

# Features

# ICE Technology\*

- +115°C Maximum Case Temperature
- -45°C Minimum Case Temperature
- Baseplate Case Style
- 2250VDC Isolation
- Wide 4:1 Input Voltage Range
- EN-50155 and EN-50121-3-2 Certified

## Description

The RPR50 series DC/DC converters are designed for railway rolling stock applications. Besides covering all the input voltages from 40VDC up to 160VDC, the converters have a very wide operating temperature range of -45°C to +115°C. The RPR50 has a baseplate case for high vibration or bulkhead-mounting applications. It is EN-50155 and EN-50121-3-2 certified.

## Selection Guide

| Part Number    | Input Voltage Range [VDC] | Input Current [mA] | Output Voltage [VDC] | Output Current [mA] | Efficiency typ. [%] | Max. Capacitive Load [μF] |
|----------------|---------------------------|--------------------|----------------------|---------------------|---------------------|---------------------------|
| RPR50-11012S-B | 40-160                    | 510                | 12                   | 4170                | 88                  | 1000                      |

### Notes:

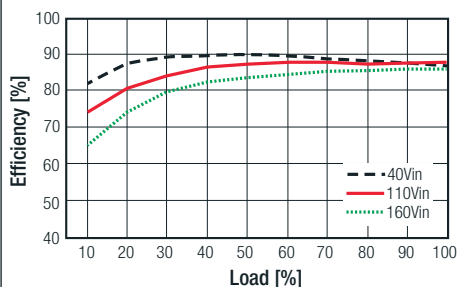
Note1: Typical values at nominal input voltage and full load.

## Specifications (measured @ ta= 25°C, nominal input voltage, full load and after warm-up)

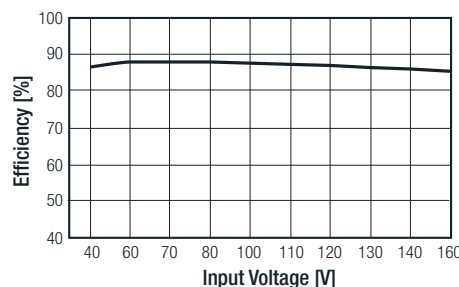
### BASIC CHARACTERISTICS

| Parameter                    | Condition                             | Min.                  | Typ.     | Max.        |
|------------------------------|---------------------------------------|-----------------------|----------|-------------|
| Input Voltage Range          | nom. Vin= 110VDC                      | 40VDC                 | 110VDC   | 160VDC      |
| Transient Input Voltage      | ≤100ms                                |                       |          | 180VDC      |
| Inrush Current               | with EMC Filter<br>without EMC Filter |                       |          | 50A<br>40A  |
| Under- Voltage Lockout       | DC-DC ON<br>DC-DC OFF                 | 39VDC                 |          | 36VDC       |
| Remote ON/OFF                | ON / high logic<br>OFF / low logic    | Open, 8V<br>Short, 0V |          | 60V<br>1.2V |
| Remote OFF Input Voltage     | nominal input                         |                       | 5mA      |             |
| Start Up Time                | when use CTRL function                |                       | 20ms     |             |
| Internal Operating Frequency |                                       | 220kHz                | 260kHz   | 300kHz      |
| Output Voltage Trimming      |                                       |                       | ±10%     |             |
| Efficiency                   | typ. Vin, full load                   | 87%                   | 88%      |             |
| Minimum Load                 |                                       | 0%                    |          |             |
| Output Ripple and Noise      | 20MHz limited, 1μF output MLCC        |                       | 120mVp-p | 180mVp-p    |

Efficiency vs. Load



Efficiency vs. Input Voltage



continued on next page

**RECOM**  
DC/DC Converter

**RPR50-11012S-B**

50 Watt 4:1  
2" x 1.6"



Baseplate Style  
Single Output



EN50155 Certified  
IEC/EN60950-1 Certified

### \* ICE Technology

ICE (Innovation in Converter Excellence) uses state-of-the-art techniques to minimise internal power dissipation and to increase the internal temperature limits to extend the ambient operating temperature range to the maximum.



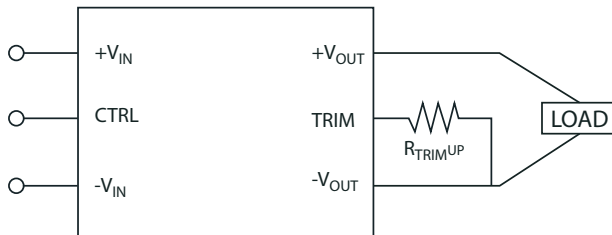
[https://www.recom-power.com/pdf/Powerline\\_DC-DC/RSPxxx-168.pdf](https://www.recom-power.com/pdf/Powerline_DC-DC/RSPxxx-168.pdf)

Specifications (measured @  $t_a = 25^\circ\text{C}$ , nominal input voltage, full load and after warm-up)

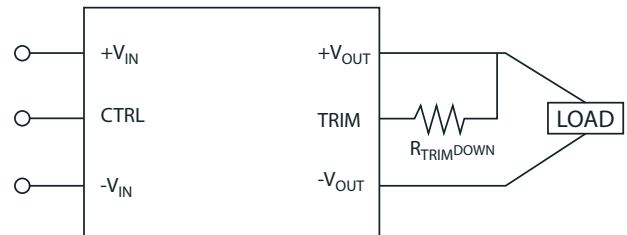
### Trimming Output Voltage

Only the single output converters have a trim function that allows users to adjust the output voltage from +10% to -10%, please refer to the trim table that follow for details. Adjustment to the output voltage can be used with a simple fixed resistor as shown in Figures 1 and 2. A single fixed resistor can increase or decrease the output voltage depending on its connection. Resistor should be located close to the converter. If the trim function is not used, leave the trim pin open.

Trim adjustments higher than the specified range can have an adverse effect on the converter's performance and are not recommended. Excessive voltage differences between output voltage sense voltage, in conjunction with trim adjustment of the output voltage; can cause the OVP circuitry to activate. Thermal derating is based on maximum output current and voltage at the converter's output pins. Use of the trim and sense function can cause output voltages to increase, thereby increasing output power beyond the converter's specified rating. Therefore:  $(V_{out} \text{ at Pins}) \times (I_{out}) \leq \text{rated output power}$ .



**Figure 1.** Trim connections to increase output voltage using fixed resistors



**Figure 2.** Trim connections to decrease output voltage using fixed resistors

|       | Trim up register value (K $\Omega$ ) |       |      |      |      |      |      |     |     |     |
|-------|--------------------------------------|-------|------|------|------|------|------|-----|-----|-----|
| Vout  | 1%                                   | 2%    | 3%   | 4%   | 5%   | 6%   | 7%   | 8%  | 9%  | 10% |
| 12VDC | 238.7                                | 113.1 | 68.2 | 46.3 | 32.1 | 22.4 | 15.4 | 9.8 | 6.5 | 3.2 |

|       | Trim down register value (K $\Omega$ ) |       |      |      |      |      |      |     |     |      |
|-------|--|-------|------|------|------|------|------|-----|-----|------|
| Vout  | -1%                                    | -2%   | -3%  | -4%  | -5%  | -6%  | -7%  | -8% | -9% | -10% |
| 12VDC | 322.2                                  | 137.2 | 81.1 | 53.1 | 35.5 | 24.0 | 16.0 | 9.7 | 5.0 | 1.3  |

| REGULATIONS              |   |                        |
|--------------------------|---|------------------------|
| Parameter                | Condition   | Value                  |
| Output Voltage Accuracy  | 50% load  | $\pm 1.5\%$ max.       |
| Line Voltage Regulation  | low line to high line   | $\pm 0.3\%$ max.       |
| Load Voltage Regulation  | 10% to 100% load  | $\pm 0.5\%$ max.       |
| Transient Recovery Time  | 25% load step change, $\Delta I_o/\Delta t = 2.5\text{A}/\mu\text{s}$ | 800 $\mu\text{s}$ typ. |
| Transient Peak Deviation | 25% load step change, $\Delta I_o/\Delta t = 2.5\text{A}/\mu\text{s}$ | $\pm 2\% V_{out}$ max. |

| PROTECTIONS                       |                          |                                      |
|-----------------------------------|--------------------------|--------------------------------------|
| Parameter                         | Condition                | Value                                |
| Surge Resistance                  | $\leq 10\text{ms}$       | 250VDC                               |
| Output Power Protection (OPP)     | Hiccup Mode              | 120% typ.                            |
| Over Voltage Protection (OVP)     | 10% load                 | 120% typ.                            |
| Over Temperature Protection (OTP) | case temperature         | 120 $^\circ\text{C}$ , auto-recovery |
| Isolation Voltage                 | I/P to O/P, at 70% RH    | 2250VDC / 1 Minute                   |
|                                   | I/P to Case, O/P to Case | 1500VDC / 1 Minute                   |
| Isolation Resistance              | I/P to O/P, at 70% RH    | 100M $\Omega$ min.                   |
| Isolation Capacitance             | I/P to O/P               | 330pF typ.                           |

**Notes:**

Note2: This Power Module is not internally fused. A input fuse must be always used. Recommended Fuse: T2A

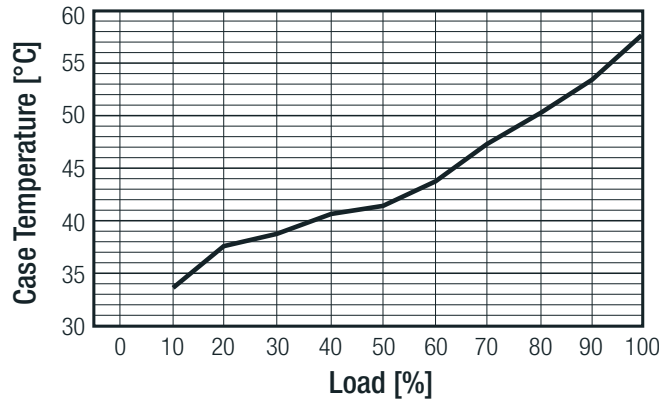
Specifications (measured @  $t_a = 25^\circ\text{C}$ , nominal input voltage, full load and after warm-up)

### ENVIRONMENTAL

| Parameter                        | Condition  | Value  |
|----------------------------------|--|--|
| Operating Case Temperature Range | start up by $-45^\circ\text{C}$                            | $-45^\circ\text{C}$ to (see calculation)                         |
| Temperature Coefficient          |  | $\pm 0.04\%$ / $^\circ\text{C}$ max.                             |
| Thermal Impedance                | natural convection<br>mounting at FR4 (254x254mm) PCB      | vertical $4.8^\circ\text{C/W}$<br>horizontal $7^\circ\text{C/W}$ |
| Humidity                         |  | 95%, non condensing  |
| MTBF (+50 $^\circ\text{C}$ G.B.) | according to MIL-HDBK-217F<br>according to BellCore-TR-332 | $609 \times 10^3$ hours<br>$1541 \times 10^3$ hours              |

### Derating Graph

( $T_a = +25^\circ\text{C}$ , natural convection, typ.  $V_{in}$  and vertical mounting)



### Calculation

$$R_{th\text{case-ambient}} = 4.8^\circ\text{C/W (vertical)}$$

$$R_{th\text{case-ambient}} = 7^\circ\text{C/W (horizontal)}$$

$$R_{th\text{case-ambient}} = \frac{T_{\text{case}} - T_{\text{ambient}}}{P_{\text{dissipation}}}$$

$$P_{\text{dissipation}} = P_{\text{IN}} - P_{\text{OUT}} = \frac{P_{\text{OUTapp}}}{\eta} - P_{\text{OUTapp}}$$

$T_{\text{case}}$  = Case Temperature

$T_{\text{ambient}}$  = Environment Temperature

$P_{\text{dissipation}}$  = Internal losses

$P_{\text{IN}}$  = Input Power

$P_{\text{OUT}}$  = Output Power

$\eta$  = Efficiency under given Operating Conditions

$R_{th\text{case-ambient}}$  = Thermal Impedance

### Practical Example:

Take the RPR50-11012S-B with 50% load. What is the maximum ambient operating temperature? Use converter vertical in application.

$$\text{Eff}_{\text{min}} = 87\% @ V_{\text{nom}}$$

$$P_{\text{OUT}} = 50\text{W}$$

$$P_{\text{OUTapp}} = 50 \times 0.5 = 25\text{W}$$

$$P_{\text{dissipation}} = \frac{P_{\text{OUTapp}}}{\eta} - P_{\text{OUTapp}}$$

$$\eta = \sim 88\% \text{ (from Eff vs Load Graph)}$$

$$P_{\text{dissipation}} = \frac{25}{0.88} - 25 = 3.41\text{W}$$

$$R_{th} = \frac{T_{\text{casemax}} - T_{\text{ambient}}}{P_{\text{dissipation}}} \rightarrow 4.8^\circ\text{C/W} = \frac{115^\circ\text{C} - T_{\text{ambient}}}{3.41\text{W}}$$

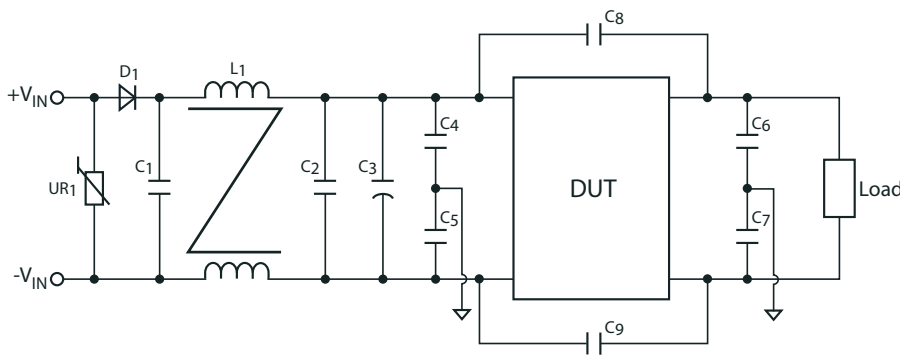
$$T_{\text{ambientmax}} = \underline{98.6^\circ\text{C}}$$

Specifications (measured @  $t_a = 25^\circ\text{C}$ , nominal input voltage, full load and after warm-up)

### SAFETY AND CERTIFICATIONS

| Certificate Type                             | Report / File Number   | Standard / Edition         |
|--|--|----------------------------|
| IEC/EN General Safety                        | SPCLVD1108088-1  | IEC/EN-60950-1 2nd Edition |
| Certificate Type (Environmental)             | Conditions   | Standard / Criterion       |
| EMI  | with external Filter   | EN-55022, Class A          |
| ESD  | $\pm 8\text{kV}$ Air Discharge, $\pm 6\text{kV}$ Contact Discharge | EN-61000-4-2, Criteria B   |
| Radiated Immunity                            | Level 3, 10V/M   | EN-61000-4-3, Criteria A   |
| Fast Transient                               | $\pm 4\text{kV}$ Applied   | EN-61000-4-4, Criteria B   |
| Surge  | $\pm 4\text{kV}$ Applied   | EN-61000-4-5, Criteria B   |
| Conducted Immunity                           | Level 3, 10V rms   | EN-61000-4-6, Criteria A   |
| Vibration                                    | 50-150Hz, along X,Y and Z  | EN-60068-2-6               |
| Thermal Cycling (complies with MIL-STD-810F) | 12 cycles  | EN-60068-2-14              |
| Shock  | 5g / 30ms  | EN-60068-2-27              |

### EMC Filtering - Suggestions



It is recommended to add UR1 and D1 in railway application. C1, C2, C3 & L1 can be modified for required EMI standards. To meet EN61000-4-2, module case should be earth grounded. We offer independent case pin option on request, the location is between pin 2 and pin 6.

| Standard                | UR1         | D1        | C1                      | L1                            | C2         | C3                      | C4, C5, C6, C7  | C8, C9       |
|-------------------------|-------------|-----------|-------------------------|-------------------------------|------------|-------------------------|-----------------|--------------|
| EN55022 Class A         | MOV 14D361K | 250V / 3A | 1.5 $\mu\text{F}$ /250V | 1200 $\mu\text{H}$ $\pm 20\%$ | 470nF/250V | 680 $\mu\text{F}$ /250V | 0.47nF (Y1 CAP) | 1nF (Y1 CAP) |
| EN61000-4-2, 3, 4, 5, 6 |             |           | N/A                     |                               |            |                         |                 |              |

### Soldering

#### Hand Soldering

Hand Soldering is the least preferred method because the amount of solder applied, the time the soldering iron is held on the joint, the temperature of the iron and the temperature of the solder joint are variable.

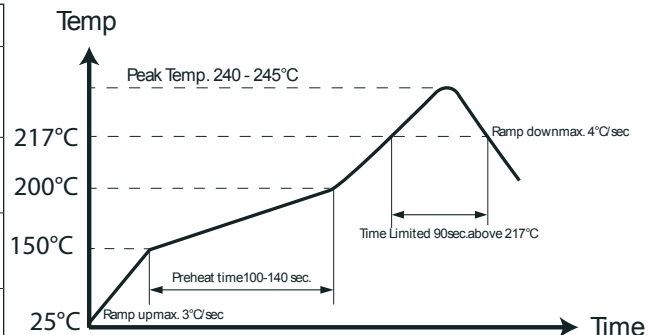
The recommended hand soldering guideline is listed in Table 1. The suggested soldering process must keep the power module's internal temperature below the critical temperature of  $217^\circ\text{C}$  continuously.

#### Wave Soldering

High temperature and long soldering time will result in IMC layer increasing in thickness and thereby shorten the solder joint lifetime. Therefore the peak temperature over  $245^\circ\text{C}$  is not suggested due to the potential reliability risk of components under continuous high-temperature. In the meanwhile, the soldering time of temperature above  $217^\circ\text{C}$  should be less than 90 seconds. Please refer to the soldering profile below for recommended temperature profile parameters.

**Table 1 Hand-Soldering Guideline**

| Parameter              | Single-side Circuit Board  | Double-side Circuit Board  | Multi-layers Circuit Board |
|------------------------|----------------------------|----------------------------|----------------------------|
| Soldering Iron Wattage | 90W                        | 90W                        | 90W                        |
| Tip Temperature        | $385 \pm 10^\circ\text{C}$ | $420 \pm 10^\circ\text{C}$ | $420 \pm 10^\circ\text{C}$ |
| Soldering Time         | 2-6 seconds                | 4-10 seconds               | 4-10 seconds               |

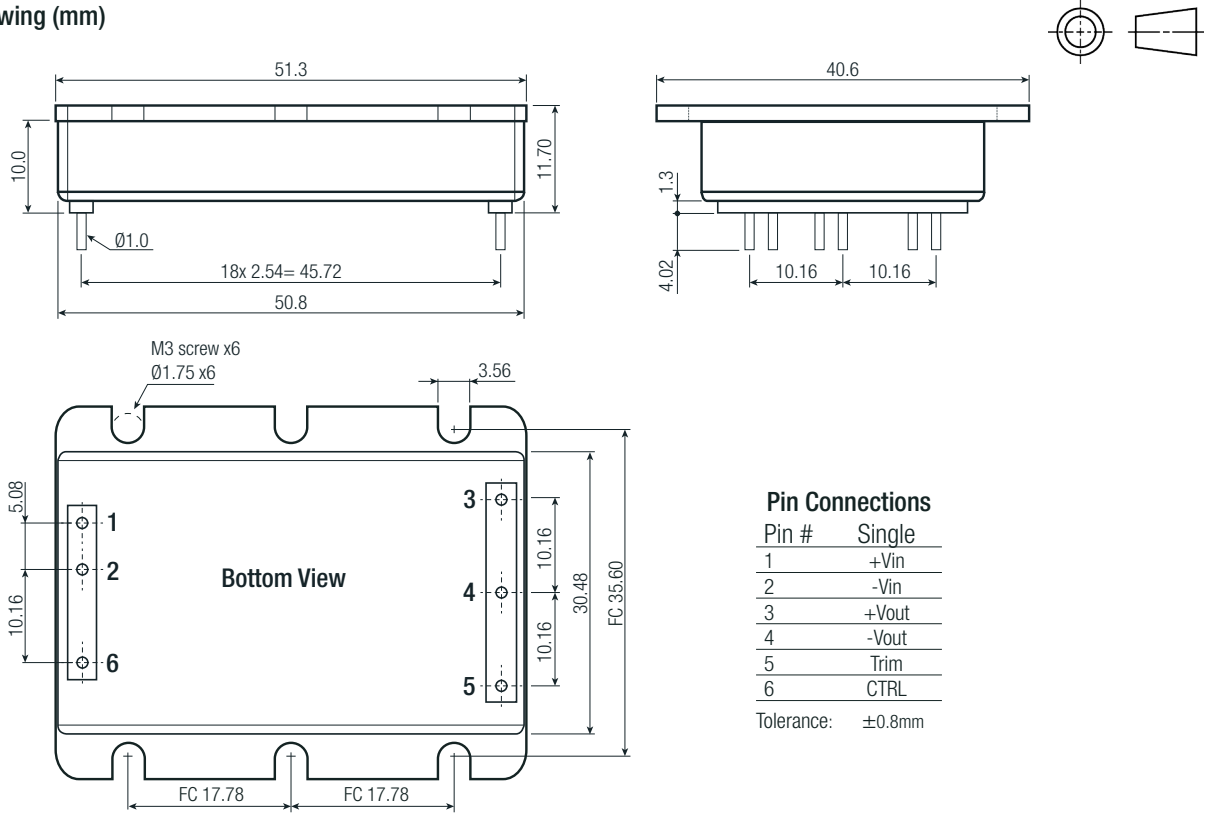


Specifications (measured @ ta= 25°C, nominal input voltage, full load and after warm-up)

**DIMENSION AND PHYSICAL CHARACTERISTICS**

| Parameter                 | Value                |
|---------------------------|----------------------|
| Case Material             | Aluminium            |
| Package Dimension (LxWxH) | 51.3 x 40.6 x 11.7mm |
| Package Weight            | 40g                  |

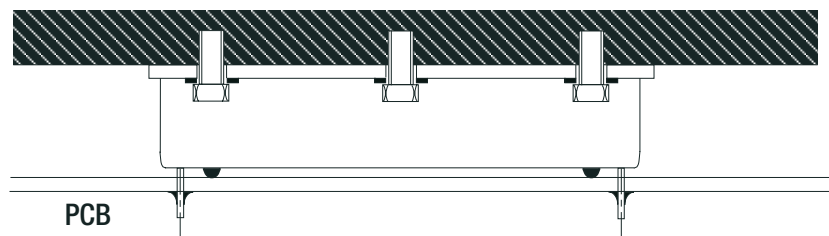
**Dimension Drawing (mm)**



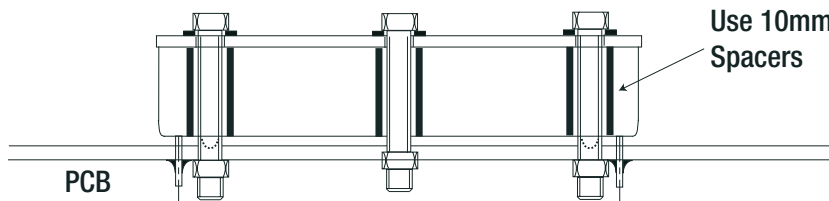
**INSTALLATION and APPLICATION**

**Mounting Instruction**

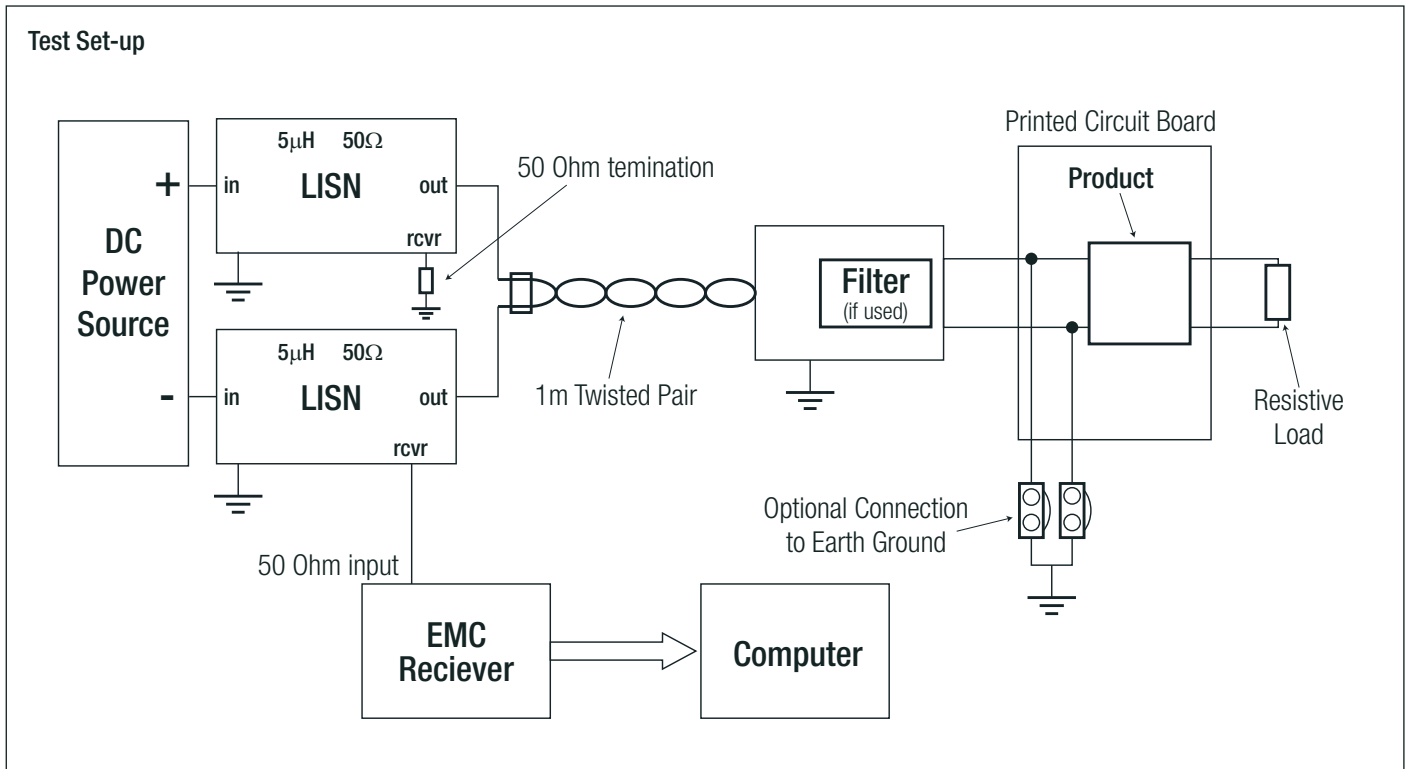
**Baseplate Case Fixing - Mounting onto Heatsink/Bulkhead**



**Baseplate Case Fixing - Anti Vibration Mounting onto PCB**



Specifications (measured @  $t_a = 25^\circ\text{C}$ , nominal input voltage, full load and after warm-up)



### PACKAGING INFORMATION

| Parameter                   | Type | Value                 |
|-----------------------------|------|-----------------------|
| Packaging Dimension (LxWxH) | Tube | 200.0 x 55.0 x 20.0mm |
| Packaging Quantity          |      | 4pcs                  |
| Storage Temperature Range   |      | -55°C to +125°C       |

The product information and specifications may be subject to changes even without prior written notice. The product has been designed for various applications; its suitability lies in the responsibility of each customer. The products are not authorized for use in safety-critical applications without RECOM's explicit written consent. A safety-critical application is an application where a failure may reasonably be expected to endanger or cause loss of life, inflict bodily harm or damage property. The applicant shall indemnify and hold harmless RECOM, its affiliated companies and its representatives against any damage claims in connection with the unauthorized use of RECOM products in such safety-critical applications.