Qualification of BRNS/BRFS/BRDS series (Point of Load applications) to Intermediate Bus Architecture
## BRNS series

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1. Pin configuration

Fig. 1.1
Pin connection for BRNS (bottom view)

(a) BRNS6/12

(b) BRNS20

Table 1.1
Pin connection and function of BRNS

<table>
<thead>
<tr>
<th>Pin No.</th>
<th>BRNS 6/12</th>
<th>BRNS 20</th>
<th>Pin Connection</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td>RC</td>
<td>Remote ON/OFF</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td>+Vin</td>
<td>+DC input</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td>GND</td>
<td>GND(-DC input, -DC output)</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td>+Vout</td>
<td>+DC output</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td>S</td>
<td>+Remote sensing</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
<td>TRM</td>
<td>Adjustment of output voltage</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
<td>SGND</td>
<td>Signal GND</td>
</tr>
<tr>
<td>8</td>
<td></td>
<td></td>
<td>CLK(NC)</td>
<td>Clock output</td>
</tr>
<tr>
<td>9</td>
<td></td>
<td></td>
<td>SEQ</td>
<td>Control of Start up time and turn</td>
</tr>
<tr>
<td>10</td>
<td></td>
<td></td>
<td>PGOOD</td>
<td>Power good</td>
</tr>
<tr>
<td>11</td>
<td></td>
<td></td>
<td>SYNC</td>
<td>Input for frequency synchronization</td>
</tr>
<tr>
<td>12</td>
<td></td>
<td></td>
<td>-S</td>
<td>NC : BRNS6/12 -Remote sensing : BRNS20</td>
</tr>
<tr>
<td>13</td>
<td></td>
<td></td>
<td>NC</td>
<td>NC</td>
</tr>
<tr>
<td>14</td>
<td></td>
<td></td>
<td>NC</td>
<td>NC</td>
</tr>
<tr>
<td>15</td>
<td></td>
<td></td>
<td>NC</td>
<td>NC</td>
</tr>
<tr>
<td>16</td>
<td></td>
<td></td>
<td>NC</td>
<td>NC</td>
</tr>
<tr>
<td>17</td>
<td></td>
<td></td>
<td>NC</td>
<td>NC</td>
</tr>
<tr>
<td>18</td>
<td></td>
<td></td>
<td>NC</td>
<td>NC</td>
</tr>
<tr>
<td>19</td>
<td></td>
<td></td>
<td>NC</td>
<td>NC</td>
</tr>
</tbody>
</table>
2.1 Mounting

- The unit can be mounted in any direction. When two or more power supplies are used side by side, position them with proper intervals to allow enough air ventilation. The temperature around each power supply should not exceed the temperature range shown in the derating curve.
- Avoid placing the DC input line pattern layout underneath the unit, it will increase the line conducted noise. Make sure to leave an ample distance between the line pattern layout and the unit. Also avoid placing the DC output line pattern underneath the unit because it may increase the output noise. Lay out the pattern away from the unit.
- Avoid placing the signal line pattern layout underneath the unit, this power supply might become unstable. Lay out the pattern away from the unit.
- Avoid placing pattern layout in hatched area in Fig. 2.1.1 to insulate between pattern and power supply.
2.2 Automatic Mounting

- To mount BRNS series automatically, use the coil area near the center of the PCB as an adsorption point. Please see Fig.2.2.1 for details of the adsorption point.

![Fig. 2.2.1 Adsorption area](image)

(a) BRNS6/12
(b) BRNS20

2.3 Soldering

- Fig.2.3.1 shows condition for reflow of BRNS series. Please make sure that the temperature of board’s pattern near by +VOUT and GND terminal.
- While soldering, having vibration or impact on the unit should be avoided, because of solder melting.
- Please do not do the implementation except the reflow.
- Because some parts drops, please do not do reflow of the back side.

![Fig. 2.3.1 Recommended reflow soldering condition](image)

<table>
<thead>
<tr>
<th>A</th>
<th>1.0 - 5.0°C/s</th>
</tr>
</thead>
<tbody>
<tr>
<td>A'</td>
<td>Ty1: 160±10°C</td>
</tr>
<tr>
<td></td>
<td>Ty2: 180±10°C</td>
</tr>
<tr>
<td></td>
<td>Ty1 - Ty2: 120s max</td>
</tr>
<tr>
<td>B</td>
<td>1.0 - 5.0°C/s</td>
</tr>
<tr>
<td>B'</td>
<td>Tp: Max245°C 10s max</td>
</tr>
<tr>
<td></td>
<td>Tx: 220°C or more : 70s max</td>
</tr>
<tr>
<td>C</td>
<td>1.0 - 5.0°C/s</td>
</tr>
</tbody>
</table>
2.4 Stencil Openings

- Recommended size for stencil openings is shown in Fig. 2.4.1.

Fig. 2.4.1
Recommended size for stencil openings
(Top view)

(a) BRNS6 / 12

(b) BRNS20

Dimensions in mm, [ ] = inches
Recommended stencil thickness is 0.12mm

BRNS 2-3
2.5 Cleaning

- When cleaning is necessary, clean under the following conditions.
  - Method: Varnishing, ultrasonic wave and vapor
  - Cleaning agents: IPA (Solvent type)
  - Total time: 2 minutes or less
- Do not apply pressure to the lead and name plate with a brush or scratch it during the cleaning.
- After cleaning, dry them enough.

2.6 Storage

- To stock unpacked products in your inventory, it is recommended to keep them under controlled condition, 5-30°C, 60%RH and use them within a year.
- 24-hour baking is recommended at 125°C, if unpacked products were kept under uncontrolled condition, which is 30°C, 60%RH or higher.
  - Original reels are not heat-resistant. Please move them to heat-resistant trays in preparation to bake.
  - To check moisture condition in the pack, Silica gel packet has some moisture condition indicator particles. Indicated blue means good. Pink means alarm to bake it.
- The reels will be deformed and the power supply might be damaged, if the vacuum pressure is too much to reseal.

2.7 Safety Consideration

- To apply for safety standard approval using this power supply, the following conditions must be met.
  - This unit must be used as a component of the end-use equipment.
  - Safety approved fuse must be externally installed on input side.
3.1 Connection for standard use

- In order to use power supply, it is necessary to wire as shown in Fig. 3.1.1.

- Short the following pins to turn on the power supply.
  - GND⇔RC, +VOUT⇔+S, GND⇔-S (-S : only BRNS20)
- Connect resistance to set the output voltage between TRM and GND.
- Between input and output is not isolated.
- The BRNS series handle only the DC input. Avoid applying AC input directly. It will damage the power supply.
3.2 Wiring input pin

(1) External fuse

- Fuse is not built-in on input side. In order to protect the unit, install the normal-blow type fuse on input side.
- When the input voltage from a front end unit is supplied to multiple units, install the normal-blow type fuse in each unit.
- When the fuse is open, power good signal is not outputted.
- It is not necessary to use fuse if it can be protected by the overcurrent protection function of bus converter on the input side.

<table>
<thead>
<tr>
<th>Model</th>
<th>BRNS6</th>
<th>BRNS12</th>
<th>BRNS20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated current</td>
<td>15A</td>
<td>20A</td>
<td>40A</td>
</tr>
</tbody>
</table>

(2) External capacitor on the input side

- Install an external capacitor Ci, between +VIN and GND input pins for low line-noise and for stable operation of the power supply.

<table>
<thead>
<tr>
<th>Model</th>
<th>BRNS6</th>
<th>BRNS12</th>
<th>BRNS20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ci</td>
<td>22μF×2</td>
<td>22μF×2</td>
<td>22μF×3</td>
</tr>
</tbody>
</table>

- Ci is within 5mm for pins. Make sure that ripple current of Ci is less than its rating.
- When an impedance and inductance level of the input line become higher, the input voltage may become unstable. In that case, the input voltage becomes stable by increasing Ci.

(3) Recommendation for noise-filter

- Install an external input filter as shown in Fig.3.2.1 in order to reduce conducted noise. Ci is shown in Table 3.2.2.
(4) Reverse input voltage protection

- Avoid the reverse polarity input voltage. It will damage the power supply.

It is possible to protect the unit from the reverse input voltage by installing an external diode as shown in Fig.3.2.2.
3.3 Wiring output pin

- When the BRNS series supplies the pulse current for the pulse load, please install a capacitor Co between +VOUT and GND pins.

![Diagram of wiring external output capacitor](image)

**Table 3.3.1**

<table>
<thead>
<tr>
<th>No.</th>
<th>Model</th>
<th>Recommended Co</th>
<th>Max Co</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>BRNS6</td>
<td>47μF x 1 + 100μF x 1</td>
<td>1,000μF</td>
</tr>
<tr>
<td>2</td>
<td>BRNS12</td>
<td>47μF x 1 + 100μF x 1</td>
<td>1,000μF</td>
</tr>
<tr>
<td>3</td>
<td>BRNS20</td>
<td>100μF x 2</td>
<td>1,000μF</td>
</tr>
</tbody>
</table>

- The output ripple voltage may grow big by resonance with Co and ESL of the wiring, if resonance frequency and switching frequency are close.
- Ripple and Ripple Noise are measured, as shown in the Fig.3.3.2. Cin is shown in Table 3.2.2. Co1 and Co2 is shown in Table 3.3.2.

![Diagram of measuring method of Ripple and Ripple Noise](image)

**Table 3.3.2**

<table>
<thead>
<tr>
<th>No.</th>
<th>Model</th>
<th>Vo</th>
<th>Co1</th>
<th>Co2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>BRNS6</td>
<td>0.6-3.3V</td>
<td>47μF x 1</td>
<td>100μF x 1</td>
</tr>
<tr>
<td>2</td>
<td>BRNS6</td>
<td>3.3-5.5V</td>
<td>22μF x 1</td>
<td>22μF x 1</td>
</tr>
<tr>
<td>3</td>
<td>BRNS12</td>
<td>0.6-3.3V</td>
<td>47μF x 1</td>
<td>100μF x 1</td>
</tr>
<tr>
<td>4</td>
<td>BRNS12</td>
<td>3.3-5.5V</td>
<td>22μF x 1</td>
<td>22μF x 2</td>
</tr>
<tr>
<td>5</td>
<td>BRNS20</td>
<td>0.6-3.3V</td>
<td>100μF x 1</td>
<td>100μF x 1</td>
</tr>
<tr>
<td>6</td>
<td>BRNS20</td>
<td>3.3-5.5V</td>
<td>22μF x 2</td>
<td>22μF x 2</td>
</tr>
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</table>
4. Applications data

4.1 Efficiency

Fig. 4.1.1
Efficiency (BRNS6) at 25°C

Fig. 4.1.2
Efficiency (BRNS12) at 25°C
Fig. 4.1.3
Efficiency (BRNS20) at 25°C

Vout = 5.0V

Vout = 1.2V

Vout = 3.3V

BRNS 4-2
4.2 Dynamic Load Response

4.2.1 BRNS6

Vin 12V, Vout 1.2V, Cin 22μF × 2, Cout 1000μF
Testing Circuitry Fig. 4.2.3.2

For BRNS series
4.2.2 BRNS12

Vin 12V, Vout 1.2V, Cin 22μF x 2, Cout 1000μF

Testing Circuitry  Fig. 4.2.3.2
4.2.3 BRNS20

Vin 12V, Vout 1.2V, Cin 22μF x 3, Cout 1000μF
Testing Circuitry  Fig. 4.2.3.2

Cycle 5 ms
Load Current

Load 0% (0A) → Load 50% (10A)
Load 50% (10A) → Load 100% (20A)
100 mV/div
100 μs/div
100 μs/div

BRNS 4-5
Fig. 4.2.3.2
Measuring method of Dynamic Load Response

---

DC Input

Cin

GND

Cout1

Cout2

Load

Oscilloscope Bw: 20MHz

<table>
<thead>
<tr>
<th>No.</th>
<th>Model</th>
<th>Cin</th>
<th>Cout1</th>
<th>Cout2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>BRNS6</td>
<td>22µF×2</td>
<td>100µF</td>
<td>900µF</td>
</tr>
<tr>
<td>2</td>
<td>BRNS12</td>
<td>22µF×2</td>
<td>100µF</td>
<td>900µF</td>
</tr>
<tr>
<td>3</td>
<td>BRNS20</td>
<td>22µF×3</td>
<td>100µF</td>
<td>900µF</td>
</tr>
</tbody>
</table>

BRNS 4-6
4.3 Ripple Voltage

**Fig. 4.3.1**
Ripple Voltage of BRNS at 25°C

- 5 mV/div
- Vin 12V
- Vout 1.2V
- Load Current 6A
- 1 µs/div

(a) BRNS6

- 10 mV/div
- Vin 12V
- Vout 1.2V
- Load Current 20A
- 1 µs/div

(c) BRNS20

**Fig. 4.3.2**
Measuring method of Ripple Voltage

<table>
<thead>
<tr>
<th>No.</th>
<th>Model</th>
<th>Cin</th>
<th>Cout1</th>
<th>Cout2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>BRNS6</td>
<td>22µF×2</td>
<td>47µF</td>
<td>100 µF</td>
</tr>
<tr>
<td>2</td>
<td>BRNS12</td>
<td>22µF×2</td>
<td>47µF</td>
<td>100 µF</td>
</tr>
<tr>
<td>3</td>
<td>BRNS20</td>
<td>22µF×3</td>
<td>100µF</td>
<td>100 µF</td>
</tr>
</tbody>
</table>

For BRNS series
4.4 Rise time

**Fig. 4.4.1**
BRNS6
Rise at 25°C

Load current: 0A, Cin: 22µF×2, Cout: 47µF+100µF

- 200mV/div
- 2V/div
- 5ms/div

Rise time: 3.3ms
Vin: 8V, Vout: 0.6V

Rise time: 3.8ms
Vin: 12V, Vout: 5.5V

**Fig. 4.4.2**
BRNS12
Rise at 25°C

Load current: 0A, Cin: 22µF×2, Cout: 100µF+47µF

- 200mV/div
- 2V/div
- 5ms/div

Rise time: 3.5ms
Vin: 8V, Vout: 0.6V

Rise time: 3.8ms
Vin: 12V, Vout: 5.5V

**Fig. 4.4.3**
BRNS20
Rise at 25°C

Load current: 0A, Cin: 22µF×3, Cout: 100µF+100µF

- 200mV/div
- 2V/div
- 5ms/div

Rise time: 3.3ms
Vin: 8V, Vout: 0.6V

Rise time: 3.5ms
Vin: 12V, Vout: 5.5V
4.5 Derating

- Shows the temperature measurement points in Figure 4.5.2 and Figure 4.5.3. That the temperature of the specified point be less than or equal to the temperature shown in FIG. 1. Ambient temperature must be maintained at 85 °C or less.
Fig. 4.5.5 ~ 4.5.13 show the derating curve in the condition that is measured as shown in Fig.4.5.4. Verify final design by actual temperature measurement. The temperature measurement location as shown in Fig.4.5.2 and Fig.4.5.3 must keep below 120°C.

Fig. 4.5.4
Measuring method

Fig. 4.5.5
Derating curve for BRNS6 at 12Vin 1.2Vout

Fig. 4.5.6
Derating curve for BRNS6 at 12Vin 3.3Vout
Fig. 4.5.7 Derating curve for BRNS6 at 12Vin 5.5Vout

Fig. 4.5.8 Derating curve for BRNS12 at 12Vin 1.2Vout

Fig. 4.5.9 Derating curve for BRNS12 at 12Vin 3.3Vout

Fig. 4.5.10 Derating curve for BRNS12 at 12Vin 5.5Vout
For BRNS series

Fig. 4.5.11
Derating curve for BRNS20 at 12V in 1.2V out

Fig. 4.5.12
Derating curve for BRNS20 at 12V in 3.3V out

Fig. 4.5.13
Derating curve for BRNS20 at 12V in 5.5V out
5. Adjustable voltage range

- Output voltage is adjustable by the external resistor.
- The temperature coefficient could become worse, depending on the type of a resistor. Resistor...Metal film type, coefficient of less than $\pm 100\text{ppm/}^\circ\text{C}$
- When TRM is opened, output voltage is 0.6V.
- $R_{\text{TRM}}$ is calculated in the following expressions.

$$R_{\text{TRM}} = \frac{12}{\text{VOUT} - 0.6}\text{[k}\Omega]\text{]$$

![Fig. 5.1.1 Calculation result](image1)

<table>
<thead>
<tr>
<th>No.</th>
<th>+VOUT</th>
<th>$R_{\text{TRM}}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.6</td>
<td>OPEN</td>
</tr>
<tr>
<td>2</td>
<td>1.2</td>
<td>20.00kΩ</td>
</tr>
<tr>
<td>3</td>
<td>1.8</td>
<td>10.00kΩ</td>
</tr>
<tr>
<td>4</td>
<td>2.5</td>
<td>6.32kΩ</td>
</tr>
<tr>
<td>5</td>
<td>3.3</td>
<td>4.44kΩ</td>
</tr>
<tr>
<td>6</td>
<td>5.0</td>
<td>2.73kΩ</td>
</tr>
</tbody>
</table>

![Fig. 5.1.2 Connecting $R_{\text{TRM}}$](image2)
Please use the output voltage in the operating area of Fig.5.1.3. Transient response may worsen when used in vicinity of the border of the operating area. Only for output voltage is rising and output current is small, there is a possibility that the ripple voltage is high value. If the ripple voltage value is problem, connecting a capacitor of Table 3.3.1 value.

When start of DC INPUT is slow, BRNS may start on the outside of the operating area. By the circuitry of the Fig.5.1.4, you can raise the start-up voltage.
6. Protect circuit

6.1 Overcurrent Protection

Over Current Protection (OCP) is built-in and works at 105% of the rated current or higher. However, use in an overcurrent situation must be avoided whenever possible. The output voltage of the power module will recover automatically when the fault causing overcurrent is corrected.

When the output voltage drops after OCP works, the power module enters a "hiccup mode" where it repeatedly turns on and off at a certain frequency (5ms typ).
7. Remote ON/OFF

- The remote ON/OFF function is incorporated in the input circuitry and operated with RC and GND. If positive logic control is required, order the power supply with "-R" option.
- When remote on/off function is not used, please open RC.

<table>
<thead>
<tr>
<th>Table. 7.1.1</th>
<th>Specification of Remote ON/OFF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard</td>
<td>Negative</td>
</tr>
<tr>
<td>ON/OFF logic</td>
<td>L level (-0.2-0.3V) or short or open</td>
</tr>
<tr>
<td>Between RC and GND</td>
<td>H level (3.0-VIN)</td>
</tr>
<tr>
<td>Optional -R</td>
<td>Positive</td>
</tr>
<tr>
<td>ON/OFF logic</td>
<td>L level (-0.2-0.3V) or short</td>
</tr>
<tr>
<td>Output voltage</td>
<td>H level (3.0-VIN) or open</td>
</tr>
</tbody>
</table>

Fig. 7.1.1
Internal circuitry of Remote ON/OFF

Fig. 7.1.2
RC connection example
8. Remote sensing

8.1 When the remote sensing function is not use

- When the remote sensing function is not in use, it is necessary to confirm that pins are shorted between +S & +VOUT and between -S & GND.
- Wire between +S & +VOUT and between -S & GND as short as possible.
  Loop wiring should be avoided.
  This power supply might become unstable by the noise coming from poor wiring.

8.2 When the remote sensing function is use

- Twisted-pair wire or shield wire should be used for sensing wire.
- Thick wire should be used for wiring between the power supply and a load.
  Line drop should be less than 0.5V.
  Voltage between +VOUT and GND should remain within the output voltage adjustment range.
- If the sensing patterns are short, heavy-current is drawn and the pattern may be damaged.
  The pattern disconnection can be prevented by installing the protection parts as close as possible to a load.
9. Power Good

- By using PGOOD, it is possible to monitor power supply whether normal operation or abnormal operation.
- PGOOD terminal inside is comprised of at open drain. Sink current of PGOOD is 50 µA.
- Voltage of PGOOD pin become low when over current protection circuitry is work, or output voltage is different from a set point more than ±10%.

![Internal circuitry of PGood](image)

**Fig. 9.1.1**
Internal circuitry of PGood

**Fig. 9.1.2**
BRNS6
PGOOD

<table>
<thead>
<tr>
<th>RC(5V/div)</th>
<th>Vin: 12V</th>
<th>t0: 5ms(Max)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vout(2V/div)</td>
<td>Vout: 5.5V</td>
<td>load current: 0A</td>
</tr>
<tr>
<td>PGOOD(2V/div)</td>
<td>Cin: 22uF x 2</td>
<td>Cout: 100uF + 47uF</td>
</tr>
</tbody>
</table>

**Fig. 9.1.3**
BRNS12
PGOOD

<table>
<thead>
<tr>
<th>RC(5V/div)</th>
<th>Vin: 12V</th>
<th>t0: 5ms(Max)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vout(2V/div)</td>
<td>Vout: 5.5V</td>
<td>load current: 0A</td>
</tr>
<tr>
<td>PGOOD(2V/div)</td>
<td>Cin: 22uF x 2</td>
<td>Cout: 100uF + 47uF</td>
</tr>
</tbody>
</table>

**Fig. 9.1.4**
BRNS20
PGOOD

<table>
<thead>
<tr>
<th>RC(5V/div)</th>
<th>Vin: 12V</th>
<th>t0: 5.0ms(Max)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vout(2V/div)</td>
<td>Vout: 5.5V</td>
<td>load current: 0A</td>
</tr>
<tr>
<td>PGOOD(2V/div)</td>
<td>Cin: 22uF x 3</td>
<td>Cout: 100uF x 2</td>
</tr>
</tbody>
</table>

BRNS 9-1
10. Sequence

- The adjustment of the rise time is possible by connecting $C_{SEQ}$.

$$C_{SEQ}[nF] = 6 \times T_{RISE}[ms] - 15$$

- $C_{SEQ}$ should be less than 1.0 µF.
- At the time of start, the output voltage follows the SEQ voltage.
  Output voltage and SEQ voltage are expressed in the following calculation.

$$V_{OUT} = V_{SEQ} \times \left( \frac{20\,\Omega}{R_{TRM}} + 1 \right)$$

* $V_{SEQ} < 0.6V$
With the voltage to input into SEQ pin, you can control a start sequence of plural BRNS.

Fig. 10.1.1

Example of sequence control

(a) The same time

(b) The same voltage

(c) The time lag

If this function is unnecessary, please make SEQ pin open.
11. Frequency synchronization

- BRNS can operate at the switching frequency that synchronized to frequency of square wave input into SYNC pin. There is a delay of 300nsec.
- Fig.11.1.1 is example of frequency synchronization. And recommended wave form of SYNC pin is shown in Fig.11.1.2
- If this function is unnecessary, please make SYNC pin open or short to GND.
- Please wire the input pin of both power supplies which is synchronizing to the same pattern and voltage.

![Fig. 11.1.1 Example of frequency synchronization](image)

![Fig. 11.1.2 Recommended wave form of SYNC](image)

<table>
<thead>
<tr>
<th>No.</th>
<th>VIN</th>
<th>VSYNC</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Lo level</td>
</tr>
<tr>
<td></td>
<td></td>
<td>min</td>
</tr>
<tr>
<td>1</td>
<td>≤5.5V</td>
<td>-0.2V</td>
</tr>
<tr>
<td>2</td>
<td>&gt;5.5V</td>
<td></td>
</tr>
</tbody>
</table>

BRNS 11-1
As shown in Fig.11.1.3, frequency synchronization is possible without using an outside clock.

The maximum synchronization number is 5.

After the power supply which output CLK started, please start the synchronizing power supplies. And when stop power supplies, you should stop the power supply which output CLK at first.

The max voltage of CLK pin is DC input voltage.

Applied voltage of the SYNC pin is equal to or larger than 5.5V to connect the $ZD_{CLK}$ (refer to Table.11.1.1)
12. Series operation/Parallel operation/Redundancy operation

12.1 Series operation

- Series operation is not possible.

12.2 Parallel operation/Redundancy operation

- Parallel operation is not possible.
- Redundancy operation is available by wiring as shown below.

Even a slight difference in output voltage can affect the balance between the values of $I_1$ and $I_2$.
- Current $I_3$ should not exceed the rated current of the power supply.

$I_3 \leq \text{the rated current value}$
13. Package Information

- Please refer to Fig.13.1.1 ~ Fig.13.1.3 for Package form (Reel).
- The packed number is 200.

Fig. 13.1.1
Taping dimensions of BRNS6/12

Fig. 13.1.2
Taping dimensions of BRNS20
Fig. 13.1.3
Reel dimensions of BRNS

<table>
<thead>
<tr>
<th>Model</th>
<th>Tape width [mm]</th>
<th>W1 [mm]</th>
<th>W2 [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>BRNS6</td>
<td>24</td>
<td>25.5±1.0</td>
<td>29.5±1.0</td>
</tr>
<tr>
<td>BRNS12</td>
<td>24</td>
<td>25.5±1.0</td>
<td>29.5±1.0</td>
</tr>
<tr>
<td>BRNS20</td>
<td>32</td>
<td>33.5±1.0</td>
<td>37.5±1.0</td>
</tr>
</tbody>
</table>
## BRFS/BRDS series

<table>
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<th>Section</th>
<th>Page</th>
</tr>
</thead>
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<td>BRFS/BRDS 1-1</td>
</tr>
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<td>1.2 BRFS50/BRFS50L/BRFS60/BRFS100</td>
<td>BRFS/BRDS 1-2</td>
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<td>1.3 BRDS40</td>
<td>BRFS/BRDS 1-3</td>
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<td>1.4 BRDS60/100</td>
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<td>BRFS/BRDS 2-1</td>
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<td>BRFS/BRDS 2-2</td>
</tr>
<tr>
<td>2.3 Soldering</td>
<td>BRFS/BRDS 2-2</td>
</tr>
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<td>2.6 Safety considerations</td>
<td>BRFS/BRDS 2-3</td>
</tr>
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<td>3. Connection for standard use</td>
<td>BRFS/BRDS 3-1</td>
</tr>
<tr>
<td>3.1 Connection for standard use</td>
<td>BRFS/BRDS 3-1</td>
</tr>
<tr>
<td>3.2 Wiring input pin</td>
<td>BRFS/BRDS 3-2</td>
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<td>3.3 Wiring output pin</td>
<td>BRFS/BRDS 3-4</td>
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<td>4. Applications data</td>
<td>BRFS/BRDS 4-1</td>
</tr>
<tr>
<td>4.1 Efficiency</td>
<td>BRFS/BRDS 4-1</td>
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<tr>
<td>4.2 Dynamic load response</td>
<td>BRFS/BRDS 4-3</td>
</tr>
<tr>
<td>4.3 Ripple voltage</td>
<td>BRFS/BRDS 4-7</td>
</tr>
<tr>
<td>4.4 Rise time</td>
<td>BRFS/BRDS 4-8</td>
</tr>
<tr>
<td>4.5 Derating</td>
<td>BRFS/BRDS 4-9</td>
</tr>
<tr>
<td>4.6 Thermal simulation model</td>
<td>BRFS/BRDS 4-12</td>
</tr>
<tr>
<td>5. Adjustable voltage range</td>
<td>BRFS/BRDS 5-1</td>
</tr>
<tr>
<td>6. Protect circuitry</td>
<td>BRFS/BRDS 6-1</td>
</tr>
<tr>
<td>6.1 Overcurrent protection</td>
<td>BRFS/BRDS 6-1</td>
</tr>
<tr>
<td>6.2 Thermal protection</td>
<td>BRFS/BRDS 6-1</td>
</tr>
<tr>
<td>7. Remote ON/OFF</td>
<td>BRFS/BRDS 7-1</td>
</tr>
<tr>
<td>8. Remote sensing</td>
<td>BRFS/BRDS 8-1</td>
</tr>
<tr>
<td>8.1 When the remote sensing function is not in use</td>
<td>BRFS/BRDS 8-1</td>
</tr>
<tr>
<td>8.2 When the remote sensing function is in use</td>
<td>BRFS/BRDS 8-1</td>
</tr>
<tr>
<td>9. Power Good</td>
<td>BRFS/BRDS 9-1</td>
</tr>
<tr>
<td>10. Series operation / Parallel operation</td>
<td>BRFS/BRDS 10-1</td>
</tr>
<tr>
<td>10.1 Series operation</td>
<td>BRFS/BRDS 10-1</td>
</tr>
<tr>
<td>10.2 Parallel operation</td>
<td>BRFS/BRDS 10-1</td>
</tr>
<tr>
<td>11. Sequence</td>
<td>BRFS/BRDS 11-1</td>
</tr>
<tr>
<td>12. Package information</td>
<td>BRFS/BRDS 12-1</td>
</tr>
</tbody>
</table>
1. Pin configuration

1.1 BRFS30/40

Fig. 1.1.1
Pin connection for BRFS30/40 (bottom view)

Table 1.1.1
Pin connection and function of BRFS40

<table>
<thead>
<tr>
<th>Pin No.</th>
<th>Pin Connection</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>RC</td>
<td>Remote ON/OFF</td>
</tr>
<tr>
<td>2</td>
<td>+VIN</td>
<td>+DC input</td>
</tr>
<tr>
<td>3</td>
<td>SEQ</td>
<td>Control of Start up time and turn</td>
</tr>
<tr>
<td>4</td>
<td>GND</td>
<td>GND (-DC input, -DC output)</td>
</tr>
<tr>
<td>5</td>
<td>+VOUT</td>
<td>+DC output</td>
</tr>
<tr>
<td>6</td>
<td>TRM</td>
<td>Adjustment of output voltage</td>
</tr>
<tr>
<td>7</td>
<td>+S</td>
<td>+Remote sensing</td>
</tr>
<tr>
<td>8</td>
<td>GND</td>
<td>GND (-DC input, -DC output)</td>
</tr>
<tr>
<td>9</td>
<td>NC (PGOOD/SHARE)</td>
<td>NC (optional: Power good (BRFS30/40), SHARE (BRFS40))</td>
</tr>
<tr>
<td>10</td>
<td>SGND</td>
<td>Signal GND</td>
</tr>
</tbody>
</table>
1.2 BRFS50/BRFS50L/BRFS60/BRFS100

(a) BRFS50/50L/60

(b) BRFS100

Table 1.2.1
Pin connection and function of BRFS50/50L/60/100

<table>
<thead>
<tr>
<th>Pin No.</th>
<th>Pin Connection</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-15</td>
<td>+VIN</td>
<td>+DC input</td>
</tr>
<tr>
<td>2</td>
<td>GND</td>
<td>GND (-DC input, -DC output)</td>
</tr>
<tr>
<td>3-10</td>
<td>+VOUT</td>
<td>+DC output</td>
</tr>
<tr>
<td>4-12</td>
<td>+VOUT</td>
<td>+DC output</td>
</tr>
<tr>
<td>5-19</td>
<td>GND</td>
<td>GND (-DC input, -DC output)</td>
</tr>
<tr>
<td>6-20</td>
<td>+VIN</td>
<td>+DC input</td>
</tr>
<tr>
<td>7</td>
<td>SEQ</td>
<td>Control of Start up time and turn</td>
</tr>
<tr>
<td>8</td>
<td>PGOOD</td>
<td>Power good</td>
</tr>
<tr>
<td>9</td>
<td>RC</td>
<td>Remote ON/OFF</td>
</tr>
<tr>
<td>10</td>
<td>-S</td>
<td>-Remote sensing</td>
</tr>
<tr>
<td>11</td>
<td>+S</td>
<td>+Remote sensing</td>
</tr>
<tr>
<td>12</td>
<td>+TRM</td>
<td>+Adjustment of output voltage</td>
</tr>
<tr>
<td>13</td>
<td>-TRM</td>
<td>-Adjustment of output voltage</td>
</tr>
<tr>
<td>14</td>
<td>SHARE</td>
<td>Parallel operation</td>
</tr>
</tbody>
</table>
1.3 BRDS40

Fig. 13.1
Pin connection for BRDS40 (bottom view)

Table 13.1
Pin connection and function of BRDS40

<table>
<thead>
<tr>
<th>Pin No.</th>
<th>Pin Connection</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>RC</td>
<td>Remote ON/OFF</td>
</tr>
<tr>
<td>2</td>
<td>+VIN</td>
<td>+DC input</td>
</tr>
<tr>
<td>3</td>
<td>SEQ</td>
<td>Control of Start up time and turn</td>
</tr>
<tr>
<td>4</td>
<td>GND</td>
<td>GND (-DC input, -DC output)</td>
</tr>
<tr>
<td>5</td>
<td>+VOUT</td>
<td>+DC output</td>
</tr>
<tr>
<td>6</td>
<td>TRM</td>
<td>Adjustment of output voltage</td>
</tr>
<tr>
<td>7</td>
<td>+S</td>
<td>+Remote sensing</td>
</tr>
<tr>
<td>8</td>
<td>GND</td>
<td>GND (-DC input, -DC output)</td>
</tr>
<tr>
<td>9</td>
<td>SHARE</td>
<td>Parallel operation</td>
</tr>
<tr>
<td>10</td>
<td>SGND</td>
<td>Signal GND</td>
</tr>
<tr>
<td>11</td>
<td>SGND</td>
<td>Signal GND</td>
</tr>
<tr>
<td>12</td>
<td>-S</td>
<td>-Remote sensing</td>
</tr>
<tr>
<td>13</td>
<td>CLK</td>
<td>PMBus communication clock input</td>
</tr>
<tr>
<td>14</td>
<td>DATA</td>
<td>PMBus communication data input &amp; output</td>
</tr>
<tr>
<td>15</td>
<td>NC</td>
<td>NC</td>
</tr>
<tr>
<td>16</td>
<td>PGOOD</td>
<td>Power good</td>
</tr>
<tr>
<td>17</td>
<td>SMBALERHT</td>
<td>PMBus alarm output</td>
</tr>
<tr>
<td>18</td>
<td>ADDR0</td>
<td>Address setting</td>
</tr>
<tr>
<td>19</td>
<td>ADDR1</td>
<td>Address setting</td>
</tr>
</tbody>
</table>
1.4 BRDS60/100

Fig. 1.4.1
Pin connection for BRDS60/100 (bottom view)

(a) BRDS60

(b) BRDS100

Table 1.4.1
Pin connection and function of BRDS60/100

<table>
<thead>
<tr>
<th>Pin No.</th>
<th>BRDS60</th>
<th>BRDS100</th>
<th>Pin Connection</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>15</td>
<td>+VIN</td>
<td>+DC input</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>16</td>
<td>GND</td>
<td>GND (-DC input, -DC output)</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>17</td>
<td>+VOUT</td>
<td>+DC output</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>18</td>
<td>+VOUT</td>
<td>+DC output</td>
</tr>
<tr>
<td>5</td>
<td>5</td>
<td>19</td>
<td>GND</td>
<td>GND (-DC input, -DC output)</td>
</tr>
<tr>
<td>6</td>
<td>6</td>
<td>20</td>
<td>+VIN</td>
<td>+DC input</td>
</tr>
<tr>
<td>7</td>
<td>7</td>
<td></td>
<td>SEQ</td>
<td>Control of Start up time and turn</td>
</tr>
<tr>
<td>8</td>
<td>8</td>
<td></td>
<td>PGOOD</td>
<td>Power good</td>
</tr>
<tr>
<td>9</td>
<td>9</td>
<td></td>
<td>RC</td>
<td>Remote ON/OFF</td>
</tr>
<tr>
<td>10</td>
<td>10</td>
<td></td>
<td>-S</td>
<td>-Remote sensing</td>
</tr>
<tr>
<td>11</td>
<td>11</td>
<td></td>
<td>+S</td>
<td>+Remote sensing</td>
</tr>
<tr>
<td>12</td>
<td>12</td>
<td></td>
<td>+TRM</td>
<td>+Adjustment of output voltage</td>
</tr>
<tr>
<td>13</td>
<td>13</td>
<td></td>
<td>-TRM</td>
<td>-Adjustment of output voltage</td>
</tr>
<tr>
<td>14</td>
<td>14</td>
<td></td>
<td>SHARE</td>
<td>Parallel operation</td>
</tr>
<tr>
<td>15</td>
<td>21</td>
<td></td>
<td>SMBALERT</td>
<td>PMBus alarm output</td>
</tr>
<tr>
<td>16</td>
<td>22</td>
<td></td>
<td>DATA</td>
<td>PMBus communication data input &amp; output</td>
</tr>
<tr>
<td>17</td>
<td>23</td>
<td></td>
<td>SGN</td>
<td>Signal GND</td>
</tr>
<tr>
<td>18</td>
<td>24</td>
<td></td>
<td>CLK</td>
<td>PMBus communication clock input</td>
</tr>
<tr>
<td>19</td>
<td>25</td>
<td></td>
<td>ADDR0</td>
<td>Address setting</td>
</tr>
<tr>
<td>20</td>
<td>26</td>
<td></td>
<td>ADDR1</td>
<td>Address setting</td>
</tr>
</tbody>
</table>
2.1 Mounting

- The unit can be mounted in any direction. When two or more power supplies are used side by side, position them with proper intervals to allow enough air ventilation. The temperature around each power supply should not exceed the temperature range shown in derating curve.
- Avoid placing the DC input line pattern layout underneath the unit, it will increase the line conducted noise. Make sure to leave an ample distance between the line pattern layout and the unit. Also avoid placing the DC output line pattern underneath the unit because it may increase the output noise. Lay out the pattern away from the unit.
- Avoid placing the signal line pattern layout underneath the unit, this power supply might become unstable. Lay out the pattern away from the unit.
- Avoid placing pattern layout in hatched area in Fig.2.1.1 to insulate between pattern and power supply.

![Fig.2.1.1](image)

Prohibition area of Pattern layout (top view)

(a) BRFS30

(b-1) BRFS50/BRFS50L/BRFS60

(b-2) BRDS60
Applications manual

For BRFS/BRDS series

(c-1)BRFS40

(c-2)BRDS40

(d-1)BRFS100

(d-2)BRDS100

BRFS/BRDS 2-2
2.2 Automatic Mounting

To mount BRFS/BRDS series automatically, use the coil area near the center of the PCB as an adsorption point. Please see Fig.2.2.1 for details of the adsorption point.
2.3 Soldering

- Fig. 2.3.1 shows condition for reflow of BRFS/BRDS series. Please make sure that the temperature of pin shown in Fig. 2.3.2 do not exceed the temperatures shown in Fig. 2.3.1.
- While soldering, having vibration or impact on the unit should be avoided, because of solder melting.
- Please do not do the implementation except the reflow.
- Because some parts drops, please do not do reflow of the back side.

**Fig. 2.3.1**
Recommended reflow soldering condition

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1.0 - 5.0°C/s</td>
<td></td>
</tr>
<tr>
<td>A'</td>
<td>Ty1: 160 ±10°C</td>
<td>Ty2: 180 ±10°C</td>
</tr>
<tr>
<td></td>
<td>Ty1 - Ty2: 120s max</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>1.0 - 5.0°C/s</td>
<td></td>
</tr>
<tr>
<td>B'</td>
<td>Tp: Max 245°C 10s max</td>
<td>Tx: 220°C or more: 70s max</td>
</tr>
<tr>
<td>C</td>
<td>1.0 - 5.0°C/s</td>
<td></td>
</tr>
</tbody>
</table>

**Fig. 2.3.2**
Measurement point of temperature (bottom view)

(a) BRFS30/40, BRDS40
(b) BRFS50/50L/60, BRDS60
(c) BRFS100, BRDS100
2.4 Cleaning

- When cleaning is necessary, clean under the following conditions.
  - Method: Varnishing, ultrasonic wave and vapor
  - Cleaning agents: IPA (Solvent type)
  - Total time: 2 minutes or less
- Do not apply pressure to the lead and name plate with a brush or scratch it during the cleaning.
- After cleaning, dry them enough.

2.5 Storage

- To stock unpacked products in your inventory, it is recommended to keep them under controlled condition, 5-30°C, 60%RH and use them within a year.
- 24-hour baking is recommended at 125°C, if unpacked products were kept under uncontrolled condition, which is 30°C, 60%RH or higher.
  - Original reels are not heat-resistant. Please move them to heat resistant trays in preparation to bake.
  - To check moisture condition in the pack, Silica gel packet has some moisture condition indicator particles. Indicated blue means good. Pink means alarm to bake it.
- The reels will be deformed and the power supply might be damaged, if the vacuum pressure is too much to reseal.

2.6 Safety Consideration

- To apply for safety standard approval using this power supply, the following conditions must be met.
  - This unit must be used as a component of the end-use equipment.
  - Safety approved fuse must be externally installed on input side.
3. Connection method for standard use

3.1 Connection for standard use

- Connection to be as Fig.3.1.1 and Fig.3.1.2.

Fig.3.1.1
Connection for standard use of BRFS30/40

Fig.3.1.2
Other Model

- Short the following pins to turn on the power supply.
  GND ←→ RC, +VOUT ←→ +S, GND ←→ -S (-S: other model than BRFS30/40)
- Connect resistance to set the output voltage between TRM and GND.
- Between input and output is not isolated.
- The BRFS/BRDS series handle only the DC input.
  Avoid applying AC input directly.
  It will damaged the power supply.
3.2 Wiring input pin

(1) External fuse

■ Fuse is not built-in on input side. In order to protect the unit, install the normal-blow type fuse on input side.(Recommended fuse current shown by Table 3.2.1)
■ When the input voltage from a front end unit is supplied to multiple units, install the normal-blow type fuse in each unit.
■ When the fuse is open, power good signal is not outputted.
■ It is not necessary to use fuse if it can be protected by the overcurrent protection function of bus converter on the input side.

<table>
<thead>
<tr>
<th>No.</th>
<th>Model</th>
<th>Rated current</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>BRFS30/40, BRDS40</td>
<td>40A</td>
</tr>
<tr>
<td>2</td>
<td>BRFS50/50L</td>
<td>40A</td>
</tr>
<tr>
<td>3</td>
<td>BRFS60, BRDS60</td>
<td>60A</td>
</tr>
<tr>
<td>4</td>
<td>BRFS100, BRDS100</td>
<td>80A</td>
</tr>
</tbody>
</table>

(2) External capacitor on the input side

■ Install an external capacitor Ci, between +VIN and GND input pins for low line-noise and for stable operation of the power supply.

<table>
<thead>
<tr>
<th>No.</th>
<th>Model</th>
<th>Vin=5V</th>
<th>Vin=12V</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>BRFS30/40, BRDS40</td>
<td>8 × 22μF</td>
<td>4 × 22μF</td>
</tr>
<tr>
<td>2</td>
<td>BRFS50/50L</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>BRFS60, BRDS60</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>BRFS100, BRDS100</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

■ Ci is within 5mm for pins. Make sure that ripple current of Ci is less than its rating.
■ When an impedance and inductance level of the input line become higher, the input voltage may become unstable. In that case, the input voltage becomes stable by increasing Ci.

(3) Recommendation for noise-filter

■ Install an external input filter as shown in Fig.3.2.1 in order to reduce conducted noise. Ci is shown in Table 3.2.1
(4) Reverse input voltage protection

- Avoid the reverse polarity input voltage. It will damage the power supply.

It is possible to protect the unit from the reverse input voltage by installing an external diode as shown in Fig.3.2.2.
3.3 Wiring output pin

- When the BRFS/BRDS series supplies the pulse current for the pulse load, please install a capacitor Co between +VOUT and GND pins.

![Wiring external output capacitor](image)

**Table.3.3.1 Recommended Co and MAX Co**

<table>
<thead>
<tr>
<th>No.</th>
<th>Model</th>
<th>Recommend Co</th>
<th>Maximum Co</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>BRFS30/40,BRDS40</td>
<td>3 x 100µF</td>
<td>10,000µF</td>
</tr>
<tr>
<td>2</td>
<td>BRFS50/50L</td>
<td>2 x 100µF</td>
<td>10,000µF</td>
</tr>
<tr>
<td>3</td>
<td>BRFS60,BRDS60</td>
<td>2 x 100µF</td>
<td>10,000µF</td>
</tr>
<tr>
<td>4</td>
<td>BRFS100,BRDS100</td>
<td>4 x 100µF</td>
<td>20,000µF</td>
</tr>
</tbody>
</table>

- The output ripple voltage may grow big by resonance with Co and ESL of the wiring., if resonance frequency and switching frequency are close.
- Ripple and Ripple Noise are measured, as shown in Fig.3.3.2. Co1, Co2 and Co3 is shown in Table 3.3.2.

![Measuring method of Ripple and Ripple Noise](image)

**Table.3.3.2 Co1,Co2 and Co3 which is used in measuring**

<table>
<thead>
<tr>
<th>No.</th>
<th>Model</th>
<th>Co0</th>
<th>Co1</th>
<th>Co2</th>
<th>Co3</th>
<th>Co4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>BRFS30</td>
<td></td>
<td>100 µF</td>
<td>100 µF</td>
<td>100 µF</td>
<td>100 µF</td>
</tr>
<tr>
<td>2</td>
<td>BRFS40 · BRDS40</td>
<td>100 µF</td>
<td>-</td>
<td>100 µF</td>
<td>100 µF</td>
<td>100 µF</td>
</tr>
<tr>
<td>3</td>
<td>BRFS50/50L/60 · BRDS60</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>100 µF</td>
<td>100 µF</td>
</tr>
<tr>
<td>4</td>
<td>BRFS100 · BRDS100</td>
<td>100 µF</td>
<td>-</td>
<td>100 µF</td>
<td>100 µF</td>
<td>100 µF</td>
</tr>
</tbody>
</table>

BRFS/BRDS 3-4
The inductance reduction of output line, it can reduce the fluctuation of the power supply output voltage. Inductance must not be inserted. Lowering the inductance of the board pattern.

**Fig.3.3.3**
Output pattern Inductance

- +VOUT and GND are adjacent to each other between the layers of the multilayer board.

**Fig.3.3.4**
Inductance reduction of the multilayer board

- (a) Adjacent to the next layer
- (b) Adjacent in the same layer

For the avoidance of unstable operation by the output pattern inductance, recommended remote sensing the nearby load.

**Fig.3.3.5**
Remote sensing the nearby load
4. Overview

4.1 Efficiency

Fig 4.1.1
Efficiency (BRFS30) at 25°C

Vout = 0.8V

Vout = 1.0V

Vout = 1.2V

Vout = 1.8V

Vout = 2.5V

Vout = 3.3V
Fig 4.1.2
Efficiency
(BRFS40/BRDS40)
at 25°C

Vout = 0.6V

Vout = 1.0V

Vout = 1.2V

Vout = 1.8V

Vout = 2.0V
Fig 4.1.3
Efficiency (BRFS50) at 25°C
Fig 4.1.4
Efficiency
(BRFS60/BRDS60)
at 25°C

Vout = 0.7V

Vout = 1.0V

Vout = 1.2V

Vout = 1.8V

Vout = 2.0V
Fig 4.1.5
Efficiency
(BRFS100/BRDS100)
at 25°C

Vout = 0.7V

Vout = 1.0V

Vout = 1.2V

Vout = 1.8V

Vout = 2.0V

For BRFS/BRDS series

Applications manual
4.2 Dynamic Load Response

4.2.1 Wave Form

1) BRFS30

Vin 12V, Vout 1.2V, Cin 22μF x 4, Cout 4000μF

Testing Circuitry Fig.4.2.3.1

Fig.4.2.1.1 Dynamic Load Response

Load Current

Cycle 5 ms

Min. Load (0A) ←→ Load 50% (15A)

100 mV/div

100 μs/div

100 μs/div

Load 50% (15A) ←→ Load 100% (30A)

100 mV/div

100 μs/div

100 μs/div

BRFS/BRDS 4-6
For BRFS/BRDS series

2) BRFS40, BRDS40

Vin 12V, Vout 1.2V Cin 22μF × 4, Cout 4000μF
Testing Circuitry Fig 4.2.3.1

Fig 4.2.1.2 Dynamic Load Response
Cycle 5 ms Load Current

| t1, t2=50 μs |

Min. Load (0A) → Load 50% (20A)
100 mV/div 100 μs/div

Load 50% (20A) → Load 100% (40A)
100 mV/div 100 μs/div
For BRFS/BRDS series

3) BRFS50

Vin 12V, Vout 1.2V, Cin 22μF × 4, Cout 4000μF

Testing Circuitry  Fig.4.2.3.1

Cycle 5 ms

Load Current

Min. Load (0 A) ←→ Load 50% (25 A)

Load 100% (50 A)

Load 50% (25 A) ←→ Load 100% (50 A)

100 mV/div

100 μs/div

100 mV/div

100 μs/div

BRFS/BRDS 4-8
4) BRFS60, BRDS60

Vin 12V, Vout 1.2V, Cin 22μF × 4, Cout 4000μF
Testing Circuitry  Fig.4.2.3.1

Fig.4.2.1.4
Dynamic Load Response

Cycle 5 ms
Load Current

Min. Load (0A) ←→
Load 50% (30A)

100 mV/div
100 μs/div

Load 50% (30A) ←→
Load 100% (60A)

100 mV/div
100 μs/div

BRFS/BRDS 4-9
5) BRFS100, BRDS100

Vin 12V, Vout 1.2V, Cin 22µF × 4, Cout 8000µF

Testing Circuitry  Fig.4.2.3.1

Dynamic Load Response

Fig.4.2.1.5

Load Current

Cycle 5 ms

t1, t2 = 50 µs

100 mV/div

100 µs/div

Min. Load (0A) → Load 50% (50A)

Load 50% (50A) → Load 100% (100A)

100 mV/div

100 µs/div

Min. Load (0A) → Load 50% (50A)

Load 50% (50A) → Load 100% (100A)
4.2.2 Capacitance - Dynamic Load Response characteristics

1) BRFS30

Fig. 4.2.2.1
Capacitance - Dynamic Load Response characteristics (BRFS30)

\[ \Delta V = \Delta V_A (\Delta V_A > \Delta V_B) \]
or \[ \Delta V_B (\Delta V_A < \Delta V_B) \]

2) BRFS40, BRDS40

Fig. 4.2.2.2
Capacitance - Dynamic Load Response characteristics (BRFS40, BRDS40)

\[ \Delta V = \Delta V_A (\Delta V_A > \Delta V_B) \]
or \[ \Delta V_B (\Delta V_A < \Delta V_B) \]

Vin 12V, Cin 22\( \mu \)F \( \times \) 4, SR 1A/\( \mu \)s, Testing Circuitry Fig. 4.2.3.2

Applications manual
For BRFS/BRDS series
3) BRFS50

Fig 4.2.2.3
Capacitance -
Dynamic Load
Response
characteristics
(BRFS50)

\[ \Delta V = \Delta V_A (\Delta V_A > \Delta V_B) \]
\[ \text{or } \Delta V_B (\Delta V_A < \Delta V_B) \]

4) BRFS60/BRDS60

Fig 4.2.2.4
Capacitance -
Dynamic Load
Response
characteristics
(BRFS60/BRDS60)

\[ \Delta V = \Delta V_A (\Delta V_A > \Delta V_B) \]
\[ \text{or } \Delta V_B (\Delta V_A < \Delta V_B) \]
Fig. 4.2.5. Capacitance - Dynamic Load Response characteristics (BRFS100/BRDS100)

\[ \Delta V = \Delta V_A (\Delta V_A > \Delta V_B) \]

or

\[ \Delta V_B (\Delta V_A < \Delta V_B) \]

- 0-50% Vout=0.7V
- 0-50% Vout=1.2V
- 0-50% Vout=2.0V

- 0-80% Vout=0.7V
- 0-80% Vout=1.2V
- 0-80% Vout=2.0V
For BRFS/BRDS series

4.2.3 Figure

Fig. 4.2.3.1
Measuring method of Dynamic Load Response

Fig. 4.2.3.2
Measuring method of Dynamic Load Response

No. | Model         | L     | Cout
---|---------------|-------|-------
1  | BRFS30        | 10mm  | 4,000µF
2  | BRFS40/BRDS40 | 10mm  | 4,000µF
3  | BRFS50        | 50mm  | 4,000µF
4  | BRFS60/BRDS60 | 50mm  | 4,000µF
5  | BRFS100/BRDS100 | 50mm | 8,000µF

No. | Model         | Cout
---|---------------|-------
1  | BRFS30        | 300µF ~ 4,000µF
2  | BRFS40/BRDS40 | 300µF ~ 4,000µF
3  | BRFS50        | 200µF ~ 4,000µF
4  | BRFS60/BRDS60 | 200µF ~ 4,000µF
5  | BRFS100/BRDS100 | 400µF ~ 8,000µF
4.3 Ripple Voltage

Fig.4.3.1
Ripple Voltage
of BRFS/BRDS

Vin 12V
Vout 1.2V
Load Current 30A
Cin 22μF x 4
Cout 100μF x 3
(Cout=Co2,Co3,Co4)

(a) BRFS30

Vin 12V
Vout 1.2V
Load Current 40A
Cin 22μF x 4
Cout 100μF x 4
(Cout=Co0,Co2,Co3,Co4)

(b) BRFS40/BRDS40

Vin 12V
Vout 1.2V
Load Current 50A
Cin 22μF x 4
Cout 100μF x 2
(Cout=Co3,Co4)

(c) BRFS50

Vin 12V
Vout 1.2V
Load Current 60A
Cin 22μF x 4
Cout 100μF x 2
(Cout=Co3,Co4)

(d) BRFS60/BRDS60
Fig. 4.3.2 Measuring method of Ripple Voltage

Vin 12V
Vout 1.2V
Load Current 100A
Cin 22 µF × 4
Cout 100 µF × 4
(Cout = Co1, Co2, Co3, Co4)

(e) BRFS100/BRDS100

<table>
<thead>
<tr>
<th>No.</th>
<th>Model</th>
<th>Co0</th>
<th>Co1</th>
<th>Co2</th>
<th>Co3</th>
<th>Co4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>BRFS30</td>
<td></td>
<td></td>
<td>100 µF</td>
<td>100 µF</td>
<td>100 µF</td>
</tr>
<tr>
<td>2</td>
<td>BRFS40, BRDS40</td>
<td>100 µF</td>
<td></td>
<td>100 µF</td>
<td>100 µF</td>
<td>100 µF</td>
</tr>
<tr>
<td>3</td>
<td>BRFS50/50L/60, BRDS60</td>
<td></td>
<td></td>
<td></td>
<td>100 µF</td>
<td>100 µF</td>
</tr>
<tr>
<td>4</td>
<td>BRFS100, BRDS100</td>
<td></td>
<td>100 µF</td>
<td></td>
<td>100 µF</td>
<td>100 µF</td>
</tr>
</tbody>
</table>

BRFS/BRDS 4-16
4.4 Rise time

Vin : 12V, Load current: 0A, Cin: 22uFx4

Fig. 4.4.1
BRFS30
Cout: 300uF

Rise time: 1.0ms
(a) Vout : 0.8V

Rise time: 5.5ms
(b) Vout : 3.63V

Fig. 4.4.2
BRFS40, BRDS40
Cout: 300uF

Rise time: 1.0ms
(a) Vout : 0.6V

Rise time: 3.0ms
(b) Vout : 2.0V

Fig. 4.4.3
BRFS50
Cout: 200uF

Rise time: 1.0ms
(a) Vout : 0.7V

Rise time: 3.0ms
(b) Vout : 2.0V

Fig. 4.4.4
BRFS60, BRDS60
Cout: 200uF

Rise time: 1.0ms
(a) Vout : 0.7V

Rise time: 3.0ms
(b) Vout : 2.0V
For BRFS/BRDS series

Fig. 4.4.5
BRFS100, BRDS100
Cout: 400uF

200mV/div

1V/div

5ms/div

Rise time: 1.0ms
(a) Vout : 0.7V

Rise time: 3.0ms
(b) Vout : 2.0V
4.5 Derating

- Make sure the temperatures measurement locations shown from Fig.4.5.2 and Fig.4.5.3 below are on or under the derating curve in Fig.4.5.1. Ambient temperature must be kept at 85°C or under.
Fig. 4.5.5 ~ 4.5.10 show the derating curve in the condition that is measured as shown in Fig.4.5.4. Verify final design by actual temperature measurement. The temperature measurement location as shown in Fig.4.5.2 and Fig.4.5.3 must keep below 120℃.

**For BRFS/BRDS series**
Fig. 4.5.7
Derating curve for BRFS30 at 12Vin 3.3Vout

Fig. 4.5.8
Derating curve for BRFS50 at 12Vin 0.7Vout

Fig. 4.5.9
Derating curve for BRFS50 at 12Vin 1.2Vout

Fig. 4.5.10
Derating curve for BRFS50 at 12Vin 2.0Vout

Applications manual For BRFS/BRDS series
Fig. 4.5.8
Derating curve for BRFS60/BRDS60 at 12Vin 0.7Vout

Fig. 4.5.9
Derating curve for BRFS60/BRDS60 at 12Vin 1.2Vout

Fig. 4.5.10
Derating curve for BRFS60/BRDS60 at 12Vin 2.0Vout
Fig. 4.5.8
Derating curve for BRFS100/BRDS100 at 12Vin 0.7Vout

Fig. 4.5.9
Derating curve for BRFS100/BRDS100 at 12Vin 1.2Vout

Fig. 4.5.10
Derating curve for BRFS100/BRDS100 at 12Vin 2.0Vout

Applications manual
For BRFS/BRDS series
4.6 Thermal simulation model

We offer a thermal simulation model that can be used for thermal design. It shows the simulation model and the simulation example of BRFS30 and BRFS50 below. These models will enable thermal design on simulation using ANSYS icepack. Please contact our customer support for more information or request of the simulation model.

![Fig.4.6.1 Thermal simulation model](image)

(a) BRFS30 model  
(b) BRFS50 model

![Fig.4.6.2 Simulation example (BRFS50)](image)

(a) Simulation(BRFS50)  
(b) Actual measurement(BRFS50)
Output voltage is adjustable by the external resistor.

- The temperature coefficient could become worse, depending on the type of a resistor.
  - Resistor: Metal film type, coefficient of less than ±100 ppm/°C
- When TRM is opened, output voltage is the minimum.
- \( R_{\text{TRM}} \) is calculated in the following expressions.

\[
R_{\text{TRM}} = \frac{8}{VOUT - 0.8} \, [k\Omega] \\
R_{\text{TRM}} = \frac{12}{VOUT - 0.6} \, [k\Omega] \\
R_{\text{TRM}} = \frac{14}{VOUT - 0.7} \, [k\Omega]
\]

(a) BRFS30

(b) BRFS40/BRDS40

(c) Other models

Table 5.1.1
Calculation result

<table>
<thead>
<tr>
<th>No</th>
<th>VOUT</th>
<th>( R_{\text{TRM}} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.8</td>
<td>OPEN</td>
</tr>
<tr>
<td>2</td>
<td>1.0</td>
<td>40.0kΩ</td>
</tr>
<tr>
<td>3</td>
<td>1.2</td>
<td>20.0kΩ</td>
</tr>
<tr>
<td>4</td>
<td>1.5</td>
<td>11.429kΩ</td>
</tr>
<tr>
<td>5</td>
<td>1.8</td>
<td>8.0kΩ</td>
</tr>
<tr>
<td>6</td>
<td>2.5</td>
<td>4.706kΩ</td>
</tr>
<tr>
<td>7</td>
<td>3.3</td>
<td>3.2kΩ</td>
</tr>
</tbody>
</table>

Table 5.1.2
Calculation result

<table>
<thead>
<tr>
<th>No</th>
<th>VOUT</th>
<th>( R_{\text{TRM}} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.7</td>
<td>OPEN</td>
</tr>
<tr>
<td>2</td>
<td>1.0</td>
<td>46.6kΩ</td>
</tr>
<tr>
<td>3</td>
<td>1.2</td>
<td>28kΩ</td>
</tr>
<tr>
<td>4</td>
<td>1.5</td>
<td>17.5kΩ</td>
</tr>
<tr>
<td>5</td>
<td>1.8</td>
<td>13.3kΩ</td>
</tr>
<tr>
<td>6</td>
<td>2.5</td>
<td>10.0kΩ</td>
</tr>
</tbody>
</table>

Table 5.1.3
Calculation result

<table>
<thead>
<tr>
<th>No</th>
<th>VOUT</th>
<th>( R_{\text{TRM}} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.6</td>
<td>OPEN</td>
</tr>
<tr>
<td>2</td>
<td>1.0</td>
<td>30.0kΩ</td>
</tr>
<tr>
<td>3</td>
<td>1.2</td>
<td>20.0kΩ</td>
</tr>
<tr>
<td>4</td>
<td>1.5</td>
<td>13.3kΩ</td>
</tr>
<tr>
<td>5</td>
<td>1.8</td>
<td>10.0kΩ</td>
</tr>
</tbody>
</table>

Fig. 5.1.1
Connecting

(a) BRFS30

(b) BRFS40/BRDS40

(c) Other models
6. Protect circuit

6.1 Overcurrent Protection

- Over Current Protection (OCP) is built-in and works at 105% of the rated current or higher. However, use in an overcurrent situation must be avoided whenever possible. The output voltage of the power module will recover automatically when the fault causing overcurrent is corrected.

When the output voltage drops after OCP works, the power module enters a "hiccup mode" where it repeatedly turns on and off at a certain frequency (1.2 sec typ).

6.2 Thermal protection

- When the power supply temperature is kept above 120℃, the thermal protection will be activated and simultaneously shut down the output. The output voltage of the power supply will recover automatically when the unit is cool down.
The remote ON/OFF function is incorporated in the input circuitry and operated with RC and \(-Vin\). If positive logic control is required, order the power supply with \("-R"\) option.

- When remote on/off function is not used, please short GND and RC.

### Table 7.1.1

<table>
<thead>
<tr>
<th></th>
<th>ON/OFF logic</th>
<th>Between RC and GND</th>
<th>Output voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard</td>
<td>Negative</td>
<td>L level (-0.2 - 0.6V) or short</td>
<td>ON</td>
</tr>
<tr>
<td></td>
<td></td>
<td>H level (3.0 - VIN) or open</td>
<td>OFF</td>
</tr>
<tr>
<td>Optional (&quot;-R)</td>
<td>Positive</td>
<td>L level (-0.2 - 0.6V) or short</td>
<td>OFF</td>
</tr>
<tr>
<td></td>
<td></td>
<td>H level (3.0 - VIN) or open</td>
<td>ON</td>
</tr>
</tbody>
</table>

*Source current from RC pin is 0.5mA(max).*
8. Remote sensing

8.1 When the remote sensing function is not in use

- When the remote sensing function is not in use, it is necessary to confirm that pins are shorted between +S and +VOUT, and between -S and GND.
- Wire between +S and +VOUT, and between -S and GND as short as possible.
  Loop wiring should be avoided.
  This power supply might become unstable by the noise coming from poor wiring.

8.2 When the remote sensing function is in use

- Twisted-pair wire or shield wire should be used for sensing wire.
- Thick wire should be used for wiring between the power supply and a load.
  Line drop should be less than 0.5V.
  Voltage between +VOUT and GND should remain within the output voltage adjustment range.
- If the sensing patterns are short, heavy-current is drawn and the pattern may be damaged.
  The pattern disconnection can be prevented by installing the protection parts as close as possible to a load.
9. Power Good

- Power Good is built-in, internal circuitry as shown in Fig. 9.1.1.
- Power Good pin becomes low state (0.3V max), when output becomes condition such as overcurrent or output voltage ±12.5%(Typ) outside the set point value.
- The sink current of Power Good pin is 10mA max.

![Internal circuitry of PGOOD](image)

- When the input voltage is less than the start-up voltage, Power Good pin voltage is undefined.
- The voltage of Power Good is shown in Fig. 9.1.2.
- Power Good cannot be used in the area of undefined.

![Voltage of PGOOD](image)

![BRFS30-I](image)  
**Fig. 9.1.3**  
**BRFS30-I**  
PGOOD  
**RC (2V/div)**  
**Vin**: 12V  
**t0**: 12ms (Max)  
**Vout**: 3.63V  
**load current**: 0A  
**Cin**: 22uF x4  
**Cout**: 300uF

![BRFS50](image)  
**Fig. 9.1.4**  
**BRFS50**  
PGOOD  
**RC (2V/div)**  
**Vin**: 12V  
**t0**: 9ms (Max)  
**Vout**: 2.0V  
**load current**: 0A  
**Cin**: 22uF x4  
**Cout**: 200uF

BRFS/BRDS 9-1
10. Series operation / Parallel operation

10.1 Series operation

- Series operation is not possible.

10.2 Parallel operation

1) The basic note
- Parallel operation is impossible BRFS30, BRFS40*1.
  *1 BRFS40-P can be parallel operation.
- Parallel operation is impossible different series.
- Total number of units should be no more than 5 pieces.
- Rating output current at parallel operation
  \[ \text{Rating output current} = \text{Rating current per unit} \times \text{number of unit} \times 0.9 \]

2) Wiring
- The wiring of the parallel operation in Fig 10.2.1.
- TRM terminal of slave should be connect to GND (100Ω or less).
- Sensing terminal of the slave to open.
- Connect all SHARE terminal.
- When controlling the rise time by SEQ is possible to connect all SEQ pin.
- RC terminal of the slave to connected GND or connect to the master of the RC terminal.
- Input power should be supplied from the same power supply.
- BRFS40-P and BRDS40 is required inductance of more than 0.1uH to the Vin line.

Fig. 10.2.1
Example of wiring method in parallel operation
3) Patterning of the PCB

- Input and output pattern should be the same width and length.
- Voltage drop from the output terminal to remote sensing point must be less than 0.2V.
- ESR from the slave of the output terminal to remote sensing point must be 10mΩ or less
- Parallel operation should be separated Vin line of each BRxS (Fig 10.2.2)
- The beat noise reduction of parallel operation, it is effective to put the input CH (Fig 10.2.3)

---

**Fig. 10.2.2**
Patterning of the PCB

(a) BRxS40

(b) Other models

**Fig. 10.2.3**
Beat noise reduction

- Separate Vin pattern
- Connected Vin pattern

- Must be 0.1uH pattern or parts
- Recommended
- Deprecated

---

BRFS/BRDS 10-2
11. Sequence

- The adjustment of the rise time is possible by connecting $C_{SEQ}$.

Fig.11.1.1
Example of soft start circuitry

- When the voltage is applied to the terminal SEQ, the output voltage tracks this voltage until the output reaches the set-point voltage.

SEQ terminal voltage vs output voltage is calculated by the following formula.

$$C_{SEQ} [\mu F] = \frac{0.284}{V_o [V]} - 0.06 \times T [ms]$$

(Vo min $\leq$ Vo $\leq$ 2.0V)

Vo min : 0.6V (only BRxS40) or 0.7V

$$C_{SEQ} [\mu F] = \frac{0.284}{V_o [V]} - 0.047 \times T [ms]$$

(2.0 $< V_o \leq$ 3.63V only BRFS30)

Avoid SEQ terminal voltage is set below the set voltage output by Rtrim, the output voltage does not rise to set output voltage. Maximum applicable voltage of terminal SEQ is Vin. When the function is not used, open terminal SEQ.

Fig.11.1.2
SEQ > Vout setting

Fig.11.1.3
SEQ < Vout setting
(not recommended)
With the voltage to input into SEQ pin, you can control a start sequence of plural BRFS/BRDS.

Fig. 11.1.4  
Example of sequence control

(a) The same
(b) The same voltage
(c) The time lag

If this function is unnecessary, please make SEQ pin open.
12. Package Information

- Please refer to Fig.12.1.1 ~ Fig.12.1.3 for Package form (Reel).
- The packed number is shown in Table 12.

<table>
<thead>
<tr>
<th>Model</th>
<th>Capacity of reel</th>
</tr>
</thead>
<tbody>
<tr>
<td>BRFS30/40, BRDS40</td>
<td>200 pcs</td>
</tr>
<tr>
<td>BRFS50/50L/60, BRDS60</td>
<td>100 pcs</td>
</tr>
<tr>
<td>BRFS100, BRDS100</td>
<td>80 pcs</td>
</tr>
</tbody>
</table>

For BRFS/BRDS series
For BRFS/BRDS series

Fig 12.1.3
Taping dimensions of BRFS100/BRDS100

Fig 12.1.3
Reel dimensions of BRFS/BRDS

<table>
<thead>
<tr>
<th>No.</th>
<th>Model</th>
<th>Tape Width[mm]</th>
<th>Hub Diameter</th>
<th>W1[mm]</th>
<th>W2[mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>BRFS30/40,BRDS40</td>
<td>56</td>
<td>100</td>
<td>57.4±1.0</td>
<td>61.4±1.0</td>
</tr>
<tr>
<td>2</td>
<td>BRFS50/50L/60,BRDS60</td>
<td>56</td>
<td>150</td>
<td>57.5±1.0</td>
<td>61.5±1.0</td>
</tr>
<tr>
<td>3</td>
<td>BRFS100,BRDS100</td>
<td>56</td>
<td>150</td>
<td>57.5±1.0</td>
<td>61.5±1.0</td>
</tr>
</tbody>
</table>
# CHS series and BR series

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
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<td>CHS and BR 1-1</td>
</tr>
<tr>
<td>2. Applications data</td>
<td>CHS and BR 2-1</td>
</tr>
<tr>
<td>2.1 Startup Sequence</td>
<td>CHS and BR 2-1</td>
</tr>
<tr>
<td>2.2 Efficiency of the combination of CHS and BR</td>
<td>CHS and BR 2-2</td>
</tr>
<tr>
<td>2.3 Dynamic Input Response</td>
<td>CHS and BR 2-4</td>
</tr>
</tbody>
</table>
For CHS series and BR series

1. Power Supply of Cosel for Intermediate Bus Architecture

**Fig. 1.1.1**
Intermediate Bus Architecture

**Bus Converter**
- 48V

**Point of load**
- 12V
- 12V
- 3.3V
- 1.0V

**Core**
- FPGA
- Io
- optical module

**CHS series**
- CHS80
  - CHS80483R3
  - CHS804805
  - CHS804812
- CHS200
  - CHS200483R3
  - CHS2004805
  - CHS2004812
- CHS300
  - CHS3004810
  - CHS3004812
  - CHS3004812H
- CHS400/500
  - CHS4004810
  - CHS4004812
  - CHS4004812H
  - CHS5004812

**BR series**
- BRNS6/12/20
- BRFS30
- BRFS40/BRDS40
- BRFS50/50L/60, BRDS60
- BRFS100/BRDS100
2. Applications data

2.1 Startup Sequence

2.1.1 CHS4004812 and BRNS20

![Graphical representation of Startup Sequence of CHS4004812 and BRNS20 with waveforms for different load conditions](image)

2.1.2 CHS4004812 and BRFS50

![Graphical representation of Startup Sequence of CHS4004812 and BRFS50 with waveforms for different load conditions](image)

2.1.3 Measuring method of Startup Sequence

![Circuit diagram for Startup Sequence measurement](image)

<table>
<thead>
<tr>
<th>No.</th>
<th>Model</th>
<th>C1</th>
<th>C2</th>
<th>C3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CHS4004812 and BRNS20</td>
<td>100uFx3</td>
<td>22uFx3</td>
<td>100uFx2</td>
</tr>
<tr>
<td>2</td>
<td>CHS4004812 and BRFS50</td>
<td>100uFx3</td>
<td>22uFx4</td>
<td>100uFx2</td>
</tr>
</tbody>
</table>
2.2 Efficiency of the combination of CHS and BR

- When used in a 10V bus voltage, the efficiency of the device is higher than the bus voltage 12V.
- When using CHS300/4004812H, the efficiency of the device is higher than using CHS300/4004812.

![Test circuitry](image)

![Figure 2.2.2](image)

The efficiency of a combination of CHS and BR at 25°C

<table>
<thead>
<tr>
<th>Load Current [A]</th>
<th>Efficiency [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>78</td>
</tr>
<tr>
<td>20</td>
<td>80</td>
</tr>
<tr>
<td>40</td>
<td>82</td>
</tr>
<tr>
<td>60</td>
<td>84</td>
</tr>
<tr>
<td>80</td>
<td>86</td>
</tr>
<tr>
<td>100</td>
<td>88</td>
</tr>
</tbody>
</table>

(a) Efficiency (CHS300 + BRNS20 x 4)
CHS300 Vin=48V, BRNS20 Vo=1.2V

(b) Efficiency (CHS400 + BRNS20 x 4)
CHS400 Vin=48V, BRNS20 Vo=1.2V

(c) Efficiency (CHS300 + BRFS50 x 4)
CHS300 Vin=48V, BRFS50 Vo=1.2V

(d) Efficiency (CHS400 + BRFS50 x 4)
CHS400 Vin=48V, BRNS20 Vo=1.2V
For CHS series and BR series

Fig. 2.2.3
The efficiency of CHS300/400 at 25°C

Fig. 2.2.4
The efficiency of BRNS20/BRFS50 at 25°C

Remarks:
For CHS300/400 the output voltage adjustment range becomes as shown in Fig. 2.2.5 When input voltage is 36-44VDC.

Fig. 2.2.5
CHS300/400 Input voltage derating

CHS and BR 2-3
2.3 Dynamic Input Response

2.3.1 CHS4004812 and BRNS20

(a) Dynamic Input Response
Load 25% (8.25 A) → Load 75% (24.75 A) / 50 us

(b) Dynamic Input Response
Load 75% (24.75 A) → Load 25% (8.25 A) / 50 us

2.3.2 CHS4004812 and BRFS50

(a) Dynamic Input Response
Load 25% (8.25 A) → Load 75% (24.75 A) / 50 us

(b) Dynamic Input Response
Load 75% (24.75 A) → Load 25% (8.25 A) / 50 us

Fig.2.3.3
Measuring method of Dynamic Input Response

For CHS series and BR series