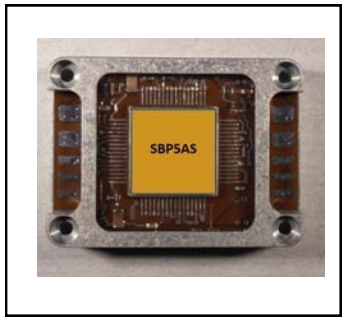
HIGH RELIABILITY RADIATION HARDENED, 6A POINT OF LOAD (POL) VOLTAGE REGULATOR

3.3V to 9.0V DC Input
0.8V to 3.3V DC Output



Description

The SBP5AS/XX is a space qualified high reliability point of load (POL) voltage regulator designed to provide a high quality single regulated DC output from a regulated or unregulated DC voltage power source. The output current rating is 6A maximum up to the output power of 20W depending on the output voltage. Output voltage is user adjustable with a single resistor. The POL is a PCB based assembly with aluminum frames to insure mechanical ruggedness.

The SBP POL is designed to operate continuously onboard a spacecraft over the wide temperature range of -35°C to +115°C. The SBP POL design has been characterized for total ionizing dose (TID) performance including enhanced low dose rate sensitivity (ELDRS) and for single events effects (SEE). The POL is suitable for harsh radiation environments normally encountered in the geo-synchronous orbit (GEO), medium earth orbit (MEO), low earth orbit (LEO), deep space, and other challenging radiation design applications requiring mission life up to 15 years. For higher output power requirements, IR's SBB series POLs are available for power requirements up to 30W or 14A design applications.

The SBP POL operates from a DC input power source with the voltage range of 3.3 to 12V. It converts a DC input voltage to a fixed and highly stable DC output as low as 0.8V to as high as 3.3V, or up to 85% of input voltage.

The SBP POL is a non-isolated voltage mode control synchronous buck regulator. It includes several key functional features to accommodate today's power system design needs. It switches at a fixed frequency of 500kHz to provide an excellent output transient response, low output ripple and stability robustness.

Features

- Total dose >100kRads (Si)
- SEE hardness rated, SEL/SEB/SET/SEGR with LET > 86 MeV-cm^2/mg
- Rated Input Voltage Range from 3.3V to 12V DC
- Output Voltage: Adjustable from 0.8V to 3.3V with External Resistor
- Rated Output Power up to 20W and Output Current up to 6A
- Remote Voltage Sense Compensation
- Fixed 500KHz Operating Frequency
- Enable Pin with Comparator Type Input
- Overload and Short Circuit Protection
- Low Noise with Inclusion of Input and Output Filters
- No External Filter Elements Required
- Adjustable Soft Start
- Adjustable Input Under Voltage Lockout (UVLO)
- Power-Good Output Voltage Monitor
- Output Sequencing of Multiple Modules via Track and Enable Pins
- Extended Operating Case Temperature Range: -35°C to +115°C
- Derating per MIL-STD-1547 and NASA EEE-INST-002

Applications

- Geosynchronous & Low Earth Orbit Satellites
- Launch Vehicles
- Communication Systems

Description (continued from page 1)

The SBP is a stand alone point of load voltage regulator, external filtering is not required for typical design applications. An internal input filter provides low input ripple current and stabilizes the input impedance. This allows for up to 2µH of input wire inductance without affecting the overall converter performance. It also includes an internal output filter providing low ripple voltage and stabilizing the voltage control loop. This allows for a large variation in external filter without affecting the stability of the control loop.

The SBP POL module includes output short circuit and overload protection with current limit threshold preset at the factory. Operations down to no load are permissible. An enable function with comparator type input is also provided to remotely turn on and turn off the regulator. Output sequencing of two or more POLs can be accomplished with via the Enable and Track pins. Power-good signal via the POK pin is available to indicate status of the output. Output voltage sense is also available to compensate for a voltage drop in the positive output line if needed. See Functional/Application Notes Section for details.

The SBP POL measures 1.528"L x 1.134"W x 0.433"H (38.8mm x 28.8mm x 11mm) with a mere foot print of 1.73 square inches. With the inclusion of many useful functional, protection and diagnostic features, the SBP POL is poised to meet most of today's space power system design needs.

The SBP POL simplifies the design and procurement process. Users need to procure only one SBP POL module type for all output voltage requirements. Only one external resistor is required to trim the output to a desired voltage. The SBP offers guaranteed end of- life efficiency and total output voltage regulation performances through worst case analysis (WCA). One set of design analyses including WCA is available for the extended standard output voltages, 0.8V to 3.3V.

The SBP POL is manufactured, tested, and qualified at IR's facility in California which is qualified to ISO9001 and MIL-PRF-38534 by DLA Land and Maritime. Non-flight versions of the SBP POL converters are available for system development and qualification purposes. Refer to Model Definition and Test Plan table for screening details.

Standard documentation including worst case analysis, radiation tests report, stress analysis, thermal analysis, and reliability report are available upon request.

Functional / Application Notes

Refer Fig. 8 for following functional adjustments.

Enable / Input Under Voltage Protection: The POL can be turned on and turned off via the Enable pin. With a power source of 3V or greater applied to the Input pin, the POL operates normally when the Enable pin is left open or connected to an open collector circuit. The POL will turn off when the Enable pin is pulled below 0.6V with respect to Input Return. The input turn-on threshold voltage and input voltage turn-off hysteresis can be calibrated by external resistors. Refer to a separate SBP product application note.

Output Voltage Adjustment: The output of an SBP POL can be set to a desired output voltage with a single resistor. The voltage range of the output is 0.8V to 3.3V or 85% of input voltage, and 75% of input voltage for large load variations. The resistor shall be connected between the adjust pin and ground. The tolerance data will be calculated with a resistor with 1% initial tolerance and 100ppm of temperature drift. The resistor value for a desired voltage output can be determined using the following formula.

Without remote sense:

$$R_{Adjust} = \frac{191686}{31.600 \cdot \mathrm{Vout} - 25.026} - 1210$$

With remote sense:

$$R_{Adjust} = \frac{189600}{31.600 \cdot \mathrm{Vout} - 24.960} - 1210$$

R_{ADJUST} value is in Ohms.

Remote Sense: Output pin may be connected to the remote Sense pin for proper operation. The Sense pin may be connected remotely to the output line at the load to compensate for a voltage drop in the output line for best possible output regulation. (Remark: The output voltage must be kept below 85% of the input voltage. There is no sense pin for the output return)

Synchronization: A Synchronization pin is provided to allow the multiple SBP POL modules to be synchronized to a common operational frequency with an external signal source to minimize the noise interference coming from the switching operation of the POLs. The synchronization frequency range is 425KHz to 575KHz. The synchronization signal source must be able to source the current of 1.0mA with the voltage level of minimum 2.0V at high and maximum 0.8V at low.

POK (Power OK Monitor): The SBP series POL also provides an output status signal at the Pgood pin. The pin is an open drain connection. An open signal status is present when the POL's output is within ±10% of the output voltage. A low signal (shorted to ground) at the Pgood pin indicates the POL's output voltage is outside the ±10% of the output voltage.

Tracking: Tracking of two or more SBP modules is covered in details in the SBP application note.

Soft Start: Soft start can be increased by adding a capacitor between the track pin and ground. Refer to SBP application note for details.
.

Assembly Mounting and Cooling Considerations:
The POL must be mounted to a thermally conductive plate or chassis with four screws. Proposed screw size is M2 or UNC 1-72 and 12 mm (0.47") in length. A recommended torque is 0.25nm (35Ozln). The host chassis should be mechanically rigid and thermally conductive enough to support the mass and power loss. Typical power loss at full load is 3.5W, but can be smaller at a lighter load. Interface temperature at the screw joint must not exceed the maximum operating case temperature on page 4.

Specifications

Absolute Maximum Ratings		Recommended Operating Conditions	
Input voltage range	-0.5V_{DC} to +12V_{DC}	Input voltage range (Note 12)	3.3V_{DC} to 9.0V_{DC}
Output power	Internally limited	Output power	0 to maximum current
Lead temperature	+300°C for 10 seconds		
Operating case temperature	-35°C to +115°C (Note 11)	Operating case temperature (Note 12)	-35°C to +85°C
Storage temperature	-55°C to +125°C		

Electrical Performance Characteristics

Parameter	Condition	Conditions -35°C ≤ T_C ≤ +85°C V_{IN} = 5.0V DC ± 5%, C_L = 0 Unless otherwise specified, Note 4	Limits			Unit
			Min	Nom	Max	
Input Voltage (V_{IN})	1, 2, 3	V_{OUT} = 0.8V to 2.5V, I_{OUT} =100% Rated Load V_{OUT} =>2.5V to 3.3V, I_{OUT} =100% Rated Load	3.3 3.3		9.0 9.0	V
Output Voltage (V_{OUT}), Note 13	1, 2, 3	I_{OUT} = 100% rated load		V_{OUT}		V
Output Power (P_{OUT})	1, 2, 3	V_{IN} = Min, Nom and Max V , Note 2			20	W
Output Current (I_{OUT})	1, 2, 3	V_{IN} = Min, Nom and Max V , Note 2			6.0	A
Line Regulation (VR_{LINE})	1, 2, 3	V_{IN} = Min, Nom and Max V , Note 2 I_{OUT} = 0, 50%, 100% Rated	V_{OUT} - 0.5 V_{OUT} - 1.0		V_{OUT} + 0.5 V_{OUT} + 1.0	%
Load Regulation (VR_{LOAD})	1, 2, 3	V_{IN} = 4.5V to 9.0V I_{OUT} = 0, 50%, 100% Rated	V_{OUT} - 1.0 V_{OUT} - 2.3		V_{OUT} + 1.0 V_{OUT} + 2.3	%
Output Voltage at End of Life (EOL)	1, 2, 3	Temperature, Radiation, Aging, Line/Load Regulation, Note 14	V_{OUT} - 2%		V_{OUT} +2%	V
Switching Frequency (F_S)	1, 2, 3	Sync (Pin 8) open	450	500	550	kHz
Input Current (I_{IN})	1, 2, 3	I_{OUT} = 0, Pin 3 (Enable) open Pin 3 (Enable) shorted to Pin 2 (Input RTN)		60 10	70 17	mA
Output Ripple / Noise	1, 2, 3	V_{IN} = 4.5V to 9.0V I_{OUT} = 0 - 100% Rated Load		35	70	mV $_{P-P}$
Output Ripple at Switching Frequency	1, 2, 3	V_{IN} = 4.5V to 9.0V I_{OUT} = 0 - 100% Rated Load, Note 3			10	mV rms
Efficiency (E_{FF}) V_{OUT} = 1.0V V_{OUT} = 1.2V V_{OUT} = 1.5V V_{OUT} = 1.8V V_{OUT} = 2.5V V_{OUT} = 3.3V	1, 2, 3	V_{IN} = 6.5V, IOUT = 100% Rated Load, 25°C	 67 70 75 79 83 86	 70 73 78 81 85 88		%

For Notes to Electrical Performance Characteristics, refer to page 6

Electrical Performance Characteristics (continued)

Parameter	Condition	Conditions -35°C ≤ T_C ≤ +85°C V_{IN} = 5.0V DC ± 5%, C_L = 0 Unless otherwise specified	Limits			Unit
			Min	Nom	Max	
Synchronization Input Frequency Range Pulse High Level Pulse Low Level	1, 2, 3	External Clock for Sync (Pin 8), Note 1	 425 2.0 -0.3		 575 V_{IN} 0.8	 KHz V V
Current Limit Point	1, 2, 3	V_{OUT} = 90% of Nominal , Note 10	6.5		11	A
Power Dissipation, Load Fault (P_D)	1, 2, 3	Short Circuit, Overload, Note 5			3.5	W
Input Under voltage Lockout UVLO) (turn off when input voltage decreasing)	1, 2, 3	No Load to Full Load	3.85	3.97	4.11	V
Input Under voltage Release UVR) (turn on when input voltage rising)	1, 2, 3	No Load to Full Load	4.21	4.53	4.85	V
Output Response to Step Load Changes (V_{TLD})	1, 2, 3	Half Load to/from Full Load, Note 6	-36	±24	+36	mV pk
Recovery Time, Step Load Changes (T_{TLD})	1, 2, 3	Half Load to/from Full Load, Notes 6, 7		30	50	µs
Output Response to Step Line Changes (V_{TLN})	1, 2, 3	V_{IN} Min to/from V_{IN} Max I_{OUT} = 100% Rated Load, Notes 1, 8	-36		36	mV pk
Recovery Time, Step Line Changes (T_{TLN})	1, 2, 3	V_{IN} Min to/from V_{IN} Max I_{OUT} = 100% Rated Load, Notes 1, 7, 8			500	µs
Turn-on Response Overshoot (V_{OS}) 1.8V 3.3V Turn-on Delay (T_{DLY})	 1, 2, 3 1, 2, 3 1, 2, 3	 10% Load, Full Load, Note 9	 1.3		 25 25 3.0	 mV mV ms
Capacitive Load (C_L)	1	I_{OUT} = 100% Rated Load, Notes 1, 7, 8 No effect on DC Performance, Notes 1, 4			8000	µF
Isolation	1	Any Pin to Case, 100VDC	20			MΩ
Device Weight					25	g
MTBF		MIL-HDBK-217F2, SF, 40°C	1.5 X 10^7			Hr

For Notes to Electrical Performance Characteristics, refer to page 6

Electrical Performance Characteristics - Definition of Conditions

Condition	Definition	Comment
1	BOL at +25°C interface temperature	Initial setting
2	BOL at -35°C to +85°C interface temperature	Initial setting and worst case temperature variation
3	EOL at -35°C to +85°C interface temperatura	Worst case performance including initial setting, temperature variation, ageing and radiation degradation.

Notes: Electrical Performance Characteristics Table

1. Parameter is tested as part of design characterization or after design changes. Thereafter, parameter shall be guaranteed to the limits specified.
2. Parameter verified during line and load regulation tests.
3. Guaranteed for a D.C. to 20MHz bandwidth. Tested using a 20kHz to 10MHz bandwidth.
4. Capacitive load may be any value from 0 to the maximum limit without compromising dc performance. Turn-on delay during start up may require an adjustment via the Soft Start pin when a capacitive load is present. Refer to SBP application note for details. A capacitive load in excess of the maximum limit may interfere with the proper operation of the converter's overload protection, causing erratic behavior during turn-on.
5. Overload power dissipation is defined as the device power dissipation with the load set such that V_{OUT} = 90% of nominal.
6. Load step transition time > 1.0µs.
7. Recovery time is measured from the initiation of the transient to where V_{OUT} has returned to within ±1% of its steady state value.
8. Line step transition time > 500µs.
9. 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 6) to the point where V_{OUT} = 90% of nominal.
10. Current limit point expressed as a percentage of full rated load current.
11. Although operation at temperatures between +85°C to +115°C and -35°C to -55°C is guaranteed, no parameter limits are specified.
12. Meets the de rating requirements of MIL-HDBK-1547 and EEE-INST-002 - except for ceramic capacitors with voltage stress below 10V will minimum be rated at 25V. Furthermore, a tantalum type is used on the input and another is used on the output, which gives a temperature / input voltage / output voltage de rating. See Fig. 1 and 2 for other de rating conditions.
13. V_{OUT} is to be trimmed by a user with an external resistor. See resistor selection and allowable output range in the functional notes within this document.
14. Refer to worst case analysis (WCA) report for detail.

Radiation Performance Characteristics

Test	Conditions	Min	Unit
Total Ionizing Dose (TID) (Gamma)	MIL-STD-883, Method 1019.5 Operating bias applied during exposure Full Rated Load, V_{IN} = 5.0V	100	kRrads (Si)
Single Event Effects (SEE) SEU, SEGR, SEB - Note 1	Heavy Ions (LET) Operating bias applied during exposure, Full Rated Load, V_{IN} = 3.3V to 9V	82	MeV.cm^2/mg

Device Derating

The component in question regarding derating is a 6.3V output capacitor and a 16V input capacitor.

Figure 1: MIL-HDBK-1547 Derating compliance

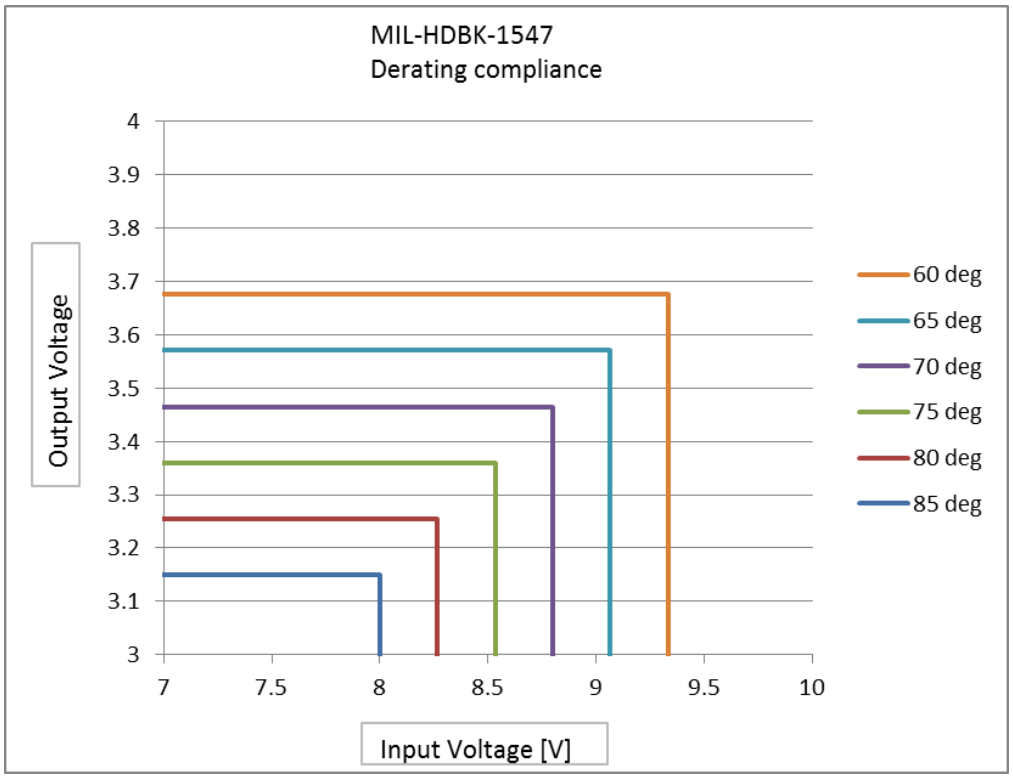


Figure 2: EEE-INST-002 Derating compliance

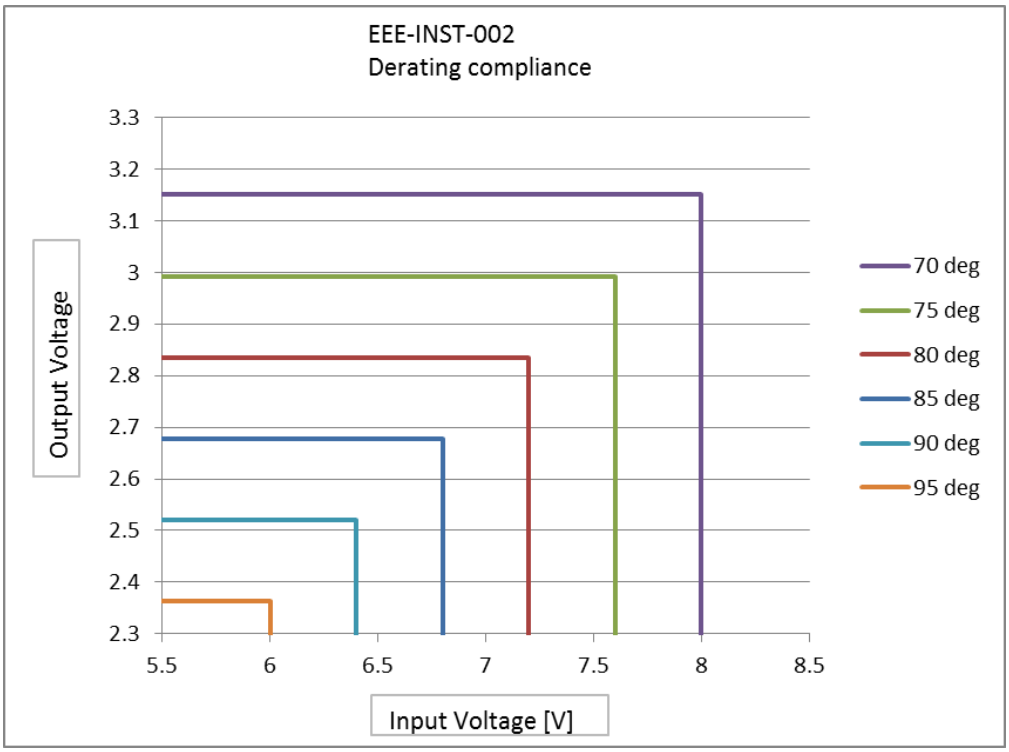


Figure 3: Typical Conducted Emission Performance on Input (voltage), 1µH harness
Input voltage ripple, Iout 6A, 6dB shall be added (50 Ohm terminated in both ends)

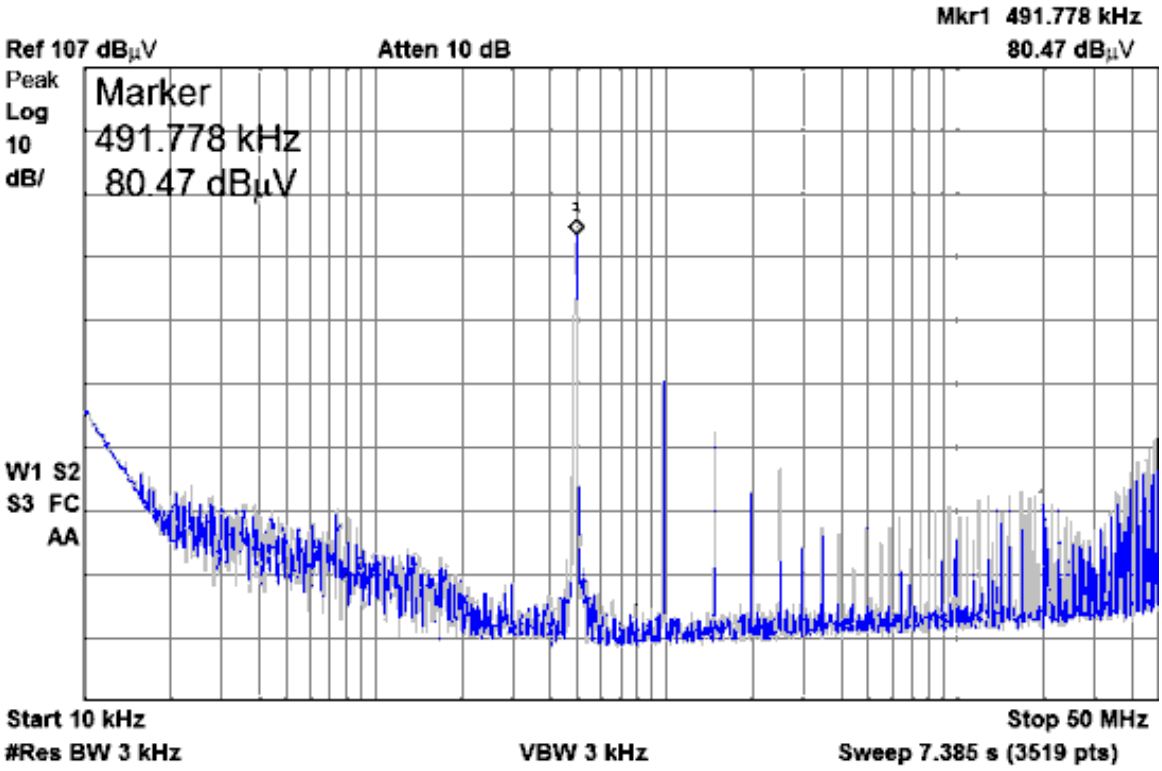


Figure 4: Typical Conducted Emission Performance on Input (current), 1µH harness

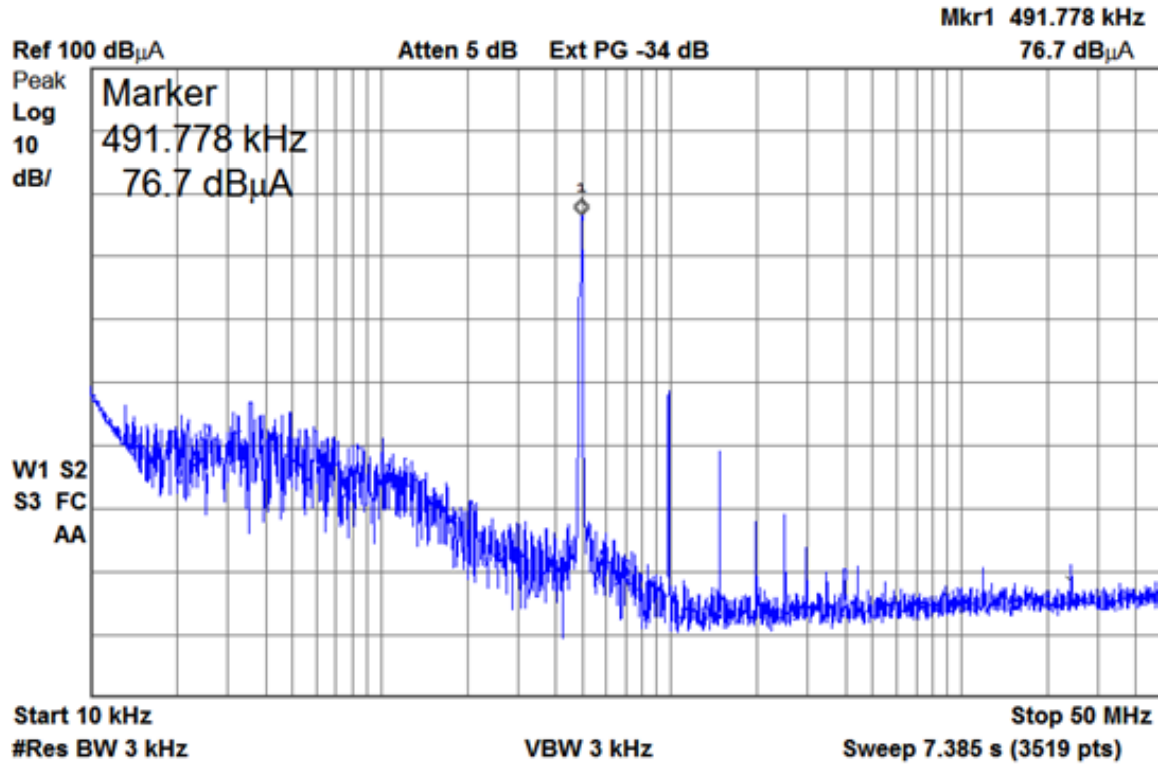


Figure 5: Typical Conducted Emission Performance on Output
6dB shall be added (50 Ohm terminated in both ends)

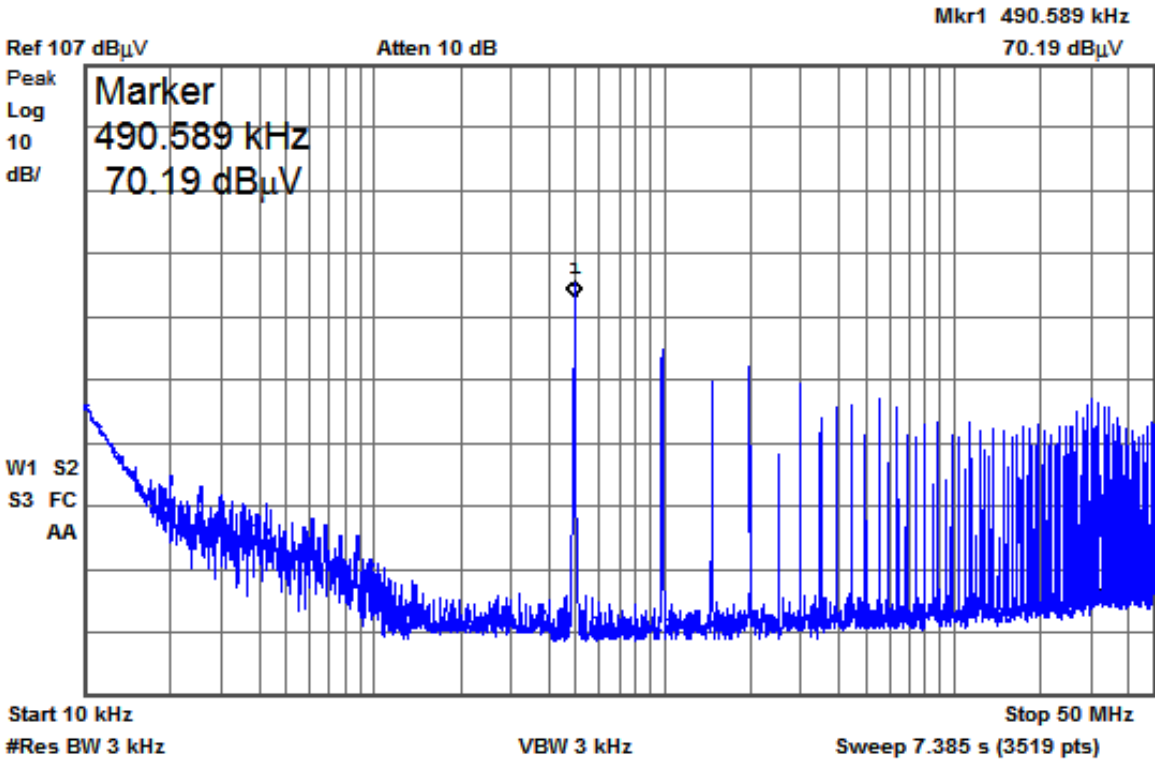
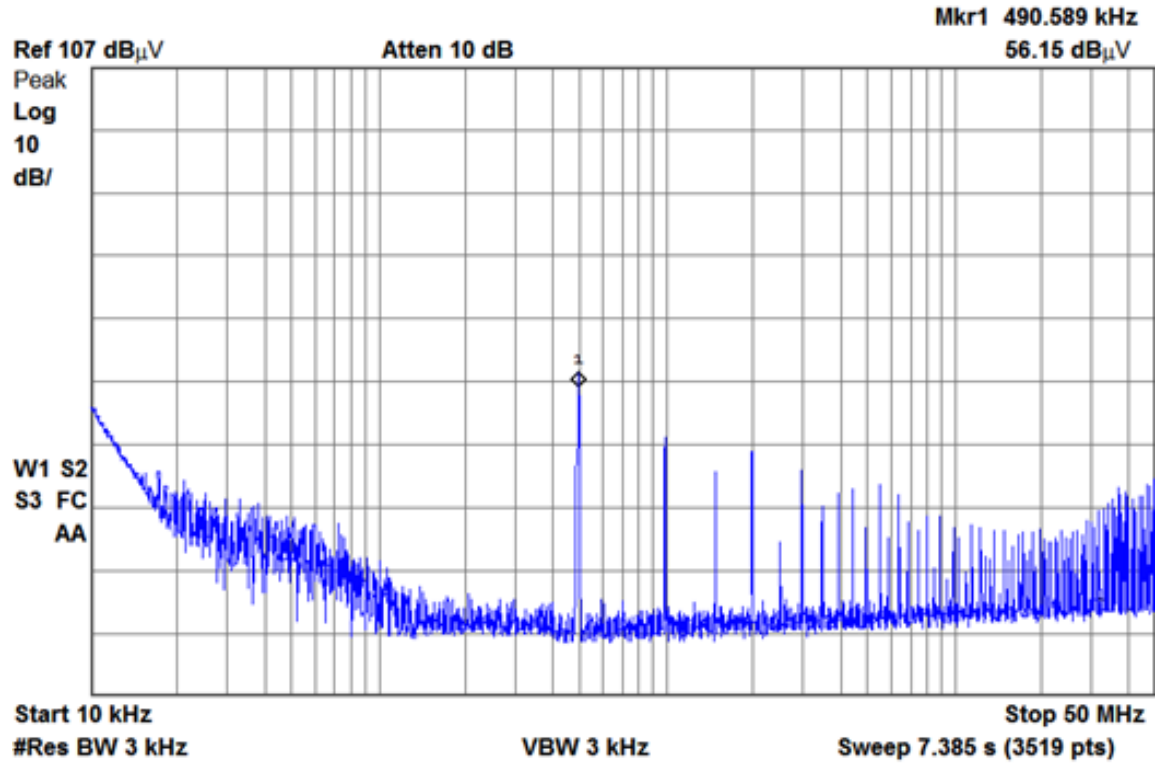


Figure 6: Typical Conducted Emission Performance on External Output Filter (15mm wire and a T530 / 470µF / 5mOhm)
6dB shall be added (50 Ohm terminated in both ends)



Block Diagram

Figure 7: Functional Block Diagram

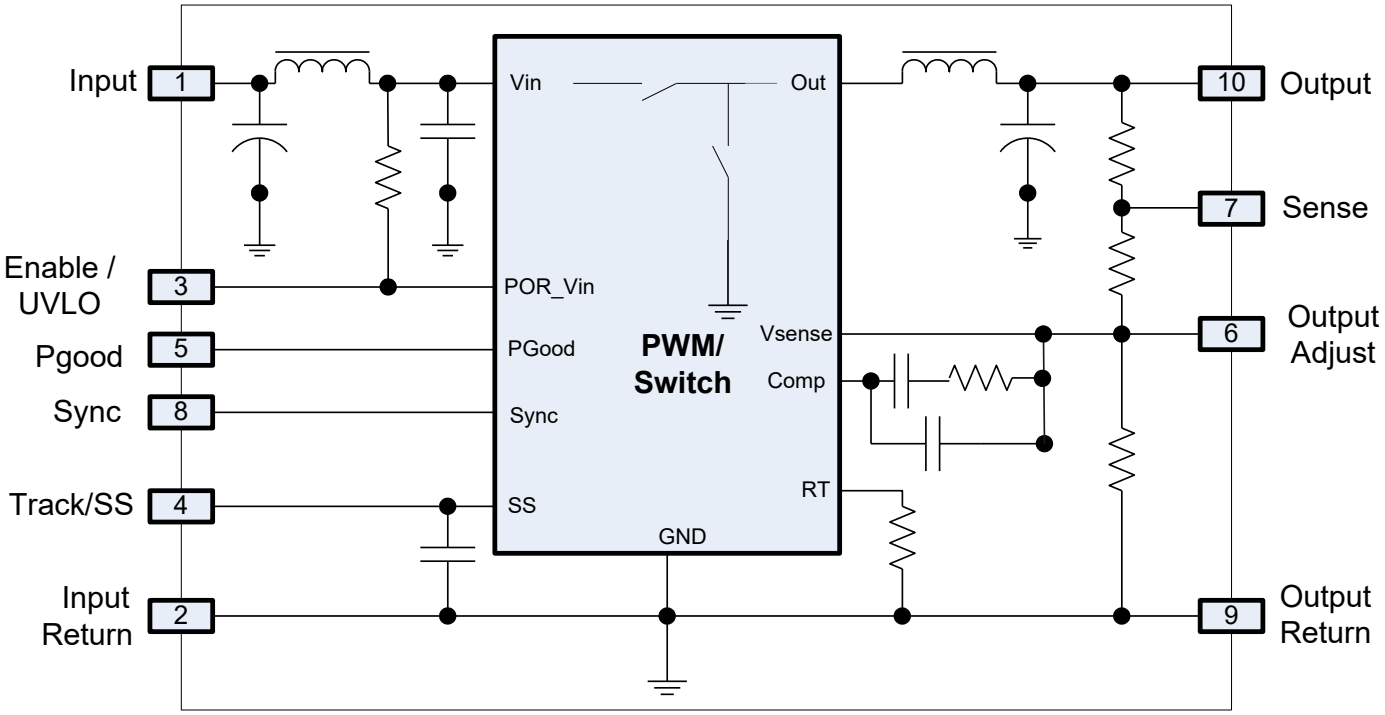
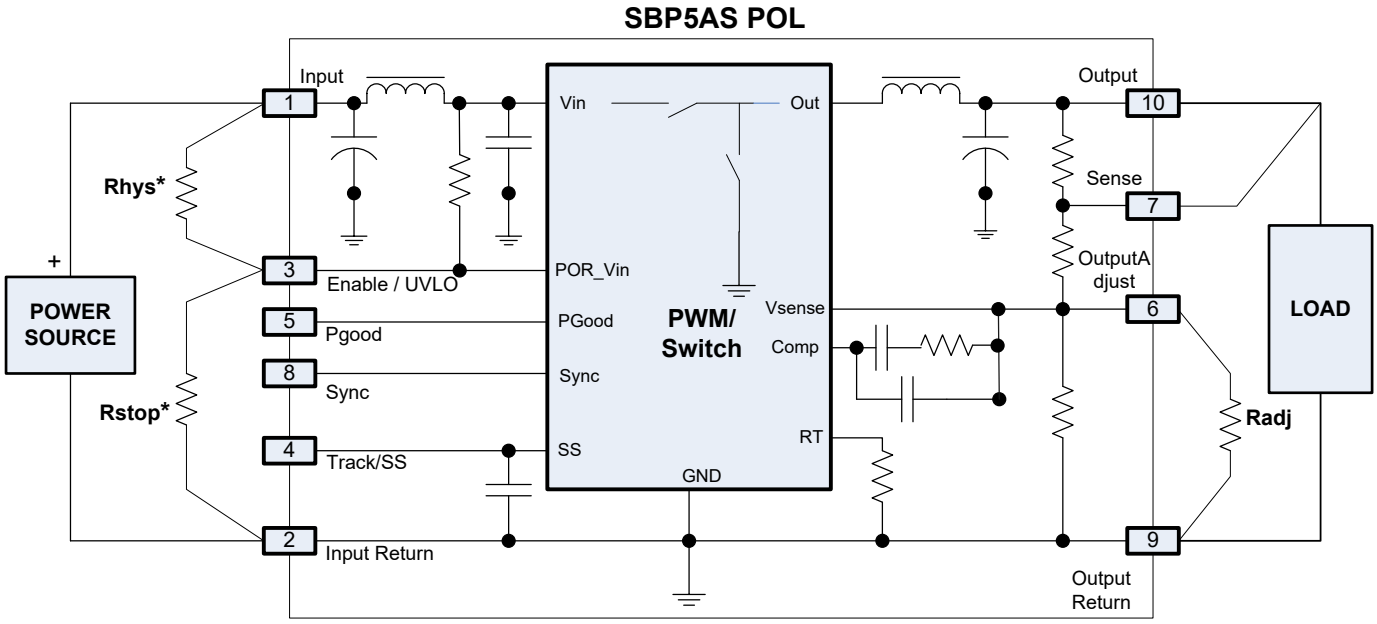
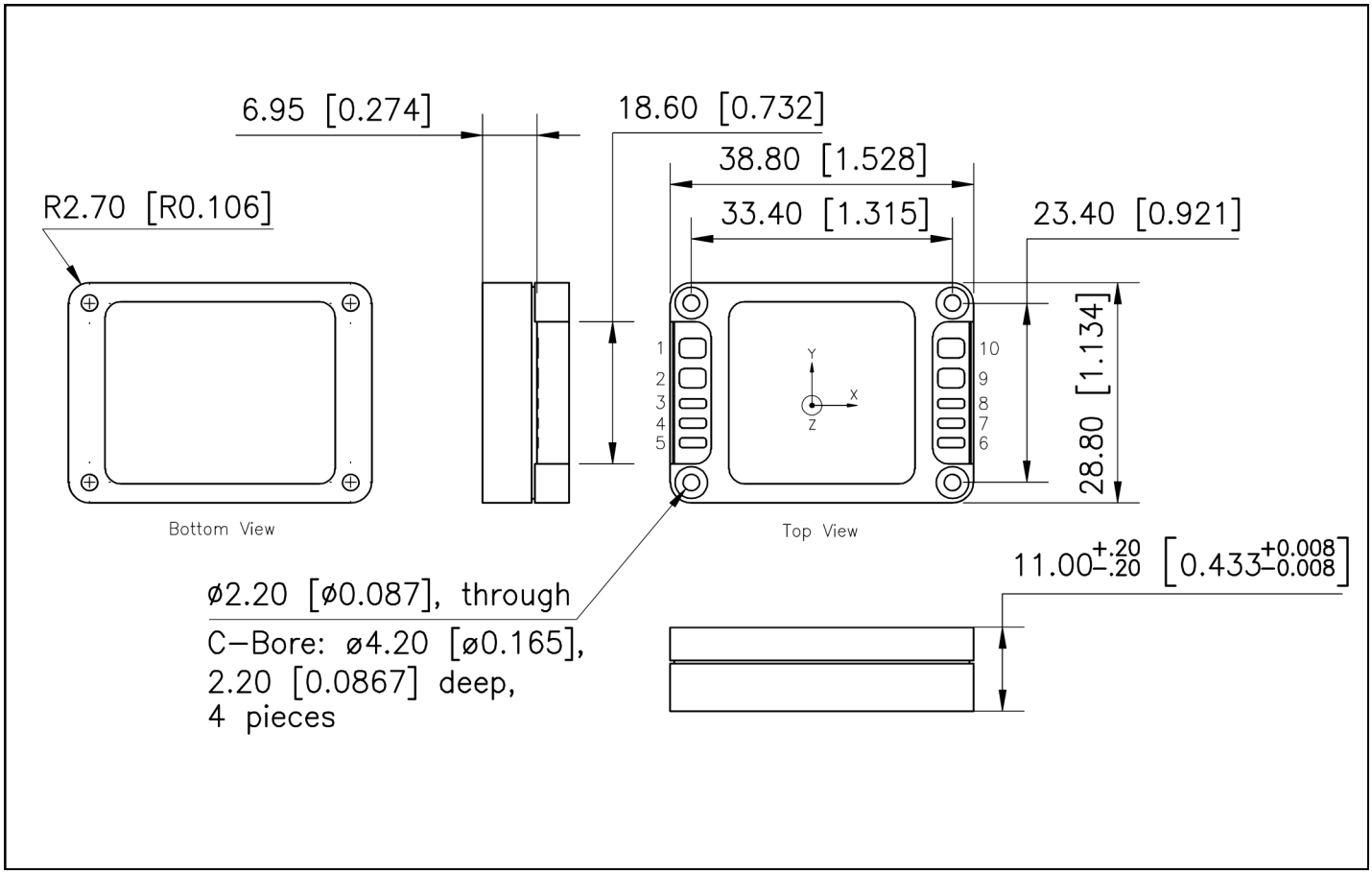


Figure 8: Typical Application Block Diagram



Mechanical Outline (Surface Mount Pins)



Pin Designation

Pin #	Designation
1	Input
2	Input Return
3	Enable / UVLO
4	Track / Soft-Start
5	Power Good
6	Output Adjust
7	Sense
8	Sync
9	Output Return
10	Output

Model Definition and Test Plan

Model	Description	Build Standard
EM	The EM is a representative model of the same basic electrical performances and the same mechanical footprint as the flight model (FM). The EM is intended to be used by customers in their prototype at equipment level for engineering evaluation purposes only. Passes full functional test at room temperature per SBP standard acceptance test procedure.	May be populated, hand soldered and built by non-manufacturing personnel. May not have staking or conformal coating. Lower grade EEE parts and materials may be used for convenience.
FM	Flight standard models. Passes all electrical tests under room and extreme temperatures and burn-in test per SBP standard acceptance procedure.	Flight standard for processes with components as specified by standard EEE parts table herein

EEE Standard Parts for Flight Model

Component Class	Component Type	Specification	Quality/Screening Level (minimum)
Capacitors	Ceramic 0603-1209	MIL-PRF-38534	Class K, See Note 1
	Ceramic 1812	Screened per MIL-PRF-49470	Nonstandard, K level
		NASDA2040_L104-4532	See Note 2
	Solid tantalum T510	MIL–PRF–55365	Weibull C
	Solid tantalum T541	DSCC Drawing. 04052	Weibull C
Diodes	Schottky, surface mount	PRF-19500	JANS
Inductors	MPP Toroid	MIL-STD-981	See Note 3
Resistors	Chip, Film, RM603	MIL-PRF-55342	MIL-R
	Chip, Film, RM1005	MIL-PRF-55342	MIL-R
	Chip, Film, RM1206	MIL-PRF-55342	MIL-R
	SMP-PW, 2010	ESCC 4001/027	ESCC Level B
Integrated Circuit	PWM controllers/FETs	MIL-PRF-38535	QML V

Notes:
1. Parts are tested and screened to internal standard GCS 8101-1503 which references MIL-PRF-38534 and MIL-PRF-123.
1. Failure rate similar to level S, see AAE2040_L104A.
2. Custom magnetics (chokes and transformers) screening is as per MIL-STD-981 with exception for: Radiographic inspection, monitoring during last thermal shock cycle, power burn-in.

Part Numbering

SBP 5 A S _ /EM

Product Name
SBP = POL 6A,
20 Watts, PCB based

Nominal Input Voltage
5 = 5V

Output Voltage
A = Adjustable with an external resistor

Number of Outputs
S = Single

Output Voltage Range
Blank = Standard, 0.8V to 3.3V
X = To be assigned for custom range

Quality Level: Per Model Defination and Test Plan Table
EM = Engineering Model
FM = Standard Flight Model

An Infineon Technologies Company
www.infineon.com/irhirel

Infineon Technologies Service Center: USA Tel: +1 (866) 951-9519 and International Tel: +49 89 234 65555
Leominster, Massachusetts 01453, USA Tel: +1 (978) 534-5776
San Jose, California 95134, USA Tel: +1 (408) 434-5000
Data and specifications subject to change without notice.

IMPORTANT NOTICE

The information given in this document shall be in no event regarded as guarantee of conditions or characteristic. The data contained herein is a characterization of the component based on internal standards and is intended to demonstrate and provide guidance for typical part performance. It will require further evaluation, qualification and analysis to determine suitability in the application environment to confirm compliance to your system requirements.

With respect to any example hints or any typical values stated herein and/or any information regarding the application of the product, Infineon Technologies hereby disclaims any and all warranties and liabilities of any kind including without limitation warranties on non- infringement of intellectual property rights and any third party.

In addition, any information given in this document is subject to customer's compliance with its obligations stated in this document and any applicable legal requirements, norms and standards concerning customer's product and any use of the product of Infineon Technologies in customer's applications.

The data contained in this document is exclusively intended for technically trained staff. It is the responsibility of any customer's technical departments to evaluate the suitability of the product for the intended applications and the completeness of the product information given in this document with respect to applications.

For further information on the product, technology, delivery terms and conditions and prices, please contact your local sales representative or go to (www.infineon.com/hirel).

WARNING

Due to technical requirements products may contain dangerous substances. For information on the types in question, please contact your nearest Infineon Technologies office.

单击下面可查看定价，库存，交付和生命周期等信息

>>Infineon Technologies(英飞凌)