Regulator IC Series for Automotive

Termination Regulator for DDR-SDRAMs

BD35395FJ-M

General Description
BD35395FJ-M is a termination regulator compatible with JEDEC DDR1/2/3/3L-SDRAM, which functions as a linear power supply incorporating an N-channel MOSFET and provides a sink/source current capability up to 1A respectively. A built-in high-speed OP-AMP specially designed offers an excellent transient response. Requires 3.3 volts or 5.0 volts as a bias power supply to drive the N-channel MOSFET. Has an independent reference voltage input pin (VDDQ) and an independent feedback pin (VTT) to maintain the accuracy in voltage required by JEDEC, and offers an excellent output voltage accuracy and load regulation.

Features
- Incorporates a push-pull power supply for termination (VTT).
- Incorporates an enabler.
- Incorporates an under voltage lockout (UVLO).
- Employs SOP-J8 package: 4.9 x 6.0 x 1.65 (mm).
- Incorporates a thermal shutdown protector (TSD).
- Operates with input voltage from 2.7 to 5.5 volts.
- Compatible with Dual Channel (DDR1, DDR2, DDR3/DDR3L)
- Incorporates PGOOD function.

Applications
- Power supply for DDR1/2/3/3L SDRAM

Key Specifications
- Input Voltage Range: 2.7V to 5.5V
- Termination Input Voltage: 1.0V to 5.5V
- VDDQ Reference Voltage: 1.0V to 2.75V
- Output Current: -1.0V~1.0A(Max)
- Upper Side ON Resistance: 0.35Ω(Typ)
- Lower Side ON Resistance: 0.35Ω(Typ)
- Standby Current: 0.5mA Typ)
- Operating Temperature Range: -40°C to +105°C

Package(s)
- SOP-J8
  - 4.90mm x 6.00mm x 1.65mm
Pin Configuration(s)

TOP VIEW

<table>
<thead>
<tr>
<th>Pin No.</th>
<th>Pin Name</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>PGOOD</td>
<td>PGOOD output pin</td>
</tr>
<tr>
<td>2</td>
<td>GND</td>
<td>GND</td>
</tr>
<tr>
<td>3</td>
<td>VTTS</td>
<td>Detector Pin for Termination Voltage</td>
</tr>
<tr>
<td>4</td>
<td>EN</td>
<td>ENABLE input pin</td>
</tr>
<tr>
<td>5</td>
<td>VDDQ</td>
<td>Reference Voltage Input Pin</td>
</tr>
<tr>
<td>6</td>
<td>VCC</td>
<td>VCC Pin</td>
</tr>
<tr>
<td>7</td>
<td>VTT_IN</td>
<td>Termination power supply Pin</td>
</tr>
<tr>
<td>8</td>
<td>VTT</td>
<td>Termination Output Pin</td>
</tr>
</tbody>
</table>

Block Diagram

Reference Block

Thermal Protection

TSD

Enable

EN

GND
Description of Block(s)

• **VCC**
  In BD35395FJ-M, an independent power input pin is provided for an internal circuit operation of the IC. This is used to drive the amplifier circuit of the IC, and its maximum current rating is 4mA. The power supply voltage is 2.7 to 5.5 volts. It is recommended to connect a bypass capacitor of 1μF or so to VCC.

• **VDDQ**
  Reference input pin for the output voltage that may be used to satisfy the JEDEC requirement for DDR1/2/3/3L-SDRAM (VTT = 1/2VDDQ) by dividing the voltage inside the IC with two 100kΩ voltage-divider resistors. For BD35395FJ-M, care must be taken to an input noise to VDDQ pin because this IC also cuts such noise input into half and provides it with the voltage output divided in half. Such noise may be reduced with an RC filter consisting of such resistance and capacitance (220Ω and 2.2μF, for instance) that may not give significant effect to voltage dividing inside the IC.

• **VTT_IN**
  VTT_IN is a power supply input pin for VTT output. Voltage in the range between 1.0 and 5.5 volts may be supplied to this VTT_IN terminal, but care must be taken to the current limitation due to on-resistance of the IC and the change in allowable loss due to input/output voltage difference. Generally, the following voltages are supplied:
  - DDR1 VTT_IN=2.5V
  - DDR2 VTT_IN=1.8V
  - DDR3 VTT_IN=1.5V
  - DDR3L VTT_IN=1.35V
  Higher impedance of the voltage input at VTT_IN may result in oscillation or degradation in ripple rejection, which must be noted. To VTT_IN terminal, it is recommended to use a 10μF capacitor characterized with less change in capacitance. But it may depend on the characteristics of the power supply input and the impedance of the pc board wiring, which must be carefully checked before use.

• **PGOOD**
  PGOOD pin is power good output pin. This is the open drain pin, so pull up resistor is connected via other power supply. If VTT voltage becomes over 1/2 × VDDQ+30mV or under 1/2 × VDDQ-30mV, it outputs High voltage.

• **VTTS**
  An isolated pin provided to improve load regulation of VTT output. In case that longer wiring is needed to the load at VTT output, connecting VTTS from the load side may improve the load regulation.

• **VTT**
  A DDR memory termination output pin. BD35395FJ-M has a sink/source current capability of ±1.0A respectively. The output voltage tracks the voltage divided in half at VDDQ pin. VTT output is turned to OFF when VCC UVLO or thermal shutdown protector is activated with EN pin level turned to “Low”. Do not fail to connect a capacitor to VTT output pin for a loop gain phase compensation and a reduction in output voltage variation in the event of sudden change in load. Insufficient capacitance may cause an oscillation. High ESR (Equivalent Series Resistance) of the capacitor may result in increase in output voltage variation in the event of sudden change in load. It is recommended to use a 10μF or so ceramic capacitor, though it depends on ambient temperature and other conditions.

• **EN**
  With an input of 2.3 volts or higher, the level at EN pin turns to “High” to provide VTT output. If the input is lowered to 0.8 volts or less, the level at EN pin turns to “Low” and VTT status turns to Hi-Z.
### Absolute Maximum Ratings (Ta = 25°C)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Limit (Note1)</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Voltage</td>
<td>VCC</td>
<td>7</td>
<td>V</td>
</tr>
<tr>
<td>Enable Input Voltage</td>
<td>VEN</td>
<td>7</td>
<td>V</td>
</tr>
<tr>
<td>Termination Input Voltage</td>
<td>VTT_IN</td>
<td>7</td>
<td>V</td>
</tr>
<tr>
<td>VDDQ Reference Voltage</td>
<td>VDDQ</td>
<td>7</td>
<td>V</td>
</tr>
<tr>
<td>Output Current (when pulse is active)</td>
<td>ITT</td>
<td>1</td>
<td>A</td>
</tr>
<tr>
<td>Power Dissipation1</td>
<td>Pd1</td>
<td>563</td>
<td>mW</td>
</tr>
<tr>
<td>Power Dissipation2</td>
<td>Pd2</td>
<td>675</td>
<td>mW</td>
</tr>
<tr>
<td>Operating Temperature Range</td>
<td>Topr</td>
<td>-40 to +105</td>
<td>°C</td>
</tr>
<tr>
<td>Storage Temperature Range</td>
<td>Tstg</td>
<td>-55 to +150</td>
<td>°C</td>
</tr>
<tr>
<td>Maximum Junction Temperature</td>
<td>Tjmax</td>
<td>+150</td>
<td>°C</td>
</tr>
</tbody>
</table>

(1) Should not exceed Pd.
(2) Instantaneous surge voltage, back electromotive force and voltage under less than 10% duty cycle.
(3) Voltage under less than 10u sec.
(4) Reduced by 4.50°C/W for each increase in Ta of 1°C over 25°C (when don’t mounted on a heat radiation board)
(5) Reduced by 5.40°C/W for each increase in Ta of 1°C over 25°C (when mounted on a 70mm × 70mm × 1.6mm glass epoxy board)

### Recommended Operating Conditions (Ta = 25°C)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>MIN</th>
<th>MAX</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Voltage</td>
<td>VCC</td>
<td>2.7</td>
<td>5.5</td>
<td>V</td>
</tr>
<tr>
<td>Termination Input Voltage</td>
<td>VTT_IN</td>
<td>1.0</td>
<td>5.5</td>
<td>V</td>
</tr>
<tr>
<td>VDDQ Reference Voltage</td>
<td>VDDQ</td>
<td>1.0</td>
<td>2.75</td>
<td>V</td>
</tr>
<tr>
<td>Enable Input Voltage</td>
<td>VEN</td>
<td>-0.3</td>
<td>5.5</td>
<td>V</td>
</tr>
</tbody>
</table>
# Electrical Characteristics

(Unless otherwise specified Ta=25°C, VCC=3.3V, VEN=3V, VDDQ=1.8V, VTT_IN=1.8V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Limit</th>
<th>Unit</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standby Current</td>
<td>IST</td>
<td>-</td>
<td>0.5</td>
<td>1.0 mA VEN=0V</td>
</tr>
<tr>
<td>Bias Current</td>
<td>ICC</td>
<td>-</td>
<td>2</td>
<td>4 mA VEN=3V</td>
</tr>
<tr>
<td>[Enable]</td>
<td>VENHIGH</td>
<td>2.3</td>
<td>-</td>
<td>5.5 V</td>
</tr>
<tr>
<td>Low Level Enable Input Voltage</td>
<td>VENLOW</td>
<td>-0.3</td>
<td>-</td>
<td>0.8 V</td>
</tr>
<tr>
<td>Enable Pin Input Current</td>
<td>IEN</td>
<td>-</td>
<td>7</td>
<td>10 µA VEN=3V</td>
</tr>
<tr>
<td>[Termination]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Termination Output Voltage (DDR2)</td>
<td>VTT2</td>
<td>1/2 × VDDQ</td>
<td>1/2 × VDDQ +30m</td>
<td>V</td>
</tr>
<tr>
<td>Termination Output Voltage (DDR1)</td>
<td>VTT1</td>
<td>1/2 × VDDQ</td>
<td>1/2 × VDDQ +30m</td>
<td>V</td>
</tr>
<tr>
<td>Termination Output Voltage (DDR3)</td>
<td>VTT3</td>
<td>1/2 × VDDQ</td>
<td>1/2 × VDDQ +15m</td>
<td>V</td>
</tr>
<tr>
<td>Termination Output Voltage (DDR3L)</td>
<td>VTT3L</td>
<td>1/2 × VDDQ</td>
<td>1/2 × VDDQ +13.5m</td>
<td>V</td>
</tr>
<tr>
<td>Source current</td>
<td>ITT+</td>
<td>1.0</td>
<td>-</td>
<td>- A</td>
</tr>
<tr>
<td>Sink current</td>
<td>ITT-</td>
<td>-</td>
<td>-1.0</td>
<td>- A</td>
</tr>
<tr>
<td>Load Regulation</td>
<td>△VTT</td>
<td>-</td>
<td>50</td>
<td>mV ITT=-1.0A to 1.0A</td>
</tr>
<tr>
<td>Upper Side ON Resistance</td>
<td>HRON</td>
<td>-0.35</td>
<td>0.65</td>
<td>Ω</td>
</tr>
<tr>
<td>Lower Side ON Resistance</td>
<td>LRON</td>
<td>-0.35</td>
<td>0.65</td>
<td>Ω</td>
</tr>
<tr>
<td>[VREF]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input Impedance</td>
<td>ZVDDQ</td>
<td>140</td>
<td>200</td>
<td>260 kΩ</td>
</tr>
<tr>
<td>[PGOOD]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VTT PGOOD Low Threshold voltage</td>
<td>PGDLow</td>
<td>-</td>
<td>1/2 × VDDQ -30m</td>
<td>-</td>
</tr>
<tr>
<td>VTT PGOOD High Threshold Voltage</td>
<td>PGDHigh</td>
<td>-</td>
<td>1/2 × VDDQ +30m</td>
<td>-</td>
</tr>
<tr>
<td>PGOOD output ON resistor</td>
<td>PGDRon</td>
<td>-</td>
<td>10</td>
<td>20 Ω</td>
</tr>
<tr>
<td>PGOOD output leakage current</td>
<td>PGDleak</td>
<td>-</td>
<td>-</td>
<td>1 µA PGOOD=6V</td>
</tr>
<tr>
<td>PGOOD delay time</td>
<td>PGDdelay</td>
<td>1</td>
<td>2</td>
<td>4 Ms</td>
</tr>
<tr>
<td>[UVLO]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Threshold Voltage</td>
<td>VUVLO</td>
<td>2.35</td>
<td>2.50</td>
<td>2.65 V VCC : sweep up</td>
</tr>
<tr>
<td>Hysteresis Voltage</td>
<td>△VUVLO</td>
<td>120</td>
<td>180</td>
<td>240 mV VCC : sweep down</td>
</tr>
</tbody>
</table>
Typical Performance Curves

Figure 1. DDR3 (-1A→1A)

Figure 2. DDR2 (-1A→1A)

Figure 3. DDR1 (-1A→1A)

Figure 4. DDR3 (1A→-1A)
Typical Performance Curves - continued

Figure 5. DDR2 (1A→1A)

Figure 6. DDR1 (1A→1A)

Figure 7. Input sequence 1

Figure 8. Input sequence 2
Typical Performance Curves - continued

Figure 9. Input sequence

Figure 10. ITT-VTT (DDR2)

Figure 11. ITT-VTT (DDR1)

Figure 12. ITT-VTT (DDR3)
Typical Performance Curves - continued

Fig. 13 EN soft start (DDR2)

Fig. 14 PGOOD Delay (Start up-Shut down)

Fig. 15 PGOOD Delay (TSD OFF-TSD ON)

(100μsec/Div.)

(10μsec/Div.)
Application Example

BD35395FJ-M Evaluation Board Circuit

<table>
<thead>
<tr>
<th>Designation</th>
<th>Value</th>
<th>Company</th>
<th>Part No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>U1</td>
<td>-</td>
<td>ROHM</td>
<td>BD35395FJ-M</td>
</tr>
<tr>
<td>R1</td>
<td>10kΩ</td>
<td>ROHM</td>
<td>MCR031002</td>
</tr>
<tr>
<td>R4</td>
<td>220Ω</td>
<td>ROHM</td>
<td>MCR032200</td>
</tr>
<tr>
<td>J1</td>
<td>0Ω</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>J2</td>
<td>0Ω</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>C3</td>
<td>1µF</td>
<td>KYOCERA</td>
<td>CM105B105K06A</td>
</tr>
<tr>
<td>C4</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

BD35395FJ-M Evaluation Board Application Components

<table>
<thead>
<tr>
<th>Designation</th>
<th>Value</th>
<th>Company</th>
<th>Part No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>C5</td>
<td>10µF</td>
<td>KYOCERA</td>
<td>CM21B106M06A</td>
</tr>
<tr>
<td>C6</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>C7</td>
<td>10µF</td>
<td>KYOCERA</td>
<td>CM21B106M06A</td>
</tr>
<tr>
<td>C8</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>C9</td>
<td>2.2µF</td>
<td>KYOCERA</td>
<td>CM105B225K06A</td>
</tr>
<tr>
<td>C10</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>C11</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
Power Dissipation

Thermal design must be conducted with the operation under the conditions listed below (which are the guaranteed temperature range requiring consideration on appropriate margins etc):

1: Ambient temperature $T_a$: 105°C or lower
2: Chip junction temperature $T_j$: 150°C or lower

The chip junction temperature $T_j$ can be considered as follows: Most of heat loss in BD35395FJ-M occurs at the output N-channel FET. The power lost is determined by multiplying the voltage between $V_{IN}$ and $V_o$ by the output current. As this IC employs the power PKG, the thermal derating characteristics significantly depends on the pc board conditions. When designing, care must be taken to the size of a pc board to be used.

Power consumption (W) = Input voltage ($V_{TT\_IN}$)-Output voltage ($V_{TT} \approx 1/2V_{DDQ}$) × Io(Ave)

Example) Where $V_{TT\_IN} = 1.8$V, $V_{DDQ} = 1.8$V, Io(Ave) = 0.5A

\[
\text{Power consumption(W)} = \left\{1.8(V) - 0.9(V)\right\} \times 0.5(A) = 0.45(W)
\]

Heat dissipation characteristics

(1) mounted on 70mm × 70mm × 1.6mm glass-epoxy board
\[\theta_{j-c}=185.2^\circ C/W\]

(2) With no heat sink
\[\theta_{j-a}=222.2^\circ C/W\]
Operational Notes

1. **Reverse Connection of Power Supply**
   Connecting the power supply in reverse polarity can damage the IC. Take precautions against reverse polarity when connecting the power supply, such as mounting an external diode between the power supply and the IC’s power supply pins.

2. **Power Supply Lines**
   Design the PCB layout pattern to provide low impedance supply lines. Separate the ground and supply lines of the digital and analog blocks to prevent noise in the ground and supply lines of the digital block from affecting the analog block. Furthermore, connect a capacitor to ground at all power supply pins. Consider the effect of temperature and aging on the capacitance value when using electrolytic capacitors.

3. **Ground Voltage**
   Ensure that no pins are at a voltage below that of the ground pin at any time, even during transient condition. OR

4. **Ground Wiring Pattern**
   When using both small-signal and large-current ground traces, the two ground traces should be routed separately but connected to a single ground at the reference point of the application board to avoid fluctuations in the small-signal ground caused by large currents. Also ensure that the ground traces of external components do not cause variations on the ground voltage. The ground lines must be as short and thick as possible to reduce line impedance.

5. **Thermal Consideration**
   Should by any chance the power dissipation rating be exceeded the rise in temperature of the chip may result in deterioration of the properties of the chip. The absolute maximum rating of the Pd stated in this specification is when the IC is mounted on a 70mm x 70mm x 1.6mm glass epoxy board. In case of exceeding this absolute maximum rating, increase the board size and copper area to prevent exceeding the Pd rating.

6. **Recommended Operating Conditions**
   These conditions represent a range within which the expected characteristics of the IC can be approximately obtained. The electrical characteristics are guaranteed under the conditions of each parameter.

7. **Inrush Current**
   When power is first supplied to the IC, it is possible that the internal logic may be unstable and inrush current may flow instantaneously due to the internal powering sequence and delays, especially if the IC has more than one power supply. Therefore, give special consideration to power coupling capacitance, power wiring, width of ground wiring, and routing of connections.

8. **Operation Under Strong Electromagnetic Field**
   Operating the IC in the presence of a strong electromagnetic field may cause the IC to malfunction.

9. **Testing on Application Boards**
   When testing the IC on an application board, connecting a capacitor directly to a low-impedance output pin may subject the IC to stress. Always discharge capacitors completely after each process or step. The IC’s power supply should always be turned off completely before connecting or removing it from the test setup during the inspection process. To prevent damage from static discharge, ground the IC during assembly and use similar precautions during transport and storage.

10. **Inter-pin Short and Mounting Errors**
    Ensure that the direction and position are correct when mounting the IC on the PCB. Incorrect mounting may result in damaging the IC. Avoid nearby pins being shorted to each other especially to ground, power supply and output pin. Inter-pin shorts could be due to many reasons such as metal particles, water droplets (in very humid environment) and unintentional solder bridge deposited in between pins during assembly to name a few.
Operational Notes – continued

11. Unused Input Pins
Input pins of an IC are often connected to the gate of a MOS transistor. The gate has extremely high impedance and extremely low capacitance. If left unconnected, the electric field from the outside can easily charge it. The small charge acquired in this way is enough to produce a significant effect on the conduction through the transistor and cause unexpected operation of the IC. So unless otherwise specified, unused input pins should be connected to the power supply or ground line.

12. Regarding the Input Pin of the IC
This monolithic IC contains P+ isolation and P substrate layers between adjacent elements in order to keep them isolated. P-N junctions are formed at the intersection of the P layers with the N layers of other elements, creating a parasitic diode or transistor. For example (refer to figure below):

When GND > Pin A and GND > Pin B, the P-N junction operates as a parasitic diode.
When GND > Pin B, the P-N junction operates as a parasitic transistor.

Parasitic diodes inevitably occur in the structure of the IC. The operation of parasitic diodes can result in mutual interference among circuits, operational faults, or physical damage. Therefore, conditions that cause these diodes to operate, such as applying a voltage lower than the GND voltage to an input pin (and thus to the P substrate) should be avoided.

13. Ceramic Capacitor
When using a ceramic capacitor, determine the dielectric constant considering the change of capacitance with temperature and the decrease in nominal capacitance due to DC bias and others.

14. Area of Safe Operation (ASO)
Operate the IC such that the output voltage, output current, and power dissipation are all within the Area of Safe Operation (ASO).

15. Thermal Shutdown Circuit (TSD)
This IC has a built-in thermal shutdown circuit that prevents heat damage to the IC. Normal operation should always be within the IC's power dissipation rating. If however the rating is exceeded for a continued period, the junction temperature (Tj) will rise which will activate the TSD circuit that will turn OFF all output pins. When the Tj falls below the TSD threshold, the circuits are automatically restored to normal operation.

Note that the TSD circuit operates in a situation that exceeds the absolute maximum ratings and therefore, under no circumstances, should the TSD circuit be used in a set design or for any purpose other than protecting the IC from heat damage.

Figure xx. Example of monolithic IC structure
Ordering Information

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Package</th>
<th>Packaging and forming specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>BD35395FJ-M</td>
<td>E2</td>
<td>E2: Embossed tape and reel</td>
</tr>
</tbody>
</table>

Marking Diagrams

### Part Number Marking

- **LOT Number**
- **1PIN MARK**
- **Part Number Marking**

<table>
<thead>
<tr>
<th>Part Number Marking</th>
<th>Package</th>
<th>Orderable Part Number</th>
</tr>
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<tbody>
<tr>
<td>35395</td>
<td>SOP-J8</td>
<td>BD35395FJ-ME2</td>
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</tbody>
</table>
### Physical Dimension, Tape and Reel Information

<table>
<thead>
<tr>
<th>Package Name</th>
<th>SOP-J8</th>
</tr>
</thead>
</table>

#### Physical Dimensions

- **Max**: 5.25 (include BURR)
- **4.9±0.2**
- **3.9±0.2**
- **6.0±0.3**
- **0.545**
- **1.27**
- **0.42±0.1**
- **0.2±0.1**

#### Tape and Reel Information

<table>
<thead>
<tr>
<th>Tape</th>
<th>Embossed carrier tape</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2500pcs</td>
</tr>
</tbody>
</table>

- **Direction of feed**
  - **E2**: The direction is the 1pin of product is at the upper left when you hold the reel on the left hand and you pull out the tape on the right hand.

- **Reel**: 1pin
- **Direction of feed**: Order quantity needs to be multiple of the minimum quantity.
## Revision History

<table>
<thead>
<tr>
<th>Date</th>
<th>Revision</th>
<th>Changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>5-Jun.2014</td>
<td>002</td>
<td>The specification is added for DDR3L. (P.5)</td>
</tr>
<tr>
<td>30-Nov.2017</td>
<td>003</td>
<td>The item of “16. Over Current Protection Circuit (OCP)” in “Operational Notes” is deleted. (P.13)</td>
</tr>
</tbody>
</table>
Notice

Precaution on using ROHM Products

1. If you intend to use our Products in devices requiring extremely high reliability (such as medical equipment (Note 1), aircraft/spacecraft, nuclear power controllers, etc.) and whose malfunction or failure may cause loss of human life, bodily injury or serious damage to property ("Specific Applications"), please consult with the ROHM sales representative in advance. Unless otherwise agreed in writing by ROHM in advance, ROHM shall not be in any way responsible or liable for any damages, expenses or losses incurred by you or third parties arising from the use of any ROHM’s Products for Specific Applications.

(Note1) Medical Equipment Classification of the Specific Applications

<table>
<thead>
<tr>
<th>JAPAN</th>
<th>USA</th>
<th>EU</th>
<th>CHINA</th>
</tr>
</thead>
<tbody>
<tr>
<td>CLASS III</td>
<td>CLASS III</td>
<td>CLASS II b</td>
<td>CLASS III</td>
</tr>
<tr>
<td>CLASS IV</td>
<td></td>
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</tbody>
</table>

2. ROHM designs and manufactures its Products subject to strict quality control system. However, semiconductor products can fail or malfunction at a certain rate. Please be sure to implement, at your own responsibilities, adequate safety measures including but not limited to fail-safe design against the physical injury, damage to any property, which a failure or malfunction of our Products may cause. The following are examples of safety measures:
   [a] Installation of protection circuits or other protective devices to improve system safety
   [b] Installation of redundant circuits to reduce the impact of single or multiple circuit failure

3. Our Products are not designed under any special or extraordinary environments or conditions, as exemplified below. Accordingly, ROHM shall not be in any way responsible or liable for any damages, expenses or losses arising from the use of any ROHM’s Products under any special or extraordinary environments or conditions. If you intend to use our Products under any special or extraordinary environments or conditions (as exemplified below), your independent verification and confirmation of product performance, reliability, etc. prior to use, must be necessary:
   [a] Use of our Products in any types of liquid, including water, oils, chemicals, and organic solvents
   [b] Use of our Products outdoors or in places where the Products are exposed to direct sunlight or dust
   [c] Use of our Products in places where the Products are exposed to sea wind or corrosive gases, including Cl2, H2S, NH3, SO2, and NO2
   [d] Use of our Products in places where the Products are exposed to static electricity or electromagnetic waves
   [e] Use of our Products in proximity to heat-producing components, plastic cords, or other flammable items
   [f] Sealing or coating our Products with resin or other coating materials
   [g] Use of our Products without cleaning residue of flux (even if you use no-clean type fluxes, cleaning residue of flux is recommended); or Washing our Products by using water or water-soluble cleaning agents for cleaning residue after soldering
   [h] Use of the Products in places subject to dew condensation

4. The Products are not subject to radiation-proof design.

5. Please verify and confirm characteristics of the final or mounted products in using the Products.

6. In particular, if a transient load (a large amount of load applied in a short period of time, such as pulse.) is applied, confirmation of performance characteristics after on-board mounting is strongly recommended. Avoid applying power exceeding normal rated power; exceeding the power rating under steady-state loading condition may negatively affect product performance and reliability.

7. De-rate Power Dissipation depending on ambient temperature. When used in sealed area, confirm that it is the use in the range that does not exceed the maximum junction temperature.

8. Confirm that operation temperature is within the specified range described in the product specification.

9. ROHM shall not be in any way responsible or liable for failure induced under deviant condition from what is defined in this document.

Precaution for Mounting / Circuit board design

1. When a highly active halogenous (chlorine, bromine, etc.) flux is used, the residue of flux may negatively affect product performance and reliability.

2. In principle, the reflow soldering method must be used on a surface-mount products, the flow soldering method must be used on a through hole mount products. If the flow soldering method is preferred on a surface-mount products, please consult with the ROHM representative in advance.

For details, please refer to ROHM Mounting specification
Precautions Regarding Application Examples and External Circuits
1. If change is made to the constant of an external circuit, please allow a sufficient margin considering variations of the characteristics of the Products and external components, including transient characteristics, as well as static characteristics.

2. You agree that application notes, reference designs, and associated data and information contained in this document are presented only as guidance for Products use. Therefore, in case you use such information, you are solely responsible for it and you must exercise your own independent verification and judgment in the use of such information contained in this document. ROHM shall not be in any way responsible or liable for any damages, expenses or losses incurred by you or third parties arising from the use of such information.

Precaution for Electrostatic
This Product is electrostatic sensitive product, which may be damaged due to electrostatic discharge. Please take proper caution in your manufacturing process and storage so that voltage exceeding the Products maximum rating will not be applied to Products. Please take special care under dry condition (e.g. Grounding of human body / equipment / solder iron, isolation from charged objects, setting of Ionizer, friction prevention and temperature / humidity control).

Precaution for Storage / Transportation
1. Product performance and soldered connections may deteriorate if the Products are stored in the places where:
   [a] the Products are exposed to sea winds or corrosive gases, including Cl2, H2S, NH3, SO2, and NO2
   [b] the temperature or humidity exceeds those recommended by ROHM
   [c] the Products are exposed to direct sunshine or condensation
   [d] the Products are exposed to high Electrostatic

2. Even under ROHM recommended storage condition, solderability of products out of recommended storage time period may be degraded. It is strongly recommended to confirm solderability before using Products of which storage time is exceeding the recommended storage time period.

3. Store / transport cartons in the correct direction, which is indicated on a carton with a symbol. Otherwise bent leads may occur due to excessive stress applied when dropping of a carton.

4. Use Products within the specified time after opening a humidity barrier bag. Baking is required before using Products of which storage time is exceeding the recommended storage time period.

Precaution for Product Label
A two-dimensional barcode printed on ROHM Products label is for ROHM’s internal use only.

Precaution for Disposition
When disposing Products please dispose them properly using an authorized industry waste company.

Precaution for Foreign Exchange and Foreign Trade act
Since concerned goods might be fallen under listed items of export control prescribed by Foreign exchange and Foreign trade act, please consult with ROHM in case of export.

Precaution Regarding Intellectual Property Rights
1. All information and data including but not limited to application example contained in this document is for reference only. ROHM does not warrant that foregoing information or data will not infringe any intellectual property rights or any other rights of any third party regarding such information or data.

2. ROHM shall not have any obligations where the claims, actions or demands arising from the combination of the Products with other articles such as components, circuits, systems or external equipment (including software).

3. No license, expressly or implied, is granted hereby under any intellectual property rights or other rights of ROHM or any third parties with respect to the Products or the information contained in this document. Provided, however, that ROHM will not assert its intellectual property rights or other rights against you or your customers to the extent necessary to manufacture or sell products containing the Products, subject to the terms and conditions herein.

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2. The Products may not be disassembled, converted, modified, reproduced or otherwise changed without prior written consent of ROHM.

3. In no event shall you use in any way whatsoever the Products and the related technical information contained in the Products or this document for any military purposes, including but not limited to, the development of mass- destruction weapons.

4. The proper names of companies or products described in this document are trademarks or registered trademarks of ROHM, its affiliated companies or third parties.
General Precaution

1. Before you use our Products, you are requested to carefully read this document and fully understand its contents. ROHM shall not be in any way responsible or liable for failure, malfunction or accident arising from the use of any ROHM's Products against warning, caution or note contained in this document.

2. All information contained in this document is current as of the issuing date and subject to change without any prior notice. Before purchasing or using ROHM's Products, please confirm the latest information with a ROHM sales representative.

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