SLH Single and Dual DC-DC Converters

16 TO 40 VOLT INPUT – 1.5 WATT

FEATURES

- Radiation tolerant space DC-DC converter

  Single event effects (SEE) LET performance to 86 MeV cm^2/mg

  Total ionizing dose (TID) guaranteed per MIL-STD-883 method 1019, radiation hardness assurance (RHA)

  L = 50 krad(Si), R = 100 krad(Si)
- Operating temperature -55°C to +125°C
- Qualified to MIL-PRF-38534 Class H and K
- Input voltage range 16 to 40 V
- Transient protection 50 V for 50 ms
- Fully isolated magnetic feedback
- Inhibit function
- Indefinite short circuit protection

MODELS OUTPUT VOLTAGE (V)	
SINGLES	DUALS
5	±5
12	±12
15	±15

DESCRIPTION

The Interpoint® SLH Series™ of DC-DC converters offers up to 1.5 watts of power in a radiation tolerant design. The low profile SLH 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. A small footprint of 0.79 square inches saves board space. The wide input voltage range of 16 to 40 volts accepts the varying voltages of space, military, or aerospace bus power and regulates output voltages to protect downstream components. Single output models feature outputs of 5, 12, or 15 volts, and dual output models feature outputs of ±5, ±12 and ±15 volts.

Screening

SLH converters offer screening to Class H or K and radiation hardness assurance (RHA) levels L - 50 krad(Si) or R - 100 krad(Si). Single event effects (SEE) LET performance to 86 MeV cm^2/mg. See Table 9 on page 12 for more information.

Converter Design

SLH Series DC-DC converters incorporate a flyback topology with a variable switching frequency. Feedback provides output voltage regulation. Output voltage is magnetically fed back to the input side of the PWM to regulate output voltage.

Up to 80% of the load of the dual output models may be on one output providing that the other output carries a minimum of 20% of the total load. The dual models can be used as a single output voltage by connecting the load between positive and negative outputs, leaving the common unconnected resulting in double the output voltage. (for example, SLH2805D can be used as a 10 volt output.)

When used with Interpoint's STF28-461 filter, the combination will meet the requirements of MIL-STD-461C, CE03.

Inhibit Function

The SLH Series incorporates an inhibit terminal that can be used to disable internal switching. The converter is inhibited when an active low (≤ 0.5 V) signal is applied to the inhibit pin (pin 7). In the inhibit mode the inhibit pin sources up to 2 mA maximum. The converter resumes normal operation when an open circuit is applied to the inhibit pin. The open circuit voltage of the inhibit is 7 to 8 volts. Do not apply an external pull-up to the inhibit terminal.

Protection Features

All models include a soft-start function to prevent large current draw and minimize overshoot. The converters provide short circuit protection (by restricting the current) and output overload protection.

Convenient Packaging

The SLH Series converters are packaged in hermetically sealed metal cases which provide EMI/RFI shielding.

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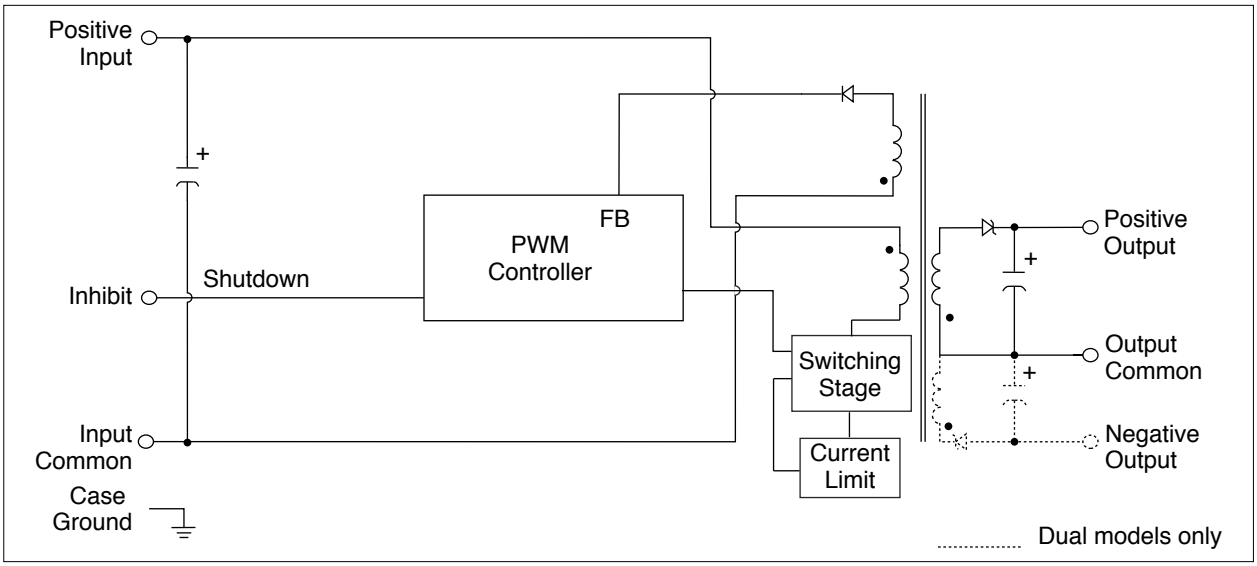
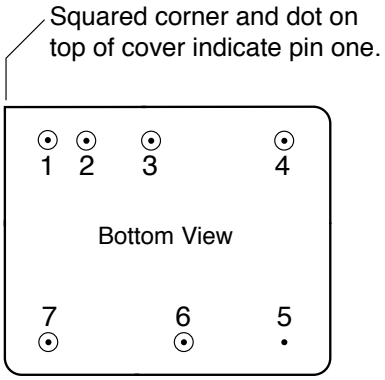


FIGURE 1: SLH BLOCK DIAGRAM

PIN OUT		
Pin	**Single Output**	**Dual Output**
1	Positive Input	Positive Input
2	Input Common	Input Common
3	Positive Output	Positive Output
4	Output Common	Output Common
5	Case Ground	Case Ground
6	No Connection	Negative Output
7	Inhibit	Inhibit

TABLE 1: PIN OUT



See Figure 23 on page 10 for dimensions.

FIGURE 2: PIN OUT

PINS NOT IN USE	
Inhibit	Leave unconnected
“No Connection” pin	Leave unconnected

TABLE 2: PINS NOT IN USE

SLH Single and Dual DC-DC Converters

16 TO 40 VOLT INPUT – 1.5 WATT

MODEL NUMBERING KEY

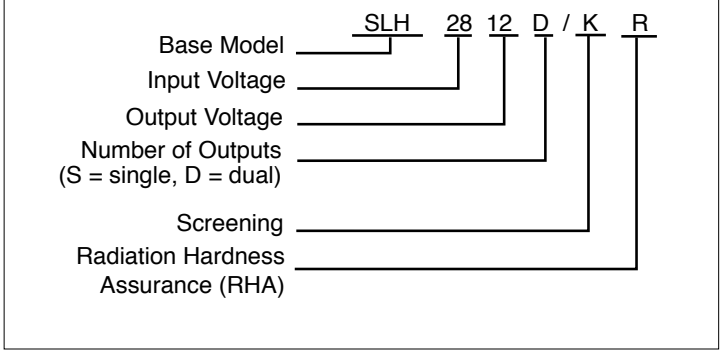


FIGURE 3: MODEL NUMBERING KEY

SMD NUMBERS

STANDARD MICROCIRCUIT DRAWING (SMD)	SLH SIMILAR PART
5962R0052601KXC	SLH2805S/KR
5962R0052701KXC	SLH2812S/KR
5962R0052801KXC	SLH2815S/KR
5962R0250402KXC	SLH2805D/KR
5962R9955602KXC	SLH2812D/KR
5962R9852902KXC	SLH2815D/KR

The SMD number shown is for Class K screening and radiation hardness assurance (RHA) level R. See the SMD for the numbers for other screening and radiation levels. For exact specifications for an SMD product, refer to the SMD drawing. SMDs can be downloaded from https://landandmaritimeapps.dla.mil/programs/smcr

TABLE 3: SMD NUMBER CROSS REFERENCE

MODEL NUMBER OPTIONS

ON THE LINES BELOW, ENTER ONE SELECTION FROM EACH CATEGORY TO DETERMINE THE MODEL NUMBER.

CATEGORY	Base Model and Input Voltage	Output Voltage	Number of Outputs [1]	Screening [2]	RHA [3]
OPTIONS	SLH28	05, 12, 15	S	O	O
		05, 12, 15	D	H	L
				K	R
FILL IN FOR MODEL # [4]	SLH28	_____	_____	/ _____	_____

Notes:
1. Number of Outputs: S is a single output and D is a dual output.
2. Screening: A screening level of O is a Space Prototype and is only used with RHA O. See Table 8 on page 11 and Table 9 on page 12 for more information.
3. RHA: 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 9 on page 12 for more information.
4. If ordering by model number add a "-Q" to request solder dipped leads (SMRT2805S/KR-Q). Available only for Class H and K.

TABLE 4: SMD NUMBER CROSS REFERENCE

SLH Single and Dual DC-DC Converters

16 TO 40 VOLT INPUT – 1.5 WATT

TABLE 5: OPERATING CONDITIONS - ALL MODELS, 25°C CASE, 28 VOLTS VIN, UNLESS OTHERWISE SPECIFIED

		ALL MODELS			
PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
LEAD SOLDERING TEMPERATURE [1]	10 SECONDS MAX.	—	—	300	°C
STORAGE TEMPERATURE		-65	—	+150	°C
CASE OPERATING	FULL POWER	-55	—	+125	°C
TEMPERATURE	ABSOLUTE [1]	-55	—	+135	
DERATING OUTPUT POWER/CURRENT [1]	LINEARLY	From 100% at 125°C to 0% at 135°C			
ESD RATING [1] MIL-PRF-38534, 3.9.5.8.2	MIL-STD-883 METHOD 3015 CLASS 3B	—	—	≧8000	V
ISOLATION, INPUT TO OUTPUT OR ANY PIN TO CASE EXCEPT CASE PIN	@ 500 VDC AT 25°C	100	—	—	Megohms
INPUT TO OUTPUT CAPACITANCE [1]		—	100 - 170	—	pF
CONVERSION FREQUENCY [2]	5, 12, 15, ±5 AND ±15	220	280	320	kHz
-55° TO +125°C	±12	220	—	420	
INHIBIT ACTIVE LOW (OUTPUT DISABLED) Do not apply a voltage to the inhibit pin [3]	INHIBIT PIN PULLED LOW	—	—	0.5	V
	INHIBIT PIN SOURCE CURRENT [1]	—	—	2	mA
	REFERENCED TO	INPUT COMMON			
INHIBIT ACTIVE HIGH (OUTPUT ENABLED) Do not apply a voltage to the inhibit pin [3]	INHIBIT PIN CONDITION	OPEN COLLECTOR OR UNCONNECTED			
	OPEN INHIBIT PIN VOLTAGE [1]	7	—	8	V

For mean time between failures (MTBF) contact Applications Engineering
powerapps@crane-eg.com +1 425.882.3100 option 7

Notes:
1. Guaranteed by qualification test and/or analysis. Not an in-line test.
2. Since the SLH is a variable frequency converter, the frequency range, with different line and load conditions, can be significantly different than the stated values in this table.
3. An external inhibit interface should be used to pull the inhibit low or leave it floating. The inhibit pin can be left unconnected if not used. Do not apply an external pull-up.

SLH Single and Dual DC-DC Converters

16 TO 40 VOLT INPUT – 1.5 WATT

TABLE 6: ELECTRICAL CHARACTERISTICS: -55° TO +125°C CASE, 28 VIN, 100% LOAD, UNLESS OTHERWISE SPECIFIED

SINGLE OUTPUT MODELS		SLH2805S			SLH2812S			SLH2815S			UNITS
PARAMETER	CONDITIONS	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
OUTPUT VOLTAGE [2]		4.80	5.00	5.20	11.52	12.00	12.48	14.40	15.00	15.60	V
OUTPUT CURRENT	V_{IN} = 16 TO 40 V	—	—	300	—	—	125	—	—	100	mA
OUTPUT POWER	V_{IN} = 16 TO 40 V	—	—	1.5	—	—	1.5	—	—	1.5	W
OUTPUT RIPPLE	T_C = 25°C	—	65	150	—	35	200	—	60	200	mV p-p
10 kHz - 2 MHz	T_C = -55°C TO +125°C	—	—	250	—	—	300	—	—	300	
LINE REGULATION	V_{IN} = 16 TO 40 V	—	115	300	—	60	400	—	60	650	mV
LOAD REGULATION [3]	LOAD 10% TO 100%	—	440	700	—	380	700	—	410	700	mV
INPUT VOLTAGE	CONTINUOUS NO LOAD TO FULL	16	28	40	16	28	40	16	28	40	V
	TRANSIENT [1] 50 ms	—	—	50	—	—	50	—	—	50	
INPUT CURRENT	NO LOAD	—	2.9	17	—	2.3	17	—	2.4	17	mA
	INHIBITED	—	1.3	5	—	1.3	5	—	1.3	5	
INPUT RIPPLE CURRENT [4]	10 kHz - 10 MHz	—	85	250	—	75	300	—	60	300	mA p-p
EFFICIENCY	T_C = 25°C	72	79	—	80	87	—	80	88	—	%
	T_C = -55°C TO +125°C	69	—	—	69	—	—	69	—	—	
LOAD FAULT [5, 6]	SHORT CIRCUIT POWER DISSIPATION	—	0.4	1.5	—	0.3	1.2	—	0.3	1.2	W
	RECOVERY [1]	—	—	30	—	—	30	—	—	30	ms
STEP LOAD RESPONSE [6, 7]	TRANSIENT	—	±250	±400	—	±220	±700	—	±220	±700	mV pk
50% - 100% - 50%	RECOVERY [1]	—	—	400	—	—	400	—	—	400	µs
STEP LINE RESPONSE [1, 6, 8]	TRANSIENT	—	—	±600	—	—	±600	—	—	±600	mV pk
16 - 40 - 16 V	RECOVERY	—	—	500	—	—	500	—	—	500	µs
START-UP [6, 9]	DELAY	—	1	20	—	1	20	—	1	20	ms
	OVERSHOOT [1]	—	—	100	—	—	500	—	—	500	mV pk
CAPACITIVE LOAD [1] T_C = 25°C	NO EFFECT ON DC PERFORMANCE	—	—	100	—	—	100	—	—	100	µF

Notes:
1. Guaranteed by characterization test and/or analysis. Not a production test.
2. Specified at 50% load.
3. Although no minimum load is required, at no load the output voltage may exceed rating by up to approximately 15%.
4. An external 6 µH inductor, added in series to the input, is necessary to maintain specifications.
5. Load fault is a short circuit into 1Ω. Recovery is into resistive full load.
6. Recovery and start-up times are measured from application of the transient or change in condition to the point at which V_{OUT} is within 1% of final value.
7. Step load test is performed at 10 microseconds typical. Step load response is mostly due to the effects of load regulation. See Figure 10 on page 8.
8. Step line test is performed at 100 microseconds ± 20 microseconds.
9. Measured from release of inhibit.

SLH Single and Dual DC-DC Converters

16 TO 40 VOLT INPUT – 1.5 WATT

TABLE 7: ELECTRICAL CHARACTERISTICS: -55° TO +125°C CASE, 28 VIN, 100% LOAD, UNLESS OTHERWISE SPECIFIED

DUAL OUTPUT MODELS		SLH2805D			SLH2812D			SLH2815D			UNITS
PARAMETER	CONDITIONS	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
OUTPUT VOLTAGE [2]	$\pm V_{OUT}$	4.80	5.00	5.20	11.52	12.00	12.48	14.40	15.00	15.60	V
OUTPUT CURRENT [3]	EACH OUTPUT	—	150	240	—	62.5	100	—	50	80	mA
V_{IN} = 16 TO 40 V	TOTAL			300			125			100	
OUTPUT POWER [3]	EACH OUTPUT	—	0.75	1.2	—	0.75	1.2	—	0.75	1.2	W
V_{IN} = 16 TO 40 V	TOTAL			1.5			1.5			1.5	
OUTPUT RIPPLE	T_C = 25°C	—	—	150	—	—	200	—	—	300	mV p-p
10 kHz - 2 MHz $\pm V_{OUT}$	T_C = -55°C TO +125°C	—	—	250	—	—	400	—	—	500	
LINE REGULATION $\pm V_{OUT}$	V_{IN} = 16 TO 40 V	—	75	400	—	75	700	—	85	650	mV
LOAD REGULATION [4]	BALANCED LOADS	—	310	700	—	350	700	—	370	700	mV
10% - 100%	$\pm V_{OUT}$										
INPUT VOLTAGE	CONTINUOUS NO LOAD TO FULL	16	28	40	16	28	40	16	28	40	V
	TRANSIENT [1] 50 ms	0	—	50	0	—	50	0	—	50	
INPUT CURRENT	NO LOAD	—	3.1	17	—	3.1	17	—	3.3	17	mA
	INHIBITED	—	1.4	5	—	1.4	5	—	1.4	5	
INPUT RIPPLE CURRENT [5]	10 kHz - 10 MHz	–	80	250	–	90	300	–	100	300	mA p-p
EFFICIENCY	T_C = 25°C	72	75	—	80	87	—	80	87	—	%
	T_C = -55°C TO +125°C	69	—	—	69	—	—	69	—	—	
LOAD FAULT [6, 7]	SHORT CIRCUIT POWER DISSIPATION	—	0.3	1.5	—	0.3	1.2	—	0.3	1.2	W
	RECOVERY [1]	—	—	30	–	1	30	—	1	30	ms
STEP LOAD RESPONSE [7, 8]											
BALANCED LOADS	TRANSIENT	—	±150	±400	—	±170	±600	—	±200	±700	mV pk
50% - 100% - 50% $\pm V_{OUT}$	RECOVERY [1]	—	—	600	—	—	360	—	—	600	µs
STEP LINE RESPONSE [1, 7, 9]	TRANSIENT	—	—	±600	—	—	±600	—	—	±600	mV pk
16 - 40 - 16 V, $\pm V_{OUT}$	RECOVERY	—	—	500	—	—	500	—	—	500	µs
START-UP [7, 10]	DELAY	—	1	20	—	2	20	—	2	20	ms
$\pm V_{OUT}$	OVERSHOOT [1]	—	—	500	—	—	500	—	—	500	mV pk
CAPACITIVE LOAD [1] T_C = 25°C, EACH OUTPUT	NO EFFECT ON DC PERFORMANCE	—	—	100	—	—	100	—	—	100	µF

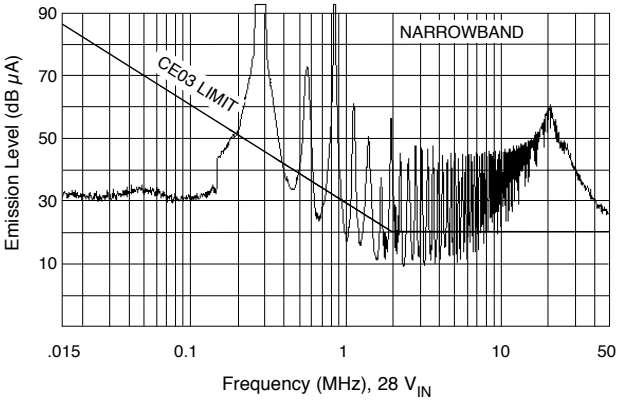
Notes
1. Guaranteed by characterization test and/or analysis. Not a production test.
2. Specified at 50%/50% balanced loads and one half of full load.
3. Maximum specification indicates 80% of the converter's total current/power is available from either output, provided the other output carries 20% of the total power.
4. Although no minimum load is required, at no load the output voltage may exceed rating by up to approximately 15%.
5. An external 6 µH inductor, added in series to the input, is necessary to maintain specifications.
6. Load fault is a short circuit into 1Ω. Recovery is into resistive full load.
7. Recovery and start-up times are measured from application of the transient or change in condition to the point at which V_{OUT} is within 1% of final value.
8. Step load test is performed at 10 microseconds typical. Step load response is mostly due to the effects of load regulation. See Figure 18 on page 9.
9. Step line test is performed at 100 microseconds ± 20 microseconds.
10. Measured from release of inhibit.

SLH Single and Dual DC-DC Converters

16 TO 40 VOLT INPUT – 1.5 WATT

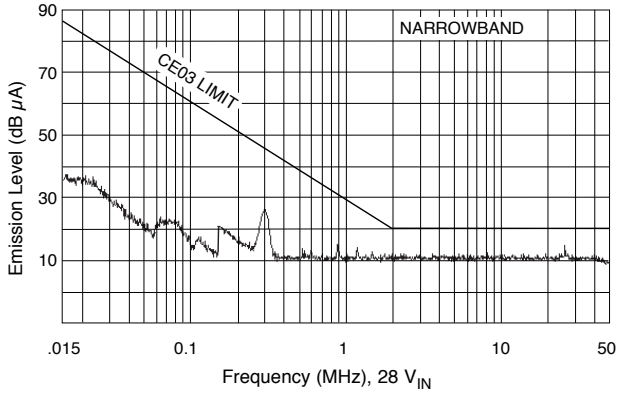
TYPICAL PERFORMANCE PLOTS: 28 VIN, 25°C CASE, 100% LOAD, UNLESS OTHERWISE SPECIFIED.
These are examples for reference only and are not guaranteed specifications.

EMI: Representative of all SLH Models



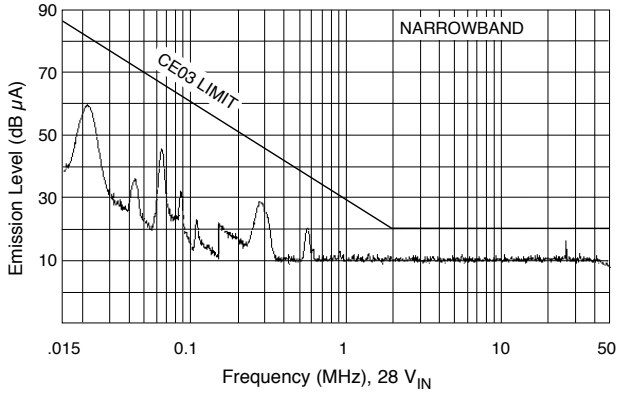
SLH Unfiltered

FIGURE 4



SLH2805S with STF EMI Filter and required 4 µF capacitors (per STF datasheet), MIL-STD-461C, CE03

FIGURE 5



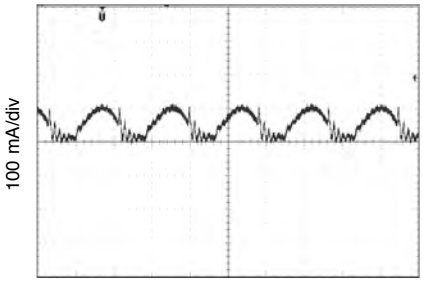
Two SLH2805S with STF EMI Filter and required 4 µF capacitors (per STF datasheet), MIL-STD-461C, CE03

FIGURE 6

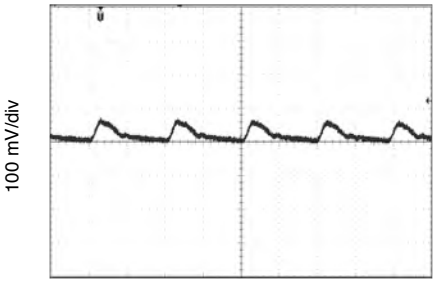
SLH Single and Dual DC-DC Converters

16 TO 40 VOLT INPUT – 1.5 WATT

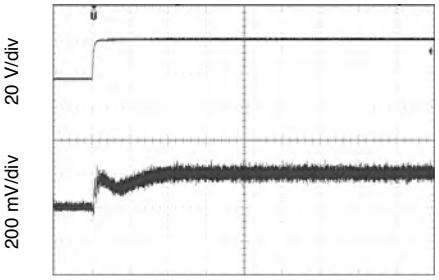
TYPICAL PERFORMANCE PLOTS: 28 VIN, 25°C CASE, 100% LOAD, UNLESS OTHERWISE SPECIFIED.
These are examples for reference only and are not guaranteed specifications.



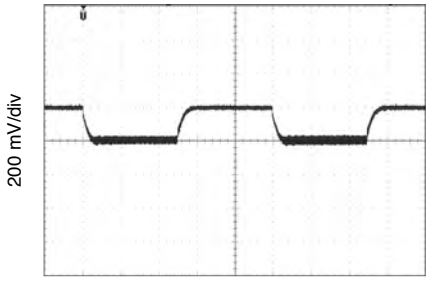
6 µH inductor in series with input
Representative of Single Input Ripple Current
FIGURE 7



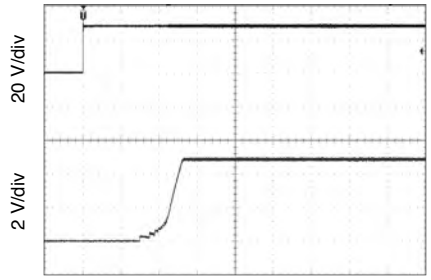
Representative of Single Output Ripple Voltage
FIGURE 8



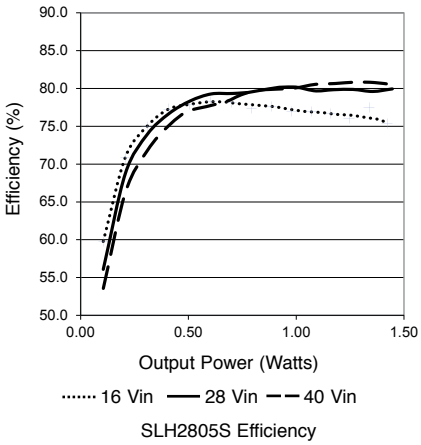
Vin 16 to 40 to 16 Volts, full resistive load
Representative of Single Output Line Transient
FIGURE 9



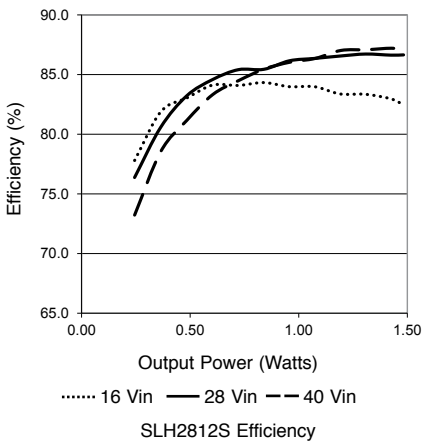
Representative of Single Output Load Transient
FIGURE 10



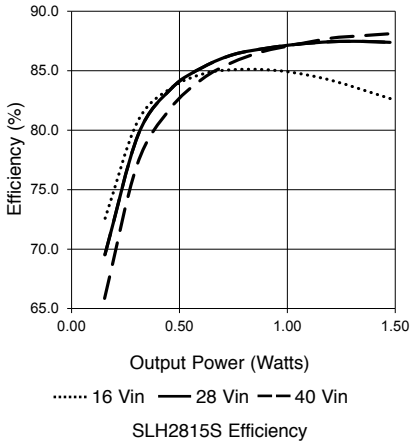
Representative of Single Output Turn-On Delay
FIGURE 11



SLH2805S Efficiency
FIGURE 12



SLH2812S Efficiency
FIGURE 13

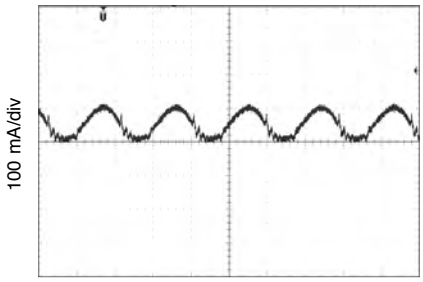


SLH2815S Efficiency
FIGURE 14

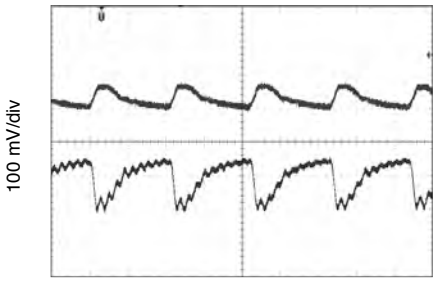
SLH Single and Dual DC-DC Converters

16 TO 40 VOLT INPUT – 1.5 WATT

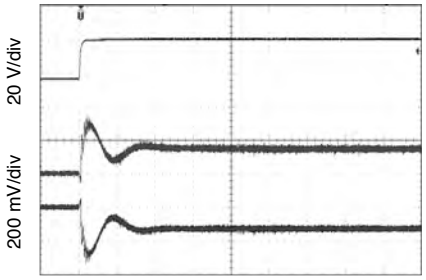
TYPICAL PERFORMANCE PLOTS: 28 VIN, 25°C CASE, 100% LOAD, UNLESS OTHERWISE SPECIFIED.
These are examples for reference only and are not guaranteed specifications.



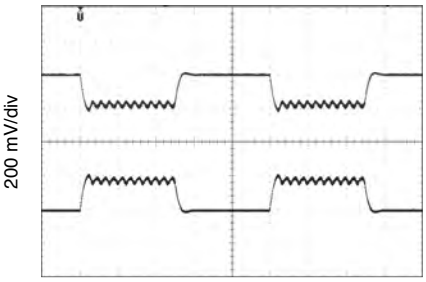
2 µs/div
6 µH inductor in series with input
Representative of Dual Input Ripple Current
FIGURE 15



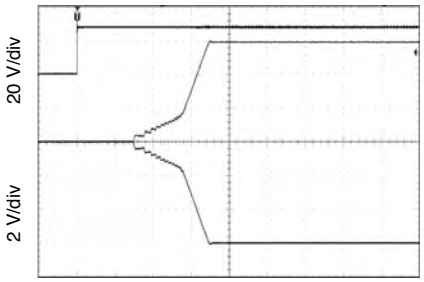
2 µs/div
Representative of Dual Output Ripple Voltage
FIGURE 16



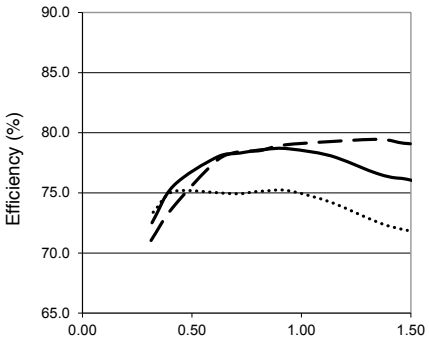
100 µs/div
Vin 16 to 40 to 16 Volts, full resistive load
Representative of Single Output Line Transient
FIGURE 17



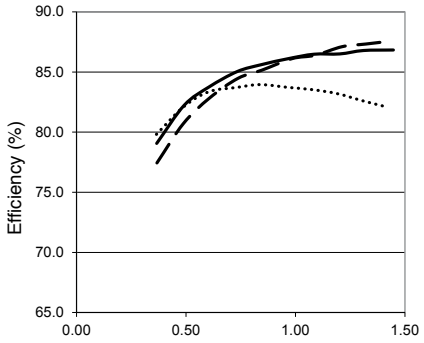
400 µs/div
Representative of Dual Output Load Transient
FIGURE 18



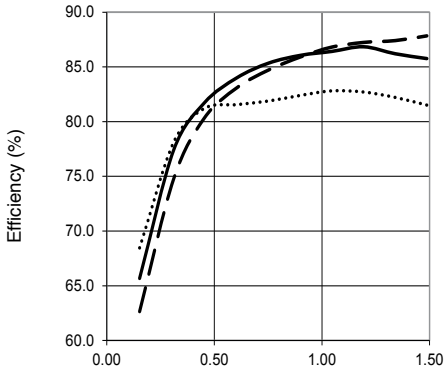
1 ms/div
Representative of Dual Output Turn-On Delay
FIGURE 19



SLH2805D Efficiency
FIGURE 20



SLH2812D Efficiency
FIGURE 21

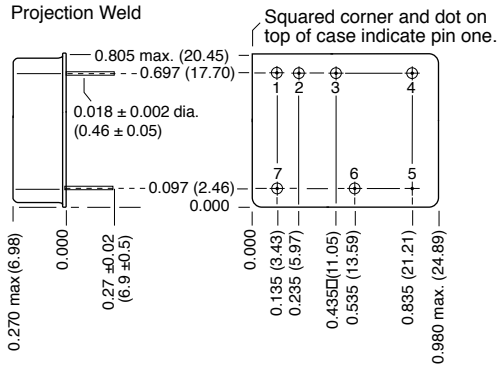


SLH2815D Efficiency
FIGURE 22

SLH Single and Dual DC-DC Converters

16 TO 40 VOLT INPUT – 1.5 WATT

BOTTOM VIEW CASE A2



Weight: 12 grams typical

Case dimensions in inches (mm)
Tolerance ±0.005 (0.13) for three decimal places
±0.01 (0.3) for two decimal places
unless otherwise specified

CAUTION
Solder pins individually with heat application not exceeding 300°C for 10 seconds per pin.

Materials

Header	Kovar/Nickel/Gold
Cover	Kovar/Nickel
Pins	Kovar/Nickel/Gold matched glass seal Gold plating of 50 - 225 microinches included in pin diameter Seal hole: 0.056 ±0.001 (1.42 ±0.03)

Please refer to the numerical dimensions for accuracy.

FIGURE 23: CASE A2

SLH Single and Dual DC-DC Converters

16 TO 40 VOLT INPUT – 1.5 WATT

Element Evaluation Space DC-DC Converters Prototype, Class H and Class K

	NON-QML [1]	QML [2]			
	Prototype	Class H		Class K	
	/O	/H		/K	
Component-Level Test Performed	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				■	

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.

Definitions
Element Evaluation: Component testing/screening per MIL-STD-883 as determined by MIL-PRF-38534
SEM: scanning electron microscopy

Table 8: Element Evaluation

SLH Single and Dual DC-DC Converters

16 TO 40 VOLT INPUT – 1.5 WATT

ENVIRONMENTAL SCREENING SPACE DC-DC CONVERTERS PROTOTYPE, CLASS H AND CLASS K, RHA [1] P, L AND R

	NON-QML [2]	QML [3]					
	PROTOTYPE	CLASS H			CLASS K		
TEST PERFORMED	/OO [4]	/HP	/HL	/HR	/KP	/KL	/KR
Non-destruct wire bond pull, Method 2023		■ [5]	■ [5]	■ [5]	■	■	■
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		■ [5]	■ [5]	■ [5]	■	■	■
Pre burn-in test, Group A, Subgroups 1 and 4	■	■ [5]	■ [5]	■ [5]	■	■	■
Burn-in Method 1015, +125°C case, typical [6]							
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					■ [5]	■ [5]	■ [5]
Final visual inspection, Method 2009	■	■	■	■	■	■	■
RHA P: 30 krad(Si) total dose [1, 7, 8]		■			■		
RHA L: 50 krad(Si) total dose [1, 7, 8]			■			■	
RHA R: 100 krad(Si) total dose [1, 7, 8]				■			■
SEE, LET 86 MeV cm^2/mg [1, 9]		■	■	■	■	■	■

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 "P", "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. "O" in the RHA designator position in Interpoint model numbers indicates DLA RHA "-" defined as no RHA.
5. Not required by DLA but performed to assure product quality.
6. Burn-in temperature designed to bring the case temperature to +125°C minimum. Burn-in is a powered test.
7. High dose rate test.
8. Low dose rate test.
9. No destructive events or SEL.

TABLE 9: ENVIRONMENTAL SCREENING AND RHA LEVELS