



## SERIES: VHK50W | DESCRIPTION: DC-DC CONVERTER

### FEATURES

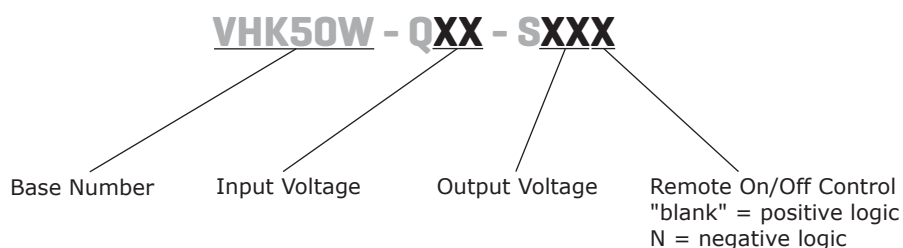
- up to 50 W isolated output
- rugged metal enclosure with integrated heat sink
- 4:1 input range (9~36 Vdc, 18~75 Vdc)
- single output from 3.3~48 Vdc
- 1,500 Vdc isolation
- over current, over temperature, over voltage, and short circuit protections
- remote on/off
- efficiency up to 83%



| MODEL           | input<br>voltage<br>range<br>(Vdc) | output<br>voltage<br>(Vdc) | output<br>current<br>max<br>(A) | output<br>power<br>max<br>(W) | ripple<br>and noise <sup>1</sup><br>max<br>(mVp-p) | efficiency<br><br>typ<br>(%) |
|-----------------|------------------------------------|----------------------------|---------------------------------|-------------------------------|----------------------------------------------------|------------------------------|
| 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 10 $\mu$ F tantalum capacitor and 1 $\mu$ F ceramic capacitor across output. The 48 Vdc output models only require the 1 $\mu$ F ceramic capacitor across the output.

### 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        |
| 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 <sup>1</sup>       | 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            |     |     | 10,000 | μF    |
|                               | 12 V output models                   |     |     | 4,160  | μF    |
|                               | 15 V output models                   |     |     | 3,330  | μF    |
|                               | 24 V output models                   |     |     | 2,080  | μF    |
|                               | 28 V output models                   |     |     | 1,780  | μF    |
|                               | 48 V output models                   | 47  |     | 1,040  | μF    |
| line regulation <sup>2</sup>  | measured from high line to low line  |     |     | ±0.2   | %     |
| load regulation <sup>2</sup>  | measured from full load to zero load |     |     | ±0.2   | %     |
| voltage accuracy <sup>2</sup> |                                      |     |     | ±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                 |     | 100 |     | °C    |
|                             | restart threshold        |     | 70  |     | °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

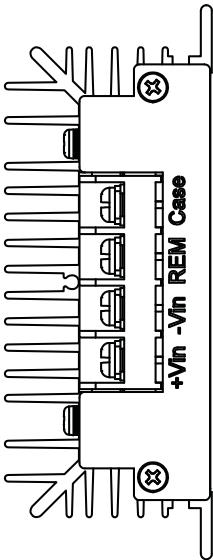
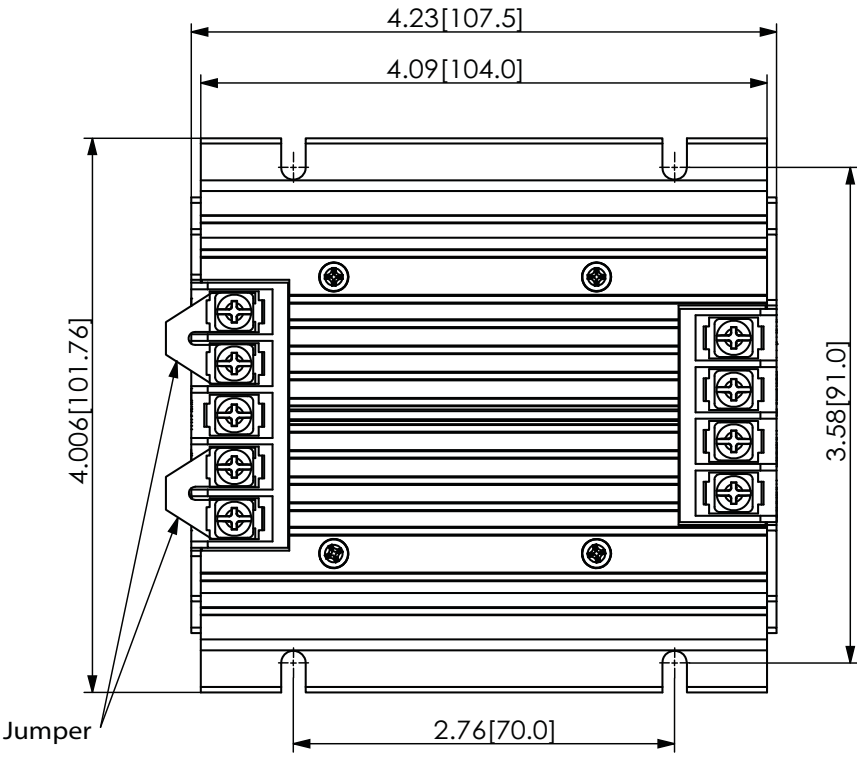
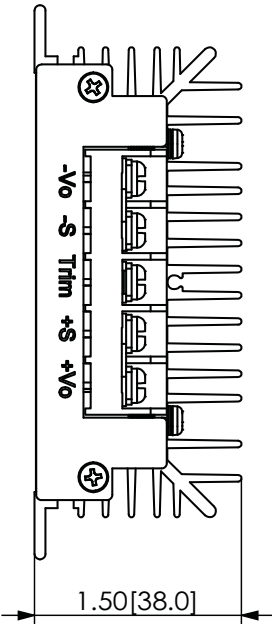
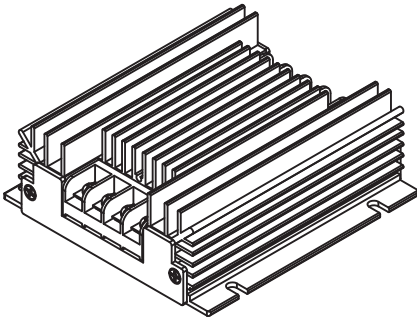
| parameter     | conditions/description                        | min | typ | max | units |
|---------------|-----------------------------------------------|-----|-----|-----|-------|
| dimensions    | 4.23 x 4.01 x 1.50 (107.5 x 101.76 x 38.0 mm) |     |     |     | inch  |
| case material | steel and aluminum extrusion                  |     |     |     |       |
| weight        |                                               |     | 502 |     | g     |

MECHANICAL DRAWING

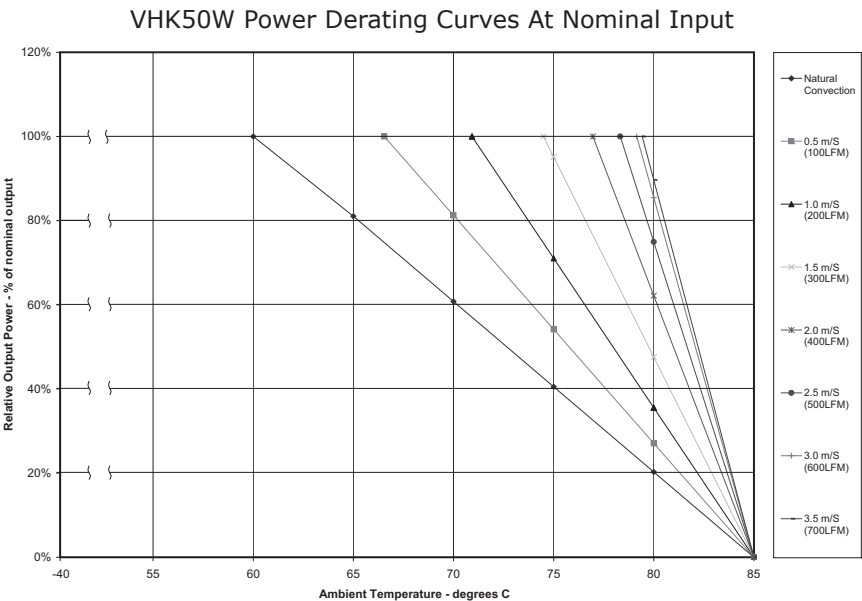
units: inch[mm]  
tolerance: X.XX =  $\pm 0.02[\pm 0.5]$   
              X.XXX =  $\pm 0.010[\pm 0.25]$

wire range: 22~12 AWG  
screw size: #6-32

| 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

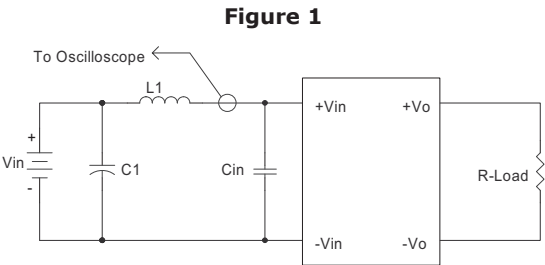


Table 1

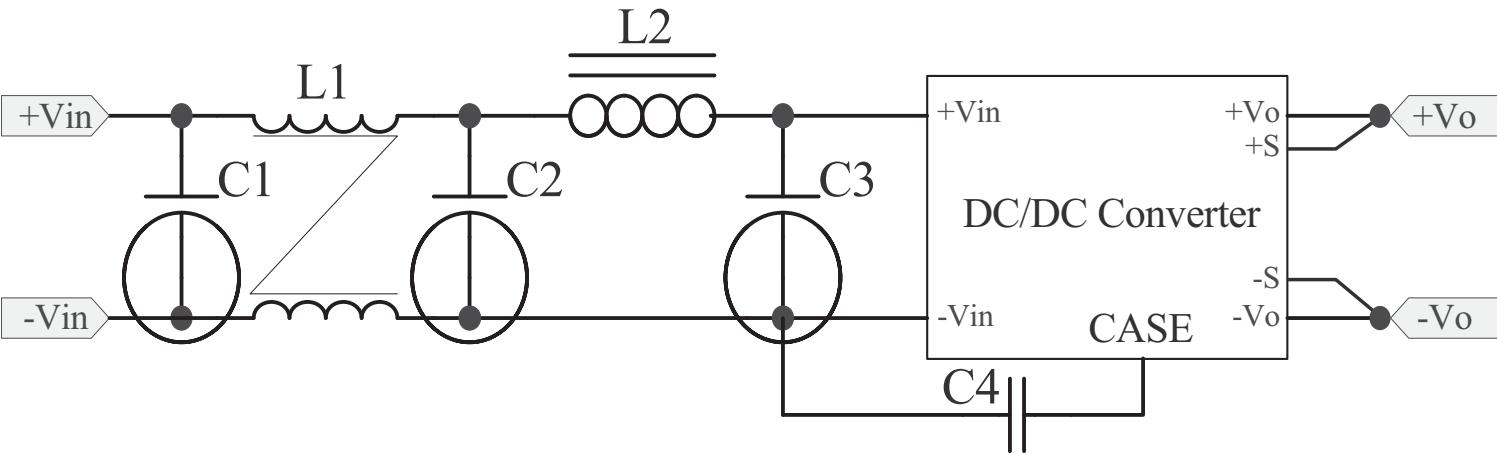
| External components |                              |
|---------------------|------------------------------|
| L1                  | 12μH                         |
| C1                  | 220μF, ESR < 0.1Ω at 100 KHz |
| Cin                 | 100μF, ESR < 0.1Ω at 100 KHz |

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

EMC RECOMMENDED CIRCUITS

EN55022 CLASS A

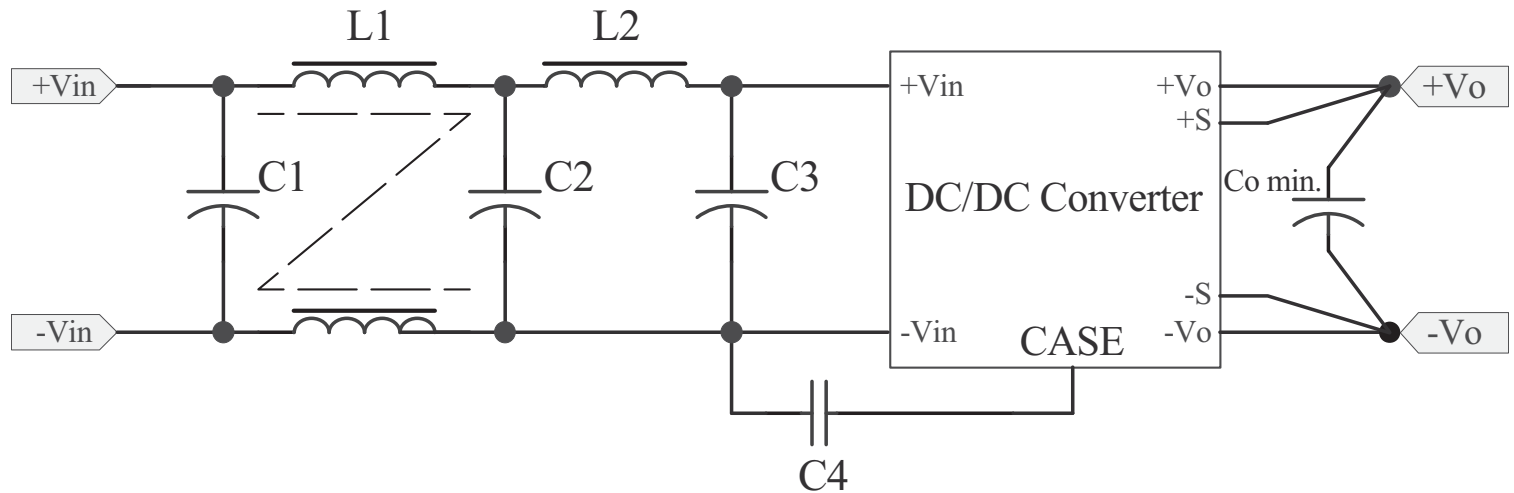
Figure 2  
Recommended Circuit for EN55022 Class A  
(for all 3.3, 5, 12, 15, 24, & 28 Vdc output models)



## 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**

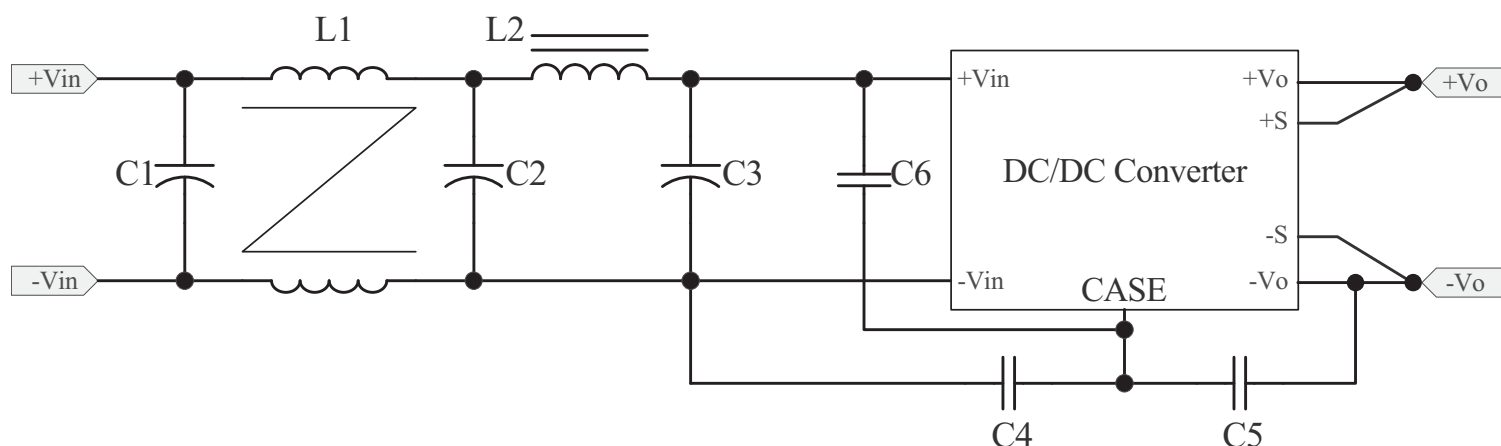
| Model           | C1 <sup>1</sup> | C2 <sup>2</sup>   | C3 <sup>2</sup>   | C4 <sup>1</sup> | L1     | L2          | Co min.    |
|-----------------|-----------------|-------------------|-------------------|-----------------|--------|-------------|------------|
| VHK50W-Q24-S3R3 | NC              | 100 $\mu$ F/50 V  | 100 $\mu$ F/50 V  | 2200 pF/2 kV    | Short  | 3.5 $\mu$ H | NC         |
| VHK50W-Q24-S5   | NC              | 100 $\mu$ F/50 V  | 100 $\mu$ F/50 V  | 2200 pF/2 kV    | Short  | 3.5 $\mu$ H | NC         |
| VHK50W-Q24-S12  | NC              | 100 $\mu$ F/50 V  | 100 $\mu$ F/50 V  | 2200 pF/2 kV    | Short  | 3.5 $\mu$ H | NC         |
| VHK50W-Q24-S15  | NC              | 100 $\mu$ F/50 V  | 100 $\mu$ F/50 V  | 2200 pF/2 kV    | Short  | 3.5 $\mu$ H | NC         |
| VHK50W-Q24-S24  | 10 $\mu$ F/50 V | 100 $\mu$ F/50 V  | 100 $\mu$ F/50 V  | NC              | 1.5 mH | 3.4 $\mu$ H | NC         |
| VHK50W-Q24-S28  | NC              | 100 $\mu$ F/50 V  | 100 $\mu$ F/50 V  | 2200 pF/2 kV    | Short  | 3.4 $\mu$ H | NC         |
| VHK50W-Q24-S48  | NC              | 100 $\mu$ F/50 V  | 100 $\mu$ F/50 V  | NC              | Short  | 3.5 $\mu$ H | 47 $\mu$ F |
| VHK50W-Q48-S3R3 | NC              | 47 $\mu$ F/100 V  | 47 $\mu$ F/100 V  | 2200 pF/2 kV    | Short  | 3.4 $\mu$ H | NC         |
| VHK50W-Q48-S5   | NC              | 47 $\mu$ F/100 V  | 47 $\mu$ F/100 V  | 2200 pF/2 kV    | Short  | 3.4 $\mu$ H | NC         |
| VHK50W-Q48-S12  | NC              | 47 $\mu$ F/100 V  | 47 $\mu$ F/100 V  | 2200 pF/2 kV    | Short  | 3.4 $\mu$ H | NC         |
| VHK50W-Q48-S15  | NC              | 47 $\mu$ F/100 V  | 47 $\mu$ F/100 V  | 2200 pF/2 kV    | Short  | 3.4 $\mu$ H | NC         |
| VHK50W-Q48-S24  | NC              | 47 $\mu$ F/100 V  | 47 $\mu$ F/100 V  | 2200 pF/2 kV    | Short  | 3.4 $\mu$ H | NC         |
| VHK50W-Q48-S28  | NC              | 100 $\mu$ F/100 V | 100 $\mu$ F/100 V | 2200 pF/2 kV    | Short  | 3.4 $\mu$ H | NC         |
| VHK50W-Q48-S48  | NC              | 47 $\mu$ F/100 V  | 47 $\mu$ F/100 V  | 2200 pF/2 kV    | Short  | 3.5 $\mu$ H | 47 $\mu$ F |

Note: 1. Ceramic capacitors  
 2. Aluminum capacitors

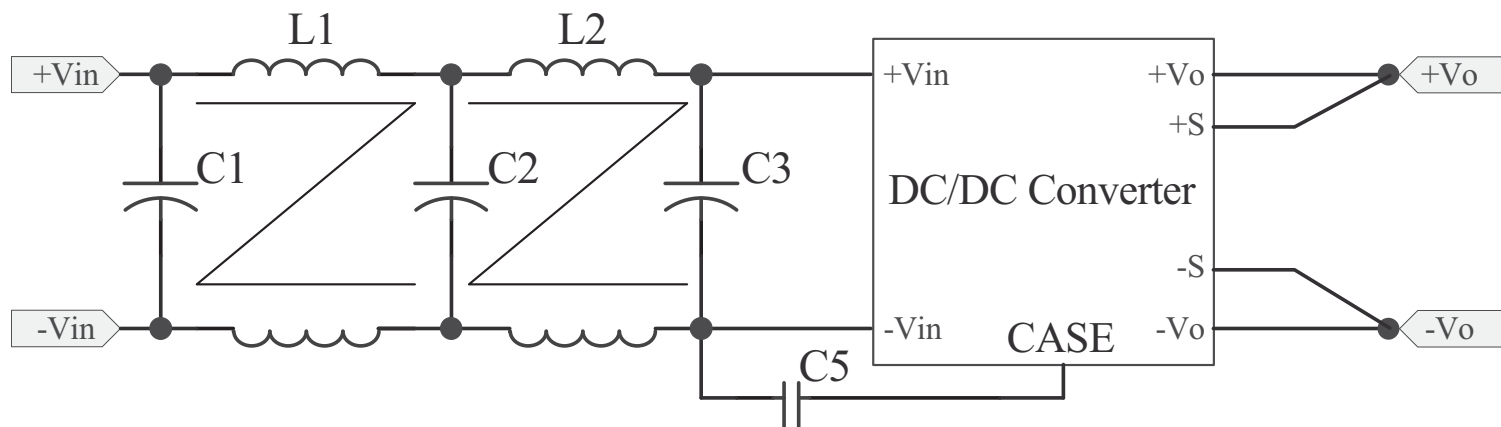
## EMC RECOMMENDED CIRCUITS (CONTINUED)

## EN55022 CLASS B

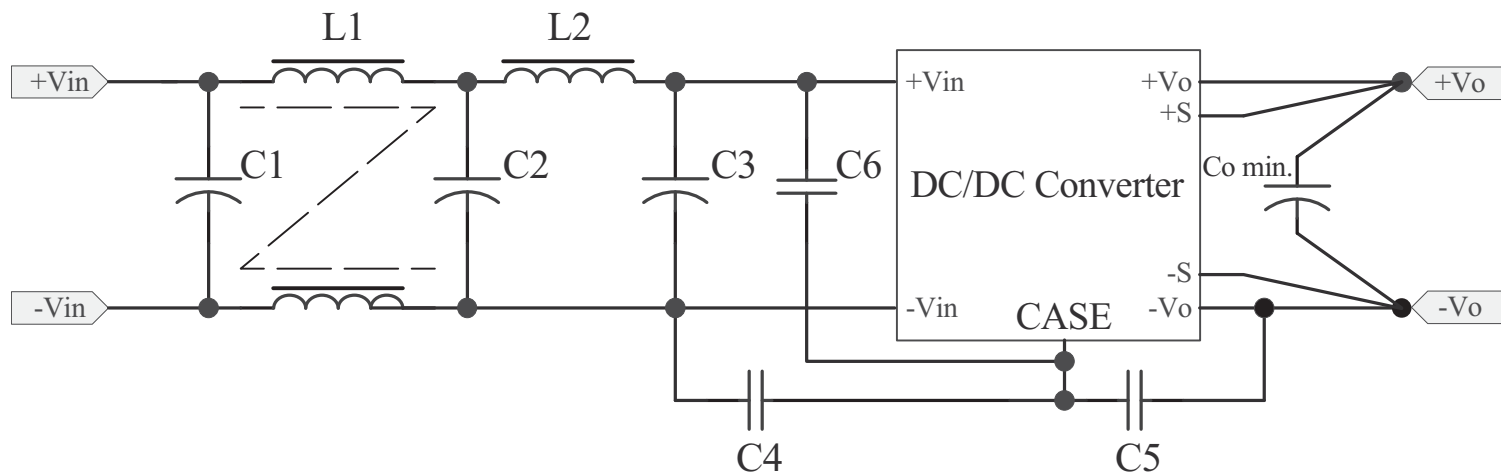
**Figure 4**  
**Recommended Circuit for EN55022 Class B**  
 (for all 3.3, 5, 12, 15, & 24 Vdc output models)



**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 <sup>2</sup>         | C2 <sup>2</sup> | C3 <sup>2</sup> | C4 <sup>1</sup> | C5 <sup>1</sup> | C6 <sup>1</sup> | 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 <sup>1</sup> | 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 <sup>1</sup> | 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

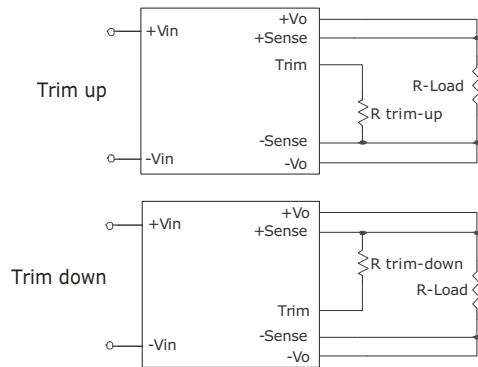
## APPLICATION NOTES

### 1. Output Voltage Trimming

Leave open if not used.

**Figure 7**

Application Circuit for Trim pin



### Formula for Trim Resistor

$$R_{trim - up} = \left( \frac{R_1(V_r - V_f(\frac{R_2}{R_2 + R_3}))}{V_o - V_{o, nom}} \right) - \frac{R_2 R_3}{R_2 + R_3} (K\Omega)$$

$$R_{trim - down} = \frac{R_1(V_o - V_r)}{V_{o, nom} - V_o} - R_2 (K\Omega)$$

Note:  $R_{trim-up}$  is the external resistor in  $K\Omega$   
 $R_{trim-down}$  is the external resistor in  $K\Omega$   
 $V_{o, nom}$  is the nominal output voltage  
 $V_o$  is the desired output voltage  
 $R_1, R_2, R_3,$  and  $V_r$  are internal (see Table 4).

**Table 4**

| Vout (Vdc) | R1 (K $\Omega$ ) | R2 (K $\Omega$ ) | R3 (K $\Omega$ ) | Vr (V) | Vf (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   |

## 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 |

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



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