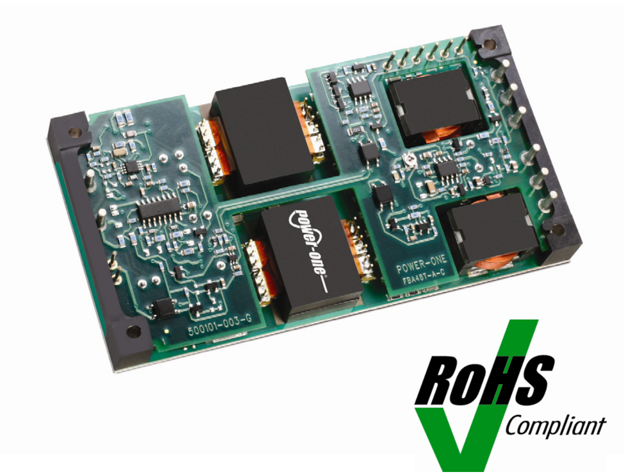
FBA48T25280 DC-DC Converter
36-75 VDC Input; 28VDC @ 25A Output

Preliminary Data Sheet



Applications

- RF Power Amplifiers
- Wireless communications

Benefits

- High efficiency
- Low cost
- Integrated metal baseplate design
- Higher power output at elevated temperatures and low airflow

Features

- RoHS lead-free solder and lead-solder-exempted products are available
- 28V regulated output at 700W
- Efficiency up to 92%
- Fixed-frequency operation
- Start-up into pre-biased load
- No minimum load required
- Fully protected: UVLO, OCP, OTP, and OVP
- Current share
- Output Good signal
- Auxiliary Output of 7 to 9V at up to 20 mA
- Output voltage trim range: +15%/−40% with industry-standard trim equations
- Remote differential output voltage sense
- Isolated two-pin ON/OFF
- On-board input differential LC-filter
- Industry-standard fullbrick size and pinout
- Low height of 0.50” (12.7mm)
- Wide operating temperature range from -40 to 100°C
- High reliability: MTBF = TBD million hours
- UL60950 recognized in US and Canada and DEMKO certified per IEC/EN60950 (pending)
- All materials meet UL94, V-0 flammability rating

Description

The new high performance 700W FBA48T25280 DC-DC converter provides a high efficiency single 28V output in the fullbrick package. Specifically designed for operation in wireless systems that have limited airflow and increased ambient temperatures, the FBA48T25280 converter utilizes the same pinout and functionality as the industry-standard power amplifier bricks.

Operating from a 36-75V input, the FBA48T25280 converter provides a full regulated 28V output voltage that can be trimmed from –40% to +15% of the nominal output voltage, thus providing outstanding design flexibility. The open frame module is constructed with a dual board approach using the metal baseplate and discrete magnetics. The standard feature set includes remote ON/OFF, differential output voltage sensing, input undervoltage lockout, overtemperature, output overvoltage and overcurrent protections, current sharing, auxiliary voltage output, and the Output Good signal.

With standard pinout and trim equations, the FBA48T25280 converter is a perfect solution for existing and new designs. Inclusion of this converter in a design can result in significant power and cost savings. The designer can expect reliability improvement over other available converters because of the FBA48T25280’s optimized thermal efficiency.

Electrical Specifications

Conditions: T_A = 25 °C, Vin = 48 VDC, Cin=2x220µF, Cout=220µF unless otherwise specified.

Parameter	Notes	Min	Typ	Max	Units
Absolute Maximum Ratings					
Input Voltage	Continuous	0		75	VDC
Input Voltage Transient	100 ms			100	VDC
Operating Ambient Temperature	Limited by baseplate temperature	-40		85	°C
Operating Baseplate Temperature		-40		100	°C
Storage Temperature		-55		125	°C
Isolation Characteristics					
Input to Output Isolation		1500			VDC
Isolation Capacitance			2600		pF
Isolation Resistance		10			MΩ
Input to Baseplate Isolation		1500			VDC
Output to Baseplate Isolation		500			VDC
Feature Characteristics					
Switching Frequency			300		kHz
Output Voltage Trim Range[1]	Industry-standard equations	-40		+15	%
Remote Sense Compensation[1]	Percent of V_{OUT}(NOM)			+10	%
Output Overvoltage Protection	Latching	120	128	135	%
Overtemperature Protection (baseplate)	Non-latching	120	125	130	°C
Overtemperature Protection Hysteresis			10		°C
ON/OFF Control	Controlled by current between ON/OFF+ and ON/OFF- pins				
Converter OFF (current is low)		-10		0.1	mADC
Converter ON (current is high)		1		5	mADC
Auxiliary Output Voltage		7		9	VDC
Auxiliary Output Current	No protected from overcurrent			20	mADC
Output Good Signal (open collector)	Output is in regulation – Low, Output is out of regulation - High				
Output Good Current Sink				5	mADC
Output Good External Pull-up Voltage				35	VDC
Current Share Accuracy	Two units connected in parallel			±10%	
Parallel Pin Voltage			156		mV/A

Additional Notes:

[1] Vout can be increased up to 10% via the sense leads or 15% via the trim function. However, the total output voltage trim from all sources should not exceed 15% of V_{OUT}(NOM).

Electrical Specifications (continued)

Conditions: T_A = 25 °C, Vin = 48 VDC, Cin=2x220μF, Cout=220μF unless otherwise specified..

Parameter	Notes	Min	Typ	Max	Units
Input Characteristics					
Operating Input Voltage Range		36	48	75	VDC
Input Undervoltage Lockout					
Turn-on Threshold		33		36	VDC
Turn-off Threshold		31.5		34.5	VDC
UVLO Hysteresis		1.5			VDC
Maximum Input Current	Full Load at 36VDC In			25	ADC
Input Standby Current	Vin = 48V, converter disabled		25		mA
Input No Load Current (0A load on the output)	Vin = 48V, converter enabled		30		mA
Input Reflected-Ripple Current, i_c	Vin = 48V, 25 MHz bandwidth (Figure 13)			30 7	mA_{PK-PK} mA_{PK-PK}
Input Ripple Current, i_s	Vin = 48V, 25 MHz bandwidth (Figure 13)			2000 500	mA_{PK-PK} mA_{PK-PK}
Input Voltage Ripple Rejection	120 Hz		TBD		dB
Output Characteristics					
External Load Capacitance	Plus full load (resistive)	220		10,000	μF
Turn-On Time from Vin	Time from UVLO to Vo=90%V_{OUT}(NOM)		30		ms
Turn-On Time from ON/OFF	Time from Enable to Vo=90%V_{OUT}(NOM)		15		ms
Output Current Range		0		25	ADC
Current Limit Inception	Non-latching	27.5	30	33	ADC
Peak Short-Circuit Current	Non-latching, Short = 10 mΩ			65	A
RMS Short-Circuit Current	Non-latching			35	Arms
Output Voltage Set Point (no load)		27.72		28.28	VDC
Output Regulation					
Over Line			±28	±56	mV
Over Load			±28	±56	mV
Over Temperature				200	DPPM
Output Voltage Range	Over line, load and temperature	27.25		28.50	VDC
Output Ripple and Noise – 25 MHz bandwidth	Full load + 10μF tantalum + 1μF ceramic +220uF electrolytic		190	280	mV_{PK-PK}
Dynamic Response					
Load Change 50%-75%-50% of Iout Max, di/dt = 0.1 A/μs			450		mV
di/dt = 1A/μs	Co =10,000μF		450		mV
Settling Time to 1% of Vout			500		μs
Mechanical					
Weight			TBD		g
Operating Humidity	RH (non-condensing)			95	%
Storage Humidity	RH (non-condensing)			95	%
Vibration (Sinusoidal)	GR-63-CORE, Section 5.4.2				
Shock	Half Sinewave, 3-axis	50			g
Reliability					
MTBF	Telcordia SR-332, Method I Case 1 50% electrical stress, 40°C ambient		TBD		MHrs

Operations

Input and Output Impedance

These power converters have been designed to be stable with a minimum external output capacitor of 220µF when used in low inductance input and output circuits. If the ambient temperature is lower than -20°C, then use 4 x 220uF to reduce ESR. Nichicon UPW1H221MPD or equivalent is recommended.

In many applications, the inductance associated with the distribution from the power source to the input of the converter can affect the stability of the converter. It is recommended that 2 x 220µF with a voltage rating of 100VDC be used on the input of the FBA48T25280.

In applications where the user has to use decoupling capacitance at the load, the power converter will exhibit stable operation with the external load capacitance up to 10,000 µF.

ON/OFF Control (Pins 1 and 2)

The ON/OFF pins are used to turn the power converter on or off remotely via a system signal. The on/off control is a current driven control. It is isolated from both the primary and the secondary by 1500VDC. The ON/OFF control turns the converter on when 1 to 5 mA of current flows from the ON/OFF+ pin to the ON/OFF- pin. The converter is off when no current or a small reverse current flows between the pins. Maximum reverse voltage shall not exceed 6VDC.

The ON/OFF control current can be generated from the primary or from the secondary as shown in the application schematics in Figure 1 and Figure 2.

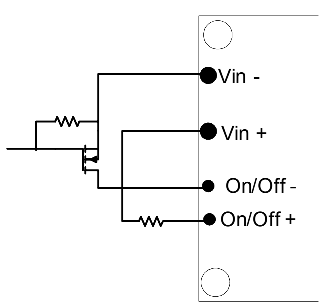


Figure 1. ON/OFF Control Using Vin

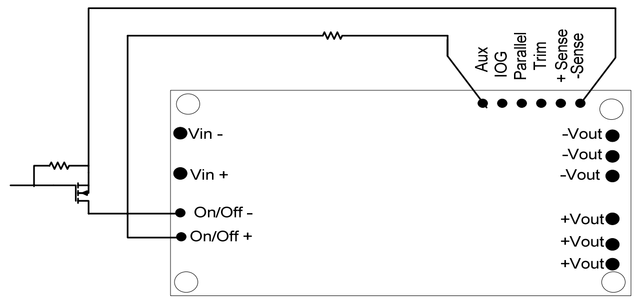


Figure 2. ON/OFF Control Using Auxiliary Voltage

Remote Sense (Pins 16 and 17)

The remote sense feature of the converter compensates for voltage drops occurring between the output pins of the converter and the load. The SENSE(-) (Pin 16) and SENSE(+) (Pin 17) pins should be connected at the load or at the point where regulation is required.

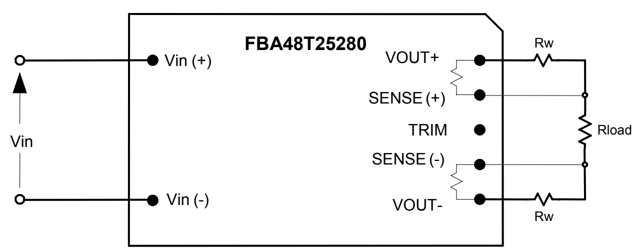


Figure 3. Remote sense circuit configuration.

CAUTION

If remote sensing is not utilized, the SENSE(-) pin must be connected to the Vout(-) pin, and the SENSE(+) pin must be connected to the Vout(+) pin to ensure the converter will regulate at the specified output voltage. If these connections are not made, the converter will deliver an output voltage that is higher than the specified data sheet value.

Because the sense leads carry minimal current, large traces on the end-user board are not required. However, sense traces should be run side by side and located close to a ground plane to minimize system noise and ensure optimum performance.

The converter's output overvoltage protection (OVP) senses the voltage across VOUT+ and VOUT-, and not across the sense lines, so the resistance (and resulting voltage drop) between the output pins of the converter and the load should be minimized to prevent unwanted triggering of the OVP.

When utilizing the remote sense feature, care must be taken not to exceed the maximum allowable output power capability of the converter, which is equal to the product of the nominal output voltage and the allowable output current for the given conditions.

When using remote sense, the output voltage at the converter can be increased by as much as 10% above the nominal rating in order to maintain the required voltage across the load. Therefore, the designer must, if necessary, decrease the maximum current (originally obtained from the derating curves) by the same percentage to ensure the converter's actual output power remains at or below the maximum allowable output power.

Output Voltage Adjust /TRIM (Pin 15)

The output voltage can be adjusted up 15% or down 40%, relative to the rated output voltage by the addition of an externally connected resistor. Trim up to 15% is guaranteed only at Vin ≥ 40V.

The TRIM pin should be left open if trimming is not being used.

To increase the output voltage, refer to Figure 4. A trim resistor, $R_{T\text{-}INCR}$, should be connected between the TRIM pin and SENSE+ pin, with a value of:

$$R_{T-INCR} = \frac{(100+\Delta)V_{O-NOM} - 122.5}{1.225\Delta} - 2\ ,[k\Omega]$$

where,

R_{T-INCR} = Required value of trim-up resistor kΩ]

V_{O-NOM} = Nominal value of output voltage [V]

$$\Delta = \left| \frac{(V_{O-REQ} - V_{O-NOM})}{V_{O-NOM}} \right| \mathbf{X\ 100} \qquad [\%]$$

V_{O-REQ} = Desired (trimmed) output voltage [V].

When trimming up, care must be taken not to exceed the converter's maximum allowable output power. See the previous section for a complete discussion of this requirement.

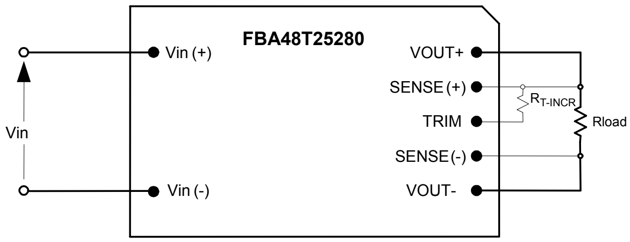


Figure 4. Configuration for increasing output voltage.

To decrease the output voltage (Figure 5), a trim resistor $R_{T\text{-}DECR}$ should be connected between the TRIM pin and the SENSE- pin, with a value of:

$$R_{T-DECR} = \frac{100}{|\Delta|} - 2\ ,[k\Omega]$$

where,

R_{T-DECR} = Required value of trim-down resistor [kΩ] and **Δ** is defined above.

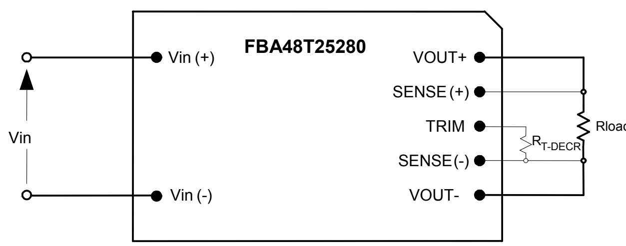


Figure 5. Configuration for decreasing output voltage.

Trimming/sensing beyond 115% of the rated output voltage is not an acceptable design practice, as this condition could cause unwanted triggering of the output overvoltage protection (OVP) circuit. The designer should ensure that the difference between the voltages across the converter's output pins and its sense pins does not exceed 15% of V_{OUT}(NOM), or:

$$[V_{OUT}(+) - V_{OUT}(-)] - [V_{SENSE}(+) - V_{SENSE}(-)] \le V_{O-NOM} \times \mathbf{15\%}\ [V]$$

This equation is applicable for any condition of output sensing and/or output trim.

Parallel Applications

The FBA48T25280 features the active current share circuit to ensure that the two converters connected in parallel will share current within ±10% of the total output current.

Auxiliary Voltage Output (Pin 12)

The FBA48T25280 has the auxiliary voltage output voltage connected to pin 12. The voltage on this pin is not precisely regulated and will vary from 7V to 9V depending on line and load conditions. This output is not internally protected and shorting this pin to ground or to any of the other converter terminals may cause permanent damage to the converter.

Output Voltage Good signal (IOG) (Pin13)

The signal on pin 13 is active low (open collector). Whenever the output voltage is out of regulation the pin is in the high impedance state. The IOG pin can sink the maximum of 5mADC and it can be externally pulled up to the maximum of 35VDC.

Protection Features

Input Undervoltage Lockout

Input undervoltage lockout is standard with this converter. The converter will shut down when the input voltage drops below a pre-determined voltage.

The input voltage must be typically 34 V for the converter to turn on. Once the converter has been turned on, it will shut off when the input voltage drops typically below 32 V. This feature is beneficial in preventing deep discharging of batteries used in telecom applications.

Output Overcurrent Protection (OCP)

The converter is protected against overcurrent or short circuit conditions. Upon sensing an overcurrent condition, the converter will switch to constant current operation and thereby begin to reduce its output voltage.

When the output voltage drops below 10% of the nominal value of output voltage, the converter will shut down.

Once the converter has shut down, it will attempt to restart nominally every 20 ms with a typical 20% duty cycle. The attempted restart will continue indefinitely until the overload or short circuit condition is removed or the output voltage rises above 90% of its nominal value.

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

Output Overvoltage Protection (OVP)

The converter will shut down if the output voltage across VOUT+ and VOUT- exceeds the threshold of the OVP circuitry. The OVP circuitry contains its own reference, independent of the output voltage regulation loop. Once the converter has shut down it will latch off. The latch can be reset by toggling the ON/OFF inputs or by recycling the input voltage..

Overtemperature Protection (OTP)

The converter will shut down under an overtemperature condition to protect itself from overheating caused by operation outside the thermal derating curves, or operation in abnormal conditions such as system fan failure. Ince the converter has shut down, it will automatically restart after it has cooled to a safe operating temperature.

Safety Requirements

The converters meet North American and International safety regulatory requirements per UL60950 and EN60950. Basic Insulation is provided between input and output.

The converters have no internal fuse. If required, the external fuse needs to be provided to protect the converter 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.

Abnormal and component failure tests were conducted with the input protected by a 30A fuse. If a fuse rated greater than 30A is used, additional testing may be required. To protect a group of converters with a single fuse, the rating can be increased from the recommended value above.

Electromagnetic Compatibility (EMC)

EMC requirements must be met at the end-product system level, as no specific standards dedicated to EMC characteristics of board mounted component dc-dc converters exist. However, Power-One tests its converters to several system level standards, primary of which is the more stringent EN55022, *Information technology equipment - Radio disturbance characteristics-Limits and methods of measurement.*

An effective internal LC differential filter significantly reduces input reflected ripple current, and improves EMC.

With the addition of a simple external filter, the FBA48T25280 converter passes the requirements of Class A conducted emissions per EN55022 and FCC requirements. Refer to Figure 6 for the recommended configuration of the input filter.

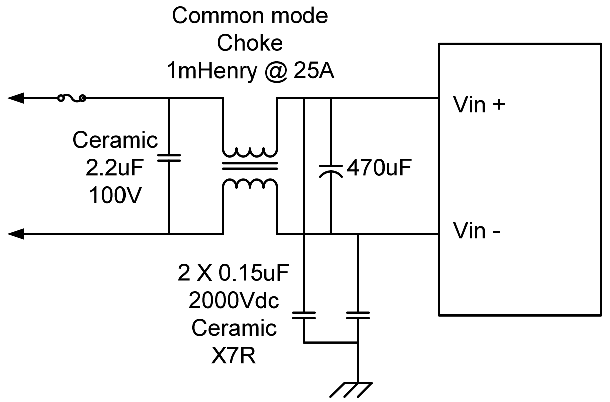


Figure 6. Input Filter Configuration Required to Meet CISPR 22 Class A for Conducted Emissions.

Startup Information

Scenario #1: Initial Startup From Bulk Supply
ON/OFF function enabled, converter started via application of V_{IN}. See Figure E.

Time	Comments
t_0	ON/OFF pin is ON; system front-end power is toggled on, V_{IN} to converter begins to rise.
t_1	V_{IN} crosses undervoltage Lockout protection circuit threshold; converter enabled.
t_2	Converter begins to respond to turn-on command (converter turn-on delay).
t_3	Converter V_{OUT} reaches 90% of nominal value.

For this example, the total converter startup time (t_3- t_1) is typically 30 ms.

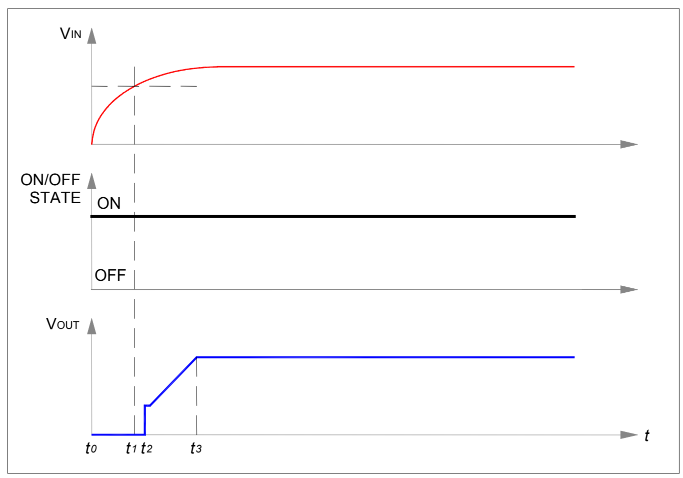


Figure 7. Startup scenario #1.

Scenario #2: Initial Startup Using ON/OFF Pin
With V_{IN} previously powered, converter started via ON/OFF pin. See Figure F.

Time	Comments
t_0	V_{INPUT} at nominal value.
t_1	Arbitrary time when ON/OFF pin is enabled (converter enabled).
t_2	End of converter turn-on delay.
t_3	Converter V_{OUT} reaches 90% of nominal value.

For this example, the total converter startup time (t_3- t_1) is typically 15 ms.

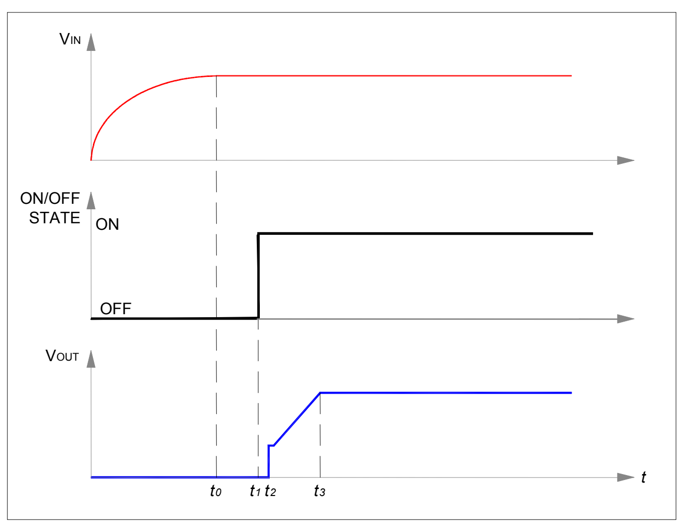


Figure 8. Startup scenario #2.

Characterization

General Information

The converter has been characterized for many operational aspects, to include thermal derating (maximum load current as a function of baseplate temperature), efficiency, startup and shutdown parameters, output ripple and noise, transient response to load step-change, overload, and short circuit.

The following pages contain specific plots or waveforms associated with the converter. Additional comments for specific data are provided below.

Test Conditions

All thermal data presented was taken with the converter mounted to a 6”x12”x1” finned heatsink. The FBA is designed to operate in an enclosed environment with the dissipated power being extracted though the baseplate into the heatsink.

Thermocouples were used to ensure that the internal components were operating with in their SOA with the baseplate at 100°C. Refer to Figure 9 for the optimum thermocouple location.

Thermal Derating

For each set of conditions, the maximum load current was defined as the lowest of:

(i) The output current at which the base plate temperature does not exceed a maximum specified temperature of 100°C as indicated by thermocouple measure, or

(ii) The nominal rating of the converter.

Temperature at the thermocouple location shown in Figure 9 should not exceed 100°C in order to operate inside the derating curves.

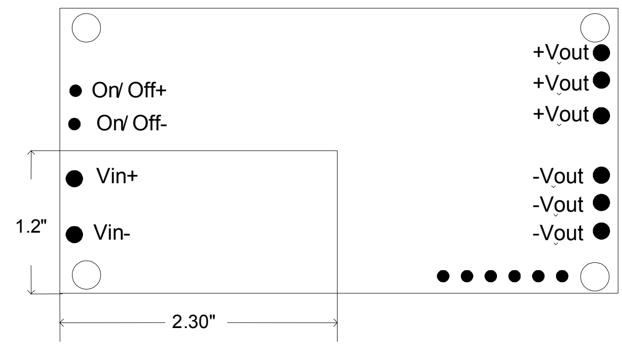


Figure 9. Location of the thermocouple for thermal testing.

The derating curve showing available output power as a function of the baseplate temperature is shown in Figure 12.

Efficiency

Figure 10 shows the efficiency vs. load current plot for ambient temperature of 25°C and input voltages of 36V, 48V, 60V, and 75 V.

Power Dissipation

Figure 11 shows the power dissipation vs. load current plot for Ta = 25°C and input voltages of 36V, 48V, 60V, and 75V.

Characterization Data

Efficiency Curves

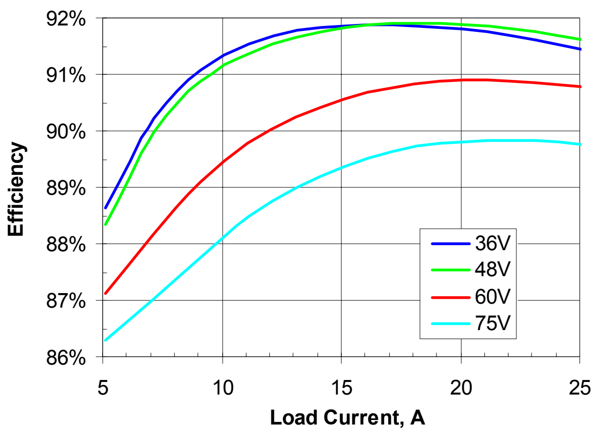


Figure 10. Efficiency vs. load current and input voltage for FBA48T25280 converter at Ta=25°C.

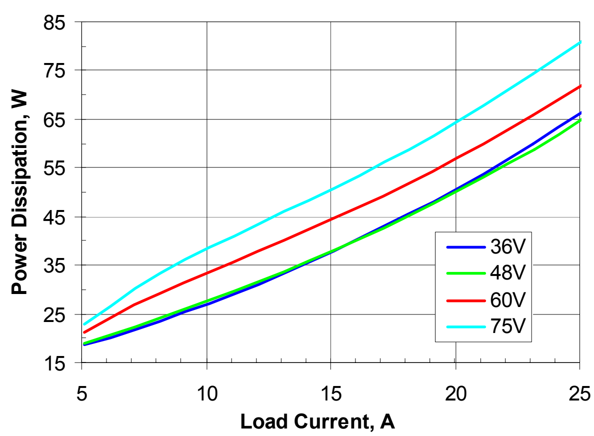


Figure 11. Power dissipation vs. load current and input voltage for FBA48T25280 converter at Ta = 25°C.

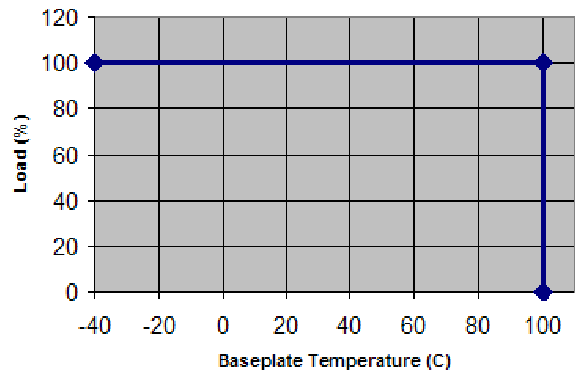


Figure 12. Available Power Vs. Baseplate Temperature

Test Setup

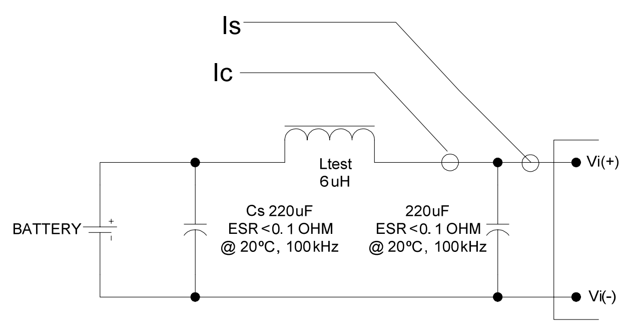
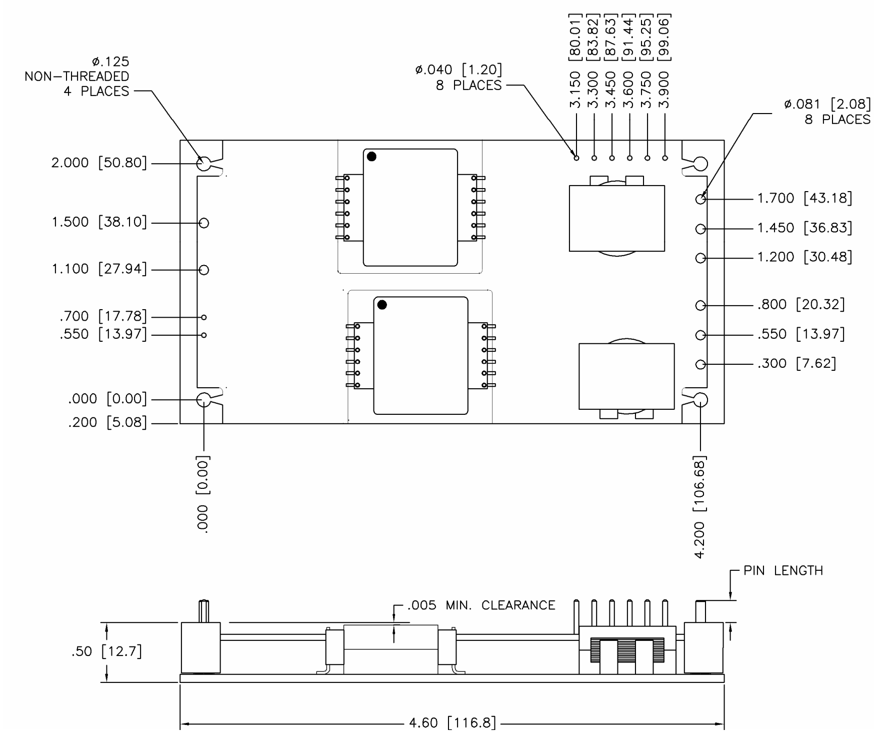


Figure 13. Test setup for measuring input reflected ripple currents, ic and is.

Physical Information

Tolerances: [Unless otherwise indicated]
x.xxx in. +/- .010 [x.xx mm +/- 0.25]
x.xx in. +/- .020 [x.x mm +/- 0.5]



Pad/Pin #	Function
1	ON/OFF+
2	ON/OFF-
3	+VIN
4	-VIN
5	-VOUT
6	-VOUT
7	-VOUT
8	+VOUT
9	+VOUT
10	+VOUT
11	Not used
12	AUX
13	IOG
14	Parallel
15	TRIM
16	-SENSE
17	+SENSE

FBA48T Platform Notes

- All dimensions are in inches [mm]
- Pins 1-2 and 12-17 are Ø 0.040” [1.02] without a shoulder
- Pins 3-10 are Ø 0.080” [2.04] without a shoulder
- Pin Material: Brass Alloy 360
- Pin Finish: Tin over Nickel

Converter Part Numbering/Ordering Information

Product Series	Input Voltage	Mounting Scheme	Rated Current	Output Voltage		ON/OFF Logic	Maximum Height [HT]	Pin Length [PL]	Special Features	RoHS
FBA	**48**	**T**	**25**	**280**	**-**	**P**	**C**	**A**	**P**	**G**
FullBrick Format	36-75 V	T ⇒ Through-hole	25 ⇒ 25ADC	280 ⇒ 28V		P ⇒ Positive	C ⇒ 0.52”	Through hole A ⇒ 0.188” B ⇒ 0.145”	P ⇒ Parallellable Q ⇒ Parallellable with M3 threaded standoffs N ⇒ Not parallellable M ⇒ Not parallellable with M3 threaded standoffs	No Suffix ⇒ RoHS lead-solder-exemption compliant G ⇒ RoHS compliant for all six substances

The example above describes P/N FBA48T25280-PCAPG: 36-75 V input, through-hole, 25A @ 28V output, positive ON/OFF logic, maximum height of 0.52”, 0.188” pins, parallelable with non-threaded standoffs, and RoHS compliant for all 6 substances.

Notes:

1. 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.
2. TECHNICAL REVISIONS - The appearance of products, including safety agency certifications pictured on labels, may change depending on the date manufactured. Specifications are subject to change without notice.