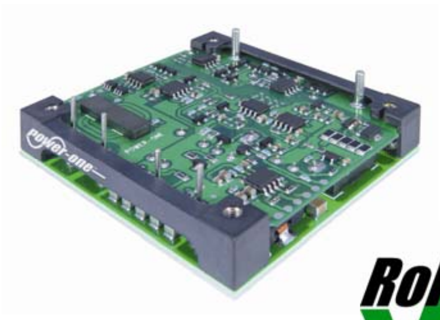


Features

- RoHS lead solder exemption compliant
- Fully regulated and quasi-regulated models available
- High output power of 360 W
- Efficiency up to 93%
- Wide-input voltage range from 36 to 75 V
- 100V/100ms input voltage surge withstand
- Input-to-output isolation: 1500 VDC
- Basic insulation
- Backdrive protection
- Start-up into pre-biased load
- Output overcurrent & overvoltage protection
- Overtemperature protection
- Remote on/off (primary referenced), positive or negative logic option
- Designed to comply with NEBS GR-1089 and GR-63
- Safety: UL60950-3rd/ CSA C22.2 60950-00, TUV EN60950-1:2001, IEC60950-1:2001

Applications

- Power systems utilizing Intermediate Bus Architecture
- Networking equipment
- Data/voice processing
- Wireless communications
- Computing

Benefits

- Simplifies power system design; reduces design time and technical risk
- Compatible with all (12 Vin nom.) POLs available in the market

Description

The HDS is a high density and highly efficient, isolated dc-dc converter that operates over an input voltage range of 36 to 75 VDC. It provides a 12 VDC nominal, fully-regulated output voltage at up to 30 Amps of current. Where adjustable voltage trim, remote sense, and tight dynamic load response are not required, a lower cost quasi-regulated model is offered. The converter is an ideal choice for building a complete power system utilizing the Intermediate Bus Architecture (IBA).
The thermally-optimized construction of the HDS allows the unit to provide high output current over a wide operating temperature range while maintaining a safe guardband for component electrical and thermal ratings. The addition of an external heat sink increases the capacity of the unit. The HDS employs 100% surface-mount components for consistency and reliability in the production process.

Model Selection

Model	Input Voltage VDC	Input Current, Max ADC [1]	Output Voltage VDC	Output Rated Current I_{rated} ADC	Output Ripple/Noise, mV p-p [2]	Typical Efficiency @ I_{RATED} %
HDS48T30120	36-75	12	12 (NOM.)	30	250	93

NOTES:
[1] @ V_{IN} min.
[2] (DC to 500 kHz)

Absolute Maximum Ratings

Stresses in excess of the absolute maximum ratings may cause performance degradation, adversely effect long-term reliability, and cause permanent damage to the converter.

Parameter	Conditions/Description	Min	Max	Units
Input voltage	Continuous		75	VDC
	Transient withstand		100	VDC
Operating Temperature [1]	Baseplate	-40	110	°C
	Ambient	-40	85	°C
Storage Temperature		-55	125	°C
ON/OFF Control Voltage	Referenced to -Vin		7	VDC
Output Power [1]			360	W

Note: [1] with appropriate power derating, see figure 14 & 15.

Environmental and Mechanical Specifications

Parameter	Conditions/Description	Min	Nom	Max	Units
Operating Humidity	Relative Humidity, Non-cond.			95	%
Storage Humidity	Relative Humidity, Non-cond.			95	%
Water Washing	Standard process		Yes		
Shock	Halfsine wave, 3 axes	50			g
Sinusoidal Vibration	GR-63-CORE, Section 5.4.2	1			g
Weight			2.6/74		Oz(g)
Dimensions	(Overall)		2.28(57.9) x 2.4(61) x 0.5(12.7)		In. (mm)
MTBF (Calculated)	Per Telcordia SR-332 Issue 1, (method 1, case 2, GB, 40^{O}C)		2.3		MHrs

Isolation Specifications

All specifications apply over specified input voltage, output load, and temperature range, unless otherwise noted.

Parameter	Conditions/Description	Min	Nom	Max	Units
Insulation Safety Rating			Basic		
Isolation Voltage	Input to Output	1500			VDC
	Input to Baseplate	1500			VDC
	Output to Baseplate	1500			VDC
Isolation Resistance	Input to Output	10			MΩ
Capacitance	Input to Output	-	1,000		pF

power-one®
Changing the Shape of Power

Safety Regulatory Compliance

Safety Agency	Standard Approved To:	Marking
CSA	UL60950-3RD / CSA C22.2 60950-00	cCSAs
TUV product service	TUV EN60950-1:2001	TUV PS Baurt mark
CB report	IEC60950-1:2001	N/A. May use CE mark
Conducted Emissions	(with external EMI filter)	CISSPR 22 class B

Input Specifications

All specifications apply over specified input voltage, output load, and temperature range, unless otherwise noted.

Parameter	Conditions/Description	Min	Nom	Max	Units
Input Voltage	Continuous	36	48	75	VDC
Maximum Input Current	Vin =36 V, Iout=I_{RATED}			12	ADC
Turn-On Input Voltage (UVLO) [1]	Ramping Up	33	34	35	VDC
Turn-Off Input Voltage [1]	Ramping Down	31.5	32.5	33.5	VDC
Turn-Off Hysteresis		1.5			VDC
Input Reflected Ripple Current	I_{RATED}, 12 µH source inductance BW=20 MHz [2, 3, 4]		150	200	mA p-p
Inrush Transient	Vin = Vin.max			1	A^2s

[1] See figure 1
[2] Vin = 48 V.
[3] See Figure 10 for measurement method
[4] Refer to Fig 1, current waveform

Output Specifications

All specifications apply over specified input voltage, output load, and temperature range, unless otherwise noted.

Output specifications reflect those of the fully-regulated model; option suffix: **-xxxR**

Parameter	Conditions/Description	Min	Nom	Max	Units
Output Voltage Set-point	(Vin = 48 V, Io = 15 A)	11.76	12	12.24	VDC
Line Regulation:	(Vi = 36 V to 75 V, Io_{RATED})			0.2	VDC
				1.7	% Vo
Load Regulation:	(Vin = 48 V, Io = 0 to 30 A)			0.2	VDC
				1.7	% Vo
Temperature Regulation	($T_{BASEPLATE}$) = -40 °C to +110 °C)		0.005	0.01	%/°C
Total Error Band	(Line, Load, Temperature)	11.64	12	12.36	VDC
Dynamic Regulation Peak Deviation Settling Time	75-100-75% load step change, di/dt=1A/µs to 1% error band Co=100 µF		360 5	720 10	mV ms

Output specifications reflect those of the quasi-regulated model; option suffix: **-xxx0**

Parameter	Conditions/Description	Min	Nom	Max	Units
Output Voltage Set-point	(Vin = 48 V, Io = 15A)	11.76	12	12.24	VDC
[1] Line Regulation:	(Vi = 36 V to 75V, Io_{RATED})			-0.4	VDC
				-3.3	% Vo
[1] Load Regulation:	(Vin = 48 V, Io = 0 to 30 A)			-0.4	VDC
				-3.3	% Vo
Temperature Regulation	($T_{BASEPLATE}$) = -40 °C to +110 °C)		.5	1	%/°C
Total Error Band	(Line, Load, Temperature)	11.3	12	12.7	VDC
Dynamic Regulation Peak Deviation Settling Time	75-100-75% load step change, di/dt=1A/µs to 1% error band Co=100 µF		1,300 5	1,500 10	mV ms

[1] See figure 4 for detailed regulation characteristics.

General Specifications

All specifications apply over specified input voltage, output load, and temperature range, unless otherwise noted.

Parameter	Conditions/Description	Min	Nom	Max	Units
Output Current	I_{rated}	0		30	ADC
Current Derating [2]	@ 200 LFM, 55 °$C_{AMBIENT}$, no heatsink			17	ADC
	@ 200 LFM, 55 °$C_{AMBIENT}$, w/ 0.45" finned heatsink			22	ADC
Efficiency [3] (T_{AMB}=25°C)	Vin_{NOM}, I_{rated} =30A	91	93		%
Switching Frequency	Fixed frequency	500	570		kHz
Output Ripple [4]	Over line and load, T_{AMB}= 0 °C to 85 °C		150 1.25	250 1.7	mVp-p % Vo
	(DC to 20 MHz)		30 0.25	60 0.5	mV_{RMS} % Vo
Turn-on Overshoot	Overall input voltage, load, and temperature conditions		0	5	%Vout
Turn-On Time [5] (via application of input voltage)	Time from Vin=UVLO to regulation band	50	75	100	ms
Turn-On Time [6] (via On/Off signal)	Time from enable to regulation band		40	60	ms
Rise Time [5, 6]	From 10 to 90% of Vout.nom		40	60	ms
Admissible Load Capacitance		100 [7]		9,000	µF

[2] See Figures 16 & 17, power derating curves.

[3] See Figure 3 for efficiency characteristics.

[4] See Figures 9 and 10 for output ripple waveform and recommended test setup.

[5] Refer to Figure 5.

[6] Refer to Figure 6.

[7] For –xxxR suffix models, Co ≥ 270uF is recommended.

Protections Specifications

All specifications apply over specified input voltage, output load, and temperature range, unless otherwise noted.

Parameter	Conditions/Description	Min	Nom	Max	Units
Overcurrent Protection (Vin = V_{NOM})					
Type	Non-latching – auto-recovery, hiccup type.				
Threshold		33	39	45	ADC
Short Circuit [1]	Hiccup Mode		2	4	A_{RMS}
Overvoltage Protection					
Type	Latching, recycle input voltage or ON/OFF signal to unlatch				
Threshold [2]	Vin = Vin.nom, Iout = I_{RATED}	13.8	14.4	15	VDC
Overtemperature Protection					
Type	Non-latching, auto-recovery				
Threshold	Baseplate temperature	120		130	°C
Hysteresis			10		°C

[1] Refer to Figure 12. [2] Refer to Figure 13.

Feature Specifications

All specifications apply over specified input voltage, output load, and temperature range, unless otherwise noted.

Parameter	Conditions/Description	Min	Nom	Max	Units
On/Off					
Negative Logic (-N suffix) On/Off (pin #3) (Primary side ref. to -Vin)	(On/Off signal is low – converter is ON)				
	Converter ON Sink current	-0.5	 0.5	0.8 1	VDC mADC
	Converter OFF Open circuit voltage	2.5	 2	7	VDC VDC
Positive Logic (-P suffix) On/Off (pin #3) (Primary side ref. to -Vin)	(On/Off signal is low – converter is OFF)				
	Converter ON Open Circuit Voltage	2.5		7 5	VDC VDC
	Converter OFF Sink Current	-0.5	 0.5	0.8 1	VDC mADC
Remote Sense [1, 2]					
Remote Sense Headroom				1.2	VDC
Output Voltage Trim [1, 2]					
Trim Up				1.2	VDC
Trim Down		-1.2			VDC

[1] Applies only to model suffix: -xxxR
[2] Combined output voltage positive adjustment can not exceed 1.2 VDC.

Performance Characteristics

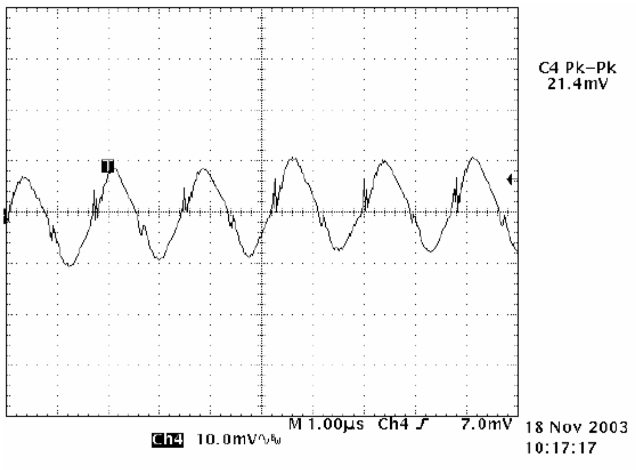


Figure 1. HDS Input Reflected Ripple Current (typ)

Scale: 5mA/10mV or 5mA/division
Conditions: Output current = 30 Amperes.
Input voltage = 48 VDC.

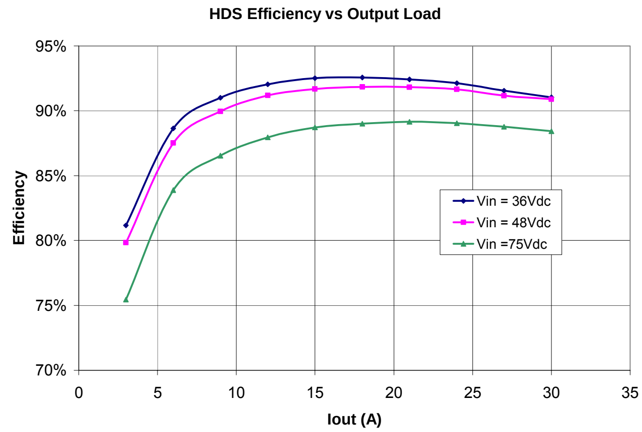


Figure 3. HDS Efficiency Characteristics (typ)

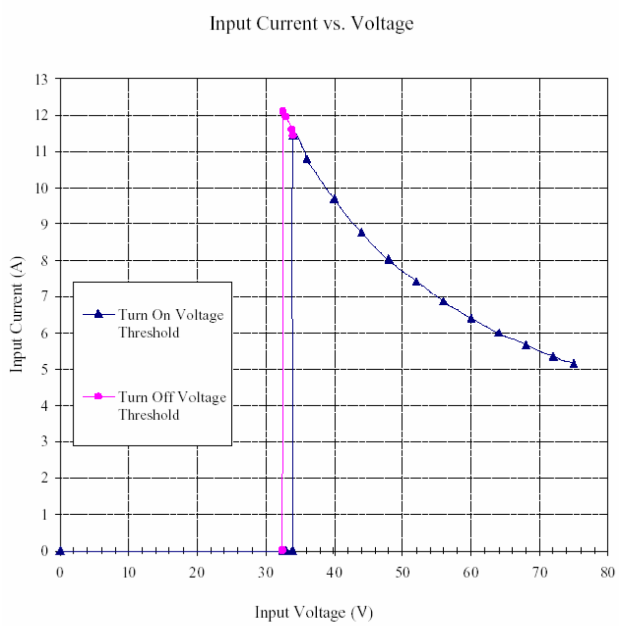


Figure 2. HDS Undervoltage Lockout Characteristics (typ)

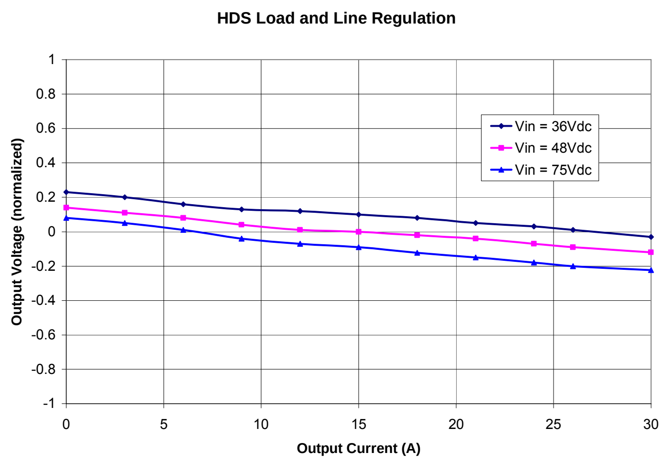


Figure 4. HDS Line and Load Regulation (typ)
Note: Quasi regulated model option, suffix: –xxx0

Line and load regulation performance above reflects that of the quasi-regulated model only; p/n suffix: -xxx0. For fully-regulated performance, select model p/n suffix: -xxxR.

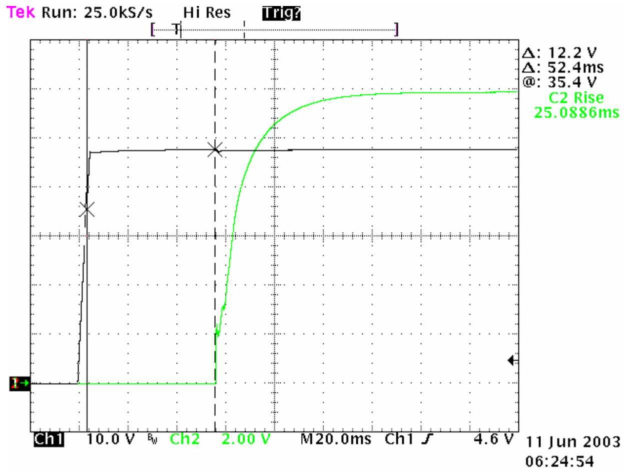


Figure 5. HDS, Turn-On Characteristics @ Power-up (typ)

When the input voltage reaches the turn-on threshold of the input undervoltage protection circuit (indicated by the solid left vertical line), an internal timer is triggered. The timer generates a delay of approximately 50 ms. The output voltage begins rising upon completion of the delay, as indicated by the right dashed vertical line. The delay allows the input voltage to stabilize before the converter output turns on and delivers power to the load, thus preventing the otherwise resultant input voltage sag and nuisance tripping of the UVLO protection circuit.

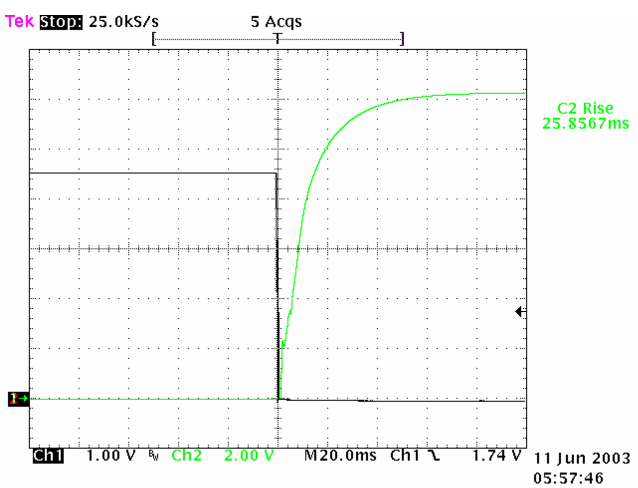


Figure 6. HDS, Turn-On Characteristics via On/Off Ctrl (typ)

(Negative logic On/Off shown)

If the converter is controlled by the ON/OFF signal, there is no turn-on delay. The output voltage starts rising immedialtely after the converter is enabled by the ON/OFF signal.

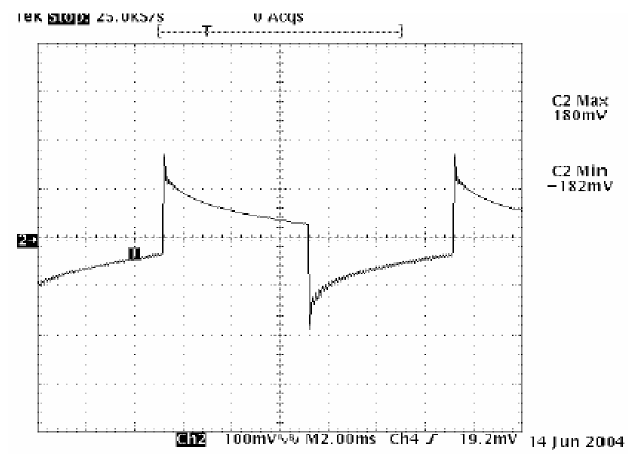


Figure 7. HDS, Dynamic Load Response (typ)
Note: Fully regulated model option, suffix: –xxxR

Conditions: The load is switched from 15 A to 22.5 A at di/dt=1A/µs.
Cext=270 µF.
Channel 1 - output voltage. (182mV deviation measured)
Scale : 1V/div, 5ms/div.

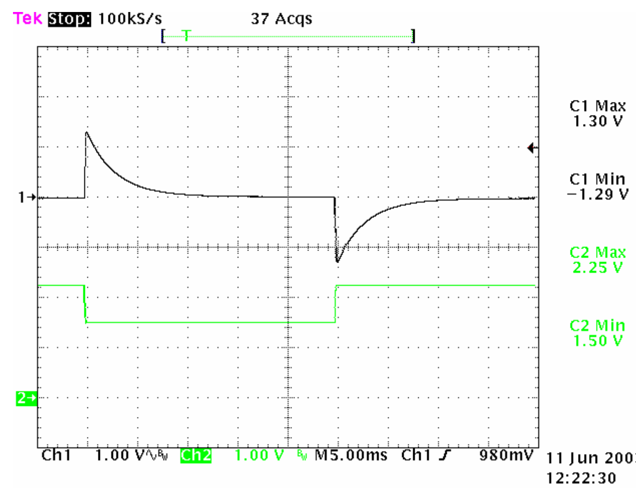


Figure 8. HDS, Dynamic Load Response (typ)
Note: Quasi regulated model option, suffix: –xxx0

Conditions: The load is switched from 15 A to 22.5 A at di/dt=1A/µs.
Cext=100 µF.
Channel 1 - output voltage, (1.3V deviation measured)
Channel 2 – output current.
Scale : 1V/div, 5ms/div.

Output Ripple and Noise

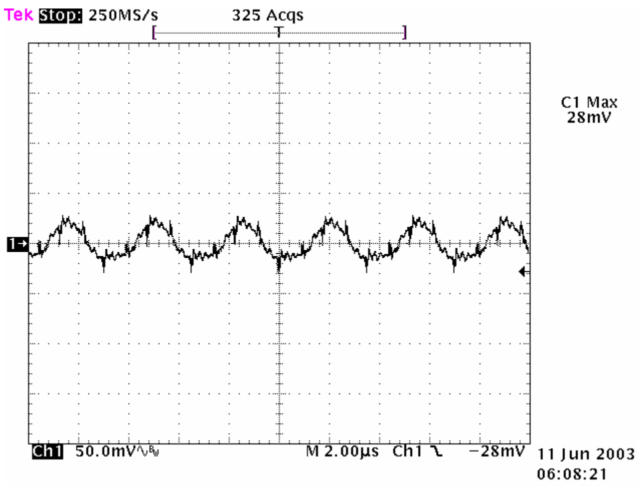


Figure 9. HDS, Output Ripple & Noise (typ)

Conditions: Vin = 48 V and Iout = 30 A.

To improve accuracy and repeatability of ripple and noise measurements, Power-One utilizes the test setup shown in Figure 10.

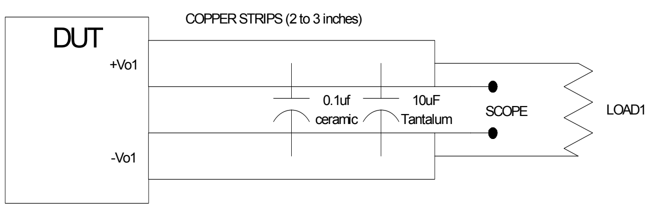


Figure 10. Output Ripple and Noise Measurement Test Setup

A BNC connector is used for the measurements to eliminate noise pickup associated with long ground leads of conventional scope probes. The connector, a 0.1µF ceramic, a 10 µF tantalum capacitor, and the load are located 2-3" away from the converter.

For output decoupling we recommend using a 10 µF low ESR tantalum (AVX TPSC106M025R0500 is used in Power-One test setup) and a 0.1 µF ceramic capacitor. Note that the capacitors do not substitute for filtering required by the load.

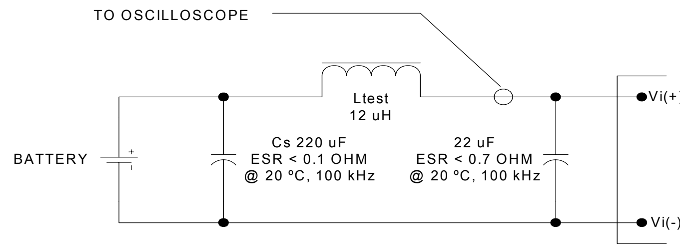


Figure 11. Input Reflected Ripple Current Measurement Setup

Note: Measure input reflected-ripple current with a simulated inductance (Ltest) of 12 µH. Capacitors offset possible battery impedance. Measure current as shown above

Overcurrent Protection

To provide protection from an output overload or short circuit condition, the HDS is equipped with current limiting circuitry and can endure the fault condition for an unlimited duration. At the point of current-limit inception, the converter enters hiccup mode, causing the output current to be limited both in peak and duration. While in the hiccup mode, the converter attempts to restart approximately once every second as shown in Figure 12. Because of very low duty cycle the RMS value of output current is limited to only 4 A_{RMS} max..

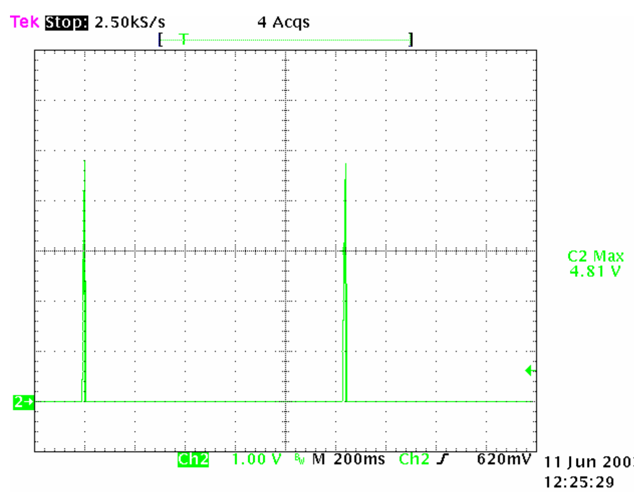


Figure 12. HDS, Short Circuit Behavior (typ)

Condition: Vin = 48 V
Scale: 10A/V.

Once the output current is brought back into its specified range, the converter automatically exits the hiccup mode and continues normal operation.

Back Driving

The HDS dc-dc converter uses a control-driven synchronous rectification technique. Applying an external voltage on the output of a unit that is shut down will not cause damage.

Overvoltage Protection

The output overvoltage protection consists of a separate control loop, independent of the primary control loop. This control loop has a higher voltage set point than the primary loop. In a fault condition the converter limits its output voltage and latches off. Figure 13 shows operation of the converter under overvoltage conditions.

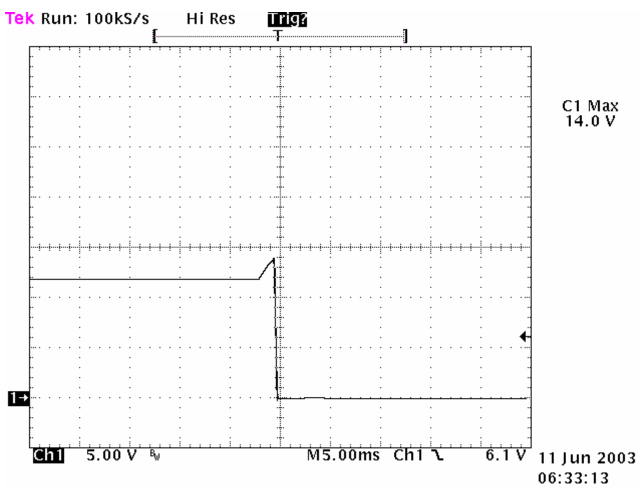


Figure 13. HDS, Overvoltage Behavior (typ).

Conditions: Vin = 75 V, no load.

Feature Description

ON/OFF (Control)

(-Pxxx suffix model)
The ON/OFF (#3) pin of the HDS converter is referenced to the –Vin (#1) pin (refer to Figure 15). With the positive logic model, when the ON/OFF pin is pulled low, the output is turned off and the unit goes into a very low input power mode.

(-Nxxx suffix model)
With negative logic, when the ON/OFF pin is pulled low, the unit is turned on.

An open collector switch is recommended to control the voltage between the ON/OFF pin and the -Vin pin of the converter. The ON/OFF pin is pulled up internally, so no external voltage source is required. The user should avoid connecting a resistor between the ON/OFF pin and the +Vin (#4) pin.

The ON/OFF pin is referenced to the -Vin (#1) pin. The control signal must not be referenced ahead of EMI filtering, or remotely from the unit. Optically coupling the control signal and locating the opto-coupler directly is recommended for trouble free operation.

If the ON/OFF pin is not used, it can be left floating (positive logic), or connected to the -Vin pin (negative logic).

Output Voltage Adjustment

(-xxxR suffix model)
The trim feature allows the user to adjust the output voltage from its nominal value.

The HDS trims up with a resistor from the Trim (# 7) pin to the +Sense (# 8) pin and trims down with a resistor from the Trim pin to the –Sense (# 6) pin as shown in the Figure 14.

The equations below determine the trim resistor value required to achieve a ΔV change in the output voltage.

$$Radj-up=\left(\frac{Vo(100+\Delta\%)}{1.225\Delta\%}-\frac{(100+2\Delta\%)}{\Delta\%}\right)k\Omega$$

$$Radj-down=\left(\frac{100}{\Delta\%}-2\right)k\Omega$$

where ΔV% is the output voltage change expressed in percent of the nominal output voltage, Vo.
(For example the maximum allowable percent change increase is 10; [i.e., 1.2 V = 10%].)

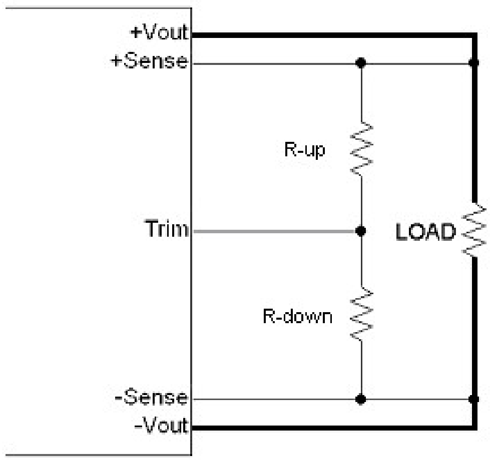


Figure 14. HDS Converter Trim Schematic (-xxxR suffix model)

Notes:

1. When the output voltage is trimmed up, the output power from the converter must not exceed its maximum rating. The power is determined by measuring the output voltage on the output pins, and multiplying it by the output current.

2. In order to avoid creating apparent load regulation degradation, it is important that the trim resistors are connected directly to the remote sense pins, and not to the load or to traces going to the load.

3. The output voltage increase can be accomplished by either the trim or by the remote sense or by the combination of both. In any case the absolute maximum output voltage increase shall not exceed the limits defined in the *Features Specification* section above.

4. Either R_{up} or R_{down} should be used to adjust the output voltage according to the equations above. If both R_{up} and R_{down} are used simultaneously, they will form a resistive divider and the equations above will not apply.

Application Information

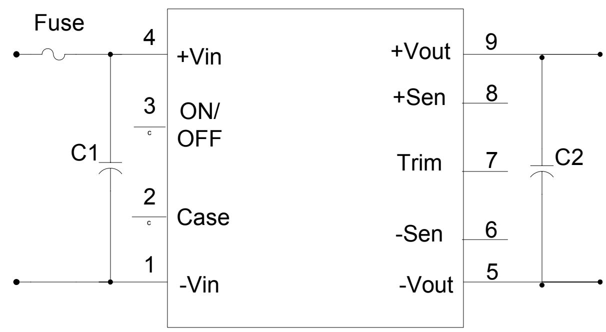


Figure 15. Recommended Connections for the HDS Converter

The HDS converter requires external capacitors at the input and output for proper operation. However, if the distribution of the input voltage to the converter contains significant inductance, additional capacitance may be required to enhance performance of the converter.

Ref. Des	Minimum recommendations	Model Suffix
C1	100µF, ESR < 100 mOhms	-xxx0 -xxxR
C2	100µF, ESR < 70 mOhms	-xxx0
C2	270µF, ESR < 70 mOhms	-xxxR

Inrush Current

Refer to the "Inrush Current Control Application Note" (http://www.power-one.com/technical/articles/dc-dc_1-app.pdf) for suggestions on how to limit the magnitude of the inrush current.

Load Dump Considerations

(Applies above 240 Watts only)

Operation above 20 Amps of output current, coupled with a severe load dump condition requires increased output capacitance from that advised above. Contact Power-One for recommended values.

Thermal Considerations

HDS converters are designed for both natural and forced-convection cooling. To achieve long term reliability, the recommended power derating curves below, were established by comparing measured junction and hot spot temperatures against those allowed per Power-One's component derating guidelines

The graph in Figure 16 & 17 shows the maximum recommended output current of the HDS converter at various ambient temperatures under both natural and forced convection (longitudinal airflow direction, from pin 1 to pin 4).

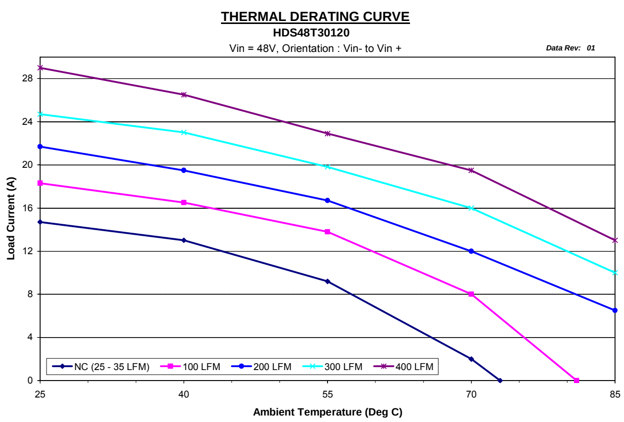


Figure 16. **HDS Power Derating Curves [no H.S.]**

Example, from Figure 16, the HDS operating at 70 °C can deliver up to 12 Amps reliably with 200 LFM of forced air.

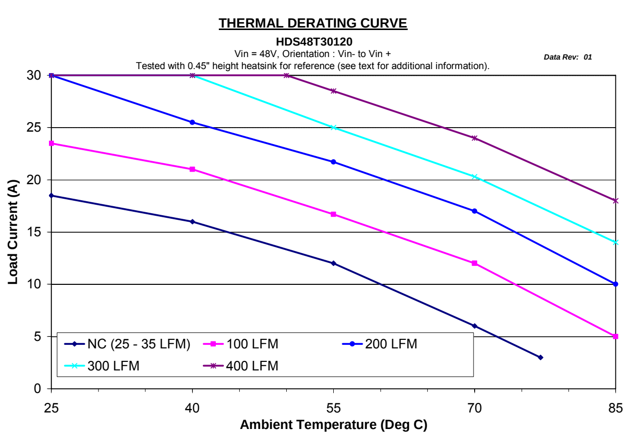


Figure 17. **HDS Power Derating Curves (w/ 0.45" tall H.S.]**

Figure 17 is provided for reference and shows the effects of adding 0.45" high aluminum fin-type heat sink (p/n: HSK-HBX500-45V) to the unit's baseplate surface. To view the heat sink dimensions and orientation, refer to link:
http://www.power-one.com/resources/products/datasheet/heatsinks.pdf

Conducted EMI

The following line filter configuration and component values are offered as a guideline to assist in designing an effective filter solution.

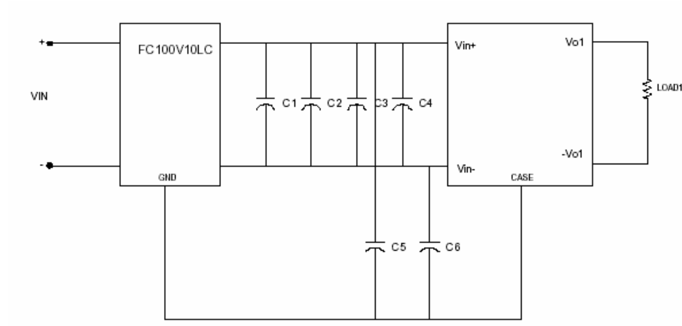


Figure 18. **Input filter Configuration Suggested to Meet NE55022 Class A Conducted Emission Limits**

Input filter components are shown in the table below, and the results of conducted EMI scan are shown in Figure 19.

Part List for the Input Filter

Ref. Des	Description	Manufacturer
C1, 2	0.47 µF @100 V MLC Capacitor (1812)	AVX or Equivalent
C3	100 µF @ 100 V Alum. Electrolytic Capacitor	Nichicon NRSZ Series or Equiv.
C4	22 µF@ 100 V Alum. Electrolytic Capacitor	United Chemicon KMG Series or Equiv.
C5, 6	0.01 µF MLC Capacitor	AVX or Equiv.
F1	FC100V10A Input Filter Module	Power-One

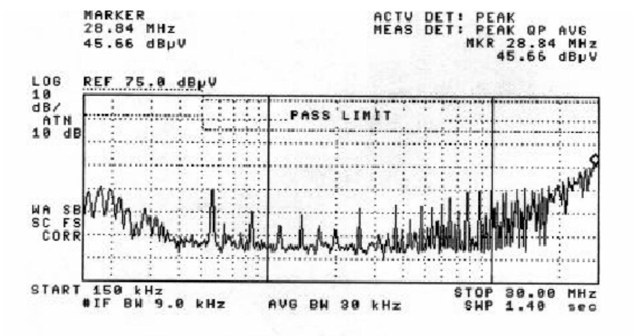


Figure 19. Conducted EMI Scan of the HDS with the Input Filter Configuration Shown in Figure Above.

Safety Considerations

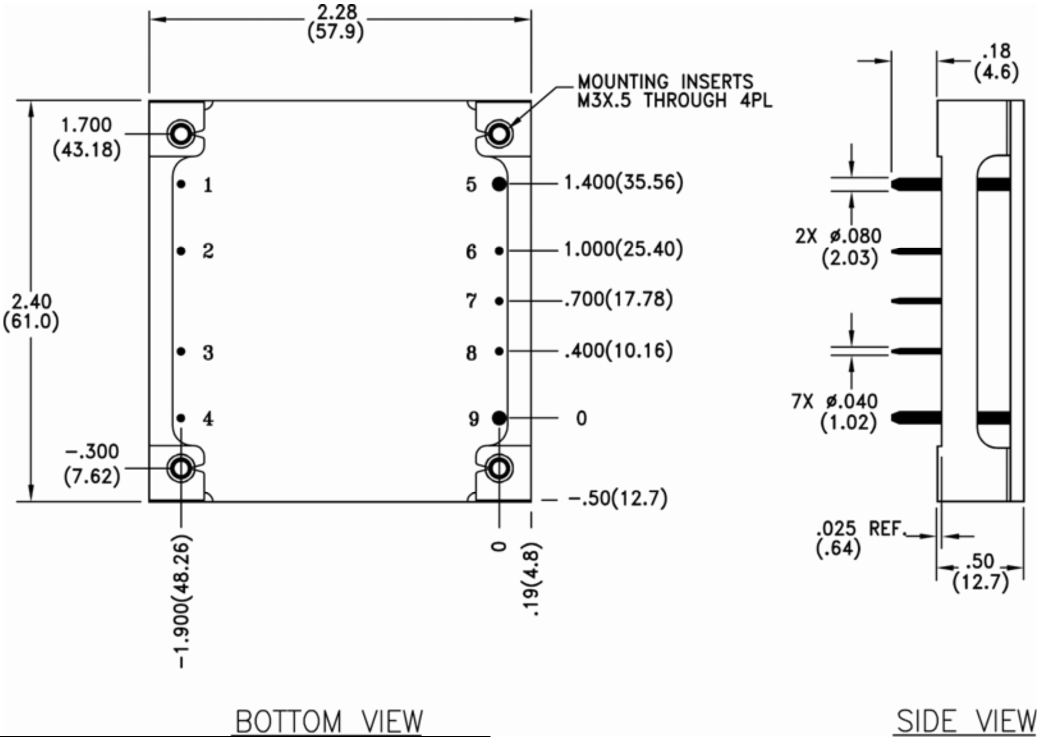
The HDS converters feature 1500 VDC isolation from the input to output. The input-to-output resistance is greater than 10MΩ. These converters are provided with Basic insulation between input and output circuits according to all IEC60950 based standards. Nevertheless, if the system using the converter needs to receive safety agency approval, certain rules must be followed in the design of the system. In particular, all of the creepage and clearance requirements of the end-use safety requirements must be observed. These documents include UL60950 - CSA60950-00 and EN60950, although other or additional requirements may be needed for specific applications.

The HDS converters have no internal fuse. **The external fuse must be provided to protect the system from catastrophic failure.** Refer to the "Input Fuse Selection for DC/DC converters" application note on www.power-one.com for proper selection of the input fuse. Both input traces and the chassis ground trace (if applicable) must be capable of conducting a current of 1.5 times the value of the fuse without opening. The fuse must not be placed in the grounded input line, if any.

In order for the output of the HDS converter to be considered as SELV (Safety Extra Low Voltage) or TNV-1, according to all IEC60950 based standards, one of the following requirements must be met in the system design:

- If the voltage source feeding the module is SELV or TNV-2, the output of the converter may be grounded or ungrounded.
- If the voltage source feeding the module is ELV, the output of the converter may be considered SELV only if the output is grounded per the requirements of the standard.
- If the voltage source feeding the module is a Hazardous Voltage Secondary Circuit, the voltage source feeding the module must be provided with at least Basic insulation between the source to the converter and any hazardous voltages. The entire system, including the HDS converter, must pass a dielectric withstand test for Reinforced insulation. Design of this type of systems requires expert engineering and understanding of the overall safety requirements and should be performed by qualified personnel.

Mechanical Drawing



Mechanical Tolerances:		
General	Inches	Millimeters
	X.XX = ±0.020	X.X = ±0.5
	X.XXX = ±0.010	X.XX ±0.25
Pin Diameter	±0.002	±0.05
Pin Length		
0.18" (-xx**A**x)	+/-.020	+/-.5
0.145" (-xx**B**x)	+/-.010	+/-.25
0.110" (-xx**C**x)	+/-.010	+/-.25

Pin Assignments:	**Model:** xxx**R**	**Model:** xxx**0**
	Function	**Function**
1	-Vin	-Vin
2	Case	Case
3	On/off	On/off
4	+Vin	+Vin
5	-Vout	-Vout
6	-Sense	n/a
7	Trim	n/a
8	+Sense	n/a
9	+Vout	+Vout

Converter Part Numbering Ordering Information

Series	# Out	Vin nom.	I/O type	Io	Vo (nom. X 10)	-	On/Off logic	Height	Pin length	Special options
HD	**S**	48	T	30	120	-	P, N	C	A, B, C	0, R
½-Brick,	single output	36 – 75 VDC	Thru-hole	ADC	VDC		See below			

Features & Options:	Descriptions:	Suffix code:
Remote ON/OFF	Positive logic	**-P**xxx
	Negative logic	**-N**xxx
Unit Height	0.50" nom. (fixed value, no alternative height)	**-**x**C**xx
Pin Length	0.18" (standard model length)	**-**xx**A**x
	0.145"	**-**xx**B**x
	0.110"	**-**xx**C**x
Special Options	None (standard model, no special options)	**-**xxx**0**
	Fully regulated model with Rem. Sen. & Trim	**-**xxx**R**
	Customer-specific models	**-**xxx**S#**

Example:

Standard HDS with negative logic & 0.145 pin length; the resulting part number is HDS48T3012–NCB0.

Notes:

1. Consult factory for the complete list of available options.

NUCLEAR AND MEDICAL APPLICATIONS - Power-One products are not designed, intended for use in, or authorized for use as critical components in life support systems, equipment used in hazardous environments, or nuclear control systems without the express written consent of the respective divisional president of Power-One, Inc.

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