The R1290K is the optimized DC/DC converter IC for TFT LCD displays. R1290K contains one PWM step-up DC/DC converter controller and two diode charge-pump controllers. The charge-pumps can control a boost output and a negative output and have the output voltage regulation function with external resistors. The power-on sequence can be made with setting the delay time with external capacitors for each charge pump channel.

FEATURES

- **Input Voltage Range (Maximum Rating)**: 2.5 V to 5.5 V (6.5 V)
- **Temperature Coefficient of VFB ($\Delta V_{FB}/\Delta T$)**: Typ. ±150 ppm/°C (−40°C ≤ Ta ≤ 105°C)
- **Temperature Coefficient of VREF ($\Delta V_{REF}/\Delta T$)**: Typ. 150 ppm/°C
- **Temperature Coefficient of CPPFB ($\Delta V_{PPFB}/\Delta T$)**: Typ. 150 ppm/°C (−40°C ≤ Ta ≤ 105°C, CPVCC=9 V)

[Step-up DC/DC Controller]
- Built-in 2 A Nch-switch ($R_{ON} = 150$ mΩ Typ.)
- Overcurrent Protection
- Adjustable $V_{OUT}$ up to 20 V with external resistors
- Adjustable Phase compensation with external components
- Maxduty adjustable with external resistors for DTC pin
- Soft-start time adjustable with external capacitor for SS pin
- Oscillator Frequency: Adjustable frequency with resistors (180 kHz to 1400 kHz)

[Charge-pump]
- Adjustable output voltage with external resistors
- Sequence function: Charge-pump turns on after the main step-up converter voltage outputs. The positive charge-pump and the negative charge-pump turn-on sequence control is adjustable by setting delay time for each channel
- Oscillator Frequency: 1/4 of the main step-up DC/DC converter oscillator frequency

[Controller]
- Under Voltage Lock-Out (UVLO: selectable detector threshold from 1.8 V/2.2 V/2.8 V)
- Reference Voltage (VREF: Typ. 1.2 V)
- Short Protection with timer latch function (adjustable delay time with external capacitor)
- Shutdown all the outputs if at least one of three outputs is shorted to the GND.
- Stand-by function by CE pin
- Package: Thin 24-pin package QFN0404-24

APPLICATIONS

- Power source for LCD and CCD
R1290K
NO.EC-154-141119

BLOCK DIAGRAM

R1290K10xA

OSC
UVLO
Duty Limit
Current Limit
PWM
Output Control

Timer
Short Protection
Start Sequence

Negative Charge-pump Control
Positive Charge-pump Control

Vref
Soft Start

Vref

LX
PGND
VFB
AGND
CPPSB
CPPDLY
CPVCC
CPGND
CPPFB
CPPS
DELAY
CE
TST
CPDLY
CPCC
CPN
CPFB
VREF

VIN
DTC
RT

Vref

Short Protection

Soft Start

Vref

Delay

CE

TST

CPDLY

CPCC

CPN

CPFB

VREF
SELECTION GUIDE

The UVLO threshold voltage is user-selectable.

<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>R1290K10xA -E2-#E</td>
<td>QFN0404-24</td>
<td>1,000 pcs</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

x: Specify the UVLO threshold voltage
1: 1.8 V
2: 2.2 V
3: 2.8 V

#: Specify the Automotive Class Code

<table>
<thead>
<tr>
<th></th>
<th>Operating Temperature Range</th>
<th>Guaranteed Specs Temperature Range</th>
<th>Screening</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>-40°C to 105°C</td>
<td>25°C</td>
<td>High Temperature</td>
</tr>
</tbody>
</table>
**PIN DESCRIPTIONS**

<table>
<thead>
<tr>
<th>Pin No.</th>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>PGND</td>
<td>Power GND Pin</td>
</tr>
<tr>
<td>2</td>
<td>PGND</td>
<td>Power GND Pin</td>
</tr>
<tr>
<td>3</td>
<td>AGND</td>
<td>Analog GND Pin</td>
</tr>
<tr>
<td>4</td>
<td>VIN</td>
<td>Power Input Pin</td>
</tr>
<tr>
<td>5</td>
<td>VREF</td>
<td>Reference Voltage Output Pin</td>
</tr>
<tr>
<td>6</td>
<td>CE</td>
<td>Chip Enable Pin</td>
</tr>
<tr>
<td>7</td>
<td>VFB</td>
<td>Step-up DC/DC Feedback Pin</td>
</tr>
<tr>
<td>8</td>
<td>SS</td>
<td>Step-up DC/DC Soft-start Pin</td>
</tr>
<tr>
<td>9</td>
<td>TST</td>
<td>TEST Pin</td>
</tr>
<tr>
<td>10</td>
<td>DTC</td>
<td>Step-up DC/DC Maxduty Setting Pin</td>
</tr>
<tr>
<td>11</td>
<td>DELAY</td>
<td>Short Protection Delay Setting Pin</td>
</tr>
<tr>
<td>12</td>
<td>AMPOUT</td>
<td>Amplifier Output Pin For Phase Compensation</td>
</tr>
<tr>
<td>13</td>
<td>RT</td>
<td>Oscillator Frequency Setting Pin</td>
</tr>
<tr>
<td>14</td>
<td>CPNDLY</td>
<td>Negative Charge-pump Delay Setting Pin</td>
</tr>
<tr>
<td>15</td>
<td>CPNFB</td>
<td>Negative Charge-pump Feedback Pin</td>
</tr>
<tr>
<td>16</td>
<td>CPPDLY</td>
<td>Positive Charge-pump Delay Setting Pin</td>
</tr>
<tr>
<td>17</td>
<td>CPPFB</td>
<td>Positive Charge-pump Feedback Pin</td>
</tr>
<tr>
<td>18</td>
<td>CPGND</td>
<td>Charge-pump GND Pin</td>
</tr>
<tr>
<td>19</td>
<td>CPN</td>
<td>Negative Charge-pump Driver Output Pin</td>
</tr>
<tr>
<td>20</td>
<td>CPVCC</td>
<td>Power Pin for Charge-pump</td>
</tr>
<tr>
<td>21</td>
<td>CPP</td>
<td>Positive Charge-pump Driver Output Pin</td>
</tr>
<tr>
<td>22</td>
<td>CPPSW</td>
<td>Output Control Pin for Positive Charge-pump</td>
</tr>
<tr>
<td>23</td>
<td>LX</td>
<td>Step-up DC/DC Driver Output Pin</td>
</tr>
<tr>
<td>24</td>
<td>LX</td>
<td>Step-up DC/DC Driver Output Pin</td>
</tr>
</tbody>
</table>

* The tab on the bottom of the package enhances thermal performance and is electrically connected to GND (substrate level). It is recommended that the tab be connected to the ground plane on the board, or otherwise be left floating.
## ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Item</th>
<th>Ratings</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>V&lt;sub&gt;IN&lt;/sub&gt;</td>
<td>V&lt;sub&gt;IN&lt;/sub&gt; pin voltage</td>
<td>6.5</td>
<td>V</td>
</tr>
<tr>
<td>V&lt;sub&gt;DTC&lt;/sub&gt;</td>
<td>DCT pin voltage</td>
<td>-0.3 to V&lt;sub&gt;IN&lt;/sub&gt;+0.3</td>
<td>V</td>
</tr>
<tr>
<td>V&lt;sub&gt;FB&lt;/sub&gt;</td>
<td>V&lt;sub&gt;FB&lt;/sub&gt; pin voltage</td>
<td>-0.3 to V&lt;sub&gt;IN&lt;/sub&gt;+0.3</td>
<td>V</td>
</tr>
<tr>
<td>V&lt;sub&gt;SS&lt;/sub&gt;</td>
<td>SS pin voltage</td>
<td>-0.3 to V&lt;sub&gt;IN&lt;/sub&gt;+0.3</td>
<td>V</td>
</tr>
<tr>
<td>V&lt;sub&gt;DELAY&lt;/sub&gt;</td>
<td>DELAY pin voltage</td>
<td>-0.3 to V&lt;sub&gt;IN&lt;/sub&gt;+0.3</td>
<td>V</td>
</tr>
<tr>
<td>V&lt;sub&gt;AMP&lt;/sub&gt;</td>
<td>AMPOUT pin voltage</td>
<td>-0.3 to V&lt;sub&gt;IN&lt;/sub&gt;+0.3</td>
<td>V</td>
</tr>
<tr>
<td>V&lt;sub&gt;LX&lt;/sub&gt;</td>
<td>L&lt;sub&gt;X&lt;/sub&gt; pin voltage</td>
<td>-0.3 to 24</td>
<td>V</td>
</tr>
<tr>
<td>I&lt;sub&gt;LX&lt;/sub&gt;</td>
<td>L&lt;sub&gt;X&lt;/sub&gt; pin current</td>
<td>Internally limited</td>
<td>A</td>
</tr>
<tr>
<td>V&lt;sub&gt;REF&lt;/sub&gt;</td>
<td>V&lt;sub&gt;REF&lt;/sub&gt; pin voltage</td>
<td>-0.3 to V&lt;sub&gt;IN&lt;/sub&gt;+0.3</td>
<td>V</td>
</tr>
<tr>
<td>V&lt;sub&gt;CPVCC&lt;/sub&gt;</td>
<td>CPVCC pin voltage</td>
<td>-0.3 to 24</td>
<td>V</td>
</tr>
<tr>
<td>V&lt;sub&gt;CE&lt;/sub&gt;</td>
<td>CE pin voltage</td>
<td>-0.3 to V&lt;sub&gt;IN&lt;/sub&gt;+0.3</td>
<td>V</td>
</tr>
<tr>
<td>V&lt;sub&gt;RT&lt;/sub&gt;</td>
<td>RT pin voltage</td>
<td>-0.3 to V&lt;sub&gt;IN&lt;/sub&gt;+0.3</td>
<td>V</td>
</tr>
<tr>
<td>V&lt;sub&gt;CPPOLY&lt;/sub&gt;</td>
<td>CPPDLY pin voltage</td>
<td>-0.3 to V&lt;sub&gt;IN&lt;/sub&gt;+0.3</td>
<td>V</td>
</tr>
<tr>
<td>V&lt;sub&gt;CPNDLY&lt;/sub&gt;</td>
<td>CPNDLY pin voltage</td>
<td>-0.3 to V&lt;sub&gt;IN&lt;/sub&gt;+0.3</td>
<td>V</td>
</tr>
<tr>
<td>V&lt;sub&gt;PFB&lt;/sub&gt;</td>
<td>CPPFB pin voltage</td>
<td>-0.3 to V&lt;sub&gt;IN&lt;/sub&gt;+0.3</td>
<td>V</td>
</tr>
<tr>
<td>V&lt;sub&gt;NFB&lt;/sub&gt;</td>
<td>CPNFB pin voltage</td>
<td>-0.3 to V&lt;sub&gt;IN&lt;/sub&gt;+0.3</td>
<td>V</td>
</tr>
<tr>
<td>V&lt;sub&gt;CPP&lt;/sub&gt;</td>
<td>CPP pin voltage</td>
<td>-0.3 to 24</td>
<td>V</td>
</tr>
<tr>
<td>V&lt;sub&gt;CPN&lt;/sub&gt;</td>
<td>CPN pin voltage</td>
<td>-0.3 to 24</td>
<td>V</td>
</tr>
<tr>
<td>V&lt;sub&gt;PSW&lt;/sub&gt;</td>
<td>CPPSW pin voltage</td>
<td>-0.3 to 24</td>
<td>V</td>
</tr>
<tr>
<td>I&lt;sub&gt;PSW&lt;/sub&gt;</td>
<td>CPPSW pin current</td>
<td>20 mA</td>
<td>mA</td>
</tr>
</tbody>
</table>

**Power dissipation**

| Standard Land Pattern - A | 670 | W |
| Standard Land Pattern - B | 800 |
| Standard Land Pattern - C | 1500 |

| T<sub>j</sub> | Junction Temperature | 125 °C |
| T<sub>stg</sub> | Storage temperature range | -55 to 125 °C |

* Refer to PACKAGE INFORMATION for detailed information.

Electronic and mechanical stress momentarily exceeded absolute maximum ratings may cause the permanent damages and may degrade the lifetime and safety for both device and system using the device in the field. The functional operation at or over these absolute maximum ratings are not assured.
## RECOMMENDED OPERATING CONDITIONS

<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 R1290K101A</td>
<td>2.0 to 5.5</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td>R1290K102A</td>
<td>2.5 to 5.5</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td>R1290K103A</td>
<td>3.3 to 5.5</td>
<td>V</td>
</tr>
<tr>
<td>CPVCC</td>
<td>CPVCC operating voltage</td>
<td>6 to 20</td>
<td>V</td>
</tr>
<tr>
<td>Ta</td>
<td>Operating temperature</td>
<td>~40 to 105</td>
<td>°C</td>
</tr>
</tbody>
</table>

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

VIN is set as shown below for every version, unless otherwise noted.
R1290K101A: VIN = 2.5 V
R1290K102A: VIN = 2.5 V
R1290K103A: VIN = 3.5 V

The specifications surrounded by [ ] are guaranteed by design engineering at −40°C ≤ Ta ≤ 105°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>IIN</td>
<td>VIN Supply Current</td>
<td>VIN=5.5 V, RT=24 kΩ</td>
<td>-</td>
<td>3.5</td>
<td>-</td>
<td>mA</td>
</tr>
<tr>
<td>UVLO1</td>
<td>UVLO Detect Voltage (VIN Falling )</td>
<td>R1290K101A</td>
<td>1.69</td>
<td>1.8</td>
<td>1.91</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>R1290K102A</td>
<td>2.08</td>
<td>2.2</td>
<td>2.35</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>R1290K103A</td>
<td>2.6</td>
<td>2.8</td>
<td>3.0</td>
<td>V</td>
</tr>
<tr>
<td>UVLO2</td>
<td>UVLO Release Voltage (VIN Rising )</td>
<td>R1290K101A</td>
<td>VUVLO1 +0.09</td>
<td>2.0</td>
<td>-</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>R1290K102A</td>
<td>VUVLO1 +0.15</td>
<td>2.5</td>
<td>-</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>R1290K103A</td>
<td>VUVLO1 +0.22</td>
<td>3.2</td>
<td>-</td>
<td>V</td>
</tr>
<tr>
<td>VFB</td>
<td>VFB Voltage</td>
<td>-</td>
<td>0.960</td>
<td>1.0</td>
<td>1.025</td>
<td>V</td>
</tr>
<tr>
<td>FBL</td>
<td>VFB “L” Output Voltage</td>
<td>-</td>
<td>VFB&gt;0.85</td>
<td>-</td>
<td>-</td>
<td>V</td>
</tr>
<tr>
<td>IFB</td>
<td>VFB Input Current</td>
<td>VIN = 5.5 V, VFB = 0 V or 5.5 V</td>
<td>-</td>
<td>0.1</td>
<td>0.1</td>
<td>µA</td>
</tr>
<tr>
<td>VTDC0</td>
<td>Duty = 0% DTC Voltage</td>
<td>RT = 24 kΩ</td>
<td>0.27</td>
<td>0.37</td>
<td>0.49</td>
<td>V</td>
</tr>
<tr>
<td>VTDC20</td>
<td>Duty = 20% DTC Voltage</td>
<td>RT = 24 kΩ</td>
<td>0.49</td>
<td>-</td>
<td>-</td>
<td>V</td>
</tr>
<tr>
<td>VTDC80</td>
<td>Duty = 80% DTC Voltage</td>
<td>RT = 24 kΩ</td>
<td>0.91</td>
<td>-</td>
<td>-</td>
<td>V</td>
</tr>
<tr>
<td>Maxduty</td>
<td>Maximum Duty Limit</td>
<td>RT = 24 kΩ, VDTC = VIN</td>
<td>94</td>
<td>91</td>
<td>98</td>
<td>%</td>
</tr>
<tr>
<td>IAMPH</td>
<td>AMP “H” Output Current</td>
<td>VFB = 0.9 V</td>
<td>R1290K101A/102A</td>
<td>1.4</td>
<td>3.2</td>
<td>5.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>R1290K103A</td>
<td>4.7</td>
<td>-</td>
<td>-</td>
<td>mA</td>
</tr>
<tr>
<td>IAMPL</td>
<td>AMP “L” Output Current</td>
<td>VFB = 1.1 V</td>
<td>-</td>
<td>30</td>
<td>80</td>
<td>135</td>
</tr>
<tr>
<td>RON</td>
<td>Switch ON Resistance</td>
<td>-</td>
<td>150</td>
<td>-</td>
<td>-</td>
<td>µΩ</td>
</tr>
<tr>
<td>ILOF</td>
<td>Leakage Current</td>
<td>VIN = 5.5 V, VLX = 20 V</td>
<td>-</td>
<td>5</td>
<td>-</td>
<td>µA</td>
</tr>
<tr>
<td>LIMDC</td>
<td>Switch Limit Current</td>
<td>-</td>
<td>1.3</td>
<td>-</td>
<td>-</td>
<td>A</td>
</tr>
<tr>
<td>fREQ</td>
<td>Oscillator Frequency</td>
<td>RT = 110 kΩ</td>
<td>100</td>
<td>180</td>
<td>260</td>
<td>kHz</td>
</tr>
<tr>
<td></td>
<td></td>
<td>RT = 24 kΩ</td>
<td>300</td>
<td>700</td>
<td>830</td>
<td>kHz</td>
</tr>
<tr>
<td></td>
<td></td>
<td>RT = 10 kΩ</td>
<td>1.2</td>
<td>1.4</td>
<td>1.6</td>
<td>MHz</td>
</tr>
<tr>
<td>VREF</td>
<td>VREF Voltage</td>
<td>-</td>
<td>1.16</td>
<td>1.2</td>
<td>1.23</td>
<td>V</td>
</tr>
<tr>
<td>IOUT</td>
<td>VREF Current</td>
<td>-</td>
<td>2.0</td>
<td>-</td>
<td>-</td>
<td>mA</td>
</tr>
<tr>
<td>Symbol</td>
<td>Item</td>
<td>Conditions</td>
<td>Min.</td>
<td>Typ.</td>
<td>Max.</td>
<td>Unit</td>
</tr>
<tr>
<td>------------------</td>
<td>-----------------------------</td>
<td>-------------------------------------</td>
<td>------</td>
<td>------</td>
<td>------</td>
<td>------</td>
</tr>
<tr>
<td>∆VREF/∆VIN</td>
<td>VREF Line Regulation</td>
<td>R1290K101A V\text{IN} = 2.0 to 5.5 V</td>
<td>5</td>
<td>15</td>
<td></td>
<td>mV</td>
</tr>
<tr>
<td></td>
<td></td>
<td>R1290K102A V\text{IN} = 2.5 to 5.5 V</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>R1290K103A V\text{IN} = 3.3 to 5.5 V</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>∆VREF/∆IOUT</td>
<td>VREF Load Regulation</td>
<td>I\text{OUT} = 0.1 mA to 2.0 mA</td>
<td>6</td>
<td>25</td>
<td></td>
<td>mV</td>
</tr>
<tr>
<td>I\text{LIM}</td>
<td>Short Current Limit</td>
<td></td>
<td>15</td>
<td></td>
<td></td>
<td>mA</td>
</tr>
<tr>
<td>ICPVCC</td>
<td>CPVCC Supply Current</td>
<td>CPVCC = 9 V, RT = 24 kΩ</td>
<td>500</td>
<td></td>
<td></td>
<td>µA</td>
</tr>
<tr>
<td>IS\text{S}</td>
<td>Soft-Start Current</td>
<td>CPVCC = 9 V</td>
<td>2.5</td>
<td>5.0</td>
<td>7.5</td>
<td>µA</td>
</tr>
<tr>
<td>t\text{PSS}</td>
<td>CPP Soft-Start Time</td>
<td>CPVCC = 9 V</td>
<td>4.0</td>
<td></td>
<td></td>
<td>ms</td>
</tr>
<tr>
<td>t\text{NSS}</td>
<td>CPN Soft-Start Time</td>
<td>CPVCC = 9 V</td>
<td>4.0</td>
<td></td>
<td></td>
<td>ms</td>
</tr>
<tr>
<td>IP\text{DLY}</td>
<td>CPPDLY Charge Current</td>
<td>CPVCC = 9 V</td>
<td>2.5</td>
<td>5.0</td>
<td>7.5</td>
<td>µA</td>
</tr>
<tr>
<td>IN\text{DLY}</td>
<td>CPNDLY Charge Current</td>
<td>CPVCC = 9 V</td>
<td>2.5</td>
<td>5.0</td>
<td>7.5</td>
<td>µA</td>
</tr>
<tr>
<td>V\text{PDLY}</td>
<td>CPPDLY Detector Threshold</td>
<td>CPVCC = 9 V</td>
<td>0.95</td>
<td>1.00</td>
<td>1.05</td>
<td>V</td>
</tr>
<tr>
<td>V\text{NDLY}</td>
<td>CPNDLY Detector Threshold</td>
<td>CPVCC = 9 V</td>
<td>0.95</td>
<td>1.00</td>
<td>1.05</td>
<td>V</td>
</tr>
<tr>
<td>V\text{PFB}</td>
<td>CPPFB Voltage</td>
<td>CPVCC = 9 V</td>
<td>1.45</td>
<td>1.500</td>
<td>1.535</td>
<td>V</td>
</tr>
<tr>
<td>V\text{NFB}</td>
<td>CPNFB Voltage</td>
<td>CPVCC = 9 V</td>
<td>0.00</td>
<td>0.035</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>V\text{PFBL}</td>
<td>CPPFB Fault Voltage</td>
<td>CPVCC = 9 V</td>
<td>V_{\text{PFB}} \times 0.85</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>V\text{NFBL}</td>
<td>CPNFB Fault Voltage</td>
<td>CPVCC = 9 V</td>
<td>0.15</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>R\text{CPPH}</td>
<td>CPP &quot;H&quot; ON Resistance</td>
<td>CPVCC = 9 V</td>
<td>5</td>
<td></td>
<td></td>
<td>Ω</td>
</tr>
<tr>
<td>R\text{CPPL}</td>
<td>CPP &quot;L&quot; ON Resistance</td>
<td>CPVCC = 9 V</td>
<td>10</td>
<td></td>
<td></td>
<td>Ω</td>
</tr>
<tr>
<td>R\text{CPNH}</td>
<td>CPN &quot;H&quot; ON Resistance</td>
<td>CPVCC = 9 V</td>
<td>5</td>
<td></td>
<td></td>
<td>Ω</td>
</tr>
<tr>
<td>R\text{CPNL}</td>
<td>CPN &quot;L&quot; ON Resistance</td>
<td>CPVCC = 9 V</td>
<td>10</td>
<td></td>
<td></td>
<td>Ω</td>
</tr>
<tr>
<td>\text{f}_{\text{REQCP}}</td>
<td>Charge-pump Frequency</td>
<td>CPVCC = 9 V</td>
<td>\text{f}_{\text{REQ}} /4</td>
<td></td>
<td></td>
<td>kHz</td>
</tr>
<tr>
<td>I\text{DELAY1}</td>
<td>DELAY Charge Current</td>
<td>CPVCC = 9 V</td>
<td>2.4</td>
<td>5.0</td>
<td>7.5</td>
<td>µA</td>
</tr>
<tr>
<td>I\text{DELAY2}</td>
<td>DELAY Discharge Current</td>
<td>CPVCC = 9 V</td>
<td>200</td>
<td></td>
<td></td>
<td>µA</td>
</tr>
<tr>
<td>V\text{DELAY}</td>
<td>DELAY Detector Threshold</td>
<td>CPVCC = 9 V</td>
<td>3.94</td>
<td>1.0</td>
<td>1.08</td>
<td>V</td>
</tr>
<tr>
<td>V\text{PSW}</td>
<td>CPPSW &quot;L&quot; Output Voltage</td>
<td>CPVCC = 9 V, I = 1 mA</td>
<td>0.2</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>I\text{standby1}</td>
<td>Standby Current</td>
<td></td>
<td>0.1</td>
<td>5</td>
<td></td>
<td>µA</td>
</tr>
<tr>
<td>I\text{standby2}</td>
<td>CPVCC Standby Current</td>
<td></td>
<td>0.1</td>
<td>5</td>
<td></td>
<td>µA</td>
</tr>
<tr>
<td>V\text{CEL}</td>
<td>CE &quot;L&quot; Input Voltage</td>
<td></td>
<td>0.3</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>V\text{CEH}</td>
<td>CE &quot;H&quot; Input Voltage</td>
<td>\text{VIN} = 5.5 V</td>
<td>1.5</td>
<td></td>
<td></td>
<td>V</td>
</tr>
</tbody>
</table>

All test items listed under Electrical Characteristics are done under the pulse load condition (\text{T_j} \approx \text{Ta} = 25°C).
TYPICAL APPLICATION

R1290K10xA  Typical Application 1

Vin=3.3V
Vout1 = 9V
Vout2 = 12V
Vout3 = -7V
R1290K

NO.EC-154-141119

Recommended External Components

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td>NR4018T220M (for 180 kHz) / NR4018T4R7M (for 700 kHz) / NR4018T2R2M (for 1.4 MHz), Taiyo Yuden</td>
</tr>
<tr>
<td>D1</td>
<td>CRS02, TOSHIBA</td>
</tr>
<tr>
<td>D2-D7</td>
<td>1SS374, TOSHIBA</td>
</tr>
<tr>
<td>Tr1</td>
<td>2SA1586, TOSHIBA</td>
</tr>
</tbody>
</table>
TECHNICAL NOTES

How to Set the Step-up Converter Output Voltage

\[ V_{\text{OUT1}} = V_{\text{FB}} \times \frac{R_1 + R_2}{R_2} \]

How to Set the Step-up Charge-pump Output Voltage

\[ V_{\text{OUT2}} = V_{\text{PFB}} \times \frac{R_3 + R_4}{R_4} \]

In the case of Typical Application 1, the maximum output voltage can be described as the following formula.

\[ V_{\text{OUT2 (Max.)}} = CP\cdot V_{\text{CC}} \times 2 - V_F \times 2 \]

Set C15, D6 and D7 of diodes, and C16 (refer to the Typical Application 2) if the output voltage needs more than the range above. In this case, the maximum output voltage can be described as the following formula.

\[ V_{\text{OUT2 (Max.)}} = CP\cdot V_{\text{CC}} \times 3 - V_F \times 4 \]

The maximum load current of the boost charge pump is determined by Cfly (C13, C15), the oscillator frequency of charge pump (f\text{RECP}), and CPP "L" ON Resistance (R\text{CPPL}) as described in the following formula.

\[ I_{\text{OUT2 (Max.)}} = C\text{fly} \times (1 - \exp (-1 / (2 \times C\text{fly} \times R\text{CPPL} \times f\text{RECP})) \times (CP\cdot V_{\text{CC}} \times 2 - V_{\text{OUT2}} - V_F \times 2) \times f\text{RECP} \]

How to Set the Inverting Charge-pump Output Voltage

\[ V_{\text{OUT3}} = \frac{V_{\text{NFB}} \times (V_{\text{REF}} - V_{\text{NFB}})}{R_5 \times R_6} \]

The minimum output voltage can be set by the following formula.

\[ V_{\text{OUT3 (Min.)}} = -(CP\cdot V_{\text{CC}} - V_F \times 2) \]

The maximum load current of inverting charge pump is determined by Cfly (C14), the oscillator frequency of charge pump (f\text{RECP}), and CPN "L" ON Resistance (R\text{CPNL}) as described in the following formula.

\[ I_{\text{OUT3 (Max.)}} = C\text{fly} \times (1 - \exp (-1 / (2 \times C\text{fly} \times R\text{CPNL} \times f\text{RECP})) \times (CP\cdot V_{\text{CC}} + V_{\text{OUT3}} - V_F \times 2) \times f\text{RECP} \]
How to set the Step-up DC/DC Converter’s Phase Compensation (Refer to Typical Application)

In the DC/DC converter, with the load current and the external components (L and C) the phase may be delayed by 180 degrees. Due to this, the phase margin of system is lost and stability would be worse. Thus, it is necessary to proceed the phase, and keep a certain phase margin.

The phase compensation and the system gain can be set with using the resistor, R7 and capacitors, C7 and C8. The position and the setting values shown in the Typical Application are one of the examples.

Select R7 and C7, so that the cut-off frequency of this Zero point may become approximately the cutoff frequency of pole made by the external components (L and C). The following formula shows the pole made by the external components (L and C) and the “Zero” point.

\[ F_{pole} \approx \frac{1}{2\pi \times \sqrt{LC}} \]

\[ F_{zero} \approx \frac{1}{2\pi \times R7 \times C7} \]

For example, when \( L = 10 \, \mu\text{H} \) and \( C_{OUT} (C1) = 10 \, \mu\text{F} \), the cut-off frequency of the pole is approximately 16 kHz. Then set the cut-off frequency of the Zero point around 16 kHz. In this case, \( R7 = 4.7 \, \text{k\Omega} \) and \( C7 = 2200 \, \text{pF} \).

The gain can be set with the ratio of the resistance of R7 and combined resistance of R1 and R2 (RT: \( RT = \frac{R1 \times R2}{R1 + R2} \)). If R7 is larger than the combined resistance (RT), the gain becomes high. If the gain is too high, the characteristics of response will be improved but the operating stability will be worse. Set R7 with an appropriate value.

Due to the R1 setting in the gain setting, another Zero point is set by R1 and C7.Set this cut-off frequency of Zero point at the lower frequency than the cut-off frequency by pole made by the external components (L and C). This Zero point is shown in the formula below.

\[ F_{zero} \approx \frac{1}{2\pi \times R1 \times C8} \]

Noise Reduction of the Feedback Voltage (Refer to Typical Application)

When the system noise is large, the output noise may be on to the feedback loop, and the operation may become unstable. In this case, set the value of the resistance R1 to R6 low and make the noise into the feedback reduction. It is possible to reduce the noise to the \( V_{FB} \) pin by connecting the resistance in the range from 1 k\Omega to 5 k\Omega around as R8.

Input Voltage

The range of \( V_{IN} \) voltage must be between 2.0 V and 5.5 V. For CPVCC pin, it is possible to use input \( V_{OUT1} \) or input another voltage of 6 V to 20 V to CPVCC as a power supply. In that case, set a capacitor of 1.0 \( \mu\text{F} \) or more as C16 between GND and CPVCC pin.
How to Set the Oscillator Frequency

Set a resistor (R12) between GND and RT pin. The oscillator frequency of the step-up converter \( f_{\text{REQ}} \) can be set according to the next formula. This value depends upon the resistance value.

\[
f_{\text{REQ}} = 2.7 \times 10^{10} / [R_{12} \times (0.66 + \sqrt{(0.66^2 + 10800 / R_{12})})]
\]

Set the frequency between 180 kHz and 1400 kHz. The oscillator frequency of the charge-pump is one fourth of the oscillator frequency of the main step-up DC/DC converter.

How to Set the Soft-start of Step-up Converter (Refer to the Timing Chart)

The soft-start of the step-up converter operates when \( V_N \) is equal to or more than the UVLO release voltage, or when CE signal is “H”. External capacitor of SS pin (C9) is charged with the soft-start charge current (\( I_{\text{SS}} \)). Then the voltage of SS pin is input to the error amplifier as the reference voltage. When the voltage of SS pin reaches to the reference voltage (Typ.1.0 V) in the normal state, the reference voltage of the error amplifier stabilized at 1.0 V, and it changes to the normal state. The soft-start of step-up converter time (\( t_{\text{SS}} \)) is set by the external capacitor (C9) for the SS pin in the next formula.

\[
t_{\text{SS}} = C_9 \times V_{FB} / I_{\text{SS}}
\]

How to Set the Start-up Sequence (Refer to the Timing Chart)

When the output voltage of step-up converter is up to 85% of a set value, and the soft-start is finished, the external capacitors (C10 and C11) of the CPPDLY pin and the CPNDLY pin are charged by the CPPDLY charge current (\( I_{\text{PDLY}} \)) and the CPNDLY charge current (\( I_{\text{NDLY}} \)). When the voltage of the CPPDLY pin and the CPNDLY pin charged up to the CPPDLY detector threshold (\( V_{\text{PDLY}} \)) and the CPNDLY detector threshold (\( V_{\text{NDLY}} \)), then the soft-start of the positive charge-pump and the negative charge-pump is operated respectively. After the step-up converter is operated, the delay time (\( t_{\text{PDLY}} \) and \( t_{\text{NDLY}} \)) until the soft-start of charge-pump is set by the external capacitors (C10 and C11) of the CPPDLY pin and the CPNDLY pin. The delay time is set by the following formula.

- The delay time until the soft-start of positive charge-pump operates: \( t_{\text{PDLY}} = C_{10} \times V_{\text{PDLY}} / I_{\text{PDLY}} \)
- The delay time until the soft-start of negative charge-pump operates: \( t_{\text{NDLY}} = C_{11} \times V_{\text{NDLY}} / I_{\text{NDLY}} \)

Thus, after the main step-up DC/DC converter starts operating, the positive charge-pump and the negative charge-pump can be operated by the arbitrary order.
Soft-start of the Charge-pump (Refer to Typical Application and Timing Chart)

When the soft-start of boost charge-pump operates, the output of CPPSW changes from "H" to "L". Setting the PNP-Tr1 (Tr1) keeps \( V_{OUT2} = 0 \) V until the positive charge-pump is started. If it is not required to keep \( V_{OUT2} = 0 \) V, then PNP-Tr1 is unnecessary. In this case, \( V_{OUT2} \) outputs approximately the same voltage as \( V_{OUT1} \). Arrange the resistor (R11) between the CPPSW pin and the base of PNP-Tr1 (Tr1). The maximum current of Tr1 can be set by the R11 value. This value can be calculated in the next formula.

\[
I_{max} = hFE \times \frac{(V_{OUT1} - V_{BE})}{R11} \quad \text{[}hFE \text{ is DC current gain of Tr1 and } V_{BE} \text{ is base emitter voltage of Tr1.}]
\]

Select the appropriate value for R11 since the efficiency gets worse if the value is too small (refer to the Short Current Protection section. PNP-Tr1 has some effect on the operation of the short-current protection).

When the positive charge-pump starts, the reference voltage of the error amplifier starts from 0 V, turns on to the reference voltage (= 1.5 V) and becomes stable. Thus, the output voltage of \( V_{OUT2} \) can turn on by set output voltage within the time period of soft-start time.

Before the soft-start of the negative charge-pump starts, the reference voltage of the error amplifier rises to \( V_{REF} \) voltage (= 1.2 V) and falls down to 0 V in the soft start time fixed internally by the soft-start operation. Thus, the output voltage of \( V_{OUT3} \) can turn on by set output voltage within the time period of soft-start time.

How to set the Short Current Protection and Timer Latch Delay Time

If any output among the step-up converter output, the positive charge-pump output or the negative charge-pump output falls, the R1290K detects the short circuit. If this short circuit condition stays for a certain time, the latch-type protection circuit shuts down all the switching outputs (Lx, CPP, CPN) and outputs "H" through the CPPSW pin. Even if the switching stopped, the current path from CPVCC to \( V_{OUT2} \) is remained. If PNP-Tr is set on the CPPSW pin, the current path to \( V_{OUT2} \) is cut off after shutdown.

The detect voltages of \( V_{FB} \), CPPFB and CPNFB are:
- 85% of predetermined \( V_{FB} \) voltage for \( V_{FB} \)
- 85% of predetermined CPPFB voltage for CPPFB
- + 0.15 V for CPNFB

The latch timer delay is set by an external capacitor (C12) of the DELAY pin. This delay time can be calculated by the next formula.

\[
I_{DLY} = C_{12} \times \frac{V_{DLY}}{I_{DLY}}
\]

To release the latch state, set \( V_{IN} \) voltage below UVLO detector threshold and restart, or Set the CE pin "L" once and change the CE pin to "H" level.

How to set the Maxduty Limit

The value of maxduty can be set by the input voltage to DTC pin. Set the voltage in which the \( V_{REF} \) output divided with the resistors R9 and R10. If the voltage of DTC pin increases more than the limit value, the lower value between the set value and the internally fixed value is selected and in valid.

TEST Pin

In terms of TEST pin, connect the GND level or remain it open.
Other Notes

- Use a 1.0 µF or higher capacitor (C4) in between GND and V_IN pin. Connect the capacitor as close as possible to the IC. If the noise level is large, use the 4.7 µF or higher capacitor is recommended.

- Use a 1.0 µF or higher capacitor (C1, C2, and C3) in between GND and each V_OUT (VOUT1, VOUT2, and VOUT3). The recommended capacitance is C1 = 4.7 µF to 22 µF, C2 = C3 = 1 µF to 2.2 µF (refer to the Typical Application).

- Use a 0.1 µF to 1 µF or higher capacitance (C6) in between V_REF and GND.

- To connect the GND of the capacitors (C9, C10, C11, and C12) for setting the delay time as short as possible to the GND of the IC.

- Selection of the diodes and inductors and capacitors should be considered. When Nch-switch turns on, the high voltage of spike by an inductor might be generated. Thus, using more than twice of the set output voltage for the voltage tolerance of the capacitor connecting to VOUT is recommended. The diode and inductors should not exceed the rated value of the voltage, the current and the power (refer to Output Current and Selection of External Components).

- Select the diode with low forward voltage such as a Schottky barrier diode. The small reverse current and the fast switching speed type is desirable. Especially, the characteristics of diode (D1) influence the efficiency and the stability of the system.

APPLICATION INFORMATION

Overcurrent Protection

R1290K monitors the Nch-switch current of the step-up DCDC converter and limits the current. If Nch-switch current reaches the current limit, the R1290K immediately turns off Nch-switch. Nch-switch turns on every internal cycle, and the R1290K monitors Nch-switch current and turns off Nch-switch if Nch-switch current reaches the current limit again. By repeating this operation, the R1290K protects itself from the overcurrent.

Under Voltage Lock Out (UVLO)

If V_IN pin voltage becomes equal to or lower than UVLO detector threshold, the R1290K immediately disables all the switching outputs (Lx, CPP, and CPN) as well as discharges the external capacitors on DTC pin and SS pin down to 0 V immediately, and the system will be reset.
In PWM step-up DC/DC converter, there are two modes; the discontinuous mode and the continuous mode. These two modes depend upon the continuous characteristic of the inductor current.

While PWM step-up DC/DC converter is turned on, the voltage into the inductance L will be $V_{IN}$, and the additional current ($i_1$) can be calculated by the next formula.

$$\Delta i_1 = V_{IN} \times \frac{ton}{L}$$

In the circuit of the step-up DC/DC converter, during the off time of the switching, the power is supplied. In this case, the decrease of input current ($i_2$) can be calculated by the next formula:

$$\Delta i_2 = (V_{OUT} - V_{IN}) \times \frac{T_f}{L}$$
In the PWM switching method, the current of inductor becomes continuous when it is \( T_f = T_{off} \). The operating of DC/DC converter becomes continuous mode. In the continuous mode, the variance of the ratio of current is equal \( (\Delta i_1 = \Delta i_2) \), therefore the DUTY in the continuous mode is calculated by the next formula.

\[
duty(\%) = \frac{t_{on}}{t_{on} + t_{off}} = \frac{V_{OUT} - V_{IN}}{V_{OUT}}
\]

If the input power and the output power are equal, the mode becomes continuous when the \( I_{out} \) value is larger than the next formula.

\[
V_{in}^2 \times t_{on} / (2 \times L \times V_{OUT})
\]

The average of the inductor current when \( T_f = T_{off} \) is calculated by the next formula.

\[
i_{1(Ave.)} = \frac{V_{IN} \times t_{on}}{2 \times L}
\]

The peak current (\( I_{Lx_{max}} \)) of the inductor in the continuous mode can be calculated by the next formula:

\[
I_{Lx_{max}} = \frac{I_{out} \times V_{OUT}}{V_{IN}} + \frac{V_{IN} \times t_{on}}{2 \times L}
\]

\[
I_{Lx_{max}} = \frac{I_{out} \times V_{OUT}}{V_{IN}} + \frac{V_{IN} \times T \times (V_{OUT} - V_{IN})}{2 \times L \times V_{OUT}}
\]

As stated above, the value of the peak current becomes larger than the \( I_{out} \) value, therefore note that the \( I_{Lx_{max}} \) to determine the I/O condition and the components around the I/O.

The actual maximum output current is 50 to 80% of the above-mentioned. Especially, in case that the IL is large, or \( V_{IN} \) is low, the loss of \( V_{IN} \) will be the amount of the ON resistance of the switch. As for the \( V_{OUT} \), it is necessary to consider the \( V_F \) of the diode (approximately 0.3 V).

Note: The above-mentioned explanation is based on the calculations of the ideal case. The external components or the loss of \( L_x \) switching are not included.
TIMING CHART

Overall Sequence Timing Chart

The timing chart above describes from the power on to the \( V_{OUT1} \), \( V_{OUT2} \), and \( V_{OUT3} \) turn on and until they are stable.

By releasing from the standby mode, \( V_{OUT1} \) begins the soft-start, and the output voltage rises gradually. After preset soft-start time passes, and the \( V_{OUT1} \) reaches the preset output voltage, the charge to capacitors set to CPPDLY pin and CPNDLY pin will start. CPPDLY pin and CPNDLY pin voltage reach respectively to the CPPDLY detector threshold (\( V_{PDLY} \)) and CPNDLY detector threshold (\( V_{NDLY} \)), then the soft-start of the charge-pump will begin. The delay time for soft-start of charge pump (\( t_{PDLY} \), \( t_{NDLY} \)) can be set respectively.

When each delay time has passed, the soft-start of the charge-pump begins. \( V_{OUT2} \) and \( V_{OUT3} \) gradually turn on, and when the soft-start time ends, \( V_{OUT2} \) and \( V_{OUT3} \) reach the preset output voltage.
**V_{OUT1} Soft-start Operation**

The timing chart above describes from the CE signal turns on until the soft-start of \( \text{V}_{\text{OUT1}} \) ends.

(\text{STEP1})
SS voltage gradually increases with the internal IC’s constant current and the external capacitor. During the soft-start time, the amplifier’s reference input to the OP AMP becomes an equal voltage as SS, and it gradually increases. Since \( \text{V}_{\text{OUT}} \) reaches to the input voltage just after the power on, the VFB voltage rises at the specific voltage determined by the resistance ratio of the input voltage and the feedback part. However, the switching does not begin since AMPOUT is "L".

(\text{STEP2})
When the SS becomes the specified voltage determined with the resistance ratio of the input voltage and the feedback part, the switching begins. In this case, the amplifier reference rises as well as SS, therefore \( \text{V}_{\text{OUT}} \) rises to balance the amplifier reference and VFB. The DUTY in this case is determined by the three inputs PWM comparator, among the AMPOUT and DTC, the lowest voltage is selected.

(\text{STEP3})
When the SS becomes 1 V, the soft-start ends. After that, the amplifier reference becomes the constant voltage (\( \approx 1 \text{ V} \)), and the operation changes to the normal switching. At this time, the voltage of the AMPOUT becomes constant. The AMPOUT value is determined by the I/O voltage and the output current.

During the soft-start period, the soft-start time needs to be set shorter than the timer latch delay time due to the charging of DELAY pin. When the preset soft-start time finishes, the charging of DELAY pin stops and discharges to the GND.
PACKAGE INFORMATION

POWER DISSIPATION (QFN0404-24)

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

<table>
<thead>
<tr>
<th>Measurement Conditions</th>
<th>Land Pattern A</th>
<th>Land Pattern B</th>
<th>Land Pattern C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mounting on Board (Wind velocity=0m/s)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Board Material</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glass cloth epoxy plastic (Double sided)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Board Dimensions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>40mm × 40mm × 1.6mm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Copper Ratio</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Top side: Approx. 50%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Back side: Approx. 50%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Top side: Approx. 90%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Back side: Approx. 90%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Through-hole</td>
<td>Ø0.25mm×24pcs</td>
<td>Ø0.25mm×24pcs</td>
<td>Ø0.25mm×33pcs</td>
</tr>
<tr>
<td>Remarks</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Top side and back side are connected by 9 through-holes in the tab area.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Measurement Result (Ta=25°C, Tjmax=125°C)

<table>
<thead>
<tr>
<th>Measurement Result</th>
<th>Land Pattern A</th>
<th>Land Pattern B</th>
<th>Land Pattern C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Dissipation</td>
<td>670mW</td>
<td>800mW</td>
<td>1500mW</td>
</tr>
<tr>
<td>Thermal Resistance</td>
<td>θja=150°C/W</td>
<td>θja=125°C/W</td>
<td>θja=67°C/W</td>
</tr>
<tr>
<td></td>
<td>θjc=15°C/W</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Power Dissipation

<table>
<thead>
<tr>
<th>Ambient Temperature (°C)</th>
<th>Power Dissipation P_D (mW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>1600</td>
</tr>
<tr>
<td>50</td>
<td>1400</td>
</tr>
<tr>
<td>75</td>
<td>1200</td>
</tr>
<tr>
<td>100</td>
<td>1000</td>
</tr>
<tr>
<td>105</td>
<td>800</td>
</tr>
<tr>
<td>125</td>
<td>670</td>
</tr>
<tr>
<td>150</td>
<td>400</td>
</tr>
</tbody>
</table>

Land Pattern A/C*        | Land Pattern B

* 9 through-holes in the available only for land pattern C.
PACKAGE DIMENSIONS (QFN0404-24)

MARK SPECIFICATION (QFN0404-24)

①②③④⑤⑥⑦⑧⑨⑩ : Product Code … Refer to MARK SPECIFICATION TABLE
⑪ : Year Code
⑫ : Month Code
⑬⑭⑮ : Lot Number … Alphanumeric Serial Number

⑪ Year Code
2006→6  2009→9
2007→7  2010→0
2008→8  2011→1

⑫ Month Code
Jan, Feb…Dec
A B M (except I )

⑬⑭⑮: Year/Month Codes are the date when the package assembly consignment document is completed.
⑬⑭⑮: Serial number from 500 to 999 is remained even if Year/Month Code changes.

QFN0404-24 Mark Specification

MARK SPECIFICATION TABLE (QFN0404-24)

<table>
<thead>
<tr>
<th>Product Name</th>
<th>①②③④⑤⑥⑦⑧⑨⑩</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1290K101A</td>
<td>R 1 2 9 0 K 1 0 1 A</td>
</tr>
<tr>
<td>R1290K102A</td>
<td>R 1 2 9 0 K 1 0 2 A</td>
</tr>
<tr>
<td>R1290K103A</td>
<td>R 1 2 9 0 K 1 0 3 A</td>
</tr>
</tbody>
</table>
TEST CIRCUIT

$V_{OUT1}$ (DCDC)

- Output Voltage vs. Output Current
- Efficiency vs. Output Current

Components

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
<th>$f_{osc} = 180$ kHz</th>
<th>$f_{osc} = 700$ kHz</th>
<th>$f_{osc} = 1400$ kHz</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1</td>
<td>For setting voltage of $V_{OUT1}$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R2</td>
<td>For setting voltage of $V_{OUT2}$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R7</td>
<td>10 kΩ</td>
<td>4.7 kΩ</td>
<td>3.3 kΩ</td>
<td></td>
</tr>
<tr>
<td>R8</td>
<td>4.7 kΩ</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R9</td>
<td>20 kΩ</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R10</td>
<td>100 kΩ</td>
<td>24 kΩ</td>
<td>10 kΩ</td>
<td></td>
</tr>
<tr>
<td>R12</td>
<td>110 kΩ</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C1, C4</td>
<td>4.7 µF, Ceramic</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C6</td>
<td>1 µF, Ceramic</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C7</td>
<td>1000 pF, Ceramic</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C8</td>
<td>1000 pF ($V_{OUT1} = 8$ V) / 560 pF ($V_{OUT1} = 12$ V) / 270 pF ($V_{OUT1} = 18$ V), Ceramic</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C9</td>
<td>0.022 µF, Ceramic</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L</td>
<td>22 µH, NR4018T220M, TAIYO YUDEN</td>
<td>4.7 µH, NR4018T4R7M, TAIYO YUDEN</td>
<td>2.2 µH, NR4018T2R2M, TAIYO YUDEN</td>
<td></td>
</tr>
</tbody>
</table>
\( V_{OUT2} \) (Step-up Charge-pump)

- Output Voltage vs. Output Current
- Efficiency vs. Output Current

(1) \( CPVCC = 8 \text{ V} \) and \( V_{OUT2} = 12 \text{ V} \), \( CPVCC = 12 \text{ V} \) and \( V_{OUT2} = 18 \text{ V} \)

### Components

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>R3</td>
<td>For setting voltage of ( V_{OUT3} )</td>
</tr>
<tr>
<td>R4</td>
<td>For setting voltage of ( V_{OUT4} )</td>
</tr>
<tr>
<td>R12</td>
<td>For setting of ( f_{osc} )</td>
</tr>
<tr>
<td>C2, C6</td>
<td>1 ( \mu \text{F} ), Ceramic</td>
</tr>
<tr>
<td>C4, C5</td>
<td>4.7 ( \mu \text{F} ), Ceramic</td>
</tr>
<tr>
<td>C13</td>
<td>For setting ( C_{fly} ), Ceramic</td>
</tr>
<tr>
<td>D2, D3</td>
<td>1SS374, TOSHIBA</td>
</tr>
</tbody>
</table>

\[ h = \frac{\left(V_{OUT2} \times I_{OUT2}\right)}{\left(CPVCC \times I_{CPVCC}\right)} \]
(2) CPVCC = 8 V and \( V_{OUT2} = 16 \) V, CPVCC = 12 V and \( V_{OUT2} = 24 \) V

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>R3</td>
<td>For setting voltage of ( V_{OUT3} )</td>
</tr>
<tr>
<td>R4</td>
<td>For setting voltage of ( V_{OUT4} )</td>
</tr>
<tr>
<td>R12</td>
<td>For setting ( f_{osc} )</td>
</tr>
<tr>
<td>C2, C6, C16</td>
<td>1 ( \mu )F, Ceramic</td>
</tr>
<tr>
<td>C4, C5</td>
<td>4.7 ( \mu )F, Ceramic</td>
</tr>
<tr>
<td>C13</td>
<td>For setting Cfly, Ceramic</td>
</tr>
<tr>
<td>C15</td>
<td>For setting Cfly, Ceramic</td>
</tr>
<tr>
<td>D2, D3</td>
<td>1SS374, TOSHIBA</td>
</tr>
</tbody>
</table>
**V_{OUT3} (Inverting Charge-pump)**

- Output Voltage vs. Output Current
- Efficiency vs. Output Current

\[ \eta = \frac{V_{OUT3} \times I_{OUT3}}{CPVCC \times I_{CPVCC}} \]

<table>
<thead>
<tr>
<th>Component</th>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>R5</td>
<td>For setting voltage of ( V_{OUT3} )</td>
</tr>
<tr>
<td></td>
<td>R6</td>
<td>For setting voltage of ( V_{OUT4} )</td>
</tr>
<tr>
<td></td>
<td>R12</td>
<td>For setting ( f_{osc} )</td>
</tr>
<tr>
<td></td>
<td>C3, C6</td>
<td>1 ( \mu )F, Ceramic</td>
</tr>
<tr>
<td></td>
<td>C4, C5</td>
<td>4.7 ( \mu )F, Ceramic</td>
</tr>
<tr>
<td></td>
<td>C14</td>
<td>For setting ( C_{fly} ), Ceramic</td>
</tr>
<tr>
<td></td>
<td>D4, D5</td>
<td>1SS374, TOSHIBA</td>
</tr>
</tbody>
</table>
TYPICAL CHARACTERISTICS

1) \( V_{OUT1} \) (DC/DC)  
1-1) Output Voltage vs. Output Current

### R1290K102A

**Fosc=180kHz**  
**L=22uH**  
**VOUT=8.0V**

![Graph 1](image1)

**Fosc=700kHz**  
**L=4.7uH**  
**VOUT=8.0V**

![Graph 2](image2)

**Fosc=1400kHz**  
**L=2.2uH**  
**VOUT=8.0V**

![Graph 3](image3)

**Fosc=180kHz**  
**L=22uH**  
**VOUT=12.0V**

![Graph 4](image4)

**Fosc=700kHz**  
**L=4.7uH**  
**VOUT=12.0V**

![Graph 5](image5)

**Fosc=1400kHz**  
**L=2.2uH**  
**VOUT=12.0V**

![Graph 6](image6)
1-2) Efficiency vs. Output Current

R1290K102A

Fosc=180kHz
L=22uH
VOUT=18.0V

19.0
18.9
18.8
18.7
18.6
18.5
18.4
18.3
18.2
18.1
18.0

Iout 1 [mA]

Vin=2.5V
Vin=3.3V
Vin=5.0V

R1290K102A

Fosc=700kHz
L=4.7uH
VOUT=18.0V

19.0
18.9
18.8
18.7
18.6
18.5
18.4
18.3
18.2
18.1
18.0

Iout 1 [mA]

Vin=2.5V
Vin=3.3V
Vin=5.0V

R1290K102A

Fosc=1400kHz
L=2.2uH
VOUT=18.0V

19.0
18.9
18.8
18.7
18.6
18.5
18.4
18.3
18.2
18.1
18.0

Iout 1 [mA]

Vin=2.5V
Vin=3.3V
Vin=5.0V

R1290K102A

Fosc=180kHz
L=22uH
VOUT=8.0V

100
90
80
70
60
50
40
30
20
10
0

Iout 1 [mA]

Vin=2.5V
Vin=3.3V
Vin=5.0V

R1290K102A

Fosc=700kHz
L=4.7uH
VOUT=8.0V

100
90
80
70
60
50
40
30
20
10
0

Iout 1 [mA]

Vin=2.5V
Vin=3.3V
Vin=5.0V
R1290K
NO.EC-154-141119

R1290K102A
Fosc=1400kHz
L=2.2uH
VOUT=8.0V

R1290K102A
Fosc=180kHz
L=22uH
VOUT=12.0V

R1290K102A
Fosc=700kHz
L=4.7uH
VOUT=12.0V

R1290K102A
Fosc=1400kHz
L=2.2uH
VOUT=12.0V

R1290K102A
Fosc=180kHz
L=22uH
VOUT=18.0V

R1290K102A
Fosc=700kHz
L=4.7uH
VOUT=18.0V
2) Vout2 (Step-up Charge-pump)
2-1) Output Voltage vs. Output Current

R1290K102A

Fosc=1400kHz
L=2.2uH
VOUT=18.0V

R1290K102A

Fosc=180kHz
CPVCC=8.0V
VOUT=12.0V

R1290K102A

Fosc=700kHz
CPVCC=8.0V
VOUT=12.0V

R1290K102A

Fosc=1400kHz
CPVCC=8.0V
VOUT=12.0V

R1290K102A

Fosc=180kHz
CPVCC=8.0V
VOUT=16.0V
R1290K102A

Fosc=700kHz  
CPVCC=8.0V  
VOUT=16.0V

Cfly=0.022uF  
Cfly=0.1uF

Iout2 [mA]  
Vout2 [V]

R1290K102A

Fosc=1400kHz  
CPVCC=8.0V  
VOUT=16.0V

Cfly=0.022uF  
Cfly=0.1uF

Iout2 [mA]  
Vout2 [V]

R1290K102A

Fosc=180kHz  
CPVCC=12.0V  
VOUT=18.0V

Cfly=0.022uF  
Cfly=0.1uF

Iout2 [mA]  
Vout2 [V]

R1290K102A

Fosc=700kHz  
CPVCC=12.0V  
VOUT=18.0V

Cfly=0.022uF  
Cfly=0.1uF

Iout2 [mA]  
Vout2 [V]

R1290K102A

Fosc=1400kHz  
CPVCC=12.0V  
VOUT=18.0V

Cfly=0.022uF  
Cfly=0.1uF

Iout2 [mA]  
Vout2 [V]

R1290K102A

Fosc=180kHz  
CPVCC=12.0V  
VOUT=24.0V

Cfly=0.022uF  
Cfly=0.1uF

Iout2 [mA]  
Vout2 [V]
3) Vout3 (Invert Charge-pump)
3-1) Output Voltage vs. Output Current

R1290K102A

Fosc=700kHz
CPVCC=12.0V
VOUT=24.0V

Cfly=0.022uF
Cfly=0.1uF

R1290K102A

Fosc=1400kHz
CPVCC=12.0V
VOUT=24.0V

Cfly=0.022uF
Cfly=0.1uF

R1290K102A

Fosc=180kHz
CPVCC=8.0V
VOUT=-6.0V

Cfly=0.022uF
Cfly=0.1uF

R1290K102A

Fosc=1400kHz
CPVCC=8.0V
VOUT=-6.0V

Cfly=0.022uF
Cfly=0.1uF

R1290K102A

Fosc=700kHz
CPVCC=8.0V
VOUT=-6.0V

Cfly=0.022uF
Cfly=0.1uF

R1290K102A

Fosc=180kHz
CPVCC=12.0V
VOUT=-6.0V

Cfly=0.022uF
Cfly=0.1uF
4) VFB Voltage vs. Input Voltage
R1290K102A

5) Oscillator Frequency vs. Input Voltage
R1290K102A
6) Supply Current vs. Input Voltage
R1290K102A

Fosc=180kHz
Ta=25°C

Vin (V)
Supply Current (μA)

Fosc=700kHz
Ta=25°C

Vin (V)
Supply Current (μA)

7) Maxduty vs. Input Voltage
R1290K102A

Fosc=1400kHz
Ta=25°C

Vin (V)
Maxduty (%)

8) VIN Supply Current vs. Temperature
R1290K102A

Vin =5.5V

Ta [°C]
Supply Current (μA)

9) CP Supply Current vs. Temperature
R1290K102A

Vin =5.5V, CPVCC =6.9V

Ta [°C]
Supply Current (μA)
10) UVLO Detect Voltage vs. Temperature

R1290K102A

11) UVLO Release Voltage vs. Temperature

R1290K102A
12) VFB Voltage vs. Temperature

R1290K102A

13) Maxduty vs. Temperature

R1290K102A

14) AMP "H" Output Current vs. Temperature

R1290K102A

15) AMP "L" Output Current vs. Temperature

R1290K102A

16) Switch ON Resistance vs. Temperature

R1290K102A

17) Switch Leakage Current vs. Temperature

R1290K102A
18) Switch Limit Current vs. Temperature

R1290K102A

19) Oscillator Frequency vs. Temperature

R1290K102A

20) VREF Voltage vs. Temperature

R1290K102A

21) SS Pin Charge Current vs. Temperature

R1290K102A
22) CPP Soft-start vs. Temperature

R1290K102A

23) CPN Soft-start vs. Temperature

R1290K102A

24) CPPDLY Charge Current vs. Temperature

R1290K102A

25) CPNDLY Charge Current vs. Temperature

R1290K102A

26) CPPDLY Detector Threshold vs. Temperature

R1290K102A

27) CPNDLY Detector Threshold vs. Temperature

R1290K102A
28) CPPFB Voltage vs. Temperature
R1290K102A

VIN=2.5V

29) CPNFB Voltage vs. Temperature
R1290K102A

VIN=2.5V

30) CPP "H" ON Resistance vs. Temperature
R1290K102A

CPVCC=9.0V

31) CPP "L" ON Resistance vs. Temperature
R1290K102A

CPVCC=9.0V

32) CPN "H" ON Resistance vs. Temperature
R1290K102A

CPVCC=9.0V

33) CPN "L" ON Resistance vs. Temperature
R1290K102A

CPVCC=9.0V
34) Charge-pump Frequency vs. Temperature

R1290K102A

CPP  CPVCC=9.0V, RT=24kΩ

35) DELAY Charge Current vs. Temperature

R1290K102A

VIN=2.5V

36) DELAY Discharge Current vs. Temperature

R1290K102A

VIN=2.5V

37) DELAY Detector Threshold vs. Temperature

R1290K102A

VIN=2.5V

38) CPPSW "L" Output Voltage vs. Temperature

R1290K102A

VIN=2.5V
39) Standby Current vs. Temperature

40) CE "L" Input Voltage vs. Temperature

41) CE "H" Input Voltage vs. Temperature
42) Load Transient Response

**R1290K102A**

L=22uH, Cout=4.7uF
VIN=3.3V, VOUT=8V
Freq=180kHz, Iout=1mA - 100mA

**Output Voltage [V]**

<table>
<thead>
<tr>
<th>Time [ms]</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>VOUT</td>
<td>7</td>
<td>7.2</td>
<td>7.4</td>
<td>7.6</td>
<td>7.8</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
</tr>
</tbody>
</table>

**Output Current [mA]**

<table>
<thead>
<tr>
<th>Time [ms]</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>IOUT</td>
<td>1mA - 100mA</td>
<td>1mA - 100mA</td>
<td>1mA - 100mA</td>
<td>1mA - 100mA</td>
<td>1mA - 100mA</td>
<td>1mA - 100mA</td>
<td>1mA - 100mA</td>
<td>1mA - 100mA</td>
<td>1mA - 100mA</td>
<td>1mA - 100mA</td>
<td>1mA - 100mA</td>
</tr>
</tbody>
</table>

---

**R1290K102A**

L=22uH, Cout=4.7uF
VIN=3.3V, VOUT=12V
Freq=180kHz, Iout=1mA - 100mA

**Output Voltage [V]**

<table>
<thead>
<tr>
<th>Time [ms]</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>VOUT</td>
<td>10</td>
<td>11</td>
<td>11.25</td>
<td>11.5</td>
<td>11.75</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>12</td>
</tr>
</tbody>
</table>

**Output Current [mA]**

<table>
<thead>
<tr>
<th>Time [ms]</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>IOUT</td>
<td>1mA - 100mA</td>
<td>1mA - 100mA</td>
<td>1mA - 100mA</td>
<td>1mA - 100mA</td>
<td>1mA - 100mA</td>
<td>1mA - 100mA</td>
<td>1mA - 100mA</td>
<td>1mA - 100mA</td>
<td>1mA - 100mA</td>
<td>1mA - 100mA</td>
<td>1mA - 100mA</td>
</tr>
</tbody>
</table>

---

**R1290K102A**

L=22uH, Cout=4.7uF
VIN=3.3V, VOUT=18V
Freq=180kHz, Iout=1mA - 100mA

**Output Voltage [V]**

<table>
<thead>
<tr>
<th>Time [ms]</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>VOUT</td>
<td>16</td>
<td>16.5</td>
<td>17</td>
<td>17.5</td>
<td>18</td>
<td>18.5</td>
<td>19</td>
<td>19.5</td>
<td>20</td>
<td>20</td>
<td>20</td>
</tr>
</tbody>
</table>

**Output Current [mA]**

<table>
<thead>
<tr>
<th>Time [ms]</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>IOUT</td>
<td>1mA - 100mA</td>
<td>1mA - 100mA</td>
<td>1mA - 100mA</td>
<td>1mA - 100mA</td>
<td>1mA - 100mA</td>
<td>1mA - 100mA</td>
<td>1mA - 100mA</td>
<td>1mA - 100mA</td>
<td>1mA - 100mA</td>
<td>1mA - 100mA</td>
<td>1mA - 100mA</td>
</tr>
</tbody>
</table>
42) Load Transient Response

**R1290K102A**

\[ L=4.7\mu\text{H}, \, \text{Cout}=4.7\mu\text{F} \]

\[ \text{VIN}=3.3\text{V}, \, \text{VOUT}=8\text{V} \]

\[ \text{Freq}=700\text{kHz}, \, \text{Iout}=1\text{mA} - 100\text{mA} \]

<table>
<thead>
<tr>
<th>Time [ms]</th>
<th>Output Voltage [V]</th>
<th>Output Current [mA]</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>7.2</td>
<td>50</td>
</tr>
<tr>
<td>2</td>
<td>7.4</td>
<td>100</td>
</tr>
<tr>
<td>3</td>
<td>7.6</td>
<td>150</td>
</tr>
<tr>
<td>4</td>
<td>7.8</td>
<td>200</td>
</tr>
<tr>
<td>5</td>
<td>8</td>
<td>250</td>
</tr>
<tr>
<td>6</td>
<td>8.2</td>
<td>300</td>
</tr>
<tr>
<td>7</td>
<td>8.4</td>
<td>350</td>
</tr>
<tr>
<td>8</td>
<td>8.6</td>
<td>400</td>
</tr>
<tr>
<td>9</td>
<td>8.8</td>
<td>450</td>
</tr>
<tr>
<td>10</td>
<td>9</td>
<td>500</td>
</tr>
</tbody>
</table>

**R1290K102A**

\[ L=4.7\mu\text{H}, \, \text{Cout}=4.7\mu\text{F} \]

\[ \text{VIN}=3.3\text{V}, \, \text{VOUT}=12\text{V} \]

\[ \text{Freq}=700\text{kHz}, \, \text{Iout}=1\text{mA} - 100\text{mA} \]

<table>
<thead>
<tr>
<th>Time [ms]</th>
<th>Output Voltage [V]</th>
<th>Output Current [mA]</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>10.75</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>11</td>
<td>50</td>
</tr>
<tr>
<td>2</td>
<td>11.25</td>
<td>100</td>
</tr>
<tr>
<td>3</td>
<td>11.5</td>
<td>150</td>
</tr>
<tr>
<td>4</td>
<td>11.75</td>
<td>200</td>
</tr>
<tr>
<td>5</td>
<td>12</td>
<td>250</td>
</tr>
<tr>
<td>6</td>
<td>12.25</td>
<td>300</td>
</tr>
<tr>
<td>7</td>
<td>12.5</td>
<td>350</td>
</tr>
<tr>
<td>8</td>
<td>12.75</td>
<td>400</td>
</tr>
<tr>
<td>9</td>
<td>13</td>
<td>450</td>
</tr>
<tr>
<td>10</td>
<td>13.25</td>
<td>500</td>
</tr>
</tbody>
</table>

**R1290K102A**

\[ L=4.7\mu\text{H}, \, \text{Cout}=4.7\mu\text{F} \]

\[ \text{VIN}=3.3\text{V}, \, \text{VOUT}=18\text{V} \]

\[ \text{Freq}=700\text{kHz}, \, \text{Iout}=1\text{mA} - 100\text{mA} \]

<table>
<thead>
<tr>
<th>Time [ms]</th>
<th>Output Voltage [V]</th>
<th>Output Current [mA]</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>16</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>16.5</td>
<td>50</td>
</tr>
<tr>
<td>2</td>
<td>17</td>
<td>100</td>
</tr>
<tr>
<td>3</td>
<td>17.5</td>
<td>150</td>
</tr>
<tr>
<td>4</td>
<td>18</td>
<td>200</td>
</tr>
<tr>
<td>5</td>
<td>18.5</td>
<td>250</td>
</tr>
<tr>
<td>6</td>
<td>19</td>
<td>300</td>
</tr>
<tr>
<td>7</td>
<td>19.5</td>
<td>350</td>
</tr>
<tr>
<td>8</td>
<td>20</td>
<td>400</td>
</tr>
<tr>
<td>9</td>
<td>20.5</td>
<td>450</td>
</tr>
<tr>
<td>10</td>
<td>21</td>
<td>500</td>
</tr>
</tbody>
</table>
42) Load Transient Response

R1290K102A

L=2.2uH, Cout=4.7uF
VIN=3.3V, VOUT=8V
Freq=1400kHz, Iout=1mA - 100mA

R1290K102A

L=2.2uH, Cout=4.7uF
VIN=3.3V, VOUT=12V
Freq=1400kHz, Iout=1mA - 100mA

R1290K102A

L=2.2uH, Cout=4.7uF
VIN=3.3V, VOUT=18V
Freq=1400kHz, Iout=1mA - 100mA
43) CE Switch Response

R1290K102A

VIN=3.3V
Vout1=8V/20mA, Vout2=12V/2mA, Vout3=-6V/2mA

Output Voltage1
Output Voltage2
Output Voltage3

R1290K102A

VIN=3.3V
Vout1=12V/20mA, Vout2=18V/2mA, Vout3=-6V/2mA

Output Voltage1
Output Voltage2
Output Voltage3

R1290K102A

VIN=3.3V
Vout1=18V/20mA, Vout2=24V/2mA, Vout3=-8V/2mA

Output Voltage1
Output Voltage2
Output Voltage3
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 in this document are designed for automotive applications. However, when using the products for automotive applications, please make sure to contact Ricoh sales representative in advance due to confirming the quality level.
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, fire containment 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. The X-ray exposure can influence functions and characteristics of the products. Confirm the product functions and characteristics in the evaluation stage.
9. WL CSP products should be used in light shielded environments. The light exposure can influence functions and characteristics of the products under operation or storage.
10. There can be variation in the marking when different AOI (Automated Optical Inspection) equipment is used. In the case of recognizing the marking characteristic with AOI, please contact Ricoh sales or our distributor before attempting to use AOI.
11. Please contact Ricoh sales representatives should you have any questions or comments concerning the products or the technical information.

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.

https://www.e-devices.ricoh.co.jp/en/