OUTLINE

The R1116x Series are CMOS-based voltage regulator ICs with high output voltage accuracy, low supply current, low on Resistance, and high ripple rejection. Each of these ICs consists of a voltage reference unit, an error amplifier, resistor-net for voltage setting, a short current limit circuit, a chip enable circuit, and so on.

These ICs perform with low dropout voltage and the chip-enable function. The supply current at no load of this IC is only 10μA, and the line transient response and the load transient response of the R1116x Series are excellent, thus these ICs are very suitable for the power supply for hand-held communication equipment.

The supply current at no load of R1116x Series is remarkably reduced compared with R1114x Series. The mode change signal to reduce the supply current is not necessary. The output voltage accuracy is also improved. (±1.5%)

The output voltage of these ICs is fixed with high accuracy. Since the packages for these ICs are SOT-23-5 and SON1612-6 therefore high density mounting of the ICs on boards is possible.

R1126N Series that a pin configuration differs from R1116N Series are available.

FEATURES

- Supply Current ................................................................. Typ. 10μA
- Standby Current .............................................................. Typ. 0.1μA
- Input Voltage Range ...................................................... 1.8V to 6.0V
- Output Voltage Range .................................................... 1.5V to 4.0V (0.1V steps)
  (For other voltages, please refer to MARK INFORMATIONS.)
- Dropout Voltage ............................................................. Typ. 0.29V (IOUT=150mA, VOUT=2.8V)
- Ripple Rejection ............................................................ Typ. 70dB (f=1kHz, VOUT=3.0V)
  Typ. 53dB (f=10kHz)
- Output Voltage Accuracy ................................................ ±1.5% (1.5V ≤ VOUT ≤ 3.0V), ±2.0% (VOUT>3.0V)
- Temperature-Drift Coefficient of Output Voltage .............. Typ. ±100ppm/°C
- Line Regulation ............................................................... Typ. 0.02%/V
- Packages .......................................................................... SOT-23-5, SON1612-6
- Built-in Fold Back Protection Circuit ................................. Typ. 40mA (Current at short mode)
- Ceramic capacitors are recommended to be used with this IC ... CIN=COUT=1.0μF (Ceramic)

APPLICATIONS

- Power source for portable communication equipment.
- Power source for portable music player.
- Power source for electrical appliances such as cameras, VCRs and camcorders.
- Power source for battery-powered equipment.
**SELECTION GUIDE**

The output voltage, auto discharge function, package, and the taping type, 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>R1116Dxx1*-TR-FE</td>
<td>SON1612-6</td>
<td>4,000 pcs</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>R1116Nxx1*-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 4.0V(40) in 0.1V steps. (For other voltages, please refer to MARK INFORMATIONS.)

* CE pin polarity and auto discharge function at off state are options as follows.
  (B) "H" active, without auto discharge function at off state
  (D) "H" active, with auto discharge function at off state
PIN CONFIGURATIONS

• SOT-23-5

• SON1612-6

PIN DESCRIPTIONS

• SOT-23-5

<table>
<thead>
<tr>
<th>Pin No.</th>
<th>Symbol</th>
<th>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</td>
<td>Chip Enable Pin</td>
</tr>
<tr>
<td>4</td>
<td>NC</td>
<td>No Connection</td>
</tr>
<tr>
<td>5</td>
<td>V_{OUT}</td>
<td>Output pin</td>
</tr>
</tbody>
</table>

• SON1612-6

<table>
<thead>
<tr>
<th>Pin No.</th>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CE</td>
<td>Chip Enable Pin</td>
</tr>
<tr>
<td>2</td>
<td>GND</td>
<td>Ground Pin</td>
</tr>
<tr>
<td>3</td>
<td>V_{DD}</td>
<td>Input Pin</td>
</tr>
<tr>
<td>4</td>
<td>V_{OUT}</td>
<td>Output Pin</td>
</tr>
<tr>
<td>5</td>
<td>GND</td>
<td>Ground Pin</td>
</tr>
<tr>
<td>6</td>
<td>NC</td>
<td>No Connection</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>6.5</td>
<td>V</td>
</tr>
<tr>
<td>VCE</td>
<td>Input Voltage (CE Pin)</td>
<td>6.5</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>160</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 (SON1612-6)*</td>
<td>500</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.

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

- **R1116xxx1B/D**

#### Symbol | Item | Conditions | Min. | Typ. | Max. | Unit
--- | --- | --- | --- | --- | --- | ---
\( V_{\text{OUT}} \) | Output Voltage | \( V_{\text{IN}} = \text{Set } V_{\text{OUT}} + 1V \) \( 1mA \leq I_{\text{OUT}} \leq 30mA \) \( V_{\text{OUT}} \leq 3.4V \) \( V_{\text{OUT}} > 3.4V \) | \( \times 0.985 \) | \( \times 1.015 \) | \( \times 0.980 \) | \( \times 1.020 \) | V
\( I_{\text{OUT}} \) | Output Current | \( V_{\text{IN}} - V_{\text{OUT}} = 1.0V \) | 150 | mA
\( \Delta V_{\text{OUT}} / \Delta I_{\text{OUT}} \) | Load Regulation | \( V_{\text{IN}} = \text{Set } V_{\text{OUT}} + 1V \) \( 1mA \leq I_{\text{OUT}} \leq 150mA \) \( 1.5V \leq V_{\text{OUT}} < 2.0V \) \( 2.0V \leq V_{\text{OUT}} < 3.0V \) \( 3.0V \leq V_{\text{OUT}} \) | 28 | 55 | mV
\( V_{\text{DIFF}} \) | Dropout Voltage | Refer to the ELECTRICAL CHARACTERISTICS by OUTPUT VOLTAGE
\( I_{\text{SS}} \) | Supply Current | \( V_{\text{IN}} = \text{Set } V_{\text{OUT}} + 1V, I_{\text{OUT}} = 0mA \) | 10 | 18 | μA
\( I_{\text{standby}} \) | Supply Current (Standby) | \( V_{\text{IN}} = \text{Set } V_{\text{OUT}} + 1V, V_{\text{CE}} = V_{\text{DD}} \) | 0.1 | 1.0 | μA
\( \Delta V_{\text{OUT}} / \Delta V_{\text{IN}} \) | Line Regulation | \( I_{\text{OUT}} = 30mA \) \( \text{Set } V_{\text{OUT}} + 0.5V \leq V_{\text{IN}} \leq 6.0V \) | 0.02 | 0.10 | %/V
\( \text{RR} \) | Ripple Rejection | \( f = 1kHz \) \( f = 10kHz \) \( \text{Ripple } 0.2Vp-p \) \( V_{\text{IN}} = V_{\text{OUT}} = 1.0V, I_{\text{OUT}} = 30mA \) | 70 | 53 | dB
\( V_{\text{IN}} \) | Input Voltage | | 1.8 | 6.0 | V
\( \Delta V_{\text{OUT}} / \Delta V_{\text{Topt}} \) | Output Voltage Temperature Coefficient | \( I_{\text{OUT}} = 30mA \) \( -40^\circ C \leq V_{\text{Topt}} \leq 85^\circ C \) | ±100 | ppm /°C
\( I_{\text{SC}} \) | Short Current Limit | \( V_{\text{OUT}} = 0V \) | 40 | mA
\( I_{\text{PD}} \) | CE Pull-down Current | | 0.5 | μA
\( V_{\text{CEH}} \) | CE Input Voltage “H” | | 1.0 | 6.0 | V
\( V_{\text{CEL}} \) | CE Input Voltage “L” | | 0.0 | 0.3 | V
\( I_{\text{en}} \) | Output Noise | \( BW = 10Hz \text{ to } 100kHz \) | 30 | μVrms
\( R_{\text{LOW}} \) | On Resistance of Nch Tr. for auto-discharge (Only for D version) | \( V_{\text{CE}} = 0V \) | 70 | Ω

#### 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>Dropout Voltage $V_{DIF}$ (V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{OUT} = 1.5V$</td>
<td><strong>Condition</strong></td>
</tr>
<tr>
<td>$1.5V &lt; V_{OUT} \leq 1.6V$</td>
<td>$I_{OUT}=150mA$</td>
</tr>
<tr>
<td>$1.6V &lt; V_{OUT} \leq 1.7V$</td>
<td></td>
</tr>
<tr>
<td>$1.7V &lt; V_{OUT} \leq 2.0V$</td>
<td></td>
</tr>
<tr>
<td>$2.0V &lt; V_{OUT} \leq 2.7V$</td>
<td></td>
</tr>
<tr>
<td>$2.7V &lt; V_{OUT} \leq 4.0V$</td>
<td></td>
</tr>
</tbody>
</table>

TYPICAL APPLICATIONS

(External Components)
C2 Ceramic 1.0μF  Ex. Murata GRM155B30J105KE18B
Kyocera CM05X5R105K06AB
C1 Ceramic 1.0μF
TEST CIRCUITS

Fig.1 Standard test Circuit

Fig.2 Supply Current Test Circuit

Fig.3 Ripple Rejection, Line Transient Response Test Circuit

C1=Ceramic 1.0μF
C2=Ceramic 1.0μF
TYPICAL CHARACTERISTICS

1) Output Voltage vs. Output Current (Topt=25°C)

2) Output Voltage vs. Input Voltage (Topt=25°C)
3) Supply Current vs. Input Voltage (Topt=25°C)

**Graphs:**
- **R1116x401x**: Shows output voltage (V) on the Y-axis and input voltage (V) on the X-axis. Different lines represent different current levels (Iout=1mA, 30mA, 50mA, 150mA).
- **R1116x151x**: Graphs showing supply current (IIS) in μA against input voltage (V).
- **R1116x281x**: Similar to R1116x151x, but with a different current range.
- **R1116x401x**: Another graph showing supply current (IIS) in μA against input voltage (V), with a different voltage range.
4) Output Voltage vs. Temperature

<table>
<thead>
<tr>
<th>Temperature Topt(°C)</th>
<th>Output Voltage VOUT(V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>-50</td>
<td>1.46</td>
</tr>
<tr>
<td>0</td>
<td>1.47</td>
</tr>
<tr>
<td>25</td>
<td>1.49</td>
</tr>
<tr>
<td>50</td>
<td>1.51</td>
</tr>
<tr>
<td>75</td>
<td>1.53</td>
</tr>
<tr>
<td>100</td>
<td>1.55</td>
</tr>
</tbody>
</table>

5) Supply Current vs. Temperature

<table>
<thead>
<tr>
<th>Temperature Topt(°C)</th>
<th>Supply Current ISS(μA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>-50</td>
<td>2</td>
</tr>
<tr>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>25</td>
<td>8</td>
</tr>
<tr>
<td>50</td>
<td>12</td>
</tr>
<tr>
<td>75</td>
<td>14</td>
</tr>
<tr>
<td>100</td>
<td>16</td>
</tr>
</tbody>
</table>

6) Dropout Voltage vs. Temperature
7) Dropout Voltage vs. Set Output Voltage (Topt=25°C)
8) Ripple Rejection vs. Input Bias Voltage (Topt=25°C, C_{IN} = none, C_{OUT} = 1μF)

R1116x281x

- Ripple Vp-p=0.2V, I_{OUT}=1mA
- Ripple Vp-p=0.5V, I_{OUT}=1mA
- Ripple Vp-p=0.2V, I_{OUT}=30mA
- Ripple Vp-p=0.5V, I_{OUT}=30mA
- Ripple Vp-p=0.2V, I_{OUT}=50mA
- Ripple Vp-p=0.5V, I_{OUT}=50mA

Input Voltage VIN(V) vs. Ripple Rejection RR(dB) for different frequencies (1kHz, 10kHz, 100kHz).
9) Ripple Rejection vs. Frequency (C_{in}=none)

**R1116x151x**

\[ V_{IN}=2.7\text{Vdc}+0.5\text{Vp-p}, C_{OUT}=1\mu\text{F} \]

**R1116x151x**

\[ V_{IN}=2.7\text{Vdc}+0.5\text{Vp-p}, C_{OUT}=2.2\mu\text{F} \]

**R1116x281x**

\[ V_{IN}=3.8\text{Vdc}+0.5\text{Vp-p}, C_{OUT}=1\mu\text{F} \]

**R1116x281x**

\[ V_{IN}=3.8\text{Vdc}+0.5\text{Vp-p}, C_{OUT}=2.2\mu\text{F} \]

**R1116x401x**

\[ V_{IN}=5\text{Vdc}+0.5\text{Vp-p}, C_{OUT}=1\mu\text{F} \]

**R1116x401x**

\[ V_{IN}=5\text{Vdc}+0.5\text{Vp-p}, C_{OUT}=2.2\mu\text{F} \]
10) Input Transient Response (I_{out}=30mA, C_{in}=none, t_{r}=t_{f}=5\mu s, C_{out}=Ceramic 1\mu F)

\begin{align*}
\text{R1116x151x} & \\
\text{R1116x281x} & \\
\text{R1116x401x} & \\
\end{align*}

11) Load Transient Response (t_{r}=t_{f}=0.5\mu s, C_{in}=Ceramic 1\mu F)

\begin{align*}
\text{R1116x151x} & \\
\text{R1116x151x} & \\
\end{align*}
12) Turn-on/off speed with CE pin (D version) (C_{IN}=Ceramic 1.0\mu F, C_{OUT}=Ceramic 1.0\mu F)

R1116x151D

VIN=2.5V

Output Voltage V_{OUT}(V)

CE Input Voltage V_{CE}(V)

Output Voltage

I_{OUT}=0mA

I_{OUT}=30mA

I_{OUT}=150mA

Time t(\mu s)

-5 0 5 10 15 20 25 30 35 40 45

6 5 4 3 2 1 0

4 3 2 1 0

0 0 0

0 0 0

0 0 0

0 0 0
TECHNICAL NOTES

When using these ICs, consider the following points:

1. Mounting on PCB
   Make VDD and GND lines sufficient. If their impedance is high, noise pickup or unstable operation may result. Connect a capacitor with a capacitance value as much as 1.0\(\mu\)F or more as C1 between VDD and GND pin, and as close as possible to the pins.
   Set external components, especially the output capacitor, 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 good frequency characteristics and 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.
   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 $I_{\text{OUT}}$ (Output Current) and ESR of an output capacitor are shown below. The conditions when the white noise level is under 40μV (Avg.) are marked as the hatched area in the graph.

Measurement conditions
- $V_{\text{IN}} = V_{\text{OUT}} + 1V$
- $C_{\text{OUT}}$: GRM155B30J105KE18B
- Frequency Band: 10Hz to 2MHz
- Temperature: −40°C to 25°C
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