

## FEATURES:

60W isolated DC-DC converter in DIP package  
Ultra-wide input and regulated single output

- ◆ Ultra-wide 4:1 input voltage range
- ◆ High efficiency up to 93%
- ◆ I/O isolation test voltage 1500V<sub>DC</sub>
- ◆ Input under-voltage protection, output short-circuit, over-current, over-voltage protection
- ◆ Operating ambient temperature range: -40℃ to +70℃
- ◆ Six-sided metal shielding package
- ◆ Six-sided metal shielding package
- ◆ Warranty period of three years



## Selection Guide

| Certification | Part No.     | Input Voltage(V <sub>DC</sub> ) |                   | Output                    |                          | Full Load Efficiency <sup>②</sup><br>(%)Min./Typ. | Capacitive Load<br>(μF)Max. |
|---------------|--------------|---------------------------------|-------------------|---------------------------|--------------------------|---------------------------------------------------|-----------------------------|
|               |              | Nominal<br>(Range)              | Max. <sup>①</sup> | Voltage(V <sub>DC</sub> ) | Current(mA)<br>Max./Min. |                                                   |                             |
|               | CFDM60-24S05 | 24<br>(9-36)                    | 40                | 5                         | 12000/600                | 90/92                                             | 20000                       |
|               | CFDM60-24S12 |                                 |                   | 12                        | 5000/250                 | 91/93                                             | 6000                        |
|               | CFDM60-24S15 |                                 |                   | 15                        | 4000/200                 | 91/93                                             | 4000                        |
|               | CFDM60-24S24 |                                 |                   | 24                        | 2500/125                 | 91/93                                             | 2000                        |

Notes:

① Exceeding the maximum input voltage may cause permanent damage;

② Efficiency is measured at nominal input voltage and rated output load.

## Input Specifications

| Item                           | Operating Conditions  | Min.                                                   | Typ.    | Max.    | Unit            |
|--------------------------------|-----------------------|--------------------------------------------------------|---------|---------|-----------------|
| InputCurrent(fullload/no-load) | Nominal input voltage | --                                                     | 2718/25 | 2748/30 | mA              |
| Surge Voltage(1sec.max.)       |                       | -0.7                                                   | --      | 50      | V <sub>DC</sub> |
| Start-up Voltage               |                       | --                                                     | --      | 9       |                 |
| Input Filter                   |                       | PI filter                                              |         |         |                 |
| Hot Plug                       |                       | Unavailable                                            |         |         |                 |
| CNT *                          | Module on             | CNT pin open or pulled high TTL (3-12V <sub>DC</sub> ) |         |         |                 |
|                                | Module off            | CNT pin pulled low to GND(0-1.2V <sub>DC</sub> )       |         |         |                 |

Note: \*The CNT pin voltage is referenced to input GND.

## Output Specifications

| Item                         | Operating Conditions                                  | Min.      | Typ. | Max. | Unit |
|------------------------------|-------------------------------------------------------|-----------|------|------|------|
| Voltage Accuracy             | 5%-100% load                                          | --        | ±1   | ±2   | %    |
|                              | 0%-5% load                                            | --        | ±2   | ±5   |      |
| Linear Regulation            | Input voltage variation from low to high at full load | --        | ±0.2 | ±0.5 |      |
| Load Regulation              | 5%-100% load                                          | --        | ±0.5 | ±1   |      |
| Transient Response Deviation | 25% load step change, input                           | 5V output | --   | ±3   | ±10  |

|                                                                                                          |                                                      |                                                     |                           |     |       |       |
|----------------------------------------------------------------------------------------------------------|------------------------------------------------------|-----------------------------------------------------|---------------------------|-----|-------|-------|
|                                                                                                          | voltage range                                        | Other output                                        | --                        | ±3  | ±5    |       |
| Transient Recovery Time                                                                                  | 25% load step change, nominal input voltage          |                                                     | --                        | 250 | 500   | μs    |
| Temperature Coefficient                                                                                  | Full load                                            |                                                     | --                        | --  | ±0.03 | %/℃   |
| Ripple/Noise <sup>①</sup>                                                                                | 20MHz bandwidth, nominal input voltage, 5%-100% load | 5V/12V/15V output                                   | --                        | 100 | --    | mVp-p |
|                                                                                                          |                                                      | 24V output                                          | --                        | 130 | --    |       |
|                                                                                                          |                                                      | 20MHz bandwidth, nominal input, voltage, 0%-5% load |                           | --  | --    | 3     |
| Over-voltage Protection                                                                                  | Input voltage range                                  |                                                     | 110                       | 140 | 160   |       |
| Over-current Protection                                                                                  |                                                      |                                                     | 110                       | 140 | 200   | %Io   |
| Short-circuit Protection                                                                                 |                                                      |                                                     | Continuous, self-recovery |     |       |       |
| Note:                                                                                                    |                                                      |                                                     |                           |     |       |       |
| ①By measuring method is used for Ripple and Noise test, please refer to Fig. 2. for recommended circuit. |                                                      |                                                     |                           |     |       |       |

## General Specifications

| Item                                                                                                                                         | Operating Conditions                                                                     | Min.                                   | Typ. | Max. | Unit            |
|----------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------|----------------------------------------|------|------|-----------------|
| Isolation                                                                                                                                    | Input-output Electric Strength Test for 1 minute with a leakage current of 1mA max.      | 1500                                   | --   | --   | V <sub>DC</sub> |
|                                                                                                                                              | Input/output-Case Electric Strength Test for 1 minute with a leakage current of 1mA max. | 1000                                   | --   | --   |                 |
| Insulation Resistance                                                                                                                        | Input-output resistance at 500V <sub>DC</sub>                                            | 100                                    | --   | --   | MΩ              |
| Isolation Capacitance                                                                                                                        | Input-output capacitance at 100KHz/0.1V                                                  | --                                     | 2200 | --   | pF              |
| Operating Temperature                                                                                                                        | See Fig.1                                                                                | -40                                    | --   | +70  | ℃               |
| 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 | ℃               |
| Vibration                                                                                                                                    |                                                                                          | 10-150Hz, 5G, 0.75mm. along X, Y and Z |      |      |                 |
| Switching Frequency <sup>①</sup>                                                                                                             | PWM mode                                                                                 | --                                     | 370  | --   | KHz             |
| MTBF                                                                                                                                         | MIL-HDBK-217F@25℃                                                                        | 1000                                   | --   | --   | K hours         |
| Note:                                                                                                                                        |                                                                                          |                                        |      |      |                 |
| ①Switching frequency is measured at full load. The module reduces the switching frequency for light load (below 50%) efficiency improvement. |                                                                                          |                                        |      |      |                 |

## Mechanical Specifications

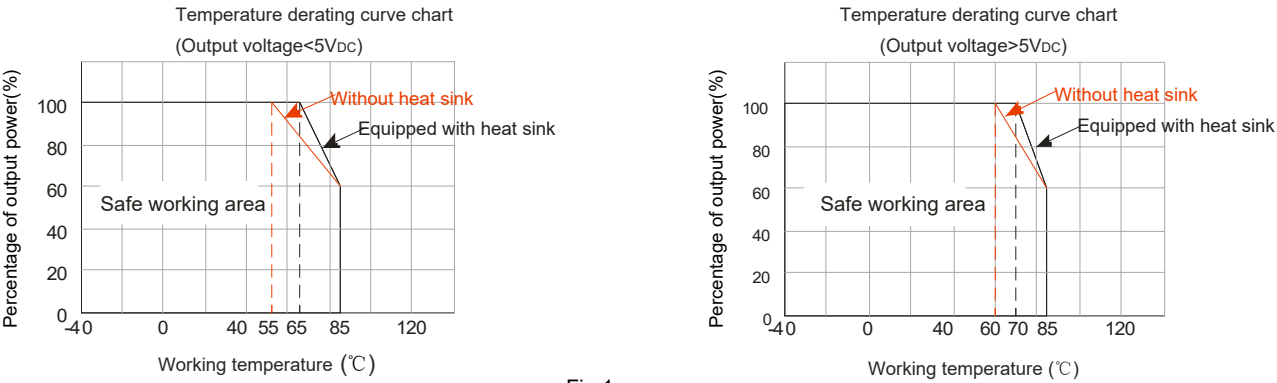
|                |                     |                    |                  |
|----------------|---------------------|--------------------|------------------|
| Case Material  | Aluminum alloy      |                    |                  |
| Dimensions     | Without heat sink   | Horizontal package | 50.8×25.4×11.8mm |
|                | Heat sink           | Horizontal package | 50.8x25.4x23.0mm |
| Weight         | Without heat sink   | Horizontal package | 41.0g            |
|                | Heat sink           | Horizontal package | 50.8g            |
| Cooling Method | Free air convection |                    |                  |

## Electromagnetic Compatibility (EMC)

|           |    |                                                                                                                                                                                                                                                                                                   |
|-----------|----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Emissions | CE | CISPR32/EN55032 CLASS A (V <sub>out</sub> = 12/15V see Fig. 3-① for recommended circuit, V <sub>out</sub> =05/24V see Fig. 3-③ for recommended circuit) / CLASS B (V <sub>out</sub> = 12/15V see Fig. 3-② for recommended circuit, V <sub>out</sub> =05/24V see Fig. 3-④ for recommended circuit) |
|           | RE | CISPR32/EN55032 CLASS A (V <sub>out</sub> = 12/15V see Fig. 3-① for recommended circuit, V <sub>out</sub> =05/24V see Fig. 3-③ for recommended circuit) / CLASS B (V <sub>out</sub> = 12/15V see Fig. 3-② for recommended circuit,                                                                |

|          |       |                                                   |                                                                                                                         |                  |
|----------|-------|---------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------|------------------|
|          |       | Vout=05/24V see Fig. 3-④ for recommended circuit) |                                                                                                                         |                  |
| Immunity | ESD   | IEC/EN61000-4-2                                   | Contact ±6KV/Air ±8KV                                                                                                   | perf. Criteria B |
|          | RS    | IEC/EN61000-4-3                                   | 10V/m                                                                                                                   | perf. Criteria A |
|          | EFT   | IEC/EN61000-4-4                                   | 100KHz ±2KV (Vout= 12/15V see Fig. 3-② for recommended circuit, Vout=05/24V see Fig. 3-④ for recommended circuit)       | perf. Criteria A |
|          | Surge | IEC/EN61000-4-5                                   | line to line ±2KV (Vout= 12/15V see Fig. 3-② for recommended circuit, Vout=05/24V see Fig. 3-④ for recommended circuit) | perf. Criteria A |
|          | CS    | IEC/EN61000-4-6                                   | 10 Vr.m.s                                                                                                               | perf. Criteria A |

Typical Characteristic Curves

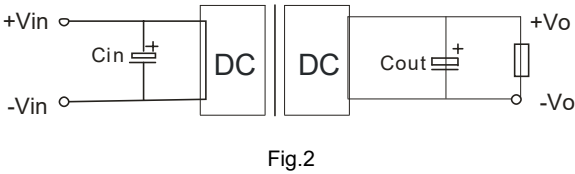


Design Reference

1. Typical application

All the DC-DC converters of this series are tested before delivery using the recommended circuit shown in Fig. 2.

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.



| Vout(V <sub>DC</sub> ) | Cin (μF)  | Cout (μF) |
|------------------------|-----------|-----------|
| 5                      | 100μF/50V | 220uF/16V |
| 12/15                  |           | 100μF/50V |
| 24                     |           | 47μF/50V  |

2. EMC compliance circuit

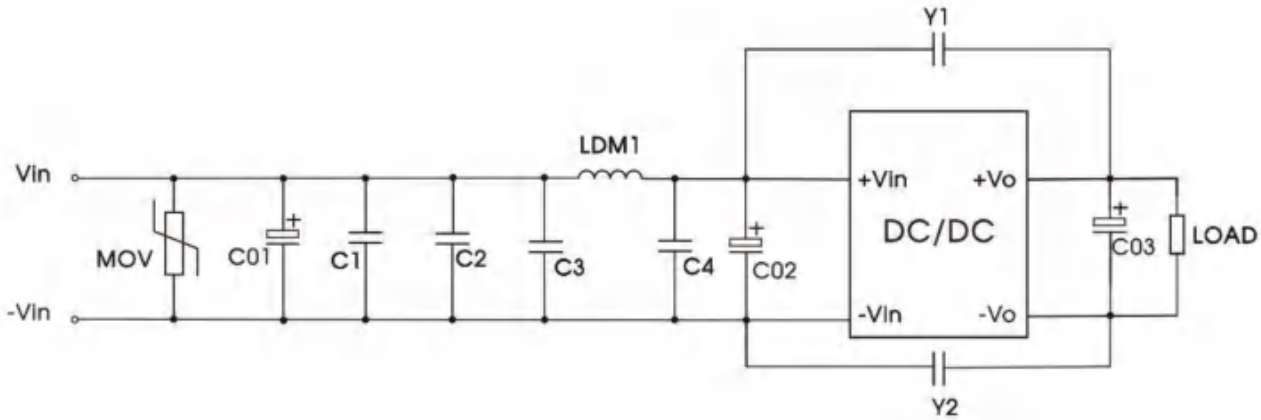


Fig.3-①

Table1 :recommended component parameters

| Model  | Parameter | Parameter description |
|--------|-----------|-----------------------|
| C 1/C2 | 4.7uF     | 50V                   |
| C3/C4  | 10uF      | 50V                   |
| C01    | 680uF     | 50V                   |
| C02    | 330uF     | 50V                   |
| C03    | 100uF     | 100V                  |
| Y1/Y2  | 2.2nF     | Y1                    |
| LDM1   | 2.2uH     | /                     |
| MOV    | 14D470    | /                     |

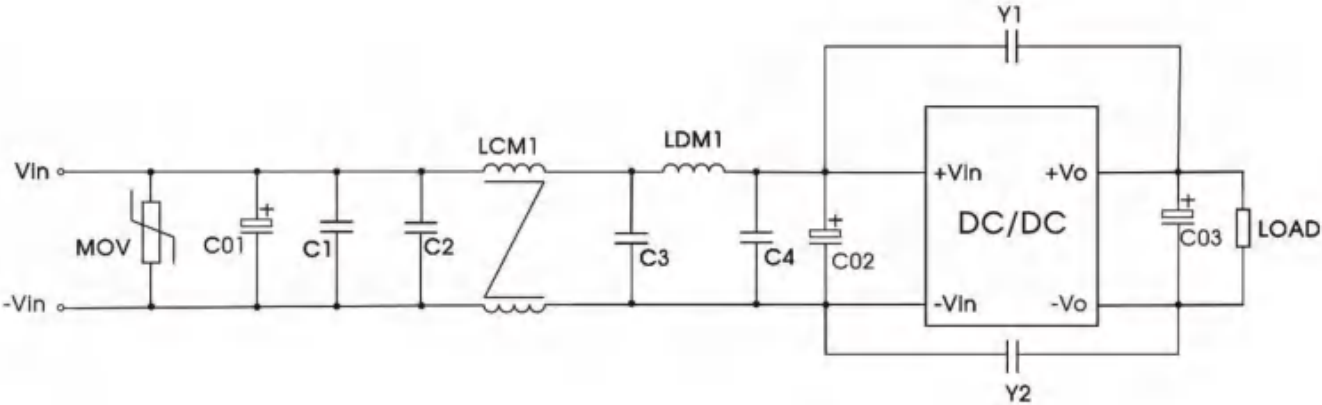


Fig. 3-②

Table 2 : recommended component parameters

| Model  | Parameter | Parameter description |
|--------|-----------|-----------------------|
| C 1/C2 | 4.7uF     | 50V                   |
| C3/C4  | 10uF      | 50V                   |
| C01    | 680uF     | 50V                   |
| C02    | 330uF     | 50V                   |
| C03    | 100uF     | 100V                  |
| Y1/Y2  | 2.2nF     | Y1                    |
| LCM1   | 2.2mH     | /                     |
| LDM1   | 2.2uH     | /                     |
| MOV    | 14D470    | /                     |

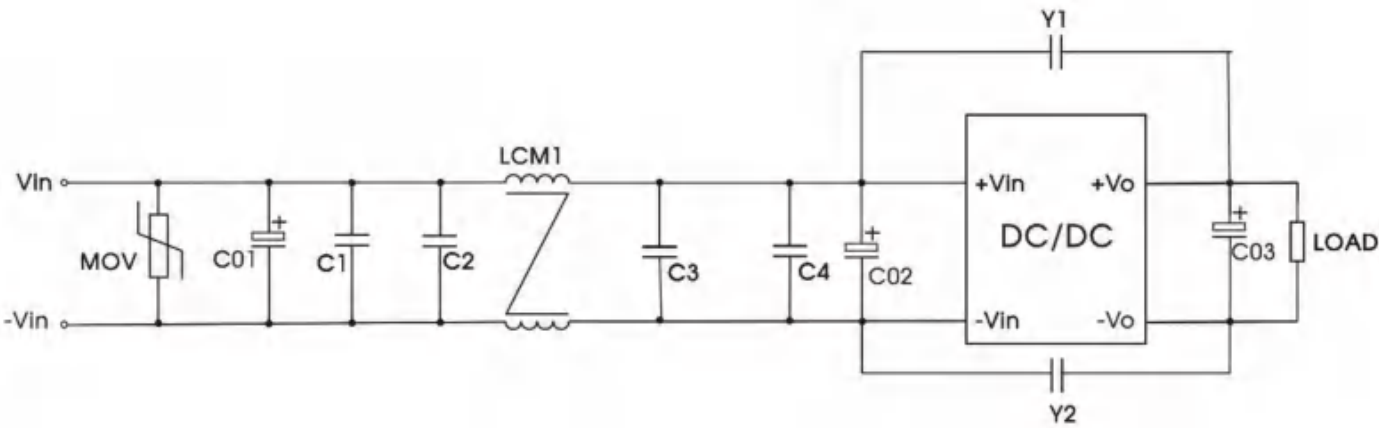


Fig. 3-③

Table 3 : recommended component parameters

| Model  | Parameter | Parameter description |
|--------|-----------|-----------------------|
| C 1/C2 | 4.7uF     | 50V                   |
| C3/C4  | 10uF      | 50V                   |
| C01    | 680uF     | 50V                   |
| C02    | 330uF     | 50V                   |
| C03    | 100uF     | 100V                  |
| Y1/Y2  | 2.2nF     | Y1                    |
| LCM1   | 10mH      | 10.0mH MIN/180mΩ Max  |
| MOV    | 14D470    | /                     |

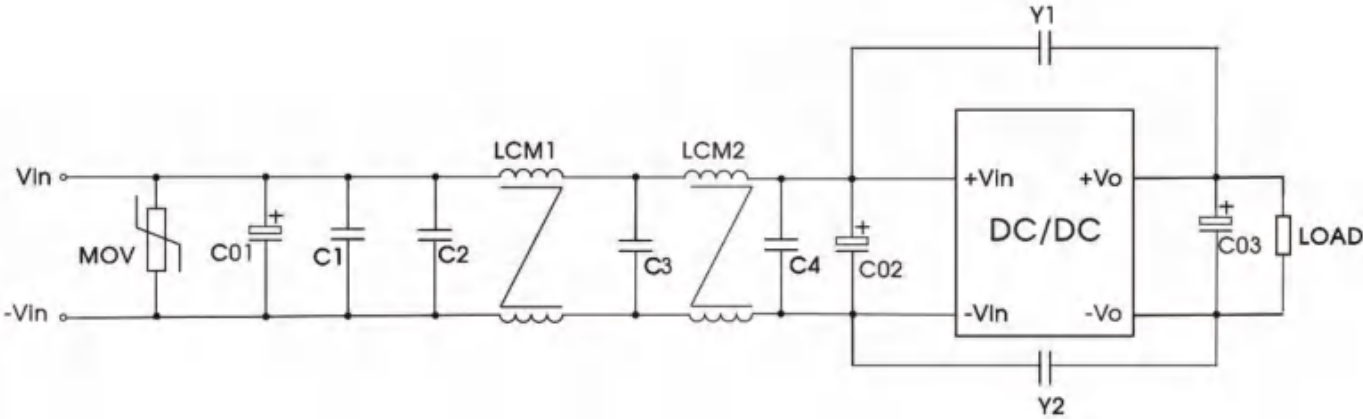
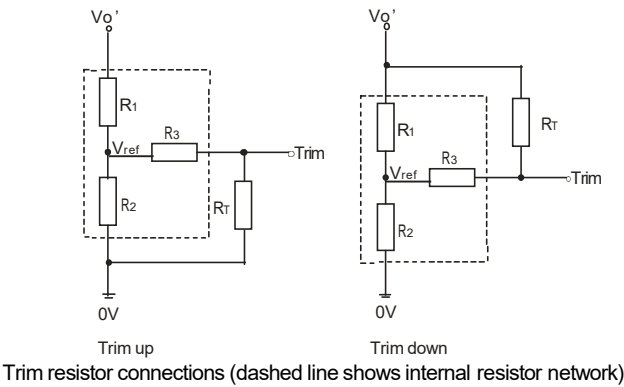


Fig. 3-④

Table 4 : recommended component parameters

| Model     | Parameter                    | Parameter description |
|-----------|------------------------------|-----------------------|
| C1/C2     | 4.7uF                        | 50V                   |
| C3        | 10uF                         | 50V                   |
| C4        | CFDM60-24S05<br>CFDM60-24S24 | 10uF<br>47uF          |
| C01       | 680uF                        | 50V                   |
| C02       | 330uF                        | 50V                   |
| C03       | 100uF                        | 100V                  |
| Y1/Y2     | 2.2nF                        | Y1                    |
| LCM1/LCM2 | 10mH                         | 10.0mH MIN/180mΩ Max  |
| MOV       | 14D470                       | /                     |

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



Calculating Trim resistor values:

$$\text{up: } R_T = \frac{aR_2}{R_2 - a} - R_3$$
$$\text{down: } R_T = \frac{aR_1}{R_1 - a} - R_3$$

$$a = \frac{V_{ref}}{V_{O'} - V_{ref}} \cdot R_1$$
$$a = \frac{V_{O'} - V_{ref}}{V_{ref}} \cdot R_2$$

$R_T$  = Trim Resistor value  
 $a$  = self-defined parameter  
 $V_{O'}$  = desired output voltage

| Vout(Vdc) | R1(KΩ) | R2(KΩ) | R3(KΩ) | Vref(V) |
|-----------|--------|--------|--------|---------|
| 05        | 2.97   | 2.87   | 6.1    | 2.5     |
| 12        | 10.91  | 2.87   | 6.1    | 2.5     |
| 15        | 14.35  | 2.87   | 6.1    | 2.5     |
| 24        | 24.77  | 2.87   | 6.1    | 2.5     |

4. Recommended solution for thermal testing

During the application process, the thermal design of the product can be evaluated in combination with the temperature derating curve of the product, or it can be determined by testing the temperature at point A, it is an safe operating area if the temperature lower than 100℃.



5. Reflected ripple current test circuit

All DC-DC converters of this series are tested using the recommended circuit shown in Fig. 5. Test point,

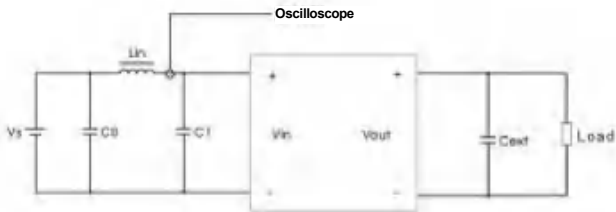
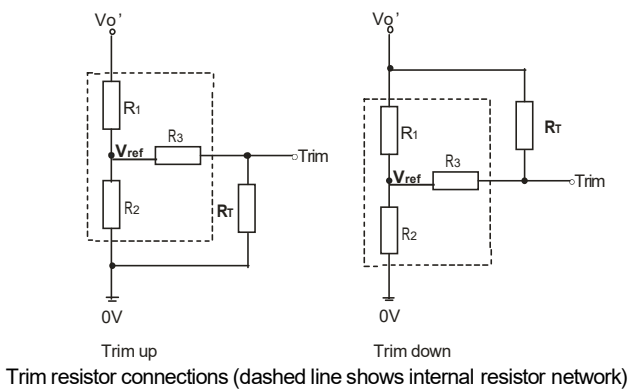


Fig. 5

| Components | Recommended Component Value |
|------------|-----------------------------|
| C0         | 220μF/100V                  |
| Lin        | 10uH/15A                    |
| C1         | 470μF/100V                  |
| Cext       | 470μF/63V                   |

6. The products do not support parallel connection of their output

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



Calculating Trim resistor values:

$$\text{up: } R_T = \frac{a R_2}{R_2 - a} - R_3$$

$$\text{down: } R_T = \frac{a R_1}{R_1 - a} - R_3$$

$$a = \frac{V_{ref}}{V_{o'} - V_{ref}} \cdot R_1$$

$$a = \frac{V_{o'} - V_{ref}}{V_{ref}} \cdot R_2$$

RT=Trim Resistor value

a = self-defined parameter

Vo' = desired output voltage

| Vout(Vdc) | R1(KΩ) | R2(KΩ) | R3(KΩ) | Vref(V) |
|-----------|--------|--------|--------|---------|
| 05        | 2.97   | 2.87   | 6.1    | 2.5     |
| 12        | 10.91  | 2.87   | 6.1    | 2.5     |
| 15        | 14.35  | 2.87   | 6.1    | 2.5     |
| 24        | 24.77  | 2.87   | 6.1    | 2.5     |

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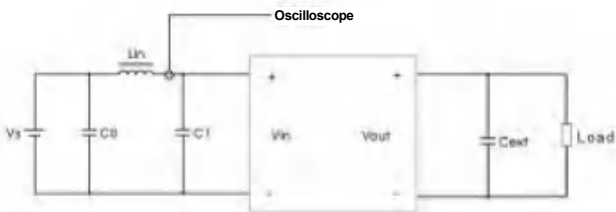
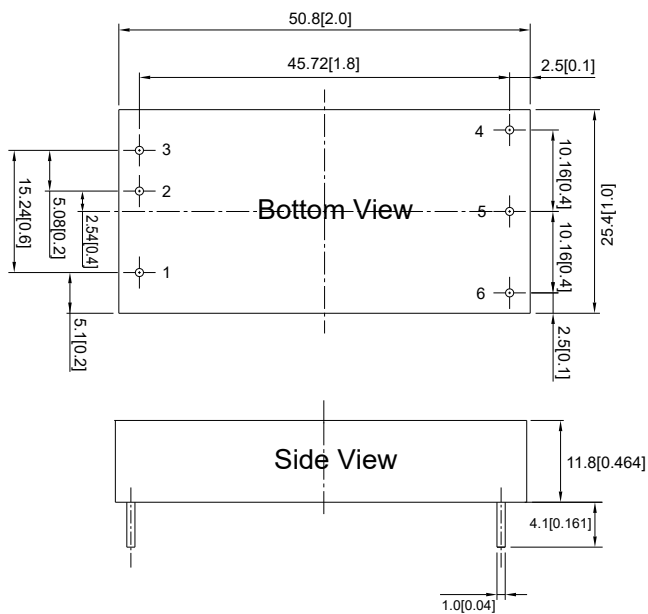


Fig. 5

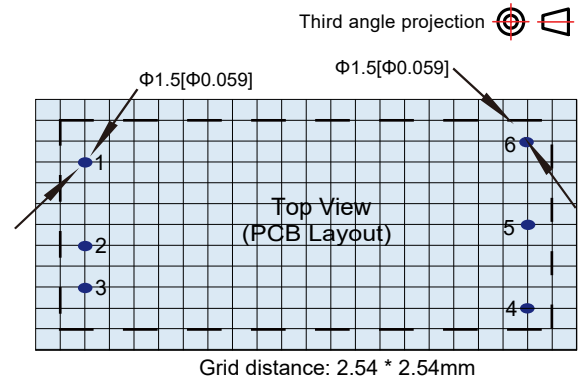
| Components | Recommended Component Value |
|------------|-----------------------------|
| C0         | 220μF/100V                  |
| Lin        | 10uH/15A                    |
| C1         | 470μF/100V                  |
| Cext       | 470μF/63V                   |

6. The products do not support parallel connection of their output

## Packaging size and printing layout:

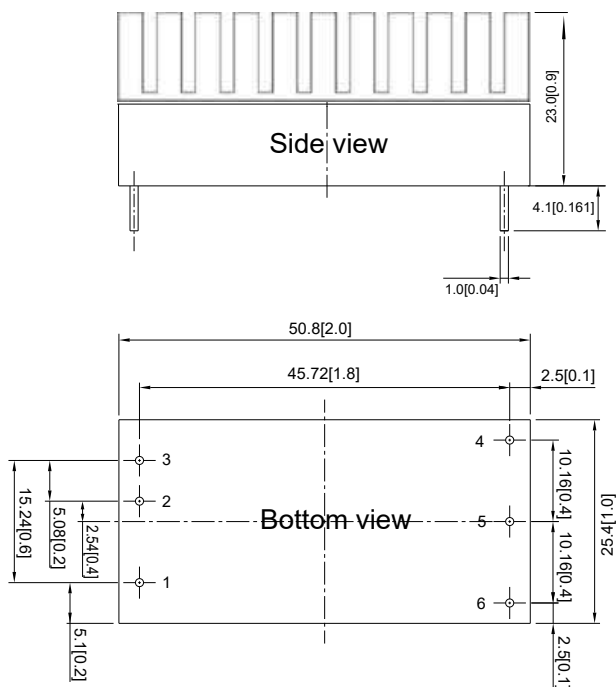


Note:  
Unit: mm[inch]  
Pin diameter tolerances:  $\pm 0.1[\pm 0.004]$   
General tolerances:  $\pm 0.5[\pm 0.02]$

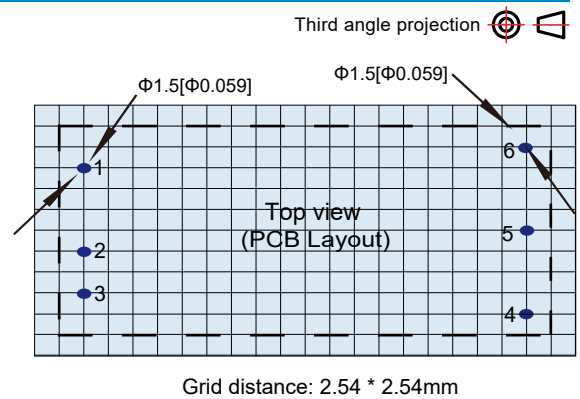


| Pin-Out |      |
|---------|------|
| Pin     | Mark |
| 1       | CNT  |
| 2       | -Vin |
| 3       | +Vin |
| 4       | +Vo  |
| 5       | -Vo  |
| 6       | Trim |

## Size with heat sink:



Note:  
Unit: mm[inch]  
Pin diameter tolerances:  $\pm 0.1[\pm 0.004]$   
General tolerances:  $\pm 0.5[\pm 0.02]$



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



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