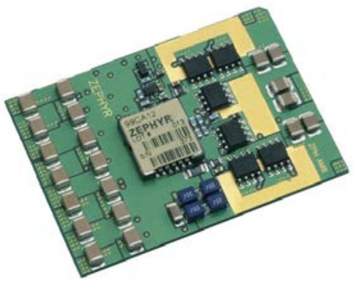
GE

Data Sheet

Titania™ Power Modules
20A Zephyr™: Non-Isolated DC-DC Power Modules

5Vdc –12Vdc input; 0.8Vdc to 3.5Vdc output; 20A Output Current



RoHS Compliant

The Zephyr Power Module provides precise voltage and very fast transient response in the industry's smallest footprint while offering very high reliability and high efficiency.

Applications

- Workstations
- Servers
- Desktop computers
- Data processing applications
- Distributed power architectures
- Telecommunications equipment
- LAN/WAN applications

Features

- Compliant to RoHS EU Directive 2011/65/EU (-Z versions)
- Compliant to RoHS EU Directive 2011/65/EU under exemption 7b (Lead solder exemption). Exemption 7b will expire after June 1, 2016 at which time this product will no longer be RoHS compliant (non-Z versions)
- Transient response met from 0A to rated full load (up to 600 A/µS)
- Exceeds VRM 8.x load transient requirements
- No external bulk output capacitors required for transient response
- Wide input range 4.5V to 12.6V
- Wide output range 0.8V to 3.5V
- Operation down to zero airflow
- Small size and very low profile
- Small size: ideal for minimizing motherboard area in multiprocessor/multi-chip applications
- High reliability: 200 FITs/5 million hour MTBF
- Surface mount design shipped in JEDEC tray
- Single control pin for margining
- Single pin for output voltage setting
- High efficiency
- 89% typical @ 16A, V_{IN} = 5V, V_{OUT} = 3.3V
- 88% typical @ 18A, V_{IN} = 5V, V_{OUT} = 2.5V
- 83% typical @ 20A, V_{IN} = 5V, V_{OUT} = 1.5V
- 75% typical @ 20A, V_{IN} = 5V, V_{OUT} = 0.8V
- Remote sense
- Programmable output voltage via resistor or voltage source
- Voltage trim capability using resistor
- Output enable and module OK signals
- Output overvoltage, overcurrent, short circuit, and thermal protection
- No heat sink required
- Low inductance surface-mount connections
- *UL** 1950 Recognized, *CSA*† C22.2 No. 950-95 Certified, and VDE 0805 (EN60950, IEC950) Licensed. CE mark meets 73/23/EEC and 93/68/EEC directives ‡
- Dimensions: 52.32 mm x 37.08 mm x 5.66 mm (2.06 in. x 1.460 in. x 0.223 in.)
- Total weight: 15.5g (0.55 oz.)

Description

The Zephyr Power Module is designed to meet the precise voltage and fast transient requirements of today's and tomorrow's high performance microprocessor, DSP, memory boards and system level applications in a distributed power architecture. Advanced circuit techniques, high-frequency switching, custom passive and active components, and very high-density, surface-mount packaging technology deliver high-quality, ultra compact, non-isolated DC-DC conversion.

* *UL* is a registered trademark of Underwriters Laboratories, Inc.

† *CSA* is a registered trademark of Canadian Standards Association.

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

imagination at work

Absolute Maximum Ratings

Stresses in excess of the absolute maximum ratings can cause permanent damage to the device. These are absolute stress ratings only. Functional operation of the device is not implied at these or any other conditions in excess of those given in the operations sections of the data sheet. Exposure to absolute maximum ratings for extended periods can adversely affect device reliability.

Table 1. Absolute Maximum Ratings

Parameter	Device	Symbol	Min	Max	Unit
Input Voltage (continuous)	—	V_{IN}	– 0.5	13	V
OUTEN Terminal Voltage	—	V_{OUTEN}	– 0.5	6	V
Maximum Ambient	—	T_{MAX}	—	85	°C
Storage Temperature	—	V_{STG}	– 40	150	°C
External Voltage applied between VADJUST+ and VADJUST-	—	V_{EXT}	0	3.5	V

Electrical Specifications

Table 2. Input Specifications

Parameter	Device	Symbol	Min	Typical	Max	Unit
Operating Input Voltage	—	V_{IN}	4.5		12.6	V
Operating Input Current						
• V_{IN} = 12V, V_{OUT} = 3.3V, I_{OUT} = 16A	—	I_{IN}	—	—	5.5 *	A
• V_{IN} = 5V, V_{OUT} = 3.3V, I_{OUT} = 16A	—	I_{IN}	—	—	13.5 *	A
Depends on output voltage						

Table 3. Output Specifications (T_A = 0 °C to 70 °C, V_{IN} = 5V to 12V)

Parameter	Symbol	Min	Typical	Max	Unit
Output Voltage Set Point* Zephyr % error = 1.4 + (0.75/V_{OUT} [V]) + 2.7/(13.44 + R_{ADJ}[kΩ]) [%] V_{OUT} = 3.3V * *TRIM pin not connected*	V_{OUT}	– 1.6	—	1.6	%
Static Regulation Static output voltage variation measured at output pins on system board with sense pins connected to measured pins					
1. Line Regulation Output voltage variation as input voltage changes from 5V to 12V with 50% load	V_{OUT}	—	1	—	mV
2. Load Regulation Output voltage variation as load changes from 0% to 100%	V_{OUT}	—	1	—	mV
Transient Response, see Figures 5 – 16. Measured as load changes from I_{OUT} = 0A to I_{OUT} = 16A at slew rate of $\Delta I_{OUT}/\Delta t$ = 600 A/µs					
1. Peak Deviation					
• V_{IN} = 12V, 0.8V < V_{OUT} < 1.3V	V_{OUT}	—	– 50	—	mV
• V_{IN} = 12V, 1.5V < V_{OUT} < 3.3V	V_{OUT}	—	– 60	—	mV
• V_{IN} = 5V, 0.8V < V_{OUT} < 1.3V	V_{OUT}	—	– 70	—	mV
• V_{IN} = 5V, 1.5V < V_{OUT} < 3.3V	V_{OUT}	—	– 80	—	mV
2. Setting Time (time until V_{OUT} returns to 10% of peak deviation)					
• V_{IN} = 12V, 0.8V < V_{OUT} < 3.3V	T_{SET1}	—	30	—	µs
• V_{IN} = 5V, 0.8V < V_{OUT} < 3.3V	T_{SET1}	—	40	—	µs
Measured as load changes from I_{OUT} = 16A to I_{OUT} = 0A at slew rate of $\Delta I_{OUT}/\Delta t$ = 600 A/µs					
1. Peak Deviation					
• V_{IN} = 12V, 0.8V < V_{OUT} < 1.3V	V_{OUT}	—	60	—	mV
• V_{IN} =12V, 1.5V < V_{OUT} < 3.3V	V_{OUT}	—	70	—	mV
• V_{IN} = 5V, 0.8V < V_{OUT} < 1.3V	V_{OUT}	—	80	—	mV
• V_{IN} = 5V, 1.5V < V_{OUT} < 3.3V	V_{OUT}	—	90	—	mV
2. Setting Time (time until V_{OUT} returns to 10% of peak deviation)					
• V_{IN} = 12V, 0.8V < V_{OUT} < 3.3V	T_{SET2}	—	30	—	µs
• V_{IN} = 5V, 0.8V < V_{OUT} < 3.3V	T_{SET2}	—	40	—	µs

Table 3. Output Specifications (T_A = 0 °C to 70 °C, V_{IN} = 5V to 12V), continued

Parameter	Symbol	Min	Typical	Max	Unit
Output Voltage Ripple and Noise, see Figures 17 – 20. Measured with I_{OUT} = 16A.					
1. RMS Value					
• V_{IN} = 12V, 0.8V < V_{OUT} < 1.8V	$V_{OUT/RMS}$	—	4	—	mVrms
• V_{IN} = 12V, 2.0V < V_{OUT} < 3.3V	$V_{OUT/RMS}$	—	5	—	mVrms
• V_{IN} = 5V, 0.8V < V_{OUT} < 3.3V	$V_{OUT/RMS}$	—	3	—	mVrms
2. Peak-to-peak (DC to 100 MHz)					
• V_{IN} = 12V, 0.8V < V_{OUT} < 2.0V	$V_{OUT/p-p}$	—	16	—	mV
• V_{IN} = 12V, 2.5V < V_{OUT} < 3.3V	$V_{OUT/p-p}$	—	20	—	mV
• V_{IN} = 5V, 0.8V < V_{OUT} < 3.3V	$V_{OUT/p-p}$	—	10	—	mV
Total Regulation Maximum output voltage error in static or transient condition including ripple and noise					
• V_{OUT} = 0.8V	V_{OUT}	– 104	—	114	mV
• V_{OUT} = 1.3V	V_{OUT}	– 113	—	123	mV
• V_{OUT} = 1.5V	V_{OUT}	– 126	—	136	mV
• V_{OUT} = 1.8V	V_{OUT}	– 131	—	141	mV
• V_{OUT} = 2.0V	V_{OUT}	– 133	—	143	mV
• V_{OUT} = 2.5V	V_{OUT}	– 144	—	154	mV
• V_{OUT} = 3.3V	V_{OUT}	– 152	—	162	mV
Maximum Output Current, depends on output voltage. See thermal derating curves for details, Figures 26 – 37. Airflow: 0 LFM – 400 LFM Ambient: 25 °C – 70 °C					
• V_{IN} = 5V	I_{OUT}	14	—	26	A
• V_{IN} = 12V	I_{OUT}	13	—	24	A
Efficiency, see Figures 38 – 39 T_A = 25 °C, 0 LFM, I_{OUT} = 16A					
• V_{OUT} = 2.5V					
V_{IN} = 12V	η	—	86	—	%
V_{IN} = 5V	η	—	89	—	%
• V_{OUT} = 0.8V					
V_{IN} = 12V	η	—	73	—	%
V_{IN} = 5V	η	—	78	—	%

Table 3. Output Specifications (T_A = 0 °C to 70 °C, V_{IN} = 5V to 12V), continued

Parameter	Symbol	Min	Typical	Max	Unit
Efficiency, see Figures 40 – 41					
T_A = 60 °C, 300 LFM, I_{OUT} = 16A					
• V_{OUT} = 2.5V					
V_{IN} = 12V	η	—	86	—	%
V_{IN} = 5V	η	—	88	—	%
• V_{OUT} = 0.8V					
V_{IN} = 12V	η	—	71	—	%
V_{IN} = 5V	η	—	77	—	%
Output Current Slew Rate Step function current from I_{OUT} = 0A to 16A with no external load capacitors	$\Delta I_{OUT}/\Delta t$	0	–	600	A/μs
External Load Capacitance* (NOT REQUIRED FOR TRANSIENT RESPONSE)					
• V_{IN} = 12V					
V_{OUT} = 0.8V	C_L	0	–	10,000	μF
V_{OUT} = 1.3V	C_L	0	–	6,800	μF
V_{OUT} = 1.5V	C_L	0	–	3,300	μF
V_{OUT} = 1.8V	C_L	0	–	1,000	μF
V_{OUT} = 2.0V	C_L	0	–	1,000	μF
V_{OUT} = 2.5V	C_L	0	–	1,000	μF
V_{OUT} = 3.3V	C_L	0	–	1,000	μF
• V_{IN} = 5V					
V_{OUT} = 0.8V	C_L	0	–	10,000	μF
V_{OUT} = 1.3V	C_L	0	–	10,000	μF
V_{OUT} = 1.5V	C_L	0	–	6,800	μF
V_{OUT} = 1.8V	C_L	0	–	3,300	μF
V_{OUT} = 2.0V	C_L	0	–	3,300	μF
V_{OUT} = 2.5V	C_L	0	–	3,300	μF
V_{OUT} = 3.3V	C_L	0	–	1,000	μF
**Maximum capacitance on output into which module can start with maximum current*					
Output Current-limit Inception, for I_{OUTMAX} at 25 °C, 400 LFM. See thermal derating curves, Figures 26 – 37	I_{OUTLIM}	105	—	160	% I_{OUTMAX}
Turn-on Response Time, see Figures 1 – 2 Measured at I_{OUT} = 16A and with maximum external load capacitor as specified above	T_{ON}	–	5.0	10.0	ms

General Specifications

Table 4. Calculated FIT Rate and Weight

Parameter	Min	Typ	Max	Unit
Calculated FIT Rate	—	—	200	Per 10^9 device hours
Weight	—	—	15.5 (0.55)	grams (oz.)

Safety Considerations

Module's printed circuit board meets the standards of *UL* flammability specifications per UL94V-0.

Feature Descriptions

Static Voltage Regulation

The output voltage measured at the converter output pins on the system board will be within the range shown in Table 3, except during turn-on and turn-off periods. The static limits apply to ambient temperatures between 0 °C and 70 °C. Static voltage regulation includes:

- DC output initial voltage and set point adjust
- Output load ranges specified in tables above
- Temperature and warm-up input voltage tolerances specified in input voltage and current

Turn-on Response Time

The output voltage will be within the specified range within 10 ms of the input voltage reaching 90% of its nominal value with OUTEN present. When OUTEN is applied with input voltage present, the output voltage will be inside its specified range within 10 ms. Figure 1 and Figure 2 represent typical start-up waveforms with the maximum load current and load capacitor on the output indicated in Table 3. A pull-up resistor of 10 kΩ is used between Module OK pin and 5V.

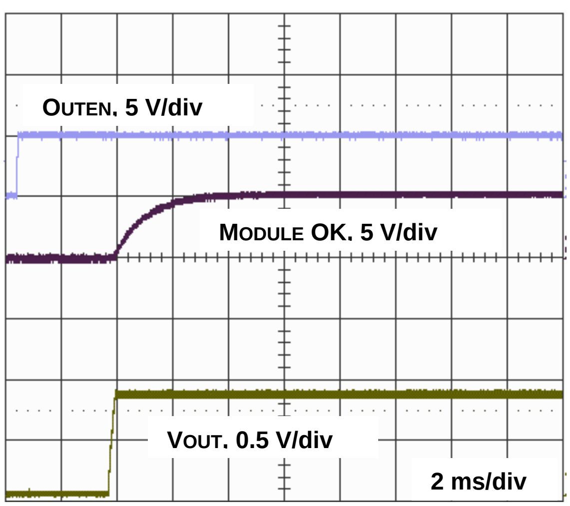


Figure 1. Turn-on Waveform: V_{IN} = 12V, V_{OUT} = 0.8V, 16A resistive load + 10,000 µF

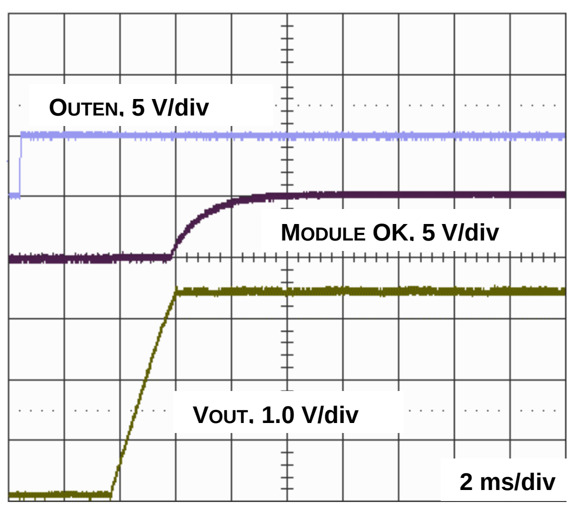


Figure 2. Turn-on Waveform: V_{IN} = 5V, V_{OUT} = 3.3V, 16A resistive load + 1,000 µF

Overshoot at Turn-on or Turn-off

Overshoot in application or removal of the input voltage, or application or removal of the OUTEN signal is 5% above the initially set output voltage. No negative voltage will be present on the output during turn-on or turn-off.

Module OK

An open collector signal with 2.0 mA current sinking capability is provided. The signal is in the low impedance (less than 250Ω) state whenever VOUT is off by more than ± 11% from its nominal value or there is no input voltage, and in the open (more than 100 kΩ) state whenever VOUT is within its specified range. The Module OK pin has an internal 0.1 μF capacitor connected to the output voltage return (GND).

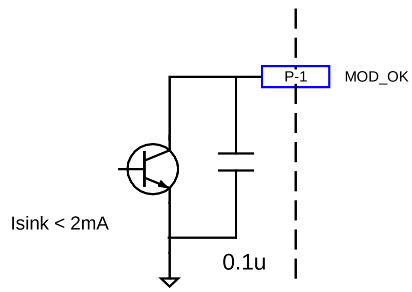


Figure 3. Module OK Circuitry

Output Enable — OUTEN

The module will accept an open collector signal consistent with TTL DC specifications for controlling the output voltage. The module is enabled when this signal is above 2.0V and disabled when this signal is less than 0.8V. The module does not source this signal with more than 0.6 mA. It is referenced to output voltage return (GND).

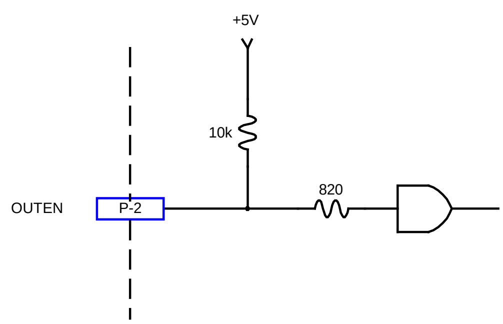


Figure 4. Output Enable Circuitry

Transient Response

The output voltage measured at the converter output pins on the system board is within the transient range shown in Table 3. The transient response is measured with DC – 200 MHz frequency bandwidth, and at ambient temperatures between 0 °C and 70 °C.

Typical transient response and noise waveforms are shown in Figures 5 – 16.

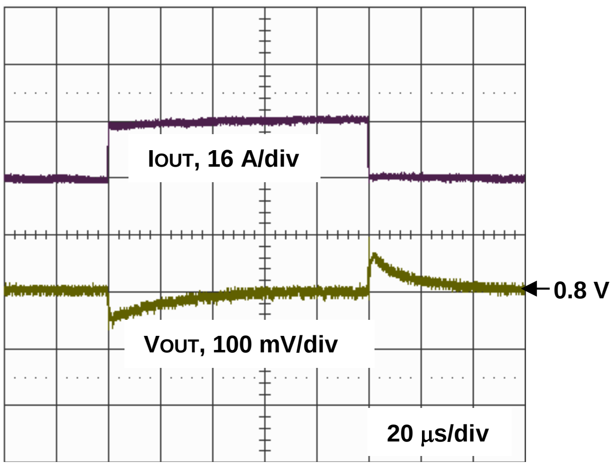


Figure 5. Transient Response: V_{IN} = 12V, V_{OUT} = 0.8V, ΔI = 16A, dI/dt = 600 A/µs

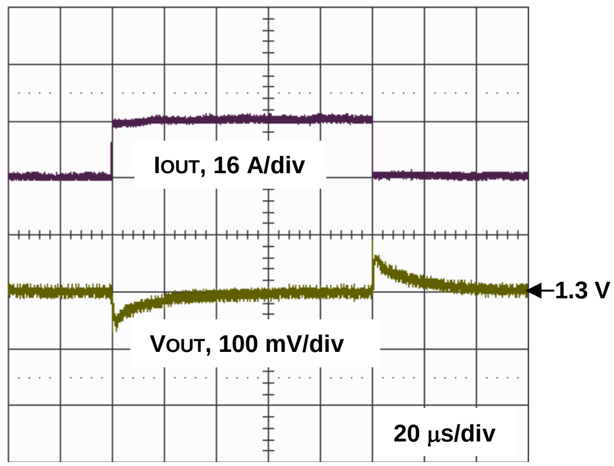


Figure 6. Transient Response: V_{IN} = 12V, V_{OUT} = 1.3V, ΔI = 16A, dI/dt = 600 A/µs

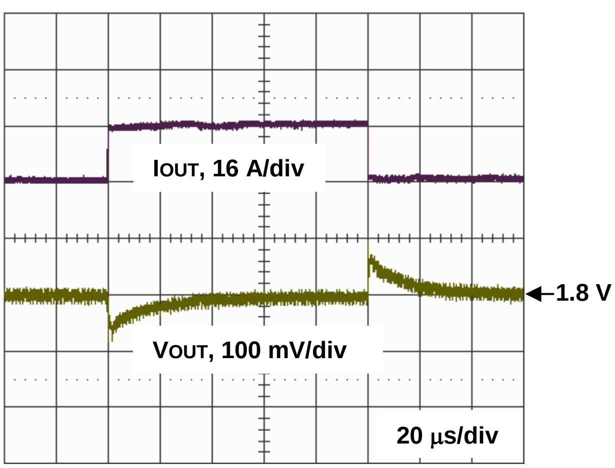


Figure 7. Transient Response: V_{IN} = 12V, V_{OUT} = 1.8V, ΔI = 16A, dI/dt = 600 A/µs

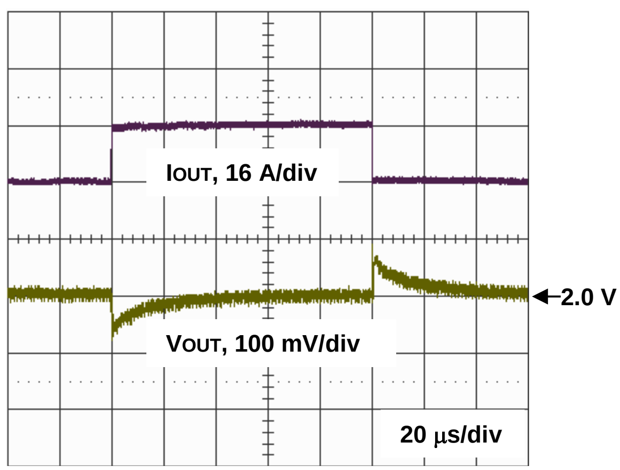


Figure 8. Transient Response: V_{IN} = 12V, V_{OUT} = 2.0V, ΔI = 16A, dI/dt = 600 A/µs

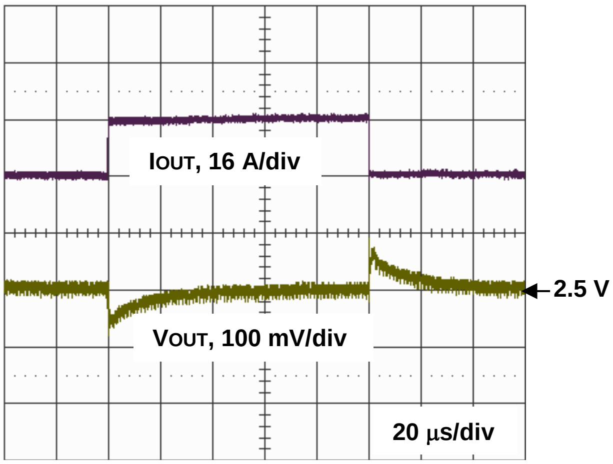


Figure 9. Transient Response: V_{IN} = 12V, V_{OUT} = 2.5V, ΔI =16A, dI/dt = 600 A/µs

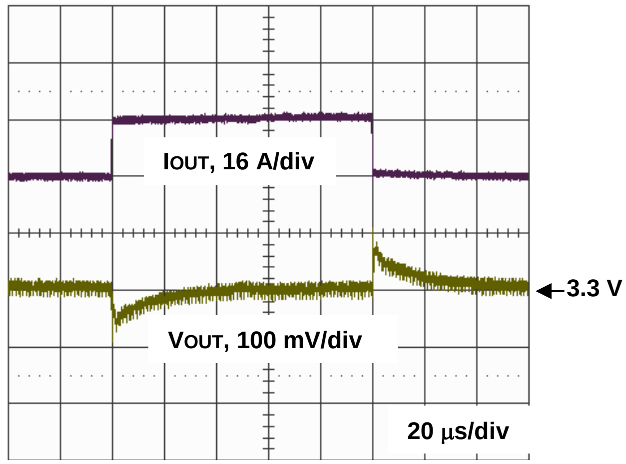


Figure 10. Transient Response: V_{IN} = 12V, V_{OUT} = 3.3V, ΔI = 16A, dI/dt = 600 A/µs

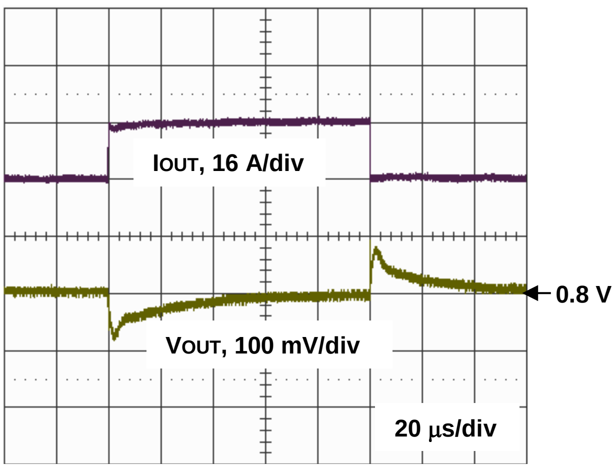


Figure 11. Transient Response: V_{IN} = 5V, V_{OUT} = 0.8V, ΔI = 16A, dI/dt = 600 A/µs

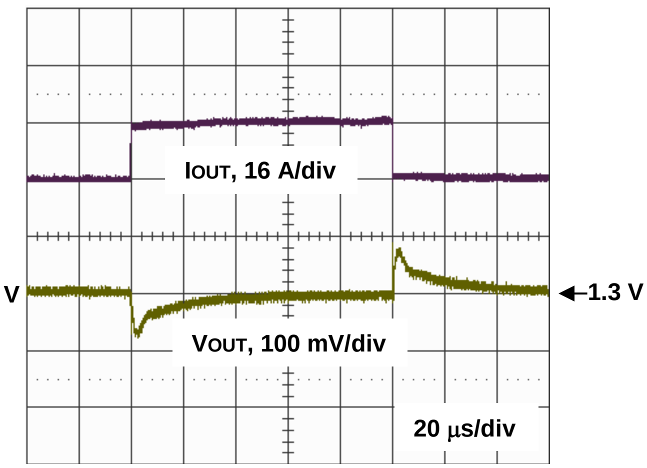


Figure 12. Transient Response: V_{IN} = 5V, V_{OUT} = 1.3V, ΔI = 16A, dI/dt = 600 A/µs

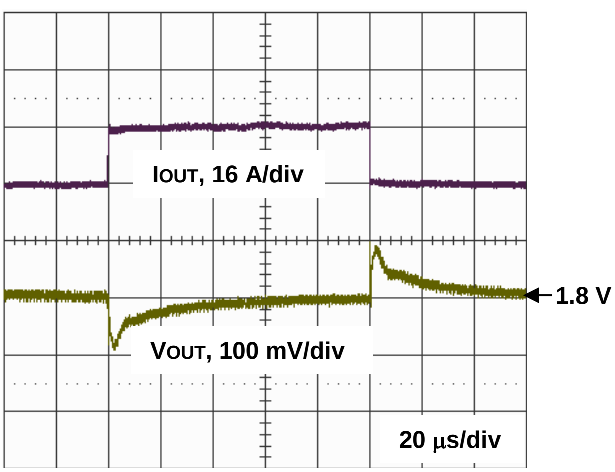


Figure 13. Transient Response: V_{IN} = 5V, V_{OUT} = 1.8V, ΔI = 16A, dI/dt = 600 A/µs

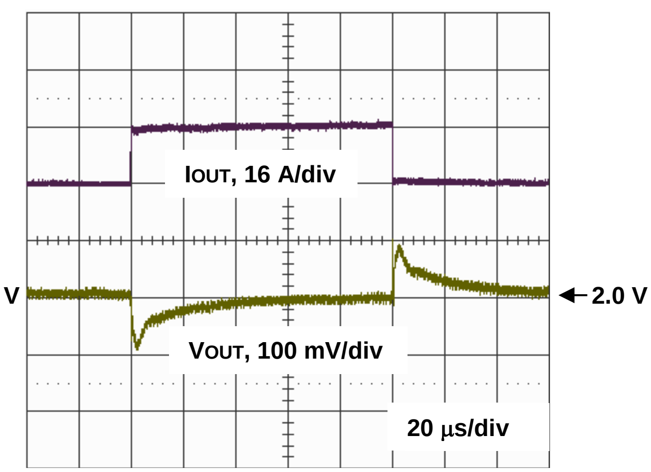


Figure 14. Transient Response: V_{IN} = 5V, V_{OUT} = 2.0V, ΔI = 16A, dI/dt = 600 A/µs

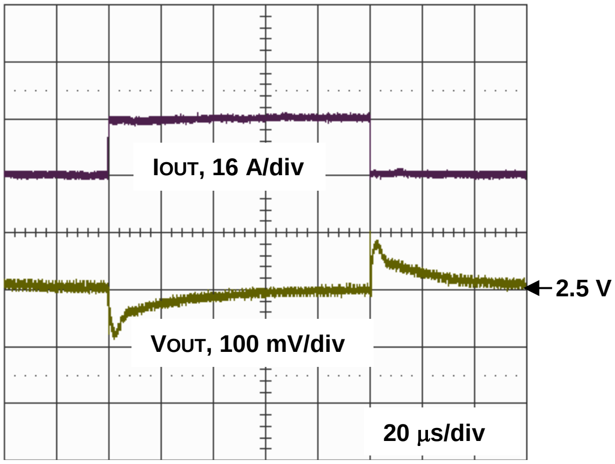


Figure 15. Transient Response: V_{IN} = 5V, V_{OUT} = 2.5V, ΔI = 16A, dI/dt = 600 A/µs

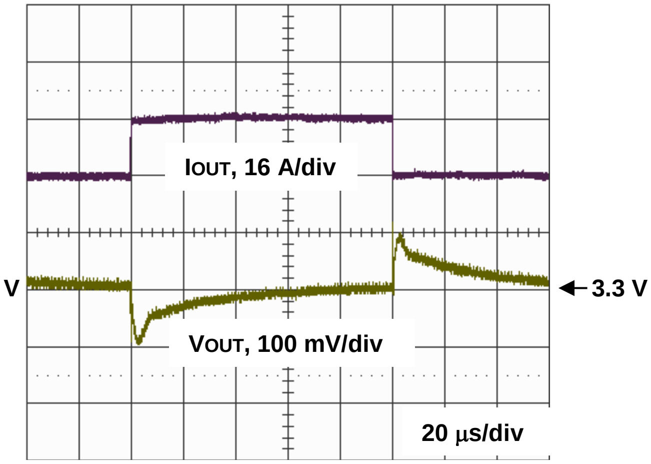


Figure 16. Transient Response: V_{IN} =5V, V_{OUT} = 3.3V, ΔI = 16A, dI/dt = 600 A/µs

Output Voltage Ripple and Noise

Output voltage ripple and noise are defined as periodic or random signals measured at the output pins on the system board with DC – 200 MHz frequency bandwidth and constant load. Figures 17 – 20 represent output voltage ripple and noise at characteristic input and output voltages, measured with 200 MHz bandwidth and 16A constant current load.

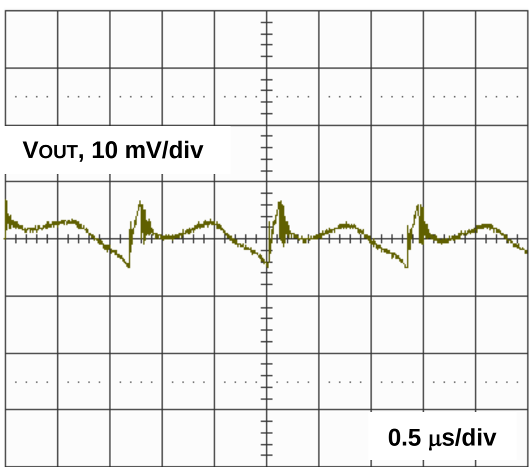


Figure 17. Output Voltage Ripple and Noise: V_{IN} = 12V, V_{OUT} = 0.8V, 16A static load

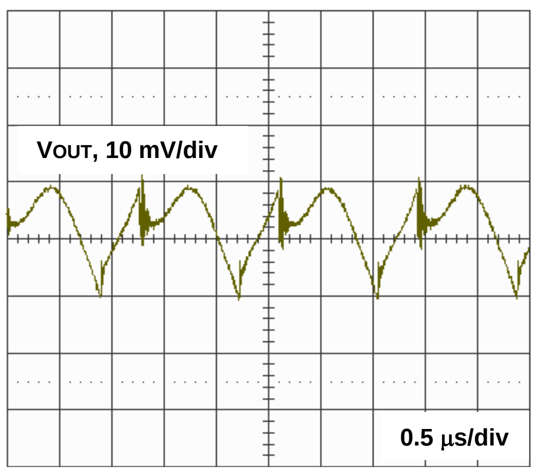


Figure 18. Output Voltage Ripple and Noise: V_{IN} = 12V, V_{OUT} = 3.3V, 16A static load

20A Zephyr™: Non-Isolated DC-DC Power Modules

5Vdc –12Vdc input; 0.8Vdc to 3.5Vdc output; 20A Output Current

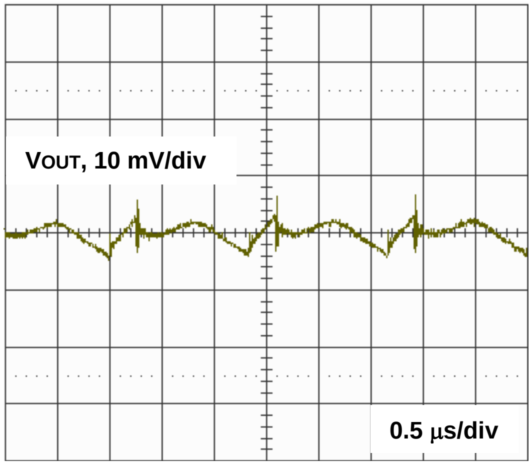


Figure 19. Output Voltage Ripple and Noise: V_{IN} = 5V, V_{OUT} = 0.8V, 16A static load

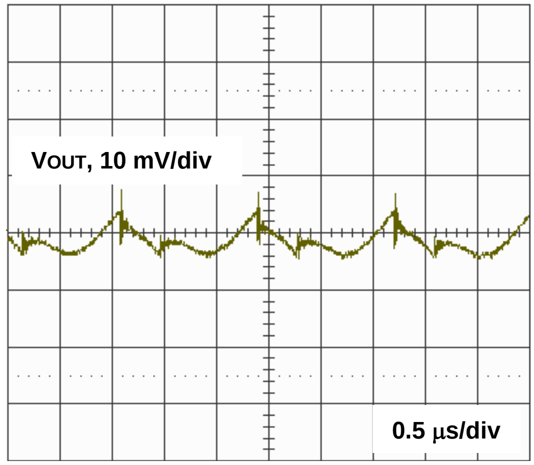


Figure 20. Output Voltage Ripple and Noise: V_{IN} = 5V, V_{OUT} = 3.3V, 16A static load

Input Voltage Ripple and Noise

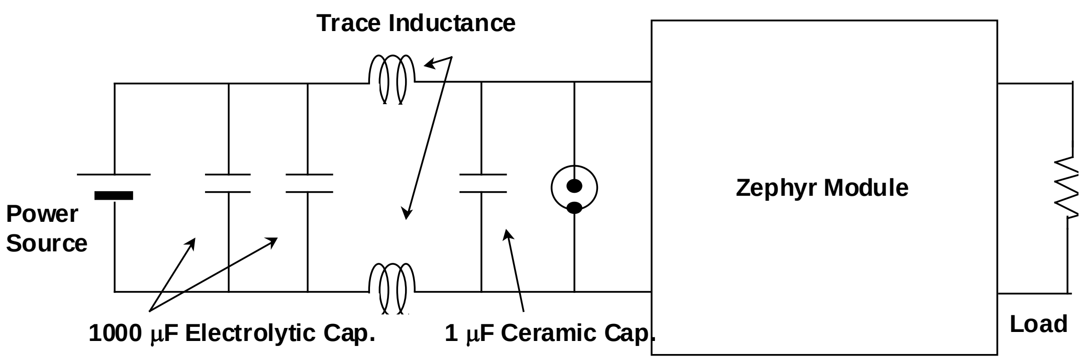


Figure 21. Test Circuit for Input Voltage Ripple and Noise Measurement

Figures 22 – 25 represent input voltage ripple and noise, measured at the input pins of the system board at characteristic input and output voltages with 200 MHz bandwidth, under 16A constant current load. The measurement was made using 50Ω coax cable terminated with 50Ω at the oscilloscope. The input capacitance consists of two Nichicon PL electrolytic capacitors, 1000 µF/16V each. The printed wiring board (PWB) trace inductance is 2.1 nH. A ceramic capacitor of 1 µF is attached to the measurement point (input pins on the system board, see Figure 21).

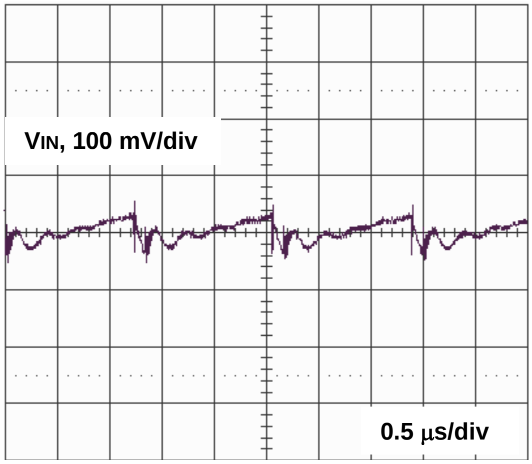


Figure 22. Input Voltage Ripple and Noise: V_{IN} = 12V, V_{OUT} = 0.8V, 16A static load

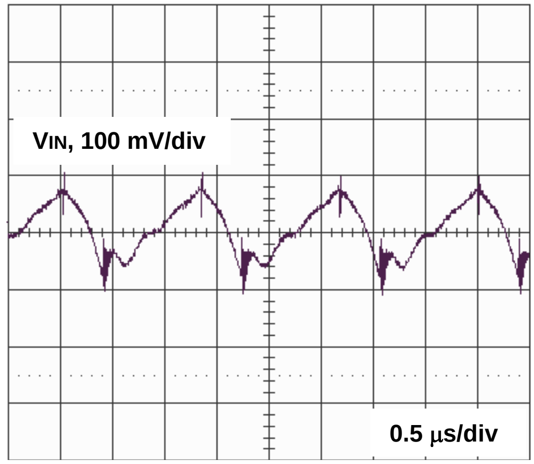


Figure 23. Input Voltage Ripple and Noise: V_{IN} = 12V, V_{OUT} = 3.3V, 16A static load

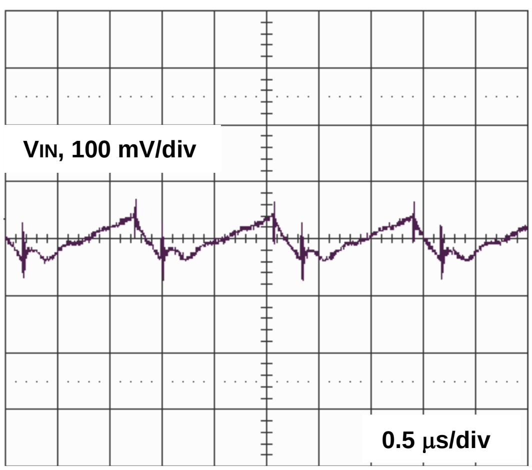


Figure 24. Input Voltage Ripple and Noise: V_{IN} = 5V, V_{OUT} = 0.8V, 16A static load

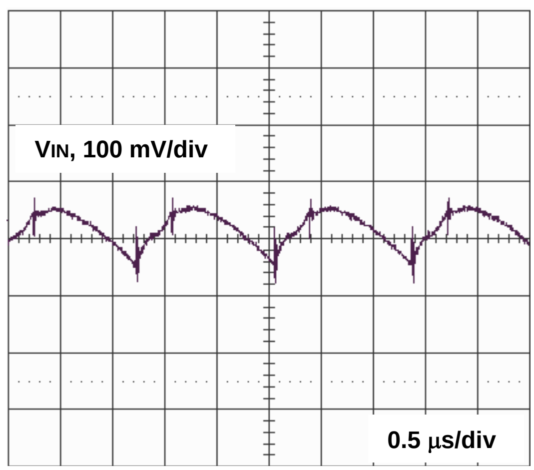


Figure 25. Input Voltage Ripple and Noise: V_{IN} = 5V, V_{OUT} = 3.3V, 16A static load

20A Zephyr™: Non-Isolated DC-DC Power Modules

5Vdc –12Vdc input; 0.8Vdc to 3.5Vdc output; 20A Output Current

Thermal Ratings

Figures 26 – 37 show thermal derating curves for 12V and 5V input voltages, at different output voltages, and with different ambient temperatures and airflow.

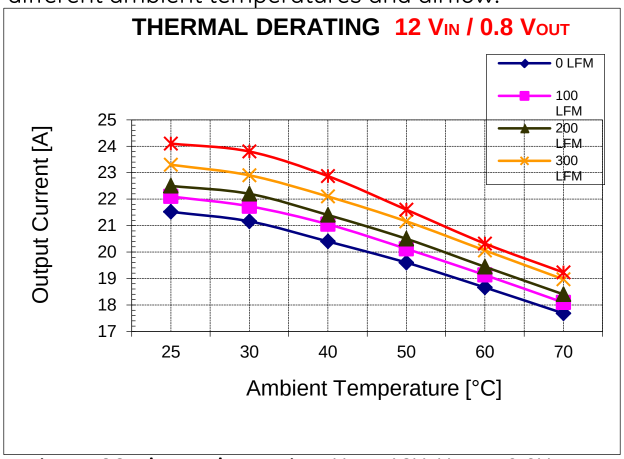


Figure 26. Thermal Derating: V_{IN} = 12V, V_{OUT} = 0.8V

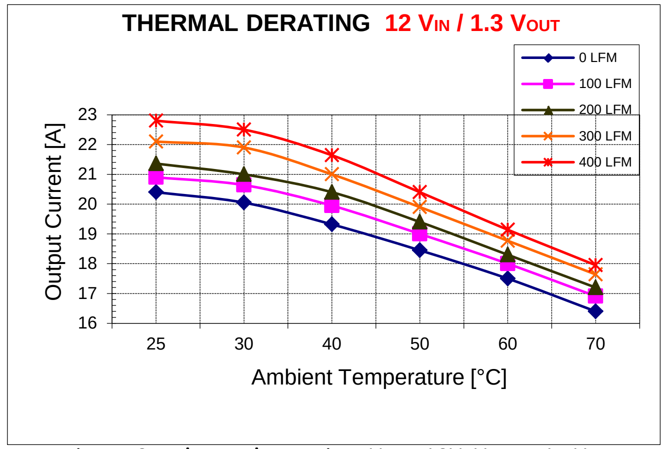


Figure 27. Thermal Derating: V_{IN} = 12V, V_{OUT} = 1.3V

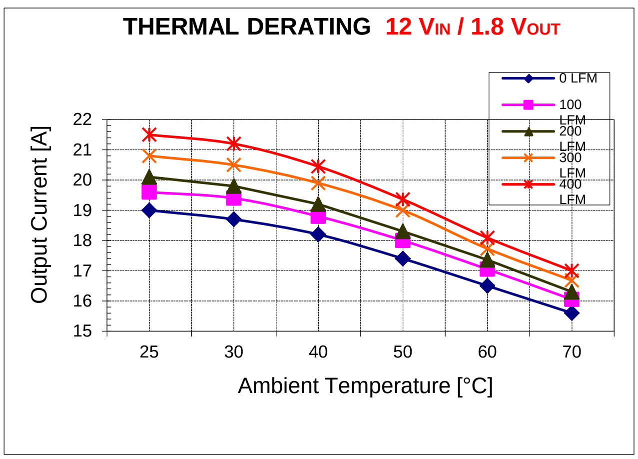


Figure 28. Thermal Derating: V_{IN} = 12V, V_{OUT} = 1.8V

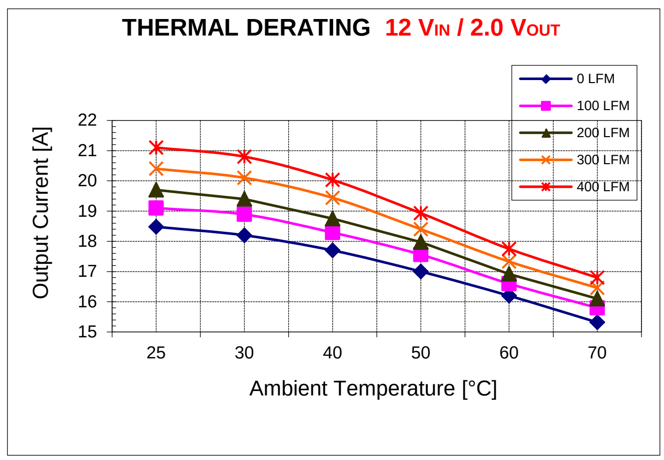


Figure 29. Thermal Derating: V_{IN} = 12V, V_{OUT} = 2.0V

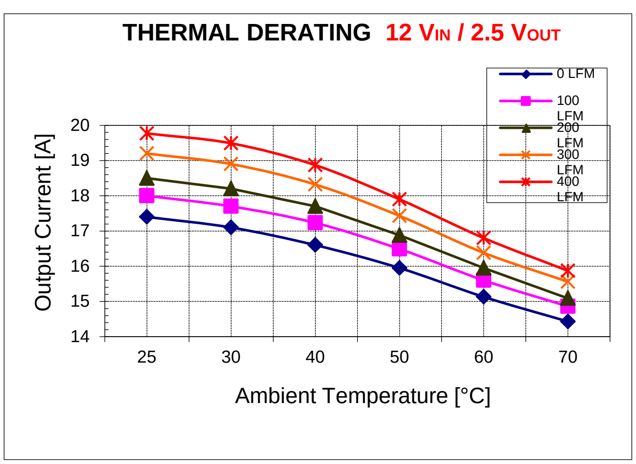


Figure 30. Thermal Derating: V_{IN} = 12V, V_{OUT} = 2.5V

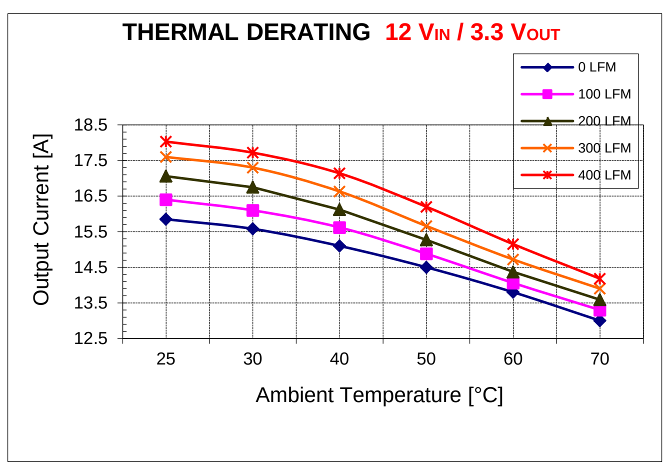


Figure 31. Thermal Derating: V_{IN} = 12V, V_{OUT} = 3.3V

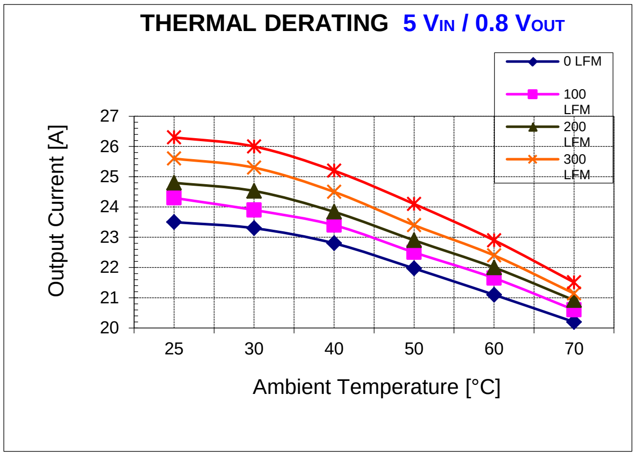


Figure 32. Thermal Derating: VIN = 5V, VOUT = 0.8V

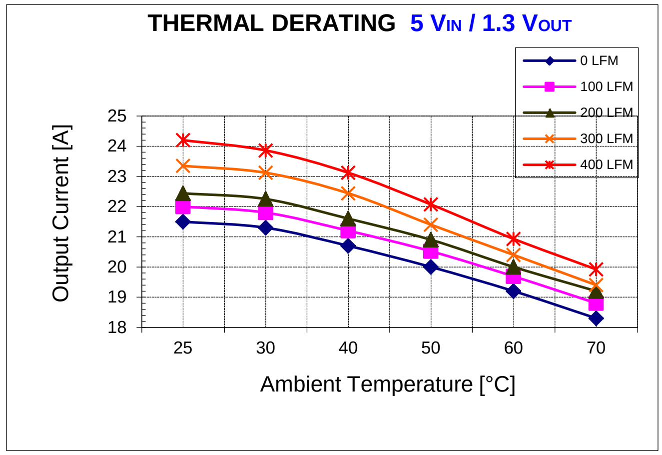


Figure 33. Thermal Derating: VIN = 5V, VOUT = 1.3V

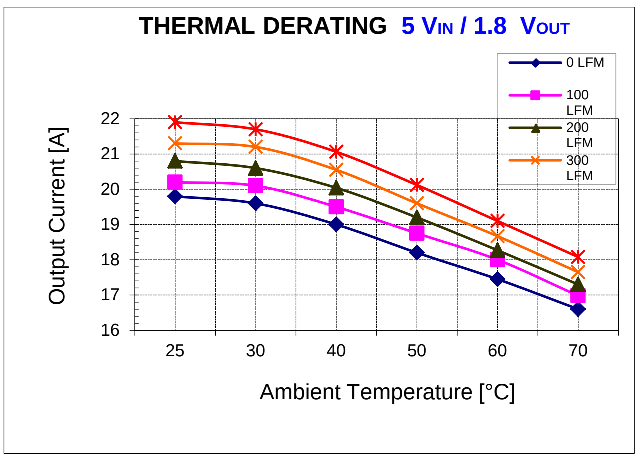


Figure 34. Thermal Derating: VIN = 5V, VOUT = 1.8V

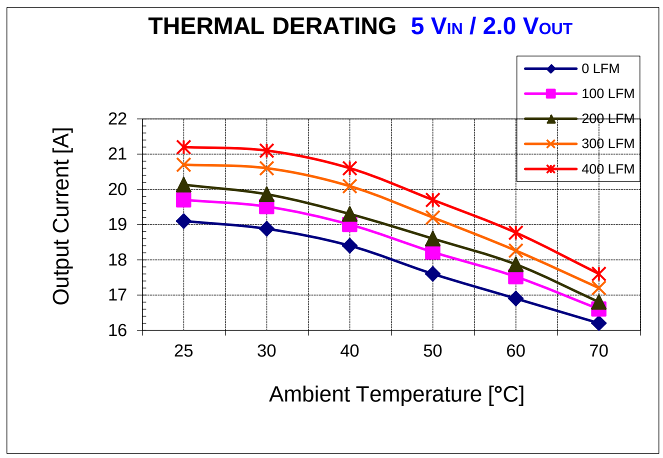


Figure 35. Thermal Derating: VIN = 5V, VOUT = 2.0V

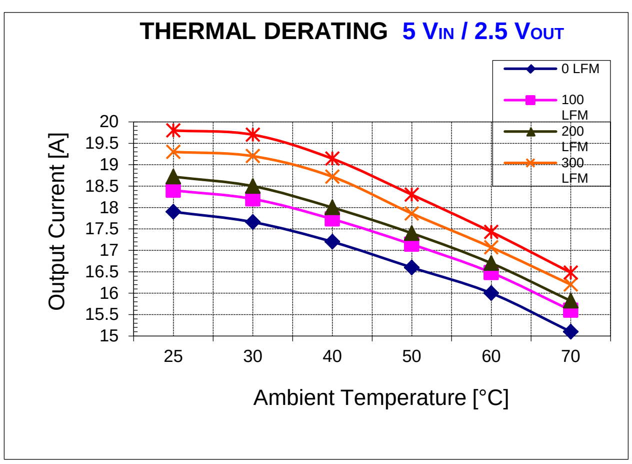


Figure 36. Thermal Derating: VIN = 5V, VOUT = 2.5V

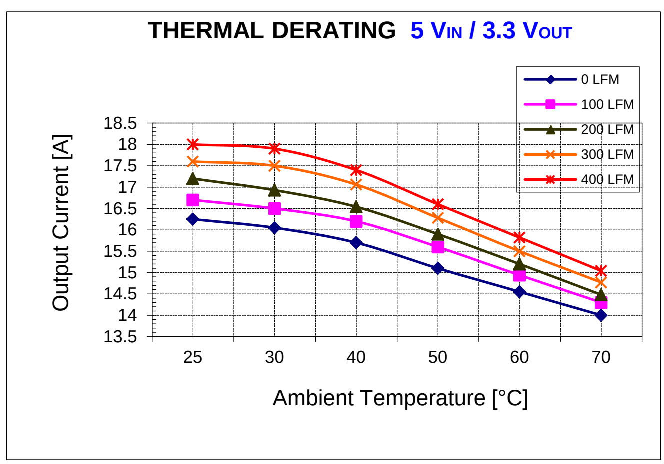


Figure 37. Thermal Derating: VIN = 5V, VOUT = 3.3V

Efficiency

Figures 38 – 41 show typical efficiency charts for 12V and 5V input voltages, at different output voltages, and with different ambient temperatures and airflow.

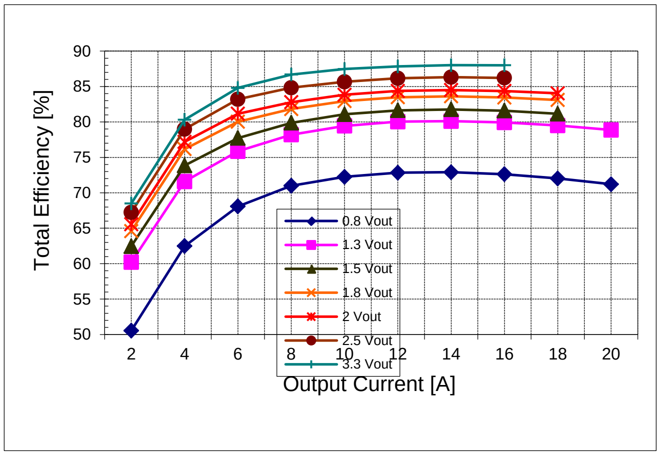


Figure 38. Efficiency: V_{IN} = 12V, 25 °C, no airflow

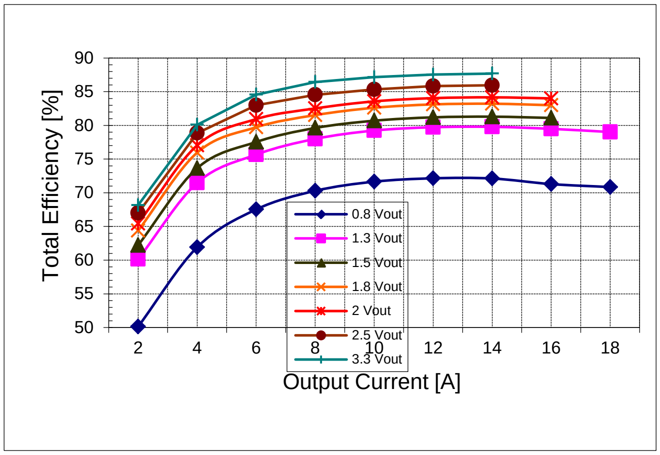


Figure 39. Efficiency: V_{IN} = 12V, 60 °C, 300 LFM

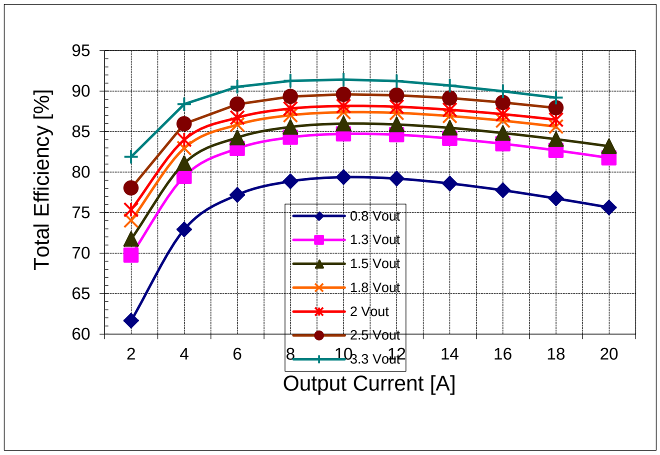


Figure 40. Efficiency: V_{IN} = 5V, 25 °C, no airflow

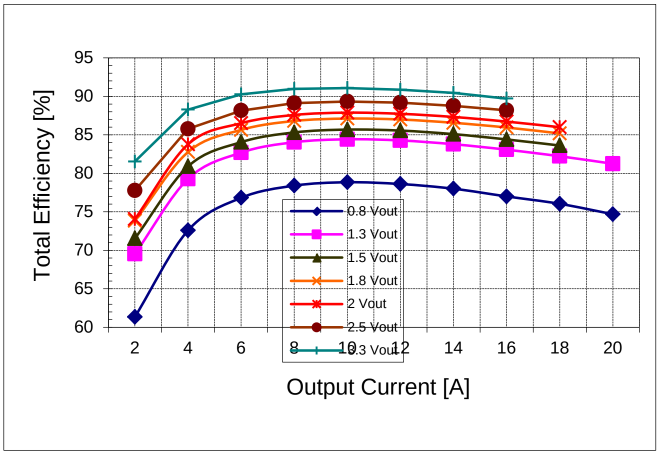


Figure 41. Efficiency: V_{IN} = 5V, 60 °C, 300 LFM

Output control

There are two ways to set the output voltage of the Zephyr:

1. A resistor calculated from the following equation can be inserted between $V_{ADJUST}+$ pin and $V_{ADJUST}-$ pin.

$$R_{ADJ} = \frac{13.44 \cdot V_{OUT} - 11.35}{3.3 - V_{OUT}} \quad [k\Omega] \qquad (1)$$

or

$$V_{OUT} = \frac{3.3 \cdot (3.44 + R_{ADJ})}{13.44 + R_{ADJ}} \quad [V] \qquad (2)$$

For example, to get the output voltage of 2.5V, R_{ADJ} = 27.8 kΩ, the closest standard resistor of 27.7 kΩ should be attached between these two pins.

Shorting and opening of these pins will give the output voltage of 0.844V and 3.30V, respectively. For the output voltage beyond this range (up to ± %5), the use of TRIM pin is recommended.

The additional output voltage error due to the tolerance R_{ADJ_TOL} [%] of R_{ADJ} [kΩ] is described as follows.

$$\pm \%V_{OUT\_RADJ} = \left(\frac{13.44 + R_{ADJ}}{3.44 + R_{ADJ}} \cdot \frac{3.44 + R_{ADJ} \cdot \left(1 \pm \frac{R_{ADJ\_TOL}}{100}\right)}{13.44 + R_{ADJ} \cdot \left(1 \pm \frac{R_{ADJ\_TOL}}{100}\right)} - 1 \right) \cdot 100 \quad [\%] \qquad (3)$$

This error should be added to the error given in the "Output Voltage Set Point" section of Table 3 to get the total DC output voltage error.

2. An external voltage V_{EXT} [V] can be applied between $V_{ADJUST}+$ pin and $V_{ADJUST}-$ pin to control output voltage. The relation between V_{OUT} and V_{EXT} is described as follows.

$$V_{OUT} = \frac{11.35 + 10 \cdot V_{EXT}}{13.44} \quad [V] \qquad (4)$$

Therefore, in order to set the output voltage to 2.5V, V_{EXT} = 2.23V. The equation (4) is valid even when specified external voltage (such as DAC) is applied between $V_{ADJUST}+$ and $V_{ADJUST}-$. Table 5 shows voltage identification code with each corresponding voltage V_{EXT} supplied from standard DAC, as well as resulting output voltages of the module V_{OUT} calculated from the equation (4). Note that if the $V_{ADJUST}+$ and $V_{ADJUST}-$ pins are open circuit, V_{OUT} = 3.3V (default value).

Table 5. Voltage Identification Code with Output Voltage of Module

VID Pins					V_{EXT} [V]	V_{OUT} [V]
VID4	VID3	VID2	VID1	VID0		
0	1	1	1	1	1.30	1.811
0	1	1	1	0	1.35	1.849
0	1	1	0	1	1.40	1.886
0	1	1	0	0	1.45	1.923
0	1	0	1	1	1.50	1.961
0	1	0	1	0	1.55	1.998
0	1	0	0	1	1.60	2.035
0	1	0	0	0	1.65	2.072
0	0	1	1	1	1.70	2.110
0	0	1	1	0	1.75	2.147
0	0	1	0	1	1.80	2.184
0	0	1	0	0	1.85	2.221
0	0	0	1	1	1.90	2.258
0	0	0	1	0	1.95	2.295
0	0	0	0	1	2.00	2.333
0	0	0	0	0	2.05	2.370
1	1	1	1	1	No Output	3.300
1	1	1	1	0	2.1	2.407
1	1	1	0	1	2.2	2.481
1	1	1	0	0	2.3	2.556
1	1	0	1	1	2.4	2.630
1	1	0	1	0	2.5	2.705
1	1	0	0	1	2.6	2.779
1	1	0	0	0	2.7	2.853
1	0	1	1	1	2.8	2.928
1	0	1	1	0	2.9	3.002
1	0	1	0	1	3.0	3.077
1	0	1	0	0	3.1	3.151
1	0	0	1	1	3.2	3.225
1	0	0	1	0	3.3	3.300
1	0	0	0	1	3.4	3.374
1	0	0	0	0	3.5	3.449

0 = Closed (Connected to Ground)

1 = Open

The additional output voltage error due to the tolerance V_{EXT_TOL} [%] of V_{EXT} is described as follows:

$$\pm\%V_{OUT\_VEXT} = \left(\frac{\left(11.35 + 10 \cdot V_{EXT} \cdot \left(1 \pm \frac{V_{EXT\_TOL}}{100}\right)\right)}{(11.35 + 10 \cdot V_{EXT})} - 1 \right) \cdot 100 \qquad [\%] \qquad (5)$$

This error should be added to the error given in the "Output Voltage Set Point" section of Table 3, using R_{ADJ} = 0 kΩ, to get the total DC output voltage error.

Trim

TRIM pin is provided to margin high/low the output voltage by certain percentages independent of the output voltage. The equation to margin low by connecting a resistor, R_{LOW}, from TRIM pin to OUTSENSE + pin is:

$$R_{LOW} = \frac{654 \cdot V_{OUT} - 621 \cdot V_{NOM}}{2 \cdot V_{NOM} - 2 \cdot V_{OUT}} \quad [k\Omega] \qquad (6)$$

To margin low by 2.5%, R_{LOW} = 332.0 kΩ. Shorting TRIM pin to OUTSENSE + pin provides the maximum negative adjustment of 5.0%.

The equation to margin high by connecting a resistor, R_{HIGH}, from TRIM pin to OUTSENSE – pin is:

$$R_{HIGH} = \frac{621 \cdot V_{NOM} - 588 \cdot V_{OUT}}{2 \cdot V_{OUT} - 2 \cdot V_{NOM}} \quad [k\Omega] \qquad (7)$$

To margin high by 2.5%, R_{HIGH} = 365.0 kΩ. Shorting TRIM pin to OUTSENSE – pin provides the maximum positive adjustment of 5.0%.

If TRIM is not connected to OUTSENSE + or OUTSENSE –, $V_{OUT} = V_{NOM}$.

Output Overvoltage Protection

Protection level: The converter provides overvoltage protection by latching off when the output voltage rises beyond V_{TRIP}. V_{TRIP} is between 112% and 120% of the nominal output voltage. Care must be taken because the voltage increase due to T_{RIM} can also contribute to V_{TRIP}.

Overvoltage protection circuit protects against shorted feedback/sense connections.

Voltage sequencing: No allowed variation of input voltages or output current or control signals will falsely trigger an OVP event or damage the module.

Reset After Shutdown

If the module goes into an overvoltage shutdown state, the module cannot return to normal operation mode even after the fault has been removed. Input voltage of the module must be reset to restart the module.

Output Overcurrent Protection

Overcurrent protection is provided to protect the module from damage caused by excessive output current. Current overload is from 5% to 60% over the maximum output current values given in the thermal derating curves (at 25 °C, 400 LFM, see thermal derating curves Figure 26 – 37). The module will shut down until the overload is removed, and then will automatically restart.

Overtemperature Protection

The module is protected against failure from overtemperature conditions created by high ambient temperature or by low or no airflow condition. It will either operate properly within the requirements or shut down (nonlatching). The module will function as specified under overtemperature conditions until disabled (nonlatching) by the protection circuit.

Remote Sense

The remote sense inputs ($O_{UTSENSE}$ + and $O_{UTSENSE}$ -) should be connected to the load, using separate sense traces on the system board as shown in Figure 42. Remote sense can compensate for the total output voltage drop by up to the amount indicated in Table 6. These values are calculated to prevent unwanted overvoltage protection by the module under the worst possible voltage error listed in Table 3 (including transient error). In the event of an open remote sense lines, the module will maintain local sense regulation through 100Ω internal resistors connected to the V_{OUT} pins, with an additional + 0.3% DC error in V_{OUT}.

Table 6. Maximum Remote Sense Compensation

V_{OUT} [V]	$V_{MAXCOMP}$ [V]
0.8	0.02
1.3	0.10
1.5	0.12
1.8	0.16
2.0	0.19
2.5	0.26
3.3	0.38

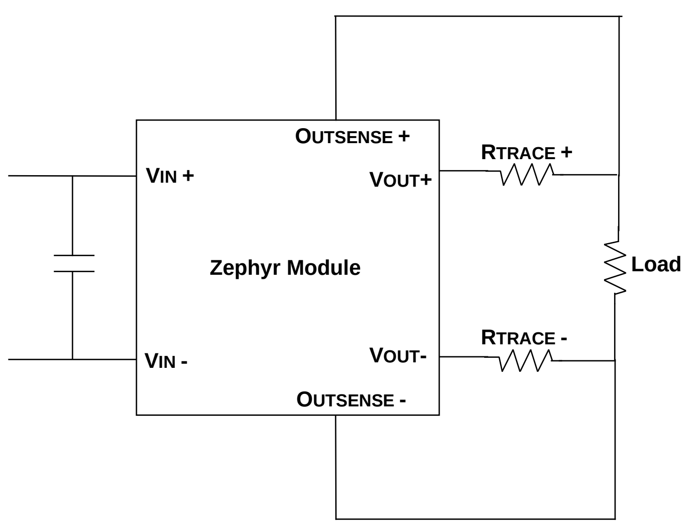


Figure 42. Remote Sense Connection to Load

Environmental

Design including materials is consistent with environmental standards in Table 7.

Table 7. Environmental and Reliability Specifications

	Operating	Nonoperating
Temperature	Ambient 0 °C to 70 °C at zero to 400 LFM, full load (see Thermal Ratings) with a maximum rate of change of 5 °C/10 minutes minimum but no more than 10 °C/hour	Ambient – 40 °C to 70 °C with a maximum rate of change of 20 °C/hour (Thermal shock of – 40 °C to 70 °C, 10 cycles; transfer time shall not exceed 5 minutes; duration of exposure to temperature extremes shall be 20 minutes)
Humidity (non-condensing)	To 85% relative humidity	To 95% relative humidity
Altitude	0 to 10,000 feet	0 to 50,000 feet
Reliability	Calculated MTBF of 5 million hours assuming continuous operation at 55 °C, at 200 LFM airflow nominal input voltage and 80% maximum load	
EMI	Complies with the limits of FCC Class B and VDE 243 Level B for radiated emissions	
Electrostatic discharge	15 KV initialization level per specification number EN61000-3-2. The direct ESD event shall cause no out-of-regulation conditions. (Includes overshoot, undershoot, and nuisance trips of the overvoltage protection, overcurrent protection, or remote shutdown circuitry)	25 KV initialization level

Module Pin-out

The pin-out of Zephyr modules is indicated in Figure 43 and Table 8.

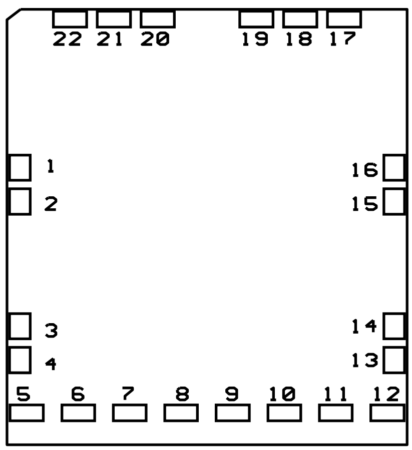


Figure 43. Top View of Board (Pins are located on the bottom side)

Table 8. Pin-out of Zephyr Module

1	MODULE OK
2	OUTEN
3	OUTSENSE -
4	OUTSENSE+
5	VOUT +
6	VOUT -
7	VOUT +
8	VOUT -
9	VOUT +
10	VOUT -
11	VOUT +
12	VOUT -
13	VADJUST +
14	VADJUST -
15	TRIM
16	RESERVED
17	VIN +
18	VIN +
19	VIN +
20	VIN -
21	VIN -
22	VIN -

Mechanical Specifications

Mechanical specifications (Table 9) and module outline (Figure 44) are illustrated below. The pin layout and the recommended pad size are shown in Figure 45 and Figure 46.

Table 9. Mechanical Specifications

Parameter	Symbol	Min	Typical	Max	Unit
Physical Size	L W H	— — —	37.08 (1.460) 52.32 (2.060) 5.66 (0.223)	37.21 (1.465) 52.45 (2.065) 6.12 (0.241)	mm (in.) mm (in.) mm (in.)
Weight	—	—	—	15.5 (0.55)	grams (oz.)

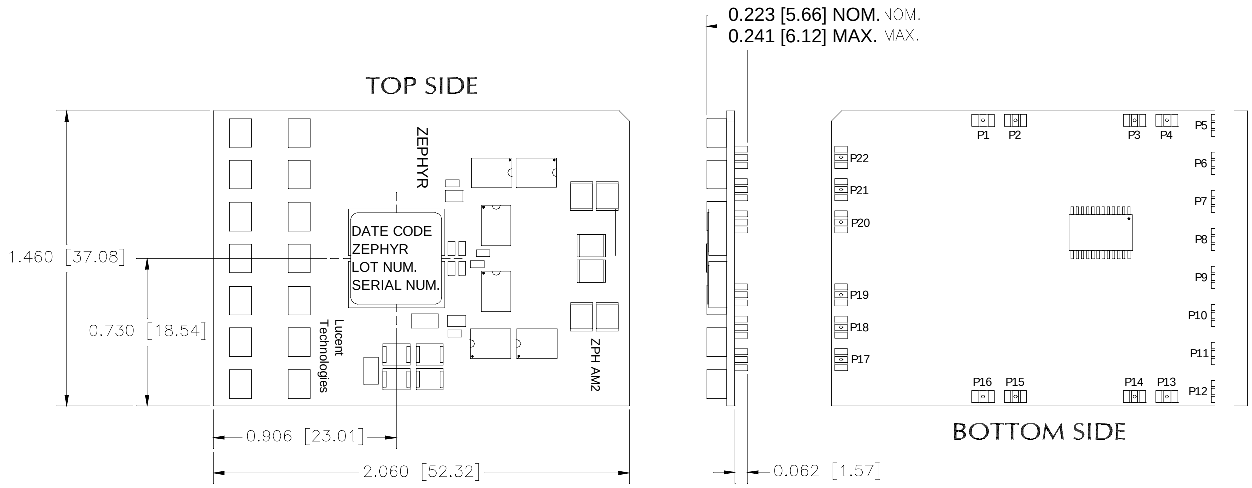


Figure 44. Outline of Zephyr Module

20A Zephyr™: Non-Isolated DC-DC Power Modules

5Vdc –12Vdc input; 0.8Vdc to 3.5Vdc output; 20A Output Current

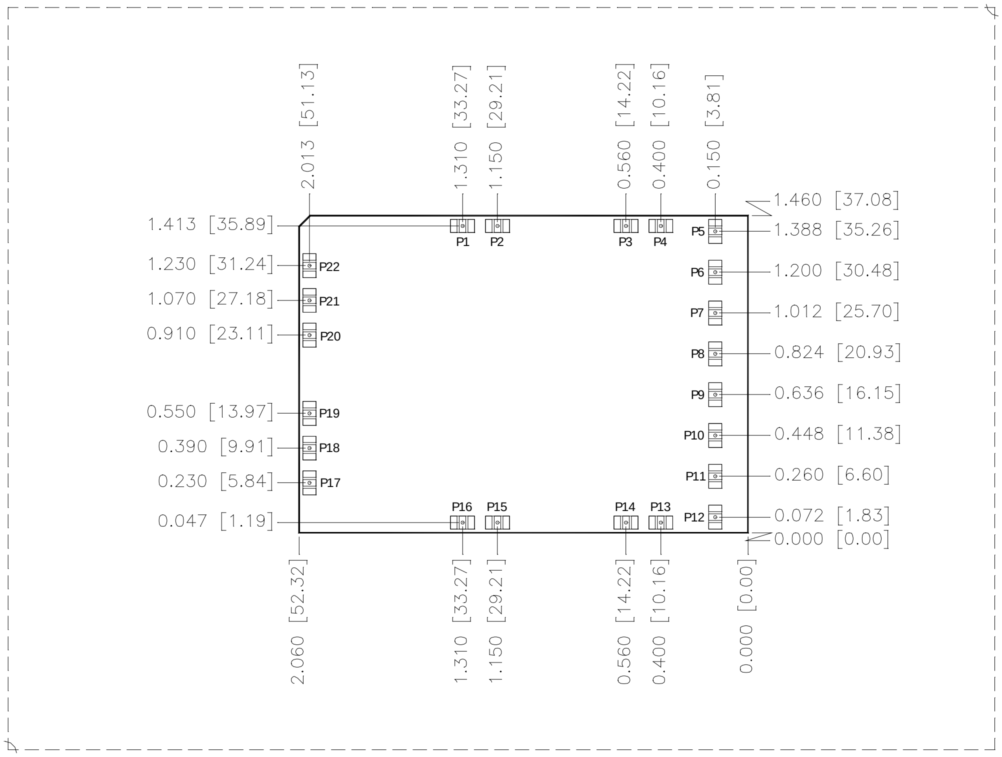


Figure 45. Pin Layout of Zephyr Module

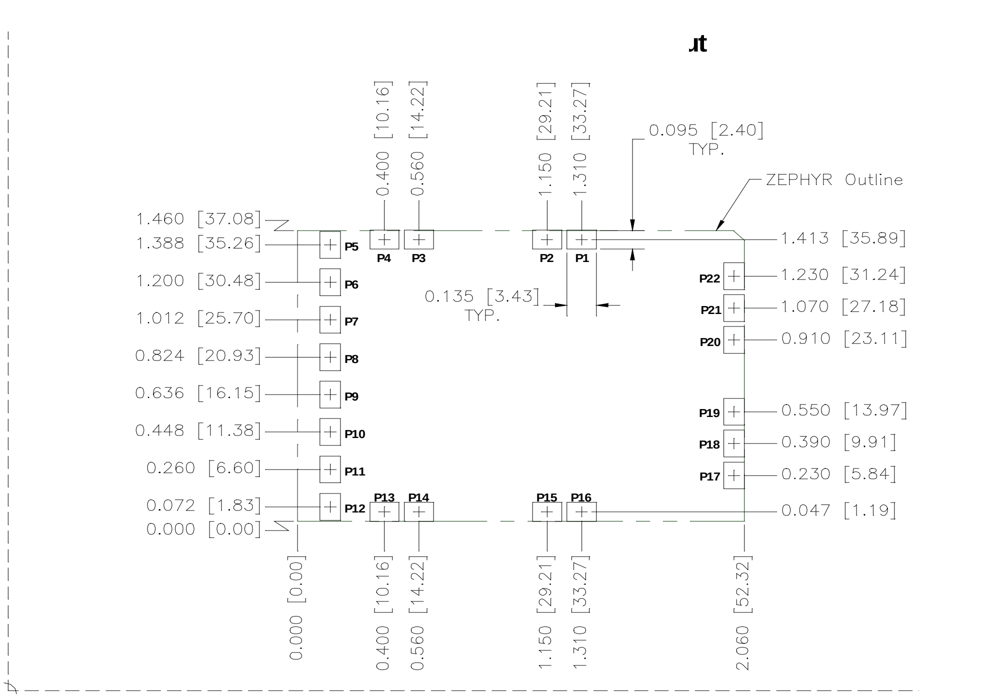


Figure 46. Recommended Pad Size and Layout

Fusing Considerations

A 10A fuse is required for input voltages of 10.6V and higher. It is not required for input voltages below 10.6V. The following fuse or equivalent is recommended:

Characteristic	Fuse Parameter	Littlefuse R451010 Nano² SMF
Fuse Current Rating	10A	10A
Voltage Rating	32 minimum	125
I^2t	100 a^2sec maximum	26.4 a^2sec
DC Interruption Rating (must be DC rated, not just AC rated)	35A minimum	35A
UL Recognized	Mandatory	Yes

The fuse should be located in the input voltage bus side of the input capacitor to minimize inductance between the input capacitor and the Zephyr Power Module. The fuse should not be located in proximity to any object which might abnormally 'preheat' the fuse, causing undesired melting.

The Zephyr Power Module begins regulating with an input voltage above approximately 4V and will draw more input current at lower voltages. If the input voltage rise times and fall times are too slow, shorter fuse life and nuisance opening may occur. To minimize such fuse input current stresses, the module should be enabled after input voltage is applied and disabled before input voltage is removed, by using the OUTEN pin.

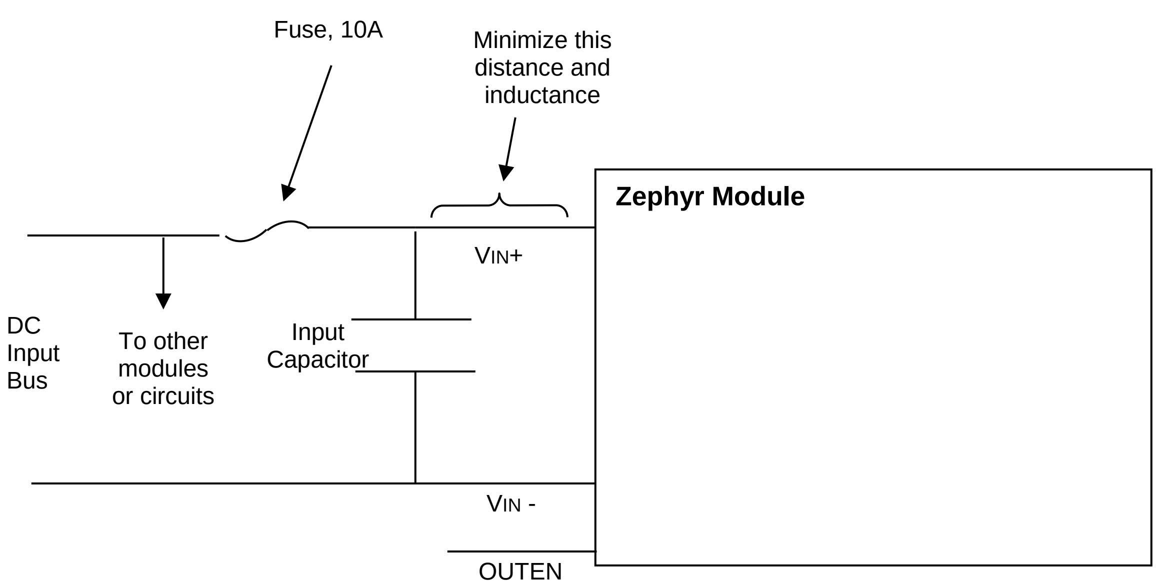


Figure 47. Fuse Placement

Surface Mount Information

Pick and Place

The Zephyr SMT modules use an open frame construction and are designed for a fully automated assembly process. The modules are fitted with a label designed to provide a large surface area for pick and place operations. The label meets all the requirements for surface mount processing, as well as safety standards, and is able to withstand reflow temperatures of up to 300°C. The label also carries product information such as product code, serial number and the location of manufacture.

Nozzle Recommendations

The module weight has been kept to a minimum by using open frame construction. Even so, these modules have a relatively large mass when compared to conventional SMT components. Variables such as nozzle size, tip style, vacuum pressure and placement speed should be considered to optimize this process. The minimum recommended nozzle diameter for reliable operation is 6mm. The maximum nozzle outer diameter, which will safely fit within the allowable component spacing, is 9 mm. Oblong or oval nozzles up to 11 x 9 mm may also be used within the space available.

Tin Lead Soldering

The Zephyr SMT power modules are lead free modules and can be soldered either in a lead-free solder process or in a conventional Tin/Lead (Sn/Pb) process. It is recommended that the customer review data sheets in order to customize the solder reflow profile for each application board assembly. The following instructions must be observed when soldering these units. Failure to observe these instructions may result in the failure of or cause damage to the modules, and can adversely affect long-term reliability.

In a conventional Tin/Lead (Sn/Pb) solder process peak reflow temperatures are limited to less than 235°C. Typically, the eutectic solder melts at 183°C, wets the land, and subsequently wicks the device connection. Sufficient time must be allowed to fuse the plating on the connection to ensure a reliable solder joint. There are several types of SMT reflow technologies currently used in the industry. These surface mount power modules can be reliably soldered using natural forced convection, IR (radiant infrared), or a combination of convection/IR. For reliable soldering the solder reflow profile should be established by accurately measuring the modules CP connector temperatures.

Lead Free Soldering

The –Z version Austin SuperLynx II SMT modules are lead-free (Pb-free) and RoHS compliant and are both forward and backward compatible in a Pb-free and a SnPb soldering process. Failure to observe the instructions below may result in the failure of or cause damage to the modules and can adversely affect long-term reliability.

20A Zephyr™: Non-Isolated DC-DC Power Modules

5Vdc –12Vdc input; 0.8Vdc to 3.5Vdc output; 20A Output Current

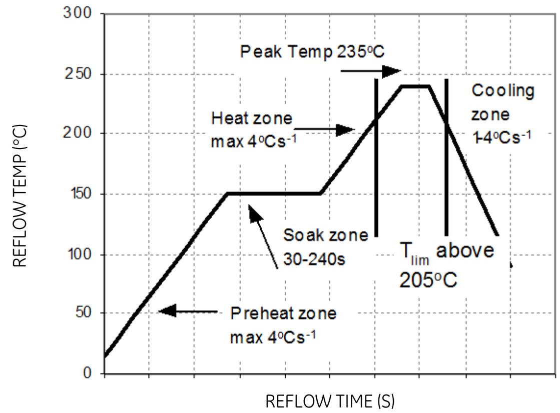


Figure 48. Reflow Profile for Tin/Lead (Sn/Pb) process

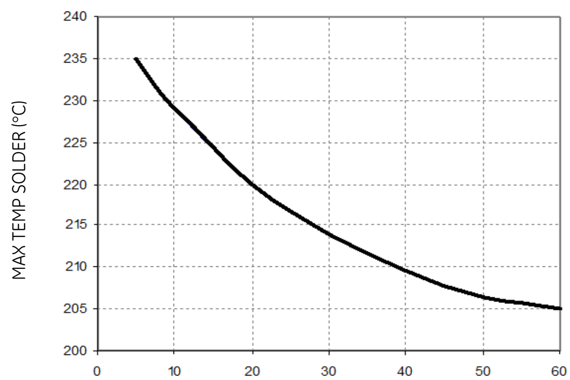


Figure 49. Time Limit Curve Above 205°C for Tin/Lead (Sn/Pb) process

Pb-free Reflow Profile

Power Systems will comply with J-STD-020 Rev. C (Moisture/Reflow Sensitivity Classification for Nonhermetic Solid State Surface Mount Devices) for both Pb-free solder profiles and MSL classification procedures. This standard provides a recommended forced-air-convection reflow profile based on the volume and thickness of the package. The suggested Pb-free solder paste is Sn/Ag/Cu (SAC). The recommended linear reflow profile using Sn/Ag/Cu solder is shown in Fig. 50.

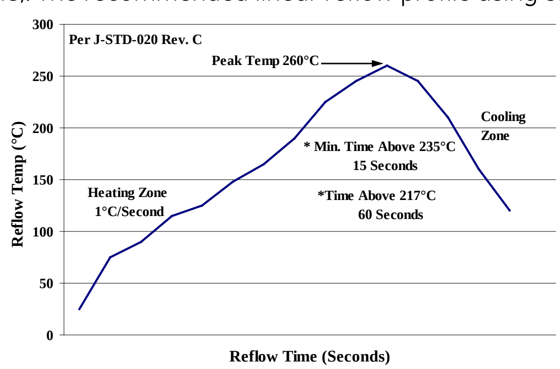


Figure 50. Recommended linear reflow profile using Sn/Ag/Cu solder.

MSL Rating

The Zephyr SMT modules have a MSL rating of 1.

Storage and Handling

The recommended storage environment and handling procedures for moisture-sensitive surface mount packages is detailed in J-STD-033 Rev. A (Handling, Packing, Shipping and Use of Moisture/Reflow Sensitive Surface Mount Devices). Moisture barrier bags (MBB) with desiccant are required for MSL ratings of 2 or greater. These sealed packages should not be broken until time of use. Once the original package is broken, the floor life of the product at conditions of ≤ 30°C and 60% relative humidity varies according to the MSL rating (see J-STD-033A). The shelf life for dry packed SMT packages will be a minimum of 12 months from the bag seal date, when stored at the following conditions: < 40° C, < 90% relative humidity.

Post Solder Cleaning and Drying Considerations

Post solder cleaning is usually the final circuit-board assembly process prior to electrical board testing. The result of inadequate cleaning and drying can affect both the reliability of a power module and the testability of the finished circuit-board assembly. For guidance on appropriate soldering, cleaning and drying procedures, refer to *Board Mounted Power Modules: Soldering and Cleaning* Application Note (AN04-001).

20A Zephyr™: Non-Isolated DC-DC Power Modules

5Vdc –12Vdc input; 0.8Vdc to 3.5Vdc output; 20A Output Current

Ordering Information

Please contact your GE Account Manager or Field Application engineer for pricing and availability.

Table 10. Coding Scheme for Ordering

Product Description	Comcode	Expanded Product Description
Zephyr 5/12 V 0.8/3.5 V 20A J	108601220	5 V_{IN} to12 V_{IN}; 0.8 V_{OUT} to 3.3 V_{OUT}; 20 A I_{OUT}; 600 A/µsec transient rate; surface mount LISMC connector; JEDEC tray package
ZRA020A0F-VZ	108995148	5 V_{IN} to12 V_{IN}; 0.8 V_{OUT} to 3.3 V_{OUT}; 20 A I_{OUT}; 600 A/µsec transient rate; surface mount LISMC connector; JEDEC tray package RoHS Compliant

-Z version refers to RoHS-compliant code.

Zephyr Power Modules are shipped in packages of four JEDEC trays with fifteen modules per tray.

Contact Us

For more information, call us at

USA/Canada:
+1 877 546 3243, or +1 972 244 9288

Asia-Pacific:
+86.021.54279977*808

Europe, Middle-East and Africa:
+49.89.878067-280

www.gecriticalpower.com

imagination at work

