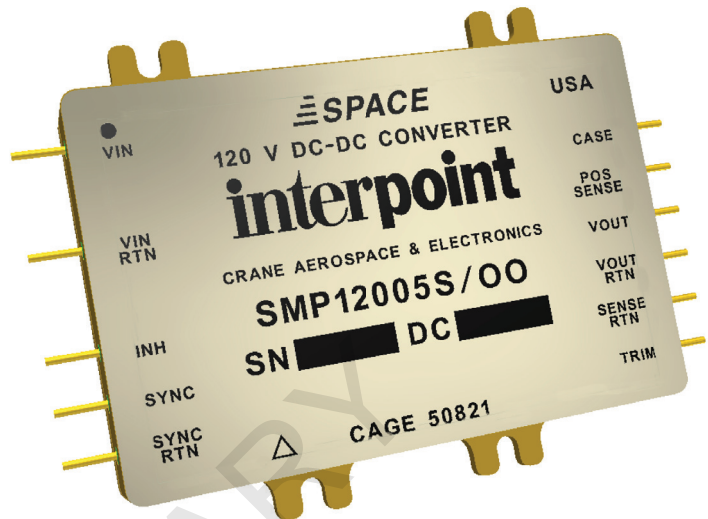


SMP120 Single Output Space DC-DC Converters

PRELIMINARY – 80-160 VOLT INPUT – 49 WATT

FEATURES

- Radiation tolerant space converter ¹
 - SEB (no burn-out) 86 MeV cm²/mg
 - Total ionizing dose (TID) guaranteed per MIL-STD-883 method 1019, radiation hardness assurance (RHA) L = 50 krad(Si), R = 100 krad(Si)
 - 50 - 300 rad(Si)/sec dose rate (Condition A)
 - 10 mrad(Si)/sec dose rate (Condition D)
- Output overvoltage protection
- Inrush current limit
- Built in EMI filter
- Output trim from 85% to 115% of nominal
- Operating temperature -55° to +125°C
- Screened to MIL-PRF-38534 Class H and K ¹
- Input voltage range 80-160 volts
- Transient protection 180 volts for 100 ms
- Fully isolated, magnetic feedback
- Fixed high frequency switching
- Remote sense
- Inhibit function, synchronization input
- Indefinite short circuit protection



MODELS
OUTPUT VOLTAGE (V)
SINGLE
5
28

HIGH VOLTAGE WARNING

Care should be taken when the converter is in a live circuit.

There is the potential for up to 160 volts at the input power pins.

DESCRIPTION

The Interpoint® SMP120 Series™ of DC-DC converters offers up to 49 watts of power in a radiation tolerant design. The low profile SMP120 converters are manufactured in our fully certified and qualified MIL-PRF-38534 Class K production facility and packaged in hermetically sealed steel cases. They are ideal for use in programs requiring high reliability, small size, and high levels of radiation hardness assurance.

The SMP120 converters are switching regulators which use a current mode control single switch forward design with a nominal switching frequency of 500 kHz. Close regulation is maintained with advanced constant frequency pulse width modulation design techniques. The SMP120's current mode control topology provides high levels of input-to-output ripple rejection.

EMI

The SMP120 includes an integrated 2-section, damped LC EMI filter to reduce the reflected input current ripple. The filter is damped to reduce the peaking at resonance to minimize the stress on the EMI filter and power components. The damping also serves to minimize the interaction of the filter output impedance with the negative input impedance of the DC-DC converter.

1. Screened to MIL-PRF-38534. Class H and K and RHA L and R are pending product validation.

SMP120 Single Output Space DC-DC Converters

PRELIMINARY – 80-160 VOLT INPUT – 49 WATT

RADIATION TOLERANCE

The SMP120 DC-DC converters are designed to provide continuous normal operation through radiation levels associated with space missions and in tactical and strategic military environments. The RHA level R converters will operate normally in radiation environments with up to 100 krad(Si) total dose and will not exhibit low dose rate (LDR) sensitivity at 10 mrad(Si)/sec dose rate up to a TID of 100 krad(Si).

These levels of radiation tolerance make the SMP120 converters suitable to provide power to electronic systems in programs where operation in high radiation environments is required.

SCREENING

SMP120 converters offer screening options of space prototype (O), Class H or K and radiation hardness assurance (RHA) levels P - 30 krad(Si), L - 50 krad(Si) or R - 100 krad(Si). The converters are screened to MIL-PRF-38534. Class H and K and RHA L and R are pending product validation.

Radiation performance,

- SEE LET performance 43 MeV cm²/mg
- SEB (no burn-out) 86 MeV cm²/mg
- SEL (no latch-up) 43 MeV cm²/mg
- SET 43 MeV cm²/mg

Note: Above 43 MeV cm²/mg, the converter may enter a non-destructive latch off mode if the ion beam is stopped prior to the converter shutting down. Power cycling or toggling the inhibit pin restores converter operation. The soft latch causes no damage to the device. If the ion beam is stopped AFTER the converter is powered down, operation to 86 MeV cm²/mg is possible.

UNDERVOLTAGE LOCKOUT

The converters have an undervoltage lockout that will allow power conversion at approximately 75 volts on a rising input voltage and a conversion shut-down on a falling voltage at approximately 72 volts. During these conditions, output regulation may not meet nominal input voltage specifications.

SYNCHRONIZATION

The Sync Input pin is isolated which allows Sync Return pin to be tied to the primary side, secondary side, or float with respect to all inputs and outputs. Input current into this pin is limited by a series 1 kohm resistance.

OUTPUT OVERVOLTAGE PROTECTION

The SMP120 overvoltage protection circuit comprises a redundant reference voltage and comparator to detect when the output voltage exceeds approximately 130% of the nominal output voltage. When an output overvoltage condition is detected, the protection circuit forces the converter to shutdown for a few milliseconds and initiate a restart. If the overvoltage condition

persists, the protection circuit will repeat the shutdown/restart cycle until the overvoltage condition goes away or the converter is inhibited externally.

When using the trim function, the margin between the trimmed voltage and the overvoltage threshold will be reduced since the overvoltage threshold is fixed at 130% of the nominal output voltage.

INRUSH CURRENT LIMITER

The SMP120 inrush current limiter comprises an N-Channel MOSFET as a simple timer. When the inhibit pin is released, a high voltage current source charges a capacitor that is connected between the gate and source of the current limiter FET. This causes the gate voltage to rise at a rate determined by the current and capacitor. When the gate voltage approaches the FET threshold voltage, the FET starts to conduct. Initially, the FET appears as a large resistance in series with the internal capacitance of the converter allowing the capacitance to charge slowly and limiting the inrush current at start up. As the gate voltage increases, the resistance of the current limiter FET decreases until the FET is fully on thereby minimizing the power loss due to the current limit circuit.

SENSE ON 5 VOLT SINGLE OUTPUT

Tight load regulation is maintained via a wide bandwidth magnetic feedback and through the use of remote sense on the 5 volt single output models. The sense pin function allows a remote connection for the voltage regulation circuit to compensate for voltage drops between the converter and the point of use. Up to 500 mV is allowed between the positive sense and the positive output and between the sense return and output return.

Note that if the sense pins are connected but the output voltage pins are not, the converter may be damaged.

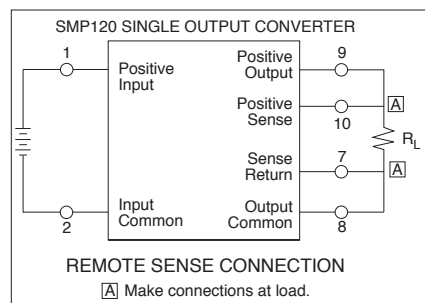


FIGURE 1: REMOTE SENSE

CAUTION: The converter will be permanently damaged if the positive sense (pin 10) is shorted to ground. Damage may also result if the output common or positive output is disconnected from the load when the remote sense leads are connected to the load.

SMP120 Single Output Space DC-DC Converters

PRELIMINARY – 80-160 VOLT INPUT – 49 WATT

INHIBIT

The SMP120 Series incorporates an inhibit terminal that can be used to disable internal switching. It is not recommended to tie the Inhibit pin of an SMP120 directly to the Inhibit pin of another converter as the SMP120 Inhibit pin can sink current.

When pulling multiple inhibit signals low, a separate interface is recommended for each SMP120. The converter is inhibited when the Inhibit pin is pulled low (<1.0 V). In the inhibit mode the inhibit pin current requirement is less than $\sim 500 \mu\text{A}$. The converter resumes normal operation when an open circuit is applied to the Inhibit pin or the Inhibit pin is released. The open circuit voltage of the Inhibit pin is 10 to 13.6 volts.

To enable the converter use an open collector on the Inhibit pin or leave it unconnected. See Figure 2.

Following a shutdown event by assertion of the inhibit function the assert to de-assert delay time must be at least TBD ms for no capacitive loading and TBD ms for maximum capacitive loading. It is highly recommended that a debounce circuit be used to drive the inhibit signal to prevent rapid turn-off and turn-on as this may cause damage to the converter. See the OPERATION and CONTROL section for more details.

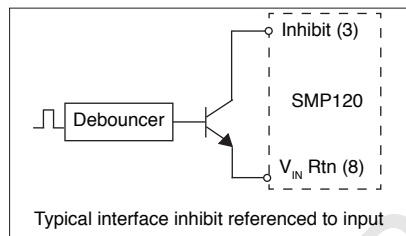


FIGURE 2: INHIBIT INTERFACE (DELAY NOT ADDED)

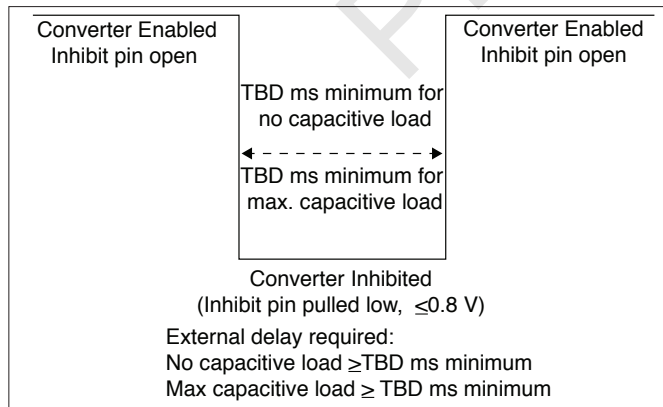


FIGURE 3: DELAY TIME FROM ASSERT TO DE-ASSERT FOR INHIBIT

ELECTROSTATIC DISCHARGE SENSITIVITY (ESD)

The SMP120 Series converters ESD rating is TBD.

OUTPUT VOLTAGE TRIM

The output voltage may be trimmed up or down approximately $\pm 15\%$ by tying the Trim pin to ground or tied to V_{OUT} pin via a programming resistor. See Figure 4. R_{EXT} is in kohms.

Formulas for setting the output voltage are:

5 volt output

$V_{out} (up) =$

$$2.5V(4.99 + (1/(1/4.99 + 1/(16.5 + R_{EXT})))) / (1/(4.99 + 1/(16.5 + R_{EXT})))$$

$V_{out} (down) =$

$$2.5V(4.99 + (1/(1/4.99 + 1/(16.5 + R_{EXT})))) / 4.99$$

28 volt output

$V_{out} (up) =$

$$2.5V(51.1 + (1/(1/4.99 + 1/(33.2 + R_{EXT})))) / (1/(4.99 + 1/(33.2 + R_{EXT})))$$

$V_{out} (down) =$

$$2.5V(4.99 + (1/(1/51.1 + 1/(33.2 + R_{EXT})))) / 4.99$$

NOTE: Do not exceed maximum output current rating when trimming down.

NOTE: Do not exceed maximum output power rating when trimming up.

FIGURE 4: TRIM

SMP120 Single Output Space DC-DC Converters

PRELIMINARY – 80-160 VOLT INPUT – 49 WATT

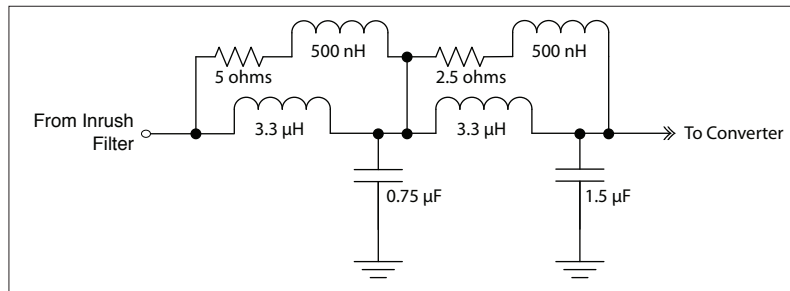


FIGURE 5: BUILT IN EMI FILTER

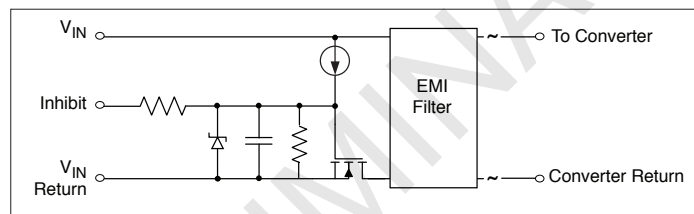


FIGURE 6: INHIBIT

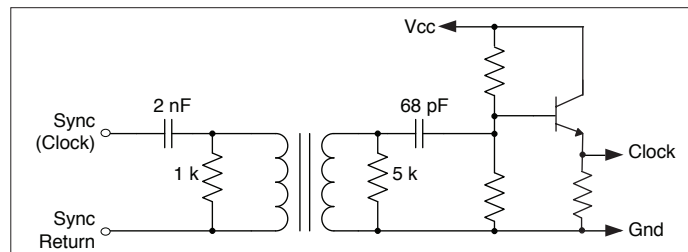


FIGURE 7: SYNC

SMP120 Single Output Space DC-DC Converters

PRELIMINARY – 80-160 VOLT INPUT – 49 WATT

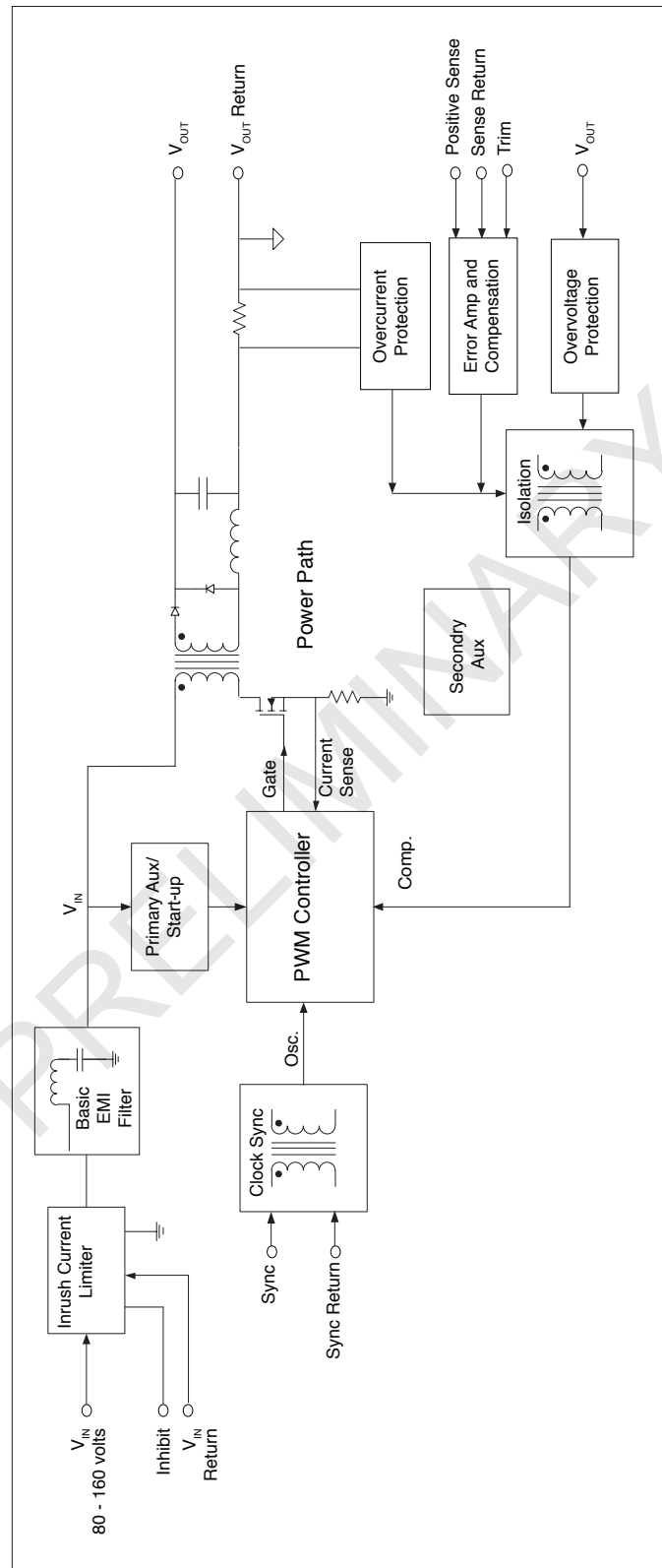


FIGURE 8: SMP120 BLOCK DIAGRAM 5 VOLT SINGLE

SMP120 Single Output Space DC-DC Converters

PRELIMINARY – 80-160 VOLT INPUT – 49 WATT

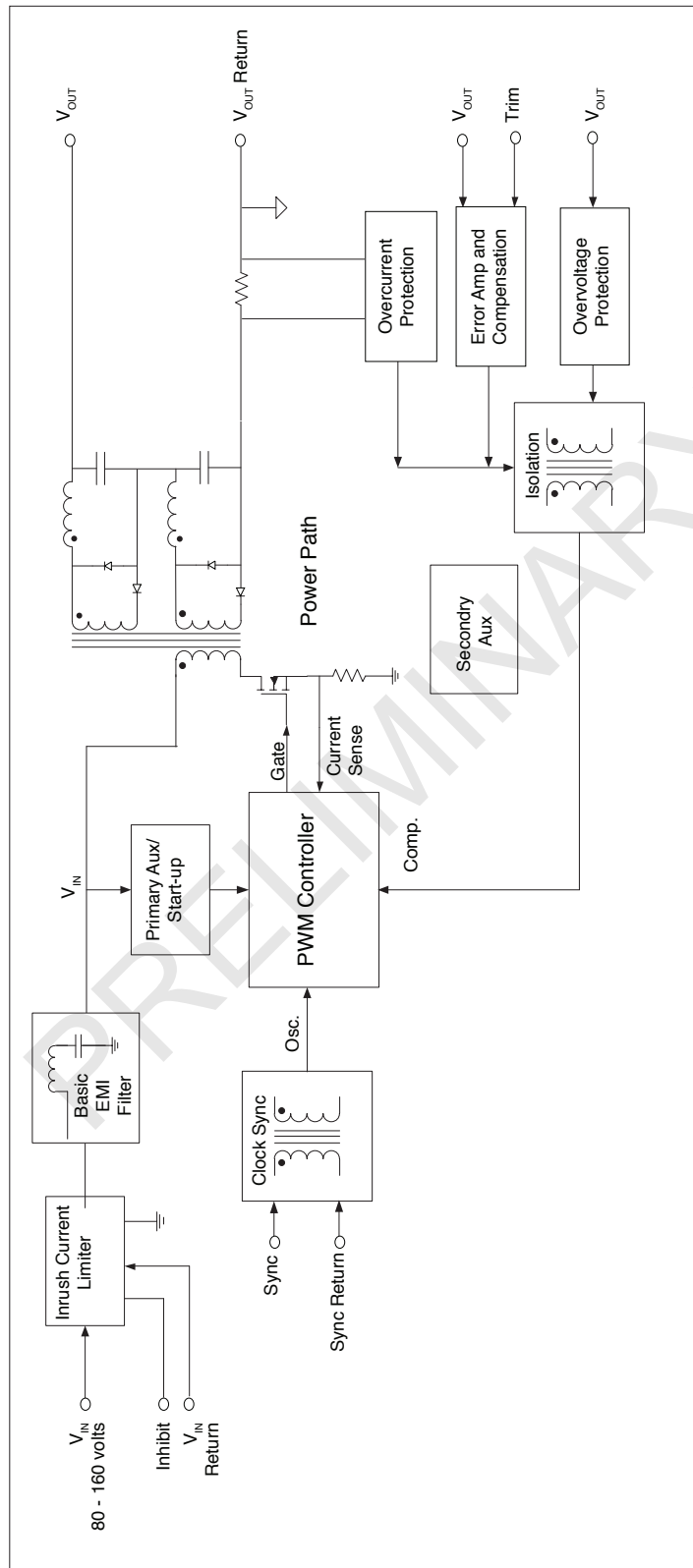


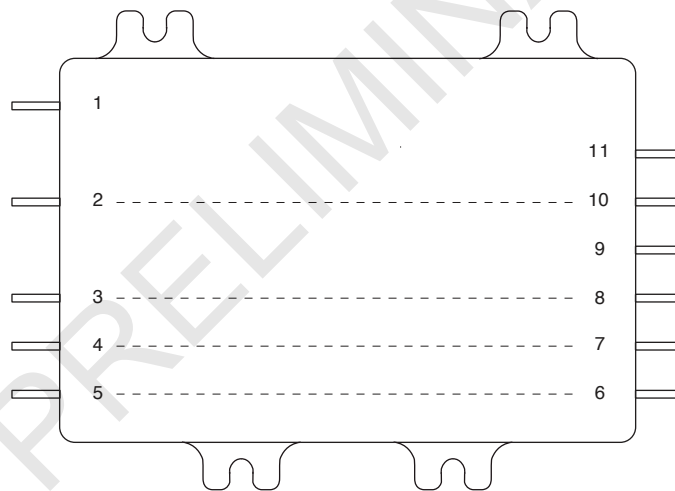
FIGURE 9: SMP120 BLOCK DIAGRAM 28 VOLT SINGLE

SMP120 Single Output Space DC-DC Converters

PRELIMINARY – 80-160 VOLT INPUT – 49 WATT

PIN OUT (PRELIMINARY)		
Pin	5 Volt Single Output	28 Volt Single Output
1	V_{IN}	V_{IN}
2	V_{IN} Return	V_{IN} Return
3	Inhibit	Inhibit
4	Sync (External Clock)	Sync (External Clock)
5	Sync Return	Sync Return
6	Trim	Trim
7	Sense Return	No Connection
8	V_{OUT} Return	V_{OUT} Return
9	V_{OUT}	V_{OUT}
10	Positive Sense	No Connection
11	Case	Case

TABLE 1: PIN OUT



For dimensions see Figure 12.

FIGURE 10: TOP VIEW PIN OUT

PINS NOT IN USE (PRELIMINARY)	
Inhibit	Leave unconnected
Sync In	Connect to Sync Return
Sense Lines	Must be connected to appropriate outputs
Trim	Leave unconnected

TABLE 2: PINS NOT IN USE

SMP120 Single Output Space DC-DC Converters

PRELIMINARY – 80-160 VOLT INPUT – 49 WATT

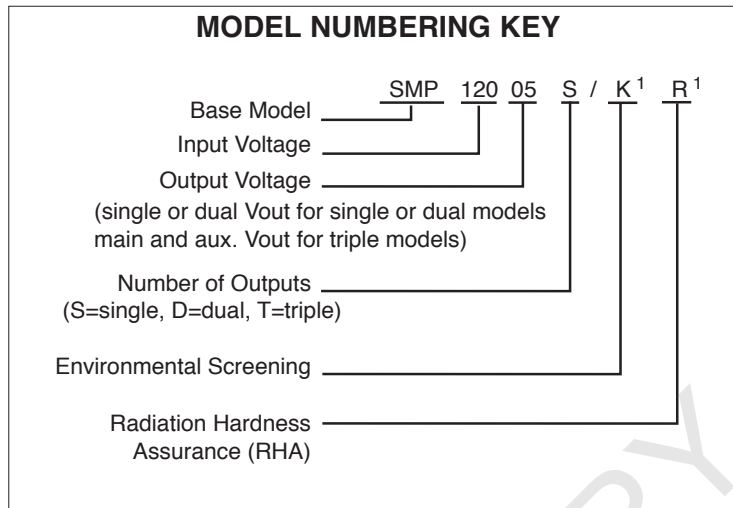


FIGURE 11: MODEL NUMBERING KEY

1. Screened to MIL-PRF-38534. Class H and K and RHA L and R are pending product validation.

MODEL NUMBER OPTIONS TO DETERMINE THE MODEL NUMBER ENTER ONE OPTION FROM EACH CATEGORY IN THE FORM BELOW.					
CATEGORY	Base Model and Input Voltage	Output Voltage	Number of Outputs ¹	Screening ²	RHA ³
OPTIONS	SMP120	05, 28	S	O H K	O L R
FILL IN FOR MODEL # ⁴	<u>SMP120</u>	<u> </u>	<u> </u>	<u>/ </u>	<u> </u>
Notes 1. Number of Outputs: S is a single output. 2. Screening: Screened to MIL-PRF-38534. Class H and K are pending product validation. A screening level of O is a Space Prototype and is only used with RHA O. See Table 6 and Table 7 for more information. 3. RHA: Screened to MIL-PRF-38534. RHA L and R are pending product validation. Interpoint model numbers use an "O" in the RHA designator position to indicate the "-" (dash) RHA level of MIL-PRF-38534, which is defined as "no RHA." RHA O is only available with screening level O. See Table 7 for more information. 4. If ordering by model number add a "-Q" to request solder dipped leads (SMP12005S/KR-Q). Available only for Class H and K.					

TABLE 3: MODEL NUMBER OPTIONS

SMP120 Single Output Space DC-DC Converters

PRELIMINARY – 80-160 VOLT INPUT – 49 WATT

TABLE 4: OPERATING CONDITIONS - ALL MODELS, 25° CASE, 120 VIN, UNLESS OTHERWISE SPECIFIED.

PARAMETER	CONDITIONS	ALL MODELS			UNITS
		MIN	TYP	MAX	
LEAD SOLDERING TEMPERATURE ¹	10 SECONDS MAX.	—	—	300	°C
STORAGE TEMPERATURE ¹		-65	—	+150	°C
CASE OPERATING TEMPERATURE	FULL POWER	-55	—	+125	°C
	ABSOLUTE ¹	-55	—	+135	
DERATING OUTPUT POWER/CURRENT ¹	LINEARLY	From 100% at 125°C to 0% at 135°C			
ESD RATING ^{1, 2} MIL-PRF-38534, 3.9.5.8.2	MIL-STD-883 METHOD 3015 CLASS TBD	—	—	TBD	V
ISOLATION: INPUT TO OUTPUT OR ANY PIN TO CASE	@ 500 VDC	100	—	—	Megohms
CURRENT LIMIT	% OF FULL LOAD	120	—	145	%
AUDIO REJECTION ¹		—	50	—	dB
OUTPUT VOLTAGE TRIM RANGE	TRIM PIN CONNECTED TO OUTPUT REFERENCE	—	—	+15	%
	TRIM PIN CONNECTED TO OUTPUT	—	—	-15	%
	NOT USED	LEAVE PIN OPEN			
SWITCHING FREQUENCY	OPERATING FREQUENCY	475	500	525	kHz
SYNCHRONIZATION ³	INPUT FREQUENCY	480	—	550	kHz
SYNC IS FLOATING AND ISOLATED	DUTY CYCLE	30	—	70	%
	ACTIVE LOW	—	—	0.8	V
	ACTIVE HIGH	3	—	5	
	REFERENCED TO	SYNC RETURN			
	IF NOT USED	CONNECT TO SYNC RETURN			
INHIBIT ACTIVE LOW (OUTPUT DISABLED) Do not apply a voltage to the Inhibit pin	INHIBIT PIN PULLED LOW ^{1, 4}	—	—	1	V
	INHIBIT PIN SOURCE CURRENT ¹	—	—	500	μA
	REFERENCED TO	INPUT COMMON			
INHIBIT ACTIVE HIGH (OUTPUT ENABLED) Do not apply a voltage to the Inhibit pin	INHIBIT PIN CONDITION	OPEN COLLECTOR OR UNCONNECTED			
	OPEN PIN VOLTAGE ¹	10	12	13.6	V

Notes

1. Characterization test and/or analysis. Not a production test.
2. Passes TBD volts.
3. Can only be synchronized above the default operating frequency.
4. Tested with Inhibit pin at <1.0 volts.

SMP120 Single Output Space DC-DC Converters

PRELIMINARY – 80-160 VOLT INPUT – 49 WATT

TABLE 5: ELECTRICAL CHARACTERISTICS: -55°C TO +125°C CASE, 120 VIN, 100% LOAD, UNLESS OTHERWISE SPECIFIED.

SINGLE OUTPUT MODELS		SMP12005S			SMP12028S			UNITS
PARAMETER	CONDITIONS	MIN	TYP	MAX	MIN	TYP	MAX	
OUTPUT VOLTAGE		4.90	5.00	5.10	27.4	28	28.6	V
OUTPUT CURRENT		—	—	8.0	—	—	1.75	A
OUTPUT POWER		—	—	40	—	—	49	W
OUTPUT RIPPLE 10 kHz - 2 MHz	T _C = 25°C	—	10	25	—	10	25	mV p-p
	T _C = -55°C TO +125°C	—	—	25	—	—	25	
OUTPUT RIPPLE 10 kHz - 20 MHz	T _C = 25°C	—	50	100	—	50	125	mV p-p
	T _C = -55°C TO +125°C	—	—	100	—	—	125	
LINE REGULATION	V _{IN} = 80 TO 160 V	—	1	10	—	1	50	mV
LOAD REGULATION	NL - FL	—	1	10	—	25	140	mV
INPUT VOLTAGE	CONTINUOUS	80	120	160	80	120	160	V
	TRANSIENT 100 ms ¹	—	—	180	—	—	180	V
INPUT CURRENT	NO LOAD	—	—	75	—	—	75	mA
	INHIBITED	—	—	2	—	—	2	
INPUT RIPPLE CURRENT	10 kHz - 2 MHz	—	20	45	—	20	45	mA p-p
	10 kHz - 20 MHz	—	—	90	—	—	90	
UNDERVOLTAGE LOCKOUT -55°C TO +125°C	RIISING V _{IN} (TURN ON)	—	75	79	—	75	79	V
	FALLING V _{IN} (TURN OFF)	71	75	—	71	75	—	
EFFICIENCY	T _C = 25°C	72	75	—	80	83	—	%
	T _C = -55°C to +100°C	71	—	—	79	—	—	
LOAD FAULT ^{2, 3}	POWER DISSIPATION	—	7	12	—	5	12	W
	RECOVERY	—	—	20	—	—	20	ms
STEP LOAD RESPONSE ^{3, 4, 5} 50% - 100% - 50%	TRANSIENT	—	—	±500	—	—	±1000	mV pk
	RECOVERY	—	—	500	—	—	500	μs
STEP LINE RESPONSE ^{1, 3, 6} V _{IN} = 80 - 160 - 80	V _{IN} TRANSIENT	—	±50	—	—	±200	—	mV pk
	RECOVERY	—	50	—	—	50	—	μs
START-UP ^{3, 7}	DELAY	—	—	25	—	—	25	ms
	OVERSHOOT	—	—	50	—	—	280	mV pk
CAPACITIVE LOAD ^{8, 9} T _C = 25°C	UNCONDITIONALLY STABLE, START-UP DELAY INCREASED	—	—	1000	—	—	200	μF

Notes

1. Characterization test and/or analysis. Not a production test.
2. Maximum power dissipation when output is shorted.
3. Recovery time is measured from application of the transient to point at which V_{OUT} is within 1% of V_{OUT} at final value.
4. Step load transition test is performed with load current rise time at 10 microseconds typical.

5. Half load to/from full load.

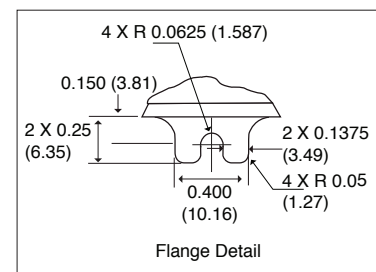
6. Step line test is performed with input voltage rise time at 100 microseconds ± 20 microseconds.

7. Measured from release of inhibit or input voltage step.

8. Minimum ESR: 0.05 ohms for 5 volt, 0.1 ohms for 28 volt.

9. Maximum ESR: 0.5 ohms for 5 volt, 1.0 ohms for 28 volt.

TOP VIEW CASE S1 SMP120



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SMP120 Single Output Space DC-DC Converters

PRELIMINARY – 80-160 VOLT INPUT – 49 WATT

ELEMENT EVALUATION SPACE DC-DC CONVERTERS PROTOTYPE, CLASS H AND CLASS K

COMPONENT-LEVEL TEST PERFORMED	NON-QML ¹	QML ²			
	PROTOTYPE	CLASS H		CLASS K	
	/O	/H		/K	
	M/S ³	M/S ³	P ⁴	M/S ³	P ⁴
Element Electrical	■	■	■	■	■
Visual		■	■	■	■
Internal Visual		■		■	
Temperature Cycling				■	■
Constant Acceleration				■	■
Interim Electrical				■	
Burn-in				■	
Post Burn-in Electrical				■	
Steady State Life				■	
Voltage Conditioning Aging					■
Visual Inspection					■
Final Electrical		■	■	■	■
Wire Bond Evaluation		■	■	■	■
SEM				■	
C-SAM: Input capacitors only ⁵			■		■

Notes

1. Non-QML products may not meet all of the requirements of MIL-PRF-38534.
2. Screened to MIL-PRF-38534. Class H and K are pending product validation.
3. M/S = Active components (microcircuit and semiconductor die)
4. P = Passive components, Class H and K element evaluation. Not applicable to space prototype ("O") element evaluation.
5. Additional test not required by H or K.

Definitions

Element Evaluation: Component testing/screening per MIL-STD-883 as determined by MIL-PRF-38534

SEM: scanning electron microscopy

C-SAM: C – Mode Scanning Acoustic Microscopy

TABLE 6: ELEMENT EVALUATION

SMP120 Single Output Space DC-DC Converters

PRELIMINARY – 80-160 VOLT INPUT – 49 WATT

ENVIRONMENTAL SCREENING SPACE DC-DC CONVERTERS PROTOTYPE, CLASS H AND CLASS K, RHA¹ L AND R

TEST PERFORMED	NON-QML ²	QML ^{3, 4}			
	PROTOTYPE	CLASS H		CLASS K	
	/OO ⁵	/HL	/HR	/KL	/KR
Non-destruct wire bond pull, Method 2023		■ ⁶	■ ⁶	■	■
Pre-cap Inspection, Method 2017, 2032	■	■	■	■	■
Temperature Cycle (10 times) Method 1010, Cond. C, -65°C to +150°C, ambient	■	■	■	■	■
Constant Acceleration Method 2001, 3000 g	■	■	■	■	■
PIND, Test Method 2020, Cond. A		■ ⁶	■ ⁶	■	■
Pre burn-in test, Group A, Subgroups 1 and 4	■	■ ⁶	■ ⁶	■	■
Burn-in Method 1015, +125°C case, typical ⁷					
96 hours	■				
160 hours		■	■		
2 x 160 hours (includes mid-BI test)				■	■
Final Electrical Test, MIL-PRF-38534, Group A,					
Subgroups 1 and 4: +25°C case	■				
Subgroups 1 through 6, -55°C, +25°C, +125°C case		■	■	■	■
Hermeticity Test, Method 1014					
Gross Leak, Cond. B ₂ , Kr85				■	■
Gross Leak, Cond. C ₁ , fluorocarbon	■	■	■		
Fine Leak, Cond. B ₁ , Kr85				■	■
Fine Leak, Cond. A ₂ , helium	■	■	■		
Radiography, Method 2012				■	■
Post Radiography Electrical Test, +25°C case				■ ⁶	■ ⁶
Final visual inspection, Method 2009	■	■	■	■	■
RHA L: 50 krad(Si) total dose ^{1, 8, 9}		■		■	
RHA R: 100 krad(Si) total dose ^{1, 8, 9}			■		■
SEE, LET 86 MeV cm ² /mg ^{1, 10, 11}		■	■	■	■

Test methods are referenced to MIL-STD-883 as determined by MIL-PRF-38534.

Notes

1. Our Redmond facility has a DLA approved RHA plan for Interpoint power products. Our SMD products with RHA "L" or "R" code meet DLA requirements.
2. Non-QML prototype products may not meet all of the requirements of MIL-PRF-38534.
3. All processes are QML qualified and performed by certified operators.
4. Screened to MIL-PRF-38534. Class H and K and RHA L and R are pending product validation.
5. "O" in the RHA designator position in Interpoint model numbers indicates DLA RHA "-" defined as no RHA.
6. Not required by DLA but performed to assure product quality.

7. Burn-in temperature designed to bring the case temperature to +125°C minimum. Burn-in is a powered test.
8. High dose rate test.
9. Low dose rate test.
10. No destructive events.
11. Above 43 MeV cm²/mg, the converter may enter a non-destructive latch off mode if the ion beam is stopped prior to the converter shutting down. Power cycling or toggling the Inhibit pin restores converter operation. The soft latch causes no damage to the device. If the ion beam is stopped AFTER the converter is powered down, operation to 86 MeV cm²/mg is possible.

TABLE 7: ENVIRONMENTAL SCREENING AND RHA LEVELS

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