CUI INC
a bel group



# SERIES: VHK50W | DESCRIPTION: DC-DC CONVERTER

## FEATURES

- up to 50 W isolated output
- rugged metal enclosure with integrated heat sink
- 4:1 input range (9~36 Vdc, 18~75 Vdc)
- single output from 3.3~48 Vdc
- 1,500 Vdc isolation
- over current, over temperature, over voltage, and short circuit protections
- remote on/off
- efficiency up to 83%

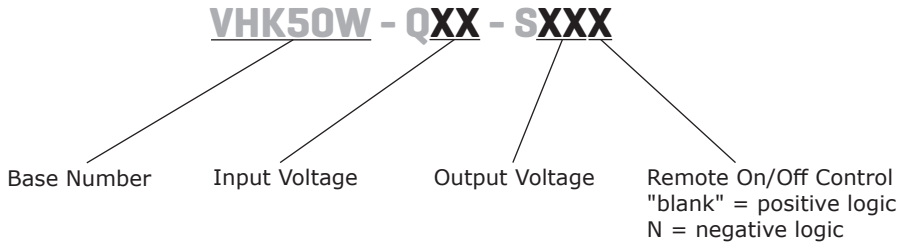

RoHS CE

## MODEL

| MODEL | input voltage range (Vdc) | output voltage (Vdc) | output current max (A) | output power max (W) | ripple and noise[1] max (mVp-p) | efficiency typ (%) |
|---|---|---|---|---|---|---|
| VHK50W-Q24-S3R3 | 9 ~ 36 | 3.3 | 10 | 33 | 100 | 75 |
| VHK50W-Q24-S5 | 9 ~ 36 | 5 | 10 | 50 | 100 | 79 |
| VHK50W-Q24-S12 | 9 ~ 36 | 12 | 4.16 | 50 | 150 | 82 |
| VHK50W-Q24-S15 | 9 ~ 36 | 15 | 3.33 | 50 | 150 | 82 |
| VHK50W-Q24-S24 | 9 ~ 36 | 24 | 2.08 | 50 | 240 | 82 |
| VHK50W-Q24-S28 | 9 ~ 36 | 28 | 1.78 | 50 | 280 | 82 |
| VHK50W-Q24-S48 | 9 ~ 36 | 48 | 1.04 | 50 | 480 | 82 |
| VHK50W-Q48-S3R3 | 18 ~ 75 | 3.3 | 10 | 33 | 100 | 76 |
| VHK50W-Q48-S5 | 18 ~ 75 | 5 | 10 | 50 | 100 | 80 |
| VHK50W-Q48-S12 | 18 ~ 75 | 12 | 4.16 | 50 | 150 | 83 |
| VHK50W-Q48-S15 | 18 ~ 75 | 15 | 3.33 | 50 | 150 | 83 |
| VHK50W-Q48-S24 | 18 ~ 75 | 24 | 2.08 | 50 | 240 | 83 |
| VHK50W-Q48-S28 | 18 ~ 75 | 28 | 1.78 | 50 | 280 | 83 |
| VHK50W-Q48-S48 | 18 ~ 75 | 48 | 1.04 | 50 | 480 | 83 |

Note: 1. Ripple and noise are measured at full load, 20 MHz BW with 10µF tantalum capacitor and 1µF ceramic capacitor across output. The 48 Vdc output models only require the 1µF ceramic capacitor across the output.

## PART NUMBER KEY



## INPUT

| parameter | conditions/description | | min | typ | max | units |
|---|---|---|---|---|---|---|
| operating input voltage | 24 Vdc input models<br>48 Vdc input models | | 9<br>18 | 24<br>48 | 36<br>75 | Vdc<br>Vdc |
| under voltage shutdown | 24 Vdc input | power up<br>power down | | 8.8<br>8 | | Vdc<br>Vdc |
| | 48 Vdc input | power up<br>power down | | 17<br>16 | | Vdc<br>Vdc |
| CTRL[1] | positive logic | models ON (open circuit) | | | | |
| | | models OFF (0~0.8 Vdc) | | | | |
| | negative logic | models ON (0~0.8 Vdc) | | | | |
| | | models OFF (open circuit) | | | | |
| filter | pi filter | | | | | |
| input fuse | 15A time delay fuse for 24 Vin models,<br>8A time delay fuse for 48 Vin models | | | | | |

Note: 1. Open collector refer to -Vin

## OUTPUT

| parameter | conditions/description | min | typ | max | units |
|---|---|---|---|---|---|
| maximum capacitive load | 3.3 and 5 V output models<br>12 V output models<br>15 V output models<br>24 V output models<br>28 V output models<br>48 V output models | <br><br><br><br><br>47 | | 10,000<br>4,160<br>3,330<br>2,080<br>1,780<br>1,040 | µF<br>µF<br>µF<br>µF<br>µF<br>µF |
| line regulation[2] | measured from high line to low line | | | ±0.2 | % |
| load regulation[2] | measured from full load to zero load | | | ±0.2 | % |
| voltage accuracy[2] | | | | ±1 | % |
| adjustability | | | ±10 | | % |
| switching frequency | | | 300 | | kHz |
| transient response | 25% step load change | | | 500 | µs |
| temperature coefficient | | | ±0.03 | | %/°C |

Note: 2. A 47 µF aluminum capacitor is required on the output for 48 Vdc output models.

## PROTECTIONS

| parameter | conditions/description | min | typ | max | units |
|---|---|---|---|---|---|
| short circuit protection | continuous | | | | |
| over current protection | % nominal output current | 110 | | 160 | % |
| over voltage protection | | 115 | | 140 | % |
| over temperature protection | shutdown<br>restart threshold | | 100<br>70 | | °C<br>°C |

## SAFETY AND COMPLIANCE

| parameter | conditions/description | min | typ | max | units |
|---|---|---|---|---|---|
| isolation voltage | for 1 min: input/output; input/case; output/case | 1,500 | | | Vdc |
| isolation resistance | | 10 | | | MΩ |
| RoHS | 2011/65/EU (CE) | | | | |

## ENVIRONMENTAL

| parameter | conditions/description | min | typ | max | units |
|---|---|---|---|---|---|
| operating temperature | see derating curve | -40 | | 85 | °C |
| storage temperature | | -55 | | 105 | °C |

## MECHANICAL

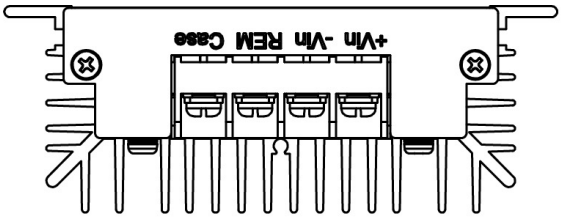
| parameter | conditions/description | min | typ | max | units |
|---|---|---|---|---|---|
| dimensions | 4.23 x 4.01 x 1.50 [107.5 x 101.8 x 38.0 mm] | | | | inch |
| case material | steel and aluminum extrusion | | | | |
| weight | | | 502 | | g |

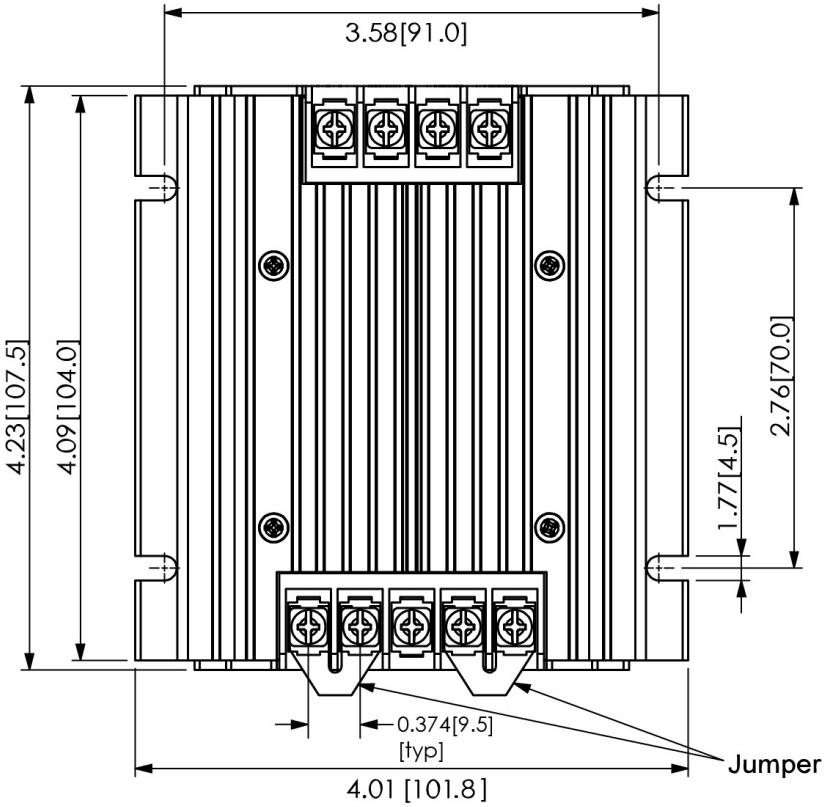
## MECHANICAL DRAWING

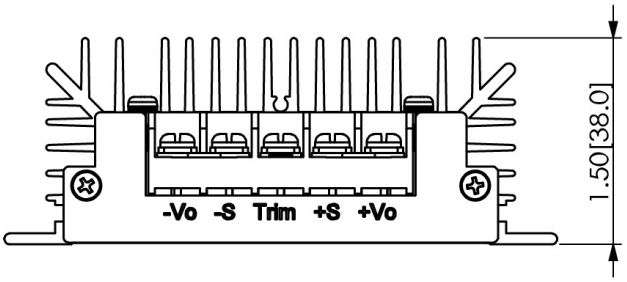
units: inch[mm]
general tolerance: ±0.04[±1.0]

wire range: 22~12 AWG
screw size: #6-32
connector tightening torque: 1.4 N·m (max)

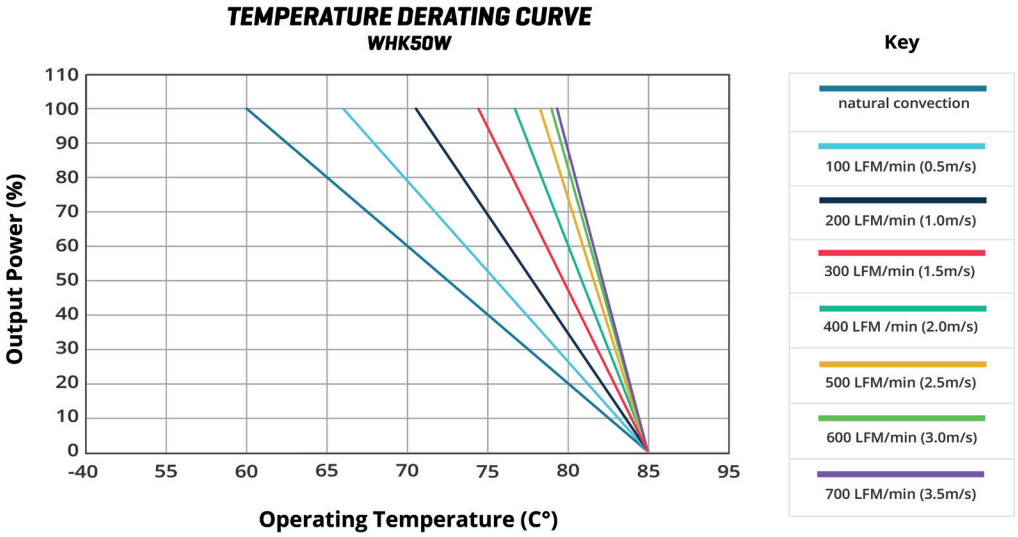
| PIN CONNECTIONS | |
|---|---|
| PIN | FUNCTION |
| 1 | -Vo |
| 2 | -S |
| 3 | trim |
| 4 | +S |
| 5 | +Vo |
| 6 | case |
| 7 | on/off |
| 8 | -Vin |
| 9 | +Vin |



## DERATING CURVES




## TEST CONFIGURATION

**Figure 1**

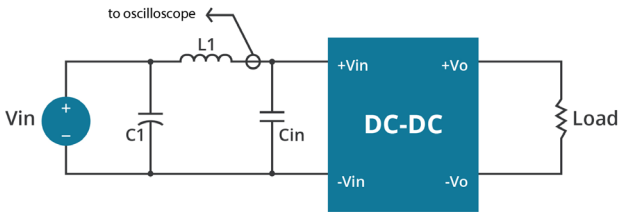



**Table 1**

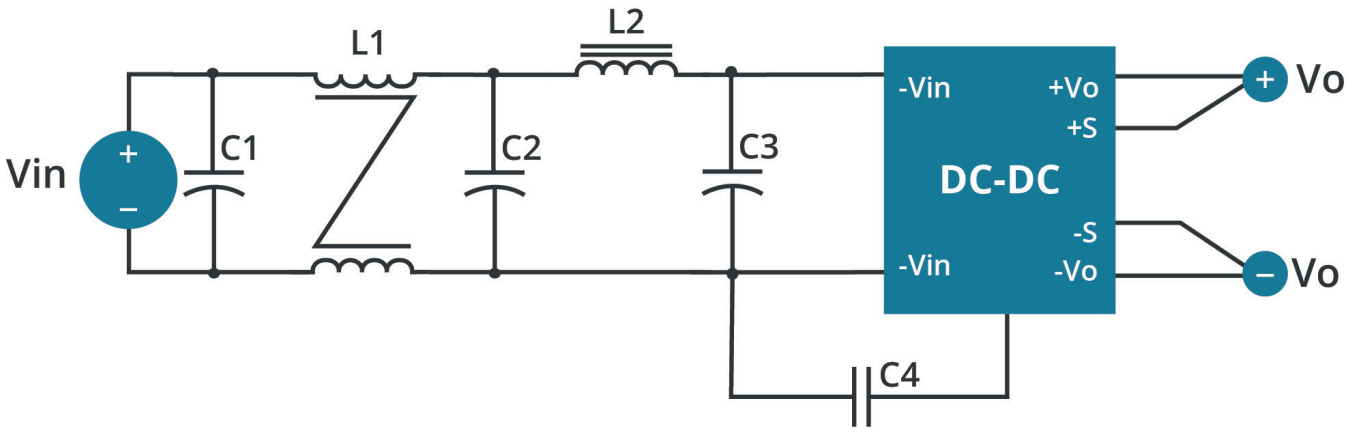
| External components | |
|---|---|
| L1 | 12µH |
| C1 | 220µF, ESR < 0.1Ω at 100 KHz |
| Cin | 100µF, ESR < 0.1Ω at 100 KHz |

Note: Input reflected-ripple current is measured with an inductor L1 and Capacitor C1 to simulate source impedance.

## EMC RECOMMENDED CIRCUITS

### EN55022 CLASS A

**Figure 2**
**Recommended Circuit for EN55022 Class A**
(for all 3.3, 5, 12, 15, 24, & 28 Vdc output models)



## EMC RECOMMENDED CIRCUITS (CONTINUED)

### EN55022 CLASS A

**Figure 3**
**Recommended Circuit for EN55022 Class A**
(for all 48 Vdc output models)

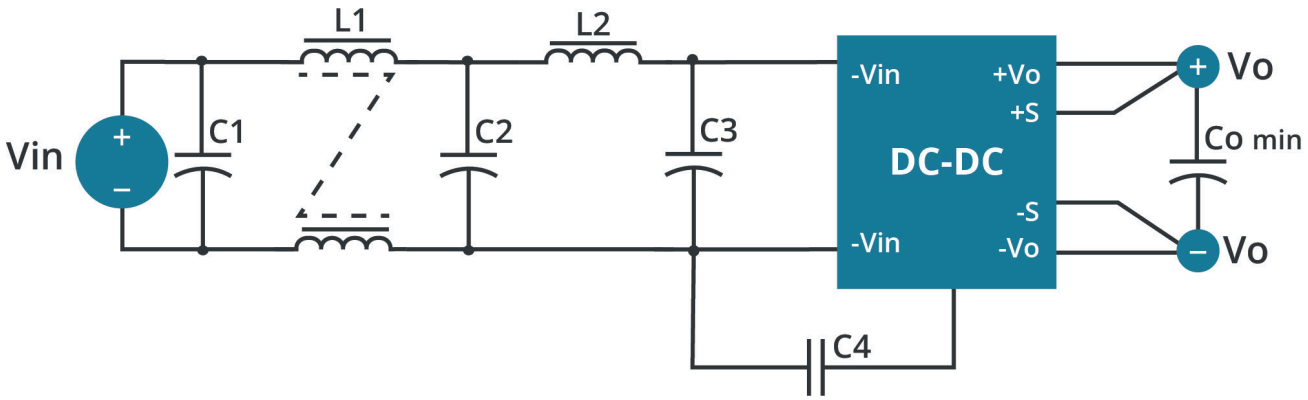



**Table 2**
**Class A Recommended Components**

| Model | C1[1] | C2[2] | C3[2] | C4[1] | L1 | L2 | Co min. |
|---|---|---|---|---|---|---|---|
| VHK50W-Q24-S3R3 | NC | 100 µF/50 V | 100 µF/50 V | 2200 pF/2 kV | Short | 3.5 µH | NC |
| VHK50W-Q24-S5 | NC | 100 µF/50 V | 100 µF/50 V | 2200 pF/2 kV | Short | 3.5 µH | NC |
| VHK50W-Q24-S12 | NC | 100 µF/50 V | 100 µF/50 V | 2200 pF/2 kV | Short | 3.5 µH | NC |
| VHK50W-Q24-S15 | NC | 100 µF/50 V | 100 µF/50 V | 2200 pF/2 kV | Short | 3.5 µH | NC |
| VHK50W-Q24-S24 | 10 µF/50 V | 100 µF/50 V | 100 µF/50 V | NC | 1.5 mH | 3.4 µH | NC |
| VHK50W-Q24-S28 | NC | 100 µF/50 V | 100 µF/50 V | 2200 pF/2 kV | Short | 3.4 µH | NC |
| VHK50W-Q24-S48 | NC | 100 µF/50 V | 100 µF/50 V | NC | Short | 3.5 µH | 47 µF |
| VHK50W-Q48-S3R3 | NC | 47 µF/100 V | 47 µF/100 V | 2200 pF/2 kV | Short | 3.4 µH | NC |
| VHK50W-Q48-S5 | NC | 47 µF/100 V | 47 µF/100 V | 2200 pF/2 kV | Short | 3.4 µH | NC |
| VHK50W-Q48-S12 | NC | 47 µF/100 V | 47 µF/100 V | 2200 pF/2 kV | Short | 3.4 µH | NC |
| VHK50W-Q48-S15 | NC | 47 µF/100 V | 47 µF/100 V | 2200 pF/2 kV | Short | 3.4 µH | NC |
| VHK50W-Q48-S24 | NC | 47 µF/100 V | 47 µF/100 V | 2200 pF/2 kV | Short | 3.4 µH | NC |
| VHK50W-Q48-S28 | NC | 100 µF/100 V | 100 µF/100 V | 2200 pF/2 kV | Short | 3.4 µH | NC |
| VHK50W-Q48-S48 | NC | 47 µF/100 V | 47 µF/100 V | 2200 pF/2 kV | Short | 3.5 µH | 47 µF |

Note: 1. Ceramic capacitors
2. Aluminum capacitors

## EMC RECOMMENDED CIRCUITS (CONTINUED)

### EN55022 CLASS B

**Figure 4**
**Recommended Circuit for EN55022 Class B**
(for all 3.3, 5, 12, 15, & 24 Vdc output models)

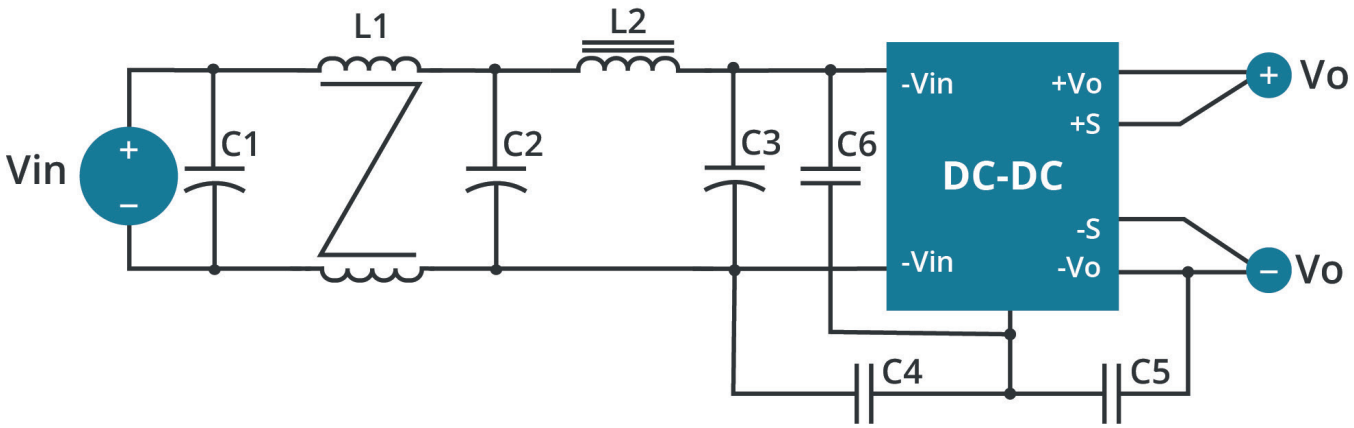



**Figure 5**
**Recommended Circuit for EN55022 Class B**
(for all 28 Vdc output models)

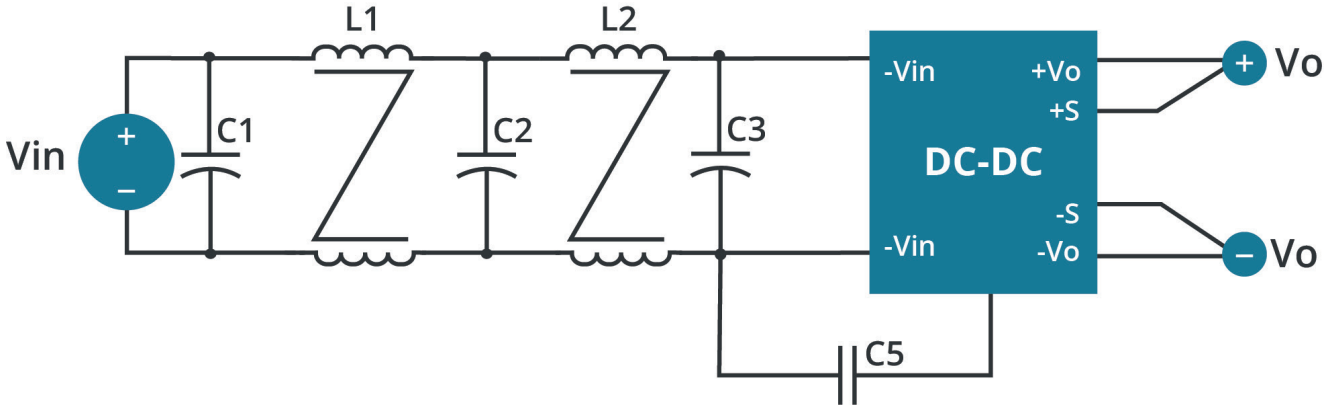
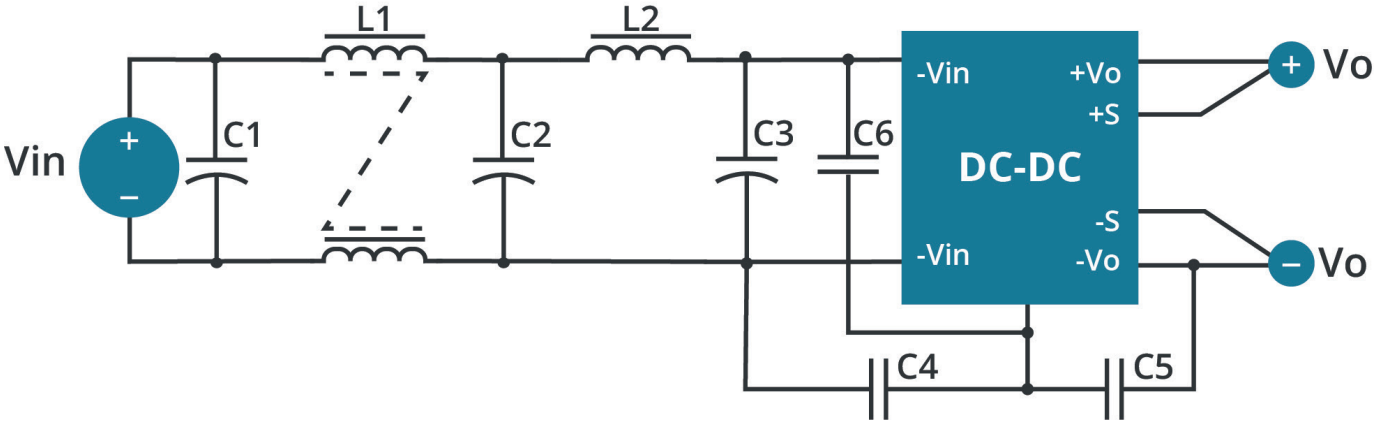



**Figure 6**
**Recommended Circuit for EN55022 Class B**
(for all 48 Vdc output models)



# EMC RECOMMENDED CIRCUITS (CONTINUED)

## EN55022 CLASS B

**Table 3**
**Class B Recommended Components**

| Model | C1[2] | C2[2] | C3[2] | C4[1] | C5[1] | C6[1] | L1 | L2 | Co min. |
|---|---|---|---|---|---|---|---|---|---|
| VHK50W-Q24-S3R3 | 100 µF/50 V | 100 µF/50 V | 100 µF/50 V | 3300 pF/2 kV | NC | NC | 0.65 mH | 1.5 µH | NC |
| VHK50W-Q24-S5 | 100 µF/50 V | 100 µF/50 V | 100 µF/50 V | 2200 pF/2 kV | NC | NC | 0.65 mH | 1.5 µH | NC |
| VHK50W-Q24-S12 | 100 µF/50 V | 100 µF/50 V | 100 µF/50 V | 3300 pF/2 kV | NC | NC | 0.65 mH | 1.5 µH | NC |
| VHK50W-Q24-S15 | 100 µF/50 V | 100 µF/50 V | 100 µF/50 V | 2200 pF/2 kV | NC | NC | 0.65 mH | 1.5 µH | NC |
| VHK50W-Q24-S24 | 10 µF/50 V[1] | 100 µF/50 V | 100 µF/50 V | 2200 pF/2 kV | 3300 pF/2 kV | 1000 pF/2 kV | 1.5 mH | 3.4 µH | NC |
| VHK50W-Q24-S28 | 100 µF/50 V | 100 µF/50 V | NC | NC | 1000 pF/2 kV | NC | 0.12 mH | 0.34 mH | NC |
| VHK50W-Q24-S48 | 10 µF/50 V[1] | 100 µF/50 V | 100 µF/50 V | 4700 pF/2 kV | 2200 pF/2 kV | 1000 pF/2 kV | 1.5 mH | 3.4 µH | 47 µF |
| VHK50W-Q48-S3R3 | 47 µF/100 V | 47 µF/100 V | 47 µF/100 V | 3300 pF/2 kV | 3300 pF/2 kV | 1000 pF/2 kV | 1.5 mH | 3.4 µH | NC |
| VHK50W-Q48-S5 | 47 µF/100 V | 47 µF/100 V | 47 µF/100 V | 3300 pF/2 kV | 3300 pF/2 kV | 1000 pF/2 kV | 1.5 mH | 3.4 µH | NC |
| VHK50W-Q48-S12 | 47 µF/100 V | 47 µF/100 V | 47 µF/100 V | 3300 pF/2 kV | 3300 pF/2 kV | 1000 pF/2 kV | 1.5 mH | 3.4 µH | NC |
| VHK50W-Q48-S15 | 47 µF/100 V | 47 µF/100 V | 47 µF/100 V | 3300 pF/2 kV | 3300 pF/2 kV | 1000 pF/2 kV | 1.5 mH | 3.4 µH | NC |
| VHK50W-Q48-S24 | 47 µF/100 V | 47 µF/100 V | 47 µF/100 V | 3300 pF/2 kV | 3300 pF/2 kV | 1000 pF/2 kV | 1.5 mH | 3.4 µH | NC |
| VHK50W-Q48-S28 | 100 µF/100 V | 100 µF/100 V | NC | NC | 1000 pF/2 kV | NC | 0.12 mH | 0.34 mH | NC |
| VHK50W-Q48-S48 | 47 µF/100 V | 47 µF/100 V | 47 µF/100 V | 4700 pF/2 kV | 2200 pF/2 kV | 1000 pF/2 kV | 1.5 mH | 3.4 µH | 47 µF |

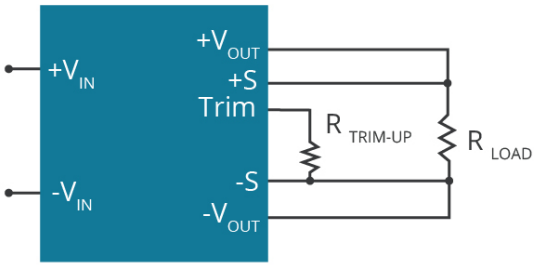
Note: 1. Ceramic capacitors
2. Aluminum capacitors

## APPLICATION NOTES

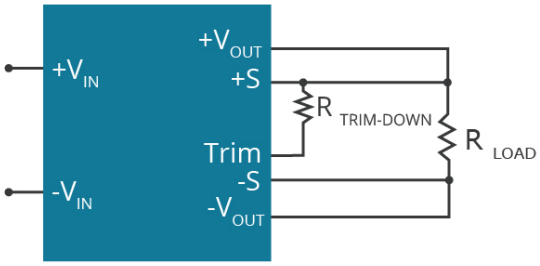
1. **Output Voltage Trimming**
   Leave open if not used.

**Figure 7**

*Trim up*




*Trim down*




$$R_{TRIM} = \left( \frac{R_{TOP}\,(V_{REF} - V_F\,(\frac{R_{BOTTOM}}{R_{BOTTOM} + R_O}))}{V_{OUT} - V_{OUT,\,NOM}} \right) - \frac{R_{BOTTOM} R_O}{R_{BOTTOM} + R_O} \quad (K\,\Omega)$$

*Formula for Trim up*

$$R_{TRIM} = \frac{R_{TOP}\,(V_{OUT} - V_{REF})}{V_{OUT,\,NOM} - V_{OUT}} - R_{BOTTOM} \quad (K\,\Omega)$$

*Formula for Trim down*

**Table 4**

| $V_{NOM}$ | $R_{TOP}$ | $R_{BOTTOM}$ | $R_O$ | $V_{REF}$ | $V_F$ |
|---|---|---|---|---|---|
| (Vdc) | (kΩ) | (kΩ) | (kΩ) | (V) | (V) |
| 3.3 | 3 | 12 | 18 | 1.24 | 0.46 |
| 5 | 2.32 | 8.2 | 0 | 2.5 | 0 |
| 12 | 9.1 | 51 | 18 | 2.5 | 0.46 |
| 15 | 12 | 82 | 18 | 2.5 | 0.46 |
| 24 | 20 | 100 | 20 | 2.5 | 0.46 |
| 28 | 23.7 | 150 | 16 | 2.5 | 0.46 |
| 48 | 36 | 270 | 14 | 2.5 | 0.46 |

Note: Value for $R_{TOP}$, $R_{BOTTOM}$, $R_O$, $V_{REF}$ ,and $V_F$ refer to Table 4 (fixed internal values).
$R_{TRIM}$: Trim resistance
a: User-defined parameter, no actual meanings
$V_{NOM}$: Nominal output voltage
$V_{OUT}$: Target output voltage

Note: 1. All specifications are measured at Ta=25°C, nominal input voltage and full output load unless otherwise specified.

## REVISION HISTORY

| rev. | description | date |
|---|---|---|
| 1.0 | initial release | 10/11/2006 |
| 1.01 | new template applied | 12/21/2011 |
| 1.02 | misc. updates and corrections | 03/13/2012 |
| 1.03 | updated mechanical drawing | 03/27/2012 |
| 1.04 | V-Infinity branding removed | 06/27/2012 |
| 1.05 | updated spec | 03/14/2013 |
| 1.06 | added trimming and EMI information | 12/17/2013 |
| 1.07 | company logo updated | 02/08/2021 |
| 1.08 | derating curve and figures updated | 06/09/2021 |
| 1.09 | mechanical tolerances updated | 04/13/2022 |
| 1.10 | output voltage trimming updated | 05/30/2023 |

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

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