

# FRH100-00

## DC-DC Converter Input Filter

Bel Power Solutions FRH100-00 Input Filter helps control EMC immunity and emission in board-level DC-DC converter applications, minimizing the conducted and radiated emissions generated by switch mode DC-DC converters.

The FRH100-00 allows board designs utilizing DC-DC converters to meet stringent EMC requirements according to railway industry standards.



### Key Features & Benefits

- Ultra-Wide input voltage range: 14 -160 VDC
- Maximum operating current 8 A
- Operating ambient temperature range -40 °C to +105 °C
- Small footprint
- Meet IEC/EN 61000-4 series standards and CISPR16 / EN 55032
- Meet railway industry EN 50155 / EN 50121-3-2 and AREMA standards



### Applications

- Railway related equipment

## 1. MODEL SELECTION

| PART NUMBER | INPUT VOLTAGE RANGE [VDC] | RATED CURRENT [A] |
|-------------|---------------------------|-------------------|
| FRH100-00   | 14 – 160                  | 8                 |

## 2. INPUT SPECIFICATIONS

| PARAMETER           | DESCRIPTION / CONDITIONS    | MIN. | TYP. | MAX. | UNIT |
|---------------------|-----------------------------|------|------|------|------|
| Input Voltage Range | Operating temperature range | 14   | 110  | 160  | VDC  |

## 3. OUTPUT SPECIFICATIONS

| PARAMETER                      | DESCRIPTION / CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|--------------------------------|--------------------------|------|------|------|------|
| Efficiency                     | 25 °C, 24 VDC @ 100 W    | 96   | 98   | –    | %    |
| Operating Current <sup>1</sup> |                          | –    | –    | 8    | A    |
| Transient Maximum Current      | 10 s                     | –    | –    | 10   | A    |

<sup>1</sup> For operating current please refer to temperature derating curves.

## 4. GENERAL SPECIFICATIONS

| PARAMETER             | DESCRIPTION / CONDITIONS                                                                 | MIN. | TYP. | MAX. | UNIT |
|-----------------------|------------------------------------------------------------------------------------------|------|------|------|------|
| Operating Temperature |                                                                                          | -40  | –    | 105  | °C   |
| Storage Temperature   |                                                                                          | -55  | –    | 125  | °C   |
| Storage Humidity      |                                                                                          | 5    | –    | 95   | %RH  |
| Withstand voltage     | +Vin~ ⊕, -Vin~ ⊕, electric strength test for 1 minute with a leakage current of 5 mA max | 2100 | –    | –    | VAC  |
| MTBF                  | MIL-HDBK-217F @ 25 °C                                                                    | 1000 | –    | –    | kh   |

## 5. MECHANICAL SPECIFICATIONS

| PARAMETER     | DESCRIPTION                                                  |
|---------------|--------------------------------------------------------------|
| Case Material | Black plastic; flame-retardant and heat-resistant (UL94 V-0) |
| Dimension     | 67.0 x 37.0 x 19.8 mm                                        |
| Weight        | 100 g (Typ.)                                                 |

## 6. ELECTROMAGNETIC COMPATIBILITY (EN50121-3-2)

| PARAMETER             | DESCRIPTION |                                                                                                                                                                                                                                                                                                                     | CLASS / CRITERIA |
|-----------------------|-------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|
| Emission <sup>1</sup> | CE          | EN 55016-2-1<br>150 kHz – 500 kHz; 79 dBuV (see Fig. 3 for recommended circuit)<br>500 kHz – 30 MHz; 73 dBuV (see Fig. 3 for recommended circuit)                                                                                                                                                                   |                  |
|                       | RE          | CISPR16-2-3<br>30 MHz – 230 MHz; 40 dBuV/m at 10 m (see Fig. 3 for recommended circuit)<br>230 MHz – 6 GHz; 47 dBuV/m at 10 m (see Fig. 3 for recommended circuit)                                                                                                                                                  |                  |
| Immunity              | ESD         | EN 61000-4-2<br>Contact $\pm 6$ kV/Air $\pm 8$ kV                                                                                                                                                                                                                                                                   | perf. Criteria A |
|                       | RS          | EN 61000-4-3<br>80 – 800 MHz; 20 V/m<br>800 – 1000 MHz; 20 V/m<br>1400 – 2000 MHz; 10 V/m<br>2000 – 2700 MHz; 5 V/m<br>5100 – 6000 MHz; 3 V/m                                                                                                                                                                       | perf. Criteria A |
|                       | EFT         | EN 61000-4-4<br>$\pm 2$ kV; 5/50 ns; 5 kHz (see Fig. 3 for recommended circuit)                                                                                                                                                                                                                                     | perf. Criteria A |
|                       | Surge       | EN 61000-4-5<br>Line to line $\pm 1$ kV (42 $\Omega$ , 0.5 $\mu$ F), line to ground $\pm 2$ kV (42 $\Omega$ , 0.5 $\mu$ F)<br>(see Fig. 3 for recommended circuit)<br>Line to line $\pm 1$ kV (2 $\Omega$ , 18 $\mu$ F) line to ground $\pm 2$ kV (12 $\Omega$ , 9 $\mu$ F)<br>(see Fig. 3 for recommended circuit) | perf. Criteria A |
|                       | CS          | EN 61000-4-6<br>0.15 MHz – 80 MHz 10 V r.m.s                                                                                                                                                                                                                                                                        | perf. Criteria A |

<sup>1</sup> Corresponds or exceeds EN 50121-3-2

## 7. ELECTROMAGNETIC COMPATIBILITY (AREMA)

| PARAMETER | DESCRIPTION |                                                                                                                                                                        | CLASS / CRITERIA |
|-----------|-------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|
| Emissions | CE          | CISPR16-2-1<br>150 kHz – 500 kHz; 79 dBuV (see Fig. 3 for recommended circuit)<br>CISPR16-1-2<br>500 kHz – 30 MHz; 73 dBuV (see Fig. 3 for recommended circuit)        | CLASS A          |
|           | RE          | CISPR16-2-3<br>30 MHz – 230 MHz; 40 dBuV/m at 10 m (see Fig. 3 for recommended circuit)<br>230 MHz – 1 GHz; 47 dBuV/m at 10 m (see Fig. 3 for recommended circuit)     | CLASS A          |
| Immunity  | ESD         | IEC 61000-4-2<br>Contact $\pm 6$ kV/Air $\pm 8$ kV                                                                                                                     | perf. Criteria A |
|           | RS          | IEC 61000-4-3<br>80 – 1000 MHz; 10 V/m<br>160 – 165 MHz; 20 V/m<br>450 – 470 MHz; 20 V/m<br>800 – 960 MHz; 20 V/m<br>1400 – 2000 MHz; 20 V/m<br>2100 – 2500 MHz; 5 V/m | perf. Criteria A |
|           | EFT         | IEC 61000-4-4<br>$\pm 2$ kV 5/50 ns; 5 kHz (see Fig. 3 for recommended circuit)                                                                                        | perf. Criteria A |
|           | Surge       | IEC 61000-4-5<br>Line to line $\pm 2$ kV (2 $\Omega$ , 18 $\mu$ F); line to ground $\pm 2$ kV (2 $\Omega$ , 18 $\mu$ F)<br>(see Fig. 3 for recommended circuit)        | perf. Criteria A |
|           | CS          | IEC 61000-4-6<br>0.15 MHz-80 MHz; 10 V r.m.s                                                                                                                           | perf. Criteria A |
|           | MS          | IEC 61000-4-8<br>60 Hz; 100 A/m (see Fig. 3 for recommended circuit)<br>IEC 61000-4-8<br>60 Hz; 300 A/m (see Fig. 3 for recommended circuit)                           | perf. Criteria A |

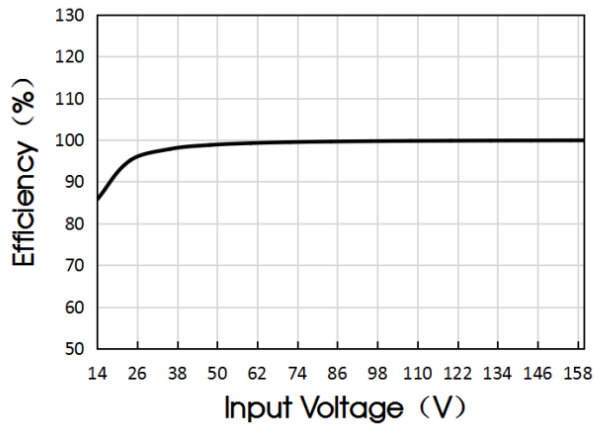


Figure 1. Efficiency vs. Input Voltage (Full Load)

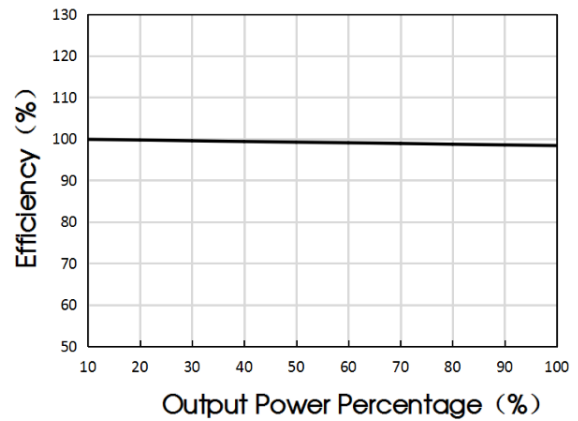


Figure 2. Efficiency vs. Output Load (Vin = 110 V)

#### Notes:

1. Test conditions of Efficiency vs Input Voltage curve: output power 100 W, input voltage range 14 -160 VDC;
2. Test conditions of Efficiency vs Output load curve: input voltage 110 VDC, output power 20 - 100 W.

## 8. DESIGN REFERENCE

### TYPICAL APPLICATION

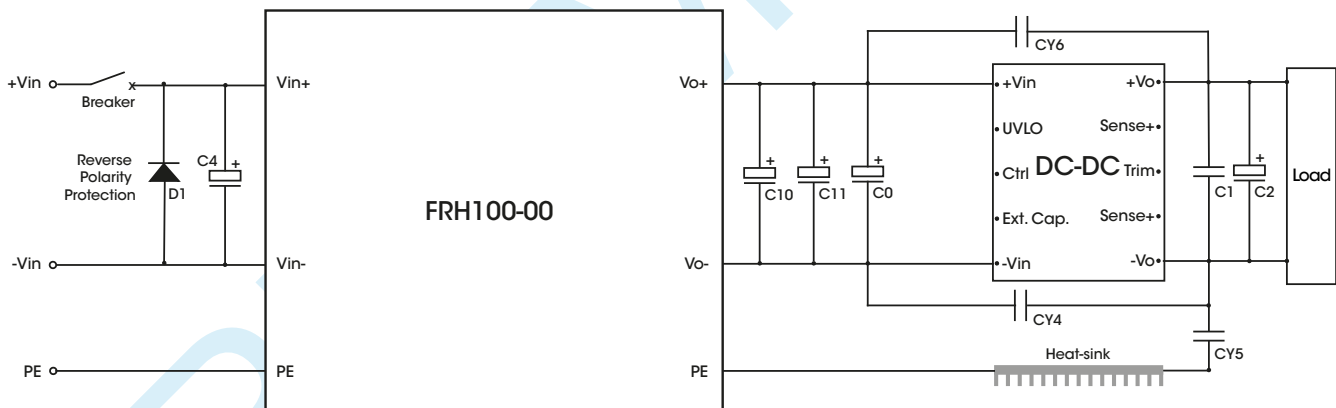


Figure 3. Typical Application

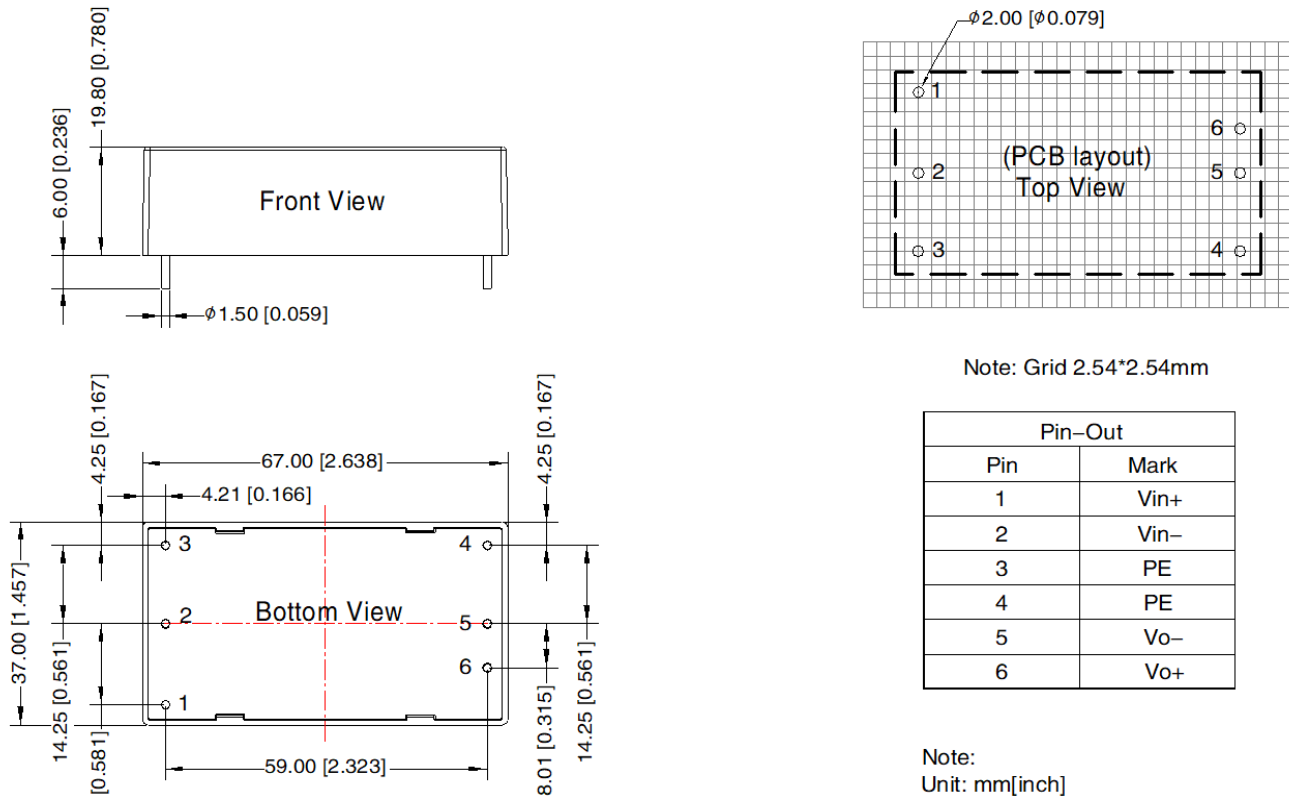
| COMPONENTS      | VALUE       | RECOMMENDED COMPONENT                                                                                        |
|-----------------|-------------|--------------------------------------------------------------------------------------------------------------|
| C1              | 1 $\mu$ F   | CERAMIC; 1 $\mu$ F; 10%; 100 V; X7R; 1206; -55 to +125°C                                                     |
| C2              | 330 $\mu$ F | ELECTROLYTIC; Al,WET; RADIAL; 330 $\mu$ F; 20%; 63 V; $\varnothing$ 10 x 20 mm; PITCH 5 mm; -40 to +105°C    |
| C4              | 330 $\mu$ F | ELECTROLYTIC; Al,WET; RADIAL; 330 $\mu$ F; 20%; 200 V; $\varnothing$ 18 x 30 mm; PITCH 7.5 mm; -40 to +105°C |
| CY4             | 1 nF        | CERAMIC; X1/Y1; 1 nF; 10%; 400 V; PITCH 10 mm; -40 to +125°C                                                 |
| CY5, CY6        | 2.2 nF      | CERAMIC; X1/Y1; 2.2 nF; 10%; 400 V; PITCH 10 mm; -40 to +125°C                                               |
| D1              | 20 A        | SCHOTTKY; DUAL; 200 V; 2x 20 A; Vf 0.95 V; TO220; -55 to +150°C; COMMON CATHODE                              |
| Fuse or Breaker | 15 A        | Type C                                                                                                       |

<sup>1</sup> Type of fuse / circuit breaker can be selected according to the actual application. The specification value must be greater than the maximum input working current and less than the rated working current of the anti-reverse polarity diode.

| SURGE STANDARD                                                                                               | COMPONENTS   | VALUE       | RECOMMENDED COMPONENT                                                                                        |
|--------------------------------------------------------------------------------------------------------------|--------------|-------------|--------------------------------------------------------------------------------------------------------------|
| line to line $\pm$ 1 kV (42 $\Omega$ , 0.5 $\mu$ F)<br>line to ground $\pm$ 2 kV (42 $\Omega$ , 0.5 $\mu$ F) | C0           | 100 $\mu$ F | ELECTROLYTIC; Al,WET; RADIAL; 100 $\mu$ F; 20%; 250 V; $\varnothing$ 16 x 20 mm; PITCH 7.5 mm; -40 to +105°C |
|                                                                                                              | C10, C11     | —           | —                                                                                                            |
| line to line $\pm$ 1 kV (2 $\Omega$ , 18 $\mu$ F)<br>line to ground $\pm$ 2 kV (12 $\Omega$ , 9 $\mu$ F)     | C0, C10      | 100 $\mu$ F | ELECTROLYTIC; Al,WET; RADIAL; 100 $\mu$ F; 20%; 250 V; $\varnothing$ 16 x 20 mm; PITCH 7.5 mm; -40 to +105°C |
|                                                                                                              | C11          | —           | —                                                                                                            |
| line to line $\pm$ 2 kV (2 $\Omega$ , 18 $\mu$ F)<br>line to ground $\pm$ 2 kV (2 $\Omega$ , 18 $\mu$ F)     | C0, C10, C11 | 100 $\mu$ F | ELECTROLYTIC; Al,WET; RADIAL; 100 $\mu$ F; 20%; 250 V; $\varnothing$ 16 x 20 mm; PITCH 7.5 mm; -40 to +105°C |



## 9. MECHANICAL SPECIFICATIONS



Note: Grid 2.54\*2.54mm

| Pin-Out |      |
|---------|------|
| Pin     | Mark |
| 1       | Vin+ |
| 2       | Vin- |
| 3       | PE   |
| 4       | PE   |
| 5       | Vo-  |
| 6       | Vo+  |

Note:

Unit: mm[inch]

Pin diameter tolerances:  $\pm 0.10$  [  $\pm 0.004$  ]

Pin tolerances(H):  $\pm 0.50$  [  $\pm 0.020$  ]

General tolerances:  $\pm 0.50$  [  $\pm 0.020$  ]

Figure 4. Mechanical drawing

For more information on these products consult: [tech.support@psbel.com](mailto:tech.support@psbel.com)

**NUCLEAR AND MEDICAL APPLICATIONS** - Products are not designed or intended for use as critical components in life support systems, equipment used in hazardous environments, or nuclear control systems.

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