V-INFINITY
a division of CUI INC

PART NUMBER: VHK200W

DESCRIPTION: chassis mount dc-dc converter

description

The VHK200W series of rugged DC-DC converters are designed for high reliability applications, featuring integral heat sink, over-temperature protection, over-current protection and input transient voltage protection. With an external input fuse, the converter can protect accidental input polarity reversal. The wide 4:1 input range (10-36V or 18-75V) is very useful to stabilize an input source like batteries in various discharging and charging conditions. Additionally, high efficiency, fast response, tight regulations, remote sense and remote On/Off control make these converters very useful in many industrial and communications applications.

features

· 132-200W isolated output
· Efficiency to 87%
· RoHS Compliant
· 4:1 input range
· Regulated output
· Continuous short circuit protection
· Metal enclosure with integrated heatsink
· Rugged design
· Over-temperature shutdown

RoHS

MODEL
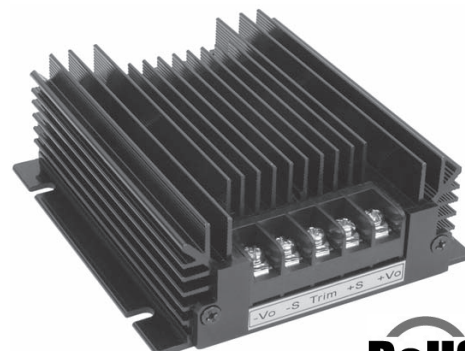
MODEL	input voltage nominal (V dc)	input voltage range (V dc)	output voltage (V dc)	output current [1] (A)	input current no load (mA)	input current full load (mA)	efficiency typ. (%)
VHK200W-Q24-S12	24	10~36	12	16.7	100	9710	84
VHK200W-Q24-S15	24	10~36	15	13.3	100	9670	84
VHK200W-Q24-S24	24	10~36	24	8.3	100	9540	84
VHK200W-Q24-S28	24	10~36	28	7.14	100	9521	87
VHK200W-Q24-S48	24	10~36	48	4.2	100	6720	87
VHK200W-Q48-S12	48	18~75	12	16.7	60	4744	86
VHK200W-Q48-S15	48	18~75	15	13.3	60	4723	86
VHK200W-Q48-S24	48	18~75	24	8.3	60	4716	86
VHK200W-Q48-S28	48	18~75	28	7.14	60	4706	87
VHK200W-Q48-S48	48	18~75	48	4.2	30	4730	88

notes: 1. see output derating curve (page 4)

INPUT

parameter	conditions/description	min	nom	max	units
input voltage range		10	24	36	V dc
		18	48	75	V dc
under voltage lockout	24 Vin power up		8.8		V dc
	24 Vin power down		8		V dc
	24 Vin power up (48V output)		9.5		V dc
	24 Vin power down (48V output)		8.5		V dc
	48 Vin power up		17		V dc
	48 Vin power down		16		V dc
remote on/off control[2]	section 15 in the application notes				
input filter	PI type				

notes: 2. add suffix "N" to the model number for negative logic on/off control

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PART NUMBER: VHK200W   **DESCRIPTION:** chassis mount dc-dc converter

OUTPUT

parameter	conditions/description	min	nom	max	units
voltage accuracy	12V, 15V & 24V			±1	%
	28V & 48V			±1.5	%
transient response	25% step load change			500	µ sec
external trim adj. range				±10	%
ripple & noise (20MHz BW)	12V & 15V			60	mV RMS
				150	mV p-p
	24V			100	mV RMS
				240	mV p-p
	28V			100	mV RMS
				280	mV p-p
	48V			150	mV RMS
				480	mV p-p
temperature coefficient			±0.03		%/°C
short circuit protection	continuous				
line regulation[3]				±0.2	%
load regulation[4]				±0.2	%
over voltage protection trip range, % Vo nom.					
	12V, 15V & 24V	115		140	%
	28V & 48V	90		110	%
over current protection	nominal output	110		160	%

GENERAL SPECIFICATIONS

parameter	conditions/description	min	nom	max	units
switching frequency	12V, 15V & 24V		300		KHz
	28V & 48V		250		KHz
operating ambient temp.[5]		-40		100	°C
storage temperature		-55		105	°C
thermal shutdown case temp.			110		°C
case material	aluminum / steel				

ISOLATION SPECIFICATIONS

parameter	conditions/description	min	nom	max	units
isolation voltage	input/output	1500			V dc
	input/case	1500			V dc
	output/case	1500			V dc
isolation resistance		100			MΩ

notes:
3. measured from high line to low line at full load
4. measured from full load to zero load at nominal input
5. see output derating curve (page 4)

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REV.	DESCRIPTION	DATE
A	NEW DRAWING	4/22/2008
B	dimension updates	8/27/2008

86.3 [3.398]

107.5 [4.232]

38.0 [1.496]

15.6 [0.614]
(TYP)

101.76 [4.006]

91.0 [3.583]
(2 PLCS)

6 7 8 9

9.70 [0.382]
(TYP)

18.75 [0.738]
(2 PLCS)

70.0 [2.756]

1 2 3 4 5

9.5 [0.374]
(TYP)

26.50 [1.043]

*DIN rail mounting kit available (part# VHK-DIN)
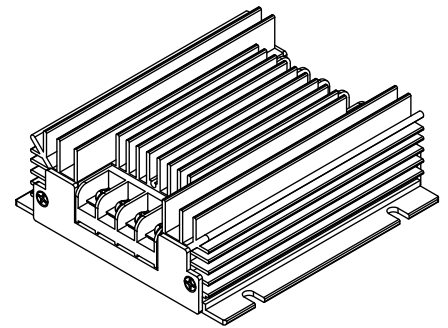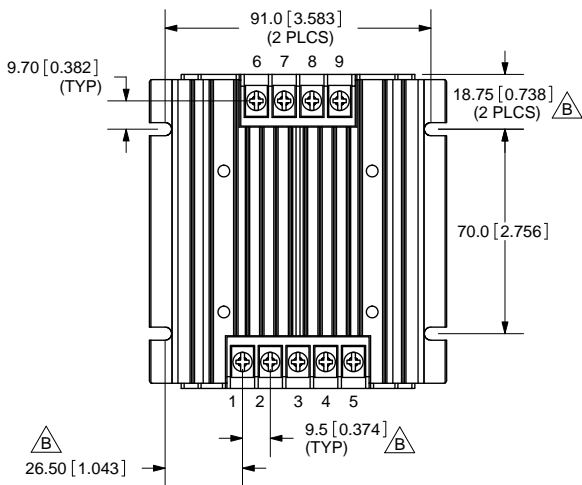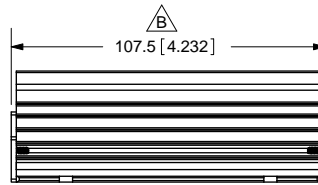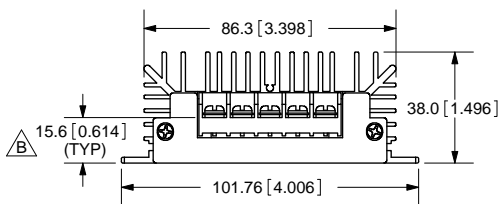
TOLERANCE:
±0.3mm UNLESS OTHERWISE
SPECIFIED

RoHS

CUI INC

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Terminal #	Description
1	- V out
2	- S
3	Trim
4	+ S
5	+ V out
6	Case
7	Remote
8	- V in
9	+ V in

TITLE: VHK — REV: B

PART NO. VHKXXW Series

UNITS: MM [INCHES]

DRAWN BY: ZRJ

APPROVED BY:

SCALE: 1:2

PC FILE NAME:
VHKXXW Series

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Material | Aluminum/Steel

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PART NUMBER: VHK200W   **DESCRIPTION:** chassis mount dc-dc converter

APPLICATION NOTES

1. OUTPUT DE-RATING

The operating ambient temperature range for VHK200W is -40 ~ +100°C, with the actual output power subject to the following de-rating curves at free-air convection and at forced air conditions. To ensure long-term reliability, it is important to ensure proper cooling at the worst operating conditions.
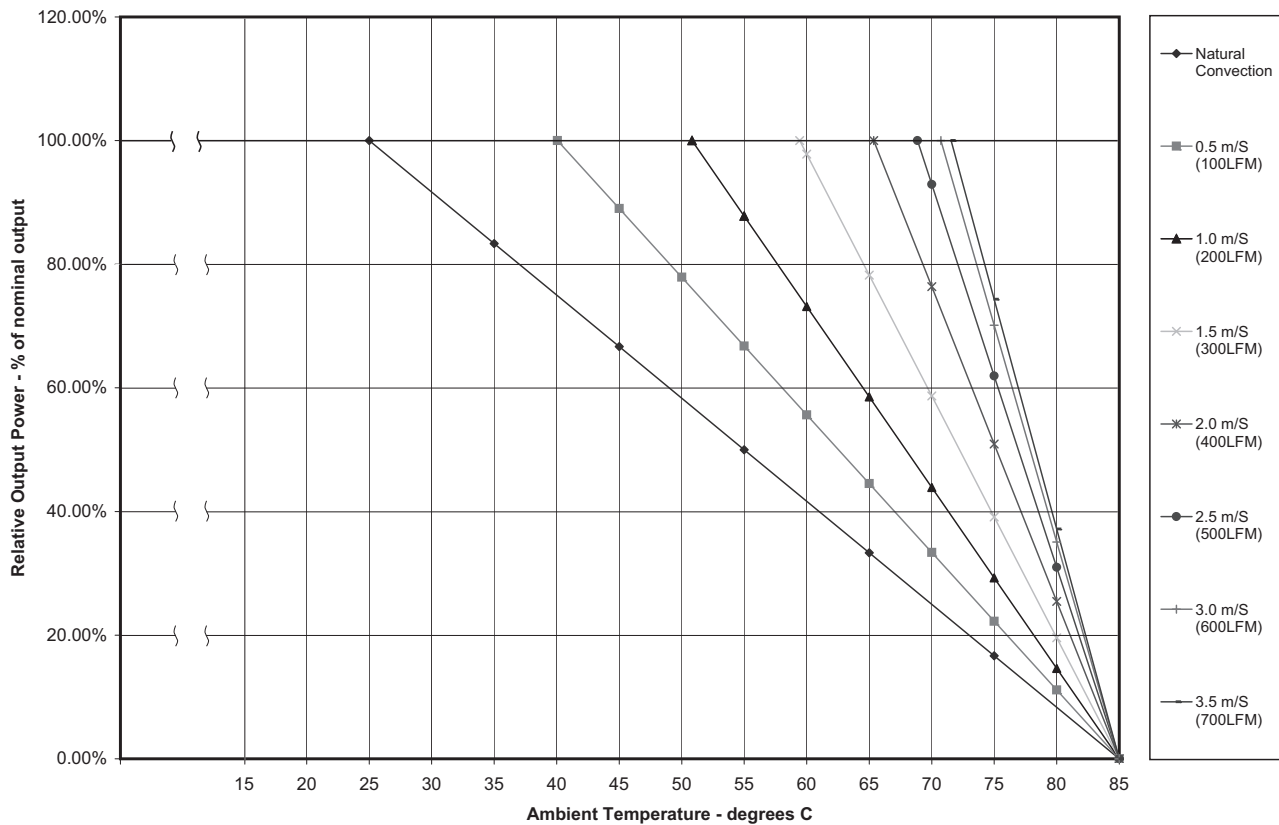
VHK200W-Q24 Power Derating Curves @ Nominal Input

FIGURE 1a. OUTPUT DERATING (24 V)

PART NUMBER: VHK200W   **DESCRIPTION:** chassis mount dc-dc converter

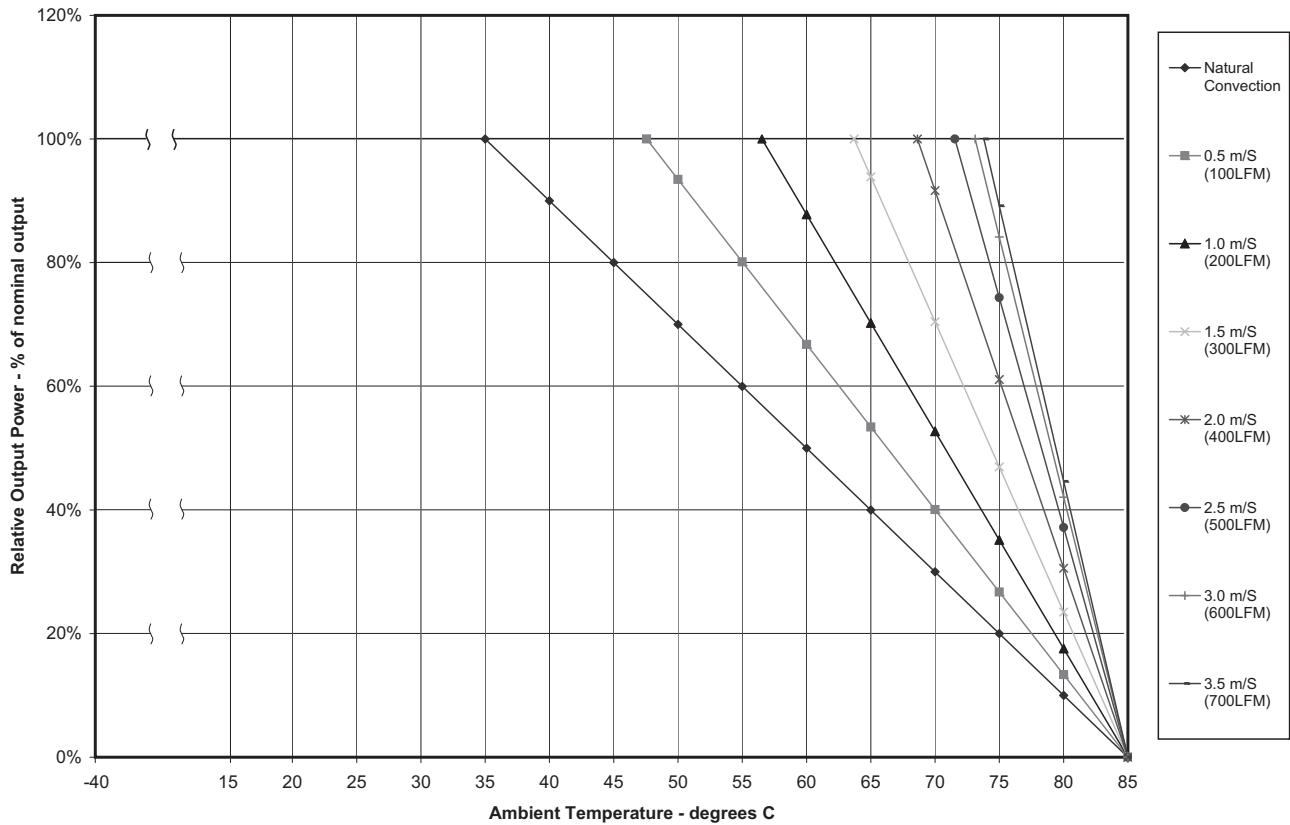**VHK200W-Q48 Power Derating Curves @ Nominal Input**

FIGURE 1b. OUTPUT DERATING (48 V)

2. INPUT VOLTAGE RANGE

It is important to ensure the input voltage measured at the converter input pins is within the range for that converter. Make sure wire losses and voltage ripples are accounted for. One possible problem is driving the converter with a linear unregulated power supply. For example, if the average voltage measured by a DMM is 9V, with a voltage ripple of 3Vpp, the actual input can swing from 7.5V to 10.5V. This will be outside the specified input range of 10-36V and the converter may not function properly. On the other end, make sure the actual input voltage does not exceed the highest voltage of 36V or 75V.

3. LEAD WIRES

Make sure the input and output wires are of adequate AWG size to minimize voltage drop, and ensure the voltage across the input terminals is above the converter's rated minimum voltage at all times. It is recommended to have the wire pairs twisted, respectively for the input pair and the output pair, so as to minimize noise pickup.

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PART NUMBER: VHK200W   **DESCRIPTION:** chassis mount dc-dc converter

4. INPUT CURRENT

The input voltage source must be able to provide enough current to the converter, otherwise it may not start up or operate properly. A typical symptom is not starting or unusually low output voltage. In general, it is recommended to be able to provide at least:
Ipeak = 150%*Pout/(η*Vmin) where Pout is the maximum output power, Vmin is the minimum input voltage and η is the converter's efficiency. As an example, for VHK200W-Q24-S12 to operate with 10~36V input, 200W output and an efficiency of 86%, the minimum source current is recommended to be: **Ipeak = 150% * 200 / (86% * 10) = 34.88A**.

5. INPUT FUSE

To limit the input current and to facilitate input reversal protection and input OVP protection, a fast-acting input fuse is recommended for the input line. The fuse rating will depend on the input range and should allow for the maximum current at the lowest input voltage, as shown in this equation: **Ipeak = 150%*Pout/(η*Vmin)**.
In the previous example of VHK200W-Q24-S12, the peak input current at 10V was calculated to be 34.88A. A 35A or a 40A fuse may be suitable for this application. Make sure the fuse voltage rating is higher than the maximum input voltage.
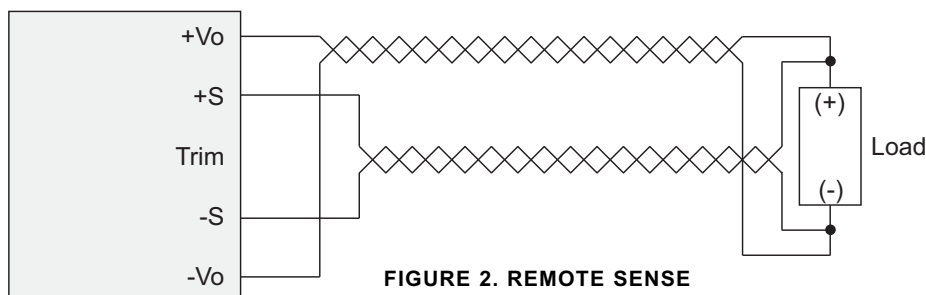
6. INPUT OVP

It is important to ensure the input voltage does not exceed the maximum rated input voltage for that model. To suppress voltage transients of short durations, the converter includes a transient voltage suppression device (TVS) at the input. The built-in TVS has a rated breakdown voltage of 39V for the VHK200W-Q24-XX models and 82V for the VHK200W-Q48 models. With small transients of short-durations, the TVS will limit the input voltage without interrupting the converters operations. For large transients, the TVS may conduct a large amount of current that may trip the input fuse. Without the input fuse, the converter may suffer permanent damages. When the fuse is open, replace it with one of same type and ratings.

7. INPUT REVERSAL PROTECTION

If the input voltage is reversed for any reason, the built-in protection circuits in the converter will limit the reverse voltage to one diode drop which is no more than 1V. With an external input fuse connected, the fuse will open and thus remove power from the converter. Check the wiring and make corrections as needed. The input fuse will need to be replaced. Make sure the new fuse is of the same type and rating. Without the input fuse, the converter may suffer permanent damages.

8. REMOTE SENSE

The converter provides regulated outputs at the output terminals. When there is a large current and/or the output cable is of some length, the voltage at the end of the output cable may be noticeably lower than at the terminals. The converter can compensate up to 0.5V of voltage drop through remote sense terminals. To ensure accurate regulation, run two separate wires (twisted) from the desired regulation points to the remote sense terminals, as shown below. Even if the load current is low, still connect +Vo to +S and -Vo to -S.


FIGURE 2. REMOTE SENSE

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9. OUTPUT TRIMMING (OPTIONAL)

The output voltages are preset to nominal values as indicated by the models table at the factory. If desired, the output voltage may optionally be trimmed to a different value (+/- 10%) with external resistors and/or potentiometer as shown below. Care should be taken to ensure that the maximum ouput power of the module remains at or below the maximum rated power (Maximum rate power = $V_{o,set}$ x $I_{o,max}$).

FIGURE 3. TRIMMING WITH EXTERNAL POTENTIOMETER
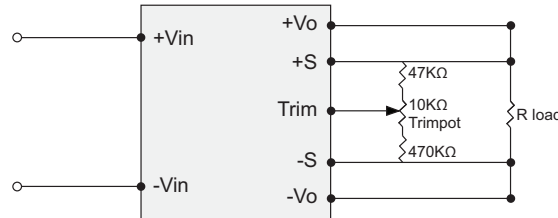
To trim the output voltage with fixed resistors, the output voltage can be calculated as follows.
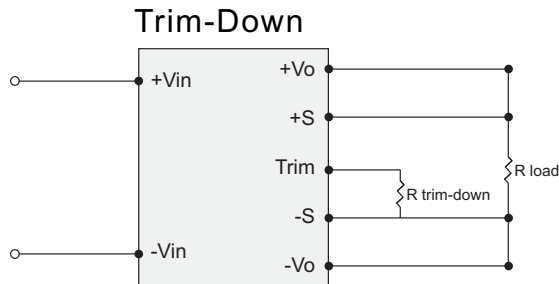
Trim-Down

FIGURE 4: TRIM-DOWN VOLTAGE SETUP

The value of $R_{trim-down}$ is defined as:

$$R_{trim-down} = \left[\frac{B}{\Delta\%} - C \right] (K\Omega)$$

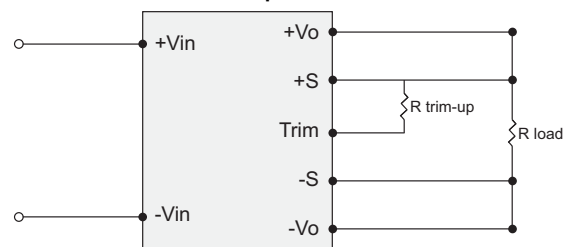$$\Delta\% = \left[\frac{V_{o,nom} - V_o}{V_{o,nom}} \right] x\ 100$$

Where: $R_{trim-down}$ is the external resistor in $K\Omega$. $V_{o,nom}$ is the nominal output voltage. V_o is the desired output voltage. B and C values are defined in Table 1. For example, to trim-down the 24V module (VHK200W-Q24-S24) by 8% to 22.08V, $R_{trim-down}$ is calculated:

$$B = 511, C = 10.22$$
$$\Delta\% = 8$$

$$R_{trim-down} = \left[\frac{511}{8} - 10.22 \right] K\Omega$$

$$R_{trim-down} = 53.66\ K\Omega$$

Trim-Up

FIGURE 5: TRIM-UP VOLTAGE SETUP

The value of $R_{trim-up}$ is defined as:

$$R_{trim-up} = \left[\frac{A(V_o)(100+\Delta\%)}{1.225\ x\ \Delta\%} - \frac{B}{\Delta\%} - C \right](K\Omega)$$

$$\Delta\% = \left[\frac{V_o - V_{o,nom}}{V_{o,nom}} \right] x\ 100$$

Where: $R_{trim-up}$ is the external resistor in $K\Omega$. $V_{o,nom}$ is the nominal output voltage. V_o is the desired output voltage. A, B and C values are defined in Table 1. For example, to trim-down the 24V module (VHK200W-Q24-S24) by 8% to 25.92V, $R_{trim-up}$ is calculated:

$$A = 5.11, B = 511, C = 10.22$$
$$\Delta\% = 8$$

$$R_{trim-up} = \left[\frac{511\ (25.92)\ (100+8)}{1.225+8} - \frac{511}{8} - 10.22 \right] K\Omega$$

$$R_{trim-up} = 1476.55\ K\Omega$$

Table 1

Output Voltage(V)	A	B	C
12, 15, 24, 28V	5.11	511	10.22
48V	20	2000	40

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PART NUMBER: VHK200W   **DESCRIPTION:** chassis mount dc-dc converter

10. OUTPUT OCP AND SHORT-CIRCUIT PROTECTION

Output overload and short circuit conditional will cause the output voltage to decline or shutdown altogether.   If the case temperature is not over 105°C, the output recovers automatically when the short or OCP conditions are removed. In the case of slight overloading, the output voltage may not shut down, but the converter may build up heat over time, causing over-temperature shutdown.

11. OVER-TEMPERATURE PROTECTION

When the case temperature reaches about 105°C, the converter's built-in protection circuit will shut down the output. When the temperature is reduced enough to a safe operating level, the converter will recover to normal operations automatically.

12. OUTPUT OVP

In case the output voltage exceeds the OVP threshold, the converter shuts down.

13. OUTPUT PARALLEL CONNECTIONS

The converter is not designed for load share on the output. However, for redundancy, the outputs of two or more converters can be connected in parallel through OR-ING diodes, as shown below. The standard version defaults to positive logic. For negative logic, indicate the selection when ordering.

FIGURE 6. OUTPUT PARALLEL CONNECTIONS
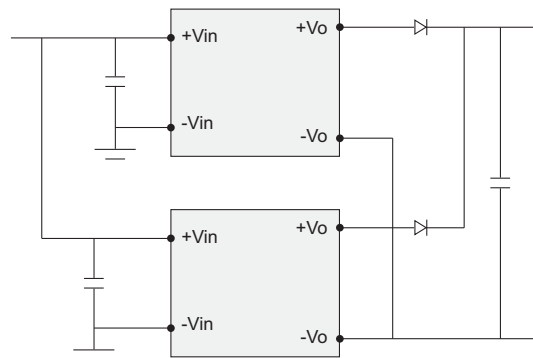
14. OUTPUT SERIES CONNECTIONS

Two or more converters can be connected in series to obtain a higher output voltage. To prevent output reverse biasing each other in case of a short, add a Schottky diode on each output in reverse polarity, as shown in the diagram. In the event of a short, the converters will forward-bias the diodes and the output reversal will be limited to one diode drop (about 0.5V) only, so as not to damage the converters. The forward current will cause each converter to go into short-circuit protection.   For proper diode selection, make sure that: 1) the diodes voltage rating is higher than each converter output; 2) the rated diode current can carry the short-circuit current; 3) the diodes do not overheat before the short is removed. Refer to FIGURE 7 (next page).

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**FIGURE 7. OUTPUT
SERIES CONNECTIONS**
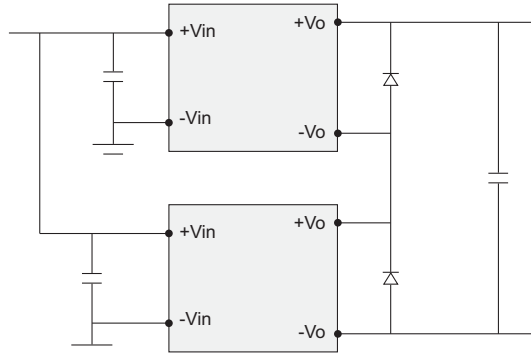
15. REMOTE OUTPUT ON/OFF CONTROL

The converter output can be enabled or disabled through the On/Off pin. The control logic is shown in this table. A common control circuit is shown below.
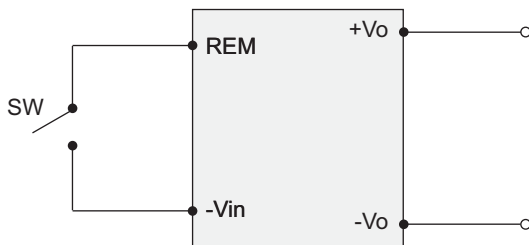
FIGURE 8. REMOTE ON/OFF CONTROL

High signal here disable output
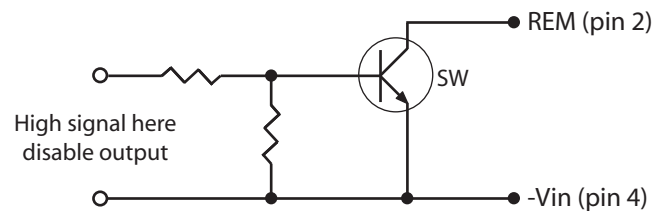
**FIGURE 9. REMOTE ON/OFF CONTROL
WITH TRANSISTOR SWITCH**

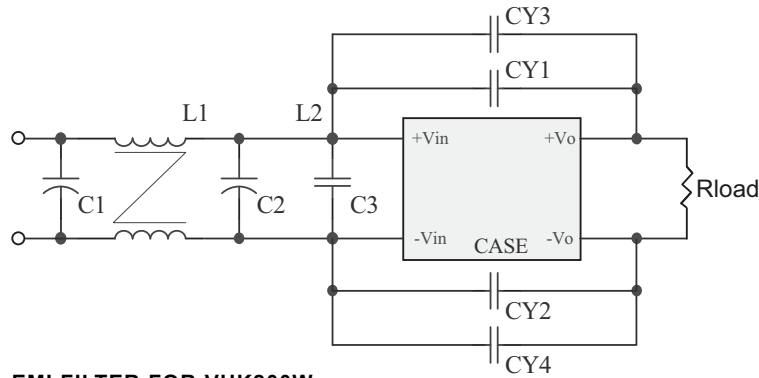| Logic Table	Negative logic	Positive logic
SW Closed (V_{REM} <1.2 V)	Output on	Output off
SW Open (V_{REM} >3.5~75 V or Open Circuit)	Output off	Output on

16. ISOLATION

The input and output of the converter are electrically isolated. If needed, an output terminal can be connected to an input terminal, resulting in the converter non-isolated.

17. INPUT FILTERING AND EMI INTERFERENCE

The VHK200W converters have input capacitors that control input current ripple and the associated EMI interference. However, they have not been tested to a formal standard for conducted emissions. Additional filtering may be needed to ensure compliance to an EMI standard. Refer to FIGURE 10 (next page) for a reference circuit.

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FIGURE 10. EMI FILTER FOR VHK200W

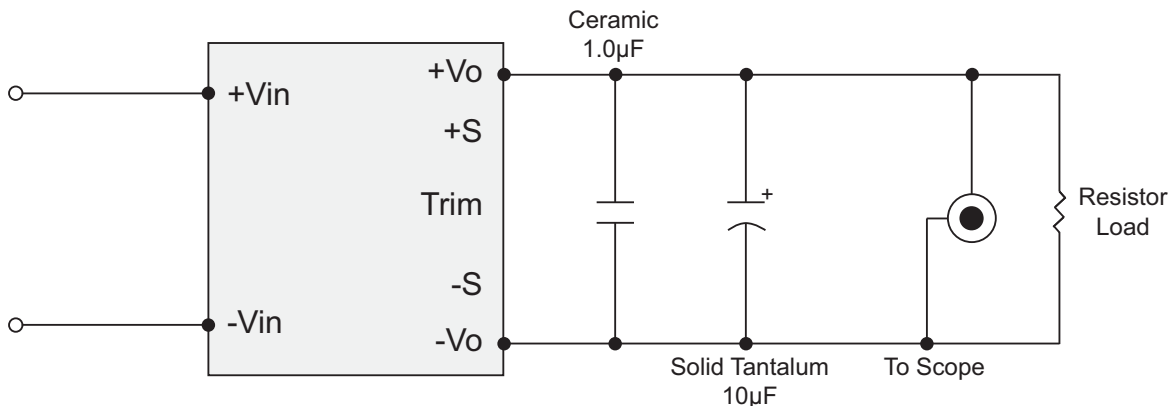| Model No.		C1	C2	C3	CY1	CY2	L1	CY3	CY4
VHK200W-Q24-S5	Class B	82uF/100V KY	82uF/100V KY	10uF/50V X7R 2220	NC	1000pF/2KV	0.5mH	NC	NC
VHK200W-Q24-S12	Class B	82uF/100V KY	82uF/100V KY	10uF/50V X7R 2221	1000pF/2KV	1000pF/2KV	0.5mH	NC	NC
VHK200W-Q24-S24	Class B	120uF/100V KY	120uF/100V KY	10uF/50V X7R 2220	1000pF/2KV	1000pF	0.5mH	NC	NC
VHK200W-Q24-S28	Class A	100uF/100V KY	100uF/100V KY	NC	NC	NC	0.5mH	NC	NC
VHK200W-Q24-S28	Class B	120uF/100V KY	120uF/100V KY	470uF/100V KY	1000pF/2KV	NC	0.45mH	1000pF/2KV	NC
VHK200W-Q24-S48	Class A	100uF/100V KY	100uF/100V KY	100uF/100V KY	680pF/2KV	680pF/2KV	1.0mH	NC	NC
VHK200W-Q24-S48	Class B	82uF/100V KY	82uF/100V KY	4.7uF/100V 2220	1000pF/2KV	1000pF/2KV	0.45mH	680pF/2KV	680pF/2KV
VHK200W-Q48-S5	Class B	82uF/100V KY	82uF/100V KY	4.7uF/100V X7R 2220	NC	680pF/2KV	0.5mH	NC	NC
VHK200W-Q48-S12	Class B	120uF/100V KY	120uF/100V KY	4.7uF/100V X7R 2220	1000pF/2KV	680pF/2KV	0.5mH	NC	NC
VHK200W-Q48-S24	Class B	120uF/100V KY	120uF/100V KY	4.7uF/100V X7R 2220	1500pF/2KV	680pF/2KV	0.5mH	NC	NC
VHK200W-Q48-S28	Class A	150uF/100V KY	150uF/100V KY	NC	NC	NC	0.5mH	NC	NC
VHK200W-Q48-S28	Class B	120uF/100V KY	120uF/100V KY	470uF/100V KY	1000pF/2KV	NC	0.45mH	1000pF/2KV	680pF/2KV
VHK200W-Q48-S48	Class A	100uF/100V KY	100uF/100V KY	100uF/100V KY	680pF/2KV	680pF/2KV	1.0mH	NC	NC
VHK200W-Q48-S48	Class B	82uF/100V KY	82uF/100V KY	4.7uF/100V 2220	2200pF/2KV	2200pF/2KV	0.45mH	NC	680pF/2KV

NOTE: The recommended components are a starting point <u>but not guaranteed</u> for meeting EMI

requirements.   More or less filtering may be required for a specific application or to meet other EMI standards.

18. OUTPUT FILTERING

The converter has built-in capacitors at the output to control ripple and noise. If desired, additional output capacitance can be introduced at the input to the powered equipment. Recommended starting point: one 10µF tantalum and one 1µF ceramic capacitor in parallel at the output.

19. OUTPUT NOISE MEASUREMENT SCHEMATIC

For proper output ripple and noise measurement, connect a 10µF tantalum and a 1µF ceramic capacitor across the output. Set the scope bandwidth to 20MHz. Probe directly off of one of the capacitors, using a small ground clip to minimize measurement error.

FIGURE 11. OUTPUT NOISE MEASUREMENT CIRCUIT

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