

50W BASEPLATE COOLED

DC-DC CONVERTER

The RDF50 Series delivers 50W and offers single output voltages ranging from 5V to 48V. With an ultra-wide 12:1 input range of 14 to 160VDC, which covers standard industrial voltages and meets all requirements of the EN50155 transportation standard.

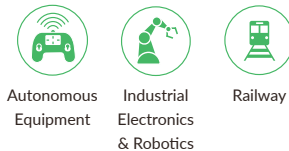
With world-wide industrial safety approvals and compliance to transportation standards, high efficiency, high reliability, 3kVAC reinforced isolation, remote on/off and wide output trimming, the RDF50 series benefits system designers with easy integration into a wide range of applications including; renewable energy, battery systems, autonomous equipment, factory automation and harsh railway applications.



Features

- Single voltage outputs from 5V to 48VDC
- Wide output voltage trim and remote sense
- 10:1 ultra-wide input range 16 to 160VDC
- Industry standard half brick format
- High efficiency, up to 89%
- 3kVAC reinforced input to output isolation
- ITE safety approvals and EN50155 compliance
- Remote On/Off and remote sense
- -40°C to +100°C operating temperature
- Overvoltage, overload, and short circuit protection
- 3 year warranty

Applications



Dimensions

36.8 x 57.9 x 12.7 mm (1.45" x 2.28" x 0.5")

Models & Ratings

| Model Number ^(1,2) | Input Voltage | Output Voltage | Output Current | Input Current ⁽³⁾ | | Maximum Capacitive Load | Ripple & Noise ⁽⁴⁾ | Efficiency ⁽⁵⁾ |
|-------------------------------|---------------|----------------|----------------|------------------------------|-----------|-------------------------|-------------------------------|---------------------------|
| | | | | No Load | Full Load | | | |
| RDF5072WS05 | 14-160VDC | 5V | 6.00A | 5mA | 2.90A | 4700µF | 100mV | 83% |
| RDF5072WS12 | | 12V | 4.20A | | 4.30A | 3300µF | 150mV | 87% |
| RDF5072WS24 | | 24V | 2.10A | | 4.20A | 1200µF | 240mV | 89% |
| RDF5072WS48 | | 48V | 1.05A | | 4.25A | 680µF | 480mV | 88% |

Notes:

1. For negative logic option, add suffix -N.
2. For threaded baseplate option, add suffix -T.
3. Typical at 14VDC input.

4. Measured at 20MHz bandwidth and 10µF electrolytic capacitor.
5. Measured at 72VDC input.

Input

| Characteristic | Minimum | Typical | Maximum | Units | Notes & Conditions |
|--------------------------------|---------|---------|---------|------------------|------------------------------------|
| Input Voltage Range | 14 | | 160 | VDC | 24, 48, 72 & 110VDC nominal inputs |
| Input Surge | | | 200 | VDC | For 100ms |
| Undervoltage Lockout | | 14.6 | | VDC | On |
| | | 12.0 | | | Off |
| Lockout Hysteresis | | 1.5 | | VDC | |
| Idle Current | | 3 | 5 | mA | When output is inhibited |
| Inrush Current | | | 0.1 | A ² s | |
| Input Reflected Ripple Current | | 40 | | mA pk-pk | Through 10µH inductor |

Output

| Characteristic | Minimum | Typical | Maximum | Units | Notes & Conditions |
|--------------------------|---|---------|---------|-------|--|
| Output Voltage | 5 | | 48 | VDC | See Models & Ratings |
| Output Trim | -20 | | +10 | % | See Application note |
| Initial Set Accuracy | | | ±1.0 | % | At full load |
| Minimum Load | No minimum load required | | | | |
| Line Regulation | | | ±0.5 | % | From minimum to maximum input at full load |
| Load Regulation | | | ±0.2 | % | From 0% to full load |
| Transient Response | | | ±5 | % | Maximum deviation, recovering to less than 1% in 250µs for 25% step load change. |
| Start Up Time | | 15 | | ms | |
| Output Voltage Rise Time | | 10 | | ms | |
| Ripple & Noise | See Models & Ratings, measured using external 10µF MLCC | | | | |
| Overload Protection | 110 | 180 | 200 | % | |
| Short Circuit Protection | Continuous hiccup mode, with autorecovery | | | | |
| Maximum Capacitive Load | See Models & Ratings table | | | | |
| Temperature Coefficient | | | 0.02 | %/°C | |
| Overvoltage Protection | 115 | 125 | 140 | % | |
| Remote On/Off | Output is on if remote on/off (pin 2) is open or high (3.5-160VDC) Output turns off if remote on/off (pin 2) is low (option -N for Negative logic) | | | | |

General

| Characteristic | Minimum | Typical | Maximum | Units | Notes & Conditions |
|---------------------------|-----------------|--------------|---------|------------------|----------------------------|
| Efficiency | | 88 | | % | See Models & Ratings table |
| Isolation | 3000 | | | VDC | Input to Output, 60s |
| | 2500 | | | | Input to Case, 60s |
| | 500 | | | VAC | Output to Case, 60s |
| Isolation Resistance | 10 ⁹ | | | Ω | |
| Isolation Capacitance | | 1000 | | pF | Input to output |
| | | 1500 | | | Input to Case |
| | | 10000 | | | Output to Case |
| Switching Frequency | 180 | 200 | 220 | kHz | Fixed |
| Power Density | | | 30 | Win ³ | |
| Mean Time Between Failure | | 780 | | khls | MIL-HDBK-217F, +25 °C GB |
| Weight | | 61.5 (0.136) | | g (lb) | |

Environmental

| Characteristic | Minimum | Typical | Maximum | Units | Notes & Conditions |
|----------------------------------|-------------------|---------|---------|-------|--------------------|
| Operating Base Plate Temperature | -40 | | +100 | °C | |
| Storage Temperature | -55 | | +125 | °C | |
| Thermal Protection | | 107 | | °C | |
| Humidity | | | 95 | %RH | Non-condensing |
| Cooling | Base plate cooled | | | | |

EMC: Emissions

| Phenomenon | Standard | Test Level | Notes & Conditions |
|-------------------|-------------|------------|-----------------------|
| ITE | EN55032 | | See Application Notes |
| Railway Equipment | EN50121-3-2 | | See Application Notes |

EMC: Immunity

| Phenomenon | Standard | Test Level | Criteria | Notes & Conditions |
|--------------------|-------------|------------|----------|--|
| Railway Equipment | EN50121-3-2 | | | See Application Notes |
| ESD Immunity | EN61000-4-2 | ±6kV/±8kV | A | Contact Discharge/Air Discharge |
| Radiated Immunity | EN61000-4-3 | 20Vrms | A | |
| EFT/Burst | EN61000-4-4 | ±2kV | A | |
| Surge | EN61000-4-5 | ±2kV | A | With external electrolytic capacitor 68µF/400V across input pins |
| Conducted immunity | EN61000-4-6 | 10Vrms | A | See application notes |
| Magnetic Fields | EN61000-4-8 | 3A/m | A | |

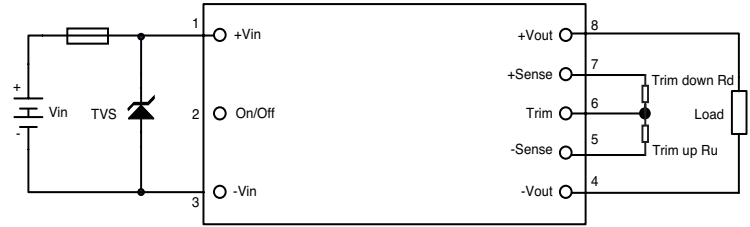
Safety Approvals

| Safety Agency | Standard | Test Level | Notes & Conditions |
|---------------|----------------------------------|------------|---------------------------------|
| UL | UL60950-1, UL62368-1 | | Pending |
| EN | EN50155 | | Railway, evaluated to EN62368-1 |
| CE | Meets all applicable directives | | |
| UKCA | Meets all applicable legislation | | |

Application Notes

Input Fusing and Safety Considerations

The RDF50 series converters have no internal fuse. In order to achieve maximum safety and system protection, always use an input line fuse. We recommended a 6A fast acting fuse. It is recommended that the circuit has a transient voltage suppressor diode (TVS) across the input terminals to protect the unit against surge or spike voltages and input reverse voltage (as shown). A suitable part would be SMDJ180A.



Output Voltage Adjustment

The Trim input permits the user to adjust the output voltage up by 10% or down by 20%. This is accomplished by connecting an external resistor between the Trim pin and either the +Sense pin or the -Sense pin.

To Trim Down

Connecting an external resistor (R_d) between the Trim pin and the Vout (+) (or +Sense) pin decreases the output voltage. The following table can be used to determine the required external resistor value to obtain a percentage output voltage change of $\Delta\%$.

| Trim Down % | 5V | 12V | 24V | 48V |
|----------------|------------------------------|-------|-------|-------|
| | R _d (k Ω) | | | |
| 1 | 215.8 | 687.3 | 1703 | 3294 |
| 2 | 103.0 | 327.1 | 807.8 | 1588 |
| 3 | 65.40 | 207.0 | 509.2 | 1019 |
| 4 | 46.60 | 147.0 | 359.9 | 735.1 |
| 5 | 35.32 | 110.9 | 270.3 | 564.5 |
| 6 | 27.80 | 86.96 | 210.6 | 450.7 |
| 7 | 22.43 | 69.81 | 167.9 | 369.5 |
| 8 | 18.40 | 56.95 | 135.9 | 308.5 |
| 9 | 15.27 | 46.94 | 111.0 | 261.1 |
| 10 | 12.76 | 38.94 | 91.16 | 223.2 |
| 11 | 10.71 | 32.39 | 74.87 | 192.2 |
| 12 | 9.00 | 26.93 | 61.20 | 166.3 |
| 13 | 7.55 | 22.31 | 49.82 | 144.5 |
| 14 | 6.31 | 18.35 | 39.97 | 125.7 |
| 15 | 5.24 | 14.92 | 31.44 | 109.5 |
| 16 | 4.30 | 11.92 | 23.97 | 95.28 |
| 17 | 3.47 | 9.277 | 17.29 | 82.73 |
| 18 | 2.73 | 6.923 | 11.53 | 71.58 |
| 19 | 2.07 | 4.817 | 6.298 | 61.60 |
| 20 | 1.48 | 2.921 | 1.583 | 52.62 |

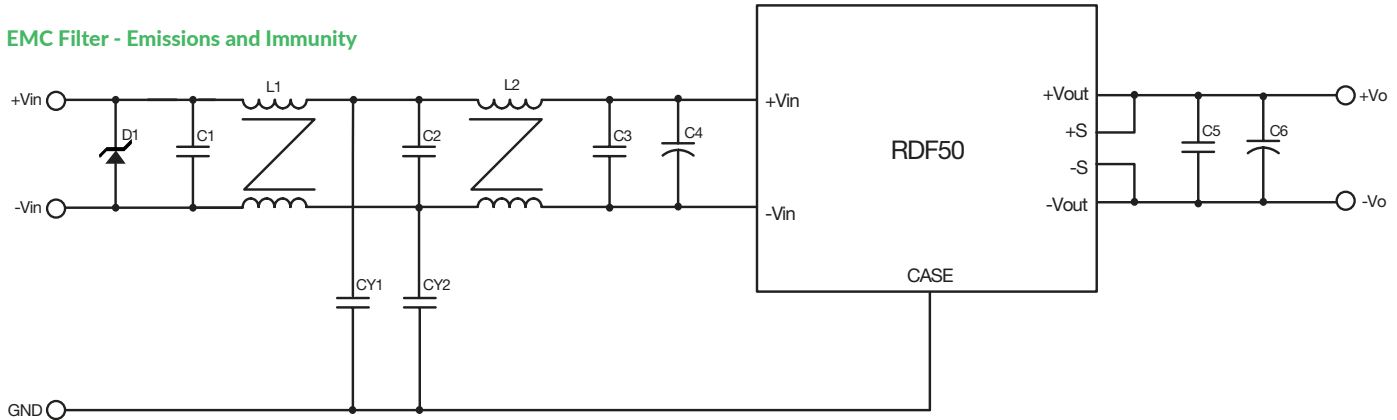
To Trim Up

Connecting an external resistor (R_u) between the Trim pin and the Vout (-) (or -Sense) pin increases the output voltage. The following table can be used to determine the required external resistor value to obtain a percentage output voltage change of $\Delta\%$.

| Trim Up % | 5V | 12V | 24V | 48V |
|--------------|------------------------------|-------|-------|-------|
| | R _u (k Ω) | | | |
| 1 | 50.45 | 154.1 | 164.0 | 147.3 |
| 2 | 24.34 | 74.95 | 78.64 | 71.29 |
| 3 | 15.63 | 48.56 | 50.18 | 45.93 |
| 4 | 11.28 | 35.37 | 35.94 | 33.24 |
| 5 | 8.67 | 27.45 | 27.40 | 25.63 |
| 6 | 6.93 | 22.17 | 21.71 | 20.56 |
| 7 | 5.69 | 18.41 | 17.64 | 16.94 |
| 8 | 4.75 | 15.58 | 14.59 | 14.22 |
| 9 | 4.03 | 13.38 | 12.22 | 12.10 |
| 10 | 3.45 | 11.62 | 10.32 | 10.41 |

Application Notes

EMC Filter - Emissions and Immunity



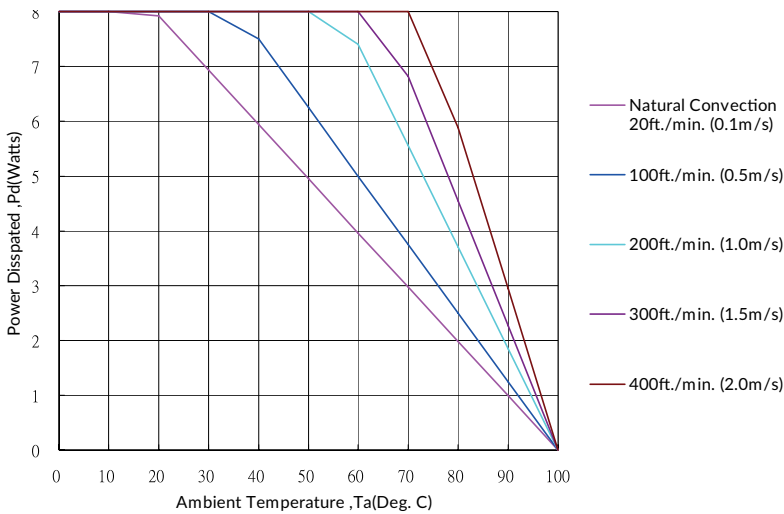
| C1, C2, C3 | C4 | C5 | C6 | CY1, CY2 | D1 | L1, L2 |
|----------------------------|-------------------------------------|-----------------------|-----------------------|----------|------------|--------------------|
| 1µF/250V 1812 Ceramic Cap. | 82µF/250V KXJ Series Aluminium Cap. | 2.2µF/100V, 1210 MLCC | 4.7µF/100V, 1812 MLCC | 1500pF | 1.5KE 180A | URT24-50055H 5.5mH |

Notes:

C4 UNITED CHEMI-CON KXJ series or equivalent, CY1, CY2 MURATA Y1 capacitors or equivalent, L1, L2 BULL WILL URT24-05055H or equivalent.

Thermal Resistance Information

Power dissipated vs Ambient Temperature and Air Flow without heatsink



Airflow Derating Graph

| Air Flow Rate | Typical Rca |
|--------------------------------------|-------------|
| Natural Convection 20ft/min (0.1m/s) | 10.1°C/W |
| 100ft/min (0.5m/s) | 8.0°C/W |
| 200ft/min (1.0m/s) | 5.4°C/W |
| 300ft/min (1.5m/s) | 4.4°C/W |
| 400ft/min (2.0m/s) | 3.4°C/W |

Example without Heatsink

To determine the minimum airflow necessary for a RDF5072S12 operating at an input voltage of 72V, an output current of 4.20A, and a maximum ambient temperature of 40°C:

Determine Power dissipation (Pd): $Pd = Pi - Po = Po(1-\eta)/\eta$,

$$Pd = 12V \times 4.2A \times (1-0.87)/0.87 = 7.53Watts$$

Where Pi = Input power, Po = Output Power and η = Efficiency

Determine airflow from airflow derating graph using data points for $Pd=7.53W$ and $Ta = 40^\circ C$

Minimum airflow= 200ft./min.

To check that the maximum case temp of 100°C is not exceeded:
Maximum temperature rise is

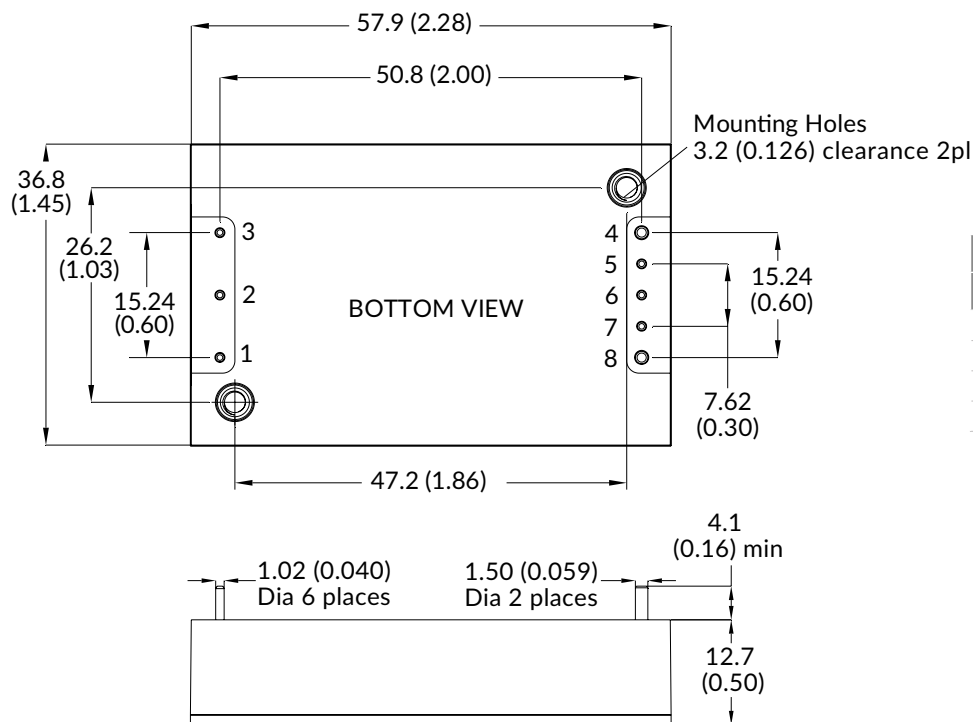
$$\Delta T = Pd \times Rca = 7.53 \times 5.4 = 40.67^\circ C.$$

Maximum case temperature is

$$Tc = Ta + \Delta T = 80.67^\circ C < 100^\circ C.$$

Where: Rca is the thermal resistance from case to ambient environment. Ta is ambient temperature and Tc is case temperature.

Mechanical Details



| Pin Connections | | | |
|-----------------|---------------|-----|----------|
| Pin | Function | Pin | Function |
| 1 | +Vin | 5 | -Sense |
| 2 | Remote On/Off | 6 | Trim |
| 3 | -Vin | 7 | +Sense |
| 4 | -Vout | 8 | +Vout |

Notes:

1. All dimensions are in mm (inches)
2. Tolerance: x.x = ± 0.5 (x.xx = ± 0.25), x.xx = ± 0.02 (x.xxx = ± 0.01)
3. Option -T for baseplate with screw threads