R1118x SERIES

AUTOMATIC MODE SHIFT / 150mA LOW VOLTAGE REGULATOR

OUTLINE

R1118x Series are CMOS-based voltage regulator ICs with ultra low supply current (Typ. 5.5\(\mu\)A), and remarkable improved transient response compared with the conventional low supply current voltage regulator. The supply current of these ICs is automatically shifts between fast mode and low power mode, it depending on the load current. The current threshold is fixed internally. R1118x shifts from low power mode to fast response mode at \(I_{\text{OUT}}=7\text{mA (Typ.)}\) and shifts fast response mode to low power mode at \(I_{\text{OUT}}=2\text{mA (Typ.)}\).

These ICs are capable of the low input voltage (Min. 1.4V) and the output voltage range from 0.8V is possible. The output voltage of R1118x is fixed in the IC.

Each of these ICs consists of a voltage reference unit, an error amplifier, a resistor net for setting output voltage, a current limit circuits for over-current.

A standby mode with ultra low supply current can be realized with the chip enable function.

Since the packages for these ICs are SOT-23-5 and DFN(PLP)1612-4B, therefore high density mounting of the ICs on boards is possible.

FEATURES

- Supply Current (Low power Mode) ........................................ Typ. 5.5\(\mu\)A (\(I_{\text{OUT}}=0\text{mA}\))
- Supply Current (Fast Mode) ........................................... Typ. 50\(\mu\)A (\(I_{\text{OUT}}=11\text{mA}\))
- Supply Current (Standby Mode) ...................................... Typ. 0.1 \(\mu\)A
- Ripple Rejection ...................................................... Typ. 70dB (f=1kHz)
  Typ. 60dB (f=10kHz)
- Input Voltage Range .................................................. 1.4V to 6.0V
- Output Voltage Range .............................................. 0.8V to 4.2V (0.1V steps)
  (For other voltages, please refer to MARK INFORMATIONS.)
- Output Voltage Accuracy ............................................. \(\pm1.0\% (1.5V < V_{\text{OUT}} \leq 3.5V, T_{\text{OPT}}=25^\circ\text{C})\)
- Temperature-Drift Coefficient of Output Voltage .......... Typ. \(\pm100\text{ppm}/^\circ\text{C}\)
- Dropout Voltage ..................................................... Typ. 0.27V (\(I_{\text{OUT}}=150\text{mA, V}_{\text{OUT}}=2.8V\))
- Line Regulation ..................................................... Typ. 0.02%/V
- Packages .................................................................. DFN(PLP)1612-4B, SOT-23-5
- Built-in Fold Back Protection Circuit ......................... Typ. 40mA
- Ceramic capacitors are recommended to be used with this IC .... 1.0\(\mu\)F

APPLICATIONS

- Power source for portable communication equipment.
- Power source for electrical appliances such as cameras, VCRs and camcorders.
- Power source for battery-powered equipment.

* R1118N (SOT-23-5) is the limited product and the R1118K (DFN(PLP)1612-4B) the non-promotion product. As of March in 2014.
**BLOCK DIAGRAMS**

**R1118xxx1B**

- **VDD**
- **GND**
- **VOUT**
- **Vref**
- **Current Limit**

**R1118xxx1D**

- **VDD**
- **GND**
- **VOUT**
- **Vref**
- **Current Limit**

**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>R1118Kxx1*-TR</td>
<td>DFN(PLP)1612-4B</td>
<td>5,000 pcs</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>R1118Nxx1*-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 0.8V(08) to 4.2V(42) 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

* R1118N (SOT-23-5) is the limited product and the R1118K (DFN(PLP)1612-4B) the non-promotion product. As of March in 2014.
PIN CONFIGURATIONS

**DFN(PLP)1612-4B**

Bottom View

1 2 3 4

Top View

1 2

**SOT-23-5**

Bottom View

1 2 3 4 5

(mark side)

PIN DESCRIPTIONS

**DFN(PLP)1612-4B**

<table>
<thead>
<tr>
<th>Pin No</th>
<th>Symbol</th>
<th>Pin Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>( V_{\text{OUT}} )</td>
<td>Output 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 (&quot;H&quot; Active)</td>
</tr>
<tr>
<td>4</td>
<td>( V_{\text{DD}} )</td>
<td>Input Pin</td>
</tr>
</tbody>
</table>

*) 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**

<table>
<thead>
<tr>
<th>Pin No</th>
<th>Symbol</th>
<th>Pin Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>( V_{\text{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 (&quot;H&quot; Active)</td>
</tr>
<tr>
<td>4</td>
<td>NC</td>
<td>No Connection</td>
</tr>
<tr>
<td>5</td>
<td>( V_{\text{OUT}} )</td>
<td>Output Pin</td>
</tr>
</tbody>
</table>

* R1118N (SOT-23-5) is the limited product and the R1118K (DFN(PLP)1612-4B) the non-promotion product. As of March in 2014.
## 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 V</td>
<td></td>
</tr>
<tr>
<td>VCE</td>
<td>Input Voltage (CE Pin)</td>
<td>-0.3 to 6.5 V</td>
<td></td>
</tr>
<tr>
<td>VOUT</td>
<td>Output Voltage</td>
<td>-0.3 to V_IN+0.3 V</td>
<td></td>
</tr>
<tr>
<td>IOUT</td>
<td>Output Current (DC)</td>
<td>180 mA</td>
<td></td>
</tr>
<tr>
<td>Pd</td>
<td>Power Dissipation (DFN(PLP)1612-4B)*</td>
<td>580 mW</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Power Dissipation (SOT-23-5)*</td>
<td>420 mW</td>
<td></td>
</tr>
<tr>
<td>T_{opt}</td>
<td>Operating Temperature Range</td>
<td>-40 to 85 °C</td>
<td></td>
</tr>
<tr>
<td>T_{stg}</td>
<td>Storage Temperature Range</td>
<td>-55 to 125 °C</td>
<td></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.

## 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

- R1118xxx1B/D

\[ V_{IN}=\text{Set } V_{OUT}+1V, \; I_{OUT}=1mA, \; \text{unless otherwise noted.} \]

The specification in [ ] is checked and guaranteed by design engineering at \(-40^\circ C \leq T_{opt} \leq 85^\circ C\), unless otherwise noted.

<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_{OUT}</td>
<td>Output Voltage</td>
<td>( T_{opt}=25^\circ C )</td>
<td>( V_{OUT} \leq 1.5V )</td>
<td>-15</td>
<td>15</td>
<td>mV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>( 1.5V &lt; V_{OUT} \leq 3.5V )</td>
<td>( \times 0.99 )</td>
<td>( \times 1.01 )</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>( 3.5V &lt; V_{OUT} \leq 5.5V )</td>
<td>( \times 0.985 )</td>
<td>( \times 1.015 )</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>( -40^\circ C \leq T_{opt} \leq 85^\circ C )</td>
<td>( V_{OUT} \leq 1.5V )</td>
<td>-10</td>
<td>10</td>
<td>mV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>( 1.5V &lt; V_{OUT} \leq 3.5V )</td>
<td>( \times 0.973 )</td>
<td>( \times 1.02 )</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>( 3.5V &lt; V_{OUT} \leq 5.5V )</td>
<td>( \times 0.968 )</td>
<td>( \times 1.025 )</td>
<td>V</td>
</tr>
<tr>
<td>I_{OUT}</td>
<td>Output Current</td>
<td></td>
<td></td>
<td>50</td>
<td>150</td>
<td>mA</td>
</tr>
<tr>
<td>( \Delta V_{OUT} / \Delta I_{OUT} )</td>
<td>Load Regulation</td>
<td>( 1mA \leq I_{OUT} \leq 150mA )</td>
<td></td>
<td>80</td>
<td></td>
<td>mV</td>
</tr>
<tr>
<td>V_{DIFF}</td>
<td>Dropout Voltage</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I_{ISS1}</td>
<td>Supply Current (Low Power Mode)</td>
<td>( I_{OUT}=0mA )</td>
<td>5.5</td>
<td>16</td>
<td></td>
<td>μA</td>
</tr>
<tr>
<td>I_{ISS2}</td>
<td>Supply Current (Fast Mode)</td>
<td>( I_{OUT}=11mA )</td>
<td>50</td>
<td>105</td>
<td></td>
<td>μA</td>
</tr>
<tr>
<td>I_{STAND}</td>
<td>Standby Current</td>
<td>( V_{IN}=6.0V, ; V_{CE}=\text{GND} )</td>
<td>0.1</td>
<td>1.0</td>
<td></td>
<td>μA</td>
</tr>
<tr>
<td>I_{OUTH}</td>
<td>Fast Mode Current Threshold</td>
<td>( I_{OUT}=1μA \rightarrow 30mA )</td>
<td>7</td>
<td>12</td>
<td></td>
<td>mA</td>
</tr>
<tr>
<td>I_{OUTL}</td>
<td>Low Power Mode Current Threshold</td>
<td>( I_{OUT}=30mA \rightarrow 1μA )</td>
<td>1</td>
<td>2</td>
<td></td>
<td>mA</td>
</tr>
<tr>
<td>( \Delta V_{OUT} / \Delta V_{IN} )</td>
<td>Line Regulation</td>
<td>Set ( V_{OUT}+0.5V \leq V_{IN} \leq 6.0V ) (In case that ( V_{OUT} \leq 0.9V, ; V_{IN} \geq 1.4V ))</td>
<td>( \pm 0.02 )</td>
<td>( \pm 0.2 )</td>
<td></td>
<td>%/V</td>
</tr>
<tr>
<td>RR</td>
<td>Ripple Rejection</td>
<td>Ripple 0.2Vp-p ( I_{OUT}=30mA ) (In case that ( V_{OUT}&lt;1.5V, ; V_{IN}=\text{Set } V_{OUT}+1.5V ))</td>
<td>f=1kHz</td>
<td>70</td>
<td></td>
<td>dB</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>f=10kHz</td>
<td>60</td>
<td></td>
<td></td>
</tr>
<tr>
<td>V_{IN}</td>
<td>Input Voltage</td>
<td></td>
<td>1.4</td>
<td>6.0</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>( \Delta V_{OUT} / \Delta T_{opt} )</td>
<td>Output Voltage Temperature Coefficient</td>
<td>( -40^\circ C \leq T_{opt} \leq 85^\circ C )</td>
<td>( \pm 100 )</td>
<td></td>
<td></td>
<td>ppm /°C</td>
</tr>
<tr>
<td>I_{SC}</td>
<td>Short Current Limit</td>
<td>( V_{OUT}=0V )</td>
<td>40</td>
<td></td>
<td></td>
<td>mA</td>
</tr>
<tr>
<td>I_{PD}</td>
<td>CE Pull-down Current</td>
<td></td>
<td>0.01</td>
<td>0.3</td>
<td>0.6</td>
<td></td>
</tr>
<tr>
<td>V_{CEH}</td>
<td>CE Input Voltage &quot;H&quot;</td>
<td></td>
<td>1.0</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>V_{CEL}</td>
<td>CE Input Voltage &quot;L&quot;</td>
<td></td>
<td></td>
<td>0.4</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>( \text{en} )</td>
<td>Output Noise</td>
<td>BW=10Hz to 100kHz</td>
<td>100</td>
<td></td>
<td></td>
<td>μVrms</td>
</tr>
<tr>
<td>R_{LOW}</td>
<td>Low Output Nch Tr. ON Resistance (of D version)</td>
<td>( V_{CE}=0V )</td>
<td>40</td>
<td></td>
<td></td>
<td>Ω</td>
</tr>
</tbody>
</table>

All of unit are tested and specified under load conditions such that \( Tj \approx T_{opt}=25^\circ C \) except for Output Noise, Ripple Rejection and Output Voltage Temperature Coefficient items.

* R1118N (SOT-23-5) is the limited product and the R1118K (DFN(PLP)1612-4B) the non-promotion product. As of March in 2014.
R1118x

- Dropout Voltage by Output Voltage

<table>
<thead>
<tr>
<th>Output Voltage $V_{\text{OUT}}$</th>
<th>Dropout Voltage $V_{\text{DIR}}$ (V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$0.8 \leq V_{\text{OUT}} &lt; 0.9$</td>
<td>Typ. 1.06</td>
</tr>
<tr>
<td>$0.9 \leq V_{\text{OUT}} &lt; 1.0$</td>
<td>Typ. 0.98</td>
</tr>
<tr>
<td>$1.0 \leq V_{\text{OUT}} &lt; 1.2$</td>
<td>Typ. 0.90</td>
</tr>
<tr>
<td>$1.2 \leq V_{\text{OUT}} &lt; 1.5$</td>
<td>Typ. 0.77</td>
</tr>
<tr>
<td>$1.5 \leq V_{\text{OUT}} &lt; 2.0$</td>
<td>Typ. 0.64</td>
</tr>
<tr>
<td>$2.0 \leq V_{\text{OUT}} &lt; 2.8$</td>
<td>Typ. 0.49</td>
</tr>
<tr>
<td>$2.8 \leq V_{\text{OUT}}$</td>
<td>Typ. 0.37</td>
</tr>
</tbody>
</table>

The specification is checked and guaranteed by design engineering at $-40^\circ C \leq T_{\text{OPT}} \leq 85^\circ C$, unless otherwise noted.

**TYPICAL APPLICATION**

![C1 R1118x Series VDD VOUT C2 CE GND VOUT](C1 R1118x Series VDD VOUT C2 CE GND VOUT)

(External Components)
Ceramic Capacitor C2 1.0µF TDK C1005JB0J105K
Kyocera CM05X5R105K06AB

**TECHNICAL NOTES**

When using these ICs, consider the following points:

**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 1.0µF or more.

If a tantalum capacitor is used, and its ESR (Equivalent Series Resistance) of C2 is large, the loop oscillation may result. Because of this, select C2 carefully considering its frequency characteristics.

**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 1.0µF 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.
TEST CIRCUITS

Basic Test Circuit

Test Circuit for Supply Current

Test Circuit for Ripple Rejection

*R1118N (SOT-23-5) is the limited product and the R1118K (DFN(PLP)1612-4B) the non-promotion product. As of March in 2014.
Test Circuit for Load Transient Response

C1=Ceramic 1.0\( \mu \)F
C2=Ceramic 1.0\( \mu \)F

* R1118N (SOT-23-5) is the limited product and the R1118K (DFN(PLP)1612-4B) the non-promotion product. As of March in 2014.
TYPICAL CHARACTERISTICS

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

2) Output Voltage vs. Input Voltage (Topt=25°C)
R1118x

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

* R1118N (SOT-23-5) is the limited product and the R1118K (DFN(PLP)1612-4B) the non-promotion product. As of March in 2014.
4) Supply Current vs. Output Current (Topt=25°C)

5) Output Voltage vs. Temperature

* R1118N (SOT-23-5) is the limited product and the R1118K (DFN(PLP)1612-4B) the non-promotion product. As of March in 2014.
6) Supply Current vs. Temperature

7) Dropout Voltage vs. Output Current

*R1118N (SOT-23-5) is the limited product and the R1118K (DFN(PLP)1612-4B) the non-promotion product. As of March in 2014.
R1118x

* R1118N (SOT-23-5) is the limited product and the R1118K (DFN(PLP)1612-4B) the non-promotion product. As of March in 2014.
8) Dropout Voltage vs. Set Output Voltage (Topt=25°C)

9) Minimum Operating Voltage

10) Ripple Rejection vs. Input Bias Voltage (C1=none, C2=Ceramic 1.0μF, Ripple=0.2Vp-p, Topt=25°C)

*R1118N (SOT-23-5) is the limited product and the R1118K (DFN(PLP)1612-4B) the non-promotion product. As of March in 2014.*
11) Ripple Rejection vs. Frequency (C1=none, Topt=25°C)

**R1118x081x**

- **V_{IN}=2.3\,\text{VDC}+0.2\,\text{Vp-p}, C_2=0.1\,\mu\text{F}**
  - I_{OUT}=5\,\text{mA}
  - I_{OUT}=15\,\text{mA}
  - I_{OUT}=50\,\text{mA}

- **V_{IN}=2.3\,\text{VDC}+0.2\,\text{Vp-p}, C_2=2.2\,\mu\text{F}**
  - I_{OUT}=5\,\text{mA}
  - I_{OUT}=15\,\text{mA}
  - I_{OUT}=50\,\text{mA}

**R1118x151x**

- **V_{IN}=2.5\,\text{VDC}+0.2\,\text{Vp-p}, C_2=1.0\,\mu\text{F}**
  - I_{OUT}=5\,\text{mA}
  - I_{OUT}=15\,\text{mA}
  - I_{OUT}=50\,\text{mA}

- **V_{IN}=2.5\,\text{VDC}+0.2\,\text{Vp-p}, C_2=2.2\,\mu\text{F}**
  - I_{OUT}=5\,\text{mA}
  - I_{OUT}=15\,\text{mA}
  - I_{OUT}=50\,\text{mA}
12) Input Transient Response (I_{OUT}=30mA, t_{RF}=5\mu s, C1=none, C2=1\mu F, T_{OPT}=25^\circ C)

**R1118x081x**

**R1118x151x**

* R1118N (SOT-23-5) is the limited product and the R1118K (DFN(PLP)1612-4B) the non-promotion product. As of March in 2014.
13) Load Transient Response (\(\text{tr}_\text{f}=500\text{ns}, \ C_1=1.0\mu\text{F}, \ \text{Topt}=25^\circ\text{C}\))

R1118x081x
(Fast Mode)

R1118x081x
(Low Power Mode→Fast Mode)

R1118x151x
(Fast Mode)

R1118x151x
(Low Power Mode→Fast Mode)

* R1118N (SOT-23-5) is the limited product and the R1118K (DFN(PLP)1612-4B) the non-promotion product. As of March in 2014.
R1118x

* R1118N (SOT-23-5) is the limited product and the R1118K (DFN(PLP)1612-4B) the non-promotion product. As of March in 2014.
14) Turn On Speed with CE pin (C1=Ceramic 1.0μF, C2=Ceramic 1.0μF, Topt=25°C)

R1118x081x

\[ V_{IN} = 1.8V \]

R1118x151x

\[ V_{IN} = 2.5V \]

R1118x281x

\[ V_{IN} = 3.8V \]

R1118x421x

\[ V_{IN} = 5.2V \]

15) Turn Off Speed with CE pin (D Version) (C1=Ceramic 1.0μF, C2=Ceramic 1.0μF, Topt=25°C)

R1118x081D

\[ V_{IN} = 1.8V \]

R1118x151D

\[ V_{IN} = 2.5V \]

* R1118N (SOT-23-5) is the limited product and the R1118K (DFN(PLP)1612-4B) the non-promotion product. As of March in 2014.
* R1118N (SOT-23-5) is the limited product and the R1118K (DFN(PLP)1612-4B) the non-promotion product. As of March in 2014.
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 40μV (Avg.) are marked as the hatched area in the graph.

**Measurement conditions**
- Frequency Band: 10Hz to 2MHz
- Temperature: $-40^\circ C$ to $85^\circ C$
- C1, C2: 1.0μF (Murata, GRM155B31A105KE)

* R1118N (SOT-23-5) is the limited product and the R1118K (DFN(PLP)1612-4B) the non-promotion product. As of March in 2014.
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.

3. Please be sure to take any necessary formalities under relevant laws or regulations before exporting or otherwise taking out of your country the products or the technical information described herein.

4. The technical information described in this document shows typical characteristics of and example application circuits for the products. The release of such information is not to be construed as a warranty of or a grant of license under Ricoh’s or any third party’s intellectual property rights or any other rights.

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 redundancy feature, firecontainment 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. Please contact Ricoh sales representatives should you have any questions or comments concerning the products or the technical information.

For the conservation of the global environment, Ricoh is advancing the decrease of the negative environmental impact material. After Apr. 1, 2006, we will ship out the lead free products only. Thus, all products that will be shipped from now on comply with RoHS Directive. Basically after Apr. 1, 2012, we will ship out the Power Management ICs of the Halogen Free products only. (Ricoh Halogen Free products are also Antimony Free.)