1160x Series have 3-mode. One is standby mode with CE or standby control pin. Other two modes are realized with ECO pin™. Fast Transient Mode (FT mode) and Low Power Mode (LP mode) are alternative with ECO pin™. Consumption current is reduced to 1/10 at Low Power Mode compared with Fast Transient Mode. Output voltage is maintained between FT mode and LP mode.

The output voltage of these ICs is internally fixed with high accuracy. Since the packages for these ICs are SOT-23-5 and SON-6 packages, high density mounting of the ICs on boards is possible.

FEATURES

- Supply Current (Low Power Mode)......................................... Typ. $3.5\mu A$ ($V_{\text{out}} \leq 1.5V$)
- Supply Current (Fast Transient Mode).................................... Typ. $40\mu A$
- Supply Current (Standby Mode).............................................. Typ. $0.1\mu A$
- Dropout Voltage ................................................................. Typ. $0.14V$ ($I_{\text{out}}=200mA$, $V_{\text{out}}=2.8V$)
- Ripple Rejection ................................................................. Typ. 70dB ($f=1kHz$, FT Mode)
- Temperature-Drift Coefficient of Output Voltage ............... Typ. $\pm 100$ppm/$^\circ\text{C}$
- Line Regulation ..................................................................... Typ. $0.05%/V$
- Output Voltage Accuracy ..................................................... $\pm 2.0\%$ ($\pm 3.0\%$ at LP Mode)
- Output Voltage Range .......................................................... 0.8V to 3.3V (0.1V steps)

(For other voltages, please refer to MARK INFORMATIONS.)

- Input Voltage Range .............................................................. 1.4V to 6.0V
- Built-in Fold Back Protection Circuit .................................... Typ. 50mA (Current at short mode)
- Packages .............................................................................. SOT-23-5, SON-6

APPLICATIONS

- Precision Voltage References.
- Power source for electrical appliances such as cameras, VCRs and hand-held communication equipment.
- Power source for battery-powered equipment.
**BLOCK DIAGRAMS**

- **R1160xxx1A**
- **R1160xxx1B**

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**SELECTION GUIDE**

The output voltage, chip enable polarity, and package, etc. 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>R1160Nxx1*+TR-FE</td>
<td>SOT-23-5</td>
<td>3,000 pcs</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>R1160Dxx1*+TR-FE</td>
<td>SON-6</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 0.8V(08) to 3.3V(33) in 0.1V steps. (For other voltages, please refer to MARK INFORMATIONS.)

- : CE pin polarity are options as follows.
  - (A) "L" active type.
  - (B) "H" active type.

* R1160D (SON-6) is the limited product. As of March in 2014.
PIN CONFIGURATION

• SOT-23-5

Top View
Bottom View

(mark side)

• SON-6

PIN DESCRIPTIONS

• 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>V_DD</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>ECO</td>
<td>MODE alternative pin</td>
</tr>
<tr>
<td>5</td>
<td>V_OUT</td>
<td>Output Pin</td>
</tr>
</tbody>
</table>

• SON-6

<table>
<thead>
<tr>
<th>Pin No</th>
<th>Symbol</th>
<th>Pin Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>V_DD</td>
<td>Input Pin</td>
</tr>
<tr>
<td>2</td>
<td>NC</td>
<td>No Connection</td>
</tr>
<tr>
<td>3</td>
<td>V_OUT</td>
<td>Output Pin</td>
</tr>
<tr>
<td>4</td>
<td>ECO</td>
<td>MODE alternative pin</td>
</tr>
<tr>
<td>5</td>
<td>GND</td>
<td>Ground Pin</td>
</tr>
<tr>
<td>6</td>
<td>CE or CE</td>
<td>Chip Enable Pin</td>
</tr>
</tbody>
</table>

*) Tab suspension leads are GND level. (They are connected to the reverse side of this IC.)
The tab suspension leads should be open and do not connect to other wires or land patterns.
**ABSOLUTE MAXIMUM RATINGS**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Item</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{IN}$</td>
<td>Input Voltage</td>
<td>6.5</td>
<td>V</td>
</tr>
<tr>
<td>$V_{ECO}$</td>
<td>Input Voltage ( ECO Pin)</td>
<td>$-0.3$ to $V_{IN}+0.3$</td>
<td>V</td>
</tr>
<tr>
<td>$V_{CE}$</td>
<td>Input Voltage ( CE or CE Pin)</td>
<td>$-0.3$ to $V_{IN}+0.3$</td>
<td>V</td>
</tr>
<tr>
<td>$V_{OUT}$</td>
<td>Output Voltage</td>
<td>$-0.3$ to $V_{IN}+0.3$</td>
<td>V</td>
</tr>
<tr>
<td>$I_{OUT}$</td>
<td>Output Current</td>
<td>250</td>
<td>mA</td>
</tr>
<tr>
<td>$P_{D}$</td>
<td>Power Dissipation (SOT-23-5)*</td>
<td>420</td>
<td>mW</td>
</tr>
<tr>
<td></td>
<td>Power Dissipation (SON-6) *</td>
<td>500</td>
<td>mW</td>
</tr>
<tr>
<td>$T_{opt}$</td>
<td>Operating Temperature Range</td>
<td>$-40$ to $85$</td>
<td>°C</td>
</tr>
<tr>
<td>$T_{stg}$</td>
<td>Storage Temperature Range</td>
<td>$-55$ to $125$</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.

**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

- **R1160xxx1A**

**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><strong>V_{OUT}</strong></td>
<td>Output Voltage (FT Mode)</td>
<td>$V_{IN}=V_{OUT}+1V, V_{ECO}=V_{IN}$</td>
<td>$0.98$</td>
<td>$1.02$</td>
<td>$1.02$</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$1\mu A \leq I_{OUT} \leq 30mA$</td>
<td>(-30mV)</td>
<td>(30mV)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Output Voltage (LP Mode)</td>
<td>$V_{IN}=V_{OUT}+1V, V_{ECO}=V_{OUT}$</td>
<td>$0.97$</td>
<td>$1.03$</td>
<td>$1.03$</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$1\mu A \leq I_{OUT} \leq 30mA$</td>
<td>(-45mV)</td>
<td>(45mV)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>I_{OUT}</strong></td>
<td>Output Current</td>
<td>$V_{IN}=V_{OUT}+1V$</td>
<td>$200$</td>
<td></td>
<td></td>
<td>mA</td>
</tr>
<tr>
<td><strong>ΔV_{OUT}/ΔI_{OUT}</strong></td>
<td>Load Regulation (FT Mode)</td>
<td>$V_{IN}=V_{OUT}+1V, V_{ECO}=V_{IN}$</td>
<td>$20$</td>
<td>$40$</td>
<td></td>
<td>mV</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$1\mu A \leq I_{OUT} \leq 200mA$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Load Regulation (LP Mode)</td>
<td>$V_{IN}=V_{OUT}+1V, V_{ECO}=GND$</td>
<td>$10$</td>
<td>$40$</td>
<td></td>
<td>mV</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$1\mu A \leq I_{OUT} \leq 100mA$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>V_{DIF}</strong></td>
<td>Dropout Voltage</td>
<td>Refer to the ELECTRICAL CHARACTERISTICS by OUTPUT VOLTAGE</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>I_{SS1}</strong></td>
<td>Supply Current (FT Mode)</td>
<td>$V_{IN}=V_{OUT}+1V, V_{ECO}=V_{IN}$</td>
<td></td>
<td></td>
<td></td>
<td>μA</td>
</tr>
<tr>
<td><strong>I_{SS2}</strong></td>
<td>Supply Current (LP Mode)</td>
<td>$V_{IN}=V_{OUT}+1V, V_{OUT} \leq 1.5V, V_{ECO}=GND$</td>
<td></td>
<td></td>
<td></td>
<td>μA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{IN}=V_{OUT}+1V, V_{OUT} \geq 1.6V, V_{ECO}=GND$</td>
<td></td>
<td></td>
<td></td>
<td>μA</td>
</tr>
<tr>
<td><strong>I_{standby}</strong></td>
<td>Supply Current (Standby)</td>
<td>$V_{IN}=V_{CE}=V_{OUT}+1V$</td>
<td></td>
<td></td>
<td></td>
<td>μA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{ECO}=GND \ or \ V_{IN}$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>ΔV_{OUT}/ΔV_{IN}</strong></td>
<td>Line Regulation (FT Mode)</td>
<td>$V_{IN}=V_{OUT}+0.5V \leq V_{IN} \leq 6V$</td>
<td>$0.05$</td>
<td>$0.20$</td>
<td></td>
<td>%/V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_{OUT}=30mA, V_{ECO}=V_{IN}$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(In case that $V_{OUT} \leq 0.9V, 1.4V \leq V_{IN} \leq 6V$)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Line Regulation (LP Mode)</td>
<td>$V_{IN}=V_{OUT}+0.5V \leq V_{IN} \leq 6V$</td>
<td>$0.10$</td>
<td>$0.30$</td>
<td></td>
<td>%/V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_{OUT}=30mA, V_{ECO}=GND$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(In case that $V_{OUT} \leq 0.9V, 1.4V \leq V_{IN} \leq 6V$)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>RR</strong></td>
<td>Ripple Rejection (FT Mode)</td>
<td>$f=1kHz$, Ripple 0.2Vp-p</td>
<td></td>
<td></td>
<td>$70$</td>
<td>dB</td>
</tr>
<tr>
<td><strong>V_{IN}</strong></td>
<td>Input Voltage</td>
<td>$V_{IN}$</td>
<td>$1.4$</td>
<td>$6.0$</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td><strong>ΔV_{OUT}/ΔT_{opt}</strong></td>
<td>Output Voltage Temperature Coefficient</td>
<td>$I_{OUT}=30mA$</td>
<td></td>
<td></td>
<td>$\pm 100$</td>
<td>ppm/°C</td>
</tr>
<tr>
<td><strong>I_{SC}</strong></td>
<td>Short Current Limit</td>
<td>$V_{OUT}=0V$</td>
<td></td>
<td></td>
<td></td>
<td>mA</td>
</tr>
<tr>
<td><strong>R_{PUC}</strong></td>
<td>ÇE Pull-up Resistance</td>
<td>$V_{CEH}=V_{IN}$</td>
<td></td>
<td></td>
<td></td>
<td>MΩ</td>
</tr>
<tr>
<td><strong>R_{PDE}</strong></td>
<td>ECO Pull-down Resistance</td>
<td>$V_{CEL}=V_{IN}$</td>
<td></td>
<td></td>
<td></td>
<td>MΩ</td>
</tr>
<tr>
<td><strong>V_{CEH}</strong></td>
<td>ÇE,EKO Input Voltage &quot;H&quot;</td>
<td>$V_{CEH}=V_{IN}$</td>
<td></td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td><strong>V_{CEL}</strong></td>
<td>ÇE,EKO Input Voltage &quot;L&quot;</td>
<td>$V_{CEL}=V_{IN}$</td>
<td></td>
<td></td>
<td></td>
<td>V</td>
</tr>
</tbody>
</table>

1: $\pm 30mV$ Tolerance for $V_{OUT} \leq 1.5V$
2: $\pm 45mV$ Tolerance for $V_{OUT} \leq 1.5V$
### R1160xxx1B

**Symbol** | **Item** | **Conditions** | **Min.** | **Typ.** | **Max.** | **Unit**
--- | --- | --- | --- | --- | --- | ---
\( V_{\text{OUT}} \) | Output Voltage (FT Mode) | \( V_{\text{IN}}=\text{Set } V_{\text{OUT}}+1V, \ V_{\text{ECO}}=V_{\text{IN}} \) \( 1\mu A \leq I_{\text{OUT}} \leq 30mA \) | \( \times 0.980 \) \((-30mV)\) | \( \times 1.020 \) \((30mV)\) | \( V \)
\( I_{\text{OUT}} \) | Output Voltage (LP Mode) | \( V_{\text{IN}}=\text{Set } V_{\text{OUT}}+1V, \ V_{\text{ECO}}=\text{GND} \) \( 1\mu A \leq I_{\text{OUT}} \leq 30mA \) | \( \times 0.970 \) \((-45mV)\) | \( \times 1.030 \) \((45mV)\) | \( V \)
\( \Delta V_{\text{OUT}}/\Delta I_{\text{OUT}} \) | Output Current | \( V_{\text{IN}}=V_{\text{OUT}}=1V \) | \( 200 \) | \( mA \)
\( \Delta V_{\text{OUT}}/\Delta V_{\text{IN}} \) | Load Regulation (FT Mode) | \( V_{\text{IN}}=\text{Set } V_{\text{OUT}}+1V, \ V_{\text{ECO}}=V_{\text{IN}} \) \( 1mA \leq I_{\text{OUT}} \leq 200mA \) | \( 20 \) | \( 40 \) | \( mV \)
\( V_{\text{DIFF}} \) | Load Regulation (LP Mode) | \( V_{\text{IN}}=\text{Set } V_{\text{OUT}}+1V, \ V_{\text{ECO}}=\text{GND} \) \( 1mA \leq I_{\text{OUT}} \leq 100mA \) | \( 10 \) | \( 40 \) | \( mV \)
\( I_{\text{ISS1}} \) | Dropout Voltage | Refer to the ELECTRICAL CHARACTERISTICS by OUTPUT VOLTAGE
\( I_{\text{ISS2}} \) | Supply Current (FT Mode) | \( V_{\text{IN}}=\text{Set } V_{\text{OUT}}+1V, \ V_{\text{ECO}}=V_{\text{IN}} \) | \( 40 \) | \( 70 \) | \( \mu A \)
\( I_{\text{ISS2}} \) | Supply Current (LP Mode) | \( V_{\text{IN}}=\text{Set } V_{\text{OUT}}+1V, \ V_{\text{OUT}} \leq 1.5V, \ V_{\text{ECO}}=\text{GND} \) | \( 3.5 \) | \( 6.0 \) | \( \mu A \)
\( I_{\text{ISS2}} \) | Supply Current (Standby) | \( V_{\text{IN}}=\text{Set } V_{\text{OUT}}+1V \) \( V_{\text{ECO}}=\text{GND} \) | \( 0.1 \) | \( 1.0 \) | \( \mu A \)
\( \Delta V_{\text{OUT}}/\Delta V_{\text{IN}} \) | Line Regulation (FT Mode) | \( V_{\text{IN}}=\text{Set } V_{\text{OUT}}+0.5V \) \( 0.5V \leq V_{\text{IN}} \leq 6.0V \) \( I_{\text{OUT}}=30mA \), \( V_{\text{ECO}}=V_{\text{IN}} \) (In case that \( V_{\text{OUT}} \leq 0.9V \), \( 1.4V \leq V_{\text{IN}} \leq 6V \) | \( 0.05 \) | \( 0.20 \) | \%/V
\( \Delta V_{\text{OUT}}/\Delta V_{\text{IN}} \) | Line Regulation (LP Mode) | \( V_{\text{IN}}=\text{Set } V_{\text{OUT}}+0.5V \) \( 0.5V \leq V_{\text{IN}} \leq 6.0V \) \( I_{\text{OUT}}=30mA \), \( V_{\text{ECO}}=\text{GND} \) (In case that \( V_{\text{OUT}} \leq 0.9V \), \( 1.4V \leq V_{\text{IN}} \leq 6V \) | \( 0.10 \) | \( 0.30 \) | \%/V
\( RR \) | Ripple Rejection (FT Mode) | \( f=1kHz \), Ripple 0.2Vp-p \( V_{\text{IN}}=\text{Set } V_{\text{OUT}}+1V \) \( I_{\text{OUT}}=30mA \), \( V_{\text{ECO}}=V_{\text{IN}} \) | \( 70 \) | \( dB \)
\( V_{\text{IN}} \) | Input Voltage | \( 1.4 \) | \( 6.0 \) | \( V \)
\( \Delta V_{\text{OUT}}/\Delta T_{\text{opt}} \) | Output Voltage Temperature Coefficient | \( I_{\text{OUT}}=30mA \) \(-40^\circ C \leq T_{\text{opt}} \leq 85^\circ C\) | \( \pm 100 \) | ppm | \%/°C
\( I_{\text{SC}} \) | Short Current Limit | \( V_{\text{OUT}}=0V \) | \( 50 \) | \( mA \)
\( R_{\text{PDG}} \) | CE Pull-down Resistance | \( V_{\text{OUT}}=0V \) | \( 2.0 \) | \( 5.0 \) | \( 14.0 \) | \( M\Omega \)
\( R_{\text{PDE}} \) | ECO Pull-down Resistance | \( V_{\text{OUT}}=0V \) | \( 1.5 \) | \( 5.0 \) | \( 14.0 \) | \( M\Omega \)
\( V_{\text{CEH}} \) | CE, ECO Input Voltage "H" | \( V_{\text{IN}} \) | \( 1.0 \) | \( V \)
\( V_{\text{CEL}} \) | CE, ECO Input Voltage "L" | \( V_{\text{IN}} \) | \( 0 \) | \( 0.3 \) | \( V \)

*1 : \( \pm 30mV \) Tolerance for \( V_{\text{OUT}} \leq 1.5V \)
*2 : \( \pm 45mV \) Tolerance for \( V_{\text{OUT}} \leq 1.5V \)
**ELECTRICAL CHARACTERISTICS by OUTPUT VOLTAGE**

<table>
<thead>
<tr>
<th>Output Voltage $V_{OUT}$ (V)</th>
<th>Dropout Voltage $V_{DIF}$ (V)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Condition</td>
</tr>
<tr>
<td>$0.8 \leq V_{OUT} \leq 0.9$</td>
<td>$I_{OUT}=200mA$</td>
</tr>
<tr>
<td>$1.0 \leq V_{OUT} \leq 1.4$</td>
<td></td>
</tr>
<tr>
<td>$1.5 \leq V_{OUT} \leq 2.5$</td>
<td></td>
</tr>
<tr>
<td>$2.6 \leq V_{OUT}$</td>
<td></td>
</tr>
</tbody>
</table>

**TEST CIRCUITS**

**Fig.1 Output Voltage vs. Output Current Test Circuit**

**Fig.2 Output Voltage vs. Input Voltage Test Circuit**

*R1160D (SON-6) is the limited product. As of March in 2014.*
Fig.3 Supply Current vs. Input Voltage Test Circuit

Fig.4 Output Voltage vs. Temperature Test Circuit

Fig.5 Supply Current vs. Temperature Test Circuit

C1=Tantal 1.0μF
C2=Tantal 2.2μF
Fig. 6 Dropout Voltage vs. Output Current/ Set Output Voltage Test Circuit

Fig. 7 Ripple Rejection Test Circuit

Fig. 8 Input Transient Response Test Circuit

C1=Tantal 1.0μF
C2=Tantal 2.2μF

C2=Tantalum Capacitor

* R1160D (SON-6) is the limited product. As of March in 2014.
* R1160D (SON-6) is the limited product. As of March in 2014.

**Fig. 9 Load Transient Response Test Circuit**

**Fig. 10 Turn on Speed with CE pin Test Circuit**

**Fig. 11 MODE Transient Response Test Circuit**
* R1160D (SON-6) is the limited product. As of March in 2014.

** TYPICAL APPLICATION **

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(C1=1.0μF  
C2=2.2μF)

(External Components)  
C1: Ceramic Capacitor 1μF  
C2: Tantalum Capacitor 2.2μF
TYPICAL CHARACTERISTICS

1) Output Voltage vs. Output Current

**R1160x081x**

- **ECO=H**
  - $V_{IN}=2.8V$
  - $1.4V$

- **ECO=L**
  - $V_{IN}=2.8V$
  - $1.4V$

**R1160x151x**

- **ECO=H**
  - $V_{IN}=3.5V$
  - $1.8V$

- **ECO=L**
  - $V_{IN}=3.5V$
  - $1.8V$

**R1160x261x**

- **ECO=H**
  - $V_{IN}=4.6V$
  - $2.9V$

- **ECO=L**
  - $V_{IN}=4.6V$
  - $2.9V$

---

* R1160D (SON-6) is the limited product. As of March in 2014.
2) Output Voltage vs. Input Voltage

VIN=5.3V

ECO=H

ECO=L
3) Supply Current vs. Input Voltage

**R1160x261x**

**ECO=H**

- I\(_{\text{OUT}}=\) 1mA
- I\(_{\text{OUT}}=\) 30mA
- I\(_{\text{OUT}}=\) 50mA

**Input Voltage VIN(V)**

0 1 2 3 4 5 6

**Output Voltage VOUT(V)**

0.0 0.5 1.0 1.5 2.0 2.5 3.0

**R1160x331x**

**ECO=H**

- I\(_{\text{OUT}}=\) 1mA
- I\(_{\text{OUT}}=\) 30mA
- I\(_{\text{OUT}}=\) 50mA

**Input Voltage VIN(V)**

0 1 2 3 4 5 6

**Output Voltage VOUT(V)**

0.0 0.5 1.0 1.5 2.0 2.5 3.0

**R1160x261x**

**ECO=L**

- I\(_{\text{OUT}}=\) 1mA
- I\(_{\text{OUT}}=\) 30mA
- I\(_{\text{OUT}}=\) 50mA

**Input Voltage VIN(V)**

0 1 2 3 4 5 6

**Output Voltage VOUT(V)**

0.0 0.5 1.0 1.5 2.0 2.5 3.0

**R1160x331x**

**ECO=L**

- I\(_{\text{OUT}}=\) 1mA
- I\(_{\text{OUT}}=\) 30mA
- I\(_{\text{OUT}}=\) 50mA

**Input Voltage VIN(V)**

0 1 2 3 4 5 6

**Output Voltage VOUT(V)**

0.0 0.5 1.0 1.5 2.0 2.5 3.0

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*R1160D (SON-6) is the limited product. As of March in 2014.*
* R1160D (SON-6) is the limited product. As of March in 2014.
4) Output Voltage vs. Temperature

**R1160x081x**

**ECO=H**

**R1160x081x**

**ECO=L**

**R1160x151x**

**ECO=H**

**R1160x151x**

**ECO=L**

**R1160x261x**

**ECO=H**

**R1160x261x**

**ECO=L**

*R1160D (SON-6) is the limited product. As of March in 2014.*
5) Supply Current vs. Input Voltage

* R1160D (SON-6) is the limited product. As of March in 2014.
* R1160D (SON-6) is the limited product. As of March in 2014.

6) Dropout Voltage vs. Output Current
R1160x

ECO=H

ECO=L

R1160D (SON-6) is the limited product. As of March in 2014.
7) Dropout Voltage vs. Set Output Voltage (Topt=25°C)

8) Ripple Rejection vs. Input Bias (Topt=25°C)
R1160x

9) Ripple Rejection vs. Frequency

R1160x261x
Ripple 0.2Vp-p, I_{out}=30mA, C_{in}; none, C_{out}=Tantal 2.2μF

R1160x261x
Ripple 0.5Vp-p, I_{out}=30mA, C_{in}; none, C_{out}=Tantal 2.2μF

R1160x261x
Ripple 0.2Vp-p, I_{out}=50mA, C_{in}; none, C_{out}=Tantal 2.2μF

R1160x261x
Ripple 0.5Vp-p, I_{out}=50mA, C_{in}; none, C_{out}=Tantal 2.2μF

R1160x081x
ECO=H, V_{in}=1.8V_{oc}+0.2V_{p-p}, C_{in}; none, C_{out}=Tantal 2.2μF

R1160x081x
ECO=L, V_{in}=1.8V_{oc}+0.2V_{p-p}, C_{in}; none, C_{out}=Tantal 2.2μF

* R1160D (SON-6) is the limited product. As of March in 2014.
R1160x

R1160x151x
ECO=H, V\text{in}=2.5\text{Vdc+0.2V}_{p-p},
C_{\text{in}}; \text{none}, C_{\text{out}}=\text{Tantal 2.2}\mu F

\begin{figure}
\centering
\includegraphics[width=0.4\textwidth]{R1160x151x}
\end{figure}

R1160x261x
ECO=H, V\text{in}=3.6\text{Vdc+0.2V}_{p-p},
C_{\text{in}}; \text{none}, C_{\text{out}}=\text{Tantal 1.0}\mu F

\begin{figure}
\centering
\includegraphics[width=0.4\textwidth]{R1160x261x}
\end{figure}

R1160x151x
ECO=L, V\text{in}=2.5\text{Vdc+0.2V}_{p-p},
C_{\text{in}}; \text{none}, C_{\text{out}}=\text{Tantal 2.2}\mu F

\begin{figure}
\centering
\includegraphics[width=0.4\textwidth]{R1160x151x}
\end{figure}

R1160x261x
ECO=L, V\text{in}=3.6\text{Vdc+0.2V}_{p-p},
C_{\text{in}}; \text{none}, C_{\text{out}}=\text{Tantal 1.0}\mu F

\begin{figure}
\centering
\includegraphics[width=0.4\textwidth]{R1160x261x}
\end{figure}

* R1160D (SON-6) is the limited product. As of March in 2014.
10) Input Transient Response

**R1160x261x**
ECO=H, IOUT=30mA, 
tr=tf=5μs, COUT=Tantal 1.0μF

**R1160x261x**
ECO=L, IOUT=10mA, 
tr=tf=5μs, COUT=Tantal 1.0μF

**R1160x331x**
ECO=H, V=4.3Voc+0.2Vp-p, 
Cin; none, Cout=Tantal 1.0μF

**R1160x331x**
ECO=L, V=4.3Voc+0.2Vp-p, 
Cin; none, Cout=Tantal 2.2μF

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* R1160D (SON-6) is the limited product. As of March in 2014.
11) Load Transient Response

**R1160x261x**

- **ECO=H, VIN=3.6V**, **CIN=Tantal 1.0μF, COUT=Tantal 1.0μF**
  - Load Current
  - Output Voltage
  - Time T(μs)
  - Output Voltage VOUT(V)
  - Load Current IOUT(mA)

**R1160x261x**

- **ECO=L, VIN=3.6V**, **CIN=Tantal 1.0μF, COUT=Tantal 1.0μF**
  - Load Current
  - Output Voltage
  - Time T(ms)
  - Output Voltage VOUT(V)
  - Load Current IOUT(mA)

**R1160x261x**

- **ECO=H, VIN=3.6V**, **CIN=Tantal 1.0μF, COUT=Tantal 2.2μF**
  - Load Current
  - Output Voltage
  - Time T(μs)
  - Output Voltage VOUT(V)
  - Load Current IOUT(mA)

**R1160x261x**

- **ECO=L, VIN=3.6V**, **CIN=Tantal 1.0μF, COUT=Tantal 2.2μF**
  - Load Current
  - Output Voltage
  - Time T(ms)
  - Output Voltage VOUT(V)
  - Load Current IOUT(mA)

**R1160x261x**

- **ECO=H, VIN=3.6V**, **CIN=Tantal 1.0μF, COUT=Tantal 4.7μF**
  - Load Current
  - Output Voltage
  - Time T(μs)
  - Output Voltage VOUT(V)
  - Load Current IOUT(mA)

**R1160x261x**

- **ECO=L, VIN=3.6V**, **CIN=Tantal 1.0μF, COUT=Tantal 4.7μF**
  - Load Current
  - Output Voltage
  - Time T(ms)
  - Output Voltage VOUT(V)
  - Load Current IOUT(mA)

* R1160D (SON-6) is the limited product. As of March in 2014.
12) Turn on speed with CE pin

**R1160x081B**

ECO=H, V\textsubscript{IN}=1.8V, C\textsubscript{IN}=Tantal 1.0μF, C\textsubscript{OUT}=Tantal 2.2μF

V\textsubscript{CE}=0V→1.8V

I\textsubscript{OUT}=200mA

**R1160x081B**

ECO=L, V\textsubscript{IN}=1.8V, C\textsubscript{IN}=Tantal 1.0μF, C\textsubscript{OUT}=Tantal 2.2μF

V\textsubscript{CE}=0V→1.8V

I\textsubscript{OUT}=200mA

**R1160x151B**

ECO=H, V\textsubscript{IN}=2.5V, C\textsubscript{IN}=Tantal 1.0μF, C\textsubscript{OUT}=Tantal 2.2μF

V\textsubscript{CE}=0V→2.5V

I\textsubscript{OUT}=200mA

**R1160x151B**

ECO=L, V\textsubscript{IN}=2.5V, C\textsubscript{IN}=Tantal 1.0μF, C\textsubscript{OUT}=Tantal 2.2μF

V\textsubscript{CE}=0V→2.5V

I\textsubscript{OUT}=200mA

**R1160x261B**

ECO=H, V\textsubscript{IN}=3.6V, C\textsubscript{IN}=Tantal 1.0μF, C\textsubscript{OUT}=Tantal 2.2μF

V\textsubscript{CE}=0V→3.6V

I\textsubscript{OUT}=200mA

**R1160x261B**

ECO=L, V\textsubscript{IN}=3.6V, C\textsubscript{IN}=Tantal 1.0μF, C\textsubscript{OUT}=Tantal 2.2μF

V\textsubscript{CE}=0V→3.6V

I\textsubscript{OUT}=200mA

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**R1160x**

* R1160D (SON-6) is the limited product. As of March in 2014.

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13) Output Voltage at Mode alternative point

**R1160x331B**
- ECO=H, \( V_\text{IN}=4.3 \text{V} \), \( C_\text{IN}=\text{Tantal 1.0} \mu\text{F}, C_\text{OUT}=\text{Tantal 2.2} \mu\text{F} \)
- CE Input Voltage \( V_{CE}(V) \)
- Output Voltage \( V_{OUT}(V) \)

**R1160x331B**
- ECO=L, \( V_\text{IN}=4.3 \text{V} \), \( C_\text{IN}=\text{Tantal 1.0} \mu\text{F}, C_\text{OUT}=\text{Tantal 2.2} \mu\text{F} \)
- CE Input Voltage \( V_{CE}(V) \)
- Output Voltage \( V_{OUT}(V) \)

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**R1160x101x**
- \( V_\text{IN}=1.3 \text{V} \), \( C_\text{IN}=\text{Tantal 1.0} \mu\text{F}, C_\text{OUT}=\text{Tantal 2.2} \mu\text{F} \)
- ECO Input Voltage \( V_{ECO}(V) \)
- Output Voltage \( V_{OUT}(V) \)

**R1160x101x**
- \( V_\text{IN}=2.0 \text{V} \), \( C_\text{IN}=\text{Tantal 1.0} \mu\text{F}, C_\text{OUT}=\text{Tantal 2.2} \mu\text{F} \)
- ECO Input Voltage \( V_{ECO}(V) \)
- Output Voltage \( V_{OUT}(V) \)
R1160x261x

\( V_{IN}=2.9\text{V}, \)
\( C_{IN}=\text{Tantal }1.0\mu\text{F}, \)
\( C_{OUT}=\text{Tantal }2.2\mu\text{F} \)

\( V_{OUT}(V) \)

\( I_{OUT}=0\text{mA} \)
\( I_{OUT}=1\text{mA} \)
\( I_{OUT}=10\text{mA} \)
\( I_{OUT}=50\text{mA} \)
\( I_{OUT}=100\text{mA} \)
\( I_{OUT}=200\text{mA} \)

Time \( T(\text{ms}) \)

R1160x261x

\( V_{IN}=3.6\text{V}, \)
\( C_{IN}=\text{Tantal }1.0\mu\text{F}, \)
\( C_{OUT}=\text{Tantal }2.2\mu\text{F} \)

\( V_{OUT}(V) \)

\( I_{OUT}=0\text{mA} \)
\( I_{OUT}=1\text{mA} \)
\( I_{OUT}=10\text{mA} \)
\( I_{OUT}=50\text{mA} \)
\( I_{OUT}=100\text{mA} \)
\( I_{OUT}=200\text{mA} \)

Time \( T(\text{ms}) \)

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TECHNICAL NOTES

(External Components)
C1: Ceramic Capacitor 1\(\mu\)F
C2: Tantalum Capacitor 2.2\(\mu\)F

When using these ICs, consider the following points:

1. PCB Layout
   Make Vdd and GND lines sufficient. If their impedance is high, noise pickup or unstable operation may result.
   Connect a capacitor C1 with a capacitance value as much as 1.0\(\mu\)F or more between Vdd and GND pin, and as close as possible to the pins.
   Set external components, especially the output capacitor C2, as close as possible to the ICs, and make wiring as short as possible.

2. Phase Compensation
   In these ICs, phase compensation is made for securing stable operation even if the load current is varied. For this purpose, use a capacitor C2 with 2.2\(\mu\)F or more and good ESR (Equivalent Series Resistance).
   (Note: If additional ceramic capacitors are connected with parallel to the output pin with an output capacitor for phase compensation, the operation might be unstable. Because of this, test these ICs with as same external components as ones to be used on the PCB.)
   If you use a tantalum type capacitor and ESR value of the capacitor is large, output might be unstable.
   Evaluate your circuit with considering frequency characteristics.
   If you use a ceramic type output capacitor, please connect about 1\(\Omega\) resistor in series for the stability of output voltage.
   Depending on the capacitor size, manufacturer, and part number, the bias characteristics and temperature characteristics are different. Evaluate the circuit with actual using capacitors.
ESR vs. Output Current

When using these ICs, consider the following points:

The relations between $I_{OUT}$ (Output Current) and ESR of an output capacitor are shown below. The conditions when the white noise level is under $40\mu V$ (Avg.) are marked as the hatched area in the graph.

**Measurement conditions**
- Frequency Band: 10Hz to 2MHz
- Temperature: 25°C

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R1160x

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R1160x

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**R1160x081x**
ECO=H, V_IN=1.8V,
C_IN=Ceramic 1.0μF, C_OUT=Ceramic 2.2μF

**R1160x081x**
ECO=L, V_IN=1.8V,
C_IN=Ceramic 1.0μF, C_OUT=Ceramic 2.2μF
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