OUTLINE

The RS5RM Series are CMOS-based step-up DC/DC converter ICs equipped with a voltage regulator (VR) and a voltage detector (VD). Each of these step-up DC/DC converter ICs consists of a PWM DC/DC converter, a linear regulator and a voltage detector. These ICs are output-voltage-fixed type regulators which function as a linear regulator when input voltage is high, and as step-up DC/DC converter+linear regulator when input voltage is low, by using an inductor, a diode and a capacitor as external parts for the ICs.

Since a voltage detector is built in these ICs, the potentials such as the output voltage of DC/DC converters can be monitored.

In addition, these step-up DC/DC converter ICs are suitable for battery-powered and hand-held instruments because internal circuits can be turned off by the chip enable function so that the standby current can be minimized.

FEATURES

- Low Supply Current ...........................................Typ. 55µA (RS5RM3624A : VIN=3.0V, at no load)
- Standby Mode ....................................................Istandby=Max. 1.0µA (RS5RMxxxxA)
  Istandby=Max. 10.0µA (RS5RMxxxxB)
- Low Voltage Operation Possible ......................Operating Voltage VIN=1.2V to 10V
- High Output Voltage Accuracy ......................Fixed Output Voltage Accuracy±2.5%
- High Voltage Detection Accuracy .....................±2.5%
- Output Voltage can be set at User's request (refer to Selection Guide).
- Voltage close to battery's voltage can be output because these ICs are of a step-up / step-down type
  (Ex. a fixed voltage of 3V can be output by a 3V battery).
- Soft Start Function, built-in Protection Circuits for Lx Driver
- Phase Compensation Circuits built in
- Pin for External Driver is equipped, and a large current output can be obtained.
- Small Packages ...............................................8pin SOP

APPLICATIONS

- Power source for cameras, camcorders, and hand-held audio equipment.
- Power source for small OA apparatus such as note book personal computers, and word processors.
- Power source for hand-held communication appliances such as pagers, cordless telephones, and cellular phones.
SELECTION GUIDE

In the RS5RM Series, the output voltage, the detector threshold, the version symbols, and the taping type for
the ICs can be selected at the user's request.

The selection can be made by designating the part number as shown below:

\[ \text{RS5RMxxxxxx -xx} \leftarrow \text{Part Number} \]

\[ \uparrow \uparrow \uparrow \uparrow \leftarrow a \ b \ c \ d \]

<table>
<thead>
<tr>
<th>Code</th>
<th>Contents</th>
</tr>
</thead>
</table>
| a    | Setting Output Voltage (VOUT):
  Stepwise setting with a step of 0.1V in the range of 1.5V to 6.0V is possible. |
| b    | Setting Detector Threshold (–VDET):
  Stepwise setting with a step of 0.1V in the range of 1.2V to 5.0V is possible. |
| c    | Designation of Version Symbols:
  A: Operation of all the internal circuits is stopped by setting CE pin at VDD level.
  B: Operation of only Step-up DC/DC converter is stopped by setting CE pin at VDD level. |
| d    | Designation of Taping Type:
  Ex. 8pin SOP : T1, T2
  (refer to Taping Specification)
  “T2” is prescribed as a standard. |

For example, the product with Output Voltage 5.0V, Detector Threshold 4.5V, Version A, and Taping Type T1,
is designated by Part Number RS5RM5045A-T1.
PIN CONFIGURATION
• 8pin SOP

PIN DESCRIPTION

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<th>Pin No.</th>
<th>Symbol</th>
<th>Pin Description</th>
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<td>1</td>
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<td>Ground Pin</td>
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<tr>
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<td>CE</td>
<td>Chip Enable Pin</td>
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<tr>
<td>3</td>
<td>VDOUT</td>
<td>Voltage Detector Output Pin, Nch Open Drain Output</td>
</tr>
<tr>
<td>4</td>
<td>VDIN</td>
<td>Detection Input Pin of Voltage Detector</td>
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<tr>
<td>5</td>
<td>VOUT</td>
<td>Output Pin for Regulator</td>
</tr>
<tr>
<td>6</td>
<td>VDD</td>
<td>Step-up Output Pin, Power Supply Pin</td>
</tr>
<tr>
<td>7</td>
<td>EXT</td>
<td>External Transistor Drive Pin</td>
</tr>
<tr>
<td>8</td>
<td>LX</td>
<td>External Inductor Drive Pin</td>
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## ABSOLUTE MAXIMUM RATINGS

<rs5rm>

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<th>Unit</th>
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<tr>
<td>VDD</td>
<td>Supply Voltage</td>
<td>–0.3 to +12</td>
<td>V</td>
</tr>
<tr>
<td>VLX</td>
<td>Lx Pin Voltage</td>
<td>Vss–0.3 to +12</td>
<td>V</td>
</tr>
<tr>
<td>VEXT</td>
<td>EXT Pin Voltage</td>
<td>Vss–0.3 to VDD+0.3</td>
<td>V</td>
</tr>
<tr>
<td>VOUT</td>
<td>VOUT Pin Voltage</td>
<td>Vss–0.3 to VDD+0.3</td>
<td>V</td>
</tr>
<tr>
<td>VDOUT</td>
<td>VDOUT Pin Voltage</td>
<td>Vss–0.3 to +12</td>
<td>V</td>
</tr>
<tr>
<td>VCE</td>
<td>CE Pin Voltage</td>
<td>Vss–0.3 to VDD+0.3</td>
<td>V</td>
</tr>
<tr>
<td>VDIN</td>
<td>VDIN Pin Voltage</td>
<td>A Version: Vss–0.3 to VDD+0.3</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>B Version: Vss–0.3 to +12</td>
<td>V</td>
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<tr>
<td>ILX</td>
<td>Lx Pin Current</td>
<td>250</td>
<td>mA</td>
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<tr>
<td>IEXT</td>
<td>EXT Pin Current</td>
<td>50</td>
<td>mA</td>
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<td>PD</td>
<td>Power Dissipation</td>
<td>300</td>
<td>mW</td>
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<td>Topt</td>
<td>Operating Temperature Range</td>
<td>–30 to +80</td>
<td>°C</td>
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<td>Tstg</td>
<td>Storage Temperature Range</td>
<td>–55 to +125</td>
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<td>Tsolder</td>
<td>Lead Temperature (Soldering)</td>
<td>260°C, 10s</td>
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</table>

Absolute Maximum ratings are threshold limit values that must not be exceeded even for an instant under any conditions. Moreover, such values for any two items must not be reached simultaneously. Operation above these absolute maximum ratings may cause degradation or permanent damage to the device. These are stress ratings only and do not necessarily imply functional operation below these limits.
ELECTRICAL CHARACTERISTICS

**RS5RM3624A,B**

Topt=25°C

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<th>Symbol</th>
<th>Item</th>
<th>Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
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<td>Operation Input Voltage</td>
<td>No load</td>
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<tr>
<td>VDD</td>
<td>Step-up Output Voltage</td>
<td>No load</td>
<td>3.99</td>
<td>4.10</td>
<td>4.21</td>
<td>V</td>
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<tr>
<td>Voscst</td>
<td>Oscillator Start-up Voltage</td>
<td>No load</td>
<td>0.9</td>
<td>1.2</td>
<td>V</td>
<td></td>
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<tr>
<td>Vhold</td>
<td>Hold-on Voltage</td>
<td>IOUT=1mA</td>
<td>0.7</td>
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<td></td>
<td>V</td>
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<tr>
<td>fosc</td>
<td>Oscillator Frequency</td>
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<td>40</td>
<td>50</td>
<td>60</td>
<td>kHz</td>
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<tr>
<td>Maxdty</td>
<td>Oscillator Maximum Duty Cycle</td>
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<td>65</td>
<td>80</td>
<td>90</td>
<td>%</td>
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<td>VOL1</td>
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<td>0.5</td>
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<td></td>
<td>V</td>
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<tr>
<td>IOH1</td>
<td>Lx Leakage Current</td>
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<td>0.01</td>
<td>10.00</td>
<td>µA</td>
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<tr>
<td>Vlxlim</td>
<td>Lx Voltage Limit</td>
<td>LX Pin On</td>
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<td></td>
<td>V</td>
</tr>
<tr>
<td>VOH</td>
<td>EXT Output Pch ON Voltage</td>
<td>IEXT=–3mA, VDD=4.1V</td>
<td>3.6</td>
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<td></td>
<td>V</td>
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<tr>
<td>VOL2</td>
<td>EXT Output Nch ON Voltage</td>
<td>IEXT=5mA, VDD=4.1V</td>
<td>0.5</td>
<td></td>
<td></td>
<td>V</td>
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<tr>
<td>VOUT</td>
<td>Output Voltage</td>
<td>IRL=–5mA</td>
<td>3.51</td>
<td>3.60</td>
<td>3.69</td>
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<td>Vdif</td>
<td>Dropout Voltage</td>
<td>IRL=–30mA</td>
<td>0.3</td>
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<td></td>
<td>V</td>
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<tr>
<td>ΔVOUT/ΔIOUT</td>
<td>Load Regulation</td>
<td>–30mA≤IRL≤0mA</td>
<td>100</td>
<td></td>
<td></td>
<td>mV</td>
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<td>–VDET</td>
<td>Detector Threshold</td>
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<td>2.34</td>
<td>2.40</td>
<td>2.46</td>
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<td>60</td>
<td>120</td>
<td>240</td>
<td>mV</td>
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<td>VOL3</td>
<td>VDOUT ON Voltage</td>
<td>IOL=5mA</td>
<td>0.5</td>
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<td>V</td>
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<td>IOH2</td>
<td>VDOUT Leakage Current</td>
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<td>0.01</td>
<td>5.00</td>
<td>µA</td>
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<td>IVDINH</td>
<td>VDIN “H” Input Current</td>
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<td>µA</td>
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<td>IVDINL</td>
<td>VDIN “L” Input Current</td>
<td>VDIN=Vss</td>
<td>–0.5</td>
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<td>µA</td>
<td></td>
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<tr>
<td>VCEH</td>
<td>CE “H” Input Voltage</td>
<td>VDD–0.3</td>
<td>VDD</td>
<td>V</td>
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<td>VCEL</td>
<td>CE “L” Input Voltage</td>
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<td>0</td>
<td>0.2VDD</td>
<td>V</td>
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<td>CE “H” Input Current</td>
<td>CE=VDD</td>
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<td>0.5</td>
<td>µA</td>
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<td>CE “L” Input Current</td>
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<td>0.5</td>
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<tr>
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<td>Supply Current</td>
<td>VIN=3V, L=100µH, C=22µF, CE=Vss, No load</td>
<td>55</td>
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<td>µA</td>
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<td>1.0</td>
<td></td>
<td>µA</td>
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</table>

(Note 1) Standby current of Version A
(Note 2) Standby current of Version B

Please refer to Basic Circuit for Test Circuit.
<table>
<thead>
<tr>
<th>Symbol</th>
<th>Item</th>
<th>Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
<th>Note</th>
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<tr>
<td>VIN</td>
<td>Operation Input Voltage</td>
<td>No load</td>
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<td>V</td>
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<td>V</td>
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<td>IEXT=5mA,VDD=5.5V</td>
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<td>V</td>
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<td>Output Voltage</td>
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<td>∆VOUT/∆IOUT</td>
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<td>VOUT ON Voltage</td>
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<td>V</td>
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<td>IOH2</td>
<td>VOUT Leakage Current</td>
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<td>V</td>
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<td>VCEL</td>
<td>CE “L” Input Voltage</td>
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<td>0.2VDD</td>
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<td>ICEH</td>
<td>CE “H” Input Current</td>
<td>CE=VDD</td>
<td>–0.5</td>
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<td>CE=VSS</td>
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<td>µA</td>
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<td>IDD</td>
<td>Supply Current</td>
<td>VIN=4V, L=100µH, C=22µF, CE=VSS, No load</td>
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<td>10.0</td>
<td>µA</td>
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<td>Note2</td>
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</table>

(Note 1) Standby current of Version A
(Note 2) Standby current of Version B
Please refer to Basic Circuit for Test Circuit.
OPERATION OF STEP-UP DC/DC CONVERTER

Step-up DC/DC Converter charges energy in the inductor when Lx Transistor (LxTr) is ON, and discharges the energy with the addition of the energy from Input Power Source thereto when LxTr is OFF, so that a higher output voltage than the input voltage is obtained.

The operation will be explained with reference to the following diagrams:

Step.1: LxTr is turned ON and current IL (=i1) flows, so that energy is charged in L. At this moment, IL (=i1) is increased from ILmin (=0) to reach ILmax in proportion to the on-time period (ton) of LxTr.

Step.2: When LxTr is turned OFF, Schottky diode (SD) is turned ON in order that L maintains IL at ILmax, so that current IL (=i2) is released.

Step.3: IL (=i2) is gradually decreased, and in the case of discontinuous mode, IL reaches ILmin (=0) after a time period of topen, so that SD is turned OFF. In the case of a continuous mode, the time period (toff) runs out before IL reaches ILmin (=0), so that LxTr is turned ON in the next cycle, and SD is turned OFF. In this case, ILmin does not reach zero, and IL (=i1) increases from ILmin (>0).

In the case of PWM control system, with the oscillator frequency (fosc) maintained constant, the output voltage is maintained constant by controlling the on-time period (ton).
OPERATION

1. **VDD Output Voltage**

   VDD output voltage is shown in Fig. B.

   (1) In the case of $V_{IN} - V_f \geq V_{DD0}$:
   
   In Area B, LxTr is maintained in an OFF state, so that $V_{IN} - V_f (V)$ is output as it is from VDD pin without step-up operation.

   (2) In the case of $V_{IN} - V_f < V_{DD0}$:
   
   In Area A, this IC functions as Step-up DC/DC converter. The step-up operation will now be explained with reference to FIG. A. The step-up operation is an operation for regulating the VDD output voltage by comparing Vref1 and the VDD output voltage by error amplifier circuits and subjecting LxTr to on-time control by PWM circuits (i.e., by controlling the step-up operation).

2. **VOUT Output Voltage**

   A constant voltage is output from VOUT pin, with above-mentioned the VDD output voltage being subjected to a step-down operation by a linear regulator. This step-down operation will now be explained with reference to FIG. A. The step-down operation is an operation for regulating the VDD output voltage by Pch Tr by comparing Vref2 and the VDD output voltage.

   | $V_{IN}$  | Input Voltage         |
   | $V_{DD0}$ | VDD Set Voltage       |
   | $V_{OUT0}$| VOUT Set Voltage      |
   | $V_f$     | ON Voltage of Diode   |

![FIG. A Diagram of RS5RM including external circuits](image)

![FIG. B Output Voltage vs. Input Voltage characteristic](image)
TEST CIRCUITS

Test Circuit 1

Test Circuit 2

Test Circuit 3

Test Circuit 4

Test Circuit 5

Digitizing Oscilloscope (for Trigger)

Note 1
Discontinued
By use of these test circuits, the typical characteristics were obtained as shown in the following pages:

Test Circuit 1: Typical Characteristics 1) 2) 3) 4) 5) 9) 10) 13) 14) 16)

(Typical Characteristics 13) and 14) were measured by replacing the capacitor shown in Note1 with a 1µF Capacitor)

Test Circuit 2: Typical Characteristics 11) 12)

Test Circuit 3: Typical Characteristics 7) 8)

Efficiency η is shown by the following formula:

\[
\eta = \frac{V_{OUT} \times I_{OUT}}{V_{IN} \times I_{IN}}
\]

Test Circuit 4: Typical Characteristics 6)

Test Circuit 5: Typical Characteristics 15)

Test Circuit 6: Typical Characteristics 17)

Test Circuit 7: Typical Characteristics 18)

Test Circuit 8: Typical Characteristics 19) 20)

In the present IC, input current at no load is defined as supply current. (\(\overline{CE}=VSS\)).

And when \(\overline{CE}=VDD\), the input current (no load) is defined as standby current.
TYPICAL CHARACTERISTICS

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

**RS5RM5045A**

- **Input Voltage VIN(V):** 0 2 4 6 8 10
- **Output Voltage VOUT(V):** 4.0 4.5 5.0 5.5
- **IOUT:** 10mA, 20mA, 30mA, 40mA

**RS5RM3624A**

- **Input Voltage VIN(V):** 0 2 4 6 8 10
- **Output Voltage VOUT(V):** 2.5 3.0 3.5 4.0
- **IOUT:** 10mA, 20mA, 30mA, 40mA

**RS5RM3329A**

- **Input Voltage VIN(V):** 0 2 4 6 8 10
- **Output Voltage VOUT(V):** 2.5 3.0 3.5 4.0
- **IOUT:** 10mA, 20mA, 30mA, 40mA

**RS5RM4036A**

- **Input Voltage VIN(V):** 0 2 4 6 8 10
- **Output Voltage VOUT(V):** 3.0 3.5 4.0 4.5
- **IOUT:** 10mA, 20mA, 30mA, 40mA

**RS5RM3531A**

- **Input Voltage VIN(V):** 0 2 4 6 8 10
- **Output Voltage VOUT(V):** 2.5 3.0 3.5
- **IOUT:** 10mA, 20mA, 30mA, 40mA

**RS5RM3027A**

- **Input Voltage VIN(V):** 0 2 4 6 8 10
- **Output Voltage VOUT(V):** 2.0 2.5 3.0 3.5
- **IOUT:** 10mA, 20mA, 30mA, 40mA

Discontinued
2) Output Voltage vs. Output Current (Topt=25˚C)

**RS5RM5045A**

- Output Voltage $V_{OUT}(V)$
  - 4.0
  - 4.5
  - 5.0
  - 5.5
- Output Current $I_{OUT}(mA)$
  - 0
  - 50
  - 100
  - 150
- $V_{IN}=2V$
- $V_{IN}=3V$
- $V_{IN}=4V$

**RS5RM4036A**

- Output Voltage $V_{OUT}(V)$
  - 3.0
  - 3.5
  - 4.0
- Output Current $I_{OUT}(mA)$
  - 0
  - 50
  - 100
  - 150
- $V_{IN}=2V$
- $V_{IN}=3V$
- $V_{IN}=4V$

**RS5RM3624A**

- Output Voltage $V_{OUT}(V)$
  - 2.5
  - 3.0
  - 3.5
  - 4.0
- Output Current $I_{OUT}(mA)$
  - 0
  - 20
  - 40
  - 60
  - 80
  - 100
- $V_{IN}=2V$
- $V_{IN}=3V$
- $V_{IN}=4V$

**RS5RM3531A**

- Output Voltage $V_{OUT}(V)$
  - 2.5
  - 3.0
  - 3.5
- Output Current $I_{OUT}(mA)$
  - 0
  - 20
  - 40
  - 60
  - 80
  - 100
- $V_{IN}=2V$
- $V_{IN}=3V$

**RS5RM3329A**

- Output Voltage $V_{OUT}(V)$
  - 2.5
  - 3.0
  - 3.5
- Output Current $I_{OUT}(mA)$
  - 0
  - 20
  - 40
  - 60
  - 80
  - 100
- $V_{IN}=2V$
- $V_{IN}=3V$

**RS5RM3027A**

- Output Voltage $V_{OUT}(V)$
  - 2.5
  - 3.0
- Output Current $I_{OUT}(mA)$
  - 0
  - 20
  - 40
  - 60
  - 80
  - 100
- $V_{IN}=2V$
- $V_{IN}=3V$

*Discontinued*
3) Ripple Voltage vs. Output Current (Topt=25˚C)

![Graph showing ripple voltage vs. output current for different load conditions and output capacitance values.](image)

- RS5RM5045A L=100µH, COUT=22µF, Tantalum
- RS5RM5045A L=47µH, COUT=22µF, Tantalum
- RS5RM5045A L=100µH, COUT=47µF, Tantalum
- RS5RM5045A L=220µH, COUT=100µF, Aluminum electrolytic

VIN=1.2V

Discontinued
4) Efficiency vs. Input Voltage (Topt=25˚C)

**RS5RM5045A**

```
Input Voltage VIN(V)

<table>
<thead>
<tr>
<th>VIN (V)</th>
<th>Efficiency η (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
</tr>
</tbody>
</table>
```

- I_{OUT} = 40mA
- I_{OUT} = 30mA
- I_{OUT} = 20mA
- I_{OUT} = 10mA

**RS5RM4036A**

```
Input Voltage VIN(V)

<table>
<thead>
<tr>
<th>VIN (V)</th>
<th>Efficiency η (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
</tr>
</tbody>
</table>
```

- I_{OUT} = 40mA
- I_{OUT} = 30mA
- I_{OUT} = 20mA
- I_{OUT} = 10mA

**RS5RM3624A**

```
Input Voltage VIN(V)

<table>
<thead>
<tr>
<th>VIN (V)</th>
<th>Efficiency η (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
</tr>
</tbody>
</table>
```

- I_{OUT} = 40mA
- I_{OUT} = 30mA
- I_{OUT} = 20mA
- I_{OUT} = 10mA

**RS5RM3531A**

```
Input Voltage VIN(V)

<table>
<thead>
<tr>
<th>VIN (V)</th>
<th>Efficiency η (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
</tr>
</tbody>
</table>
```

- I_{OUT} = 40mA
- I_{OUT} = 30mA
- I_{OUT} = 20mA
- I_{OUT} = 10mA

**RS5RM3229A**

```
Input Voltage VIN(V)

<table>
<thead>
<tr>
<th>VIN (V)</th>
<th>Efficiency η (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
</tr>
</tbody>
</table>
```

- I_{OUT} = 40mA
- I_{OUT} = 30mA
- I_{OUT} = 20mA
- I_{OUT} = 10mA

**RS5RM3027A**

```
Input Voltage VIN(V)

<table>
<thead>
<tr>
<th>VIN (V)</th>
<th>Efficiency η (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
</tr>
</tbody>
</table>
```

- I_{OUT} = 40mA
- I_{OUT} = 30mA
- I_{OUT} = 20mA
- I_{OUT} = 10mA

Discontinued
5) Efficiency vs. Output Current (Topt=25°C)

RS5RM5045A

RS5RM4036A

RS5RM3624A

RS5RM3531A

RS5RM3329A

RS5RM3027A

Discontinued

Discontinued
6) Soft Start Time vs. Input Voltage (Topt=25°C)

- RS5RM5045B, CVDD=22µF, Cout=1µF
- RS5RM5045B, CVDD=22µF, Cout=47µF
- RS5RM5045B, CVDD=22µF, Cout=100µF

7) Oscillator Frequency vs. Temperature

- RS5RM3624A

8) Oscillator Maximum Duty Cycle vs. Temperature

9) Output Voltage (Vdd) vs. Temperature
10) Output Voltage vs. Temperature

11) Detector Threshold vs. Temperature

12) VD Output Voltage vs. VD Input Voltage

13) Supply Current vs. Input Voltage

14) Standby Current vs. Temperature

15) VD Input Current vs. VD Input Voltage
16) Start-up/Hold-on Voltage vs. Output Current

![Graph showing the relationship between Start-up/Hold-on Voltage and Output Current for RS5RM5045A.]

Discontinued
17) Load Transient Response

**RS5RM5045A**

- VIN = 3.0V
- COUT = 1µF
- Output Voltage VOUT (V)
- Output Current IOUT (mA)

**RS5RM5045A**

- VIN = 5.0V
- COUT = 1µF
- Output Voltage VOUT (V)
- Output Current IOUT (mA)

**RS5RM5045A**

- VIN = 3.0V
- COUT = 47µF
- Output Voltage VOUT (V)
- Output Current IOUT (mA)

Discontinued
RS5RM5045A

VIN=5.0V
COUT=47µF

Output Voltage
Output Current

1mA

RS5RM5045A

VIN=3.0V
COUT=100µF

Output Voltage
Output Current

1mA

RS5RM5045A

VIN=5.0V
COUT=100µF

Output Voltage
Output Current

1mA

Discontinued

Discontinued
18) Line Transient Response

**RS5RM5045A**

- **Output Voltage (V):**
  - 4.4
  - 4.5
  - 4.6
  - 4.7
  - 4.8
  - 4.9
  - 5.0
  - 5.1
  - 5.2
  - 5.3
  - 5.4

- **Input Voltage (V):**
  - 4
  - 6
  - 8
  - 10
  - 12
  - 14

- **Time t (ms):**
  - -2
  - 0
  - 2
  - 4
  - 6
  - 8
  - 10
  - 12

**RS5RM5045A**

- **Output Voltage (V):**
  - 4.4
  - 4.5
  - 4.6
  - 4.7
  - 4.8
  - 4.9
  - 5.0
  - 5.1
  - 5.2
  - 5.3
  - 5.4

- **Input Voltage (V):**
  - 4
  - 6
  - 8
  - 10
  - 12
  - 14

- **Time t (ms):**
  - -2
  - 0
  - 2
  - 4
  - 6
  - 8
  - 10
  - 12

**RS5RM5045A**

- **Output Voltage (V):**
  - 4.4
  - 4.5
  - 4.6
  - 4.7
  - 4.8
  - 4.9
  - 5.0
  - 5.1
  - 5.2
  - 5.3
  - 5.4

- **Input Voltage (V):**
  - 4
  - 6
  - 8
  - 10
  - 12
  - 14

- **Time t (ms):**
  - -2
  - 0
  - 2
  - 4
  - 6
  - 8
  - 10
  - 12

---

Discontinued
RS5RM5045A

Output Voltage Vout (V)

Input Voltage Vin (V)

Iout=30mA
Cout=47µF

Time t (ms)

Output Voltage

Input Voltage

RS5RM5045A

Output Voltage Vout (V)

Input Voltage Vin (V)

Iout=30mA
Cout=47µF

Time t (ms)

Output Voltage

Input Voltage

RS5RM5045A

Output Voltage Vout (V)

Input Voltage Vin (V)

Iout=1mA
Cout=100µF

Time t (ms)

Output Voltage

Input Voltage

Discontinued
RS5RM5045A

Output Voltage $V_{OUT}$ (V)

Input Voltage $V_{IN}$ (V)

Time $t$ (ms)

RS5RM5045A

Output Voltage $V_{OUT}$ (V)

Input Voltage $V_{IN}$ (V)

Time $t$ (ms)

RS5RM5045A

Output Voltage $V_{OUT}$ (V)

Input Voltage $V_{IN}$ (V)

Time $t$ (ms)

Discontinued
19) Output Voltage vs. VDD Output Current

**RS5RM5045A**

<table>
<thead>
<tr>
<th>VDD Output Current (mA)</th>
<th>Output Voltage VOUT/VDD (V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>2.0V</td>
</tr>
<tr>
<td>200</td>
<td>3.0V</td>
</tr>
<tr>
<td>300</td>
<td>4.0V</td>
</tr>
</tbody>
</table>

**RS5RM5045A**

<table>
<thead>
<tr>
<th>VDD Output Current (mA)</th>
<th>Output Voltage VOUT/VDD (V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>400</td>
<td>2.0V</td>
</tr>
<tr>
<td>500</td>
<td>3.0V</td>
</tr>
<tr>
<td>600</td>
<td>4.0V</td>
</tr>
<tr>
<td>700</td>
<td>5.0V</td>
</tr>
</tbody>
</table>

**RS5RM5045A**

<table>
<thead>
<tr>
<th>VDD Output Current (mA)</th>
<th>Output Voltage VOUT/VDD (V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>800</td>
<td>2.0V</td>
</tr>
<tr>
<td>900</td>
<td>3.0V</td>
</tr>
</tbody>
</table>

20) Efficiency vs. VDD Output Current

**RS5RM5045A**

<table>
<thead>
<tr>
<th>Efficiency η (%)</th>
<th>VDD Output Current (mA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>2.0V</td>
</tr>
<tr>
<td>30</td>
<td>3.0V</td>
</tr>
<tr>
<td>40</td>
<td>4.0V</td>
</tr>
</tbody>
</table>

**RS5RM5045A**

<table>
<thead>
<tr>
<th>Efficiency η (%)</th>
<th>VDD Output Current (mA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>2.0V</td>
</tr>
<tr>
<td>60</td>
<td>3.0V</td>
</tr>
<tr>
<td>70</td>
<td>4.0V</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Efficiency η (%)</th>
<th>VDD Output Current (mA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>80</td>
<td>2.0V</td>
</tr>
<tr>
<td>90</td>
<td>3.0V</td>
</tr>
</tbody>
</table>

(Note) Efficiency η at Typical Characteristics 20) is shown by the following formula:

\[
\eta = \frac{(V_{DD} \times I_{DOUT}) + (V_{OUT} \times I_{OUT})}{V_{IN} \times I_{IN}} \times 100
\]
BASIC CIRCUIT

Examples of Parts: 
Inductor: RCR-664D (100µH) ; Sumida Electric Co., Ltd.
Diode: MA721 (Schottky type) ; Matsushita Electronics Corporation
Capacitor: 22µF (Tantalum type)
TYPICAL APPLICATIONS

• Current Boost Circuit 1

![Circuit Diagram 1]

Examples of Components
- L: 47 µH (SUMIDA ELECTRIC CD105)
- D: Schottky Diode (HITACHI HRP22)
- CIN: 220 µF (Aluminum electrolytic Type)
- CVDD: 100 µF (Tantalum type) / 220 µF (Aluminum electrolytic Type)
- COUT: 47 µF (Tantalum Type)

• Current Boost Circuit 2 (High Efficiency Circuit)

![Circuit Diagram 2]

Examples of Components
- L: 47 µH (SUMIDA ELECTRIC CD105)
- D: Schottky Diode (HITACHI HRP22)
- CIN: 220 µF (Aluminum electrolytic Type)
- CVDD: 33 µF (Tantalum type) / 220 µF (Aluminum electrolytic Type)
- COUT: 47 µF (Tantalum Type)

- Cd: 0.01 µF
- Cbe: 0.1 µF (RS5RM5045x, RS5RM4036x, RS5RM3624x)
- 100 µF (RS5RM3531x, RS5RM3329x, RS5RM3027x)
- NPN Tr: 2SD1628
- PNP Tr: 2SA1213
- Rb1: 220 Ω
- Rb2: 330 Ω
- Rbe: 12 kΩ

(Nota) High efficiency current boost circuit using RS5RM5045x with RN5RG50A (RICOH Voltage Regulator).
When using these ICs, be sure to take care of the following points:

- Set external components as close as possible to the IC and minimize the connection between the components and the IC. In particular, when an external component is connected to VOUT Pin, make minimum connection with the capacitor.

- Make sufficient grounding. A large current flows through VSS Pin by switching. When the impedance of the VSS connection is high, the potential within the IC is varied by the switching current. This may result in unstable operation of the IC.

- Use capacitor with a capacity of 10µF or more, and with good high frequency characteristics such as tantalum capacitor. We recommend the use of a capacitor with an allowable voltage which is at least three times the output set voltage. This is because there may be the case where a spike-shaped high voltage is generated by the inductor when Lx transistor is turned OFF.

- Take the utmost care when choosing a inductor. Namely, choose such an inductor that has sufficiently small d.c. resistance and large allowable current, and hardly reaches magnetic saturation. When the inductance value of the inductor is small, there may be the case where ILx exceeds the absolute maximum ratings at the maximum load. Use an inductor with an appropriate inductance.

- Use a diode of a Schottky type with high switching speed, and also take care of the rated current.

The performance of power source circuits using these ICs largely depends upon the peripheral components. Take the utmost care in the selection of the peripheral components. In particular, design the peripheral circuits in such a manner that the values such as voltage, current and power of each component, PCB patterns and the IC do not exceed their respective rated values.
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Ricoh completed the organization of the Lead-free production for all of our products. 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.

RICOH COMPANY, LTD.  Electronic Devices Company

RICOH COMPANY, LTD.
Electronic Devices Company

RICOH EUROPE (NETHERLANDS) B.V.

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