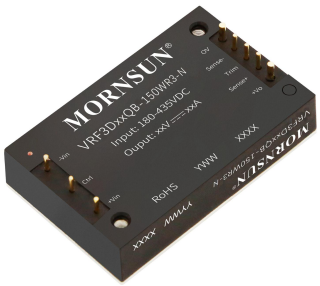
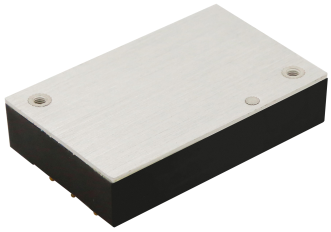
150W isolated DC-DC converter

Wide input and regulated single output





Patent Protection RoHS

## FEATURES

- Wide input voltage range: 180-435VDC
- High efficiency up to 89.5%
- Enhanced isolation, isolation voltage: 3kVAC
- Input under-voltage protection, output over-voltage, over-current, short-circuit protection, over-temperature protection
- Shell operating temperature range Tc: -40℃ to +105℃
- Industry standard 1/4-Brick package and pin-out
- Meet the EN62368 standard

*VRF3D_QB-150WR3-N series of isolated 150W DC-DC converter products, with a wide 180-435VDC input voltage range. The efficiencies of up to 89.5%, isolation voltage 3000VAC, housing allowed operating temperature -40℃ to +105℃, with input under-voltage protection, output over-voltage, over-current, short-circuit protection, over-temperature protection, widely used in industrial control, communication and other fields.*

## Selection Guide

| Certification | Part No. | Ctrl Logic① | Input Voltage (VDC) | | Output | | Full Load Efficiency③ (%)Min./Typ. | Capacitive Load (μF) Max. | Capacitive Load (μF)Min. |
|---|---|---|---|---|---|---|---|---|---|
| | | | Nominal (Range) | Max.② | Voltage (VDC) | Current (mA) Max./Min. | | | |
| -- | VRF3D05QB-150WR3-N | N | 270 (180-435) | 435 | 05 | 30000/0 | 87.5/89.5 | 10000 | 2000 |
| | VRF3D12QB-150WR3-N | N | | | 12 | 12500/0 | 87.5/89.5 | 5000 | 1000 |
| | VRF3D24QB-150WR3-N | N | | | 24 | 6250/0 | 87.5/89.5 | 2000 | 470 |
| | VRF3D28QB-150WR3-N | N | | | 28 | 5360/0 | 87/89 | 1500 | 470 |
| | VRF3D48QB-150WR3-N | N | | | 48 | 3130/0 | 87.5/89.5 | 800 | 470 |

Note:
①"P" indicates positive logic, "N" indicates negative logic;
②Exceeding the maximum input voltage may cause permanent damage;
③Efficiency is measured with nominal input voltage and rated output load.

## Input Specifications

| Item | Operating Conditions | | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| Input Current (full load/no-load) | Nominal input voltage | 5V/12V/Output | -- | 621/30 | 635/50 | mA |
| | | 24V Output | -- | 621/7 | 635/15 | |
| | | 28V Output | | 625/7 | 639/15 | |
| | | 48V Output | -- | 621/7 | 635/15 | |
| Reflected Ripple Current① | Nominal input voltage, 100% load | | -- | 100 | -- | |
| Starting Voltage | | | -- | -- | 180 | VDC |
| Input Under-voltage Protection | | | 155 | 165 | -- | |
| Start-up Time | Nominal input voltage & constant resistance load | | -- | 100 | 300 | ms |
| Input Filter | | | C filter | | | |
| Hot Plug | | | Unavailable | | | |
| Ctrl② | Module open | | Ctrl pin pulled -Vin or pulled low (0-1.2VDC) | | | |
| | Module shutdown | | Ctrl pin open or TTL pulled high (3.5-12VDC) | | | |
| | Input current when turned off | | -- | 5 | 10 | mA |

Note:
①See reflected ripple current test circuit "Design Reference" Fig 7;
②The voltage of Ctrl pin is relative to input pin -Vin.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## Output Specifications

| Item | Operating Conditions | | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| Output Voltage Accuracy | 0%-100% load | | -- | ±1 | ±3 | % |
| Line Regulation | Full load, the input voltage is from low to high | | -- | ±0.1 | ±0.5 | |
| Load Regulation | 0%-100% load | | -- | ±0.5 | ±1 | |
| Transient Response Deviation | 25% load step change, input voltage range | 5V/12V Output | -- | ±6 | ±10 | |
| | | 24V/28V Output | -- | ±5 | ±8 | |
| | | 48V Output | -- | ±3 | ±5 | |
| Transient Recovery Time | Nominal input, 25% load step change | | -- | 300 | 500 | μs |
| Temperature Coefficient | Full load | | -- | -- | ±0.03 | %/℃ |
| Ripple & Noise① | 20MHz bandwidth, 5% - 100% load② | 5V Output | -- | 150 | 200 | mVp-p |
| | | 12V/124V Output | -- | 180 | 250 | |
| | | 28V Output | -- | 200 | 300 | |
| | | 48V Output | -- | 250 | 350 | |
| Over-Temperature Protection | Case Temperature③ | | -- | 110 | -- | ℃ |
| Trim | Input voltage range | | 80 | -- | 110 | %Vo |
| Sense | | | -- | -- | 105 | |
| Output Over-voltage Protection | | | 110 | 120 | 130 | |
| Output Over-current Protection | | | 110 | 135 | 180 | %Io |
| Short-circuit Protection | | | Hiccup, continuous, self-recovery | | | |

Note:
①Under 0% -5% load conditions, ripple & noise does not exceed 5%Vo. The "Reliable measurement" method is used for ripple and noise test, please refer to DC-DC Converter Application Notes for specific information;
②The case temperature test points are shown in "Design Reference" Fig. 8.

## General Specifications

| Item | Operating Conditions | | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| Isolation | Electric strength test for 1 minute with a leakage current of 10mA max. | Input-Output | 3000 | -- | -- | VAC |
| | | Input-Case | 1500 | -- | -- | |
| | | Output-Case | 1500 | -- | -- | |
| Insulation Resistance | Input-output resistance at 500VDC | | 100 | -- | -- | MΩ |
| Isolation Capacitance | Input-output capacitance at 100kHz/0.1V | | -- | 600 | 1000 | pF |
| Shell Operating Temperature Range | See Fig. 1 | | -40 | -- | +105 | ℃ |
| Storage Temperature | | | -55 | -- | +125 | |
| Storage Humidity | Non-condensing | | 5 | -- | 95 | %RH |
| Pin Soldering Resistance Temperature* | Soldering spot is 1.5mm away from case for 10 seconds | | -- | -- | 300 | ℃ |
| | Wave soldering,10 seconds | | 255 | 260 | 265 | |
| Vibration | | | 10-150Hz, 5G, 0.75mm. along X, Y and Z | | | |
| Switching Frequency① | PWM mode | | -- | 250 | -- | kHz |
| MTBF | MIL-HDBK-217F@25℃ | | 500 | -- | -- | k hours |

Note: *The pin resistance temperature is not the actual set temperature of the soldering iron, but the temperature required for a good solder joint. The actual set temperature by the customer needs to be comprehensively set based on the thickness of the PCB, the size of the copper cladding, the power of the soldering iron, and the selection of the soldering iron tip.
①Switching frequency is measured at full load. The module reduces the switching frequency for light load (below 50%) efficiency improvement.


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## Mechanical Specifications

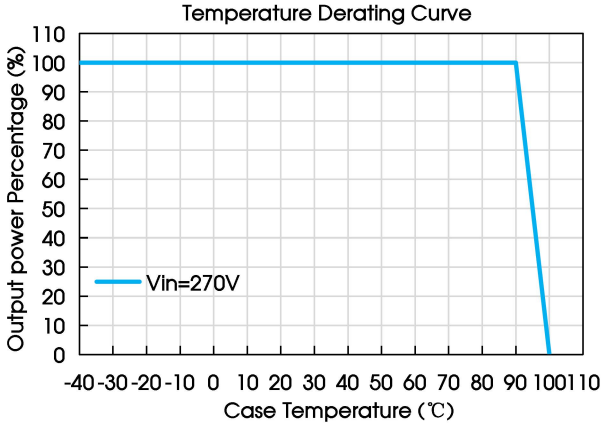
| | |
|---|---|
| Case Material | Black flame retardant and heat resistant plastic (UL94 V-0), aluminum alloy |
| Dimensions | 57.90 x 36.80 x 12.70 mm |
| Weight | 83.0g (Typ.) |
| Cooling Method | Natural convection or forced air convection |

## Electromagnetic Compatibility (EMC)

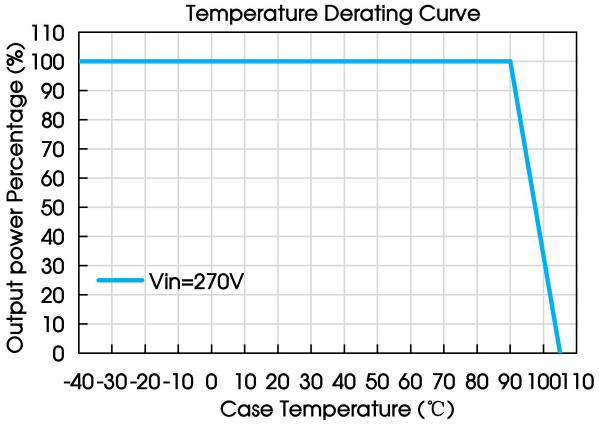
| | | | | |
|---|---|---|---|---|
| EMI | CE | CISPR32/EN55032 | CLASS A (see Fig.6 for recommended circuit) | |
| | RE | CISPR32/EN55032 | CLASS A (see Fig.6 for recommended circuit) | |
| EMS | ESD | IEC/EN61000-4-2 | Air ±8kV/Contact ±6kV (see Fig.4 for recommended circuit) | perf. Criteria B |
| | RS | IEC/EN61000-4-3 | 20V/m (see Fig.6 for recommended circuit) | perf. Criteria A |
| | EFT | IEC/EN61000-4-4 | 100khz ±2kV (see Fig.6 for recommended circuit) | perf. Criteria B |
| | Surge | IEC/EN61000-4-5 | line to line ±2kV (see Fig.6 for recommended circuit) | perf. Criteria B |
| | CS | IEC/EN61000-4-6 | 10 Vr.m.s (see Fig.6 for recommended circuit) | perf. Criteria A |

## Product Characteristic Curve

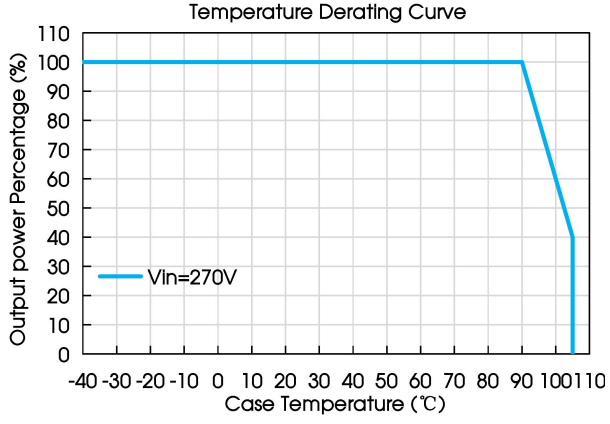
VRF3D05QB-150WR3-N
Temperature Derating Curve



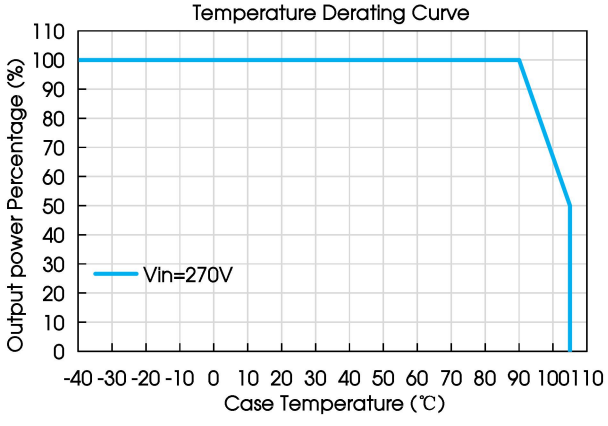

VRF3D12QB-150WR3-N
Temperature Derating Curve




VRF3D24/28QB-150WR3-N
Temperature Derating Curve




VRF3D48QB-150WR3-N
Temperature Derating Curve





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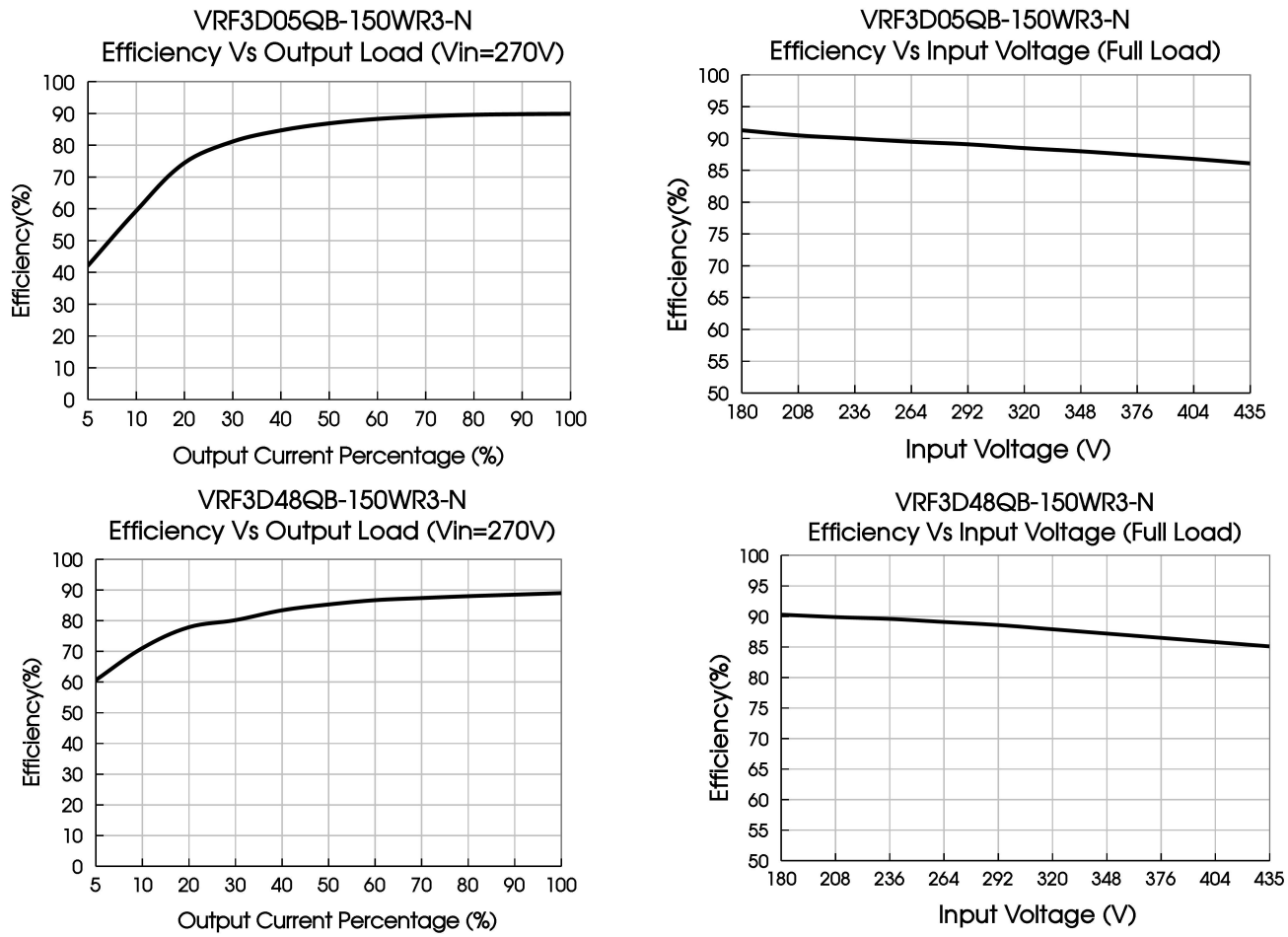


Fig.1

## Remote Sense Application

### 1. Remote Sense Connection if not used

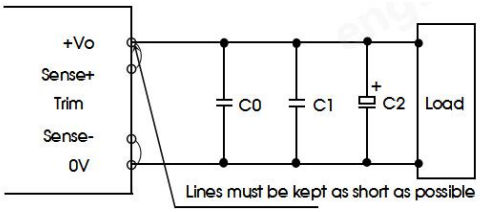


Fig.2

Note：
(1) If the sense function is not used for remote regulation the user must connect the +Sense to +Vo and -Sense to 0V.
(2) The connections between Sense lines and their respective power lines must be kept as short as possible, otherwise they may be picking up noise, interference and/or causing unstable operation of the power module.

### 2. Remote Sense Connection used for Compensation

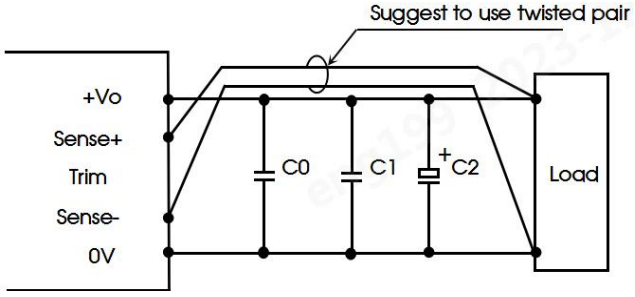


Fig.3


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Note:

(1) Using remote sense with long wires may cause unstable output, please contact technical support if long wires must be used.

(2) PCB-tracks or cables/wires for Remote Sense must be kept as short as possible. Twisted pair or shielded wires are suggested for remote compensation and must be kept as short as possible.

(3) We recommend using adequate cross section for PCB-track layout and/or cables to connect the power supply module to the load in order to keep the voltage drop below 0.3V and to make sure the power supply's output voltage remains within the specified range.

(4) Note that large wire impedance may cause oscillation of the output voltage and/or increased ripple. Consult technical support or factory for further advice of sense operation.

## Design Reference

### 1. Typical application

If the EMC recommended circuit not being used, please be sure to connect an electrolytic capacitor of at least 100uF in parallel with the input terminal to suppress the surge voltage that may be generated at the input terminal, and a capacitor larger than the minimum capacitive load in parallel with the output terminal to stabilise the product output working condition.

All the DC/DC converters of this series are tested before delivery using the recommended circuit shown in Fig. 4.

Input and/or output ripple can be further reduced by appropriately increasing the input & output capacitor values Cin and Cout and/or by selecting capacitors with a low ESR (equivalent series resistance). Also make sure that the capacitance is not exceeding the specified max. capacitive load value of the product.

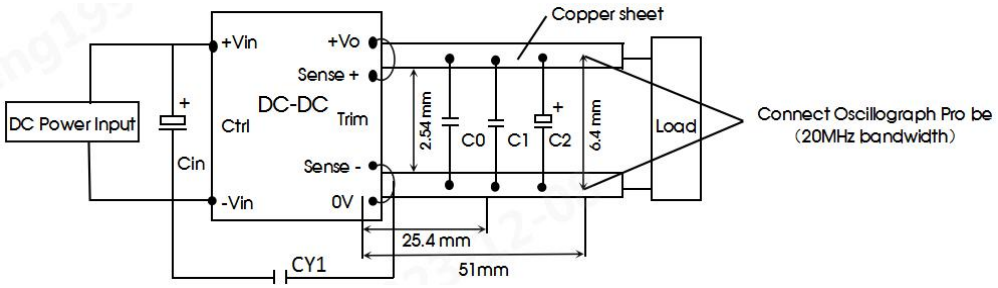


Fig.4

| Part No. | Cin Selection Guide | C0 Selection Guide | C1 Selection Guide | C2 Selection Guide | CY1 |
|---|---|---|---|---|---|
| 05V | 100uF/500V | 22uF/25V | 22uF/25V | 2000uF/10V Solid-state capacitors | 1nF/400VAC Y1 Safety capacitor |
| 12V | | 4.7uF/100V | 4.7uF/100V | 1000uF/35V Solid-state capacitors | |
| 24V | | | | 470uF/50V Electrolytic capacitor | |
| 28V | | | | 470uF/50V Electrolytic capacitor | |
| 48V | | | | 470uF/100V Electrolytic capacitor | |

### 2. Trim Function for Output Voltage Adjustment (open if unused)

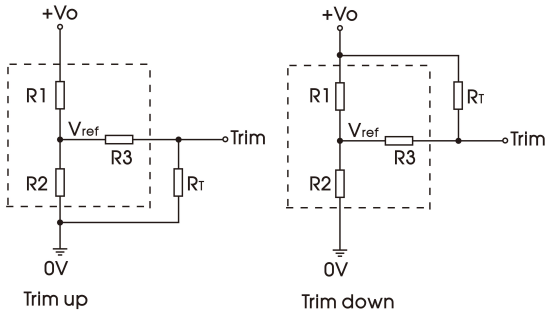


Fig.5

TRIM resistor connection (dashed line shows internal resistor network)

Calculation formula of Trim resistance:

$$\text{up: } R_T = \frac{aR_2}{R_2-a} - R_3 \qquad a = \frac{Vref}{Vo'-Vref} \cdot R_1$$

$$\text{down: } R_T = \frac{aR_1}{R_1-a} - R_3 \qquad a = \frac{Vo'-Vref}{Vref} \cdot R_2$$

Note:

a = Self-defined parameter, accurate to two decimal places;

$R_T$(kΩ): Resistance of Trim.

Vo' is the actual output voltage;

Vref (VDC) indicates the reference voltage.


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| Vout (VDC) | R1(kΩ) | R2 (kΩ) | R3 (kΩ) | Vref (V) |
|---|---|---|---|---|
| 05 | 8.7 | 2.87 | 11.5 | 1.25 |
| 12 | 10.91 | | | 2.5 |
| 24 | 24.77 | | | 2.5 |
| 28 | 29.41 | | | 2.5 |
| 48 | 52.28 | | | 2.5 |

## 3. EMC compliance circuit

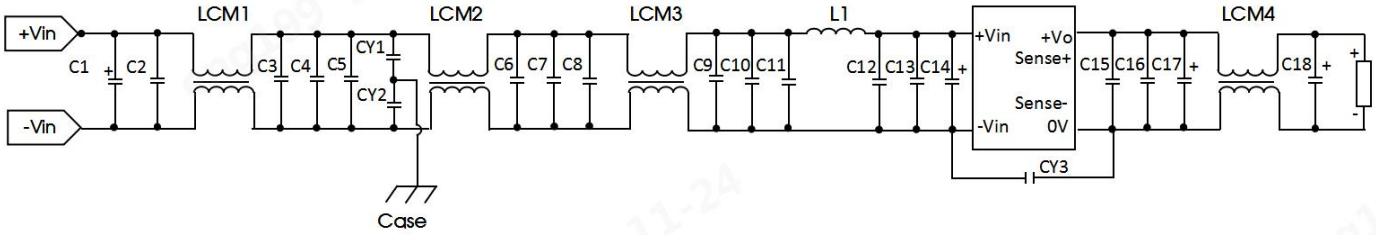


Fig.6

| Components | Parameter description: | |
|---|---|---|
| | 5V/12V Output | 24V/28V/48V Output |
| C1 | 100uF/500V (Electrolytic capacitor) | |
| C14 | 47uF/500V (Electrolytic capacitor) | |
| C2, C3, C6, C9 | 2.2μF/450V (Film capacitor) | |
| C4, C5, C7, C8, C10, C11, C12, C13 | 0.1μF/630V (Ceramic capacitor) | |
| C15, C16 | 1μF/100V (Ceramic capacitor) | |
| C17, C18 | 330μF/63V (Electrolytic capacitor) | |
| LCM1 | 10mH, Recommended to use MORNSUN P/N:FL2D-30-103B | |
| LCM2 | 1mH, Recommended to use MORNSUN P/N:FL2D-50-102 | |
| LCM3 | 7mH, Recommended to use MORNSUN P/N:FL2D-30-702B | |
| LCM4 | 4uH (Nickel zinc), Recommended to use MORNSUN P/N:FL2D-D0-040 | |
| L1 | 2.2uH/3A | |
| CY1, CY2 | 4.7nF/400VAC Y1 Safety capacitor | |
| CY3 | 1nF/400VAC Y1 Safety capacitor | NC |

## 4. Reflected ripple current--test circuit

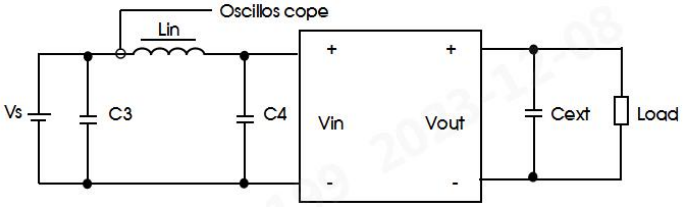


Fig.7

| Components | Parameter description: |
|---|---|
| C3 | 100uF/500V |
| Lin | 22uH/4.7A |
| C4 | 100uF/500V |
| Cext | See application circuit C0/C1/C2 |

## 5. Recommended scheme for thermal testing


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In the application process, the thermal design of the product can be evaluated with the product temperature derating curve; or by testing the temperature of point A in Fig.8 to determine the stable working range of the product, when the temperature of point A is lower than 105℃, it is the stable working range of the product.

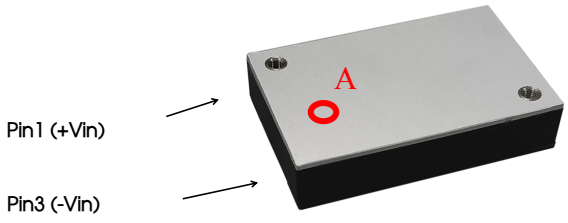
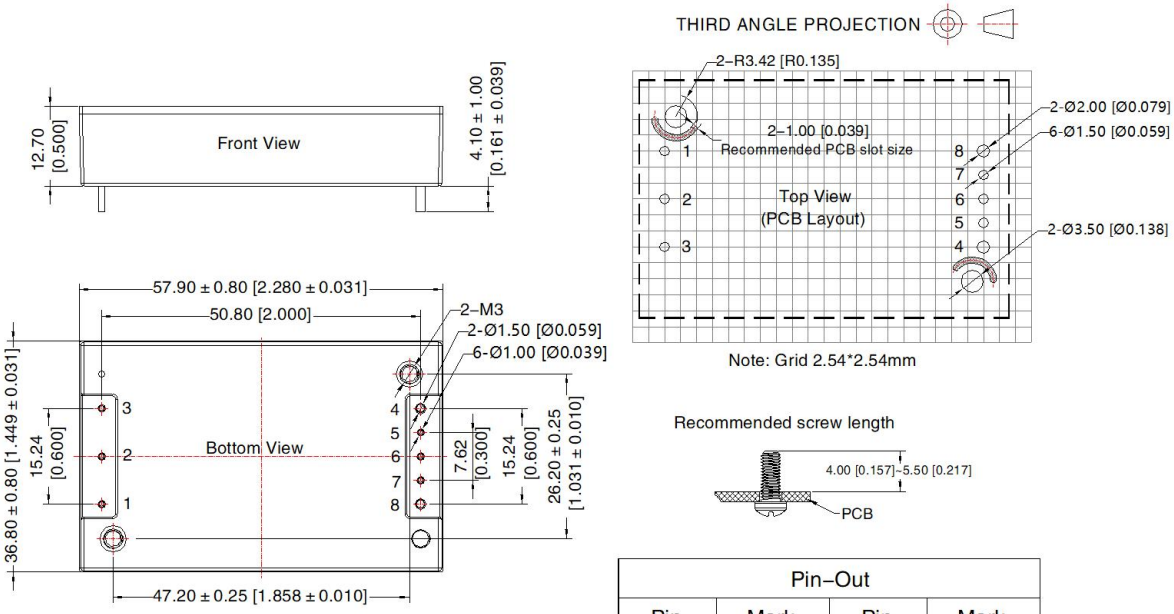



Fig.8

6. The products do not support parallel connection of their output
7. For additional information please refer to DC-DC converter application notes on www.mornsun-power.com

## Dimensions and Recommended Layout




| Pin–Out | | | |
|---|---|---|---|
| Pin | Mark | Pin | Mark |
| 1 | +Vin | 5 | Sense– |
| 2 | Ctrl | 6 | Trim |
| 3 | –Vin | 7 | Sense+ |
| 4 | 0V | 8 | +Vo |

Note:
Unit: mm[inch]
Pin1, 2, 3, 5, 6, 7's diameter: 1.00 [0.039]
Pin4, 8's diameter: 1.50 [0.059]
Pin diameter tolerances: ± 0.10 [ ± 0.004]
General tolerances: ± 0.50 [ ± 0.020]
Mounting hole screwing torque: Max 0.4 N・m

Note:
1. For additional information on Product Packaging please refer to www.mornsun-power.com. Packaging bag number:58010113;
2. The maximum capacitive load offered were tested at input voltage range and full load;
3. Unless otherwise specified, parameters in this datasheet were measured under the conditions of Ta=25℃, humidity<75%RH with nominal input voltage and rated output load;
4. All index testing methods in this datasheet are based on company corporate standards;
5. We can provide product customization service, please contact our technicians directly for specific information;
6. Products are related to laws and regulations: see "Features" and "EMC";
7. Our products shall be classified according to ISO14001 and related environmental laws and regulations, and shall be handled by qualified units.

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