CUI INC
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# SERIES: PYBE20 | DESCRIPTION: DC-DC CONVERTER

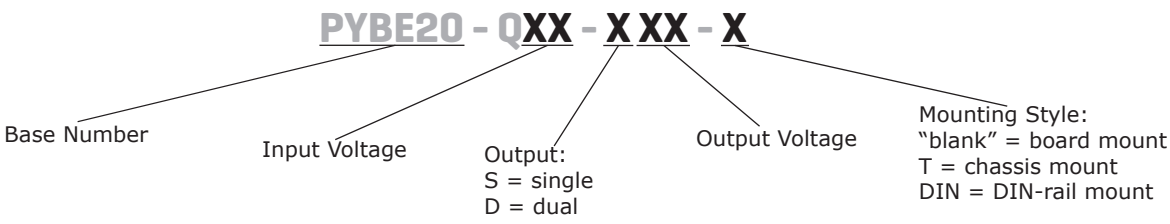
## FEATURES

- up to 20 W isolated output
- industry standard pin-out
- 4:1 input range (9~36 Vdc, 18~75 Vdc)
- single/dual regulated outputs
- 1500 Vdc isolation
- continuous short circuit protection
- efficiency up to 90%
- operating temperature range (-40~+85°C)
- EN/BS EN 62368-1

| MODEL | input voltage | | output voltage | output current | | output power | ripple & noise[1] | efficiency[2] |
|---|---|---|---|---|---|---|---|---|
| | typ (Vdc) | range (Vdc) | (Vdc) | min (mA) | max (mA) | max (W) | max (mVp-p) | typ (%) |
| PYBE20-Q24-S3[3] | 24 | 9~36 | 3.3 | 0 | 5000 | 16.5 | 100 | 86 |
| PYBE20-Q24-S5[3] | 24 | 9~36 | 5 | 0 | 4000 | 20 | 100 | 88 |
| PYBE20-Q24-S9[3] | 24 | 9~36 | 9 | 0 | 2222 | 20 | 100 | 89 |
| PYBE20-Q24-S12[3] | 24 | 9~36 | 12 | 0 | 1667 | 20 | 100 | 89 |
| PYBE20-Q24-S15[3] | 24 | 9~36 | 15 | 0 | 1333 | 20 | 100 | 90 |
| PYBE20-Q24-S24[3] | 24 | 9~36 | 24 | 0 | 834 | 20 | 100 | 90 |
| PYBE20-Q24-D5[3] | 24 | 9~36 | ±5 | 0 | ±2000 | 20 | 100 | 86 |
| PYBE20-Q24-D9[3] | 24 | 9~36 | ±9 | 0 | ±1111 | 20 | 100 | 88 |
| PYBE20-Q24-D12[3] | 24 | 9~36 | ±12 | 0 | ±834 | 20 | 100 | 88 |
| PYBE20-Q24-D15[3] | 24 | 9~36 | ±15 | 0 | ±667 | 20 | 100 | 88 |
| PYBE20-Q48-S3 | 48 | 18~75 | 3.3 | 0 | 5000 | 16.5 | 100 | 86 |
| PYBE20-Q48-S5 | 48 | 18~75 | 5 | 0 | 4000 | 20 | 100 | 86 |
| PYBE20-Q48-S9 | 48 | 18~75 | 9 | 0 | 2222 | 20 | 100 | 89 |
| PYBE20-Q48-S12 | 48 | 18~75 | 12 | 0 | 1667 | 20 | 100 | 87 |
| PYBE20-Q48-S15 | 48 | 18~75 | 15 | 0 | 1333 | 20 | 100 | 90 |
| PYBE20-Q48-S24 | 48 | 18~75 | 24 | 0 | 834 | 20 | 100 | 88 |
| PYBE20-Q48-D5 | 48 | 18~75 | ±5 | 0 | ±2000 | 20 | 100 | 86 |
| PYBE20-Q48-D12 | 48 | 18~75 | ±12 | 0 | ±834 | 20 | 100 | 88 |
| PYBE20-Q48-D15 | 48 | 18~75 | ±15 | 0 | ±667 | 20 | 100 | 89 |

Notes:
1. From 5~100% load, nominal input, 20 MHz bandwidth oscilloscope, with 10 µF tantalum and 1 µF ceramic capacitors on the output. From 0~5% load, ripple and noise is <5% Vo.
2. Measured at nominal input voltage, full load. The typical efficiencies for the chassis mount and DIN-rail mount versions are ~2% less than the board mount versions due to the input reverse polarity protection.
3. Model is not CE certified.
4. All specifications are measured at Ta=25°C, humidity < 75%, nominal input voltage, and rated output load unless otherwise specified.

## PART NUMBER KEY




## INPUT

| parameter | conditions/description | | min | typ | max | units |
|---|---|---|---|---|---|---|
| operating input voltage | 24 Vdc input models | | 9 | 24 | 36 | Vdc |
| | 48 Vdc input models | | 18 | 48 | 75 | Vdc |
| start-up voltage | 24 Vdc input models | | | | 9 | Vdc |
| | 48 Vdc input models | | | | 18 | Vdc |
| surge voltage | for maximum of 1 second | | | | | |
| | 24 Vdc input models | | -0.7 | | 50 | Vdc |
| | 48 Vdc input models | | -0.7 | | 100 | Vdc |
| under voltage shutdown | 24 Vdc input models | | 5.5 | 6.5 | | Vdc |
| | 48 Vdc input models | | 12 | 15.5 | | Vdc |
| current | 24 Vdc input models | 3.3 Vdc output models | | | 818 | mA |
| | | 5 Vdc output models | | | 993 | mA |
| | | all other models | | | 969 | MA |
| | 48 Vdc input models | 3.3 Vdc output models | | | 409 | mA |
| | | 5 Vdc output models | | | 497 | mA |
| | | all other models | | | 485 | mA |
| remote on/off (CTRL)[4] | turn on (3.5~12 Vdc or open circuit) | | | | | |
| | turn off (<1.2 Vdc) | | | | | |
| | input current when switched off | | | 4 | 7 | mA |
| filter | Pi filter | | | | | |
| input reverse polarity protection | only present on chassis mount and DIN-rail mount models | | | | | |
| no load power consumption | | | | 0.15 | | W |

Notes: 4. The voltage of the CTRL pin is referenced to input GND pin.

## OUTPUT

| parameter | conditions/description | min | typ | max | units |
|---|---|---|---|---|---|
| maximum capacitive load[5] | 3.3, 5 Vdc output models | | | 10,000 | µF |
| | 9 Vdc output models | | | 4,700 | µF |
| | 12 Vdc output models | | | 1,600 | µF |
| | 24 Vdc output models | | | 500 | µF |
| | ±5 Vdc output models | | | 4,800 | µF |
| | 15, ±9 Vdc output models | | | 1,000 | µF |
| | ±12 Vdc output models | | | 800 | µF |
| | ±15 Vdc output models | | | 625 | µF |
| voltage accuracy[6] | 0% to full load | | ±1 | ±3 | % |
| line regulation | from low line to high line, full load | | | | |
| | positive outputs | | ±0.2 | ±0.5 | % |
| | negative outputs | | ±0.5 | ±1 | % |
| load regulation[7] | from 5% to full load | | | | |
| | positive outputs | | ±0.5 | ±1 | % |
| | negative outputs | | ±0.5 | ±1.5 | % |

Note: 5. Tested at input voltage range and full load.
6. At 0~5% load, the max output voltage accuracy for the ±5 & ±9 Vdc output models is ±5%.
7. At 0~100% load, the max load regulation is ±5%.

## OUTPUT (CONTINUED)

| parameter | conditions/description | min | typ | max | units |
|---|---|---|---|---|---|
| cross regulation | dual output models:<br>main output 50% load<br>secondary output from 10~100% load | | | ±5 | % |
| start-up time | nominal input, constant resistive load | | 10 | | ms |
| adjustability[8] | see application notes | | ±10 | | % |
| switching frequency[9] | PWM mode | | 270 | | kHz |
| transient recovery time | 25% load step change, nominal input voltage | | 300 | 500 | µs |
| transient response deviation | 25% load step change, nominal input voltage<br>3.3, 5, ±5 Vdc output models<br>all other models | | <br>±5<br>±3 | <br>±8<br>±5 | <br>%<br>% |
| temperature coefficient | at full load | | | ±0.03 | %/°C |

Note: 8. For single output models only.
9. Value is based on full load. At loads <50%, the switching frequency decreases with decreasing load

## PROTECTIONS

| parameter | conditions/description | min | typ | max | units |
|---|---|---|---|---|---|
| over voltage protection | | 110 | | 160 | % |
| over current protection | | 110 | | 190 | % |
| short circuit protection | hiccup, continuous, self recovery | | | | |

## SAFETY AND COMPLIANCE

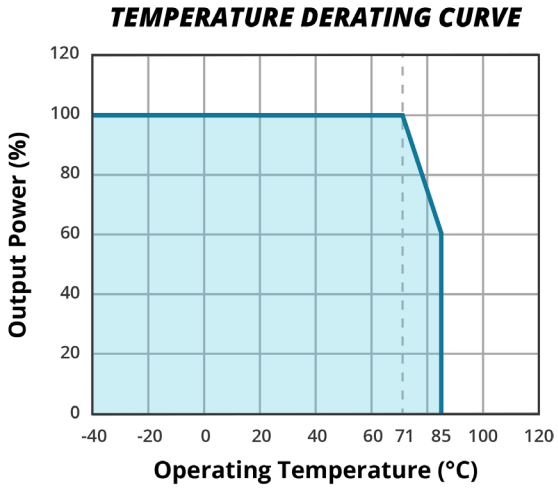
| parameter | conditions/description | min | typ | max | units |
|---|---|---|---|---|---|
| isolation voltage | input to output for 1 minute at 1 mA | 1,500 | | | Vdc |
| isolation resistance | input to output at 500 Vdc | 1,000 | | | MΩ |
| isolation capacitance | input to output, 100 kHz / 0.1 V<br>PYBE20-Q24-S24<br>all other models | | <br>2,050<br>1,050 | | <br>pF<br>pF |
| safety approvals[10, 11] | certified to 62368-1: EN, BS EN<br>certified to 60950-1: UL | | | | |
| conducted emissions | CISPR32/EN55032, class A (no external circuit); class B (external circuit required, see Figure 3-b, 4-b) | | | | |
| radiated emissions | CISPR32/EN55032, class A (no external circuit); class B (external circuit required, see Figure 3-b, 4-b) | | | | |
| ESD | IEC/EN61000-4-2, contact ± 4kV, class B | | | | |
| radiated immunity | IEC/EN61000-4-3, 10V/m, class A | | | | |
| EFT/burst | IEC/EN61000-4-4, ± 2kV, class B (external circuit required, see Figure 3-a, 4-a) | | | | |
| surge | IEC/EN61000-4-5, line-line ± 2kV, class B (external circuit required, see Figure 3-a, 4-a) | | | | |
| conducted immunity | IEC/EN61000-4-6, 3 Vr.m.s, class A | | | | |
| voltage dips & interruptions | IEC/EN61000-4-29, 0%-70%, class B | | | | |
| MTBF | as per MIL-HDBK-217F, 25°C | 1,000,000 | | | hours |
| RoHS | yes | | | | |

Note: 10. UL approval only for board mount models.
11. CE approval only applies for models that have 18~75 Vdc input range. Please refer to the model table.

## ENVIRONMENTAL

| parameter | conditions/description | min | typ | max | units |
|---|---|---|---|---|---|
| operating temperature | see derating curves | -40 | | 85 | °C |
| storage temperature | | -55 | | 125 | °C |
| storage humidity | non-condensing | 5 | | 95 | % |
| vibration | 10~55 Hz, for 30 minutes on each axis | | 10 | | G |

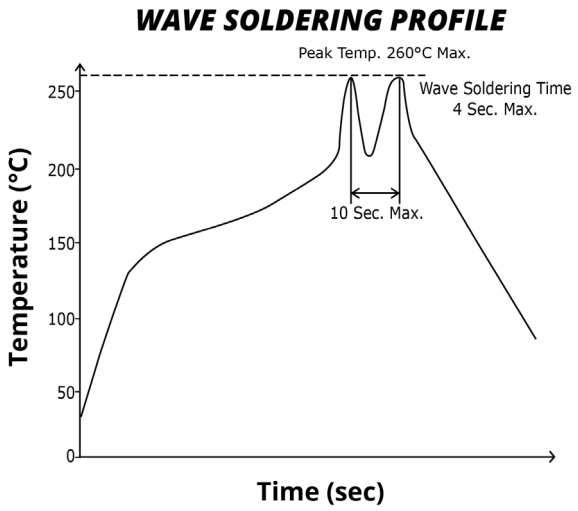
## DERATING CURVES




## SOLDERABILITY[12]

| parameter | conditions/description | min | typ | max | units |
|---|---|---|---|---|---|
| hand soldering | 1.5 mm from case for 10 seconds | | | 300 | °C |
| wave soldering | see wave soldering profile | | | 260 | °C |

Note: 12. For board mount models only.



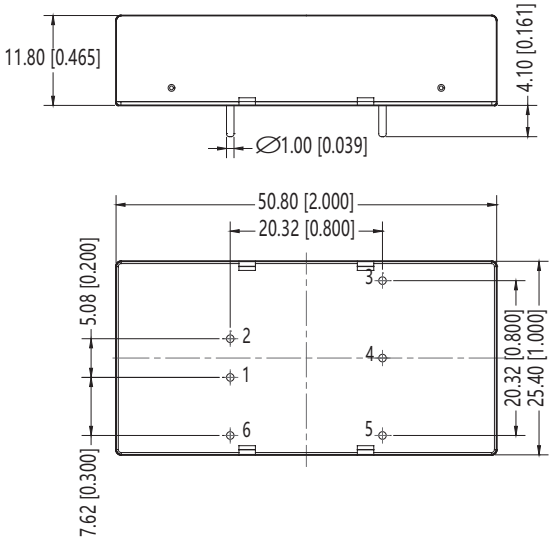
## MECHANICAL

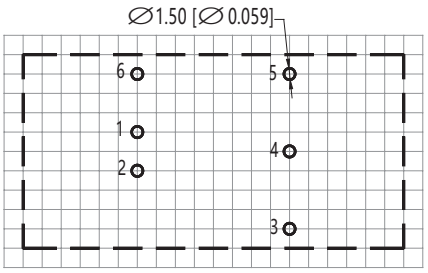
| parameter | conditions/description | min | typ | max | units |
|---|---|---|---|---|---|
| dimensions | board mount: 50.80 x 25.40 x 11.80 [2.000 x 1.000 x 0.465 inch] | | | | mm |
| | chassis mount: 76.00 x 31.50 x 21.20 [2.992 x 1.240 x 0.835 inch] | | | | mm |
| | DIN-rail mount: 76.00 x 31.50 x 25.80 [2.992 x 1.240 x 1.016 inch] | | | | mm |
| case material | aluminum alloy | | | | |
| weight | board mount | | 25 | | g |
| | chassis mount | | 48 | | g |
| | DIN-rail mount | | 68 | | g |

## MECHANICAL DRAWING (BOARD MOUNT)

units: mm [inch]
tolerance: ±0.50[±0.020]
pin diameter tolerance: ±0.10[±0.004]

| PIN CONNECTIONS | | |
|---|---|---|
| PIN | Function | |
| | Single | Dual |
| 1 | GND | GND |
| 2 | Vin | Vin |
| 3 | +Vo | +Vo |
| 4 | trim | 0V |
| 5 | 0V | -Vo |
| 6 | CTRL | CTRL |



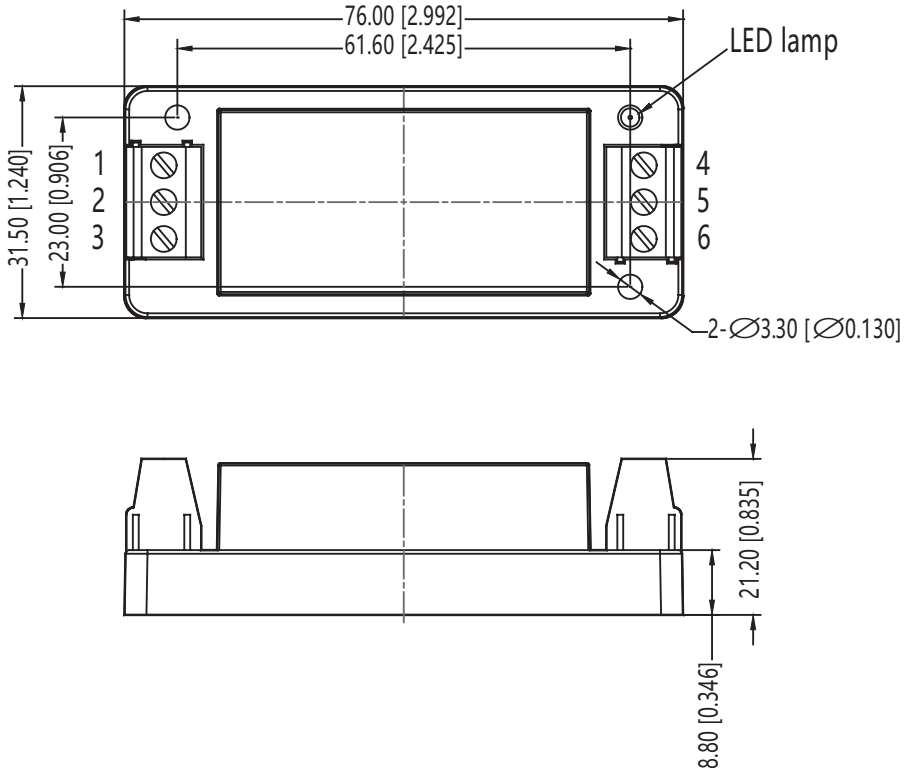

Note: Grid 2.54*2.54mm
Recommended PCB Layout
Top View

## MECHANICAL DRAWING (CHASSIS MOUNT)

units: mm [inch]
tolerance: ±0.50[±0.020]

wire range: 24~12 AWG
tightening torque: max 0.4 N*m

| PIN CONNECTIONS | | |
|---|---|---|
| PIN | Function | |
| | Single | Dual |
| 1 | CTRL | CTRL |
| 2 | GND | GND |
| 3 | Vin | Vin |
| 4 | 0V | -Vo |
| 5 | trim | 0V |
| 6 | +Vo | +Vo |

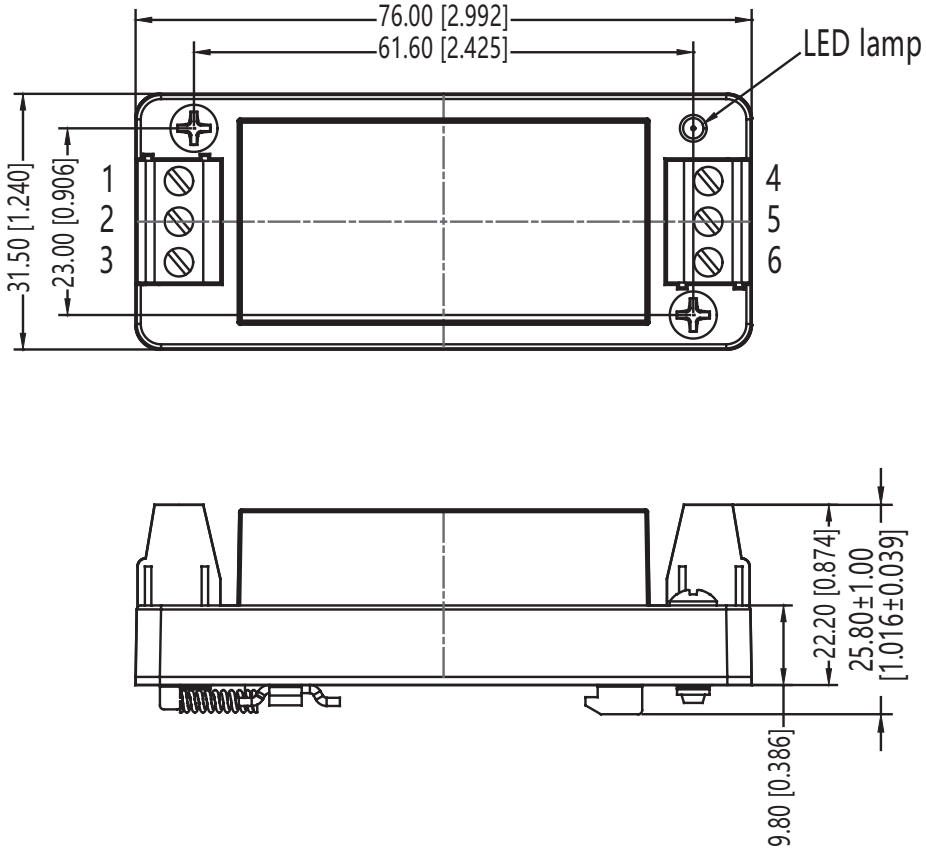



## MECHANICAL DRAWING (DIN-RAIL MOUNT)

units: mm [inch]
tolerance: ±0.50[±0.020]

installed on DIN rail TS35
wire range: 24~12 AWG
tightening torque: max 0.4 N*m

| PIN CONNECTIONS | | |
|---|---|---|
| PIN | Function | |
| | Single | Dual |
| 1 | CTRL | CTRL |
| 2 | GND | GND |
| 3 | Vin | Vin |
| 4 | 0V | -Vo |
| 5 | trim | 0V |
| 6 | +Vo | +Vo |



## APPLICATION CIRCUIT

This series has been tested according to the following recommended circuits (Figures 1 & 2) before leaving the factory. If you want to further reduce the input and output ripple, you can increase the input and output capacitors or select capacitors of low equivalent impedance provided that the capacitance is less than the maximum capacitive load of the model.

**Figure 1**
**Single Output Models**

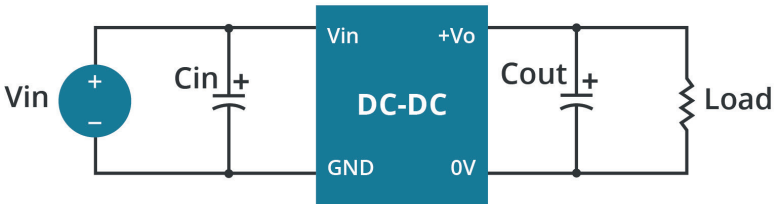



**Figure 2**
**Dual Output Models**

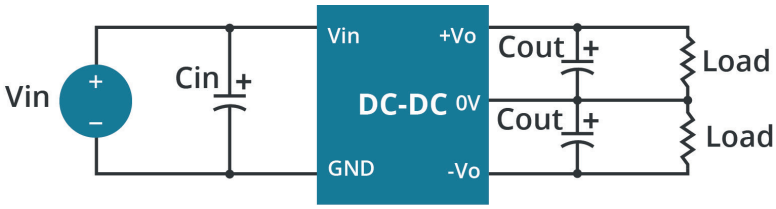



**Table 1**

| Vout (Vdc) | Cin (µF) | Cout (µF) |
|---|---|---|
| 3.3/5 | 100 | 470 |
| 9/12/15 | 100 | 220 |
| 24 | 100 | 100 |
| ±5 | 100 | 220 |
| ±9/±12/±15 | 100 | 100 |

## EMC RECOMMENDED CIRCUIT

**Figure 3**
**Single Output Models**

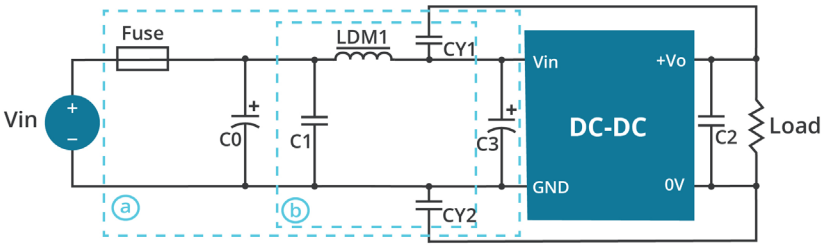



**Figure 4**
**Dual Output Models**

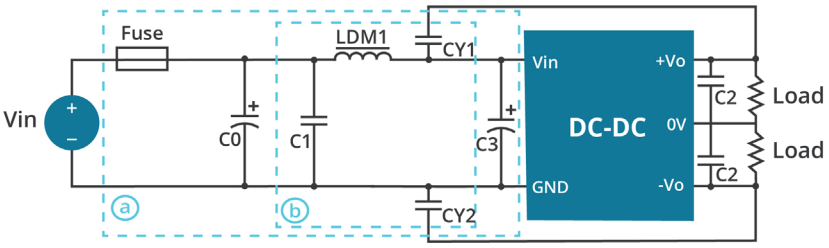



**Table 2**

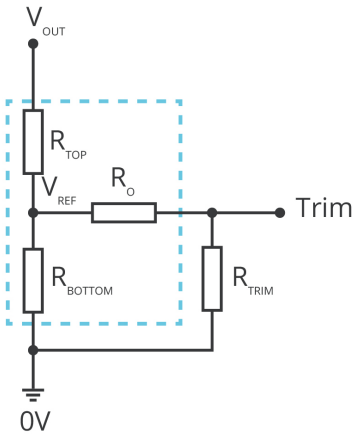
| Recommended External Circuit Components | | |
|---|---|---|
| Vin (Vdc) | 24 | 48 |
| FUSE | choose according to actual input current | |
| C0, C3 | 330 µF / 50 V | 330 µF / 100 V |
| C1 | 1 µF / 50 V | 1 µF / 100 V |
| C2 | Refer to the Cout in Table 1 | |
| LDM1 | 4.7 µH / 3.1 A | |
| CY1, CY2 | 1 nF / 2 kV | |

## APPLICATION NOTES

Output voltage trimming
Leave open if not used.

**Figure 3**

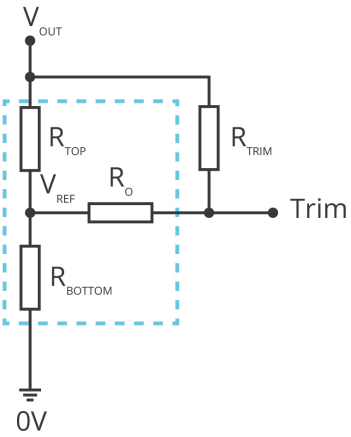
*Trim up*




$$R_{TRIM} = \frac{a \cdot R_{BOTTOM}}{R_{BOTTOM} - a} - R_O \qquad a = \frac{V_{REF}}{V_{OUT} - V_{REF}} \cdot R_{TOP}$$

*Formula for Trim up*

*Trim down*




$$R_{TRIM} = \frac{a \cdot R_{TOP}}{R_{TOP} - a} - R_O \qquad a = \frac{V_{OUT} - V_{REF}}{V_{REF}} \cdot R_{BOTTOM}$$

*Formula for Trim down*

**Table 3**

| $V_{OUT}$ | $R_{TOP}$ | $R_{BOTTOM}$ | $R_O$ | $V_{REF}$ |
|---|---|---|---|---|
| (Vdc) | (kΩ) | (kΩ) | (kΩ) | (V) |
| 3.3 | 4.801 | 2.87 | 12.4 | 1.25 |
| 5 | 2.883 | 2.87 | 10 | 2.5 |
| 9 | 7.500 | 2.87 | 15 | 2.5 |
| 12 | 11.000 | 2.87 | 15 | 2.5 |
| 15 | 14.494 | 2.87 | 15 | 2.5 |
| 24 | 24.872 | 2.87 | 17.8 | 2.5 |

Note: Value for $R_{TOP}$, $R_{BOTTOM}$, $R_O$, and $V_{REF}$ refer to Table 3 (fixed internal values).
$R_{TRIM}$: Trim resistance
a: User-defined parameter, no actual meanings
$V_{OUT}$: Nominal output voltage

## REVISION HISTORY

| rev. | description | date |
|---|---|---|
| 1.0 | initial release | 01/24/2019 |
| 1.01 | features and safety line updated | 01/12/2021 |
| 1.02 | derating curve and circuit figures updated, packaging removed | 08/23/2021 |
| 1.03 | Vref updated for 3.3 Vdc output model | 02/07/2022 |
| 1.04 | CE certification updated for 24V models | 12/21/2022 |
| 1.05 | CE note updated in the safety & compliance section | 11/10/2023 |

The revision history provided is for informational purposes only and is believed to be accurate.

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