OUTLINE

The R1151N Series are CMOS-based boost type voltage regulator ICs with high output voltage accuracy, low supply current, and high ripple rejection. Each of these voltage regulator controllers consists of a voltage reference unit, an error amplifier, comparators, resistors for output and reset voltage setting, a current limit protection circuit, and a chip enable circuit.

In addition to low consumption current by CMOS process, the chip enable function prolongs the battery life. Dynamic response and ripple rejection of the R1151N Series are excellent, further these are low noise type, plus maximum operating input voltage tolerance is up to 18.5V, thus these ICs are very suitable for the power supply for handheld equipment and other power management applications using AC adapter input voltage.

The output voltage of these ICs is internally fixed with high accuracy. Since the package for these ICs is SOT-23-6 (Mini-mold) package, high density mounting of the ICs on boards is possible.

FEATURES

- Ultra-Low Supply Current ............................................... Typ. 70µA (IOUT=0mA)
- Standby Mode ............................................................... Typ. 0.1µA
- Low Dropout Voltage ..................................................... Typ. 0.1V (IOUT=100mA *Depends on External Transistor)
- High Ripple Rejection ................................................... Typ. 60dB (f=1kHz)
- Low Temperature-Drift Coefficient of Output Voltage ...... Typ.±100ppm/°C
- High Output Voltage Accuracy ................................. ±2.0%
- Excellent Dynamic Response
- Small Package ............................................................... SOT-23-6 (Mini-mold)
- Output Voltage ............................................................. Stepwise setting with a step of 0.1V in the range of 2.5V to 9.0V
- Built-in chip enable circuit (2 types; A: active low, B: active high)
- Output Capacitor .......................................................... Tantalum type recommendation (or Ceramic+Series Resistor)
- Built-in output voltage detector ................................. with delay (C version)
- Detector Threshold Tolerance ....................................... ±2.5%
- Operating Input Voltage ............................................... Max. 18.5V

APPLICATIONS

- Power source for handheld equipment such as cameras and videos.
- Power source for home appliances.
- Power source for battery-powered equipment.
**SELECTION GUIDE**

The output voltage, mask option code, and the taping type for the ICs can be selected at the user's request. The selection can be made with designating the part number as shown below:

\[ \text{R1151Nxxxx-xx} \rightarrow \text{Part Number} \]

\[ \uparrow \uparrow \uparrow \]

a  b  c

<table>
<thead>
<tr>
<th>Code</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>Code Number for Voltage Setting</td>
</tr>
</tbody>
</table>
| b    | Setting mask option :  
|      | A: with CE (active at "L" type)  
|      | B: with CE (active at "H" type)  
|      | C: with the pin for external capacitor to set the output delay of voltage detector |
| c    | Designation of Taping Type :  
|      | Ex. TR (Refer to Taping Specifications.) |
PIN CONFIGURATION

SOT-23-6

1  EXT  External Transistor Drive Pin
2  VDET  Voltage Detector Output Pin
3  VOUT  Voltage Regulator Output Pin
4  CE or CE  Chip Enable Pin (A/B version)
5  GND  Ground Pin
6  VDD  Input Pin

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Item</th>
<th>Rating</th>
<th>Unit</th>
</tr>
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<tbody>
<tr>
<td>VIN</td>
<td>Input Voltage</td>
<td>20</td>
<td>V</td>
</tr>
<tr>
<td>VCE/CD</td>
<td>Input Voltage (CE/CE/CD Pin)</td>
<td>-0.3 – VIN+0.3</td>
<td>V</td>
</tr>
<tr>
<td>VOUT</td>
<td>Output Voltage (VOUT Pin)</td>
<td>-0.3 – VIN+0.3</td>
<td>V</td>
</tr>
<tr>
<td>VEXT</td>
<td>Output Voltage (EXT Pin)</td>
<td>-0.3 – VIN+0.3</td>
<td>V</td>
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<tr>
<td>IEXT</td>
<td>EXT Output Current</td>
<td>30</td>
<td>mA</td>
</tr>
<tr>
<td>PD</td>
<td>Power Dissipation</td>
<td>150</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>
## ELECTRICAL CHARACTERISTICS

### R1151NxxxA/B

<table>
<thead>
<tr>
<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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</thead>
<tbody>
<tr>
<td>VOUT</td>
<td>Output Voltage</td>
<td>VIN = Set VOUT + 1V, IOUT = 50mA</td>
<td>VOUT \times 0.98</td>
<td>VOUT</td>
<td>VOUT \times 1.02</td>
<td>V</td>
</tr>
<tr>
<td>IOUT</td>
<td>Output Current</td>
<td>VIN - VOUT = 1.0V</td>
<td>1mA</td>
<td>IOUT</td>
<td>100mA</td>
<td>A</td>
</tr>
<tr>
<td>ΔVOUT/ΔIOUT</td>
<td>Load Regulation</td>
<td>VIN = Set VOUT + 1V, IOUT = 1mA ≤ IOUT ≤ 100mA</td>
<td>Refer to the Load Regulation Table</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VIN</td>
<td>Dropout Voltage</td>
<td>IOUT = 100mA</td>
<td>0.1mA</td>
<td>VIN</td>
<td>0.2</td>
<td>V</td>
</tr>
<tr>
<td>IS</td>
<td>Supply Current</td>
<td>VIN = Set VOUT + 1V, IOUT = 0mA</td>
<td>70</td>
<td>IS</td>
<td>100</td>
<td>µA</td>
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<tr>
<td>Istandby</td>
<td>Supply Current (StandBy)</td>
<td>VIN = 18.5V</td>
<td>15</td>
<td>Istandby</td>
<td>µA</td>
<td></td>
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<tr>
<td>IEXTleak</td>
<td>EXT Leakage Current</td>
<td></td>
<td>0.5</td>
<td>IEXTleak</td>
<td>µA</td>
<td></td>
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<tr>
<td>ΔVOUT/ΔVIN</td>
<td>Line Regulation</td>
<td>Set VOUT + 0.3V ≤ VIN ≤ 18.5V, IOUT = 50mA</td>
<td>0.00</td>
<td>ΔVOUT/ΔVIN</td>
<td>0.10</td>
<td>%/V</td>
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<tr>
<td>RR</td>
<td>Ripple Rejection</td>
<td>f = 1kHz, Ripple 0.5Vpp</td>
<td>60</td>
<td>RR</td>
<td>dB</td>
<td></td>
</tr>
<tr>
<td>VIN</td>
<td>Input Voltage</td>
<td></td>
<td></td>
<td>VIN</td>
<td>18.5</td>
<td>V</td>
</tr>
<tr>
<td>ΔVOUT/ΔT</td>
<td>Output Voltage Temperature Coefficient</td>
<td>IOUT = 1mA, 40°C ≤ TTop ≤ 85°C</td>
<td>±100</td>
<td>ΔVOUT/ΔT</td>
<td>ppm/°C</td>
<td></td>
</tr>
<tr>
<td>Ilim</td>
<td>Current Limit</td>
<td>Base Current IB of PNP Tr., VIN - VOUT = 1.0V</td>
<td>8</td>
<td>Ilim</td>
<td>27</td>
<td>mA</td>
</tr>
<tr>
<td>IBPT</td>
<td>Short Current Limit</td>
<td>Base Current IB of PNP Tr., VOUT = 0V</td>
<td>0.7</td>
<td>IBPT</td>
<td>mA</td>
<td></td>
</tr>
<tr>
<td>RUD</td>
<td>CE, CE Pull-up/down Resistance</td>
<td></td>
<td>2</td>
<td>RUD</td>
<td>MΩ</td>
<td></td>
</tr>
<tr>
<td>VCEH</td>
<td>CE, CE Input Voltage 'H'</td>
<td>VIN</td>
<td>1.5</td>
<td>VCEH</td>
<td>VIN</td>
<td>V</td>
</tr>
<tr>
<td>VCEL</td>
<td>CE, CE Input Voltage 'L'</td>
<td>0.00</td>
<td>VCEL</td>
<td>0.25</td>
<td>V</td>
<td></td>
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<tr>
<td>-VDET</td>
<td>Detector Threshold</td>
<td>VDET</td>
<td>-VDET × 0.975</td>
<td>-VDET</td>
<td>-VDET × 1.025</td>
<td>V</td>
</tr>
<tr>
<td>VTHY</td>
<td>Detector Threshold Hysteresis Range</td>
<td>-VDET</td>
<td>-VTHY × 0.03</td>
<td>-VTHY</td>
<td>-VTHY × 0.05</td>
<td>V</td>
</tr>
<tr>
<td>IOUT2</td>
<td>Output Current 2</td>
<td>VIN = 1.5V, VOUT = 0.5V</td>
<td>2.0</td>
<td>IOUT2</td>
<td>5.0</td>
<td>10.0</td>
</tr>
<tr>
<td>ΔVDDET/ΔT</td>
<td>Detector Threshold Temperature Coefficient</td>
<td>-40°C ≤ TTop ≤ 85°C</td>
<td>±100</td>
<td>ΔVDDET/ΔT</td>
<td>ppm/°C</td>
<td></td>
</tr>
<tr>
<td>tPLH</td>
<td>Output Delay Time</td>
<td></td>
<td>0.1</td>
<td>tPLH</td>
<td>ms</td>
<td></td>
</tr>
<tr>
<td>VODL</td>
<td>Minimum Operating Voltage</td>
<td></td>
<td>0.9</td>
<td>VODL</td>
<td>1.1</td>
<td>V</td>
</tr>
</tbody>
</table>

Note: This item depends on the capability of external PNP transistor. Use low saturation type transistor with hFE value range of 100 to 300.
### Symbol Item Conditions \[\text{Min.} \times \text{Typ.} \times \text{Max.} \times \text{Unit}\]

<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>(\text{V}_{\text{OUT}})</td>
<td>Output Voltage</td>
<td>(\text{VIN} = \text{Set } \text{V}<em>{\text{OUT}}+1\text{V}) (\text{I}</em>{\text{OUT}} = 50\text{mA})</td>
<td>(\times 0.98)</td>
<td>(\times 1.02)</td>
<td>(\times 1)</td>
<td>(\text{V})</td>
</tr>
<tr>
<td>(\text{I}_{\text{OUT}})</td>
<td>Output Current</td>
<td>(\text{VIN} - \text{V}_{\text{OUT}} = 1\text{V})</td>
<td>(1\text{mA} \leq \text{I}_{\text{OUT}} \leq 100\text{mA})</td>
<td>(1\text{%})</td>
<td>(1\text{%})</td>
<td>(1\text{%})</td>
</tr>
<tr>
<td>(\Delta \text{V}<em>{\text{OUT}}/\Delta \text{I}</em>{\text{OUT}})</td>
<td>Load Regulation</td>
<td>(\text{VIN} = \text{Set } \text{V}<em>{\text{OUT}}+1\text{V}) (1\text{mA} \leq \text{I}</em>{\text{OUT}} \leq 100\text{mA})</td>
<td>Refer to the Load Regulation Table</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(\text{V}_{\text{DET}})</td>
<td>Dropout Voltage</td>
<td>(\text{I}_{\text{OUT}} = 100\text{mA})</td>
<td>(0.1\text{%})</td>
<td>(0.1\text{%})</td>
<td>(0.1\text{%})</td>
<td>(\text{V})</td>
</tr>
<tr>
<td>(\text{I}_{\text{SS}})</td>
<td>Supply Current</td>
<td>(\text{VIN} = \text{Set } \text{V}<em>{\text{OUT}}+1\text{V}; \text{I}</em>{\text{OUT}} = 0\text{mA})</td>
<td>70</td>
<td>100</td>
<td>70</td>
<td>(\mu\text{A})</td>
</tr>
<tr>
<td>(\text{I}_{\text{EXTleak}})</td>
<td>EXT Leakage Current</td>
<td></td>
<td>0.5</td>
<td>(\mu\text{A})</td>
<td>(\mu\text{A})</td>
<td>(\mu\text{A})</td>
</tr>
<tr>
<td>(\Delta \text{V}<em>{\text{OUT}}/\Delta \text{I}</em>{\text{IN}})</td>
<td>Line Regulation</td>
<td>(\text{Set } \text{V}<em>{\text{OUT}}+0.5\text{V} \leq \text{VIN} \leq 15\text{V}) (\text{I}</em>{\text{OUT}} = 50\text{mA})</td>
<td>0.00</td>
<td>0.02</td>
<td>0.10</td>
<td>%\text{V})</td>
</tr>
<tr>
<td>(\text{RR})</td>
<td>Ripple Rejection</td>
<td>(f = 1\text{kHz}, \text{Ripple } 0.5\text{Vp-p}) (\text{VIN} = \text{Set } \text{V}_{\text{OUT}}+1\text{V})</td>
<td>60</td>
<td>(\text{dB})</td>
<td>(\text{dB})</td>
<td>(\text{dB})</td>
</tr>
<tr>
<td>(\text{V}_{\text{IN}})</td>
<td>Input Voltage</td>
<td></td>
<td>18.5</td>
<td>(\text{V})</td>
<td>(\text{V})</td>
<td>(\text{V})</td>
</tr>
<tr>
<td>(\Delta \text{V}<em>{\text{OUT}}/\Delta \text{V}</em>{\text{IN}})</td>
<td>Output Voltage</td>
<td>(\text{Temperature Coefficient}) (\text{I}_{\text{OUT}} = 10\text{mA}) (-40^\circ\text{C} \leq \text{Topt} \leq 85^\circ\text{C})</td>
<td>(\pm 100)</td>
<td>ppm</td>
<td>(\pm 100)</td>
<td>(\text{ppm})</td>
</tr>
<tr>
<td>(\text{R}_{\text{lim}})</td>
<td>Current Limit</td>
<td>(\text{Base Current } \text{of PNP Tr.}) (\text{VIN} - \text{V}_{\text{OUT}} = 1\text{V})</td>
<td>8</td>
<td>27</td>
<td>27</td>
<td>(\text{mA})</td>
</tr>
<tr>
<td>(\text{I}_{\text{BPT}})</td>
<td>Short Current Limit</td>
<td>(\text{Base Current } \text{of PNP Tr.}) (\text{V}_{\text{OUT}} = 0\text{V})</td>
<td>0.7</td>
<td>(\text{mA})</td>
<td>(\text{mA})</td>
<td>(\text{mA})</td>
</tr>
<tr>
<td>(\Delta \text{V}_{\text{DET}})</td>
<td>Detector Threshold</td>
<td>(\text{Hysteresis Range}) (\text{V}<em>{\text{DET}} = 0\text{V}) (\text{V}</em>{\text{IN}} = \text{V}_{\text{DET}})</td>
<td>(\text{V}_{\text{DET}} &gt; 0.975)</td>
<td>(\text{V}_{\text{DET}} &gt; 1\text{V})</td>
<td>(\text{V}_{\text{DET}} &gt; 1\text{V})</td>
<td>(\text{V})</td>
</tr>
<tr>
<td>(\text{V}_{\text{HYS}})</td>
<td>Detector Threshold</td>
<td>(\text{V}<em>{\text{DET}} = 0.5\text{V}) (\text{Hysteresis Range}) (\text{V}</em>{\text{DET}} = 0.5\text{V})</td>
<td>(\text{V}_{\text{DET}} &gt; 0.03)</td>
<td>(\text{V}_{\text{DET}} &gt; 0.05)</td>
<td>(\text{V}_{\text{DET}} &gt; 0.07)</td>
<td>(\text{V})</td>
</tr>
<tr>
<td>(\text{I}_{\text{OUT2}})</td>
<td>Output Current 2</td>
<td>(\text{VIN} = 1.5\text{V}, \text{V}_{\text{DS}} = 0.5\text{V})</td>
<td>2.0</td>
<td>5.0</td>
<td>10.0</td>
<td>(\text{mA})</td>
</tr>
<tr>
<td>(\Delta \text{V}<em>{\text{DET}}/\Delta \text{V}</em>{\text{IN}})</td>
<td>Detector Threshold</td>
<td>(\text{Temperature Coefficient}) (-40^\circ\text{C} \leq \text{Topt} \leq 85^\circ\text{C})</td>
<td>( \pm 100)</td>
<td>ppm</td>
<td>( \pm 100)</td>
<td>( \pm 100)</td>
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<tr>
<td>(\text{t}_{\text{PLH}})</td>
<td>Output Delay Time</td>
<td>(\text{CD} = 220\text{pF})</td>
<td>0.9</td>
<td>1.6</td>
<td>2.7</td>
<td>(\text{ms})</td>
</tr>
<tr>
<td>(\text{V}_{\text{DDL}})</td>
<td>Minimum Operating Voltage</td>
<td></td>
<td>0.9</td>
<td>1.1</td>
<td>1.1</td>
<td>(\text{V})</td>
</tr>
</tbody>
</table>

**Note1:** This item depends on the capability of external PNP transistor. Use low saturation type transistor with \(\text{hFE}\) value range of 100 to 300.

**Note2:** \(\text{V}_{\text{DET}}\) pin is pulled-up to \(\text{V}_{\text{DD}}\) via 470k\(\Omega\) resistance. The time is between the rising edge of \(\text{V}_{\text{OUT}}\) level from 0.9V to \((+\text{V}_{\text{DET}})+2.0\text{V}\) and the reaching point to \(((+\text{V}_{\text{DET}})+2.0\text{V})/2\) of the \(\text{V}_{\text{DET}}\) output voltage.
• Load Regulation Table

<table>
<thead>
<tr>
<th>Output Voltage $V_{OUT}$ (V)</th>
<th>Load Regulation $\Delta V_{OUT}/\Delta I_{OUT}$ (mV)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Typ.</td>
</tr>
<tr>
<td>2.5 to 3.3</td>
<td>20</td>
</tr>
<tr>
<td>3.4 to 5.0</td>
<td>30</td>
</tr>
<tr>
<td>5.1 to 7.0</td>
<td>40</td>
</tr>
<tr>
<td>7.1 to 9.0</td>
<td>50</td>
</tr>
</tbody>
</table>

OPERATION

In these ICs, fluctuation of Output Voltage, $V_{OUT}$ is detected by the feedback registers, and the result is compared with a reference voltage with the error amplifier and control the base current of an external PNP transistor so that a constant voltage is output. The base current is monitored with the base current limit circuit. If the base current may be too large, the protection circuit works, further, output voltage is monitored with the built-in voltage detector. If the set detector threshold voltage is detected, reset signal will be output.

TECHNICAL NOTES

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 as much as $10\mu F$ capacitor as CL with good frequency characteristics and ESR (Equivalent Series Resistance). The best suitable equivalent series resistor value (ESR) is approximately $1\Omega$.

If the ESR of the output capacitor is too large, output may be unstable, therefore fully evaluation is necessary.

Make $V_{DD}$ and GND lines sufficient. When their impedance of these is high, noise pickup or unstable operation may be the result. Connect a capacitor with capacitance value of as much as $10\mu F$ between $V_{DD}$ and GND as close as possible to these pins. Set external components, especially output capacitor, as close as possible to the ICs.

Refer to the next equation to calculate the output delay time of C version and decide the capacitance value for the delay time.

$t_{PLH} = 1.83 \times C/(300 \times 10^{-9})$

$C$: Capacitance value (F)

Recommended pull-up resistance ($R_1$) value is $470k\Omega$. If the value is too small, released voltage may shift, therefore, use $10k\Omega$ or more value resistor.
TEST CIRCUITS

Fig.1 Standard test Circuit
R1=470kΩ, C1=220pF, C2=10µF

Fig.2 Supply Current Test Circuit
C1=220pF, C2=10µF

Fig.3 Ripple Rejection, Line Transient Response Test Circuit
C1=220pF, C2=10µF

Fig.4 Load Transient Response Test Circuit
C1=220pF, C2=10µF

TYPICAL APPLICATION

(External Components)
C1 10µF R1 = 470kΩ PNP Tr.: 2SA1441, 2SB940, 2SB703
CL 10µF
**TYPICAL CHARACTERISTICS**

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

a. External Tr.: 2SA1441

<table>
<thead>
<tr>
<th>VIN</th>
<th>Output Voltage VROUT (V)</th>
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</thead>
<tbody>
<tr>
<td>9.3</td>
<td>6.00</td>
</tr>
<tr>
<td>9.5</td>
<td>5.50</td>
</tr>
<tr>
<td>11</td>
<td>5.00</td>
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<tr>
<td>10</td>
<td>4.50</td>
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<table>
<thead>
<tr>
<th>VIN</th>
<th>Output Voltage VROUT (V)</th>
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</thead>
<tbody>
<tr>
<td>5.3</td>
<td>3.50</td>
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<td>5.5</td>
<td>3.25</td>
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<td>6</td>
<td>3.00</td>
</tr>
<tr>
<td>7</td>
<td>2.75</td>
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</table>

b. External Tr.: 2SB940

<table>
<thead>
<tr>
<th>VIN</th>
<th>Output Voltage VROUT (V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>11.0</td>
<td>6.00</td>
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<tr>
<td>10.0</td>
<td>5.50</td>
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<tr>
<td>9.5</td>
<td>5.00</td>
</tr>
<tr>
<td>9.3</td>
<td>4.50</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>VIN</th>
<th>Output Voltage VROUT (V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.0</td>
<td>2.50</td>
</tr>
<tr>
<td>6.0</td>
<td>2.00</td>
</tr>
<tr>
<td>5.3</td>
<td>1.50</td>
</tr>
<tr>
<td>5.5</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Limited Product
R1151N

Output Current $I_{OUT}(mA)$

Output Voltage $V_{ROUT}(V)$

$V_{DD}=5.3V$

$V_{DD}=4.3V$

$V_{DD}=3.8V$

$V_{DD}=3.6V$

$V_{IN}=11.0V$

$V_{IN}=10.0V$

$V_{IN}=9.5V$

$V_{IN}=9.3V$

Limited Product

c. External Tr.:2SB703

R1151N (VR=9.0V)

Output Current $I_{OUT}(mA)$

Output Voltage $V_{ROUT}(V)$

$V_{IN}=11.0V$

$V_{IN}=10.0V$

$V_{IN}=9.5V$

$V_{IN}=9.3V$

$V_{DD}=4.5V$

$V_{DD}=3.5V$

$V_{DD}=3.0V$

$V_{DD}=2.8V$

Limited Product
d. Output Voltage vs. Base Current (Topt=25°C)

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

External Transistor: 2SA1441
3) Output Voltage vs. Temperature

### R1151N (VR=2.5V)

- **Input Voltage VIN(V):**
  - 1.00
  - 2.00
  - 3.00

- **Output Voltage VOUT(V):**
  - 1.25
  - 1.50

### R1151N (VR=5.0V)

- **Input Voltage VIN(V):**
  - 6.0V

- **Output Voltage VOUT(V):**
  - 5.025
  - 4.975

### R1151N (VR=3.3V)

- **Input Voltage VIN(V):**
  - 3.5V

- **Output Voltage VOUT(V):**
  - 3.375
  - 3.355
4) Supply Current vs. Input Voltage

External Tr.:2SA1441

R1151N (VR=9.0V, -VD=8.0V)

![Graph 1](image1)

R1151N (VR=5.0V, -VD=4.2V)

![Graph 2](image2)

R1151N (VR=3.3V, -VD=2.9V)

![Graph 3](image3)

5) Supply Current vs. Temperature

a. External Tr.:2SA1441

R1151N (VR=9.0V)

![Graph 4](image4)

R1151N (VR=5.0V)

![Graph 5](image5)
b. External Tr.: 2SB703

R1151N (VR=3.3V)

R1151N (VR=2.5V)

R1151N (VR=9.0V)

R1151N (VR=5.0V)

Limited Product
6) Ripple Rejection vs. Ripple Frequency (Topt=25°C)

- **R1151N (VR=9.0V)**
- **R1151N (VR=5.0V)**
- **R1151N (VR=3.3V)**
- **R1151N (VR=2.5V)**

7) Ripple Rejection vs. Temperature

- **R1151N (VR=5.0V)**
- **R1151N (VR=3.3V)**
8) Input Transient Response (Topt=25°C)
   a. External Tr.: 2SA1441
b. External Tr.: 2SB703

R1151N (VR=5.0V)

\[
\begin{array}{c|c|c|c|c|c|c|c|c|c|c}
\text{Time (µs)} & 0 & 25 & 50 & 75 & 100 & 125 & 150 & 175 & 200 & 225 & 250 \\
\hline
\text{Input Voltage VIN(V)} & 25 & 50 & 75 & 100 & 125 & 150 & 175 & 200 & 225 & 250 \\
\text{Output Voltage VOUT(V)} & 5.030 & 5.005 & 5.000 & 5.005 & 5.025 & 5.030 & 5.020 & 5.015 & 5.010 & 5.000 & 4.995 \\
\end{array}
\]

R1151N (VR=3.3V)

\[
\begin{array}{c|c|c|c|c|c|c|c|c|c|c}
\text{Time (µs)} & 0 & 25 & 50 & 75 & 100 & 125 & 150 & 175 & 200 & 225 & 250 \\
\hline
\text{Input Voltage VIN(V)} & 25 & 50 & 75 & 100 & 125 & 150 & 175 & 200 & 225 & 250 \\
\end{array}
\]

R1151N (VR=2.5V)

\[
\begin{array}{c|c|c|c|c|c|c|c|c|c|c}
\text{Time (µs)} & 0 & 25 & 50 & 75 & 100 & 125 & 150 & 175 & 200 & 225 & 250 \\
\hline
\text{Input Voltage VIN(V)} & 25 & 50 & 75 & 100 & 125 & 150 & 175 & 200 & 225 & 250 \\
\end{array}
\]

c. External Tr.: 2SB940

R1151N (VR=5.0V)

\[
\begin{array}{c|c|c|c|c|c|c|c|c|c|c}
\text{Time (µs)} & 0 & 25 & 50 & 75 & 100 & 125 & 150 & 175 & 200 & 225 & 250 \\
\hline
\text{Input Voltage VIN(V)} & 25 & 50 & 75 & 100 & 125 & 150 & 175 & 200 & 225 & 250 \\
\text{Output Voltage VOUT(V)} & 5.030 & 5.005 & 5.000 & 5.005 & 5.025 & 5.030 & 5.020 & 5.015 & 5.010 & 5.000 & 4.995 \\
\end{array}
\]

R1151N (VR=3.3V)

\[
\begin{array}{c|c|c|c|c|c|c|c|c|c|c}
\text{Time (µs)} & 0 & 25 & 50 & 75 & 100 & 125 & 150 & 175 & 200 & 225 & 250 \\
\hline
\text{Input Voltage VIN(V)} & 25 & 50 & 75 & 100 & 125 & 150 & 175 & 200 & 225 & 250 \\
\end{array}
\]
R1151N

9) Load Transient Response (Topt=25°C)
   a: External Tr.: 2SA1441

R1151N (VR=2.5V)

VIN=3.5V
CIN=Ceramic 4.7µF
COUT=Ceramic 10µF

Output Voltage VOUT(V)
Output Current IOUT(mA)

Time (µs)

R1151N (VR=3.3V)

VIN=4.3V
CIN=Ceramic 4.7µF
COUT=Ceramic 10µF

Output Voltage VOUT(V)
Output Current IOUT(mA)

Time (µs)

R1151N (VR=5.0V)

VIN=6.0V
CIN=Ceramic 4.7µF
COUT=Ceramic 10µF

Output Voltage VOUT(V)
Output Current IOUT(mA)

Time (µs)
R1151N

b. External Tr.: 2SB703

R1151N (VR=5.0V)
VIN=6.0V
CIN=Ceramic 4.7µF
COUT=Ceramic 10µF

R1151N (VR=3.3V)
VIN=4.3V
CIN=Ceramic 4.7µF
COUT=Ceramic 10µF

10) Detector Threshold vs. Temperature

R1151N (-VDET=8.0V)
R1151N (-VDET=4.2V)
11) $V_{DET}$ Output Voltage vs. Input Voltage

**R1151N ($V_{DET}=2.9V$)**

- Temperature Topt(°C)
  - -40
  - -15
  - 10
  - 25
  - 85

- Detector Threshold VDET(V)
  - 3.10
  - 2.80

**R1151N ($V_{DET}=1.7V$)**

- Temperature Topt(°C)
  - -40
  - -15
  - 10
  - 25
  - 85

- Detector Threshold VDET(V)
  - 1.80
  - 1.60

**R1151N ($V_{DET}=8.0V$ Pull-up to $V_{DD}$)**

- Temperature Topt(°C)
  - -40
  - -15
  - 10
  - 25
  - 85

- VDET Output Voltage VDOUT(V)
  - 9.0
  - 8.0

**R1151N ($V_{DET}=8.0V$ Pull-up to 5V)**

- Temperature Topt(°C)
  - -40
  - -15
  - 10
  - 25
  - 85

- VDET Output Voltage VDOUT(V)
  - 6.0
  - 5.0

**R1151N ($V_{DET}=4.2V$ Pull-up to $V_{DD}$)**

- Temperature Topt(°C)
  - -40
  - -15
  - 10
  - 25
  - 85

- VDET Output Voltage VDOUT(V)
  - 5.0
  - 4.5

**R1151N ($V_{DET}=4.2V$ Pull-up to 5V)**

- Temperature Topt(°C)
  - -40
  - -15
  - 10
  - 25
  - 85

- VDET Output Voltage VDOUT(V)
  - 6.0
  - 5.0

Limited Product
12) Nch Driver Output Current vs. Vos (Topt=25°C)
13) Nch Driver Output Current vs. Input Voltage

R1151N (-VDET=2.9V)

- VDD=2.5V
- VDD=2.0V
- VDD=1.5V
- VDD=1.0V

R1151N (-VDET=1.7V)

- VDD=1.5V
- VDD=1.25V
- VDD=1.0V

R1151N (-VDET=8.0V)

- VDD=2.5V
- VDD=2.0V
- VDD=1.5V
- VDD=1.0V

R1151N (-VDET=4.2V)

- VDD=1.5V
- VDD=1.25V
- VDD=1.0V
14) CD pin Threshold Voltage vs. Temperature

<table>
<thead>
<tr>
<th>Temperature Topt(°C)</th>
<th>CD pin Threshold Voltage Vtcd(V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>-40</td>
<td>2.6</td>
</tr>
<tr>
<td>-15</td>
<td>2.4</td>
</tr>
<tr>
<td>60</td>
<td>1.8</td>
</tr>
<tr>
<td>85</td>
<td>1.6</td>
</tr>
</tbody>
</table>

15) CD Pin Output Current vs. Input Voltage

<table>
<thead>
<tr>
<th>Input Voltage VIN(V)</th>
<th>CD pin Output Current IOUT(mA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>0.00</td>
</tr>
<tr>
<td>4.0</td>
<td>0.05</td>
</tr>
<tr>
<td>2.0</td>
<td>0.10</td>
</tr>
<tr>
<td>1.0</td>
<td>0.15</td>
</tr>
<tr>
<td>0.0</td>
<td>0.20</td>
</tr>
</tbody>
</table>
16) CD Pin Output Current vs. VDS (Topt=25°C)

- **R1151N (-VDET=8.0V)**
- **R1151N (-VDET=4.2V)**

17) Output Delay Time of Release vs. Temperature

- **R1151N (-VDET=8.0V)**
  - External Capacitance=220pF
- **R1151N (-VDET=1.7V)**
  - External Capacitance=220pF
18) Output Delay Time of Release vs. External Capacitance for CD pin (Topt=25°C)

- R1151N (-VDET=8.0V)
- R1151N (-VDET=1.7V)

19) Output Delay Time of Detect vs. External Capacitance for CD pin (Topt=25°C)

- R1151N (-VDET=8.0V)
- R1151N (-VDET=4.2V)
- R1151N (-VDET=2.9V)
- R1151N (-VDET=1.7V)
Calculation of Output Delay Time of Release

t\text{PLH}(s)=1.83\times C/(300 \times 10^{-9})

For Stable Operation

Phase Compensation

In these ICs, phase compensation is externally made for securing stable operation even if the load current is varied. For this purpose, be sure to use a capacitor for the output pin with good frequency characteristics and ESR (Equivalent Series Resistance) of which is in the range described as follows:

The relations between $I_{OUT}$ (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.

<Measurement conditions>

1. $V_{IN}=V_{OUT}+1V$
2. Frequency band: 10Hz to 1MHz
3. Temperature: 25°C
4. $C_{OUT}$: Ceramic 10µF; ESR=0.075Ω (10kHz)
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