



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

### FEATURES

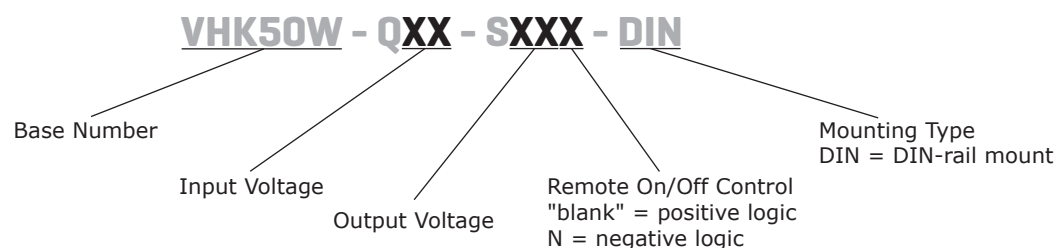
- up to 50 W isolated output
- rugged metal enclosure with integrated heat sink
- 4:1 input range (9~36 Vdc, 18~75 Vdc)
- single output from 3.3~48 Vdc
- 1,500 Vdc isolation
- over current, over temperature, over voltage, and short circuit protections
- remote on/off
- efficiency up to 83%
- comes with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



| 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-DIN | 9 ~ 36                             | 3.3                        | 10                              | 33                            | 100                                                | 75                           |
| VHK50W-Q24-S5-DIN   | 9 ~ 36                             | 5                          | 10                              | 50                            | 100                                                | 79                           |
| VHK50W-Q24-S12-DIN  | 9 ~ 36                             | 12                         | 4.16                            | 50                            | 150                                                | 82                           |
| VHK50W-Q24-S15-DIN  | 9 ~ 36                             | 15                         | 3.33                            | 50                            | 150                                                | 82                           |
| VHK50W-Q24-S24-DIN  | 9 ~ 36                             | 24                         | 2.08                            | 50                            | 240                                                | 82                           |
| VHK50W-Q24-S28-DIN  | 9 ~ 36                             | 28                         | 1.78                            | 50                            | 280                                                | 82                           |
| VHK50W-Q24-S48-DIN  | 9 ~ 36                             | 48                         | 1.04                            | 50                            | 480                                                | 82                           |
| VHK50W-Q48-S3R3-DIN | 18 ~ 75                            | 3.3                        | 10                              | 33                            | 100                                                | 76                           |
| VHK50W-Q48-S5-DIN   | 18 ~ 75                            | 5                          | 10                              | 50                            | 100                                                | 80                           |
| VHK50W-Q48-S12-DIN  | 18 ~ 75                            | 12                         | 4.16                            | 50                            | 150                                                | 83                           |
| VHK50W-Q48-S15-DIN  | 18 ~ 75                            | 15                         | 3.33                            | 50                            | 150                                                | 83                           |
| VHK50W-Q48-S24-DIN  | 18 ~ 75                            | 24                         | 2.08                            | 50                            | 240                                                | 83                           |
| VHK50W-Q48-S28-DIN  | 18 ~ 75                            | 28                         | 1.78                            | 50                            | 280                                                | 83                           |
| VHK50W-Q48-S48-DIN  | 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                                                            |                           | 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 2.07 (107.5 x 101.8 x 52.6 mm) |     |     |     | inch  |
| case material | steel and aluminum extrusion                 |     |     |     |       |
| weight        |                                              |     | 651 |     | g     |

## MECHANICAL DRAWING

units: inch[mm]

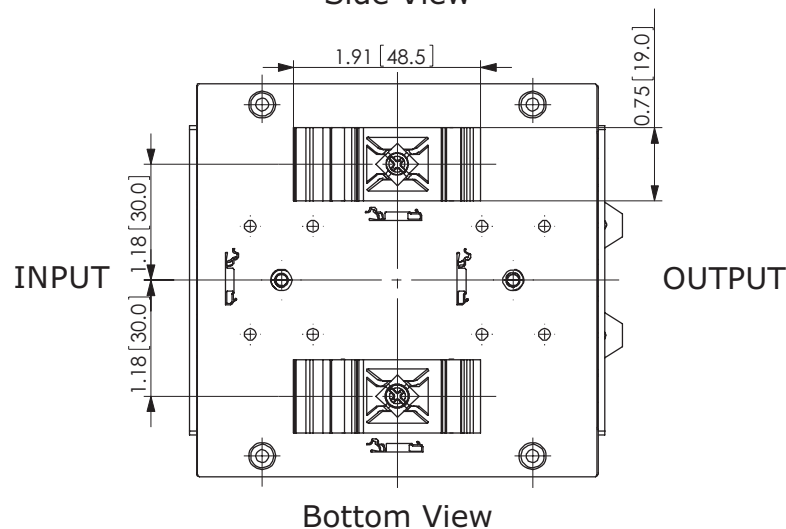
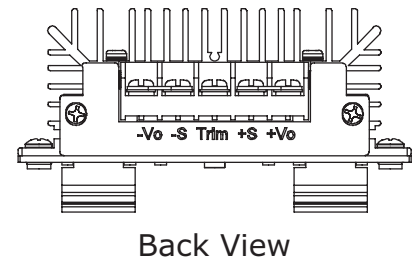
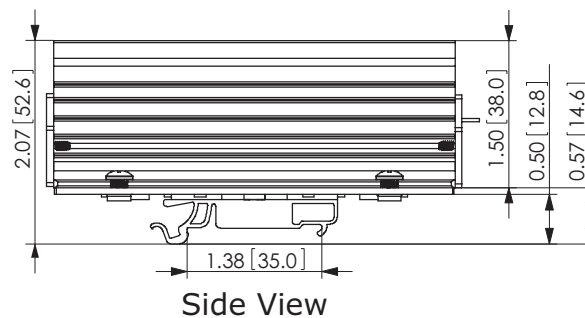
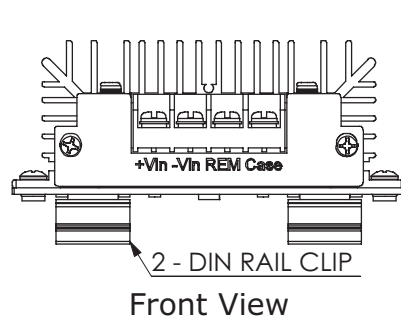
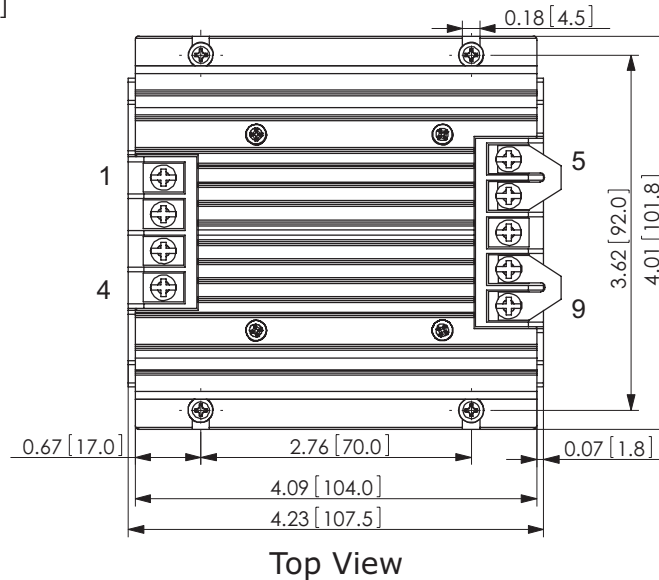
tolerance: X.XX =  $\pm 0.02$ [ $\pm 0.5$ ]X.XXX =  $\pm 0.010$ [ $\pm 0.25$ ]

wire range: 22~12 AWG

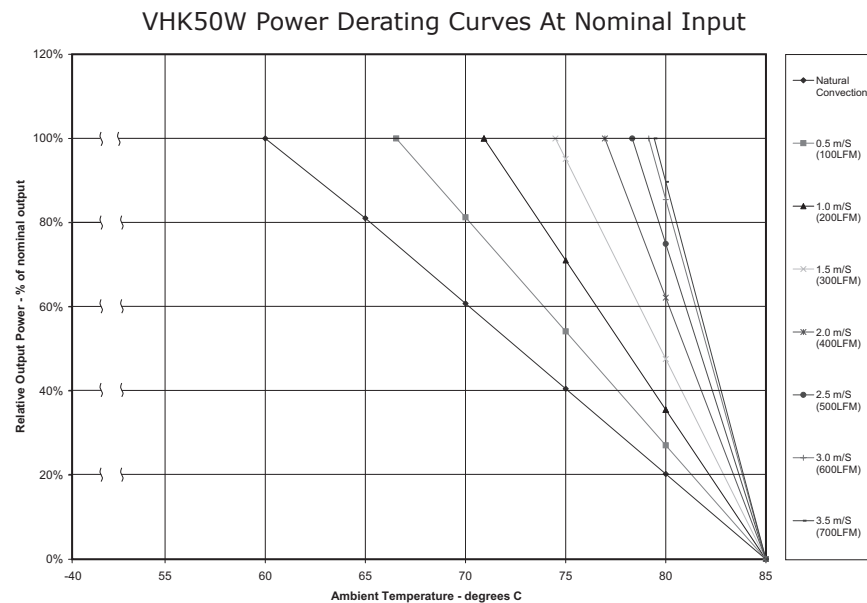
screw size: #6-32

mounts to TS35 rails

| PIN CONNECTIONS |          |
|-----------------|----------|
| PIN             | FUNCTION |
| 1               | +Vin     |
| 2               | -Vin     |
| 3               | REM      |
| 4               | CASE     |
| 5               | +Vo      |
| 6               | +S       |
| 7               | TRIM     |
| 8               | -S       |
| 9               | -Vo      |



## DERATING CURVES



## TEST CONFIGURATION

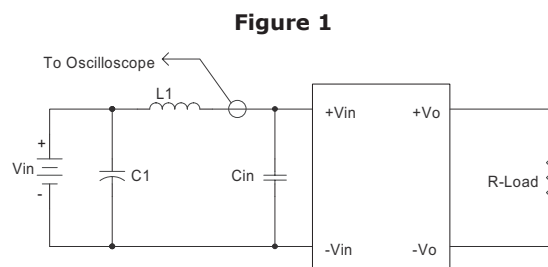


Table 1

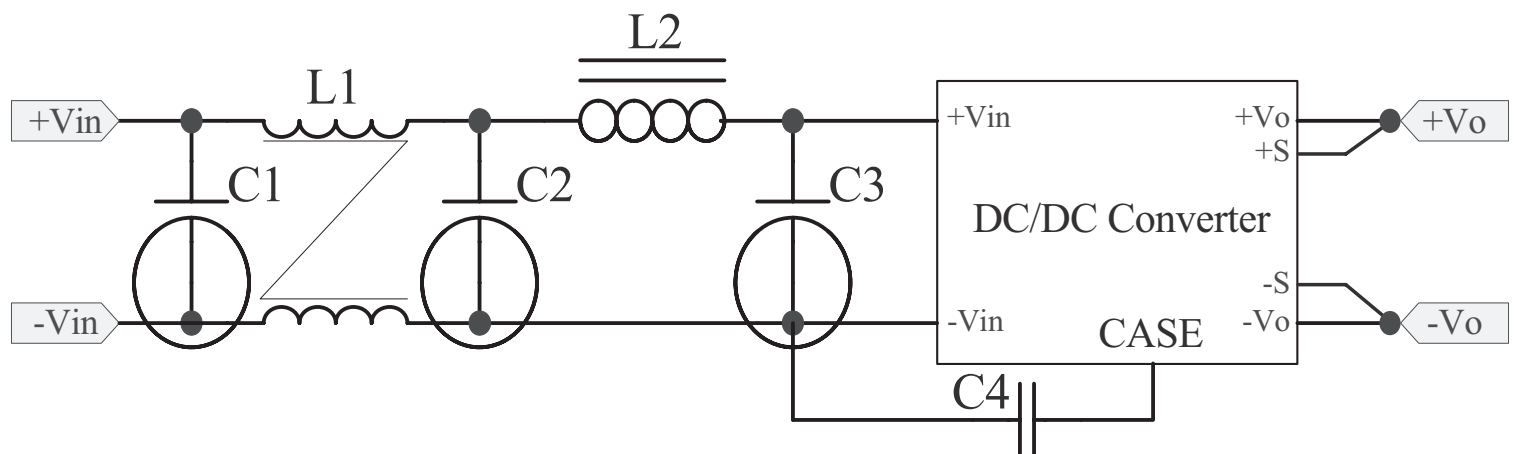
| External components |                                            |
|---------------------|--------------------------------------------|
| L1                  | 12 $\mu$ H                                 |
| C1                  | 220 $\mu$ F, ESR < 0.1 $\Omega$ at 100 KHz |
| Cin                 | 100 $\mu$ F, ESR < 0.1 $\Omega$ 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

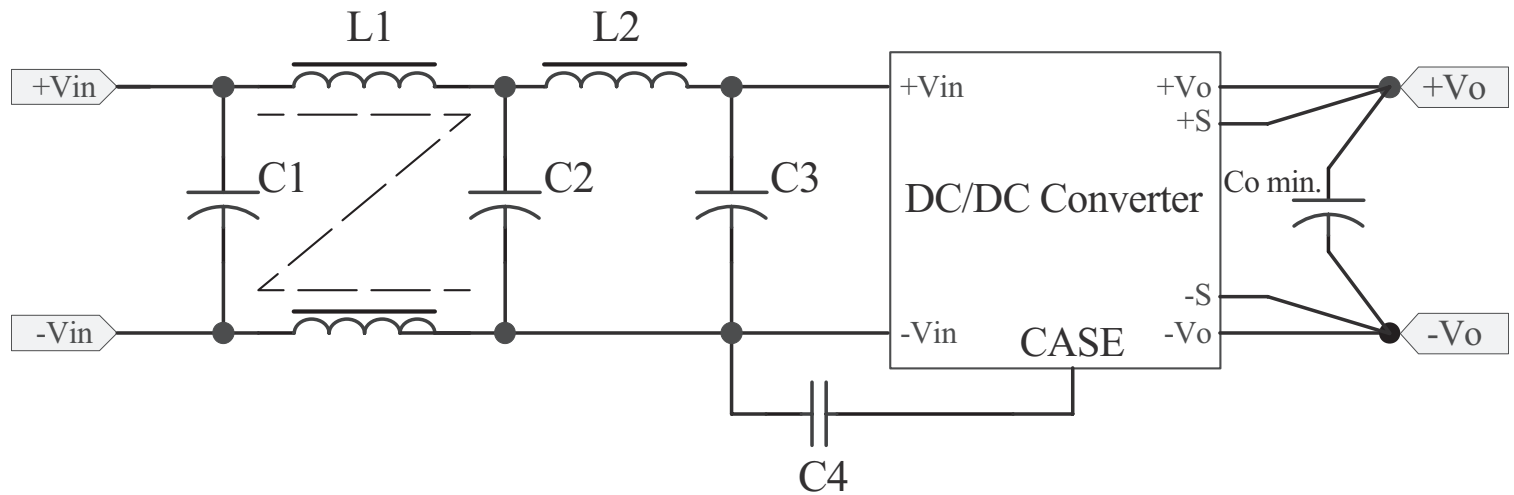
Figure 2  
Recommended Circuit for EN55022 Class A  
(for all 3.3, 5, 12, 15, 24, & 28 Vdc output models)



## 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 |

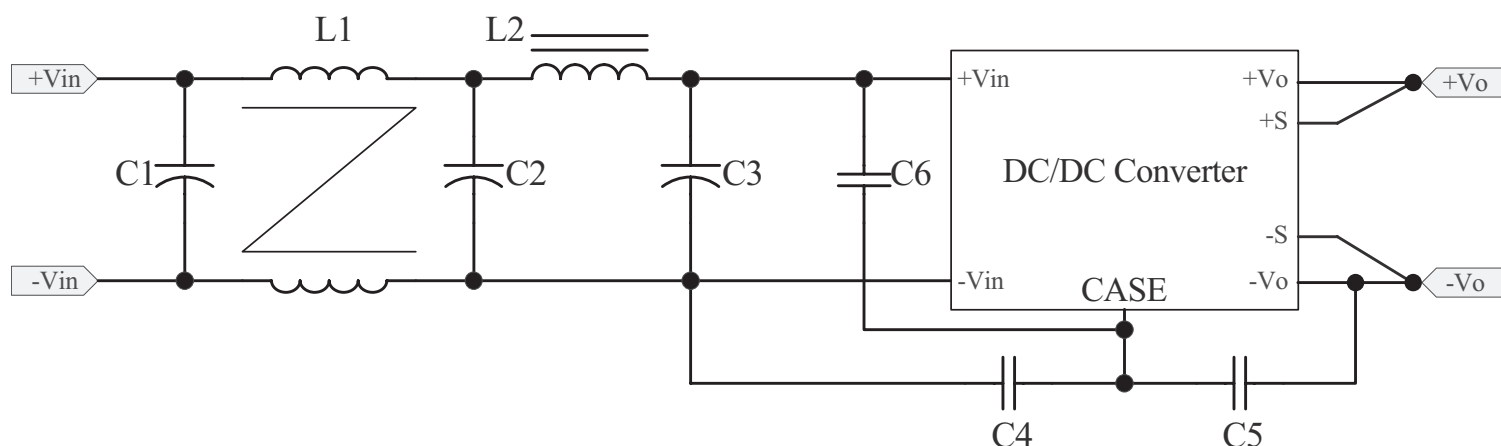
Note:

1. Ceramic capacitors
2. Aluminum capacitors

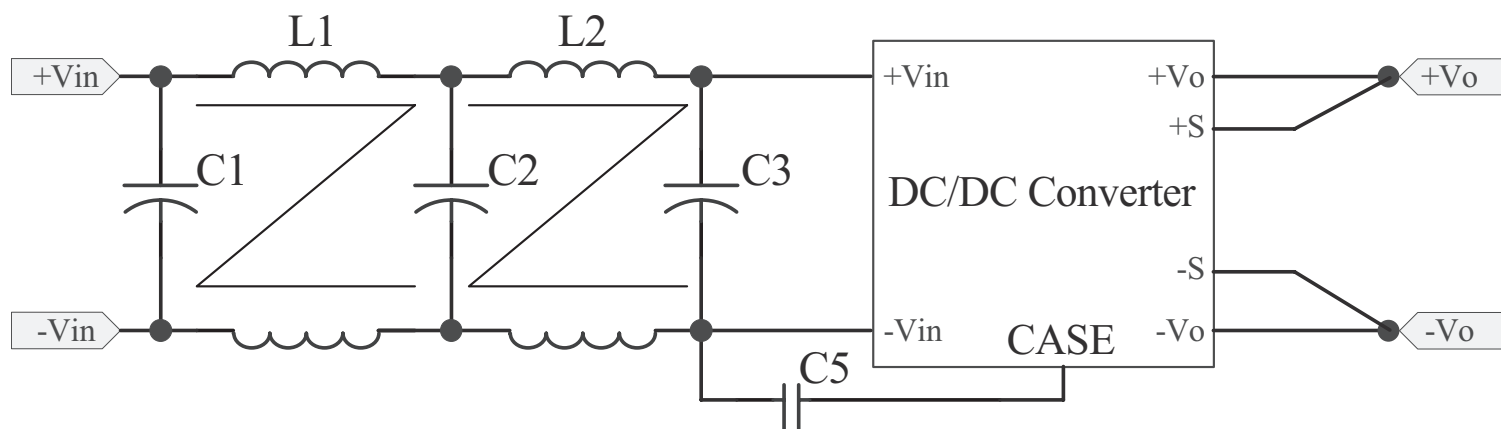
## EMC RECOMMENDED CIRCUITS (CONTINUED)

### EN55022 CLASS B

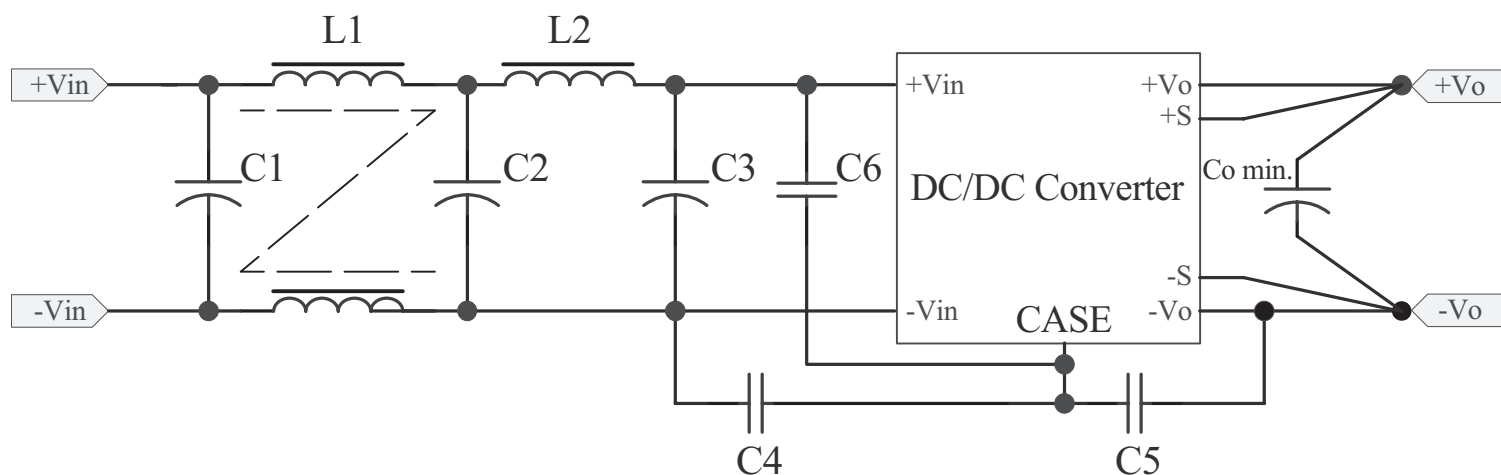
**Figure 4**  
Recommended Circuit for EN55022 Class B  
(for all 3.3, 5, 12, 15, & 24 Vdc output models)



**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 $\mu$ F/50 V             | 100 $\mu$ F/50 V  | 100 $\mu$ F/50 V | 3300 pF/2 kV    | NC              | NC              | 0.65 mH | 1.5 $\mu$ H | NC         |
| VHK50W-Q24-S5   | 100 $\mu$ F/50 V             | 100 $\mu$ F/50 V  | 100 $\mu$ F/50 V | 2200 pF/2 kV    | NC              | NC              | 0.65 mH | 1.5 $\mu$ H | NC         |
| VHK50W-Q24-S12  | 100 $\mu$ F/50 V             | 100 $\mu$ F/50 V  | 100 $\mu$ F/50 V | 3300 pF/2 kV    | NC              | NC              | 0.65 mH | 1.5 $\mu$ H | NC         |
| VHK50W-Q24-S15  | 100 $\mu$ F/50 V             | 100 $\mu$ F/50 V  | 100 $\mu$ F/50 V | 2200 pF/2 kV    | NC              | NC              | 0.65 mH | 1.5 $\mu$ H | NC         |
| VHK50W-Q24-S24  | 10 $\mu$ F/50 V <sup>1</sup> | 100 $\mu$ F/50 V  | 100 $\mu$ F/50 V | 2200 pF/2 kV    | 3300 pF/2 kV    | 1000 pF/2 kV    | 1.5 mH  | 3.4 $\mu$ H | NC         |
| VHK50W-Q24-S28  | 100 $\mu$ F/50 V             | 100 $\mu$ F/50 V  | NC               | NC              | 1000 pF/2 kV    | NC              | 0.12 mH | 0.34 mH     | NC         |
| VHK50W-Q24-S48  | 10 $\mu$ F/50 V <sup>1</sup> | 100 $\mu$ F/50 V  | 100 $\mu$ F/50 V | 4700 pF/2 kV    | 2200 pF/2 kV    | 1000 pF/2 kV    | 1.5 mH  | 3.4 $\mu$ H | 47 $\mu$ F |
| VHK50W-Q48-S3R3 | 47 $\mu$ F/100 V             | 47 $\mu$ F/100 V  | 47 $\mu$ F/100 V | 3300 pF/2 kV    | 3300 pF/2 kV    | 1000 pF/2 kV    | 1.5 mH  | 3.4 $\mu$ H | NC         |
| VHK50W-Q48-S5   | 47 $\mu$ F/100 V             | 47 $\mu$ F/100 V  | 47 $\mu$ F/100 V | 3300 pF/2 kV    | 3300 pF/2 kV    | 1000 pF/2 kV    | 1.5 mH  | 3.4 $\mu$ H | NC         |
| VHK50W-Q48-S12  | 47 $\mu$ F/100 V             | 47 $\mu$ F/100 V  | 47 $\mu$ F/100 V | 3300 pF/2 kV    | 3300 pF/2 kV    | 1000 pF/2 kV    | 1.5 mH  | 3.4 $\mu$ H | NC         |
| VHK50W-Q48-S15  | 47 $\mu$ F/100 V             | 47 $\mu$ F/100 V  | 47 $\mu$ F/100 V | 3300 pF/2 kV    | 3300 pF/2 kV    | 1000 pF/2 kV    | 1.5 mH  | 3.4 $\mu$ H | NC         |
| VHK50W-Q48-S24  | 47 $\mu$ F/100 V             | 47 $\mu$ F/100 V  | 47 $\mu$ F/100 V | 3300 pF/2 kV    | 3300 pF/2 kV    | 1000 pF/2 kV    | 1.5 mH  | 3.4 $\mu$ H | NC         |
| VHK50W-Q48-S28  | 100 $\mu$ F/100 V            | 100 $\mu$ F/100 V | NC               | NC              | 1000 pF/2 kV    | NC              | 0.12 mH | 0.34 mH     | NC         |
| VHK50W-Q48-S48  | 47 $\mu$ F/100 V             | 47 $\mu$ F/100 V  | 47 $\mu$ F/100 V | 4700 pF/2 kV    | 2200 pF/2 kV    | 1000 pF/2 kV    | 1.5 mH  | 3.4 $\mu$ H | 47 $\mu$ F |

Note:

1. Ceramic capacitors
2. Aluminum capacitors

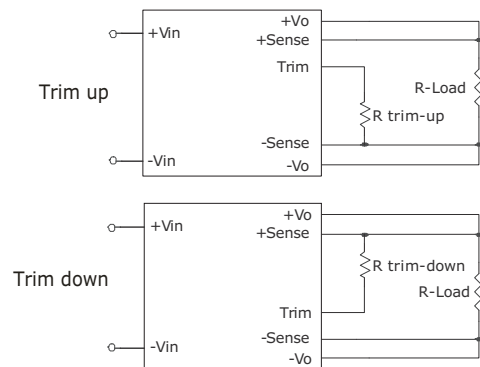
## APPLICATION NOTES

### 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        | 12/17/2013 |
| 1.01 | changed DIN-rail mount | 06/16/2014 |

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

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