Automotive LED Drivers Selection Guide

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*Before using the product(s) please verify the numerical values, data, and functions listed in the latest datasheet.
### Application Configuration Examples

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<th>LED Driver</th>
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<td>Simple Drive</td>
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<tr>
<td></td>
<td></td>
<td>BD1834EFV-M/MUF-M/P3 (1ch Boost, Buck-Boost) BD18391SEFV-M/P4 (1ch Buck)</td>
</tr>
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<td>BD1834x-M series/P11-12 (1ch Buck)</td>
</tr>
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<td></td>
<td>With pattern control</td>
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<td>Under Planning</td>
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<tr>
<td></td>
<td>Without pattern control</td>
<td>BD1834x-M series/P11-12 (1ch Buck)</td>
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<tr>
<td></td>
<td>Controller type</td>
<td>BD18346HFN-M/P13</td>
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### LED Driver Lineup for Automotive Lamps

<table>
<thead>
<tr>
<th>LED channel &amp; number</th>
<th>20mA</th>
<th>130mA</th>
<th>500mA</th>
<th>800mA</th>
<th>1A</th>
<th>2 to 6A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Long chain 6 to 15 LEDs</td>
<td>BD18351EFV-M (Boost, Buck-Boost) BD18353EFV-MUF-M (Boost, Buck-Boost) BD18312MUF-M (1ch Boost, 2ch Buck)</td>
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<tr>
<td>Multi channels 3 to 6 LEDs</td>
<td>BD1834 series (Controller) BD18346HFN-M (Small PKU/1ch) BD18347EFV-W/BD18337EFV-M (FET/4ch)</td>
<td>RCL/DRL/Turn/CL/Fog</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Multi channels 1 to 3 LEDs</td>
<td>BD837x series (Integrated FET/up to 500mA)</td>
<td>RCL/DRL/Turn/CL/Fog</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>One channel 1 to 3 LEDs</td>
<td>BD837x series (Integrated FET/up to 500mA)</td>
<td>RCL/DRL/Turn/CL/Fog</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Buck LED Driver
- Boost, Buck-Boost LED Driver
- Linear LED Driver

*Before using the ICs, please verify the numerical values, data, and functions listed in the latest datasheet.
Buck LED Drivers featuring Fixed Switching Frequency Control

**Key Features**
- Synchronous rectification buck LED drivers
- Hysteresis function
- Operating voltage range: 5.0V to 70V
- LED voltage range: 2.0V to 60V
- Switching frequency: 100kHz to 500kHz
- Fixed switching frequency control
- Spread spectrum function
- High side LED current detection function
- PWM/DC dimming function
- Supports matrix drive
- LED open/short detection function
- UVLO, TSD, OCP functions

**Target Applications**
- High/Low Beam
- Tail-Stop Lamp, DRL
- Position/TURN Lamp

**Advantages of EMC Countermeasures (Fixed Switching Frequency Control)**
- Fixed switching frequency control addresses automotive EMC standards such as CISPR25 by focusing on switching frequency fluctuations that are issues of OFF time control.
- In addition, combining with a spread spectrum function ensures sufficient margin for automotive EMC standards.
- Hysteresis control provides faster response when changing the number of LEDs compared with current mode.

**OFF Time Control**
- Constant ripple control amplitude
- Switching frequency fluctuation
  - Problem for EMC countermeasures
- \( f_{sw1} \neq f_{sw2} \)

**Fixed Switching Frequency Control**
- The ripple current amplitude will fluctuate
- Switching frequency is constant.
  - Facilitates EMC countermeasures
- \( f_{sw1} = f_{sw2} \)

**Response**
- Frequency Stabilization
  - Dependant on input/output conditions

**Package**
- HTSSOP-B16: 5.00mm × 6.40mm × 1.00mm
- VQFN24FV4040: 4.00mm × 4.00mm × 1.00mm

**Diagram**

- Under Development
LED drivers that light up multiple LEDs through matrix control, such as ADB and sequential turn lamps, require fast response, reduced LED rush current, and minimal fluctuation in the average current when changing the number of LEDs.

**OFF time control** keeps the LED current ripple constant by detecting LED peak current with comparator and fixed OFF time control of buck converter. The above requirements are realized because no phase compensation is necessary and output CAP can be minimized.

### Key Features
- Buck LED drivers with built-in FET featuring OFF time control
- Hysteresis control
- Operating voltage range: 4.5V to 70V
- LED voltage range: 0V to 60V
- LED current setting range:
  - 0.1A to 1.0A (BD18391EFV)
  - 0.2A to 2.0A (BD18395EFV)
- Switching frequency: 25kHz to 1MHz
- Standby current: 0μA (Typ.)
- Output ON resistance: 0.17Ω (Typ.)
- PWM/DC dimming function
- Supports matrix drive (output capacitance: less than 10nF)
- High side LED current detection function
- LED open/short detection function
- UVLO, TSD, OCP functions

### Target Applications
- High/Low Beam
- Tail-Stop Lamp, DRL
- Position/TURN Lamp

### Sample Waveforms When Changing the Number of LEDs

- **No. of LEDs**: 16 lamps → 1 lamp
  - The average current for 1 lamp and 16 lamps is the same
  - No overshoot or rush current when changing from 1 lamp to 16 lamps

- **No. of LEDs**: 16 lamps → 0 lamps
  - Fast response when returning from 0 lamps to 16 lamps
  - No overshoot or rush current

### Package
- HTSSOP-B20
  - W (Typ.) × D (Typ.) × H (Max.): 6.50mm × 6.40mm × 1.00mm
Boost LED Drivers

**Key Features**

- 1ch boost LED driver
- Operating voltage range: 4.5 to 65V
- Boost voltage range: 6.0 to 65V
- High accuracy power supply: 2.5V±3%
- LED current accuracy: ±3%(−40°C to +125°C)
- Switching frequency: 200kHz to 700kHz
- PWM/DC dimming function
- Built-in PWM generator
- High side LED current detection function
- Spread spectrum function
- LED open/short protection function
- UVLO, TSD, OCP functions
- Self-diagnostic function (FAIL)

**Target Applications**

- High/Low Beam
- Tail-Stop Lamp, DRL
- Position/TURN Lamp

**Package**

HTSSOP-B24

W(Typ.) × D(Typ.) × H(Max.)

7.80mm × 7.60mm × 1.00mm

**Spread Spectrum Function**

- Spread spectrum (spread spectrum clock generator) is a function that mitigates noise concentration at a certain frequency (switching frequency and its harmonics) by intentionally modulating the switching frequency. It is effective in reducing the peak noise.
- The EMC level required for automotive applications is expected to become more stringent in the future following the continued electrification of vehicles and adoption of ADAS/Autonomous driving, but adding a spread spectrum function provides a better margin against automotive EMI standards such as CISPR25. This is why it is possible to decrease the size of the input filter block by optimization of filter components.

**CISPR25/Conduction Emission Test Comparison**

- Comparison of Noise measurement result with τt type filter constants required to meet CISPR25/Class 5
  (8 white LED in series, ILED=300mA)

The spread spectrum function makes it possible to reduce the input filter constants to comply with the CISPR25 standard.
### Key Features
- 1ch boost LED driver
- Operating voltage range: 5.0V to 65V
- Boost voltage range: up to 60V
- LED current accuracy: ±3% (−40°C to +125°C)
- Switching frequency: 100kHz to 2.2MHz (T.B.D.)
- PWM/DC dimming function
- 2-system DC dimming function
- Built-in PWM generator (200Hz)
- High side LED current detection function
- Integrated Pch MOSFET driver for PWM dimming
- Spread spectrum function
- Hiccup timer
- LED open/short protection function
- UVLO, UVD, OVP, OCP, TSD functions
- Diagnostic function (FAULT_B)

### Target Applications
- High/Low Beam
- Tail-Stop Lamp, DRL
- Position/TURN Lamp

### Package
- **HTSSOP-B20**
  - W (Typ.): 6.50mm
  - D (Typ.): 6.40mm
  - H (Max.): 1.00mm
- **VQFN20FV3535**
  - W (Typ.): 3.50mm
  - D (Typ.): 3.50mm
  - H (Max.): 1.00mm

### 2-System DC Dimming Function
- The BD18353EFV-M and BD18353MUF-M each have 2 DC dimming terminals (DCDIM1 and DCDIM2)

<table>
<thead>
<tr>
<th>Configuration Example</th>
<th>DCDIM1</th>
<th>DCDIM2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>BIN resistor</td>
<td>Thermal derating (NTC)</td>
</tr>
<tr>
<td>2</td>
<td>Analog input from MCU</td>
<td>Thermal derating (NTC)</td>
</tr>
<tr>
<td>3</td>
<td>Analog input from resistor dividing</td>
<td>Thermal derating (NTC)</td>
</tr>
<tr>
<td>4</td>
<td>MCU control</td>
<td>Unused</td>
</tr>
</tbody>
</table>
Key Features

- 1ch boost power supply + 2ch buck LED driver
  - Boost block: Current mode DC/DC controller
  - Buck block: Buck LED driver featuring OFF time control
- Operating voltage range: 5.5V to 50V
- LED voltage range: 2.5V to 62V
- LED settling current range: Depends on external FET
- Switching frequency: 63kHz to 500kHz (Boost) / 25kHz to 1MHz (Buck)
- Standby current: 0μA (Typ.)
- PWM/DC dimming function
- Supports matrix drive (output capacitance ≤ 10nF)
- High side LED current detection function
- Limp home function
- Peak current correction function
- LED open/short protection function
- UVLO, TSD, OCP functions

Target Applications

- ADB
- High/Low Beam
- Tail-Stop Lamp, DRL
- Position/TURN Lamp

Limp Home Function

When communication between the LED driver IC and MCU is interrupted, the BD18312MUF-M detects an error via SPI and enters Limp Home mode. Limp-home mode first reads the BIN (Binary) resistors which is external using the A/D converter. The boost output voltage and frequency can be set by these external BIN resistors, and BD18321MUF-M maintains LED lighting operation on these settings.

Peak Current Correction Function

During ADB operation, the LED voltage fluctuates dynamically, causing variations in the LED current. The BD18312MUF-M can correct these LED current fluctuations using a peak current correction function.
Matrix LED Controller with Built-in Pattern

BD18362EFV-M

Key Features

- 8ch Matrix LED controller
- Input voltage range: 5.5V to 60V
- LED voltage range: 0V to 48V
- Max. LED current: 1.0A
- Built-in MOSFET (Ron=230mΩ)
- Standalone mode (no MCU)
- Sequential lighting pattern built in
- Internal sequential lighting time setting function
- All lights ON function
- 2 LEDs can be connected to each switch
- LED open/short detection
- UVLO, TSD functions

Target Applications

- Sequential Turn Lamp

Built-in Lighting Pattern Facilitates Design

- Sequential Turn Lamp Solution Without an MCU

Sequential control is easily achieved by combining ROHM’s buck-boost LED driver (BD18351EFV-M) with a matrix LED controller.

Block Diagram

Target Applications

- Sequential Turn Lamp

Connect 2 LEDs to Each Channel

High voltage switches of BD18362EFV-M can handle up to 9V, so that 2 series of LED can be connected. 2 chips in 1 package type of LED can be connected, too.

*The guaranteed operating range is 9V/ch

Package

HTSSOP-B28
W(Typ.) × D(Typ.) × H(Max.)
9.70mm × 6.40mm × 1.00mm

Evaluation Board

Boost LED Driver BD18351EFV-M
Matrix LED Controller BD18362EFV-M
LED Output

50mm

33mm

26mm

35mm
4ch Linear LED Drivers

BD18337EFV-M/BD18347EFV-M

**Key Features**
- 4ch linear LED drivers with built-in FET
- Operating voltage range : 5.5V to 20V
- Max. output current : 150mA/ch(Total : 500mA)
- Output current accuracy : ±5%(Ta=−40°C to +125°C)
- Power Shift function
- License lamp mode
- LED open detection mask function
  - BD18337 : 11.0V(Typ.)
  - BD18347 : 7.65V(Typ.)
- LED open/output short detection function
- Overvoltage mute function : VIN>20V(Min.)
- PBUS function
- TSD/UVLO
- UVLO, TSD functions

**Target Applications**
- Rear Lamps
- Position/DRL
- Fog
- Turn

**Individual PWM Dimming**
With BD18337EFV-M and BD18347EFV-M, individual PWM dimming can be done by connecting an Nch MOSFET to each channel. The delay time for the PWM signal when using external MOSFETs is shown in the figure of Measurement Conditions at the lower right.

**Configuration Example**

**Measurement Results**
V_{IN}=13V, Output current : 100mA Ta=25°C
Output capacitor : 0.047μF, LED : 3Strings(Color : Red)

Combining with an MCU supports applications such as sequential turn lamps

**Package**
HTSSOP-B16
5.00mm × 6.40mm × 1.00mm

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Power Shift Function

- Power shift function simplifies thermal design of LED driver board by adding external resistor.

With conventional linear LED drivers, thermal design is difficult in high power applications due to the constraints for permissible package power loss.

In contrast, BD18337EFV-M and BD18347EFV-M dissipates the power, which is consumed internally with conventional linear LED driver, externally with resistor (REXT) added between VIN and VINRES. Thus IC temperature increase is minimized. The voltage between VINRES pin and OUT1-4 pins are controlled to be less than 2.0V.

![Diagram](image)

Adding a resistor simplifies thermal design and contributes to lower total cost by reducing the number of LED drivers

Actual Effects

Measurement Conditions

- V=9V/13.5V/16V, ILED=75mA/CH (Total : 300mA), VLED=6.25V

Measurement Results

<table>
<thead>
<tr>
<th>Measurement Point</th>
<th>V=9V</th>
<th>V=13.5V</th>
<th>V=16V</th>
</tr>
</thead>
<tbody>
<tr>
<td>IC Temp.</td>
<td>64.1°C</td>
<td>82.8°C</td>
<td>81.2°C</td>
</tr>
<tr>
<td>R1 Temp.</td>
<td>49.2°C</td>
<td>65.1°C</td>
<td>79.5°C</td>
</tr>
<tr>
<td>R4 Temp.</td>
<td>46.8°C</td>
<td>65.3°C</td>
<td>82.7°C</td>
</tr>
</tbody>
</table>

Loss Curves

- ILED=300mA, VLED=6.25V, REXT=31Ω

![Graph](image)

External resistor reduces IC heat generation
Key Features

- Linear LED controllers
- Operating voltage range: 4.5V to 19V
- Reference voltage (5V) output: ±3% (Ta=25°C to 125°C)
- FB terminal voltage accuracy: ±3% (Ta=25°C to 125°C)
- Standby current: 0μA (Typ.)
- PWM dimming function
- DC dimming function (BD18340, 18341, 18345 only)
- PWMOUT synchronization signal output function (BD18340, 18341, 18345 only)
- LED open detection mask function (Variable voltage)
- LED open/output short detection function
- Overvoltage mute function: 20V (Min.)
- PBUS function
- UVLO, TSD functions

Target Applications

- Rear Lamps
- Position/DRL
- Fog
- Turn

Multiple Built-In Functions

- Standby Function
  - Standby current: 0μA (Typ.)

- LED open detection mask function
  - The LED open detection mask voltage can be changed based on the number of LED stages (variable voltage)

- CR Timer with PWM Signal External Output Function
  - The built-in CR timer eliminates the need to input a PWM signal from a timer IC or MCU (except BD18343) and the internally generated PWM signal can be externally output, facilitating synchronous control (BD18340, BD18341, and BD18345 only)

- Controller Type
  - Support for both low and high current applications (1.0A Max.) is achieved by simply changing the number of external PNP transistors
  - Low Current
  - High Current
    - Contributes to IC consolidation (common design)
    - Reduces system costs (compared with built-in switch types)

- Temperature Derating Possible
  - Luminous flux BIN setting and temperature derating is possible with NTC thermistor so that constant voltage Zener is not needed (BD18340, BD18341, and BD18345 only)
BD18345EFV-M with Enhanced DC Dimming Function

- The number of DC dimming functions was expanded from 1 system in conventional models (BD18340/BD18341) to 2 systems in the BD18345
- Achieves both LED coding and temperature derating functionality
- DC dimming accuracy improved to ±3% (DCDIM pin)

**Control Board**

- **For Luminous Flux Rank Coding**
- **For Temperature Derating**

**LED Board**

- **DC DIM pin for DC dimming**
- **THD Pin For Temperature Derating**

- Eliminates the needs to change resistor on the control board for different luminous flux ranks
- Select a BIN resistor on the LED board corresponding to the LED luminous flux rank. The voltage to DCDIM will vary depending on BIN resistor so that voltage of FB pin will be adjusted automatically.

**Ensuring high reliability by reducing LED degradation.**

**THD Pin For Temperature Derating**

Connect an NTC thermistor. (The voltage of THD pin is resistor divided voltage from VREG.) Following a rise in temperature of the LED board, the resistance value of the thermistor decreases along with the THD pin voltage. The output current can be derated based on the THD pin voltage.

**Reference Boards**

**3-System**

- **BD18341FV-M**
- **2SAR573DFHG**

**10-System**

- **BD18341FV-M**
- **2SAR533P**

**PNP Transistor 1**
- Max. temp.: 69.6˚C

**PNP Transistor 2**
- Max. temp.: 68.3˚C

**BD18341FV-M**
- 300mA/Sting
- 56.8˚C

**2SAR533P**
- 100mA/Sting
- 64.9˚C
Ultra-Compact Linear LED Driver

BD18346HFN-M

**Key Features**
- Linear LED driver with built-in FET
- Operating voltage range: 5.5V to 20V
- Max. output current: 400mA
- Output current accuracy: ±5%(Ta=−40°C to +125°C)
- **PWM dimming function**
  (PWM dimming range: 0.4% to 100% @ 200Hz)
- Output current derating function
- LED open detection mask function: 11V (Typ.)
- LED open/output short detection function
- ISET pin short protection function
- Overvoltage mute function: 15V (Min.)
- **PBUS function**
- UVLO, TSD functions

**Target Applications**
- Socket LED
- Rear Lamps
- Position/DRL
- Fog
- Turn

**Block Diagram**

**Linear LED Drivers with Built-in FET**

BD83732HFP-M/BD83733HFP-M

**Key Features**
- Linear LED driver with built-in FET
- Operating voltage range: 4.5V to 42V
- Max. output current: 500mA
- Output current accuracy: ±3%(Ta=25°C)
- **PWM dimming function**
  (PWM dimming range: 0.4% to 100% @ 200Hz)
- Output current derating function
- LED open detection mask function (during reduced power)
  BD83732: 7.6V (Typ.)
  BD83733: 11.0V (Typ.)
- LED open/short detection function
- **PBUS function**
- TSD protection function

**Target Applications**
- Rear Lamps
- Position/DRL
- Fog
- Turn

**Block Diagram**

**Package**
**Linear LED Drivers with Built-in FET**

**BD8372HFP-M/BD8372EFJ-M**

### Key Features
- Variable output type linear LED drivers with built-in FET
- Operating voltage range: 5.5V to 40V
- Max. output current: 200mA
- Max. output current: ±3%(Ta=25°C)
- Enables independent setting of Tail/Stop mode output currents
- LED open/short detection function
- Overvoltage mute function: 16V (Min.)
- PBUS function
- TSD protection function

### Target Applications
- Rear Lamps

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**Linear LED Drivers with Built-in FET**

**BD8374HFP-M/BD8374EFJ-M**

### Key Features
- Linear LED driver with built-in FET
- Operating voltage range: 4.5V to 42V
- Max. output current: 200mA
- Output current accuracy: ±3%(Ta=25°C)
- **PWM dimming function**
  (PWM dimming range: 0.4% to 100% @ 200Hz)
- LED open/short detection function
- Overvoltage mute function: 27V (Min.)
- PBUS function
- TSD protection function

### Target Applications
- Rear Lamps
- Fog
- Position/DRL
- Turn

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**Block Diagram**

**Package**
## Linear LED Driver Lineup

### BD1834x-M series/BD837x-M series

#### BD1834x-M series

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Channel Number (ch)</th>
<th>Operating Voltage Range (V)</th>
<th>Absolute Maximum Rating (V)</th>
<th>Drive Current</th>
<th>Dimmer mode</th>
<th>PWM OUT</th>
<th>Package</th>
</tr>
</thead>
<tbody>
<tr>
<td>BD18340FV-M</td>
<td>1 to 10</td>
<td>4.5 to 19</td>
<td>70</td>
<td></td>
<td>PWM OFF</td>
<td>DC</td>
<td>SSOP-B16</td>
</tr>
<tr>
<td>BD18341FV-M</td>
<td>1 to 10</td>
<td>4.5 to 19</td>
<td>70</td>
<td></td>
<td>PWM OFF</td>
<td>DC</td>
<td>SSOP-B16</td>
</tr>
<tr>
<td>BD18342FV-M</td>
<td>1 to 10</td>
<td>4.5 to 19</td>
<td>70</td>
<td></td>
<td>PWM OFF</td>
<td>DC</td>
<td>SSOP-B16</td>
</tr>
<tr>
<td>BD18343FV-M</td>
<td>1 to 10</td>
<td>4.5 to 19</td>
<td>70</td>
<td></td>
<td>PWM OFF</td>
<td>DC</td>
<td>SSOP-B16</td>
</tr>
<tr>
<td>BD18345EFV-M</td>
<td>1</td>
<td>4.5 to 19</td>
<td>70</td>
<td>400mA</td>
<td>PWM OFF</td>
<td>2port</td>
<td>HTSSOP-B20</td>
</tr>
<tr>
<td>BD18346HFN-M</td>
<td>1</td>
<td>5.5 to 20</td>
<td>42</td>
<td></td>
<td>PWM OFF</td>
<td></td>
<td>HSON8</td>
</tr>
<tr>
<td>BD18347EFV-M/BD18337EFV-M</td>
<td>4</td>
<td>5.5 to 20</td>
<td>40</td>
<td>150mA/ch</td>
<td>PWM OFF</td>
<td></td>
<td>HTSSOP-B16</td>
</tr>
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</table>

Note: Under Development

#### BD837x-M series

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Channel Number (ch)</th>
<th>Operating Voltage Range (V)</th>
<th>Absolute Maximum Rating (V)</th>
<th>Drive Current</th>
<th>Dimmer mode</th>
<th>PWM OUT</th>
<th>Package</th>
</tr>
</thead>
<tbody>
<tr>
<td>BD8372HFP-M/BD8372EFJ-M</td>
<td>1</td>
<td>5.5 to 40</td>
<td>50</td>
<td>200</td>
<td>High Current</td>
<td></td>
<td>HRP7/HTSSOP-J8</td>
</tr>
<tr>
<td>BD8374HFP-M/BD8374EFJ-M</td>
<td>1</td>
<td>4.5 to 42</td>
<td>50</td>
<td>500</td>
<td>PWM OFF</td>
<td></td>
<td>HRP7/HTSSOP-J8</td>
</tr>
<tr>
<td>BD8373HFP-M/BD83733HFP-M</td>
<td>1</td>
<td>4.5 to 42</td>
<td>50</td>
<td>500</td>
<td>PWM OFF</td>
<td></td>
<td>HRP7</td>
</tr>
</tbody>
</table>

### PBUS Function

#### BD1834x-M series/BD837x-M series

**Basic Patent : PBUS Function**

The PBUS (Protect BUS) function automatically determines LSI master or slave when detecting LED disconnection or IC output ground fault in multi-channel LED drive circuit that drive multiple LEDs and turns OFF all channels at once (all off). Each model in the BD1834x-M and BD837x-M series is equipped with this function as standard.

#### BD1834x-M series Circuit Example

Connecting the PBUS terminal between ICs makes it possible to detect a single lamp break or ground fault and turn all lamps OFF at once.
**IPD (Intelligent Power Devices)**

**Key Features**

- ROHM offers an enhanced lineup of IPS integrating MOSFET protection functions in 1ch/2ch/8ch series

**Lineup**

<table>
<thead>
<tr>
<th>High Side Switches</th>
<th>Part No.</th>
<th>Voltage Range (V)</th>
<th>VDS (Max.) (V)</th>
<th>Overcurrent Detection (Min.) (A)</th>
<th>ON-state Leakage (Typ. (mA))</th>
<th>TSD</th>
<th>Functions</th>
<th>Error Flag Output</th>
<th>Package(Package Code)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>BV1H045EFU-C</td>
<td>6.0 to 28.0</td>
<td>45</td>
<td>21</td>
<td>45</td>
<td>Self-Recovery</td>
<td>-</td>
<td>-</td>
<td>HSON8</td>
</tr>
<tr>
<td>1</td>
<td>BV1H090EFU-C</td>
<td>6.0 to 28.0</td>
<td>45</td>
<td>8</td>
<td>45</td>
<td>Self-Recovery</td>
<td>-</td>
<td>-</td>
<td>MSOP8</td>
</tr>
<tr>
<td>1</td>
<td>BV1H180EFU-C</td>
<td>4.5 to 38.0</td>
<td>45</td>
<td>27</td>
<td>90</td>
<td>Self-Recovery</td>
<td>-</td>
<td>-</td>
<td>HSON-A8</td>
</tr>
<tr>
<td>1</td>
<td>BV1H180EFU-C</td>
<td>4.5 to 38.0</td>
<td>45</td>
<td>4</td>
<td>90</td>
<td>Self-Recovery</td>
<td>-</td>
<td>-</td>
<td>SOP-J8</td>
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<tr>
<td>1</td>
<td>BD1H0500...-C</td>
<td>4.0 to 18.0</td>
<td>44.5</td>
<td>0.8</td>
<td>600</td>
<td>Self-Recovery</td>
<td>-</td>
<td>FET inverting</td>
<td>HTSOP-J8</td>
</tr>
<tr>
<td>1</td>
<td>BD1H500...-C</td>
<td>4.0 to 18.0</td>
<td>44.5</td>
<td>0.8</td>
<td>500</td>
<td>Self-Recovery</td>
<td>-</td>
<td>FET inverting</td>
<td>TO252-J3</td>
</tr>
<tr>
<td>1</td>
<td>BV1H045EFU-C</td>
<td>6.0 to 28.0</td>
<td>45</td>
<td>21</td>
<td>45</td>
<td>Self-Recovery</td>
<td>-</td>
<td>-</td>
<td>HSSOP-C16</td>
</tr>
<tr>
<td>1</td>
<td>BV1H090EFU-C</td>
<td>6.0 to 28.0</td>
<td>45</td>
<td>8</td>
<td>45</td>
<td>Self-Recovery</td>
<td>-</td>
<td>-</td>
<td>HTSSOP-B24</td>
</tr>
<tr>
<td>1</td>
<td>BV1H180EFU-C</td>
<td>4.5 to 38.0</td>
<td>45</td>
<td>27</td>
<td>90</td>
<td>Self-Recovery</td>
<td>-</td>
<td>-</td>
<td>SSOP-A24</td>
</tr>
<tr>
<td>2</td>
<td>BV2H045EFU-C</td>
<td>6.0 to 19.0</td>
<td>41</td>
<td>36</td>
<td>140</td>
<td>Self-Recovery</td>
<td>-</td>
<td>-</td>
<td>HSON8</td>
</tr>
<tr>
<td>2</td>
<td>BV2H045EFU-C</td>
<td>6.0 to 28.0</td>
<td>41</td>
<td>36</td>
<td>140</td>
<td>Self-Recovery</td>
<td>-</td>
<td>-</td>
<td>MSOP8</td>
</tr>
<tr>
<td>2</td>
<td>BV2H045EFU-C</td>
<td>6.0 to 28.0</td>
<td>41</td>
<td>36</td>
<td>140</td>
<td>Self-Recovery</td>
<td>-</td>
<td>-</td>
<td>HSON-A8</td>
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<tr>
<td>2</td>
<td>BV2H045EFU-C</td>
<td>6.0 to 28.0</td>
<td>41</td>
<td>36</td>
<td>140</td>
<td>Self-Recovery</td>
<td>-</td>
<td>-</td>
<td>SOP-J8</td>
</tr>
<tr>
<td>2</td>
<td>BV2H045EFU-C</td>
<td>6.0 to 28.0</td>
<td>41</td>
<td>36</td>
<td>140</td>
<td>Self-Recovery</td>
<td>-</td>
<td>-</td>
<td>HTSOP-J8</td>
</tr>
<tr>
<td>2</td>
<td>BV2H045EFU-C</td>
<td>6.0 to 28.0</td>
<td>41</td>
<td>36</td>
<td>140</td>
<td>Self-Recovery</td>
<td>-</td>
<td>-</td>
<td>TO252-J3</td>
</tr>
<tr>
<td>2</td>
<td>BV2H045EFU-C</td>
<td>6.0 to 28.0</td>
<td>41</td>
<td>36</td>
<td>140</td>
<td>Self-Recovery</td>
<td>-</td>
<td>-</td>
<td>HSSOP-C16</td>
</tr>
<tr>
<td>2</td>
<td>BV2H045EFU-C</td>
<td>6.0 to 28.0</td>
<td>41</td>
<td>36</td>
<td>140</td>
<td>Self-Recovery</td>
<td>-</td>
<td>-</td>
<td>HTSSOP-B24</td>
</tr>
<tr>
<td>2</td>
<td>BV2H045EFU-C</td>
<td>6.0 to 28.0</td>
<td>41</td>
<td>36</td>
<td>140</td>
<td>Self-Recovery</td>
<td>-</td>
<td>-</td>
<td>SSOP-A24</td>
</tr>
</tbody>
</table>

**Low Side Switches**

|                  |         |                  |                |                                  |                               |     |           |                   |                     |
|                  |         |                  |                |                                  |                               |     |           |                   |                     |
| 1                  | BV1L0100FJ-C | 3.0 to 5.5       | 42             | 42                              | 10                            | Self-Recovery | -            | -                 | HSON8               |
| 1                  | BV1L0100FJ-C | 3.0 to 5.5       | 42             | 42                              | 10                            | Self-Recovery | -            | -                 | MSOP8               |
| 1                  | BV1L0100FJ-C | 3.0 to 5.5       | 42             | 42                              | 10                            | Self-Recovery | -            | -                 | HSON-A8             |
| 1                  | BV1L0100FJ-C | 3.0 to 5.5       | 42             | 42                              | 10                            | Self-Recovery | -            | -                 | SOP-J8              |
| 1                  | BV1L0100FJ-C | 3.0 to 5.5       | 42             | 42                              | 10                            | Self-Recovery | -            | -                 | HTSOP-J8            |
| 1                  | BV1L0100FJ-C | 3.0 to 5.5       | 42             | 42                              | 10                            | Self-Recovery | -            | -                 | TO252-J3            |
| 1                  | BV1L0100FJ-C | 3.0 to 5.5       | 42             | 42                              | 10                            | Self-Recovery | -            | -                 | HSSOP-C16           |
| 1                  | BV1L0100FJ-C | 3.0 to 5.5       | 42             | 42                              | 10                            | Self-Recovery | -            | -                 | HTSSOP-B24          |
| 1                  | BV1L0100FJ-C | 3.0 to 5.5       | 42             | 42                              | 10                            | Self-Recovery | -            | -                 | SSOP-A24            |

**Notes**

- Under Development

**Variable overcurrent limit and mask time** makes it easy to adjust current protection conditions depending on the load conditions.

**Fixed Overcurrent Limit**

Fixed value of the IC

**Variable Overcurrent Limit**

Unlike fixed overcurrent limit methods for IC protection, abnormal current is detected and limited during steady-state operation. This limit can be adjusted based on load characteristics using an external resistor(functions after the mask time ends)

**Variable Mask Time**

Mask time prevents erroneous detection of inrush current to the capacitive load as abnormal current during steady-state operation. It can be varied based on load characteristics via external capacitor.
MOSFETs/Bipolar Transistors for Automotive LED Drivers

Nch MOSFET for BD18394EFV-M

<table>
<thead>
<tr>
<th>Package</th>
<th>Part No.</th>
<th>Absolute Maximum Ratings</th>
<th>Rs(on) Typ.(mΩ)</th>
<th>Qg Typ. (nC)</th>
<th>Ciss Typ. (pF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(HSMT8AG)</td>
<td>GAG009DG03</td>
<td>40</td>
<td>30</td>
<td>±2.0</td>
<td>6</td>
</tr>
</tbody>
</table>

Pch MOSFET for BD18353EFV/MUF-M

<table>
<thead>
<tr>
<th>Package</th>
<th>Part No.</th>
<th>Absolute Maximum Ratings</th>
<th>Rs(on) Typ.(mΩ)</th>
<th>Qg Typ. (nC)</th>
<th>Ciss Typ. (pF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SOT-346T</td>
<td>RSQ15P10</td>
<td>−100</td>
<td>−1.5</td>
<td>±2.0</td>
<td>350</td>
</tr>
</tbody>
</table>

Nch MOSFET for BD18353EFV/MUF-M

<table>
<thead>
<tr>
<th>Package</th>
<th>Part No.</th>
<th>Absolute Maximum Ratings</th>
<th>Rs(on) Typ.(mΩ)</th>
<th>Qg Typ. (nC)</th>
<th>Ciss Typ. (pF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SOT-323</td>
<td>RJU003N03</td>
<td>30</td>
<td>0.3</td>
<td>±12</td>
<td>800</td>
</tr>
</tbody>
</table>

PNP Transistors for the BD1834x Series

<table>
<thead>
<tr>
<th>Package</th>
<th>Part No.</th>
<th>Absolute Maximum Ratings</th>
<th>Rs(on) Typ.(mΩ)</th>
<th>Qg Typ. (nC)</th>
<th>Ciss Typ. (pF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SOT-89</td>
<td>2SAR533P</td>
<td>−50</td>
<td>−3</td>
<td>180</td>
<td>450</td>
</tr>
</tbody>
</table>

Under development

Anti-Sulphuration Silverless Chip LED (New Standard 3528 Size PLCC5 Package) SML-Y18U2T

New PLCC4 serie

(3.5mm×2.8mm×1.9mm)

Color Lineup: Red

Key Features

- Sulfuration-resistant
- Silverless construction
- High reliability

Dimensions (unit: mm)

**Nch MOSFET**

**Single Type**

<table>
<thead>
<tr>
<th>Package</th>
<th>Part No.</th>
<th>Absolute Maximum Ratings</th>
<th>Rs(on) Typ.(mΩ)</th>
<th>Qg Typ. (nC)</th>
<th>Ciss Typ. (pF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SOT-346T</td>
<td>RSQ15P10</td>
<td>−60</td>
<td>−1.5</td>
<td>±2.0</td>
<td>200</td>
</tr>
</tbody>
</table>

**Dual Type (Nch+Nch)**

<table>
<thead>
<tr>
<th>Package</th>
<th>Part No.</th>
<th>Absolute Maximum Ratings</th>
<th>Rs(on) Typ.(mΩ)</th>
<th>Qg Typ. (nC)</th>
<th>Ciss Typ. (pF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SOP8</td>
<td>SP9K32</td>
<td>45</td>
<td>6</td>
<td>±2.0</td>
<td>18</td>
</tr>
<tr>
<td>SOP8</td>
<td>SP9K33</td>
<td>60</td>
<td>5</td>
<td>±2.0</td>
<td>34</td>
</tr>
</tbody>
</table>

**Concept**

ROHM’s new LED achieves high brightness with superior sulfuration resistance

- Silverless structure improves sulfuration resistance
- Utilizes a high brightness chip

**Performance**

Before

After

Standard Type (Ag Plated Type)

- Decreased reflectivity due to discoloration caused by sulfuration ⇒ Reduced light intensity

Anti-Sulfuration Product

- No discoloration due to sulfuration ⇒ No brightness drop

*Please note that the specifications may change for products under development.


*This page contains a partial excerpt of ROHM’s website for the complete lineup and detailed product characteristics, or contact a ROHM sales representative.

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Schottky Barrier Diodes for Automotive LED Drivers

Key Features

- Lineup of all 3 series of automotive grade products from low Vf to ultra-low-Ir, types

<table>
<thead>
<tr>
<th>Reverse Current</th>
<th>1mA</th>
<th>1μA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Super Low Vf</td>
<td>RBxx1 series</td>
<td></td>
</tr>
<tr>
<td>Low Vf &amp; Medium Ir</td>
<td>RBE series</td>
<td></td>
</tr>
<tr>
<td>Medium Vf &amp; Low Ir</td>
<td>RBS series</td>
<td></td>
</tr>
<tr>
<td>Non-automotive type</td>
<td>RBR series</td>
<td></td>
</tr>
</tbody>
</table>

Package

- High heat dissipation packages that contribute to thinner, smaller set are currently under development

<table>
<thead>
<tr>
<th>Package</th>
<th>Part No.</th>
<th>Absolute Maximum Ratings</th>
<th>Electrical Characteristic (Tj=25°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SOD-123(PMDU)</td>
<td>2.5mm x1.3mm x0.95mm</td>
<td>3.5mm x1.6mm x0.8mm</td>
<td>4.7mm x2.5mm x0.95mm</td>
</tr>
<tr>
<td>SOD-128(PMDTM)</td>
<td>6.5mm x4.3mm x1.1mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TO-252(DPAK)</td>
<td>10.0mm x8.5mm x2.2mm</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

RBxx8 Series/Ultra Low Ir Type

<table>
<thead>
<tr>
<th>Package</th>
<th>Part No.</th>
<th>Absolute Maximum Ratings</th>
<th>Electrical Characteristic (Tj=25°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(PMDE)</td>
<td>RB16VWM40</td>
<td>40</td>
<td>1</td>
</tr>
<tr>
<td>SOD-123FL(PMDU)</td>
<td>200</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SOD-128(PMDTM)</td>
<td>300</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TO-252(DPAK)</td>
<td>500</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

RBR Series/Low Vf Type

<table>
<thead>
<tr>
<th>Package</th>
<th>Part No.</th>
<th>Absolute Maximum Ratings</th>
<th>Electrical Characteristic (Tj=25°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(PMDE)</td>
<td>RBR1VWM40A</td>
<td>40</td>
<td>1</td>
</tr>
<tr>
<td>SOD-123FL(PMDU)</td>
<td>200</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SOD-128(PMDTM)</td>
<td>300</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TO-252(DPAK)</td>
<td>500</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*This page contains a partial except of ROHM’s broad lineup and typical characteristics.* Please refer to ROHM’s website for the complete lineup and detailed product characteristics, or contact a ROHM sales representative.

*Please note that the specifications/scheduling may change without prior notice for products under development. Contact a ROHM sales representative for the latest specifications/development status.

*Indicates the JEDEC package type ( ). ROHM Package. ( ) GENERAL Code.
Wide Terminal/High Power Chip Resistors (1220 to 2550 size)

**LHR18, LTR10/18/50**

**Key Features**
- Wide terminal configuration improves heat dissipation to the substrate
- Superior junction reliability against temperature cycling
- Higher TCR accuracy through pattern optimization (LTR18)

**Concept**
- Pattern optimization further improves TCR accuracy

**Spec**

<table>
<thead>
<tr>
<th>Type</th>
<th>Size (mm)</th>
<th>Rated Power (W)</th>
<th>Tolerance</th>
<th>Resistance Range</th>
<th>Temperature Coefficient of Resistance (%)</th>
<th>Operating Temp (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LHR18</td>
<td>1632 (0812)</td>
<td>1.25</td>
<td>±0.2%</td>
<td>350Ω to 1.2Ω</td>
<td>±0.5</td>
<td>55 to +155</td>
</tr>
<tr>
<td></td>
<td>1200 (0508)</td>
<td>0.5</td>
<td>±0.2%</td>
<td>4Ω to 10Ω</td>
<td>±0.5</td>
<td>55 to +155</td>
</tr>
<tr>
<td>LTR18</td>
<td>1632 (0812)</td>
<td>1.0</td>
<td>±0.2%</td>
<td>10Ω to 1MΩ</td>
<td>±0.5</td>
<td>55 to +155</td>
</tr>
<tr>
<td></td>
<td>2550 (1002)</td>
<td>1.0</td>
<td>±0.2%</td>
<td>10Ω to 1MΩ</td>
<td>±0.5</td>
<td>55 to +155</td>
</tr>
</tbody>
</table>

**Performance**
- Superior junction reliability against temperature cycling

**High Power Anti-Surge Chip Resistors (1005 to 3225 size)**

**SDR03/10, ESR01/03/10/18/25**

**Key Features**
- Proprietary element technology improves surge resistance
- Guaranteed electrostatic breakdown voltage 2kV to 5kV (EIAJ4701-1 Human Body Model)

**Spec**

<table>
<thead>
<tr>
<th>Type</th>
<th>Size (mm)</th>
<th>Rated Power (W)</th>
<th>Tolerance</th>
<th>Resistance Range</th>
<th>Temperature Coefficient of Resistance (%)</th>
<th>Operating Temp (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SDR03</td>
<td>1608 (0603)</td>
<td>0.3</td>
<td>±0.2%</td>
<td>10Ω to 1MΩ</td>
<td>±0.5</td>
<td>55 to +155</td>
</tr>
<tr>
<td></td>
<td>2012 (0805)</td>
<td>0.5</td>
<td>±0.2%</td>
<td>10Ω to 1MΩ</td>
<td>±0.5</td>
<td>55 to +155</td>
</tr>
<tr>
<td>ESR01</td>
<td>1005 (0402)</td>
<td>0.2</td>
<td>±0.2%</td>
<td>1Ω to 200Ω</td>
<td>±0.5</td>
<td>55 to +155</td>
</tr>
<tr>
<td>ESR03</td>
<td>1608 (0603)</td>
<td>0.25</td>
<td>±0.2%</td>
<td>10Ω to 1MΩ</td>
<td>±0.5</td>
<td>55 to +155</td>
</tr>
<tr>
<td></td>
<td>2012 (0805)</td>
<td>0.4</td>
<td>±0.2%</td>
<td>10Ω to 1MΩ</td>
<td>±0.5</td>
<td>55 to +155</td>
</tr>
<tr>
<td>ESR18</td>
<td>3216 (1206)</td>
<td>0.5</td>
<td>±0.2%</td>
<td>10Ω to 1MΩ</td>
<td>±0.5</td>
<td>55 to +155</td>
</tr>
<tr>
<td>ESR25</td>
<td>3225 (1210)</td>
<td>0.66</td>
<td>±0.5%</td>
<td>10Ω to 1MΩ</td>
<td>±0.5</td>
<td>55 to +155</td>
</tr>
</tbody>
</table>

**Rated Power List**
- Class-leading power lineup contributes to system miniaturization

<table>
<thead>
<tr>
<th>Size (mm)</th>
<th>Series</th>
<th>MCR series Surge Resistance Type</th>
<th>ESR series Surge Resistance Type</th>
<th>SDR series High Surge Resistance Type</th>
<th>LTR series High Power Wide Terminal Type</th>
<th>LTR Low Ohmic series High Power Wide Terminal Type</th>
<th>LHR series High Power Low TCR Wide Serial Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1005</td>
<td>0.02W</td>
<td>0.2W</td>
<td>0.3W</td>
<td>0.2W</td>
<td>0.3W</td>
<td>0.2W</td>
<td>0.2W</td>
</tr>
<tr>
<td>1608</td>
<td>0.1W</td>
<td>0.25W</td>
<td>0.5W</td>
<td>0.25W</td>
<td>0.5W</td>
<td>0.5W</td>
<td>0.5W</td>
</tr>
<tr>
<td>2012</td>
<td>0.125W</td>
<td>0.4W</td>
<td>0.5W</td>
<td>0.25W</td>
<td>0.5W</td>
<td>0.5W</td>
<td>0.5W</td>
</tr>
<tr>
<td>3216</td>
<td>0.25W</td>
<td>0.5W</td>
<td>0.75W</td>
<td>0.5W</td>
<td>1.0W</td>
<td>1.0W</td>
<td>1.0W</td>
</tr>
<tr>
<td>5025</td>
<td>0.05W</td>
<td>0.65W</td>
<td>0.5W</td>
<td>1.0W</td>
<td>0.5W</td>
<td>1.0W</td>
<td>1.0W</td>
</tr>
</tbody>
</table>

*TR Low Ohmic Series: 10Ω to 1Ω, LTR Series: 1Ω or more  *The size in the ( ) indicates the size of the wide terminal type.
**Anti-Sulfuration Chip Resistors (1005 to 3225 size)**

### Key Features
- **Lineup offered in the 1005 to 3225 sizes**
- **Improved sulfuration resistance** (compared with ROHM’s conventional products)

### Concept
Provides a stable supply of products that deliver anti-sulfuration performance

- **Add a sulfuration-resistant layer** to the inner electrode
- **Utilize a Ni-Cr metal strong against corrosion** for the side electrodes

### Spec
<table>
<thead>
<tr>
<th>Type</th>
<th>Size (mm)</th>
<th>Rated Power</th>
<th>Tolerance</th>
<th>Resistance Range (Ω)</th>
<th>Temperature Coefficient (ppm/°C)</th>
<th>Operating Temp (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SFR01</td>
<td>1005 (0402)</td>
<td>0.063W</td>
<td>±5%</td>
<td>1 to 9.1 (E24)</td>
<td>±500 to ±250</td>
<td>-55 to +155</td>
</tr>
<tr>
<td>SFR03</td>
<td>1608 (0603)</td>
<td>0.1W</td>
<td>±5%</td>
<td>1 to 9.1 (E24)</td>
<td>±200</td>
<td>-55 to +155</td>
</tr>
<tr>
<td>SFR10</td>
<td>2012 (0805)</td>
<td>0.125W</td>
<td>±5%</td>
<td>1 to 9.1 (E24)</td>
<td>±200</td>
<td>-55 to +155</td>
</tr>
<tr>
<td>SFR18</td>
<td>3216 (1206)</td>
<td>0.25W</td>
<td>±5%</td>
<td>1 to 2.2M (E24/96)</td>
<td>±200</td>
<td>-55 to +155</td>
</tr>
<tr>
<td>SFR25</td>
<td>3225 (1210)</td>
<td>0.5W</td>
<td>±5%</td>
<td>1 to 1M (E24)</td>
<td>±200</td>
<td>-55 to +155</td>
</tr>
</tbody>
</table>

### Performance
**Disconnection rate during sulfuration testing**

- **SFR series** >3,000h life

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**Sulfuration Due to Sulfuration**

Sulfur particles are generally present in the air in various forms, such as automotive exhaust gases and sulfur gas in hot springs. These sulfur components are adsorbed on metallic surfaces and gradually react with the metal itself. Silver(Ag) is typically used for the internal electrode in thick-film chip resistors, and when sulfur components in the gas enters the gap between the protective layer and plating, silver migrates and reacts, gradually forming silver sulfide(Ag₂S) as shown in the below figure for ‘Sulfuration Mechanism’. As a result, the internal electrode may become disconnected, causing an open circuit within the resistor. This phenomenon is referred to as disconnection due to sulfuration of the chip resistance. The SFR series adopts a sulfuration-resistant layer on the internal electrode, preventing sulfur erosion.

**Sulfuration Mechanism**

![Sulfuration Mechanism Diagram](image)

- **Sulfurized gas entry point**
- **Silver sulfide formation**

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**Tech Tips**

**Chip Resistor Sulfuration**

**Disconnection of the internal electrode due to migration of Ag outside the chip caused by sulfuration**

- **External appearance of standard chip resistors**
- **Enlarged photo of sulfurized chip resistor**

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**New Products**

**Anti-Sulfuration Chip Resistors (1005 to 3225 size)**

**SFR01/03/10/18/25**

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**SFR01/03/10/18/25**

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**Automotive LED Drivers Selection Guide**
What are noise characteristics?

- **EMC**
  - **Electromagnetic Compatibility**
  
  Refers to the ability to maintain performance even if disturbed by other equipment without interfering with external systems. It is called electromagnetic compatibility due to the need to ensure normal device operation without mutual electromagnetic interference, classified as EMC and EMS, below.

- **EMI**
  - **Electromagnetic Interference (Emission)**

  EMI refers to noise generated by the target IC that can interfere with the operation of surrounding ICs and systems. Since EMI may cause peripheral IC and/or systems to malfunction, delicate circuit design is necessary to prevent this phenomenon from occurring.

- **EMS**
  - **Electromagnetic Susceptibility (Immunity)**

  EMS is the tendency (ability/tolerance) for equipment to malfunction in the presence of external noise. If sufficient tolerance cannot be secured, the circuit may malfunction or fail to operate, so a robust circuit design is necessary.

Possible issues with improper PCB layout

- The following issues may occur if the PCB layout of the LED driver is inappropriate
  - Low EMC and PI performance
  - Deterioration in light intensity (i.e. LED current accuracy)
  - LED fluctuation due to unstable operation (oscillation, switching waveform breakdown, etc.)

PCB Design Checklist

- Designing a proper PCB layout

  1. Make the power line as short and wide as possible.
  2. Keep the MOSFET-diode-capacitor loop short to minimize the AC current path.
  3. Place the oscillation frequency determination resistor RT close to the GND pin (reference GND).
  4. Place the decoupling capacitor used for constant voltage within the IC as close to the IC pin as possible.
  5. Keep the feedback line of the current detection resistor far from noise sources such as switching lines. ⇒ In the case of double-sided mounting, place the power products on the same side as the IC and other components on the backside as an effective countermeasure. At this time do not let the feedback line pass under the inductor.
  6. Separating the power GND (SBD, input/output capacitor GND) from the reference GND (RT, GND) will minimize the effects of switching noise. Make them common to the GND plane.
  7. Please refrain from using thermal relief as much as possible. ⇒ The high frequency characteristics will degrade.
### Heat Resistance and Thermal Characteristics

#### Definitions

These definitions conform to JEDEC standard JESD51

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Definition</th>
<th>Applications</th>
<th>Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\theta_{JA}$</td>
<td>The thermal resistance between the junction temperature $T_j$ and ambient temperature $T_a$ when the package is mounted on a PCB</td>
<td>Comparing the heat dissipation performance among packages of different shapes</td>
<td>$\theta_{JA} = (T_j - T_a) \div P$</td>
</tr>
<tr>
<td>$\Psi_{JT}$</td>
<td>The thermal characteristics parameter between the junction temperature $T_j$ and the temperature of the center of the upper surface of the package $T_T$.</td>
<td>Estimating junction temperature</td>
<td>$\Psi_{JT} = (T_j - T_T) \div P$</td>
</tr>
<tr>
<td>$\theta_{JC\text{-TOP}}$</td>
<td>The thermal resistance between the junction temperature $T_j$ and temperature of the top surface of the package $T_{C\text{-TOP}}$. The heat dissipation path is only on the top surface; the others are adiabatic.</td>
<td>Used for simulations using the 2-resistance model</td>
<td>$\theta_{JC\text{-TOP}} = (T_j - T_{C\text{-TOP}}) \div P$</td>
</tr>
<tr>
<td>$\theta_{JC\text{-BOT}}$</td>
<td>The thermal resistance between the junction temperature $T_j$ and temperature of the bottom surface of the package $T_{C\text{-BOT}}$. The heat dissipation path is only on the bottom surface; the others are adiabatic.</td>
<td>Used to estimate the junction temperature, since when the heat dissipation metal at the bottom of the package is exposed, most of the heat flows only through the package bottom.</td>
<td>$\theta_{JC\text{-BOT}} = (T_j - T_{C\text{-BOT}}) \div P$</td>
</tr>
</tbody>
</table>

Note 1: $\theta_{JA}/\Psi_{JT}$ is the value when mounted on a JEDEC board.  Note 2: Conventionally, the value provided as $\theta_{JC}$ is $\Psi_{JT}$ in this definition.

#### Illustrations for Each Definition

- **$\theta_{JA}$**: Thermal resistance between the junction and the ambient environment
  - *Heat dissipation through multiple thermal paths*

- **$\Psi_{JT}$**: Thermal characteristics between the junction and the center of the top surface of the package
  - *Heat conduction (with heat dissipation) other than at the top surface of the package*

- **$\theta_{JC\text{-TOP}}$**: Thermal resistance between the junction and the top surface of the package
  - *Heat is dissipated only at the top surface of the package; the others are adiabatic.*

- **$\theta_{JC\text{-BOT}}$**: Thermal resistance between the junction and the bottom surface of the package
  - *Heat is dissipated only at the bottom surface of the package; the others are adiabatic.*
### EMC Countermeasure

**Market Background**
- The increasing number of ECUs and continuing miniaturization (higher frequency) is increasing the number of cases where the internal noise interference worsens.
  - Increased risk of malfunction due to noise
  - Greater risk of generating noise which can cause malfunctions to surrounding equipment
- Also, upon further investigation the following can be expected.
  - With the continuing proliferation of ADAS and automated driving, it has become imperative to prevent malfunctions and control failures due to external noise.
  - Eliminating metal body (shield) and reducing body weight to minimize environmental load

**ROHM EMC Countermeasure Support System**
- Established an anechoic chamber (at the Shin-Yokohama Technology Center)
- Recommendations on application countermeasures designed to clear the CISPR 25 Class 5 requirements

### Automotive EMC Test Standard

**Automotive EMC Test Standard**
- EMI/EMC standards that can be tested at ROHM

<table>
<thead>
<tr>
<th>Test Method</th>
<th>Standard</th>
<th>Frequency</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>BCI Immunity</td>
<td>ISO11452-4</td>
<td>100kHz to 2.1GHz</td>
<td>200mA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>400MHz : 300mA</td>
<td></td>
</tr>
<tr>
<td>Transient Immunity</td>
<td>ISO7637-2/3/5</td>
<td>Pulse 1/2a/2b/3a/9/5a/5b</td>
<td></td>
</tr>
<tr>
<td>Radiated Immunity</td>
<td>ISO11452-2</td>
<td>80MHz to 3GHz</td>
<td>200Vlm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.2 to 1.4GHz</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.1 to 4.2GHz</td>
<td></td>
</tr>
<tr>
<td>Near field</td>
<td>Custom SPEC</td>
<td>800MHz to 2.4GHz</td>
<td>up to 15W</td>
</tr>
<tr>
<td>TEM CELL Immunity</td>
<td>ISO11452-3</td>
<td>1MHz to 400MHz</td>
<td>200W</td>
</tr>
</tbody>
</table>

### Automotive Emission Test

<table>
<thead>
<tr>
<th>Test Method</th>
<th>Standard</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radiated Emission</td>
<td>CISPR25</td>
<td>150kHz to 1GHz</td>
</tr>
<tr>
<td>Conducted Emission</td>
<td>CISPR25</td>
<td>150kHz to 108MHz</td>
</tr>
</tbody>
</table>

### Measurement Example

![Measurement Example](image)

Standard : CISPR25  Target : BD18351EFV-M
Load : White LEDs8 lamps connected in series  Iout : 300mA

### Thermal Countermeasure

**Market Background**
- The number of cases where the thermal environment for parts is worsening has increased due to mechanical integration and mounting in engine compartments
  - Increases the risk of a reduction in the quality and life of electronic components

**Thermal Simulation Support Case Study**
- Recommendations on PCB design possible using simulations
  - Ex. 1 : Analysis of temperature rise based on substrate size and component layout
  - Ex. 2 : Temperature Rise Analysis During Socket LED Development

**Thermal Resistance Measurement Environment Example**
- We are constructing an environment that conforms with JEDEC

**Initiatives to Improve Accuracy**
- Model supply and analysis enabled using high accuracy models
  - CFD Tool: FloTHERM
  - Thermal Resistance Measurement Equipment: T3Ster

*FloTHERM used: Mentor Graphics
Throughout its history cars have continued to evolve in response to the growing awareness for safety, comfort, and the environment, in step towards continued electrification.

In the course of this progress, autonomous driving and smart cities will soon be realized with the advent of next-generation vehicles.

ROHM contributes to the evolution and advancement of the automotive sector and next-generation cars by taking a quality-first approach to manufacturing and ensuring long-term, stable supply of products.
ROHM's vertically integrated production system is the result of its commitment to 'Quality First'. The ROHM Group carries out manufacturing, sales and service - from design and development to wafer fabrication - in-house and continually works on initiatives to improve quality in all processes.

Achieving High Quality and Stable Supply Through a Vertically Integrated Production System

**Commitment to Raw Materials**
Wafer production from silicon ingot pulling

**In-House Photo Mask**
Pursuing high quality through consistent quality control from IC chip design layout to photo mask production

SiCrystal, a German-based SiC single crystal wafer manufacturer, became a member of the ROHM Group in 2009. German SiC single crystal wafer maker SiCrystal became a ROHM Group Company in 2009.

**High Quality**
Achieving high quality in every process

ROHM continually pursues 'Quality First' as a corporate objective. Through our vertically integrated production system the Group implements production, sales, and service - including design, development, and wafer fabrication - and are working on initiatives to improve quality in all processes. At the same time, excellent traceability is achieved through a system that ensures worry-free use of our products by customers.

**Stable Supply**
Utilizing the Group’s collective power to fulfill supply responsibilities

The ROHM Group is tasked with supplying products that meet market demands. By managing the manufacturing process in-house using our vertically integrated production system, we are able to create a system that is less susceptible to external factors compared with general fabless and foundry manufacturers. We have established a BCM (Business Continuity Management) system that involves securing appropriate inventory and carrying out multi-site production, and endeavor to ensure a stable supply to customers.
All production equipment were developed completely in-house, making it possible to flexibly and precisely meet customer needs.

**In-house dies and lead frames**
To ensure quality, all dies for lead frame punching, lead frames, and even molds are produced in-house.

**In-House Production System**
All production systems developed in-house

**Cutting-edge packages**
Broad package lineup (i.e. CSP, BGA, COF, COC, stacked package) supports the latest assembly technologies.

**BCM System**
ROHM continues to strengthen its BCM system by performing diagnosis based on risk verification at all production sites.

- Continuous Supply
- Multi-Site Production
- Shorter Lead Time
- Multi-Site Production
- Production Facility
- Natural Disasters
- Political Unrest
- Heavy Snow
- Fire/Explosion
- Fog/Sandstorm
- Typhoon/Heavy Winds/Tornado
- Earthquake/Tsunami
- Flooding/Heavy Rain
- Lightning
- Infrastructure Problems
- Others
Approach for Automotive-Grade Products

ROHM establishes ‘Quality First’ as a corporate objective, pursues innovative, high-quality manufacturing, and provides greater peace of mind through guaranteed delivery times. ROHM implements a variety of initiatives to ensure high reliability.

**Initiative Example**

**Real-time quality checks**

From silicon ingot pulling and wafer fabrication to testing, final assembly, and shipment, ROHM adopted a screening method to check the workmanship at each process.

![Real-time quality checks](image)

**Introducing the PAT System (Conforming to AEC Guidelines)**

The PAT system statistically analyzes measurement data and removes out-of-group items even when they are within good product standards. With this method even when a product is determined to be non-defective and within the standard at the time of shipment, if it is out-of-group within the lot distribution it is removed as having the potential of being defective. This allows ROHM to act out of an abundance of caution to prevent the shipment of defective products.

**PAT System** PAT: Part Average Testing (Parts Averaging Test)

![PAT System](image)

**Dedicated automotive product line**

Automotive products are manufactured on dedicated lines by certified operators who have passed special tests. Utilizing dedicated Machine and Man results in a higher grade manufacturing environment.

**Line division and 4M differentiation**

The basic elements of ROHM’s approach to quality 4M - Man, Machine, Material, Method

All automotive-grade products are manufactured on HR (High Reliability) lines separate from general products.

**Initiative Overview (IC Case)**

<table>
<thead>
<tr>
<th>Model Design</th>
<th>Model Test Design</th>
<th>Model Qualification Testing</th>
<th>Wafer Process Management</th>
<th>Assembly Process Management</th>
<th>Traceability, keep samples, in-process defect analysis, etc.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Robust design with multiple protection circuits/improved damage resistance/easier testability/characteristics limit evaluation</td>
<td>High/normal/low temperature measurement of all chips, HV stress testing, PAT system introduction</td>
<td>Based on J/STD, JDEC/AEC-Q100/ECQ101/AEC-Q1000 compliance - Long-term reliability testing - Life prediction based on WLR data - Electrostatic breakdown test</td>
<td>SPC management/Real-time monitoring/Defect inspection of all chips</td>
<td>Real-time Work &amp; Check at main processing point (s)/Quality guarantee (i.e., internal X-ray inspection, reflow screening)/4M establishment</td>
<td>Important Security Applications All keep samples from all lots are stored for 10 years/In-process defective product analysis (all lots), etc.</td>
</tr>
</tbody>
</table>
### Home Page Design Support Content List

<table>
<thead>
<tr>
<th>Item</th>
<th>Overview</th>
</tr>
</thead>
<tbody>
<tr>
<td>Selection Guide (This Catalog)</td>
<td>A guidebook that simplifies IC selection. Product pickups and sample solutions are provided.</td>
</tr>
<tr>
<td>Datasheet</td>
<td>Contains the most important information provided to customers on ROHM products. Functional characteristics, conditions, and applicable ranges built into the products are listed, along with the scope of warranty. Also provided is application information, including the required external parts, in order to ensure stable operation and maximize performance.</td>
</tr>
<tr>
<td>Application Note Example</td>
<td>Switching Type: Capacitor Calculation for Buck Converter ICs, Considerations for Multilayer Capacitor Used for Buck Converters, Inductor Calculation for Buck Converter ICs, Considerations for Power Inductors Used for Buck Converters, Quick Reference Table for Setting the Output Voltage of Buck Converter ICs, Snubber Circuit for Buck Converter ICs, Buck Converter Efficiency, Calculating Power Loss (Synchronous Rectification Type)</td>
</tr>
<tr>
<td></td>
<td>Linear Type: Reverse Voltage Protection for Linear Regulators, Output Voltage Setting Resistance Table for Linear Regulator ICs, Linear Regulator Power Supply ON/OFF Characteristics, Simple Stability Experiments for Linear Regulators, Thermal Resistance Data of Automotive Linear Regulators</td>
</tr>
<tr>
<td>SPICE Models</td>
<td>SPICE models are offered that can be used in PSpice simulations. However, since the files are encrypted for security purposes, they are executable only with PSpice</td>
</tr>
<tr>
<td>Support Page</td>
<td>Provides new product information, evaluation boards, and videos</td>
</tr>
<tr>
<td>Technology Information Site Tech Web</td>
<td>Acquire basic knowledge on power supply ICs, Archive site on the latest topics on power supply ICs ideal for engineers - TECH INFO</td>
</tr>
</tbody>
</table>
ROHM Group Locations (Japan)

- **Sales Offices**
  - Kyoto
  - Nagoya
  - Nishi-Tokyo
  - Utsunomiya
  - Tokyo
  - Matsumoto
  - Sendai
  - Yokohama
  - Mito
  - Takasaki

- **R&D Centers**
  - Kyoto Technology Center (Head Office)
  - Kyoto Technology Center (Kyoto Ekimae)
  - Yokohama Technology Center
  - LAPIS Semiconductor Co., Ltd. (Shin-Yokohama)
  - LAPIS Semiconductor Miyazaki Design Center

- **Manufacturing Facilities**
  - ROHM Co., Ltd.
  - ROHM Shiga Co., Ltd.
  - ROHM Hamamatsu Co., Ltd.
  - ROHM Wako Co., Ltd.
  - ROHM Apollo Co., Ltd.
  - ROHM Mechatec Co., Ltd.
  - LAPIS Semiconductor Co., Ltd.
  - LAPIS Semiconductor Miyagi Co., Ltd.
  - LAPIS Semiconductor Miyazaki Co., Ltd.

- **Distribution Centers**
  - ROHM Logistec Co., Ltd.