SA50-120 Single Series

Radiation-Hardened Isolated DC-to-DC Converter

Introduction

The SA50-120 is an Isolated DC-to-DC converter capable of delivering up to 50W of output power in a small size design. The SA family provides a radiation hardened option with top class TID and SEE performance for space and military applications. With forward converter topology and a patented magnetic feedback, the SA50-120 is optimized for applications where isolated DC voltage conversion is required. The discrete surface mount design facilitates customization with reasonable lead time and modest NRE cost.

The SA50-120 series implements an internal EMI input filter which complies to MIL-STD-461. The EMI filter consists of differential- and common-mode components to attenuate conductive EMI noise effectively.

As the only non-hybrid space grade DC-DC power converter module in the market, the SA50-120 series excels in its robustness in the applications with $8x10^6$ hours of MTBF.

The SA50-120 is available in 3.055” x 2.055” x 0.5” package.

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1. Benefits and Features

- Up to 50W output Power (Parallel up to 5 for higher power)
- 86VDC to 158VDC input range
- 5 output configurations available

Output	Base Part number
3.3V	SA50-120-3R3S
5V	SA50-120-5S
12V	SA50-120-12S
15V	SA50-120-15S
28V	SA50-120-28S

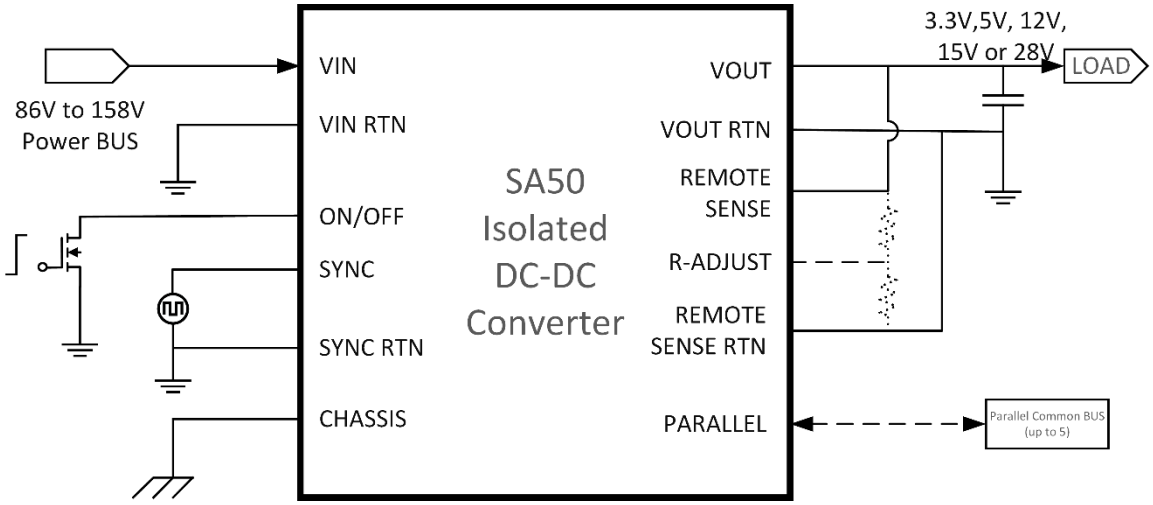
- Up to 85% efficiency @ full load
- <1% output ripple
- Internal EMI filter compliant to MIL-STD-461
- Forward topology
- Patented magnetic feedback
- Adjustable output with remote adjust
- Inhibit pin for electrical ON/OFF
- Isolated synchronization input
- Low mass 120g
- Flight proven technology with >8 x 10^6 hours of MTBF
- This Product is classified as EAR99
- Customization of input/output voltages available upon request.

2. Radiation Performance

- TID>100krad(Si) and 30krad(Si) ELDRS (<10mrad/s) per MIL-STD-883 Method 1019
- SEE (SEGR, SEB, SET, SEL) immunity 82 MeV·cm^2/mg

3. Typical Application Circuit

Figure 3-1. SA50-120 Single Typical Application Circuit



4. Absolute Maximum Ratings

Rating	Value
V_{IN} range	–0.5 VDC to 165 VDC
Output power	56 W
Lead temperature	300 °C for 10 s
Operating temperature	–55 °C to 125 °C
Storage temperature	–55 °C to 125 °C
Shock	1500 gpk, 0.5 ms, ½ sine
Constant acceleration	50 g
Random vibration	24.06 g_{rms}, 50 Hz to 2000 Hz

5. Electrical Parameters

This section shows the electrical parameters of the SA50-120 Single Series device under the following conditions unless otherwise specified:

Parameter	Output	Conditions	Min	Nom	Max	Units
Input voltage						
(Vin)		Note 2	86	120	158	V
Output voltage set point						
(V_{OUT})	28V	I_{OUT} = 100% rated load	27.73	28.00	28.27	V
	15V		14.85	15.00	15.15	
	12V		11.88	12.00	12.12	
	5V		5.05	5.10	5.15	
	3.3V		3.27	3.30	3.33	
Output Voltage Adjust						
(V_{ADJ})			10			%
Output power						
(P_{OUT})	28V	Note 13 In all cases Output power must be kept within P_{out} rating.	0		56	W
	15V				51	
	12V				50	
	5V				50	
	3.3V				33	
Output current						
(I_{OUT})	28V		0		2.0	A
	15V				3.4	
	12V				4.2	
	5V				10	
	3.3V				10	
Line regulation						
(VR_{LINE})	28V	V_{IN} = 86 V, 120 V, 158 V I_{OUT} = 10%, 50%, 100% rated Note 12	–56		56	mV
	15V		–30		30	
	12V		–24		24	
	5V		–10		10	
	3.3V		–10		10	

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Parameter	Output	Conditions	Min	Nom	Max	Units
Load regulation						
(VR_{LOAD})	28V	V_{IN} = 86 V, 120 V, 158 V I_{OUT} = 10%, 50%, 100% rated Note 11	–280		280	mV
	15V		–150		150	
	12V		–120		120	
	5V		–50		50	
	3.3V		–50		50	
Input current						
(I_{IN})		I_{OUT}=0, pin3 open		10	35	mA
		Pin 3 shorted to pin 2		3	5	
Output ripple						
(V_{RIP})	28V	V_{IN} = 86 V, 120 V, 158 V I_{OUT} = 100% rated, Note 4		100	280	mV p-p
	15V			75	150	
	12V			60	120	
	5V			25	50	
	3.3V			25	50	
Switching frequency						
(FS)		Sync input (pin 4) open	200	220	240	kHz
Efficiency						
(EFF)	28V	I_{OUT} = 100% rated load	79	85		%
	15V		79	85		
	12V		77	83		
	5V		75	81		
	3.3V		73	79		
Inhibit input						
Inhibit input: ON Threshold		Note 1	4.5			V
Inhibit input: OFF (sink)		Note 1	1000			µA
Inhibit input: OFF Threshold		Note 1			2	V

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Parameter	Output	Conditions	Min	Nom	Max	Units
Current limit point						
(% rated output)		When V_{OUT} = 90% of nominal set point	105		145	%
Synchronization						
frequency range		The external clock on sync input (pin 4)	500		600	kHz
Synchronization pulse-high level		Note 1	4.0		10.0	V
Synchronization pulse-low level		Note 1	–0.5		0.5	V
Synchronization pulse-transition rate		Note 1	200			V/µs
Synchronization pulse-duty cycle		Note 1	10		80	%
Power dissipation, load fault						
(PD)		Short circuit, overload Note 6			24	W
Output response to step load changes						
(V_{TLD})	28V	(50% to/from 100%) rated load Note 7	–2200		2200	mV peak
	15V		–1200		1200	
	12V		–900		900	
	5V		–300		300	
	3.3V		–300		300	
Recovery time, step load changes						
(T_{TLD})		(50% to/from 100%) rated load Notes 7, 8		200	2000	µs
Output response to step line changes						
(V_{TLN})	28V	86V to/from 158V I_{OUT} = 100% rated load Note 9	–1000		1000	mV peak
	15V		–600		600	
	12V		–480		480	
	5V		–300		300	
	3.3V		–300		300	

.....continued

Parameter	Output	Conditions	Min	Nom	Max	Units
Recovery time, step line changes						
(T_{TLN})		86V to/from 158V I_{OUT} = 100% rated load Notes 8, 9		200	2000	µs
Turn-on response: overshoot						
(V_{OS}) (main)	28V	(0% to 100%) rated load Notes 3, 4, 10			2800	mV
	15V				1500	
	12V				1200	
	5V				500	
	3.3V				500	
Turn-on response: turn-on delay						
(T_{DLY})		Note 10	0.1		10	ms
Capacitive load						
(CL)	28V	Note 5			200	µF
	15V				350	
	12V				450	
	5V				1000	
	3.3V				1000	
Line rejection						
		DC to 50 kHz, I_{OUT} = 100% rated load	30	60		dB
Isolation						
		@25°C and 200V 1. Input (1, 2, 3) to Outputs (7-12) 2. Sync (4-5) to All (1-3, 6-12) 3. Chassis (6) to All (1-5, 7-12)	100			MΩ
Mass						
		Standard case style A, B		120		g
MTBF						
		MIL-HDBK-217F2, SF, 35°C		$8.22x10^6$		hrs

6. Radiation Specification (Note 1)

Environment	Conditions	Min	Unit
TID (gamma)	MIL-STD-883, method 1019 The operating bias applied during exposure	100	krad (Si)
Dose rate (gamma dot temporary saturation survival)	MIL-STD-883, method 1023 The operating bias applied during exposure Full-rated load	1E10	rad (Si)/s
Neutron fluence	MIL-STD-883, 1017	1E12	Neutrons
SEE/SEU, SEL, SEGR, SEB	Heavy ions [LET] The operating bias applied during exposure	82	MeV•cm^2/mg

Notes:

1. Parameter not 100% tested, and only assured by design.

2. Parameter verified during line and load regulation tests. Regulation is specified for 10% to 100% loading on all outputs.

3. The "–H" option incorporates FET technology providing a > 82 MeV•cm2/mg (gold ion) SEE capability to the design. The "–P" option is not rated for radiation.

4. Tested and verified using a 20 kHz to 10 MHz bandwidth. Ripple is measured across a 50 Ohms termination with a 10nF Cap in series. Results applicable for DC to 20MHz bandwidth.

5. The capacitive load may be any value from 0 to the maximum limit without compromising DC performance. A capacitive load exceeding the maximum limit may interfere with the proper operation of the converter's overload protection. This situation may cause erratic behavior during turn-on.

6. Overload power dissipation is defined as the device power dissipation with the load set such that

VOUT = 90% of nominal.

7. The load step transition time is ≥ 10 µs.

8. Recovery time is measured from the initiation of the transient to where VOUT has returned to within ±1% of its steady-state value.

9. The line step transition time is ≥ 100 µs.

10. Turn-on delay time from either a step application of input power or a logic low to a logic high transition on the inhibit pin (pin 3) to the point where VOUT = 90% of nominal.

11. Load regulation relative to the output voltage at 50% rated load.

12. Line regulation relative to the output voltage at 120 VDC input.

13. For operation at temperatures between 85 °C and 125 °C: de-rate power linearly from 50 W (or rated maximum) to zero. Parameter limits are not guaranteed.

7. Parallel Operation (Notes)

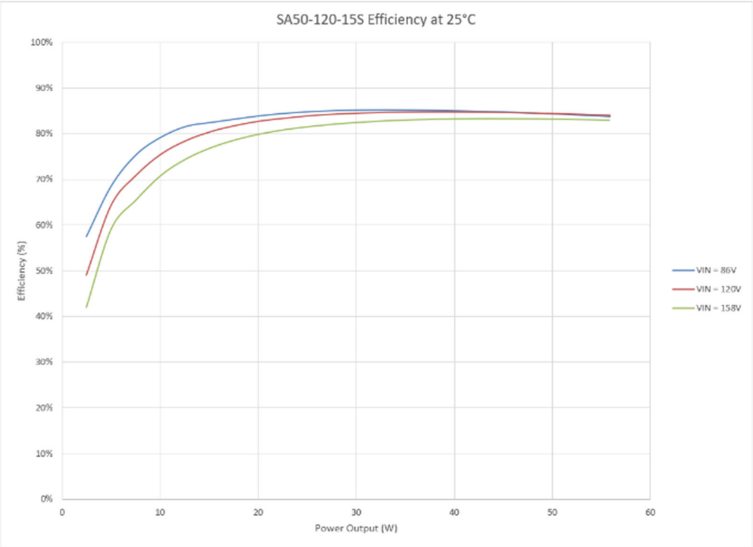
The output terminals of up to 5 modules may be connected in parallel. The expected current sharing accuracy is 10% at maximum load. To ensure current sharing, the Parallel terminal of every Power Supply module must be connected to form a common bus. These connections should be made relatively short.

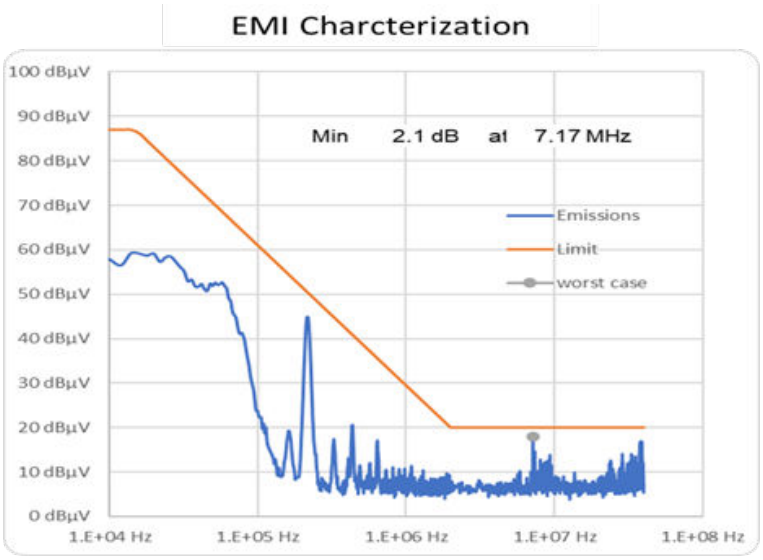
The remote sense terminals may remain unconnected. For best output voltage regulation however, the remote sense terminal of each of the paralleled set of Power Supplies should be connected to a single point, as close as possible to the positive load terminal or point where the voltage regulation is desired to be maintained. Similarly, the remote sense return terminal of each Power Supply should be connected to a single point, as close as possible to the negative load terminal.

The R-ADJUST function may be used in a system of paralleled modules. The sync function is described in the application notes. The specified sync input signal may be applied to each of the paralleled modules.

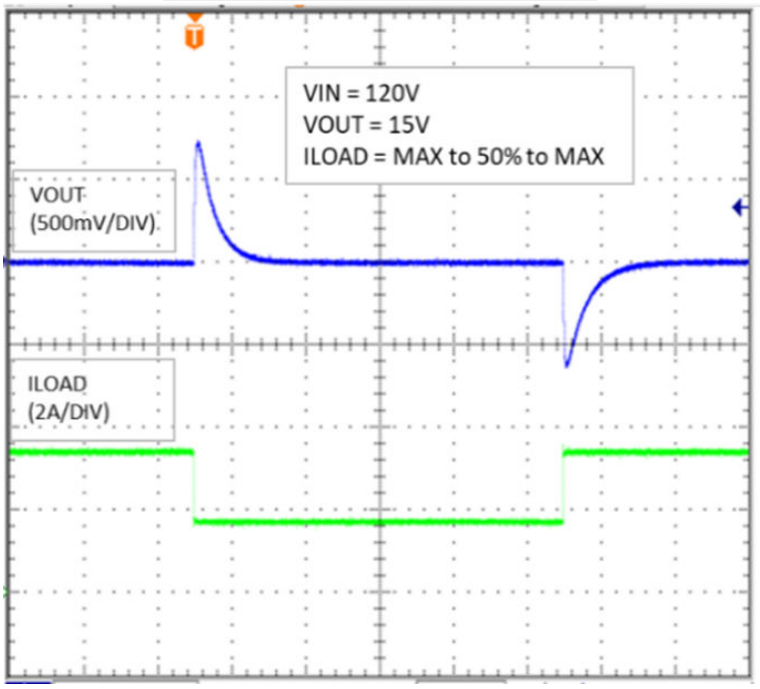
For best performance, phase shift the sync signal between modules. The sync functionality remains the same for a system of paralleled modules. The use of the sync function is optional for single and or paralleled operation. The specified sync input signal may be applied to any one of the paralleled modules.

8. Sample Electrical Waveforms (For reference only)

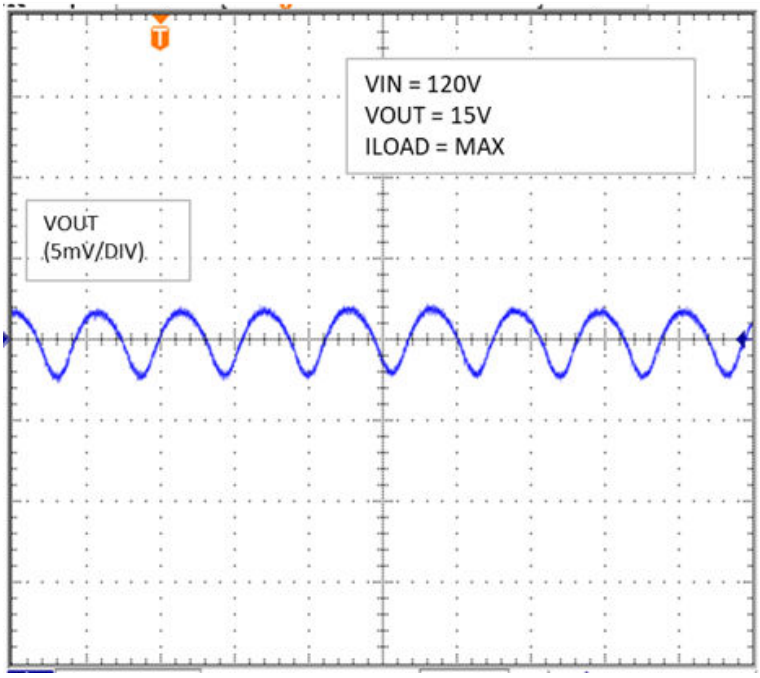




Load Transient Response



Output Voltage Ripple



9. Pin Configuration

Figure 9-1. SA50 Single Pin Configuration

10. Pin Description

PIN	NAME	Description
1	VIN	Input Voltage
2	VIN RTN	Input Voltage Return/Ground
3	ON/OFF (INHIBIT)	Power Supply ON/OFF, ON(OPEN/HIGH), OFF(SHORT/LOW)
4	SYNC	External Clock Signal Input
5	SYNC RTN	External Clock Signal Return
6	CHASSIS	Chassis Pin
7	R-ADJUST	Remote Adjust Pin to Adjust Output Voltage ±10%
8	PARALLEL	Parallel Bus Pin to use Multiple Devices for Higher Power
9	RMT SNS RTN	Load Voltage Remote Sense Return
10	RMT SNS	Load Voltage Remote Sense
11	VOUT	Output Voltage
12	VOUT RTN	Output Voltage Return/Ground

11. Radiation Performance (-H) Hardened

- TID>100krad(Si) and 30krad(Si) ELDRS (<10mrad/s) per MIL-STD-883 Method 1019
- SEE (SEGR, SEB, SET, SEL) immunity 82 MeV·cm^2/mg (H-hardened)

12. Radiation Performance (-P) Prototype

Prototype units that are functionally the same except that components are not radiation hardened. To be used for system checkout.

13. Mechanical Outline (-A) Package

Figure 13-1. Axial Pins and Thru-hole Tabs Package

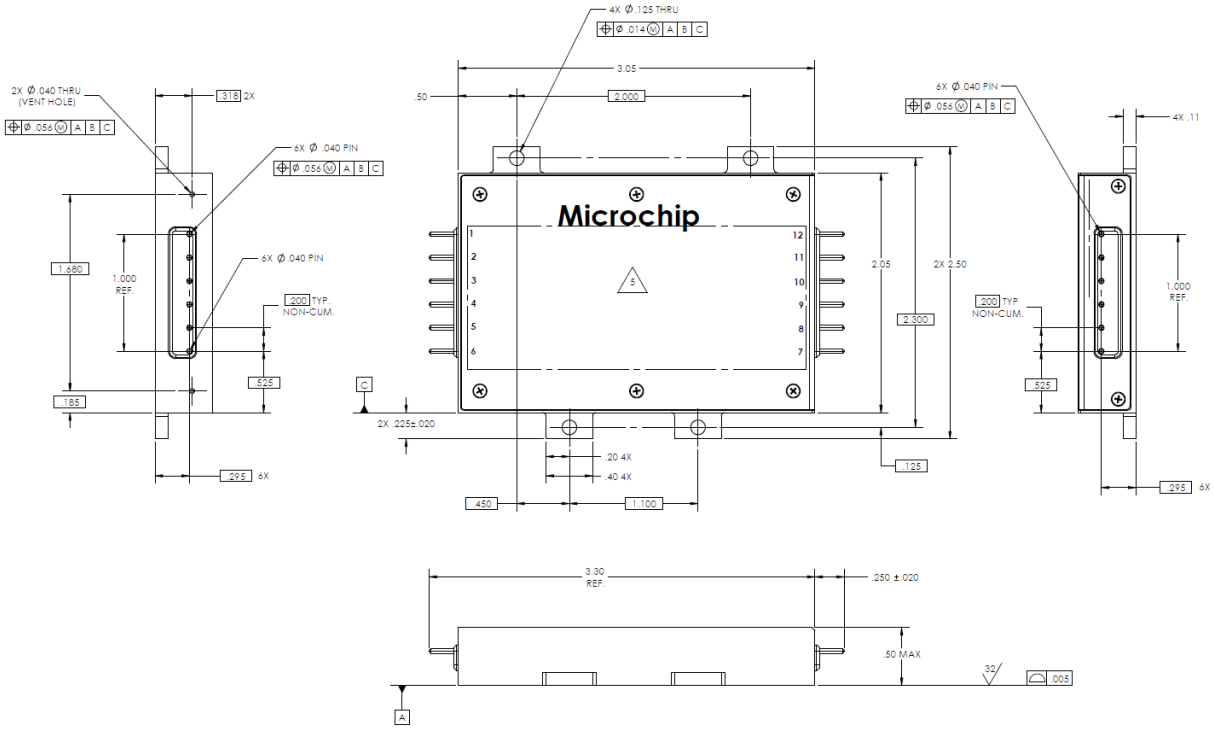
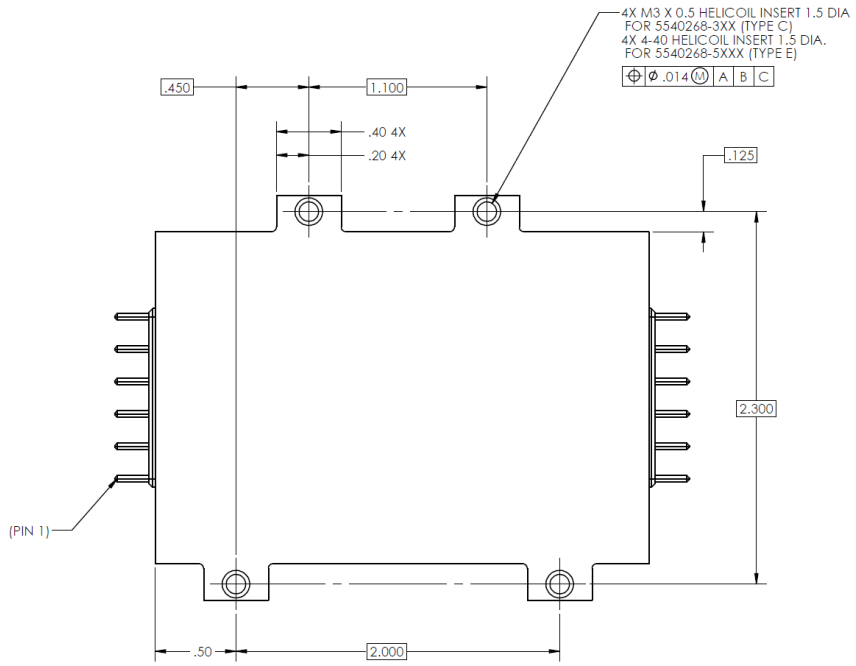


Figure 13-2. Axial Pins and Thru-hole Tabs Bottom View



14. Mechanical Outline (-B) Package

Figure 14-1. Radial Pins and Threaded Tabs Package

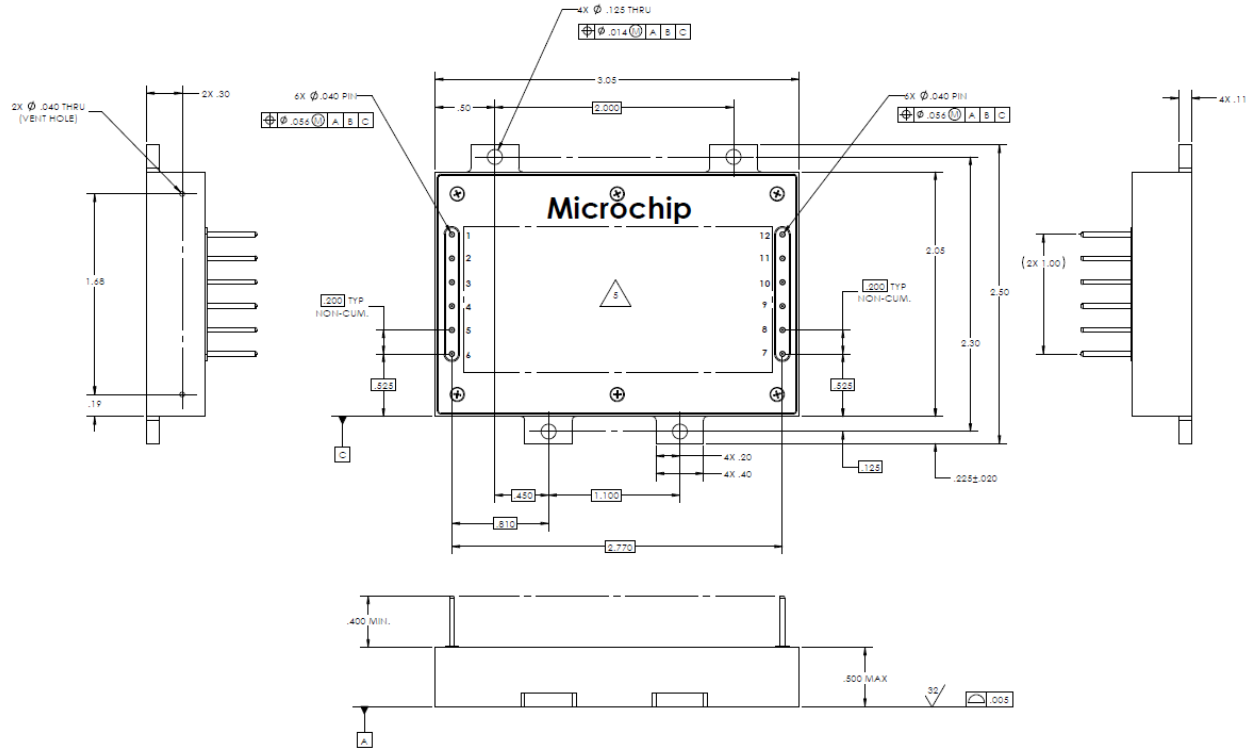
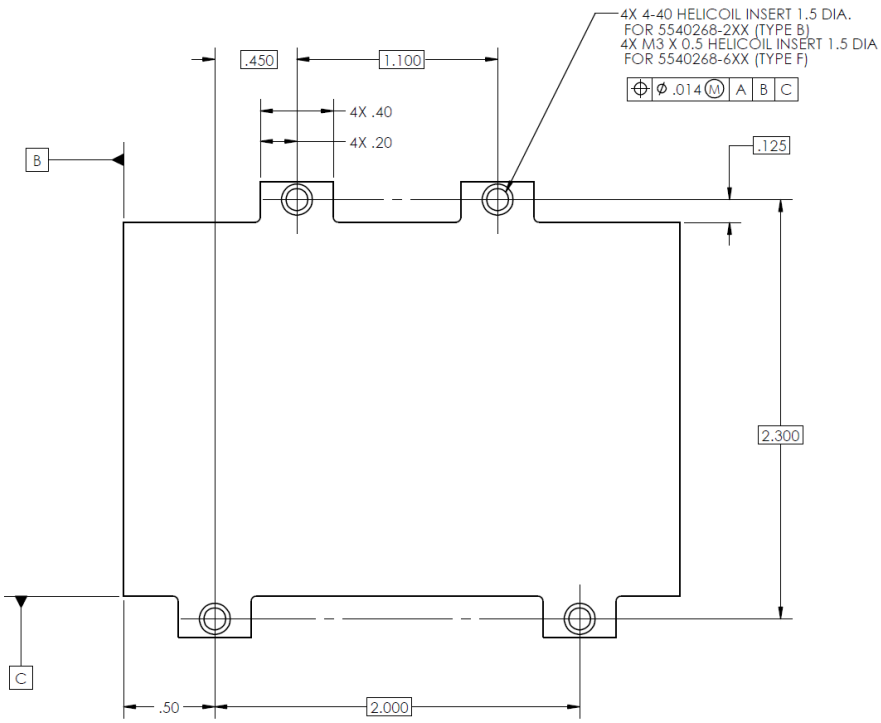


Figure 14-2. Radial Pins and Threaded Tabs Package Bottom View



15. Qualification Test (Reference Report QTR996)

Test	Conditions
External visual	Per O&M—dimensions, and mass or STD 883 2009
Electrical	Read and record (–55 °C, 25 °C, 85 °C)
Shock, non-operating	MIL-STD-202, method 213B, test condition F, 1500 gpk, 0.5 ms ½ sine pulse. Three pulses in each direction of each axis, 18 pulses total.
Vibration, operating	MIL-STD-202, method 214A, condition II-F, 24.06 grms random vibrations, 50 Hz–2000 Hz, 3 min/axis (9 min total). Outputs monitored.
Temperature cycling	10 cycles from base plate temperature, MIL-STD-883, method 1010.9, condition A
EMI	CE101, CE102, CS101, RE101, RE102, RS101, RS102 per MIL-STD-461 with setup per MIL-STD-462.
External Visual inspection	No damage
Steady state life test	1000 hrs at Tc = 105 °C, 50% of rated load
End-point electricals	Read and record (–55 °C, 25 °C, 85 °C)

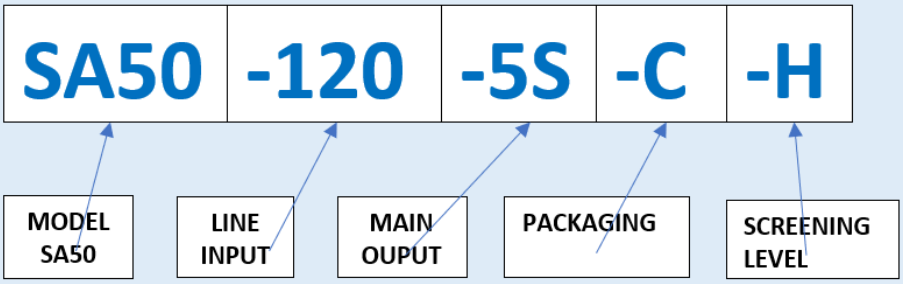
16. ATP Screening Test (-H) Hardened

Requirement	Test Method/Condition
External Visual	O&M – dimensions and mass
Initial Electrical	Full performance at +25°C
Vibration	Workmanship non-operating vibration. MIL-STD-202, Method 214, 6 grms (50Hz-2kHz) 1-minute perpendicular to the board
Post Vibration Electrical	Full performance at +25°C
Temperature Cycle	MIL-STD-883, Method 1010, Condition A, 1 cycle, +85°C to -55°C, operating Outputs monitored during thermal cycles
Burn-in	40 Hrs @ 105°C, 50% of rated load (outputs monitored)
Final Electrical	Full performance at +25°C (deliverable data)
External Visual	No damage

17. ATP Screening Test (-P) Prototypes

Requirement	Test Method/Condition
External Visual	O&M – dimensions and mass
Electrical	Full performance at +25°C
Vibration	None
Temperature Cycle	None
Burn-in	None
External Visual	No damage

18. Ordering Information



Model	SA50-120	Standard Applications 50W, 120V input modules. (Other models and input voltages available)		
Line Input	120	120.0V	Line input voltage. (120V nominal input)	
Main	-3R3S	3.3V	Main output voltage	
	-5S	5.0V		
	-12S	12.0V		
	-15S	15.0V		
	-28S	28.0V		
Mechanical Package	-A	Axial	0.125in thru-hole	Mechanical packaging options. Electrical connections are either Radial or Axial. Mounting holes are drilled thru-hole or blind hole threaded.
	-B	Radial	4-40 thread	
	-C	Axial	M3 thread	
	-D	Radial	0.125in thru-hole	
	-E	Axial	4-40 thread	
	-F	Radial	M3 thread	
Screening	-H	Hardened	We offer units with two levels of radiation screening. Hardened and Prototype (non-hardened) units.	
	-P	Prototype		

NOTE: Other input voltage and output voltage combinations are available. Please contact your local sales representative.

We also offer a thermal interface, the ST-2X3; this is a non-silicon, space-approved thermal interface. Datasheet available upon request.

19. Revision History

Revision	Date	Description
D	07/2022	Updated Electrical information in the ATP Screening Test (-P) Prototypes table.
C	04/2022	Updated Figure 14-1.

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