RICOH

R5540K SERIES

N-channel Load Switch IC

OUTLINE

The R5540 series are N-channel Load Switch ICs with the low supply current, Typ. 9µA. By using an N-channel transistor as a driver transistor, the features of low on resistance and the reverse current protection at off state are realized in these ICs. The gate voltage of the N-channel transistor is supplied from the internal step-up circuit. The R5540 is an ideal switch to supply the power from the secondary power source such as the output of a step-down DC/DC to the load circuit. Since the package for the R5540 is the ultra small-sized DFN(PLP)1010-4F, high density mounting on board is possible.

FEATURES

- Built-in an N-channel MOSFET
- Input Voltage Range ........................................... 0.75V to 3.6V (Code 002)
  ................................................................. 0.8V to 3.6V (Code 004)
- Supply Current at Operation (I_{OUT}=0mA) .......... Typ. 9µA
- Supply Current at Standby Mode .................. Typ. 0.7µA
- Switch On Resistance ........................................ Typ. 120mΩ (V_{IN}=1.2V)
- Output Current ................................................. Min. 200mA Min. 450mA
- Package ...................................................... DFN(PLP)1010-4F
- Built-in Over-current Sensing Circuit .......... TYP. 350mA/ TYP. 700mA
- Built-in Soft-start function

APPLICATION

- For secondary power source for electrical appliances such as mobile communication equipments, cameras, VCRs and Camcorders.
R5540K

BLOCK DIAGRAMS

R5540KxxxB

R5540KxxxC

R5540KxxxD
SELECTION GUIDE

The output current value, the auto-discharge function and the polarity of CE pin from "L" active, "H" active are selectable 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>R5540Kxxx+-TR</td>
<td>DFN(PLP)1010-4F</td>
<td>10,000pcs</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

xxx: The output current value can be designated by the following codes.
- 002: Output Current (200mA)
- 004: Output Current (450mA)

*: Auto-discharge function at off state and the polarity of CE pin are option as follows.
- B: "H" active, without auto-discharge function at off state
- C: "L" active, with auto-discharge function at off state
- D: "H" active, with auto-discharge function at off state

PIN CONFIGULATIONS
PIN DESCRIPTION

● R5540K : DFN(PLP)1010-4F

<table>
<thead>
<tr>
<th>Pin No</th>
<th>Symbol</th>
<th>Pin Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>GND</td>
<td>Ground Pin</td>
</tr>
<tr>
<td>2</td>
<td>CE</td>
<td>Chip Enable Pin (&quot;L&quot; Active / &quot;H&quot; Active)</td>
</tr>
<tr>
<td>3</td>
<td>VIN</td>
<td>Input Pin</td>
</tr>
<tr>
<td>4</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>VIN</td>
<td>Input Voltage</td>
<td>-0.3 to 5.0</td>
<td>V</td>
</tr>
<tr>
<td>VCE</td>
<td>Input Voltage (CE / CE Pin)</td>
<td>-0.3 to 5.0</td>
<td>V</td>
</tr>
<tr>
<td>VOUT</td>
<td>Output Voltage</td>
<td>-0.3 to 5.0</td>
<td>V</td>
</tr>
<tr>
<td>IOUT</td>
<td>Output Current</td>
<td>Internally limited</td>
<td>mA</td>
</tr>
<tr>
<td>PD</td>
<td>Power Dissipation (Standard Test Land Pattern)*</td>
<td>300</td>
<td>mW</td>
</tr>
<tr>
<td>Ta</td>
<td>Ambient Temperature</td>
<td>-40 to 85</td>
<td>°C</td>
</tr>
<tr>
<td>Tstg</td>
<td>Storage Temperature</td>
<td>-55 to 125</td>
<td>°C</td>
</tr>
</tbody>
</table>

*) For Power Dissipation, please refer to Power Dissipation to be described.

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

$V_{IN} = 0.75$ to $3.60\text{V}(\text{Code 002})$, $0.80$ to $3.60\text{V}(\text{Code 004})$, $C_{IN} = 1\mu\text{F}$, $C_{OUT} = \text{None}$, unless otherwise noted.

*The specification in surrounded by [ ] is guaranteed by design at all temperature range, $-40^\circ\text{C} \leq Ta \leq 85^\circ\text{C}$.*

**R5540Kxxxx**

<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>$V_{IN}$</td>
<td>Input Voltage</td>
<td>Code 002</td>
<td>0.75</td>
<td>3.60</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Code 004</td>
<td>0.80</td>
<td>3.60</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$R_{ON}$</td>
<td>Switch ON Resistance</td>
<td>Code 002</td>
<td></td>
<td></td>
<td>120</td>
<td>mΩ</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Code 004</td>
<td></td>
<td></td>
<td>180</td>
<td></td>
</tr>
<tr>
<td>$I_{OUT}$</td>
<td>Output Current</td>
<td>Code 002</td>
<td>200</td>
<td></td>
<td></td>
<td>mA</td>
</tr>
<tr>
<td>$I_{OUT}$</td>
<td>Output Current</td>
<td>Code 004</td>
<td>450</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_{SS}$</td>
<td>Supply Current</td>
<td>$I_{OUT}=0\text{mA}$ *Note1</td>
<td>9</td>
<td>40</td>
<td></td>
<td>µA</td>
</tr>
<tr>
<td>$I_{standby}$</td>
<td>Standby Current</td>
<td>$V_{OUT}=\text{GND}$</td>
<td>0.7</td>
<td></td>
<td></td>
<td>µA</td>
</tr>
<tr>
<td>$I_{standby}$</td>
<td></td>
<td>$V_{IN}=1.8\text{V}$ *Note2</td>
<td>Ta=25°C</td>
<td>5</td>
<td></td>
<td>µA</td>
</tr>
<tr>
<td>$I_{standby}$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Ta=85°C</td>
<td></td>
</tr>
<tr>
<td>$I_{LIM}$</td>
<td>Current Limit</td>
<td>Code 002</td>
<td>200</td>
<td>350</td>
<td>500</td>
<td>mA</td>
</tr>
<tr>
<td>$I_{LIM}$</td>
<td>Current Limit</td>
<td>Code 004</td>
<td>450</td>
<td>700</td>
<td>1000</td>
<td></td>
</tr>
<tr>
<td>$I_{SC}$</td>
<td>Short Current Limit</td>
<td>$V_{IN}=1.2\text{V}$, $V_{OUT}=0\text{V}$</td>
<td>50</td>
<td>100</td>
<td></td>
<td>mA</td>
</tr>
<tr>
<td>$I_{CE}$</td>
<td>CE Input Current</td>
<td>C version</td>
<td>0.4</td>
<td></td>
<td></td>
<td>µA</td>
</tr>
<tr>
<td>$I_{CEPD}$</td>
<td>CE Pull-down Current</td>
<td>B, D version</td>
<td>0.7</td>
<td></td>
<td></td>
<td>µA</td>
</tr>
<tr>
<td>$V_{CEH}$</td>
<td>CE Input Voltage “H”</td>
<td>$V_{IN}=2.5\text{V}$ to $3.6\text{V}$</td>
<td>1.0</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{IN}=1.0\text{V}$ to $2.5\text{V}$</td>
<td>0.9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{IN}=0.75\text{V}$ to $1.0\text{V}$</td>
<td>$V_{IN} \times 0.9$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{CEL}$</td>
<td>CE Input Voltage “L”</td>
<td>$V_{IN}=0.75\text{V}$ to $3.6\text{V}$</td>
<td>0.4</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$R_{LOW}$</td>
<td>Auto-discharge Nch Tr. ON Resistance</td>
<td>$V_{IN}=1.2\text{V}$ *Note2</td>
<td>100</td>
<td></td>
<td></td>
<td>Ω</td>
</tr>
<tr>
<td>$t_{r}$</td>
<td>Output Rise Time</td>
<td>$V_{IN}=1.2\text{V}$, $V_{OUT}=10%$ ~ $90%$</td>
<td>73</td>
<td></td>
<td></td>
<td>µs</td>
</tr>
<tr>
<td>$t_{SC}$</td>
<td>Short Current Response Time</td>
<td>$V_{OUT}=0\text{V}$</td>
<td>30</td>
<td></td>
<td></td>
<td>µs</td>
</tr>
</tbody>
</table>

*Note1 $\overline{CE}=\text{L}$ for “L” active, $CE=\text{H}$ for “H” active

*Note2 $\overline{CE}=\text{H}$ for “L” active, $CE=\text{L}$ for “H” active

All test categories were tested on the units under the pulse load condition $(Tj=Ta=25^\circ\text{C})$ except Short Current Response Time.
TYPICAL APPLICATION

Basically, the R5540K series do not require a bypass capacitor between \( V_{\text{IN}} \) and GND, however, considering the spike noise caused by the high side inductor at current limit, use 0.1uF or more capacitor as a bypass capacitor. More capacitance is also acceptable depending on the application.
TYPICAL CHARACTERISTIC

1) Output Voltage vs. Output Current $C_{IN}=1\mu F$, $C_{OUT}=1\mu F$

2) Turn on waveform (002x, $V_{IN}=1.2V$, $C_{IN}=1\mu F$, $T_{a}=25°C$)
3) Inrush current vs. output capacitor (002x)        4) Input voltage vs. Turn-on speed

5) Supply current vs. Temperature   6) Standby current vs. Input voltage

7) Standby Current vs. Temperature   8) Standby current vs. Input voltage
9) CE Input voltage "H" vs. Temperature

CE Input Voltage "H"

10) CE Input voltage "H" vs. VDD

VCEH vs VDD

11) CE Input voltage "L" vs. Temperature

CE Input Voltage "L"

12) CE Input voltage "L" vs. VDD

VCEL vs VDD

13) Short current limit vs. Temperature

Short Current Limit

14) Short current limit vs. Input voltage

Isc vs VIN

15) Switch on resistance vs. Temperature

Switch On Resistance

16) Switch on resistance vs. Input voltage

RON vs VIN
17) Output Rise time vs. Temperature

Output Turn On Delay

- $V_{IN}=0.8V$
- $V_{IN}=1.8V$
- $V_{IN}=3.6V$

18) Output Rise time vs. Input voltage

$tr$ vs $V_{IN}$

- $-40^\circ C$
- $25^\circ C$
- $85^\circ C$

19) Output Fall time vs. Temperature

Output Turn Off Delay

$tf$ vs $V_{IN}$

- $-40^\circ C$
- $25^\circ C$
- $85^\circ C$

20) Output Fall time vs. Input voltage

21) Reverse leakage current vs. Temperature

Reverse Leakage Current

$IREV$ vs $V_{IN}$

- $-40^\circ C$
- $25^\circ C$
- $85^\circ C$
23) Discharge resistance vs. Temperature

24) Discharge resistance vs. Input voltage

25) Current limit vs. Temperature (002x)

26) Current limit vs. Input voltage (002x)

TIMING CHART
Turn-on/turn-off waveform ($V_{\text{IN}} = 1.2[V]$)

- No Load
  - $t_{\text{ON}}$: 124.6 [$\mu s$]
  - $t_{\text{tr}}$: 124.3 [$\mu s$]

- 10Ω
  - $t_{\text{ON}}$: 256.9 [$\mu s$]
  - $t_{\text{tr}}$: 140.6 [$\mu s$]
POWER DISSIPATION (DFN(PLP)1010H4F)

Power Dissipation ($P_D$) depends on conditions of mounting on board. This specification is based on the measurement at the condition below:

**Measurement Conditions**

<table>
<thead>
<tr>
<th>Environment</th>
<th>Standard Land Pattern</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mounting on Board</td>
<td>Mounting on Board (Wind velocity=0m/s)</td>
</tr>
<tr>
<td>Board Material</td>
<td>Glass cloth epoxy plastic (Double sided)</td>
</tr>
<tr>
<td>Board Dimensions</td>
<td>40mm×40mm×1.6mm</td>
</tr>
<tr>
<td>Copper Ratio</td>
<td>Top side: Approx. 50%, Back side: Approx. 50%</td>
</tr>
<tr>
<td>Through-holes</td>
<td>φ 0.54mm×24pcs</td>
</tr>
</tbody>
</table>

**Measurement Result**

$\theta_{ja}=(125-25°C)/0.3W=330 °C/W$

$\theta_{jc}=48 °C/W$

On Board

![Power Dissipation Graph](image)

**Measurement Board Pattern**

![Measurement Board Pattern](image)
Ricoh is committed to reducing the environmental loading materials in electrical devices with a view to contributing to the protection of human health and the environment. Ricoh has been providing RoHS compliant products since April 1, 2006 and Halogen-free products since April 1, 2012.

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