CUI INC
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# SERIES: PQC60 | DESCRIPTION: DC-DC CONVERTER

## FEATURES

- 60 W isolated output
- 4:1 input range (9~36 Vdc)
- single regulated outputs
- 1,500 Vdc isolation
- extended temperature range (-40 to +105 C)
- over-current, input under-voltage, over-voltage and output short-circuit protection
- optional heatsink available

RoHS

## MODEL

| MODEL | input voltage typ (Vdc) | input voltage range (Vdc) | output voltage (Vdc) | output current min (mA) | output current max (mA) | output power max (W) | ripple and noise[1] max (mVp-p) | efficiency[2] typ (%) |
|---|---|---|---|---|---|---|---|---|
| PQC60-24-S5 | 24 | 9~36 | 5 | 600 | 12,000 | 60 | 100 | 92 |
| PQC60-24-S12 | 24 | 9~36 | 12 | 250 | 5,000 | 60 | 100 | 93 |
| PQC60-24-S15 | 24 | 9~36 | 15 | 200 | 4,000 | 60 | 100 | 93.3 |
| PQC60-24-S24 | 24 | 9~36 | 24 | 125 | 2,500 | 60 | 130 | 93 |

Notes:
1. Ripple and noise are measured at 20 MHz BW, 5%~100% load with 1 µF ceramic and 10 µF electrolytic capacitors on the output. 3% max from 0%-5% load. Measured at 20 MHz BW, 20MHz bandwidth, nominal input voltage.
2. Efficiency is measured at nominal input voltage and rated output load.

## PART NUMBER KEY

**PQC60 - 24 - SXX - X**

- PQC60 - Base Number
- 24 - Input Voltage
- S - Output, S = single
- XX - Output Voltage
- X - Heatsink, "blank" = no heatsink, H = with heatsink

## INPUT

| parameter | conditions/description | min | typ | max | units |
|---|---|---|---|---|---|
| operating input voltage | | 9 | 24 | 36 | Vdc |
| current (full load/no load) | at nominal input voltage | | 2718/25 | 2748/30 | mA |
| start-up voltage | | | | 9 | Vdc |
| absolute maximum continuous voltage | | | | 40 | Vdc |
| surge voltage | for maximum of 1 second | -0.7 | | 50 | Vdc |
| CTRL[3] | module on (CTRL pin open or pulled high (3~12Vdc) | | | | |
| | module off (CTRL pin pulled low to GND (0~1.2Vdc) | | | | |
| filter | Pi filter | | | | |

Notes: 3. The CTRL pin voltage is referenced to input GND.

## OUTPUT

| parameter | conditions/description | min | typ | max | units |
|---|---|---|---|---|---|
| maximum capacitive load | 5 Vdc output<br>12 Vdc output<br>15 Vdc output<br>24 Vdc output | | | 20,000<br>6,000<br>4,000<br>2,000 | µF<br>µF<br>µF<br>µF |
| line regulation | full load, input voltage from low to high | | ±0.2 | ±0.5 | % |
| load regulation | 5% to 100% load | | ±0.5 | ±1 | % |
| voltage accuracy | 5% to 100% load<br>0% to 5% load | | ±1<br>±2 | ±2<br>±5 | %<br>% |
| switching frequency[4] | PWM mode | | 370 | | kHz |
| transient recovery time | 25% load step change, nominal input voltage | | 250 | 500 | µs |
| transient response deviation | 25% load step change, nominal input voltage range<br>5 Vdc output voltage<br>all other output models | | <br>±3<br>±3 | <br>±10<br>±5 | <br>%<br>% |
| temperature coeffecient | full load | | | ±0.03 | %/°C |

Notes: 4. Switching frequency is measured at full load. The module reduces the switching frequency for light load (below 50%) efficiency improvement.

## PROTECTIONS

| parameter | conditions/description | min | typ | max | units |
|---|---|---|---|---|---|
| over voltage protection | | 110 | 140 | 160 | % |
| over current protection | | 110 | 140 | 200 | % |
| short circuit protection | auto recovery, continuous | | | | |

## SAFETY AND COMPLIANCE

| parameter | conditions/description | min | typ | max | units |
|---|---|---|---|---|---|
| isolation voltage | input to output for 1 minute at 1 mA max.<br>input/output to case for 1 minute at 1 mA max. | 1,500<br>1,000 | | | Vdc<br>Vdc |
| isolation resistance | input to output at 500 Vdc | 100 | | | MΩ |
| isolation capacitance | input to output at 100kHz/0.1V | | 2,200 | | pF |
| vibration | 10-150Hz, 5G, 0.75mm. along X, Y and Z | | | | |
| safety approvals | designed to meet 62368: EN, BS EN | | | | |
| conducted emissions | CISPR32/EN 55032 Class A (Vout=12/15V see Fig. 2-1 for recommended circuit, Vout=05/24V see Fig. 2-3 for recommended circuit) / Class B (Vout=12/15V see Fig. 2-2 for recommended circuit, Vout=05/24V see Fig. 2-4 for recommended circuit) | | | | |
| radiated emissions | CISPR32/EN 55032 Class A (Vout=12/15V see Fig. 2-1 for recommended circuit, Vout=05/24V see Fig. 2-3 for recommended circuit) / Class B (Vout=12/15V see Fig. 2-2 for recommended circuit, Vout=05/24V see Fig. 2-4 for recommended circuit) | | | | |
| ESD | IEC/EN61000-4-2 Contact ±6KV/Air ±8KV, perf. Criteria B | | | | |

## SAFETY AND COMPLIANCE (CONTINUED)

| parameter | conditions/description | min | typ | max | units |
|---|---|---|---|---|---|
| radiated immunity | IEC/EN61000-4-3 10V/m, perf. Criteria A | | | | |
| EFT/burst | IEC/EN61000-4-4 100KHz ±2KV (Vout=12/15V see Fig. 2-2 for recommended circuit, Vout=05/24V see Fig. 2-4 for recommended circuit), perf. Criteria A | | | | |
| surge | IEC/EN61000-4-5 line to line ±2KV (Vout=12/15V see Fig. 2-2 for recommended circuit, Vout=05/24V see Fig. 2-4 for recommended circuit), perf. Criteria A | | | | |
| conducted immunity | IEC/EN61000-4-6 10Vrms, perf. Criteria A | | | | |
| MTBF | as per MIL-HDBK-217F @ 25°C | 1,000,000 | | | hours |
| RoHS | yes | | | | |

## ENVIRONMENTAL

| parameter | conditions/description | min | typ | max | units |
|---|---|---|---|---|---|
| operating temperature | see derating curve | -40 | | 105 | °C |
| storage temperature | | -55 | | 125 | °C |
| storage humidity | non-condensing | 5 | | 95 | % |

## SOLDERABILITY

| parameter | conditions/description | min | typ | max | units |
|---|---|---|---|---|---|
| pin soldering resistance temperature | soldering spot is 1.5mm away from case for 10 seconds | | | 300 | °C |

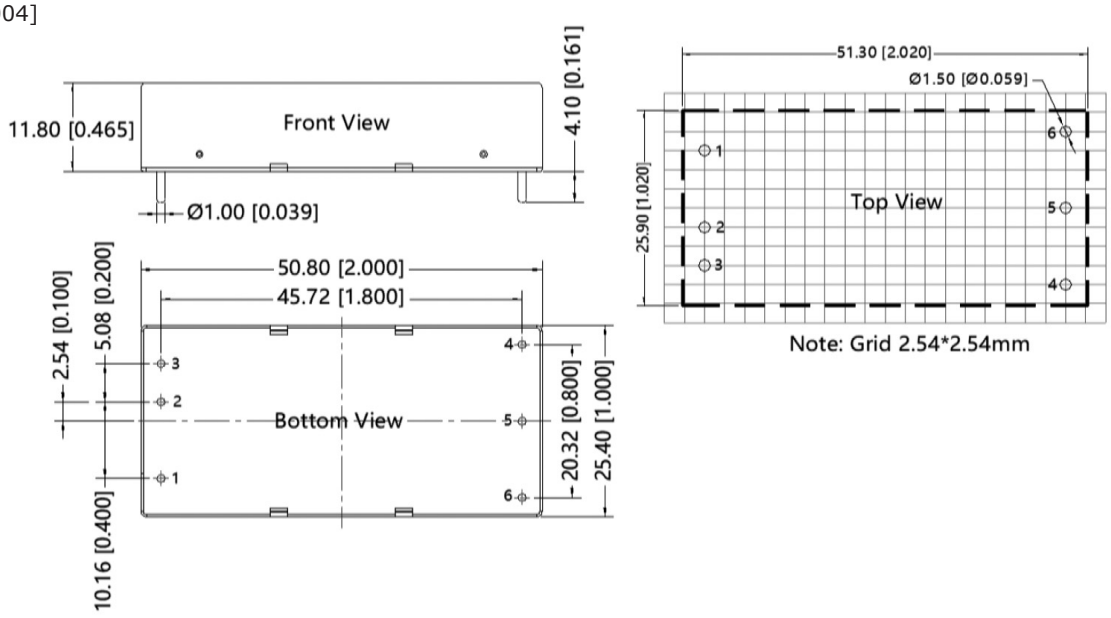
## MECHANICAL

| parameter | conditions/description | min | typ | max | units |
|---|---|---|---|---|---|
| dimensions | without heatsink: 50.80 x 25.40 x 11.80 [2.000 x 1.000 x 0.464 inch]<br>with heatsink: 51.40 x 26.20 x 16.50 [2.023 x 1.031 x 0.650 inch] | | | | mm<br>mm |
| weight | without heatsink<br>with heatsink | | 41.0<br>50.8 | | g<br>g |
| cooling method | natural convection | | | | |

## MECHANICAL DRAWING

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

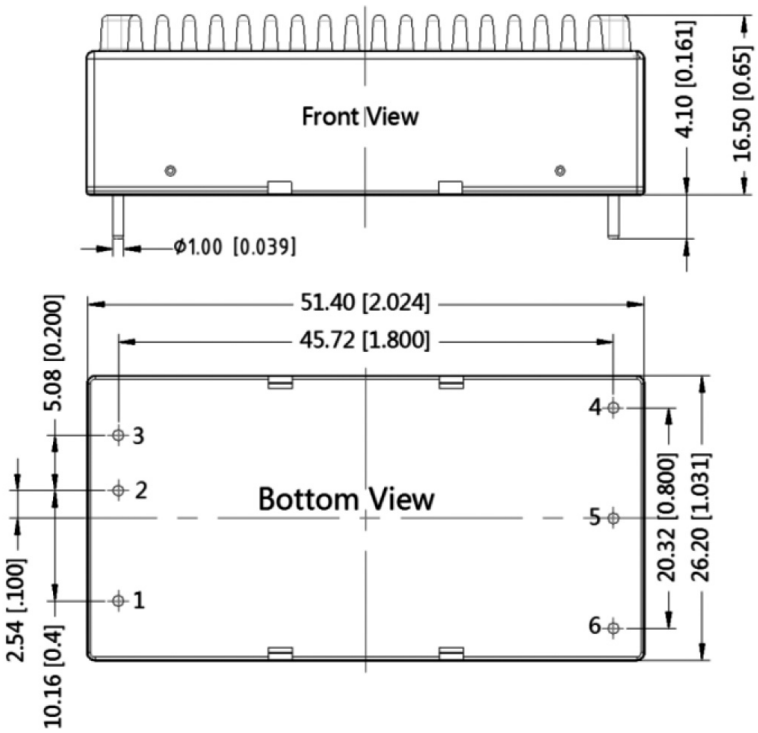
| PIN CONNECTIONS | |
|---|---|
| PIN | Function |
| 1 | CTRL |
| 2 | GND |
| 3 | Vin |
| 4 | +Vo |
| 5 | 0V |
| 6 | Trim |



## MECHANICAL DRAWING (CONTINUED)

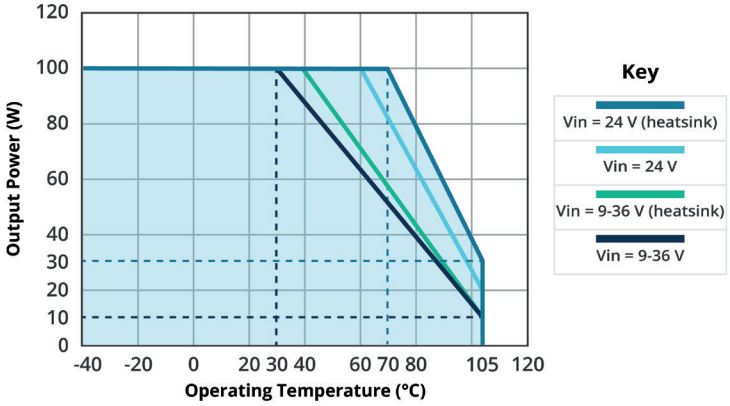
**WITH HEATSINK**
units: mm[inch]
tolerance: ±0.50[±0.020]

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

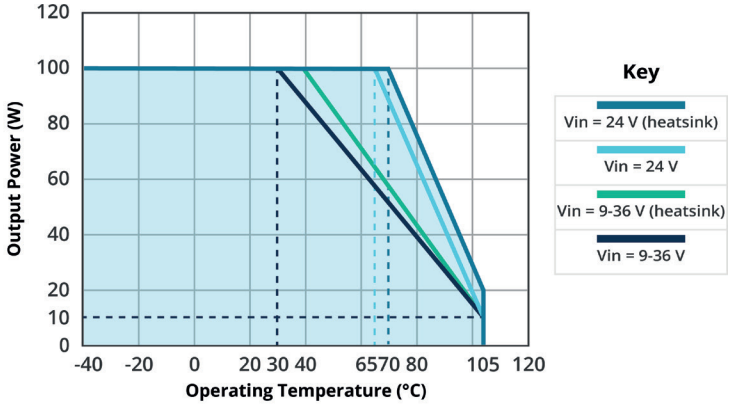


## DERATING CURVES

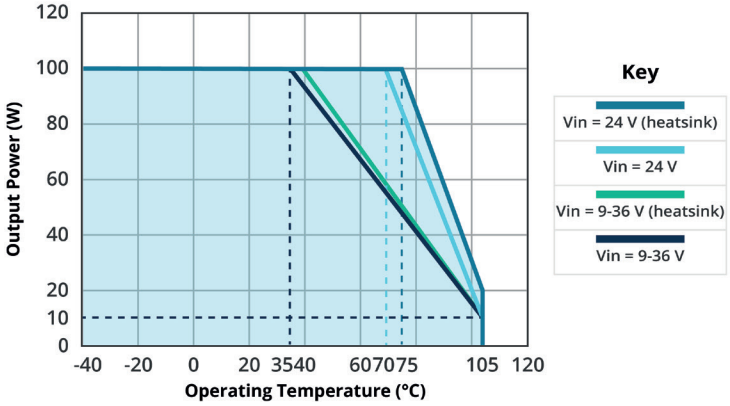
***TEMPERATURE DERATING CURVE***
***PQC60-24-S5***
***(natural convection)***



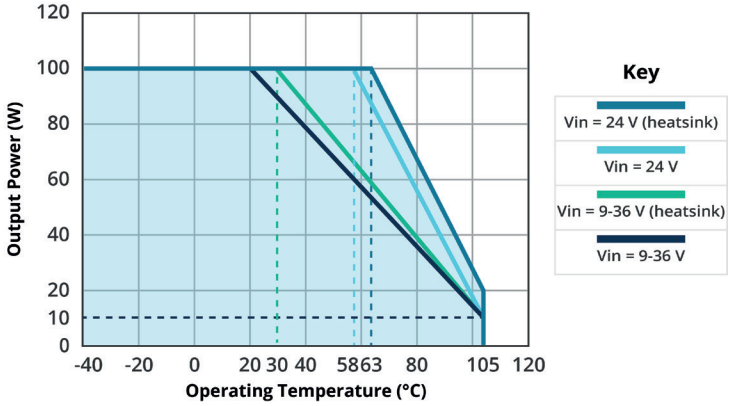

***TEMPERATURE DERATING CURVE***
***PQC60-24-S12***
***(natural convection)***




***TEMPERATURE DERATING CURVE***
***PQC60-24-S15***
***(natural convection)***

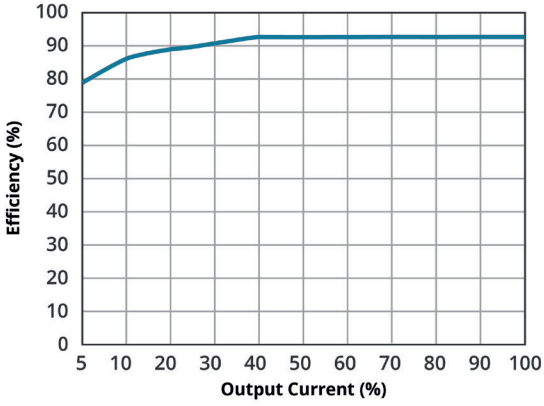



***TEMPERATURE DERATING CURVE***
***PQC60-24-S24***
***(natural convection)***

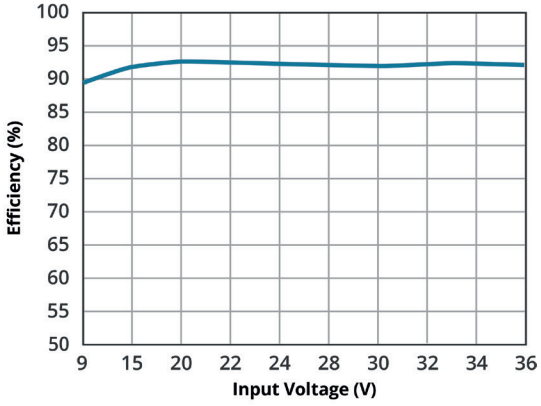



## EFFICIENCY CURVES

***EFFICIENCY VS OUTPUT LOAD***
***PQC60-24-S5(-H)***
***(Vin = 24V)***

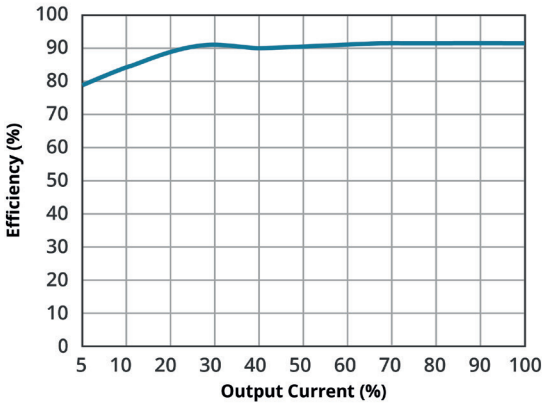



***EFFICIENCY VS INPUT VOLTAGE***
***PQC60-24-S5(-H)***
***(full load)***

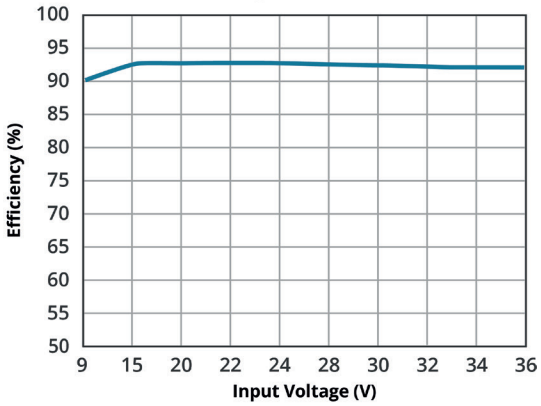


## EFFICIENCY CURVES (CONTINUED)

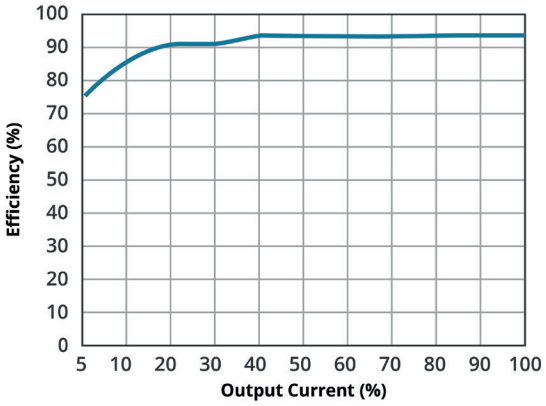
***EFFICIENCY VS OUTPUT LOAD***
***PQC60-24-S12(-H)***
***(Vin = 24V)***



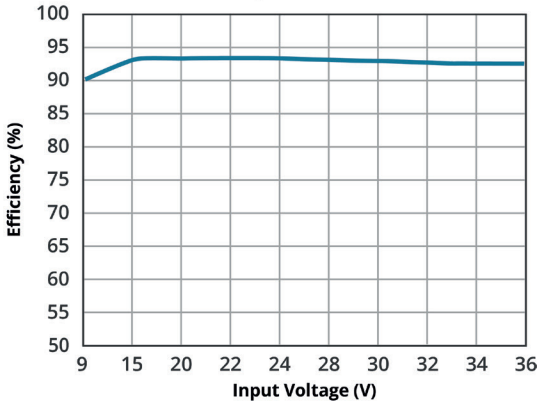

***EFFICIENCY VS INPUT VOLTAGE***
***PQC60-24-S12(-H)***
***(full load)***



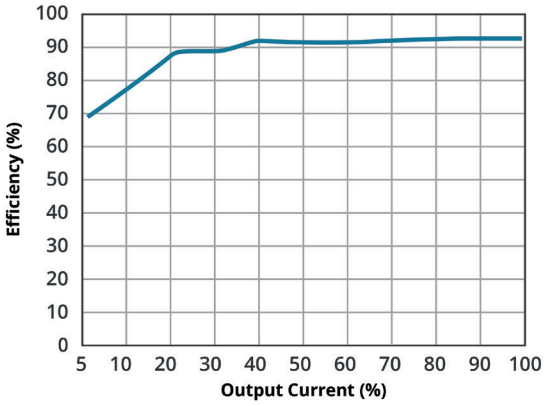

***EFFICIENCY VS OUTPUT LOAD***
***PQC60-24-S15(-H)***
***(Vin = 24V)***



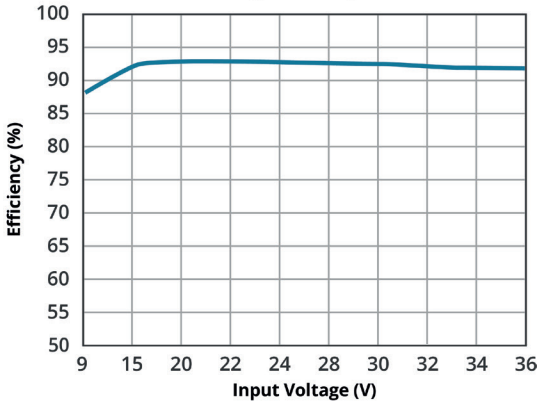

***EFFICIENCY VS INPUT VOLTAGE***
***PQC60-24-S15(-H)***
***(full load)***




***EFFICIENCY VS OUTPUT LOAD***
***PQC60-24-S24(-H)***
***(Vin = 24V)***




***EFFICIENCY VS INPUT VOLTAGE***
***PQC60-24-S24(-H)***
***(full load)***



## APPLICATION NOTES

All the DC-DC converters of this series are tested before delivery using the recommended circuit shown in Fig. 1. 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.

**Figure 1**

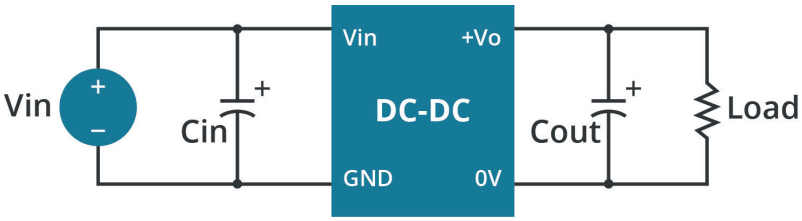



**Table 1**

| Vin (Vdc) | Vout (Vdc) | Cin (µF/V) | Cout (µF) |
|---|---|---|---|
| 24 | 5 | 100µF/50V | 220µF/16V |
| | 12/15 | | 100µF/50V |
| | 24 | | 47µF/50V |

## EMC RECOMMENDED CIRCUIT

**Figure 2-1**

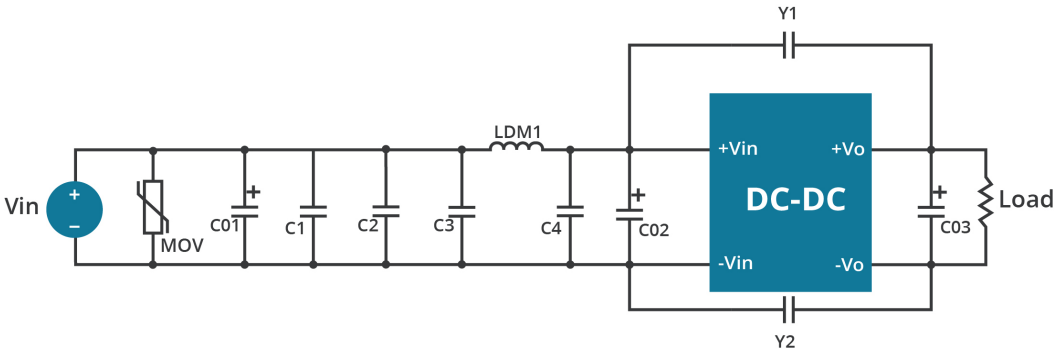



**Table 2**

| Recommended external circuit components | |
|---|---|
| C1/C2 | 4.7µF/50V |
| C3/C4 | 10µF/50V |
| C01 | 680µF/50V |
| C02 | 330µF/50V |
| C03 | 100µF/100V |
| Y1/Y2 | 2.2nF/Y1 |
| LDM1 | 2.2µH |
| MOV | 14D470 |

**Figure 2-2**

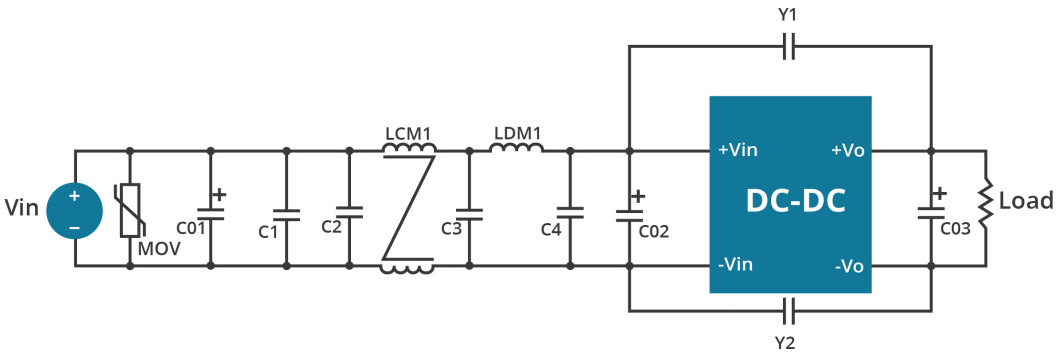



**Table 3**

| Recommended external circuit components | |
|---|---|
| C1/C2 | 4.7µF/50V |
| C3/C4 | 10µF/50V |
| C01 | 680µF/50V |
| C02 | 330µF/50V |
| C03 | 100µF/100V |
| Y1/Y2 | 2.2nF/Y1 |
| LCM1 | 2.2mH |
| LDM1 | 2.2µH |
| MOV | 14D470 |

## EMC RECOMMENDED CIRCUIT (CONTINUED)

**Figure 2-3**

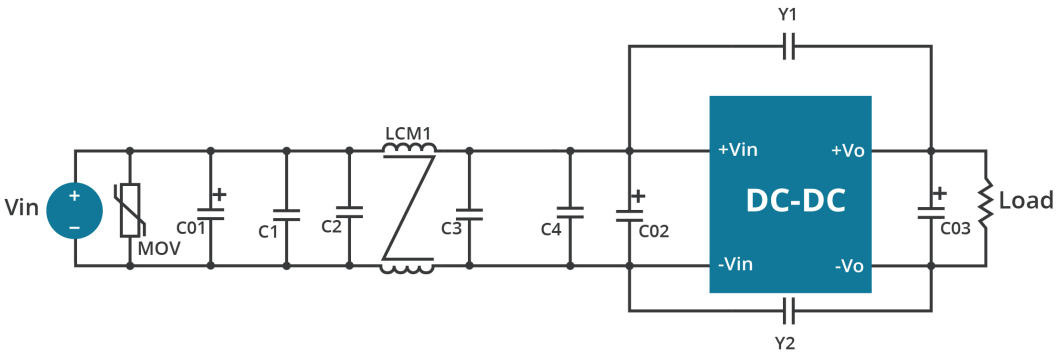



**Table 4**

| Recommended external circuit components | |
|---|---|
| C1/C2 | 4.7µF/50V |
| C3/C4 | 10µF/50V |
| C01 | 680µF/50V |
| C02 | 330µF/50V |
| C03 | 100µF/100V |
| Y1/Y2 | 2.2nF/Y1 |
| LCM1 | 10mH/<br>10.0mH min/180mΩ max |
| MOV | 14D470 |

**Figure 2-4**

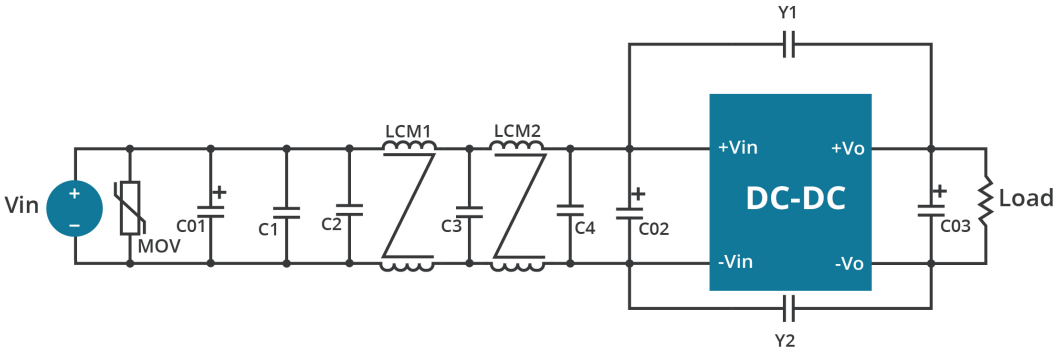



**Table 5**

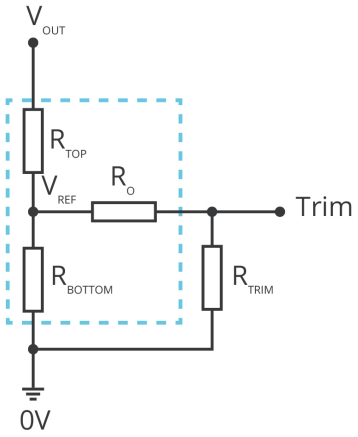
| Recommended external circuit components | | |
|---|---|---|
| C1/C2 | 4.7µF/50V | |
| C3 | 10µF/50V | |
| C4 | PQC60-24-S5<br>PQC60-24-S24 | 10µF/50V<br>47µF/50V |
| C01 | 680µF/50V | |
| C02 | 330µF/50V | |
| C03 | 100µF/100V | |
| Y1/Y2 | 2.2nF/Y1 | |
| LCM1/<br>LCM2 | 10mH/<br>10.0mH min/180mΩ max | |
| MOV | 14D470 | |

## APPLICATION NOTES

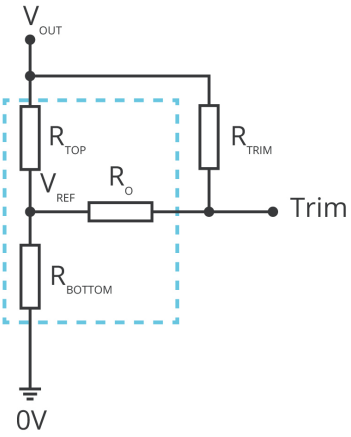
Trim Function for Output Voltage Adjustment (open if unused).

**Figure 3**

*Trim up*




*Trim down*




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

*Formula for Trim up*

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

*Formula for Trim down*

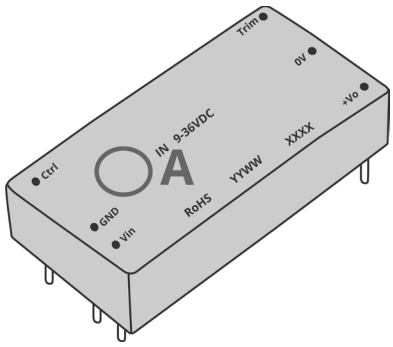
**Table 6**

| $V_{NOM}$ | $R_{TOP}$ | $R_{BOTTOM}$ | $R_O$ | $V_{REF}$ |
|---|---|---|---|---|
| (Vdc) | (kΩ) | (kΩ) | (kΩ) | (V) |
| 5 | 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 |

Note: Value for $R_{TOP}$, $R_{BOTTOM}$, $R_O$, and $V_{REF}$ refer to Table 6 (fixed internal values).
$R_{TRIM}$: Trim resistance
a: User-defined parameter, no actual meanings
$V_{NOM}$: Nominal output voltage
$V_{OUT}$: Target output voltage

## 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°C.




## REFLECTED RIPPLE CURRENT TEST CIRCUIT

All DC-DC converters of this series are tested using the recommended circuit shown in Fig. 4. Test point.

**Figure 4**

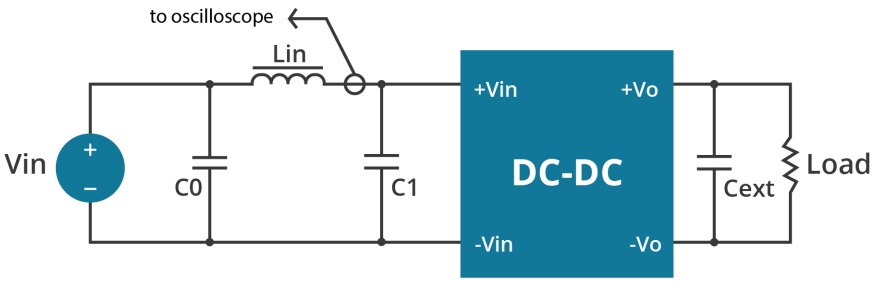



**Table 7**

| Recommended external circuit components | |
|---|---|
| C0 | 220µF/100V |
| Lin | 10µH/15V |
| C1 | 470µF/100V |
| Cext | 470µF/63V |

## REVISION HISTORY

| rev. | description | date |
|---|---|---|
| 1.0 | initial release | 01/30/2023 |

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

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CUI offers a two (2) year limited warranty. Complete warranty information is listed on our website.

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CUI products are not authorized or warranted for use as critical components in equipment that requires an extremely high level of reliability. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.