

## SPICE Modeling Report

# For Automotive, 40V 150mA 4ch Constant Current LED Driver BD18347EFV-M

In this report, the characteristics that can be confirmed by the simulation using the SPICE model of the LED Driver IC BD18347EFV-M will be described.

### Simulation Environment

- Circuit Simulator : PSpice / Cadence Design System, Inc.
- Version Information : 17.2-2016
- OS Information : Windows 10 64-bit Edition

### File Information

- Library File Name : BD183x7EFV-M.lib
- Symbol File Name : BD183x7EFV-M.olb
- Subcircuit and Symbol

Table 1. Correspondence Table

| Product Name | Subcircuit              | Symbol                             |
|--------------|-------------------------|------------------------------------|
| BD18337EFV-M | BD18337EFV-M (Rev:1.00) | BD18337EFV-M                       |
|              |                         | BD18337EFV-M_S <sup>(Note 1)</sup> |
| BD18347EFV-M | BD18347EFV-M (Rev:1.00) | BD18347EFV-M                       |
|              |                         | BD18347EFV-M_S <sup>(Note 1)</sup> |

### Caution

- These model characteristics are specifically at Ta=25°C. Thus, the simulation result with temperature variances may significantly differ from the result with the one done at actual application board (actual measurement).
- The simulation result and characteristics described in this report may differ depending on the board design. It is recommended to perform the measurement on the actual board to verify the result.
- The values from the simulation results are not guaranteed. Please use these results as a guide for your design.
- Actual measurement was done using a specific sample, thus the measured data is just as a reference.

(Note 1) Symbol with \_S at the end of the name conform to IEC60617, and were designed so that signals flow from left to right.

**BD18347EFV-M SPICE MODEL**

■ Terminal Information

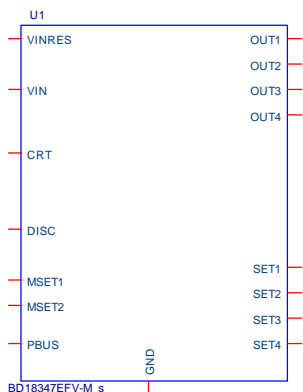


Table 2. Pin Table

| Terminal No. | Terminal Name | Terminal No. | Terminal Name |
|--------------|---------------|--------------|---------------|
| 1            | VINRES        | 9            | SET4          |
| 2            | VIN           | 10           | SET3          |
| 3            | PBUS          | 11           | MSET2         |
| 4            | CRT           | 12           | GND           |
| 5            | DISC          | 13           | OUT4          |
| 6            | MSET1         | 14           | OUT3          |
| 7            | SET1          | 15           | OUT2          |
| 8            | SET2          | 16           | OUT1          |

Figure 1. Symbol of BD18347EFV-M\_s

**Verifiable Characteristics**

- Electrical Characteristics (vs. Datasheet)..... 3-4
- Characteristics in SPICE (vs. Measured Waveform)
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## Electrical Characteristics (vs. Datasheet)

Table 3. Electrical Characteristics Comparison

Unless otherwise specified, Ta=25°C, V<sub>IN</sub>=13V

| Parameter   | Modeled<br>(Note 1) | Value               |        | Unit | Error | Condition  |
|---|---------------------|---------------------|--------|------|-------|--|
|   |                     | Datasheet<br>(Typ.) | SPICE  |      |       |  |
| <b>[Circuit Current I<sub>VIN</sub>]</b>                        |                     |                     |        |      |       |  |
| Circuit Current in Normal Mode                                  | Yes                 | 3.0                 | 2.95   | mA   | 1.7%  |  |
| Circuit Current when LED Open is Detected                       | Yes                 | 3.0                 | 2.77   | mA   | 7.7%  | At LED Open Detection  |
| Circuit Current when PBUS is Low                                | Yes                 | 3.0                 | 2.77   | mA   | 7.7%  | V <sub>PBUS</sub> =0V  |
| <b>[Output Current I<sub>OUTx</sub>]</b>                        |                     |                     |        |      |       |  |
| OUTx OFF Current  | Yes                 | 0                   | 0.0    | μA   | 0.0%  | V <sub>OUTx</sub> =2V, V <sub>CRT</sub> =0V,   |
| VINRES-OUTx Pin Drop Voltage                                    | No                  | 0.5                 | 0.19   | V    | 62.0% | I <sub>OUTx</sub> =100mA   |
| LED Open Detection Output Current                               | Yes                 | 3.2                 | 3.2    | mA   | 0.0%  | V <sub>OUTx</sub> =V <sub>VINRES</sub> -100mV  |
| <b>[Energy Sharing Control]</b>                                 |                     |                     |        |      |       |  |
| Energy Sharing Control Voltage                                  | Yes                 | 2.0                 | 1.89   | V    | 5.5%  | V <sub>VINRES</sub> -V <sub>OUTx_MAX</sub> ,<br>V <sub>IN</sub> =13V, V <sub>OUTx</sub> =9V    |
| ON Resistance Between the VIN Pin and the VINRES Pin            | Yes                 | 0.5                 | 0.50   | Ω    | 0.0%  | I <sub>VIN</sub> =100mA  |
| <b>[LED Open Detection]</b>                                     |                     |                     |        |      |       |  |
| OUTx Pin LED Open Detection Voltage                             | Yes                 | 50                  | 50.0   | mV   | 0.0%  | V <sub>VINRES</sub> -V <sub>OUTx</sub>   |
| <b>[Disable LED Open Detection Function at Reduced-Voltage]</b> |                     |                     |        |      |       |  |
| VIN Pin Voltage   | Yes                 | 7.65                | 7.650  | V    | 0.0%  |  |
| <b>[OUTx pin Short Circuit Protection]</b>                      |                     |                     |        |      |       |  |
| OUTx Pin Short Circuit Current                                  | Yes                 | 0.3                 | 0.30   | mA   | 0.0%  | V <sub>OUTx</sub> =0.9V  |
| OUTx Pin Short Circuit Protection Voltage                       | Yes                 | 0.6                 | 0.60   | V    | 0.0%  |  |
| OUTx Pin Short Circuit Protection Release Voltage               | Yes                 | 0.8                 | 0.80   | V    | 0.0%  |  |
| SCP Detect Delay Time 1   | Yes                 | 60                  | 62.7   | μs   | 4.5%  | Refer to Figure x  |
| SCP Detect Delay Time 2   | Yes                 | 20                  | 20.4   | μs   | 2.0%  | Refer to Figure x  |
| SCP Release Delay Time  | Yes                 | 40                  | 42.1   | μs   | 5.3%  | Refer to Figure x  |
| SCP Protection Disable Time at Power On                         | Yes                 | 140                 | 140.0  | μs   | 0.0%  | Refer to Figure x  |
| <b>[Output Current Setting]</b>                                 |                     |                     |        |      |       |  |
| Output Current Setting Coefficient                              | Yes                 | 1800                | 1800.0 | -    | 0.0%  | R <sub>SETx</sub> =12kΩ to 18kΩ,<br>I <sub>OUTx</sub> =K <sub>SET</sub> /R <sub>SETx</sub> [A] |
|   | Yes                 | 1800                | 1800.0 | -    | 0.0%  | R <sub>SETx</sub> =18kΩ to 36kΩ,<br>I <sub>OUTx</sub> =K <sub>SET</sub> /R <sub>SETx</sub> [A] |
| SETx Pin Voltage  | Yes                 | 1.20                | 1.200  | V    | 0.0%  |  |
| SETx Pin Short Detection Resistance                             | Yes                 | 2.4                 | 2.40   | kΩ   | 0.0%  |  |

(Note 1) Yes: Model available (supported), No: Model not available" (not supported).

Unless otherwise specified, Ta=25°C, V<sub>IN</sub>=13V

| Parameter                                | Modeled<br>(Note 1) | Value               |       | Unit | Error | Condition   |
|--|---------------------|---------------------|-------|------|-------|---|
|  |                     | Datasheet<br>(Typ.) | SPICE |      |       |   |
| <b>[CR TIMER]</b>                        |                     |                     |       |      |       |   |
| CRT Pin Charge Current                   | Yes                 | 40                  | 40.0  | μA   | 0.0%  |   |
| CRT Pin Charge Voltage                   | Yes                 | 0.80                | 0.800 | V    | 0.0%  |   |
| CRT Pin Discharge Voltage 1              | Yes                 | 2.00                | 2.000 | V    | 0.0%  |   |
| CRT Pin Discharge Voltage 2              | Yes                 | 2.40                | 2.400 | V    | 0.0%  | V <sub>CRT</sub> > V <sub>CRT_DIS2</sub><br>R <sub>DISC1</sub> → R <sub>DISC2</sub>   |
| CRT Pin Charge Resistance                | Yes                 | 30.0                | 30.00 | kΩ   | 0.0%  |   |
| CRT Discharge Constant                   | Yes                 | 0.4                 | 0.40  | V/V  | 0.0%  |   |
| DISC Pin ON Resistance 1                 | Yes                 | 50                  | 50.1  | Ω    | 0.2%  | I <sub>DISC</sub> =10mA   |
| DISC Pin ON Resistance 2                 | Yes                 | 5                   | 5.1   | kΩ   | 2.0%  | I <sub>DISC</sub> =10mA   |
| CRT Pin Leakage Current                  | Yes                 | 0                   | 0.0   | μA   | 0.0%  | V <sub>CRT</sub> =V <sub>IN</sub>   |
| <b>[Over Voltage Mute Function(OVM)]</b> |                     |                     |       |      |       |   |
| Over Voltage Mute Start Voltage          | Yes                 | 22.0                | 22.15 | V    | 0.7%  | ΔI <sub>OUTx</sub> =-3%,<br>ΔI <sub>OUTx</sub> =<br>I <sub>OUTx</sub> (@V <sub>IN</sub> =V <sub>OVM</sub> ) /<br>I <sub>OUTx</sub> (@V <sub>IN</sub> =13V) -1 |
| Over Voltage Mute Gain                   | Yes                 | -20                 | -20.0 | %/V  | 0.0%  | ΔI <sub>OUTx</sub> / ΔV <sub>IN</sub>   |
| <b>[PBUS]</b>                            |                     |                     |       |      |       |   |
| Input High Voltage                       | Yes                 | 1.4                 | 1.40  | V    | 0.0%  |   |
| Input Low Voltage                        | Yes                 | 1.6                 | 1.60  | V    | 0.0%  |   |
| PBUS Pin Source Current                  | Yes                 | 150                 | 150.0 | μA   | 0.0%  |   |
| PBUS Pin Output Low Voltage              | Yes                 | 0.2                 | 0.20  | V    | 0.0%  | Source 3mA to the PBUS pin  |
| PBUS Pin Output High Voltage             | Yes                 | 4.5                 | 4.50  | V    | 0.0%  | Sink 10μA from the PBUS pin   |
| PBUS Pin Leakage Current                 | Yes                 | 0                   | 0.0   | μA   | 0.0%  | V <sub>PBUS</sub> =7V   |
| <b>[UVLO VIN]</b>                        |                     |                     |       |      |       |   |
| UVLO VIN Detection Voltage               | Yes                 | 4.75                | 4.750 | V    | 0.0%  | V <sub>IN</sub> : Sweep down  |
| UVLO VIN Release Voltage                 | Yes                 | 5.25                | 5.250 | V    | 0.0%  | V <sub>IN</sub> : Sweep up  |
| <b>[UVLO VINRES]</b>                     |                     |                     |       |      |       |   |
| UVLO VINRES Detection Voltage            | Yes                 | 4.50                | 4.500 | V    | 0.0%  | V <sub>INRES</sub> : Sweep down   |
| UVLO VINRES Release Voltage              | Yes                 | 5.00                | 5.000 | V    | 0.0%  | V <sub>INRES</sub> : Sweep up   |
| <b>[MSET1,MSET2]</b>                     |                     |                     |       |      |       |   |
| MSET1, MSET2 Input H Voltage             | Yes                 | 1.3                 | 1.30  | V    | 0.0%  |   |
| MSET1, MSET2 Input L Voltage             | Yes                 | 1.5                 | 1.50  | V    | 0.0%  |   |
| MSET1, MSET2 Pin Outflow Current         | Yes                 | 50                  | 50.0  | μA   | 0.0%  | V <sub>MSET1</sub> =0V, V <sub>MSET2</sub> =0V  |

(Note 1) Yes: Model available (supported), No: Model not available" (not supported).

**Characteristics in SPICE (vs. Measured Waveform)**  
**1. Circuit Current in Normal Mode vs Supply Voltage**

Simulation Setting  
 Type : DC  
 Voltage Source : V1  
 (0V to 20V, 100mV step)

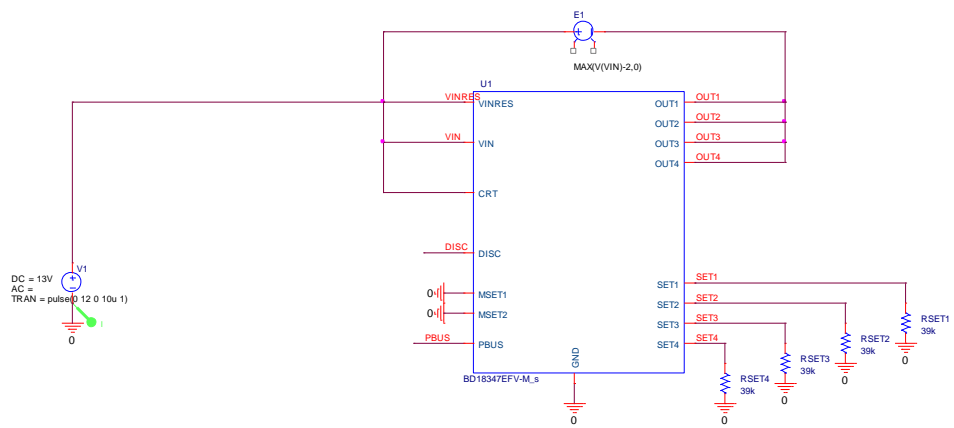


Figure 2.  
Simulation Schematic 1

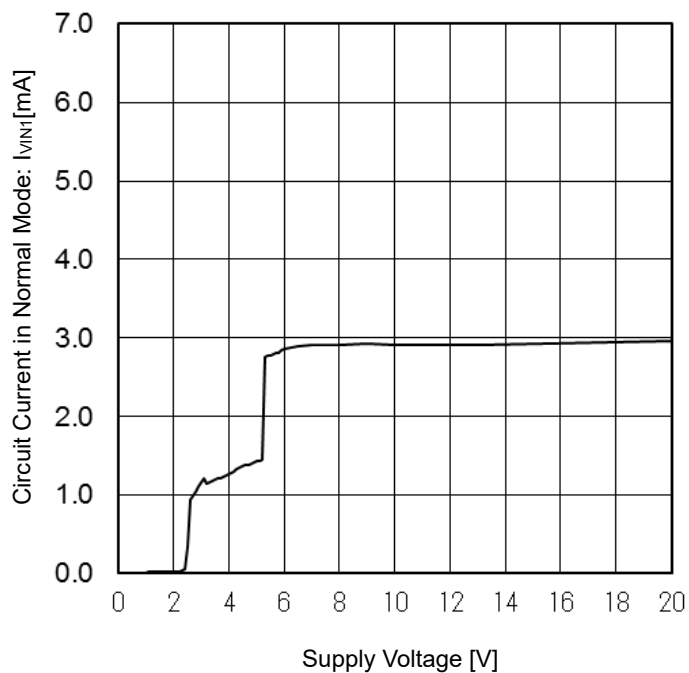


Figure 3.  
Circuit Current in Normal mode vs Supply Voltage  
(Measured Waveform)

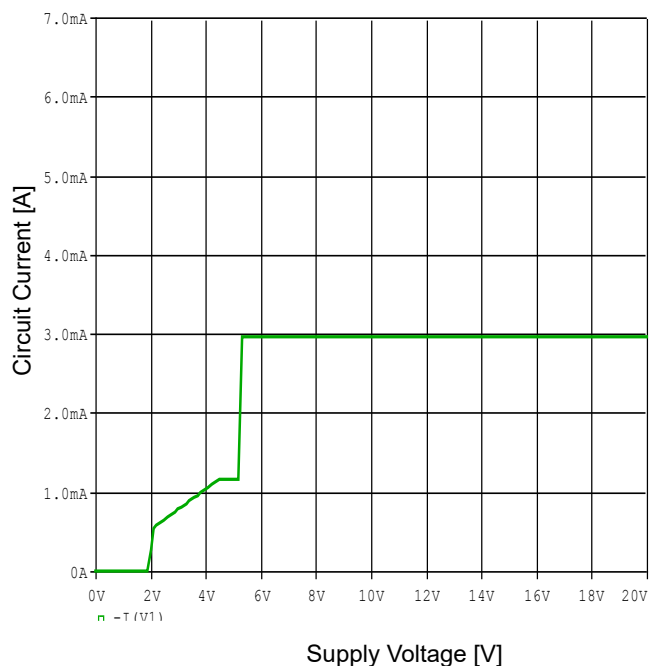


Figure 4.  
Circuit Current in Normal mode vs Supply Voltage  
(SPICE Simulation)

Table 4. Comparison of Characteristics

Unless otherwise specified, Ta=25°C, VIN=13V

| Parameter                      | Measured Result <i>(Note 1)</i> | SPICE Simulation Result | Unit | Error | Condition |
|--------------------------------|---------------------------------|-------------------------|------|-------|-----------|
| Circuit Current In Normal Mode | 2.9                             | 2.95                    | mA   | 1.7%  | -         |

(Note 1) The above data is based on a specific sample and it is not meant to be a guaranteed value.

2. Output Current vs Resistor Setting Output Current

Simulation Setting  
 Type : DC  
 Sweep Parameter : RSETx  
 (12kΩ to 36kΩ, 1kΩstep)

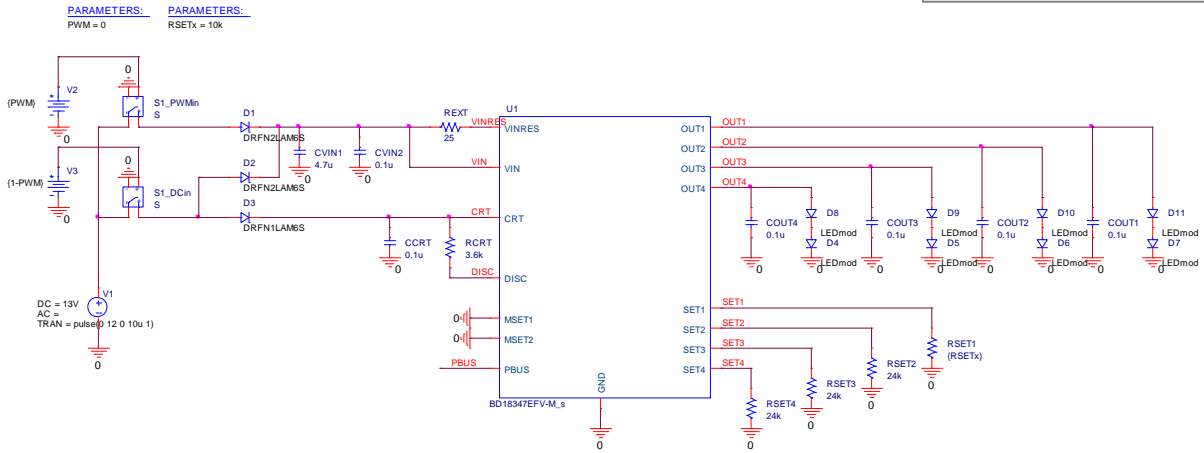


Figure 5. Simulation Schematic 2

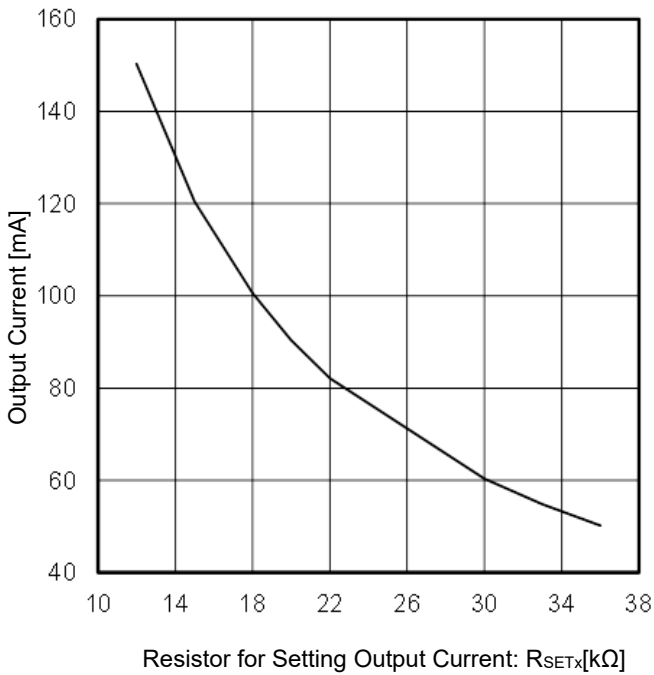


Figure 6. Output Current vs Resistor Setting Output Current (Measured Waveform)

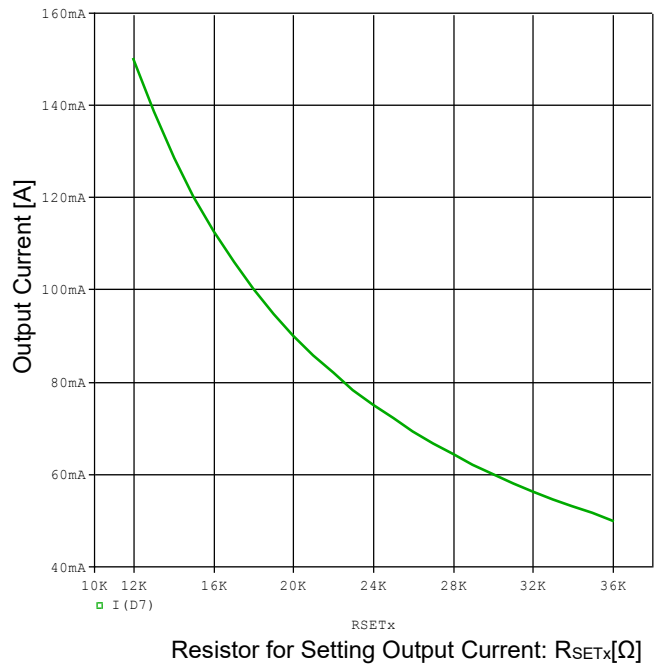


Figure 7. Output Current vs Resistor Setting Output Current (SPICE Simulation)

Table 5. Comparison of Characteristics

Unless otherwise specified, Ta=25°C, VIN=13V

| Parameter      | Measured Result <i>(Note 1)</i> | SPICE Simulation Result | Unit | Error | Condition  |
|----------------|---------------------------------|-------------------------|------|-------|------------|
| Output Current | 100                             | 100.0                   | mA   | 0.0%  | RSETx=18kΩ |

(Note 1) The above data is based on a specific sample and it is not meant to be a guaranteed value.

3. Output Current vs Supply Voltage

Simulation Setting  
 Type : DC  
 Voltage Source : V1  
 (0V to 40V, 0.1V step)

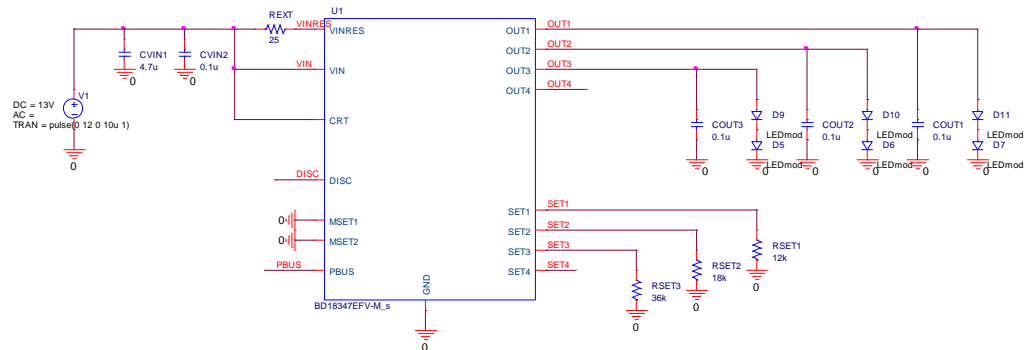


Figure 8. Simulation Schematic 3

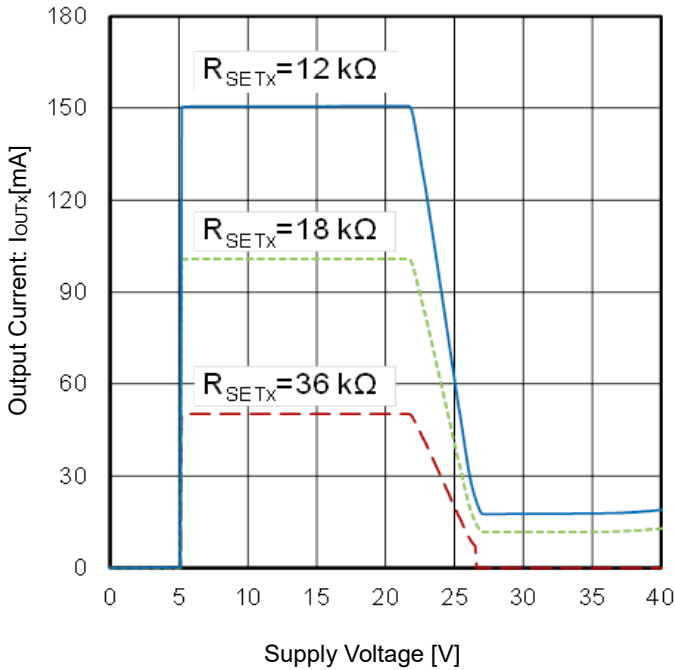


Figure 9. Output Current vs Supply Voltage (Measured Waveform)

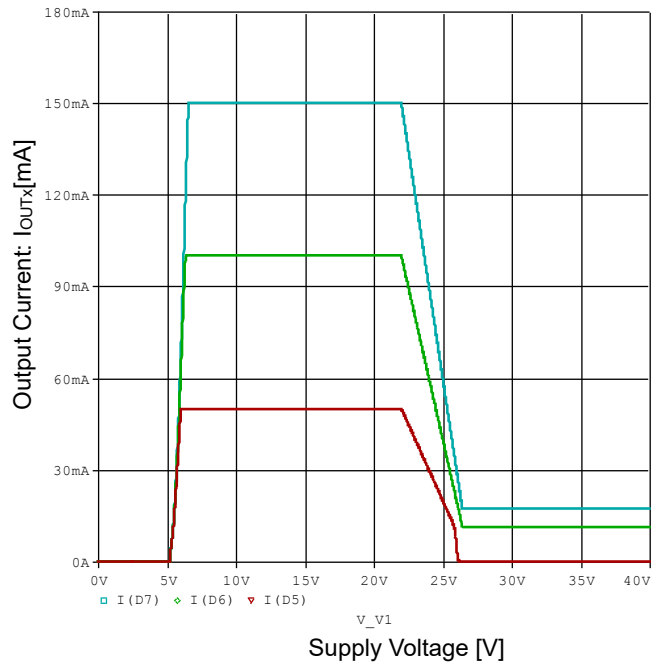


Figure 10. Output Current vs Supply Voltage (SPICE Simulation)

Table 6. Comparison of Characteristics

Unless otherwise specified, Ta=25°C, VIN=13V

| Parameter                       | Measured Result (Note 1) | SPICE Simulation Result | Unit | Error | Condition  |
|---------------------------------|--------------------------|-------------------------|------|-------|--|
| Over Voltage Mute Start Voltage | 22.0                     | 22.15                   | V    | 0.7%  | R <sub>SETx</sub> =18kΩ, ΔI <sub>OUTx</sub> =-3%,                    |
| Over Voltage Mute Gain          | -20                      | -20.0                   | %/V  | 0.0%  | R <sub>SETx</sub> =18kΩ, ΔI <sub>OUTx</sub> /ΔVIN (VIN = 22V to 25V) |

(Note 1) The above data is based on a specific sample and it is not meant to be a guaranteed value.

### 4. Energy Sharing Control Operation 1

**Simulation Setting**  
 Type : DC  
 Voltage Source : V1  
 (5V to 20V, 100mV step)

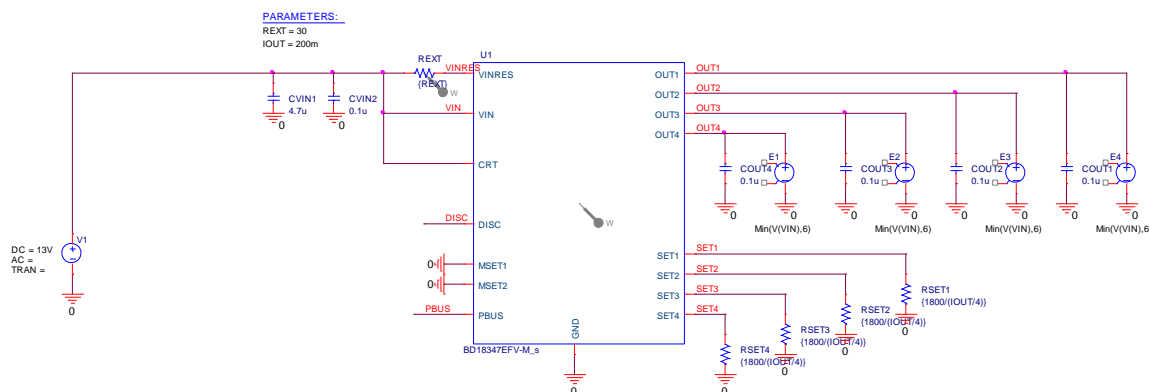


Figure 11. Simulation Schematic 4

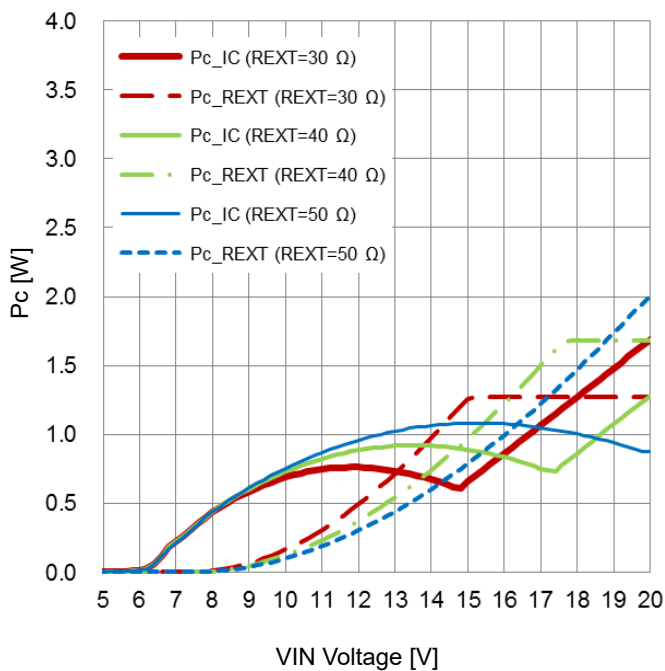


Figure 12. Energy Sharing Control Operation 1 (Measured Waveform)

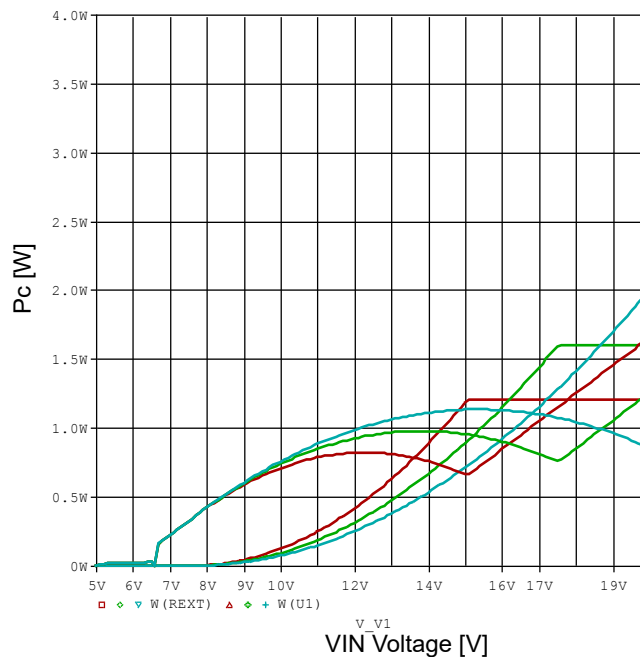


Figure 13. Energy Sharing Control Operation 1 (SPICE Simulation)

Table 7. Comparison of Characteristics

Unless otherwise specified, Ta=25°C, VIN=13V

| Parameter | Measured Result <i>(Note 1)</i> | SPICE Simulation Result | Unit | Error | Condition   |
|-----------|---------------------------------|-------------------------|------|-------|---|
| Pc_IC     | 0.92                            | 0.967                   | W    | 5.1%  | IOUT_TOTAL=200mA,<br>VOUTx(x=1 to 4)=6V, REXT=40Ω |
| Pc_REXT   | 0.54                            | 0.472                   | W    | 12.6% |   |

*(Note 1)* The above data is based on a specific sample and it is not meant to be a guaranteed value.



5. Energy Sharing Control Operation 2

**Simulation Setting**  
 Type : DC  
 Voltage Source : V1  
 (5V to 20V, 100mV step)

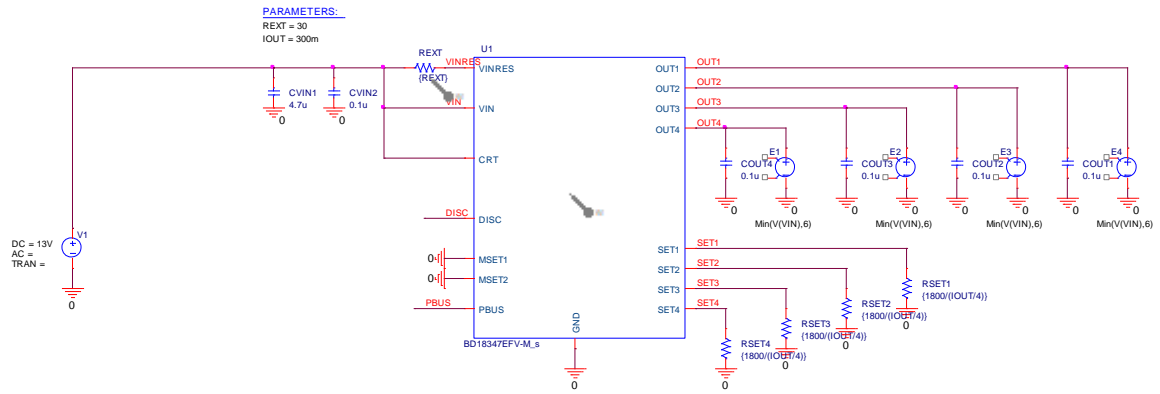


Figure 14. Simulation Schematic 5

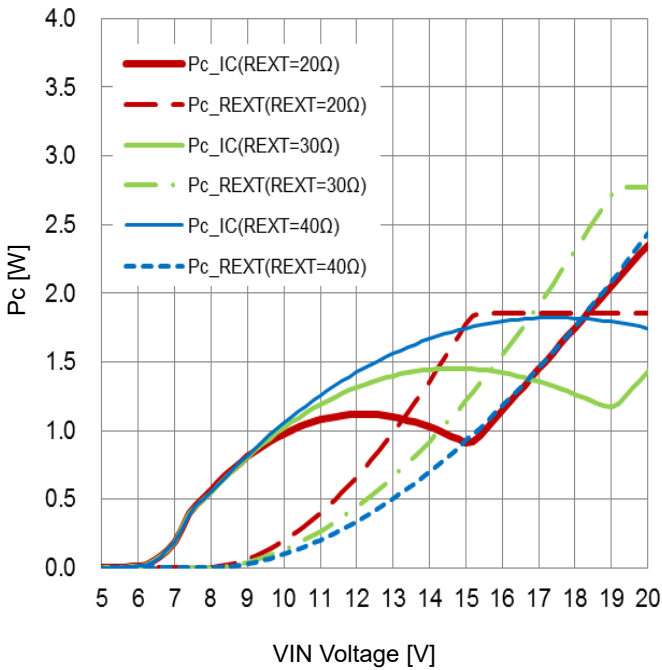


Figure 15. Energy Sharing Control Operation 2 (Measured Waveform)

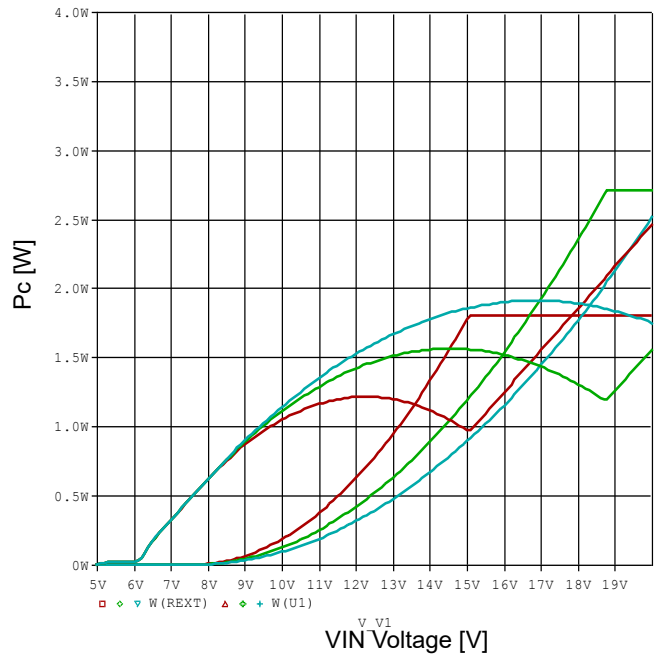


Figure 16. Energy Sharing Control Operation 2 (SPICE Simulation)

Table 8. Comparison of Characteristics

Unless otherwise specified, Ta=25°C, VIN=13V

| Parameter | Measured Result <i>(Note 1)</i> | SPICE Simulation Result | Unit | Error | Condition  |
|-----------|---------------------------------|-------------------------|------|-------|--|
| Pc_IC     | 1.40                            | 1.509                   | W    | 7.8%  | IOU_TOTAL=300mA,<br>VOUTx(x=1 to 4)=6V, REXT=30Ω |
| Pc_REXT   | 0.67                            | 0.630                   | W    | 6.0%  |  |

(Note 1) The above data is based on a specific sample and it is not meant to be a guaranteed value.

6. Energy Sharing Control Operation 3

**Simulation Setting**  
 Type : DC  
 Voltage Source : V1  
 (5V to 20V, 100mV step)

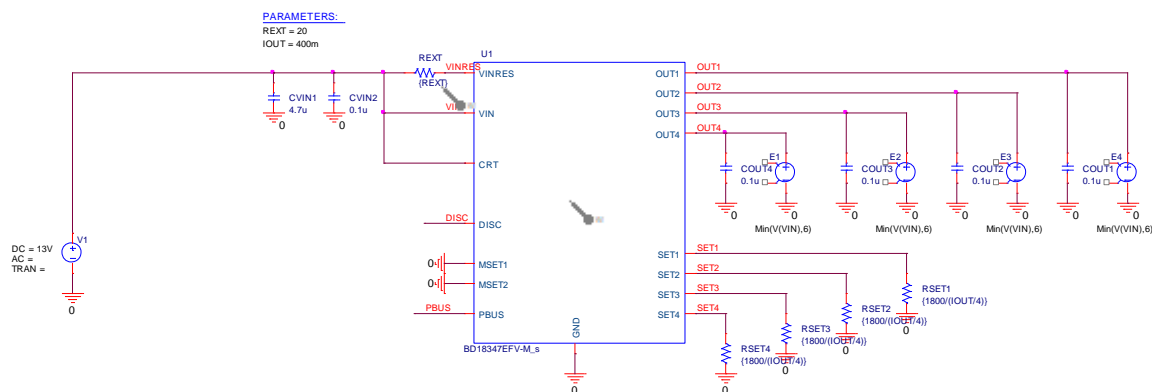


Figure 17. Simulation Schematic 6

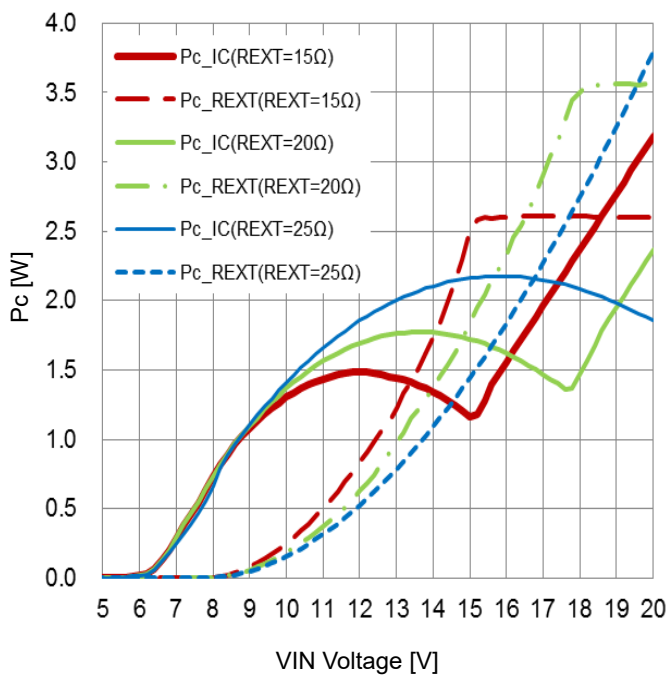


Figure 18. Energy Sharing Control Operation 3 (Measured Waveform)

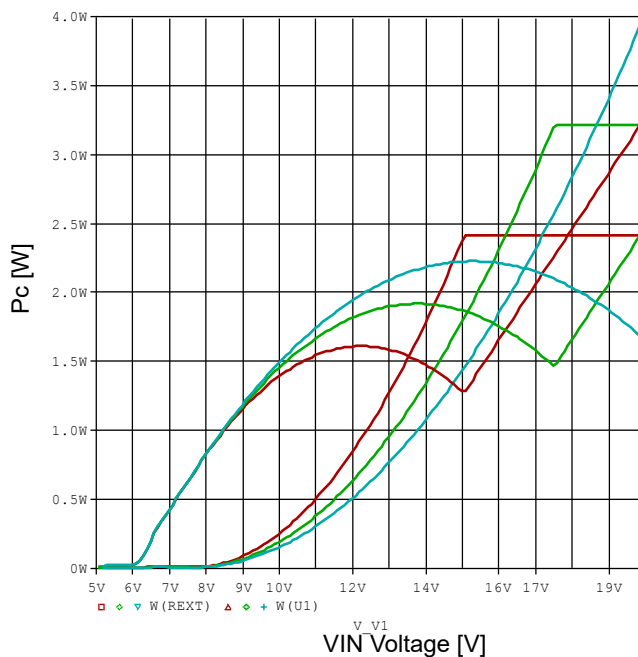


Figure 19. Energy Sharing Control Operation 3 (SPICE Simulation)

Table 9. Comparison of Characteristics

Unless otherwise specified, Ta=25°C, VIN=13V

| Parameter | Measured Result <i>(Note 1)</i> | SPICE Simulation Result | Unit | Error | Condition   |
|-----------|---------------------------------|-------------------------|------|-------|---|
| Pc_IC     | 1.76                            | 1.895                   | W    | 7.7%  | IOUT_TOTAL=400mA,<br>VOUTx(x=1 to 4)=6V, REXT=20Ω |
| Pc_REXT   | 0.98                            | 0.946                   | W    | 3.5%  |   |

(Note 1) The above data is based on a specific sample and it is not meant to be a guaranteed value.

**Revision History**

| Date     | Revision | Changes     |
|----------|----------|-------------|
| Sep.2019 | 001      | New Release |

## Notes

- 1) The information contained herein is subject to change without notice.
- 2) Before you use our Products, please contact our sales representative and verify the latest specifications :
- 3) Although ROHM is continuously working to improve product reliability and quality, semiconductors can break down and malfunction due to various factors.  
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