OUTLINE

The R1162x Series consist of CMOS-based voltage regulator ICs with high output voltage accuracy and low supply current. 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 so on. The output voltage is internally fixed with high accuracy.

These ICs perform with the chip enable function and realize a standby mode with ultra low supply current. To prevent the destruction by over current, the current limit circuit is included. The R1162x 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 at Low Power Mode compared with Fast Transient Mode. The output voltage is maintained between FT mode and LP mode.

Since the packages for these ICs are SOT-23-5 and SON1612-6 packages, high density mounting of the ICs on boards is possible.

FEATURES

- Supply Current ....................................................... Typ. 5.5μA (Low Power Mode),
  Typ. 70μA (Fast Transient Mode)
- Standby Current..................................................... Typ. 0.1μA
- High Ripple Rejection ............................................Typ. 70dB (f=1kHz, Fast Transient Mode)
  Typ. 60dB (f=10kHz, Fast Transient Mode)
- Input Voltage Range .............................................. 2.0V to 6.0V
- Output Voltage Range ............................................ 1.5V to 4.0V (0.1V steps)
  (For other voltages, please refer to MARK INFORMATIONS.)
- Output Voltage Accuracy........................................... ±2.0% (±3.0% at Low Power Mode)
- Temperature-Drift Coefficient of Output Voltage ...Typ. ±100ppm/°C
- Dropout Voltage .................................................... Typ. 0.25V (Iout=150mA, Vout=2.8V)
- Line Regulation ..................................................... Typ. 0.02%/V
- Package ............................................................... SON1612-6, SOT-23-5
- Built-in fold-back protection circuit .................Typ. 40mA (Current at short mode)
- Performs with Ceramic Capacitors .................Cin=1.0μF, Cout=0.47μF

APPLICATIONS

- Precision Voltage References.
- Power source for electrical appliances such as cameras, VCRs and hand-held communication equipment.
- Power source for battery-powered equipment.
The output voltage, auto discharge function, 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>R1162Dxx1+-TR-FE</td>
<td>SON1612-6</td>
<td>4,000 pcs</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>R1162Nxx1+-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.)

*: The auto discharge function at off state are options as follows.
(B) without auto discharge function at off state
(D) with auto discharge function at off state
PIN CONFIGURATIONS

- **SON1612-6**

- **SOT-23-5**

PIN DESCRIPTIONS

- **SON1612-6**

<table>
<thead>
<tr>
<th>Pin No</th>
<th>Symbol</th>
<th>Pin Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CE</td>
<td>Chip Enable Pin (&quot;H&quot; Active)</td>
</tr>
<tr>
<td>2</td>
<td>GND</td>
<td>Ground Pin</td>
</tr>
<tr>
<td>3</td>
<td>VDD</td>
<td>Input Pin</td>
</tr>
<tr>
<td>4</td>
<td>VOUT</td>
<td>Output Pin</td>
</tr>
<tr>
<td>5</td>
<td>GND</td>
<td>Ground Pin</td>
</tr>
<tr>
<td>6</td>
<td>ECO</td>
<td>MODE alternative pin</td>
</tr>
</tbody>
</table>

- **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</td>
<td>Chip Enable Pin (&quot;H&quot; Active)</td>
</tr>
<tr>
<td>4</td>
<td>ECO</td>
<td>MODE alternative pin</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>$V_{IN}$</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 6.5</td>
<td>V</td>
</tr>
<tr>
<td>$V_{CE}$</td>
<td>Input Voltage (CE Pin)</td>
<td>−0.3 to 6.5</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>180</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>$T_{opt}$</td>
<td>Operating Temperature Range</td>
<td>−40 ~ 85</td>
<td>°C</td>
</tr>
<tr>
<td>$T_{stg}$</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.

### 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

**R1162xxx1B/D**

**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>$V_{\text{IN}} = \text{Set } V_{\text{OUT}} + 1V$ $V_{\text{ECO}} = V_{\text{IN}}$ $1mA \leq I_{\text{OUT}} \leq 30mA$</td>
<td>$V_{\text{OUT}}$ x0.98</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$\Delta V_{\text{OUT}}$</td>
<td>Output Voltage Deviation between FT Mode and LP Mode</td>
<td>$V_{\text{IN}} = \text{Set } V_{\text{OUT}} + 1V$ $V_{\text{OUT}} \leq 2.0V$</td>
<td>-1.2</td>
<td>0.0</td>
<td>1.2</td>
<td>%</td>
</tr>
<tr>
<td>$I_{\text{OUT}}$</td>
<td>Output Current</td>
<td>$V_{\text{IN}} - V_{\text{OUT}} = 1.0V$</td>
<td>150</td>
<td></td>
<td></td>
<td>mA</td>
</tr>
</tbody>
</table>

### Symbol Descriptions

- **VIN**: Input Voltage
- **VOUT**: Output Voltage
- **IOUT**: Output Current
- **VECO**: Output Enable Signal
- **Istandby**: Supply Current (Standby)
- **Isc**: Short Current Limit
- **IPD**: CE Pull-down Constant Current
- **Rpd**: ECO Pull-down Resistance
- **VCEH**: CE, ECO Input Voltage "H"
- **VCEL**: CE, ECO Input Voltage "L"
- **en**: Output Noise
- **RLOW**: Nch On resistance for auto-discharge (Applied to D version)
ELECTRICAL CHARACTERISTICS by OUTPUT VOLTAGE

<table>
<thead>
<tr>
<th>Output Voltage $V_{\text{out}}$ (V)</th>
<th>Dropout Voltage (mV)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Condition</td>
</tr>
<tr>
<td>$1.5 \leq V_{\text{out}} &lt; 1.6$</td>
<td>400</td>
</tr>
<tr>
<td>$1.6 \leq V_{\text{out}} &lt; 1.7$</td>
<td>380</td>
</tr>
<tr>
<td>$1.7 \leq V_{\text{out}} &lt; 1.8$</td>
<td>350</td>
</tr>
<tr>
<td>$1.8 \leq V_{\text{out}} &lt; 2.0$</td>
<td>340</td>
</tr>
<tr>
<td>$2.0 \leq V_{\text{out}} &lt; 2.8$</td>
<td>290</td>
</tr>
<tr>
<td>$2.8 \leq V_{\text{out}} \leq 4.0$</td>
<td>250</td>
</tr>
</tbody>
</table>

$I_{\text{out}} = 150\text{mA}$

TYPICAL APPLICATION

(External Components)
C2 Ceramic 0.47μF  Ex. Murata GRM40B474K
Kyocera CM105B474K

C1 Ceramic 1.0μF
TYPICAL CHARACTERISTICS Unless otherwise provided, capacitors are ceramic type.

1) Output Voltage vs. Output Current

**R1162x15x (ECO=H)**

- **Vin=2V**
- **Vin=2.5V-3.5V**

**R1162x15x (ECO=L)**

- **Vin=2V**
- **Vin=2.5V-3.5V**

**R1162x28x (ECO=H)**

- **Vin=3.1V**
- **Vin=3.3V-4.8V**

**R1162x28x (ECO=L)**

- **Vin=3.1V**
- **Vin=3.3V-4.8V**

**R1162x40x (ECO=H)**

- **Vin=4.3V**
- **Vin=4.5V-6.0V**

**R1162x40x (ECO=L)**

- **Vin=4.3V**
- **Vin=4.5V-6.0V**
2) Output Voltage vs. Input Voltage

R1162x15x (ECO=H)

R1162x15x (ECO=L)

R1162x28x (ECO=H)

R1162x28x (ECO=L)

R1162x40x (ECO=H)

R1162x40x (ECO=L)
3) Supply Current vs. Input Voltage

**R1162x15x (ECO=H)**

**R1162x15x (ECO=L)**

**R1162x28x (ECO=H)**

**R1162x28x (ECO=L)**

**R1162x40x (ECO=H)**

**R1162x40x (ECO=L)**
4) Output Voltage vs. Temperature

**R1162x15x (ECO=H)**

- **Output Voltage H** (VOUTH): 1.46, 1.47, 1.53, 1.50, 1.49, 1.52, 1.51, 1.48
- **Output Voltage L** (VOUTL): 2.76, 2.77, 2.83, 2.80, 2.79, 2.82, 2.81, 2.78

**R1162x15x (ECO=L)**

- **Output Voltage H** (VOUTH): 1.48, 1.49, 1.52, 1.51, 1.50, 1.49, 1.47, 1.46
- **Output Voltage L** (VOUTL): 2.78, 2.79, 2.81, 2.80, 2.79, 2.78, 2.77, 2.76

**R1162x28x (ECO=H)**

- **Output Voltage H** (VOUTH): 2.76, 2.77, 2.83, 2.80, 2.79, 2.82, 2.81, 2.78
- **Output Voltage L** (VOUTL): 3.97, 3.98, 4.05, 4.02, 4.01, 4.04, 4.03, 4.00

**R1162x28x (ECO=L)**

- **Output Voltage H** (VOUTH): 2.78, 2.79, 2.81, 2.80, 2.79, 2.78, 2.77, 2.76
- **Output Voltage L** (VOUTL): 4.00, 4.01, 4.04, 4.03, 4.02, 4.05, 4.04, 4.03

**R1162x40x (ECO=H)**

- **Output Voltage H** (VOUTH): 3.97, 3.98, 4.05, 4.03, 4.02, 4.04, 4.03, 4.01
- **Output Voltage L** (VOUTL): 3.99, 3.99, 4.02, 4.01, 4.00, 4.03, 4.02, 4.01

**R1162x40x (ECO=L)**

- **Output Voltage H** (VOUTH): 4.00, 4.01, 4.04, 4.03, 4.02, 4.05, 4.04, 4.03
- **Output Voltage L** (VOUTL): 4.01, 4.02, 4.04, 4.03, 4.02, 4.05, 4.04, 4.03
5) Supply Current vs. Temperature

R1162x15x (ECO=H)

R1162x15x (ECO=L)

R1162x28x (ECO=H)

R1162x28x (ECO=L)

R1162x40x (ECO=H)

R1162x40x (ECO=L)
6) Dropout Voltage vs. Output Current

**R1162x15x (ECO=H)**

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Dropout Voltage (V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>85°C</td>
<td>0.5</td>
</tr>
<tr>
<td>25°C</td>
<td>0.4</td>
</tr>
<tr>
<td>-40°C</td>
<td>0.3</td>
</tr>
</tbody>
</table>

**R1162x15x (ECO=L)**

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Dropout Voltage (V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>85°C</td>
<td>0.5</td>
</tr>
<tr>
<td>25°C</td>
<td>0.4</td>
</tr>
<tr>
<td>-40°C</td>
<td>0.3</td>
</tr>
</tbody>
</table>

**R1162x16x (ECO=H)**

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Dropout Voltage (V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>85°C</td>
<td>0.5</td>
</tr>
<tr>
<td>25°C</td>
<td>0.4</td>
</tr>
<tr>
<td>-40°C</td>
<td>0.3</td>
</tr>
</tbody>
</table>

**R1162x16x (ECO=L)**

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Dropout Voltage (V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>85°C</td>
<td>0.5</td>
</tr>
<tr>
<td>25°C</td>
<td>0.4</td>
</tr>
<tr>
<td>-40°C</td>
<td>0.3</td>
</tr>
</tbody>
</table>

**R1162x17x (ECO=H)**

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Dropout Voltage (V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>85°C</td>
<td>0.5</td>
</tr>
<tr>
<td>25°C</td>
<td>0.4</td>
</tr>
<tr>
<td>-40°C</td>
<td>0.3</td>
</tr>
</tbody>
</table>

**R1162x17x (ECO=L)**

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Dropout Voltage (V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>85°C</td>
<td>0.5</td>
</tr>
<tr>
<td>25°C</td>
<td>0.4</td>
</tr>
<tr>
<td>-40°C</td>
<td>0.3</td>
</tr>
</tbody>
</table>
R1162x

Dropdown Voltage H: $V_{DIFH}(V)$

Dropdown Voltage L: $V_{DIFL}(V)$

Output Current $I_{OUT}(mA)$

Temperature:
- 85°C
- 25°C
- -40°C

Limited Product
7) Dropout Voltage vs. Set Output Voltage

R1162x (ECO=H)

8) Ripple Rejection vs. Input Bias Voltage

R1162x28x (ECO=H)
9) Ripple Rejection vs. Frequency

**R1162x15x (ECO=H)**

\[ C_{in}=\text{none}, \quad C_{out}=0.47\mu F, \quad V_{in}=2.5V_{DC}+0.2V_{P-P}, \quad I_{out}=30mA \quad \text{Ripple}=0.2V_{P-P} \]

\[ C_{in}=\text{none}, \quad C_{out}=0.47\mu F, \quad V_{in}=2.5V_{DC}+0.2V_{P-P}, \quad I_{out}=50mA \quad \text{Ripple}=0.5V_{P-P} \]

**R1162x15x (ECO=L)**

\[ C_{in}=\text{none}, \quad C_{out}=0.47\mu F, \quad V_{in}=2.5V_{DC}+0.2V_{P-P}, \quad I_{out}=1mA \]

\[ C_{in}=\text{none}, \quad C_{out}=0.47\mu F, \quad V_{in}=2.5V_{DC}+0.2V_{P-P}, \quad I_{out}=30mA \]

\[ C_{in}=\text{none}, \quad C_{out}=0.47\mu F, \quad V_{in}=2.5V_{DC}+0.2V_{P-P}, \quad I_{out}=50mA \]
10) Input Transient Response

**R1162x15x (ECO=H)**

C\(_{\text{in}}\)=none, C\(_{\text{out}}\)=0.47\(\mu\)F, I\(_{\text{out}}\)=30mA

**R1162x15x (ECO=L)**

C\(_{\text{in}}\)=none, C\(_{\text{out}}\)=0.47\(\mu\)F, I\(_{\text{out}}\)=10mA
11) Load Transient Response

R1162x15x (ECO=H)

\[ V_{IN}=2.5V, \ C_{IN}=1\mu F, \ C_{OUT}=0.47\mu F \]

---

R1162x28x (ECO=H)

\[ C_{IN}=none, \ C_{OUT}=0.47\mu F, \ I_{OUT}=10mA \]
12) Turn on speed with CE pin

R1162x28x (ECO=H)  
$V_{IN}=3.8\text{V}, C_{IN}=1\mu\text{F}, C_{OUT}=1\mu\text{F}$

R1162x28x (ECO=L)  
$V_{IN}=3.8\text{V}, C_{IN}=1\mu\text{F}, C_{OUT}=0.47\mu\text{F}$

R1162x15x (ECO=H)  
$V_{IN}=2.5\text{V}, C_{IN}=1\mu\text{F}, C_{OUT}=0.47\mu\text{F}, I_{OUT}=0\text{mA}$

R1162x15x (ECO=L)  
$V_{IN}=2.5\text{V}, C_{IN}=1\mu\text{F}, C_{OUT}=0.47\mu\text{F}, I_{OUT}=0\text{mA}$
R1162x

R1162x28x (ECO=H)
- $V_{IN}=3.8\,V$, $C_{IN}=1\,\mu F$, $C_{OUT}=0.47\,\mu F$, $I_{OUT}=30\,mA$

R1162x28x (ECO=L)
- $V_{IN}=3.8\,V$, $C_{IN}=1\,\mu F$, $C_{OUT}=0.47\,\mu F$, $I_{OUT}=30\,mA$

R1162x28x (ECO=H)
- $V_{IN}=3.8\,V$, $C_{IN}=1\,\mu F$, $C_{OUT}=0.47\,\mu F$, $I_{OUT}=150\,mA$

R1162x28x (ECO=L)
- $V_{IN}=3.8\,V$, $C_{IN}=1\,\mu F$, $C_{OUT}=0.47\,\mu F$, $I_{OUT}=150\,mA$

R1162x40x (ECO=H)
- $V_{IN}=5.0\,V$, $C_{IN}=1\,\mu F$, $C_{OUT}=0.47\,\mu F$, $I_{OUT}=0\,mA$

R1162x40x (ECO=L)
- $V_{IN}=5.0\,V$, $C_{IN}=1\,\mu F$, $C_{OUT}=0.47\,\mu F$, $I_{OUT}=0\,mA$
VIN=5.0V, CIN=1μF, COUT=0.47μF, IOUT=30mA

VIN=5.0V, CIN=1μF, COUT=0.47μF, IOUT=150mA
13) Turn off speed with CE pin

**R1162x15xD**

VIN=2.5V, Cin=1μF, Cout=0.47μF

**R1162x28xD**

VIN=3.8V, Cin=1μF, Cout=0.47μF

**R1162x40xD**

VIN=5.0V, Cin=1μF, Cout=0.47μF

Limited Product
14) Output Voltage at Mode alternative point

R1162x15x
VIN=2.5V, CIN=Ceramic 1.0μF,
COUT=Ceramic 0.47μF

R1162x28x
VIN=3.8V, CIN=Ceramic 1.0μF,
COUT=Ceramic 0.47μF

Limited Product
TECHNICAL NOTES

(External Components)

C2 Ceramic 0.47μF  Ex. Murata GRM40B474K
Kyocera CM105B474K

C1 Ceramic 1.0μF

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 as much as 1.0μF capacitor between VDD and GND pin 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.

2. Phase Compensation
   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 0.47μF or more capacitor COUT with good frequency characteristics and ESR (Equivalent Series Resistance).
   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:

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) in the range described as follows:

The relations between $I_{\text{OUT}}$ (Output Current) and ESR of 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.

<Test conditions>

(1) Frequency band: 10Hz to 2MHz

R1162x15x (ECO=H) $V_N=2.0V$ to $6.0V$, $C_{\text{IN}}=1μF$, $C_{\text{OUT}}=0.47μF$

R1162x15x (ECO=L) $V_N=2.0V$ to $6.0V$, $C_{\text{IN}}=1μF$, $C_{\text{OUT}}=0.47μF$

R1162x28x (ECO=H) $V_N=3.1V$ to $6.0V$, $C_{\text{IN}}=1μF$, $C_{\text{OUT}}=0.47μF$

R1162x28x (ECO=L) $V_N=3.1V$ to $6.0V$, $C_{\text{IN}}=1μF$, $C_{\text{OUT}}=0.47μF$
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.

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

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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.)

RoHS Compliant
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