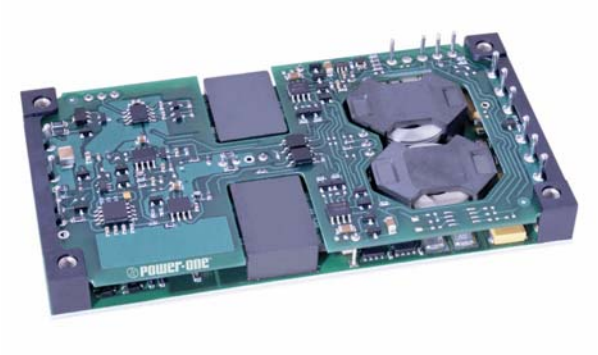


Applications

- Base station amplifiers
- Distributed power architectures
- Telecommunications equipment
- LAN/WAN applications
- Data processing applications

Features

- Low profile – 12.7 mm height
- Input-to-output isolation: 1500 VDC
- Basic insulation
- High efficiency - up to 93% at full load
- Tight dynamic load response
- Output overcurrent protection
- Output overvoltage protection
- Overtemperature protection
- Remote sense
- Remote on/off (primary referenced), positive or negative logic option
- Output voltage trim adjust, positive or negative option
- UL 1950 Recognition, CSA 22.2 No. 950-95 certification, TUV IEC950

Description

The FHS Series power modules are dc-dc converters that operate over an input voltage range of 36 to 75 VDC and provide a regulated DC output voltage at up to 18 amps of output current. The output is fully isolated from the input, which allows a positive or negative output configuration.

The open-frame module is constructed with a two-board approach. The power devices are connected to an Insulated Metal Substrate (IMS) base plate, which provides very low thermal impedance. A separate PCB is populated with the control circuitry and is physically isolated from the hotter IMS board. This approach allows for lower component temperatures, hence increased reliability. The standard feature set includes remote on/off, remote output voltage sensing, negative logic output trim (optional positive logic output trim available[1]), input under and overvoltage lockout and overtemperature shutdown with hysteresis.

Model Selection

Model	Input voltage (VDC)	Input current, Max, (ADC)	Output voltage (VDC)	Output rated current $I_{rated,}$ (ADC)	Output Ripple/Noise (mV p-p)	Typical Efficiency @ $I_{rated,}$ (%)
FHS18Z28	36-75	16	28	18	150	93

This product is intended for integration into end-use equipment. All the required procedures for CE marking of end-use equipment should be followed.

Model numbers highlighted in yellow or shaded are not recommended for new designs.

[1] Consult factory for availability.

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, 100ms		100	VDC
Operating Temperature	Baseplate Temperature	-40	110	°C
Storage Temperature		-55	125	°C
ON/OFF Control Voltage	Referenced to -Vin		7	VDC
Output Power			504	W

Environmental and Mechanical Specifications

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

Parameter	Conditions/Description	Min	Nom	Max	Units
Shock	Halfsine wave, 3 axes	50			g
Sinusoidal Vibration	GR-63-CORE, Section 5.4.2	1			g
Weight			5.4/152		Oz/g
Water Washing	Standard process		Yes		
MTBF	Per Bellcore TR-NWT-000332		1,000		kHrs

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, input to base plate	1500			VDC
Isolation Voltage	Output to base plate	1500			VDC
Isolation Resistance		10			MOhm
Isolation Capacitance			1000		pF

Safety Regulatory Compliance

Safety Agency	Standard Approved To:	Marking
Underwriters Laboratories	UL60950/CSA60950-00	cULus
TUV product Service	TUV EN60950:2000	TUV PS Baurt mark
CB report	IEC60950:1999	N/A.

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
Turn-On Input Voltage	Ramping Up [1]	32	34	36	VDC
Turn-Off Input Voltage	Ramping Down [1]	30	32	34	VDC
Turn On/Off Hysteresis		1.5			VDC
Input over voltage protection	Turn-Off threshold	76	80	84	VDC
Input Reflected Ripple Current	Full Load, 12µH source inductance BW=20MHz [2]			60	mA_{P-P}
Inrush Transient	Vin=Vin.max			0.1	A^2s

[1] Refer to Fig. 2 for waveform.

[2] Refer to Fig. 10 for Test measurement circuit.

Output Specifications

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

Parameter	Conditions/Description	Min	Nom	Max	Units
Output Voltage Setpoint Accuracy	Vin=Vin.nom, Full Load	27.44	28	28.56	Vdc
Output Current		1.8		18	A
Line Regulation	Vin.min to Vin.max, $I_{RATED-MAX}$		0.2	0.5	%Vout
Load Regulation	Vin=Vin.nom, 10% to 100%I_{rated}		0.5	1.0	%Vout
Output Temperature Regulation	$T_{Baseplate}$ = -40°C to +110°C)			0.02	%Vo/°C
Ripple and Noise, DC to 20MHz [1,2]	Over line and load Tamb= 0°C to 85°C		150 30		mV_{P-P} mV_{RMS}
Dynamic Regulation Peak Deviation Settling Time	50-75% load step change to 1% error band		 700 250	 800 750	 mV µs
Output Turn-On Time [3]	To 97% Vo_{NOM}		15	25	ms
Admissible Load Capacitance	$I_{RATED,\ resistive\ load}$, Vin_{NOM}			100	µF/A
Backdrive Protection	No damage to converter		Yes		
Switching Frequency			400		kHz

[1] At Iout<Iout-min, the output may contain low frequency component that exceeds ripple specifications.

[2] See Figure 11 for test setup

[3] Refer to fig. 3

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					
Type	Non-latching, auto-recovery				
Threshold		20	23	29	A
Short Circuit	Hiccup-type [1]			15	A_{RMS}
Overvoltage Protection [2]					
Type	Clamping / Hiccup, auto-recovery				
Threshold	All Vin and Io conditions	115		140	% Vout
Overtemperature Protection					
Type	Non-latching, auto-recovery				
Threshold	Baseplate temperature	120		130	°C
Recovery			90		°C

[1] Refer to Fig. 4 [2] Refer to Fig. 5

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 [1]					
Negative Logic (-N suffix)	ON/OFF signal is low or the pin is connected to -Vin – converter is ON Von/off in reference to -Vin				
Converter ON	ON/OFF pin is connected to -Vin	-0.5		0.8	VDC
Source Current	Von/off in reference to -Vin		0.5	1	mADC
Converter OFF	ON/OFF pin is floating	2.5		7	VDC
Open Circuit Voltage				5	VDC
Positive Logic (no suffix)	On/Off signal is low or the pin is floating –converter is OFF Von/off in reference to -Vin				
Converter ON	ON/OFF pin is floating	2.5		7	VDC
Open Circuit Voltage	Von/off in reference to -Vin			5	VDC
Converter OFF	ON/OFF pin is connected to -Vin	-0.5		0.8	VDC
Source Current			0.5	1	mADC
Remote Sense [2]					
Remote Sense Headroom				5	%Vout
Output Voltage Trim [2]					
Trim Up	Vin = Vin-nom, Iout=I_{rated}			10	%
Trim Down	Vin = Vin-nom, Iout=I_{rated}			-10	%

[1] Additional information located on page 6.
2 Vout can be increased up to 10% via the sense leads or up to 10% via the trim function, however total output voltage trim from all sources should not exceed 10% of Vout.

Efficiency Characteristics

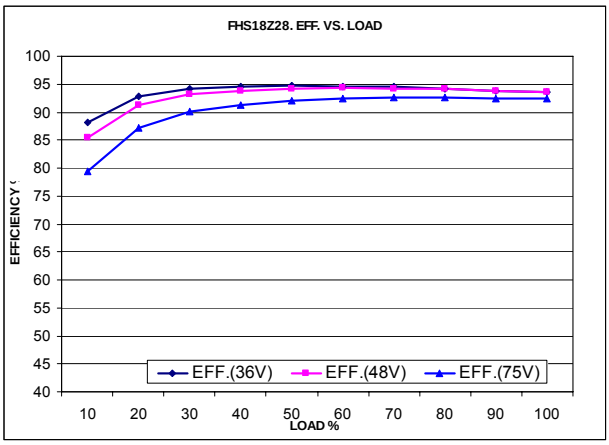


Figure 1. FHS18Z28 Efficiency vs. Output Load

Input Turn-On / Off Operation

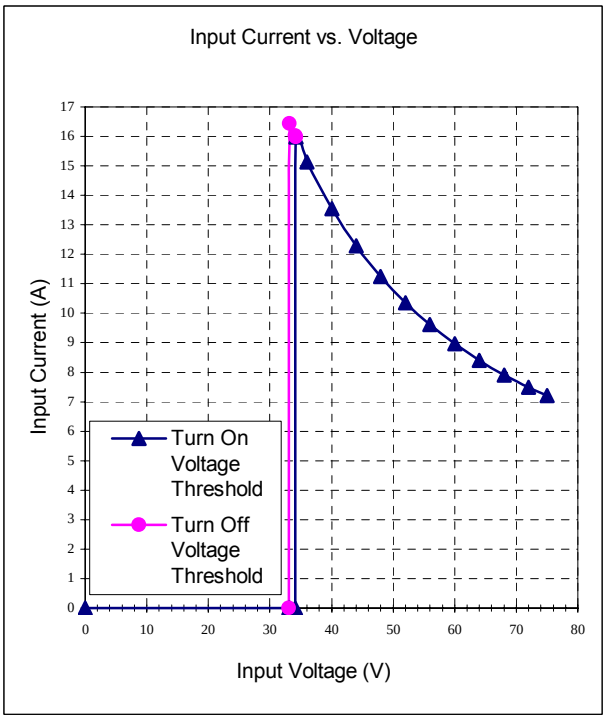


Figure 2. FHS18Z28 Input UVLO Characteristics

Turn-on Waveform

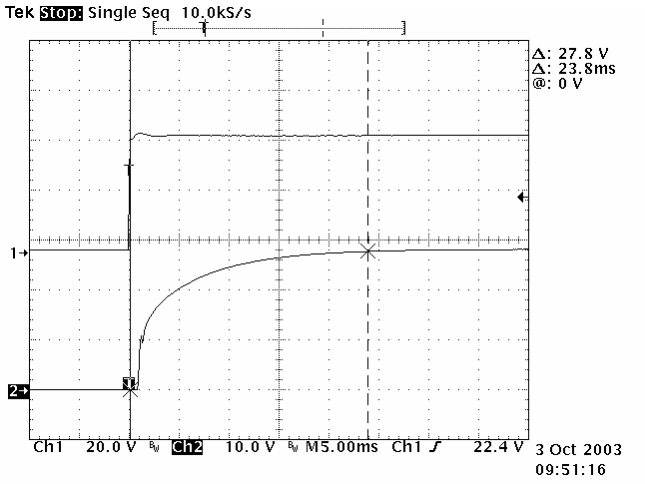


Figure 3. Output Voltage turn-on FHS18Z28
Conditions: Vin=48V, Load: full, , Co=none
(Note: monotonic rise characteristic)

Short Circuit Operation

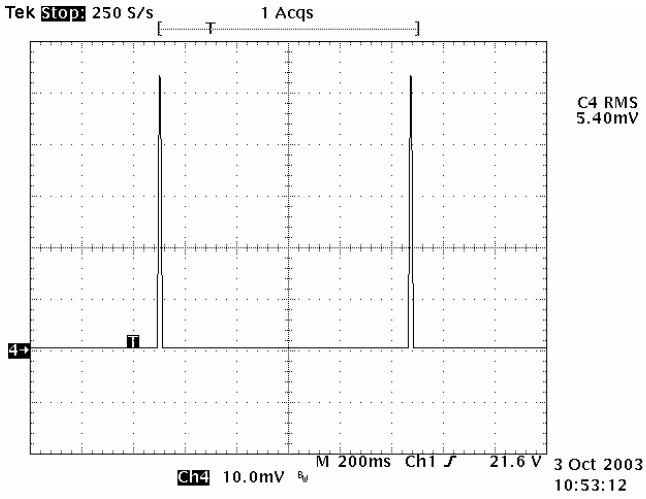


Figure 4. Output Current with Shorted Output Pins,
Vin = 75Vdc, Scale is 20Amp/Div.
(Actual amplitude: $10.8A_{RMS}$)

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

OVP Operation

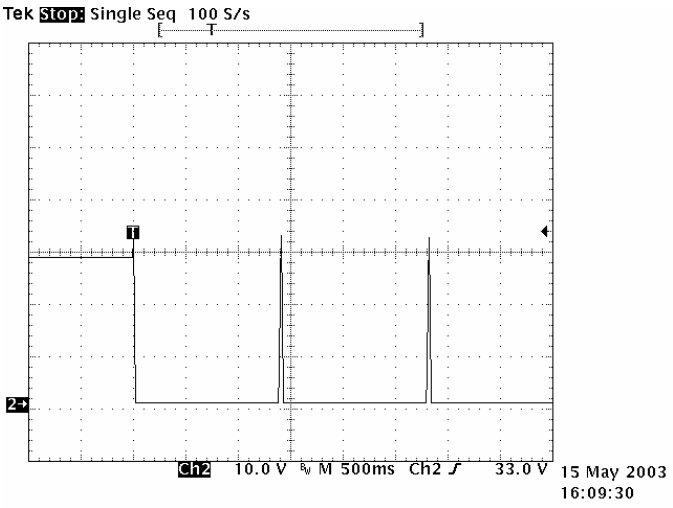


Figure 5. Output Voltage Under OVP Condition, Vin = 75Vdc, Min Load. Scale is 10V/Div.
(Actual amplitude: $34V_{PEAK}$)

Typical Application

Figure 6 shows the recommended connections for the FHS Series converter.

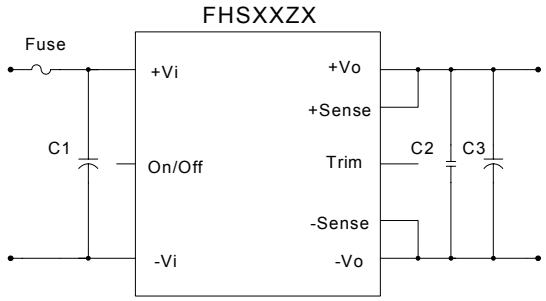


Figure 6. Typical Application of the FHS Series

FHS Series converters do not require any external components for proper operation. However, if the distribution of the input voltage to the converter contains significant inductance, the capacitor C1 may be required to enhance performance of the converter. A minimum of a 100 µF electrolytic capacitor with the ESR<0.7Ω is recommended.

Refer to the "Inrush Current Control Application Note" on www.power-one.com for suggestions on how to limit the magnitude of the inrush current.

For output decoupling we recommend to use a 10 µF tantalum and a 1 µF ceramic capacitors connected directly across the output pins of the converter. Note that the capacitors do not substitute the filtering required by the load.

Shutdown Feature Description

The ON/OFF pin in the FHS Series converters functions as a normal soft shutdown. It is referenced to the –Vin pin or signal ground (see Figure 6). With the positive logic, when the ON/OFF pin is pulled low, the output is turned off and the unit exhibits very low input current.

With negative logic (which is denoted by the suffix "–N" in the part number), 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 pin.

When the ON/OFF pin is used to achieve remote control, the user must take care to insure that the pin reference for the control is really the -Vin pin. The control signal must not be referenced ahead of EMI filtering, or remotely from the unit. Optically coupling the information and locating the optical coupler directly at the module will solve any of these problems.

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

Remote Sense

The FHS Series converters have the capability to remotely sense both lines of the output. This feature moves the effective output voltage regulation point from the output of the unit to the point of connection of the remote sense pins. This feature automatically adjusts the output voltage of the converter in order to compensate for voltage drops in distribution and maintain a regulated voltage at the point of load. This is shown in Figures 6, 7 & 8.

If the remote sense feature is not to be used, the sense pins should be connected locally. The +Sense (or Vsense) pin should be connected to the +Vout pin directly at the output of the converter and the –Sense (Vsense RTN) pin should be connected to the -Vout pin directly at the output of the converter.

If sense pins are not connected to the load, or the respective output pins, the converter will not be

damaged, but may not meet the output voltage regulation specifications.

Output Voltage Trim

The trim feature allows the user to adjust the output voltage from the nominal value. This can be used to compensate for distribution drops, perform margining in production, or accommodate other requirements when output voltage needs to be adjusted from the nominal value. There are two trim options available.

Optional Positive Trim (suffix –T)

The -T option units trim up with a resistor from the TRIM pin to the (+)Vsense pin and trim down with a resistor from the TRIM pin to the (-)Vsense RTN pin as shown in Figure 7.

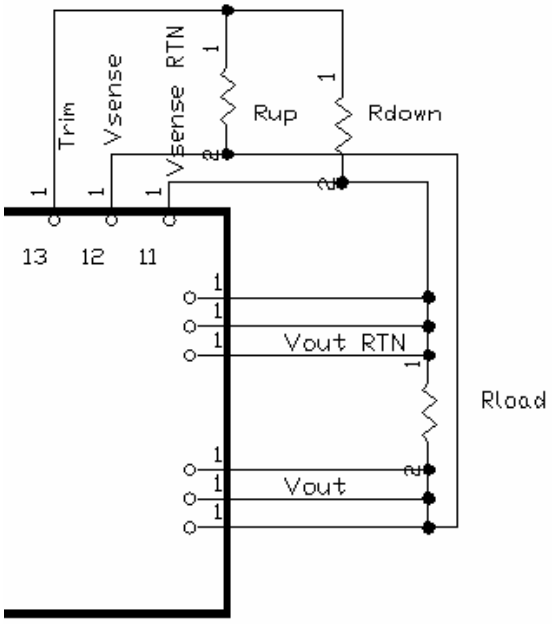


Figure 7. FHS Series Positive Trim Schematic (-T)

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

$$Radj-up=\left(\frac{4.17Vonom(100+\Delta\%)}{\Delta\%}-\frac{510}{\Delta\%}-42.2)\right)k\Omega$$

$$Radj-down=\left(\frac{510}{\Delta\%}-42.2)\right)k\Omega$$

where Δ% is the output voltage change expressed in percent of the nominal output voltage, Vout. (example: to trim up or down by 5% of Vo nominal, Δ% = 5)

Negative Logic Trim (no P/N suffix)

The negative logic trim unit trims down with a resistor from Trim to Vsense, and trims up with a resistor from Trim to VsenseRTN (see figure 8).

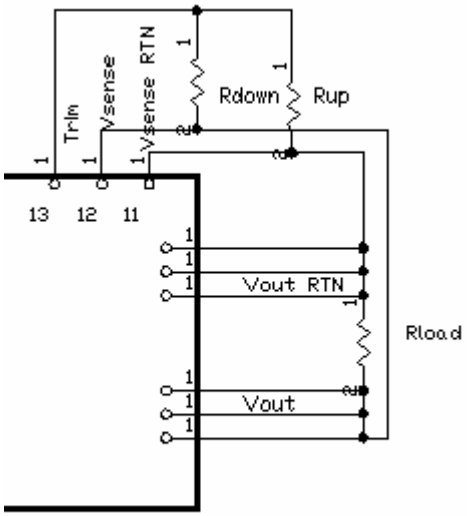


Figure 8. FHS Series Negative Trim Schematic

The equations below determine the trim resistor value required to achieve a new output voltage.

$$Radj-up=\left(\frac{2.49}{2.49/(1.225*54.4/(Voadj-1.225))-1}-20\right)k\Omega$$

$$Radj-down=\left(\frac{54.4}{54.4/(2.03(Voadj-1.225))-1}-20\right)k\Omega$$

where *Voadj* is the desired output voltage

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 FHS Series converters will trim down further than the 10% limit. In general, this is permissible. The user must confirm that the results are acceptable in the application.

Safety Considerations

The FHS Series converters feature 1500 VDC isolation from input to output. The input-to-output resistance is greater than 10 MΩ. 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 FHS Series converters have no internal fuse. The external fuse must be provided to protect the system from catastrophic failure as shown in Figure 6. The fuse with a rating not greater than 20 A is recommended. The user can select a lower rating fuse based upon the highest inrush transient at the maximum input voltage and the maximum input current of the converter, which occurs at the minimum input voltage. 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 FHS Series 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 FHS 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.

Thermal Considerations

FHS Series converters are designed for natural or forced convection cooling. The maximum allowable output current of the converters is determined by meeting the derating criteria for all components used in the converters. For example, the maximum semiconductor junction temperature is not allowed to exceed 125 °C to ensure reliable long-term operation of the converters. Contact Power-One for the complete list of the derating criteria.

Figure 9 shows the maximum output current of the FHS Series at different ambient temperatures under both natural and forced (longitudinal airflow direction, from pin 1 to pin 4) convection.

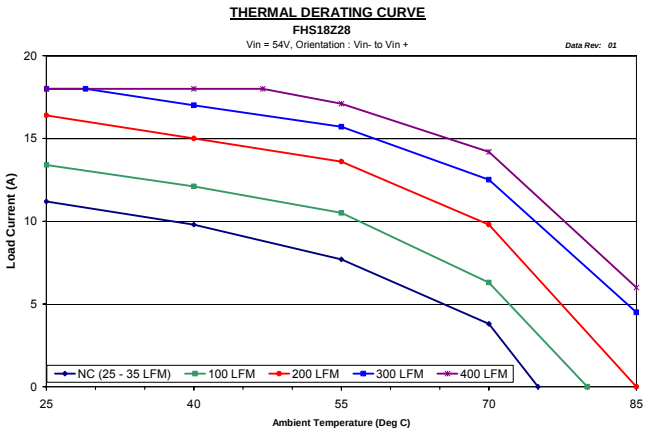
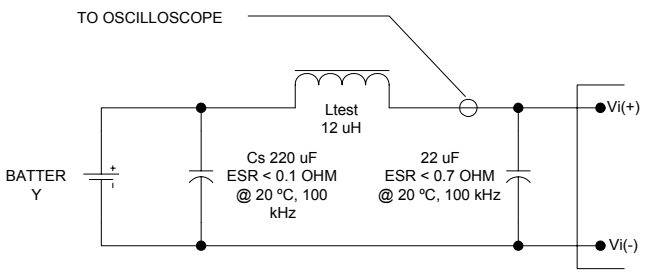


Figure 9. FHS18Z28 Derating Curves

Test Configurations



. Figure 10. Input Reflected Ripple Current Test 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.

To improve accuracy and repeatability of output ripple and noise measurements, Power-One utilizes the test setup shown in Figure 11.

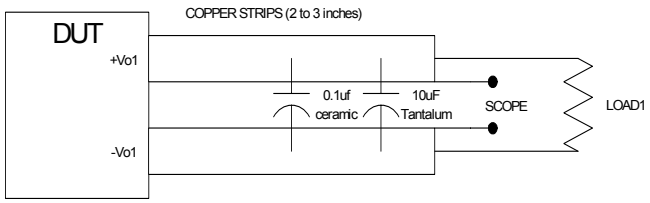
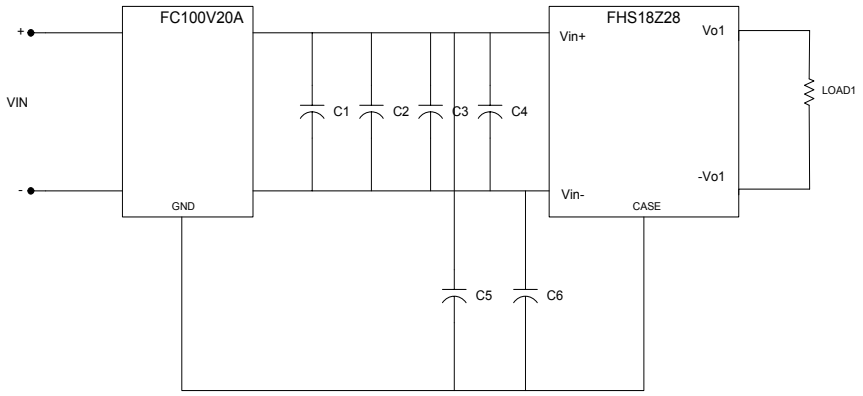


Figure 11. Output Ripple and Noise Measurement Test Setup

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

Conducted EMI (Line)



Ref. Des	Description	Manufacture
C1, 2	0.47µF @100V MLC Capacitor (1812)	AVX or Equivalent (Equiv.)
C3	100µF @ 100V Alum. Electrolytic Capacitor	Nichicon NRSZ Series or Equiv.
C4	22µF@ 100V Alum. Electrolytic Capacitor	United Chemicon KMG Series or Equiv.
C5, 6	0.01µF MLC Capacitor	AVX or Equiv.
F1	FC100V20A Input Filter Module	Power-One

Figure 12. Recommended Filter Configuration
(to meet CISPR 22 Class A for Conducted Emissions)

The above circuit and component values are offered as a guide. Performance results vary depending on circuit layout techniques, proximity to noise emitting components and conductor traces and other variables of the specific application. Verification of compliance must be performed.

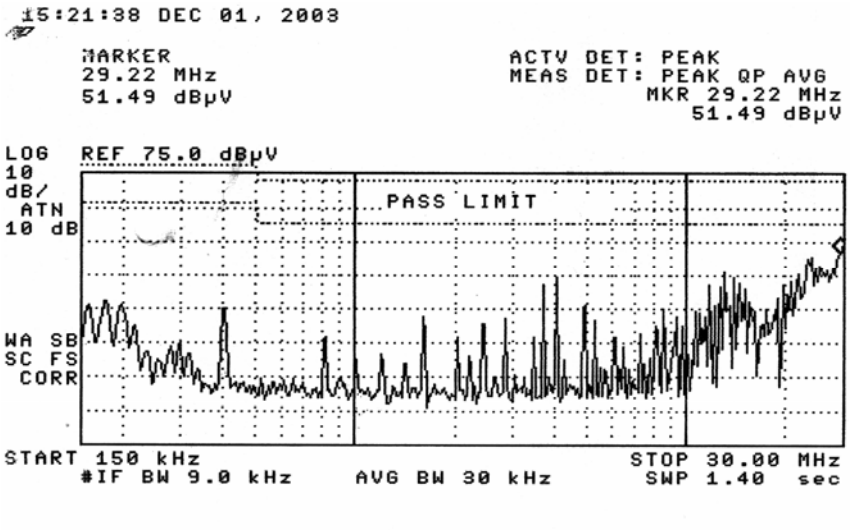
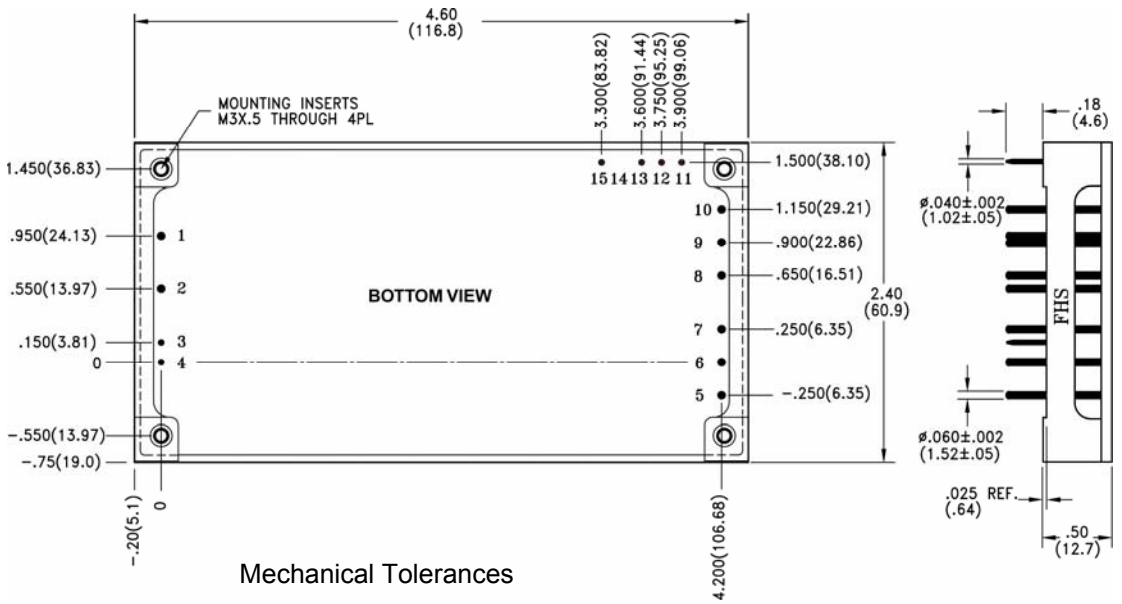


Figure 13. Measured Performance Characteristics
CISPR 22 Class A for Conducted Emissions
Vin=48Vdc, Io=18Amps

Mechanical Drawing



Mechanical Tolerances

	Inches	Millimeters
	X.XX ±0.020	X.X ±0.5
	X.XXX ±0.010	X.XX ±0.25
Pin	±0.002	±0.05

Ordering Information

Options	Suffixes to add to part number
Remote ON/OFF	Positive- Standard, no suffix required
	Negative- Add “N” suffix
Trim	Negative- No suffix required
	Positive - Add “T” suffix [1]
Pin Length	0.18”- Standard, no suffix required
	0.11”- Add “8” suffix [1]
	0.15”- Add “9” suffix [1]

Pin	Function
1	-Vin
2	+Vin
3	Sgnd
4	On/off
5, 6, 7	Vout
8,9,10	-Vout
11	-Sense
12	+Sense
13	Trim
14	NU
15	IOG

Notes:

[1] Consult factory for availability.

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