DC/DC CONVERTERS 28 VOLT INPUT

SMHF SERIES SINGLE AND DUAL 15 WATT

FEATURES

- **Fully qualified to Class H or K**
- **Radiation hardened**
- **–55° to +125°C operation**
- **16 to 40 VDC input**
- Fully Isolated
- Red hard optocoupler feedback
- Fixed frequency, 550 kHz typical
- Topology – Single Ended Forward
- Transient protection 50 V/120 ms
- Inhibit function
- Sync function
- Indefinite short circuit protection
- Undervoltage lockout
- Up to 84% efficiency

MODELS	
VDC OUTPUT	
SINGLE	DUAL
3.3	±5
5	±12
12	±15
15	

Size (max.): Non flanged 1.460 x 1.130 x 0.330 (37.08 x 28.70 x 8.38 mm)
Flanged 2.005 x 1.130 x 0.330 (50.93 x 28.70 x 8.38 mm)
See Figures 21 through 24 for dimensions.
Weight: 30 grams maximum.
Screening: Standard, Class H, or Class K (MIL-PRF-38534)
Radiation hardness levels O, L, and R

DESCRIPTION

The SMHF Series™ of 28 V DC/DC converters offers a wide input voltage range of 16 to 40 volts and up to 15 watts of output power. The units are capable of withstanding short term transients up to 50 volts. The package is a hermetically sealed, seam-welded metal case. Flanged and non-flanged models are available.

SCREENING AND REPORTS

SMHF converters offer three screening options (Standard, Class H, or Class K) and three levels of radiation hardness (O, L, and R). See Tables 1, 2, and 3 for more information. Detailed reports on product performance are also available and are listed in Table 4.

CONVERTER DESIGN

The SMHF converters are switching regulators that use a quasi-square wave, single-ended forward converter design with a constant switching frequency of 550 kHz. Isolation between input and output circuits is provided with a transformer in the forward path and a temperature compensated opto-coupler in the feedback control loop. The opto-coupler is radiation hardened and is especially selected for space applications.

For the SMHF dual output models, cross regulation is maintained by tightly coupled output magnetics. Up to 70% of the total output power is available from either output, providing the opposite output is simultaneously carrying 30% of the total output power. Predictable current limit is accomplished by directly monitoring the output load current and providing a constant current output above the overload point.

HIGHER POWER DENSITY

The SMHF Series offers a new standard of performance for small size and high power density. At just 0.33 inch high and a total footprint of 1.7 in^2, this low profile package offers a total power density of up to 30 watts per cubic inch.

LOW NOISE, HIGH AUDIO REJECTION

The SMHF converters' feed-forward compensation system provides excellent dynamic response and noise rejection. Audio rejection is typically 50 dB. Typical output voltage response for a 50% to 100% step load transient is as low as 1.3% with a 150 msec recovery time. Input ripple current is typically 35 mA p-p with output ripple voltage typically 30 mV p-p .

INHIBIT FUNCTION

SMHF converters provide an inhibit terminal that can be used to disable internal switching, resulting in no output and very low quiescent input current. The converter is inhibited when a TTL compatible low (≤0.8 – output disabled) is applied to the inhibit pin. The unit is enabled when the pin, which is internally connected to a pull-up resistor, is left unconnected or is connected to an open-collector gate. The open circuit output voltage associated with the inhibit pin is 8.5 to 12 VDC. In the inhibit mode, a maximum of 12 mA must be sunk from the inhibit pin at 28 VDC input.

SYNCHRONIZATION

A synchronization feature is included with the SMHF Series that allows the user to match the switching frequency of the converter to the frequency of the system clock. An external synchronization feature is included that allows the user to adjust the nominally 550kHz operating frequency to any frequency within the range of 500 kHz to 600 kHz. This is initiated by applying a TTL compatible input of the desired frequency to pin 5.

SHORT CIRCUIT PROTECTION

SMHF Series converters provide short circuit protection by restricting the output current to approximately 115% of the full load output current. The output current is sensed in the secondary stage to provide highly predictable and accurate current limiting, and to eliminate foldback characteristics.

UNDERVOLTAGE LOCKOUT

Undervoltage lockout prevents the units from operating below approximately 14 VDC input voltage to keep system current levels smooth, especially during initialization or re-start operations.

SMHF SERIES SINGLE AND DUAL 15 WATT

DC/DC CONVERTERS

ABSOLUTE MAXIMUM RATINGS

Input Voltage
- 16 to 40 VDC

Power Dissipation (Pd)
- 8 W

Output Power
- 12 to 15 watts depending on model

Lead Soldering Temperature (10 sec per lead)
- 300°C

Storage Temperature Range (Case)
- –65°C to +150°C

RECOMMENDED OPERATING CONDITIONS

Input Voltage Range
- 16 to 40 VDC continuous
- 0 V for up to 50 msec transient

Case Operating Temperature (Tc)
- –55°C to +125°C full power
- –55°C to +135°C absolute

Derating Output Power/Current (Tc)
- Linearly from 100% at 125°C to 0% at 135°C

SYNC AND INHIBIT

Sync In (500 to 600 kHz)
- Duty cycle 40% to 60%
- Logic low 0.8 V max
- Logic high 4.5 V min, 5 V max
- Referenced to input common
- If not used, connect to input common

Inhibit TTL Open Collector
- Logic low (output disabled)
  Logic low voltage ≤0.8 V max
  Inhibit pin current 4.0 mA max
- Referenced to input common
- Logic high (output enabled)
  Open collector or unconnected

TYPICAL CHARACTERISTICS

Output Voltage Temperature Coefficient
- 100 ppm /°C typical
- 150 ppm/°C maximum

Input to Output Capacitance
- 60 pF typical

Undervoltage Lockout
- 12 V input typical

Current Limit
- 115% of full load typical

Isolation
- 100 megohm minimum at 500 V

Audio Rejection
- 50 dB typical

Conversion Frequency (º55°C to +125°C Tc)
- Free run 550 kHz typical
  480 kHz min, 620 kHz max

Inhibit Pin Voltage (unit enabled)
- 8.5 to 12 V

Electrical Characteristics: 25°C Tc, 28 VDC Vin, 100% load, radiation level O, unless otherwise specified.

SINGLE OUTPUT MODELS		SMHF283R3S			SMHF2805S			SMHF2812S			SMHF2815S			
OUTPUT VOLTAGE	Tc = 25°C	3.27	3.3	3.33	4.95	5	5.05	11.88	12	12.12	14.85	15	15.15	VDC
OUTPUT CURRENT	V_{IN} = 16 TO 40 VDC	—	—	2.4	—	—	2.4	—	—	1.25	—	—	1.00	A
OUTPUT POWER	V_{IN} = 16 TO 40 VDC	0	—	8	0	—	12	0	—	15	0	—	15	W
OUTPUT RIPPLE	10 kHz - 2 MHz	—	60	160	—	30	80	—	60	160	—	60	75	mV p-p
VOLTAGE	Tc = –55°C TO +125°C	—	80	240	—	150	240	—	50	120	—	100	260	
LINE REGULATION	V_{IN} = 16 TO 40 VDC	—	5	100	—	5	100	—	5	100	—	5	100	mV
LOAD REGULATION	NO LOAD TO FULL	—	20	50	—	20	50	—	20	50	—	20	50	mV
INPUT VOLTAGE	CONTINUOUS	16	28	40	16	28	40	16	28	40	16	28	40	VDC
NO LOAD TO FULL	TRANSIENT 120 ms	0	—	50	0	—	50	0	—	50	0	—	50	V
INPUT CURRENT	NO LOAD	—	25	65	—	25	40	—	25	50	—	25	62	mA
	FULL LOAD	—	—	397	—	560	624	—	680	752	—	670	752	
	INHIBITED	—	5	12	—	5	12	—	5	12	—	5	12	
INPUT RIPPLE	10k Hz - 10 MHz	—	45	80	—	35	80	—	35	80	—	35	80	mA p-p
CURRENT	Tc = –55°C TO +125°C	—	—	120	—	—	120	—	—	120	—	—	120	
EFFICIENCY	Tc = 25°C	70	73	—	73	75	—	78	79	—	74	80	—	%
LOAD FAULT[1]	SHORT CIRCUIT POWER DISSIPATION	—	5	8	—	3.5	8	—	3.5	8	—	3.5	7	W
	RECOVERY[2]	—	7.5	30	—	7.5	30	—	7.5	30	—	7.5	30	ms
STEP LOAD RESPONSE	50 %–100%– 50% TRANSIENT	–400	150	500	–500	150	500	–700	150	700	–800	200	800	mV pk
	RECOVERY[2]	—	150	300	—	150	300	—	150	500	—	600	1200	µs
STEP LINE RESPONSE	16 TO 40 TO 16 V_{IN} TRANSIENT[3]	–800	550	800	–800	550	800	–800	550	800	–800	550	800	mV pk
	RECOVERY[2]	—	0.8	1.2	—	0.8	1.2	—	0.8	1.2	—	0.8	1.2	µs
START-UP	DELAY	—	10	25	—	10	25	—	10	25	—	10	25	µs
0 TO 28 VIN	OVERSHOOT[4]	—	200	300	—	100	600	—	200	1200	—	200	1500	mV pk

Notes
1. Indefinite short circuit protection not guaranteed above 125°C (case)
2. Recovery time is measured from application of the transient to the point at which Vout is within regulation.
3. Input step transition time >10µs.
4. Input step transition time <100µs.

Electrical Characteristics: 25°C Tc, 28 VDC Vin, 100% load, radiation level O, unless otherwise specified.

DUAL OUTPUT MODELS		SMHF2805D			SMHF2812D			SMHF2815D			
PARAMETER	**CONDITIONS**	**MIN**	**TYP**	**MAX**	**MIN**	**TYP**	**MAX**	**MIN**	**TYP**	**MAX**	**UNITS**
OUTPUT VOLTAGE	$+V_{OUT}$	4.95	5.00	5.05	11.88	12.00	12.12	14.85	15.00	15.15	VDC
	$-V_{OUT}$	4.92	5.00	5.08	11.82	12.00	1218	14.78	15.00	15.23	
OUTPUT CURRENT[1]	V_{IN} = 16 to 40 VDC	—	±1.2	1.68	—	±0.625	0.875	—	±0.500	0.700	A
OUTPUT POWER[1]	V_{IN} = 16 to 40 VDC	—	—	12	—	—	15	—	—	15	W
OUTPUT RIPPLE	10 kHz - 2 MHz	—	60	160	—	70	175	—	70	175	mV p-p
VOLTAGE $\pm V_{OUT}$	Tc = –55°C to +125°C	—	100	240	—	100	275	—	100	275	
LINE REGULATION	BALANCED $+V_{OUT}$	—	5	50	—	5	50	—	5	50	mV
Vin = 16 to 40 VDC	LOAD $-V_{OUT}$	—	—	100	—	—	100	—	—	100	
LOAD REGULATION	BALANCED $+V_{OUT}$	—	20	50	—	20	50	—	20	50	mV
	LOAD $-V_{OUT}$	—	—	150	—	—	150	—	—	150	
CROSS REGULATION[2]	NEGATIVE V_{OUT}	—	6	7.5	—	3	6	—	3	6	%
INPUT VOLTAGE	CONTINUOUS	16	28	40	16	28	40	16	28	40	VDC
NO LOAD TO FULL	TRANSIENT 50 msec	—	—	50	—	—	50	—	—	50	V
INPUT CURRENT	NO LOAD	—	20	50	—	25	50	—	25	50	mA
	FULL LOAD	—	540	600	—	645	754	—	638	754	
	INHIBITED	—	6	12	—	5	12	—	5	12	
INPUT RIPPLE	10 kHz - 10 MHz	—	30	80	—	40	80	—	40	80	mA p-p
CURRENT	Tc = –55°C to +125°C	—	60	120	—	55	120	—	55	120	
EFFICIENCY		75	77	—	74	81	—	74	82	—	%
LOAD FAULT	SHORT CIRCUIT[3] POWER DISSIPATION	—	3	8	—	3	6	—	3	6	W
	RECOVERY[4]	—	7.5	30	—	7.5	50	—	7.5	50	ms
STEP LOAD RESP.[5]	50% – 100% – 50%										
BALANCED LOADS	TRANSIENT $+V_{OUT}$	–600	200	600	–600	300	600	–600	300	600	mV pk
	$-V_{OUT}$	–600	150	600	–600	100	500	–600	100	600	
	RECOVERY[4]	—	150	500	—	200	500	—	200	600	µs
STEP LINE RESP.	16 – 40 – 40 VDC										
$\pm V_{OUT}$	TRANSIENT[6]	–800	600	800	–750	550	750	–750	550	750	mV pk
	RECOVERY[4]	—	0.8	1.2	—	0.8	1.2	—	0.8	1.2	ms
START-UP	DELAY	—	12	30	—	12	25	—	12	25	ms
	OVERSHOOT[7]	0	100	500	0	200	500	0	200	500	mV pk

Notes

1. Up to 70% of the total output power is available from either output providing the opposite output is simultaneously carrying 30% of the total output power. Each output must carry a minimum of 30% of the total output power in order to maintain regulation on the negative outputs.
2. Effect on –Vout for the following conditions, percentages are of total power:
   +Po = 50% to 10% and –Po = 50%
   +Po = 50% and –Po = 50% to 10%
3. Indefinite short circuit protection not guaranteed above 125°C (case)
4. Recovery time is measured from application of the transient to point at which Vout is within regulation.
5. Response of either output with the opposite output held at half of the total output power.
6. Input step transition time >10µs.
7. Input step transition time <100µs.

BLOCK DIAGRAM

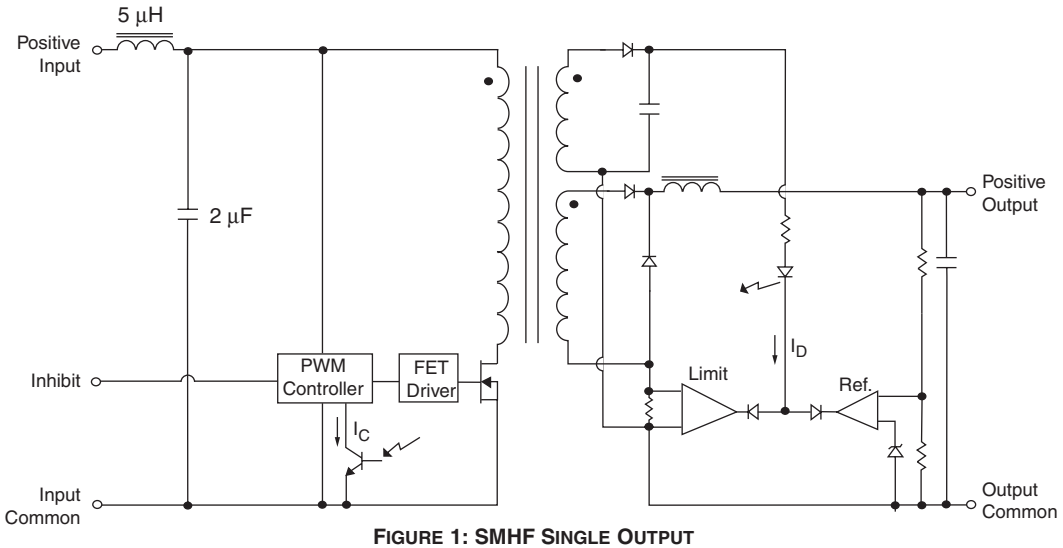
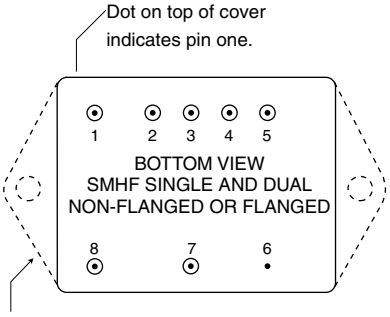


FIGURE 1: SMHF SINGLE OUTPUT

PIN OUT

Pin	Single Output	Dual Output
1	Inhibit	Inhibit
2	No connection	Positive Output
3	Output Common	Output Common
4	Positive Output	Negative Output
5[1]	Sync	Sync
6	Case Ground	Case Ground
7	Input Common	Input Common
8	Positive Input	Positive Input

1. If Sync is not used, pin 5 should be connected to input common.



See Figures 21 through 24 for dimensions.

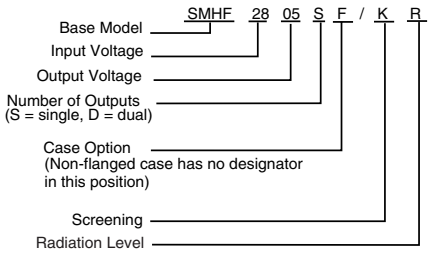
FIGURE 2: PIN OUT

SMD NUMBERS

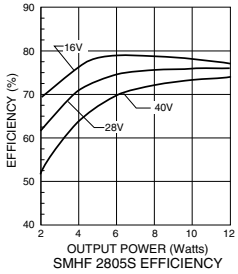
STANDARD MICROCIRCUIT DRAWING (SMD)	SMHF SIMILAR PART
5962-9213902HXC	SMHF2805S/HO
IN PROCESS	SMHF2812S/HO
5962-9160102HXC	SMHF2815S/HO
5962-9555902HXC	SMHF2805D/HO
5962-9214402HXC	SMHF2812D/HO
5962-9161402HXC	SMHF2815D/HP

To indicate the flanged case option change the "X" to "Z" In the SMD number. The SMD number shown is for Class H screening, non-flanged, and no Radiation Hardness Assurance (RHA) level. See the SMD for the numbers for other screening and radiation levels. For exact specifications for an SMD product, refer to the SMD drawing. Call your Interpoint representative for status on the SMHF SMD releases which are "in process." SMDs can be downloaded from http://www.dscc.dla.mil/programs/smcr

MODEL NUMBERING KEY

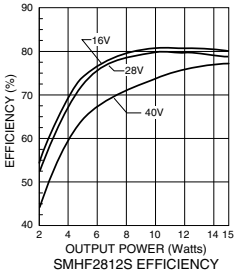


Typical Performance Curves: 25°C Tc , 28 VDC Vin, 100% load, free run, unless otherwise specified.



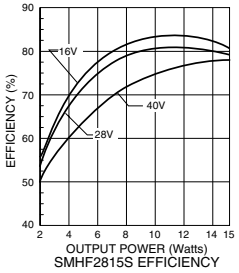
SMHF 2805S EFFICIENCY

FIGURE 3



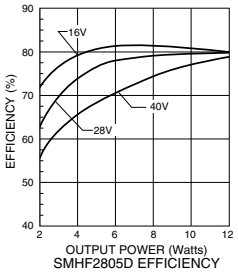
SMHF2812S EFFICIENCY

FIGURE 4



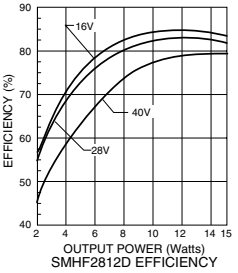
SMHF2815S EFFICIENCY

FIGURE 5



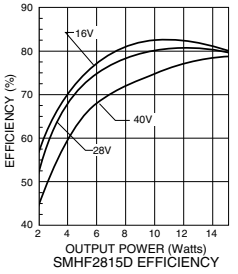
SMHF2805D EFFICIENCY

FIGURE 6



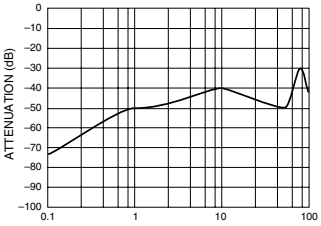
SMHF2812D EFFICIENCY

FIGURE 7



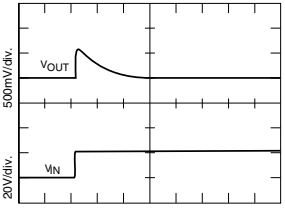
SMHF2815D EFFICIENCY

FIGURE 8



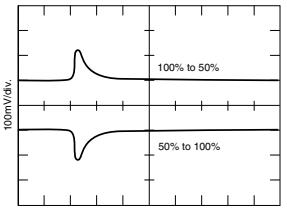
SMHF SERIES AUDIO REJECTION

FIGURE 9



16V TO 40V
SMHF2805S STEP LINE RESPONSE

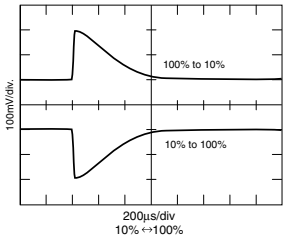
FIGURE 10



50% ↔ 100%
SMHF2805S STEP LOAD RESPONSE

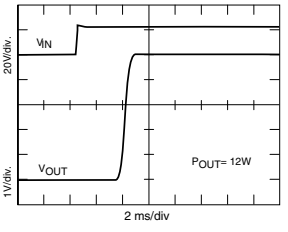
FIGURE 11

Typical Performance Curves: 25°C Tc , 28 VDC Vin, 100% load, free run, unless otherwise specified.



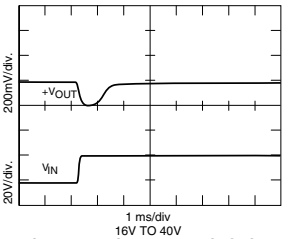
SMHF2805S STEP LOAD RESPONSE

FIGURE 12



SMHF2805S TURN-ON INTO FULL LOAD

FIGURE 13



SMHF2815D STEP LINE RESPONSE

FIGURE 14

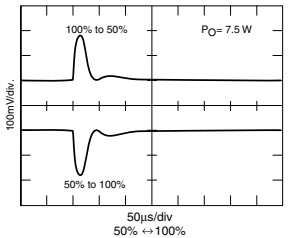
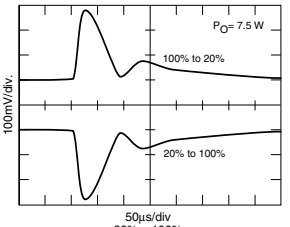
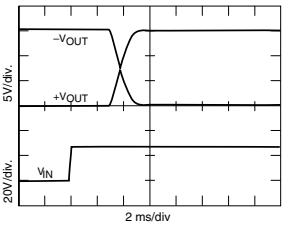


FIGURE 15



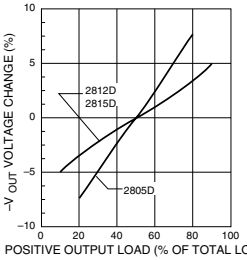
SMHF+2815D V_{OUT} STEP LOAD RESPONSE

FIGURE 16



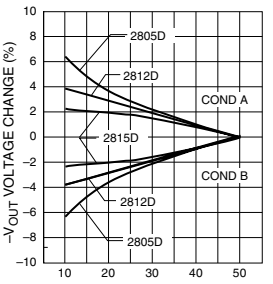
SMHF2815D TURN-ON INTO FULL LOAD

FIGURE 17



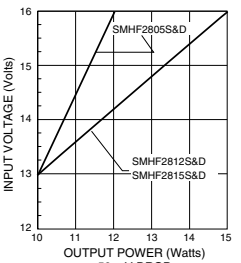
$-V_{OUT}$ WITH SHIFT IN LOAD BALANCE
CROSS REGULATION

FIGURE 18



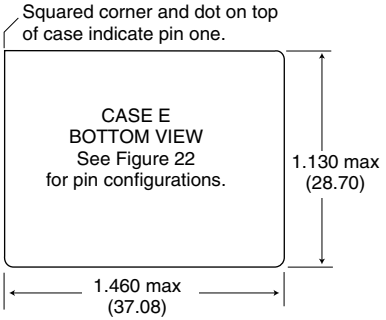
COND. A: 50% LOAD +V; 50% to 10% –V
COND. B: 50% LOAD –V; 50% to 10% +V
SMHF2805D/SMHF2812D/SMHF2815D
CROSS REGULATION

FIGURE 19



50 mV DROP
LOW LINE DROPOUT VS. LOAD

FIGURE 20



Materials

Header	Cold Rolled Steel/Nickel/Gold
Cover	Kovar/Nickel (SMHF Series Cold Rolled Steel/Nickel/Gold)
Pins	#52 alloy/Gold compression glass seal

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

Heat from reflow or wave soldering may damage the device. Solder pins individually with heat application not exceeding 300°C for 10 seconds per pin.

FIGURE 21: CASE E MAXIMUM DIMENSIONS

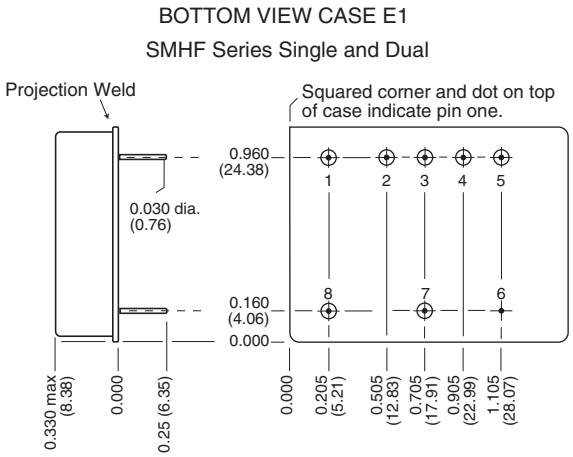
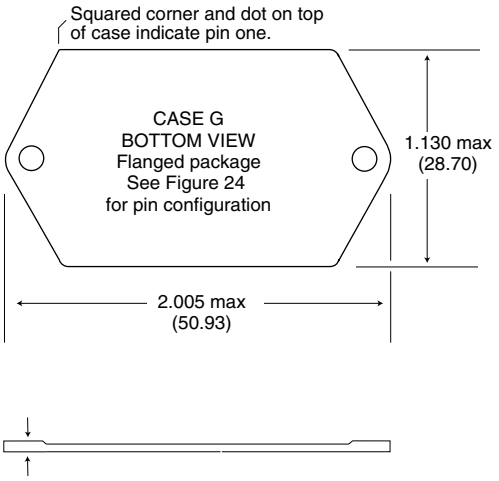


FIGURE 22: CASE E1

Note: Although every effort has been made to render the case drawings at actual size, variations in the printing process may cause some distortion. Please refer to the numerical dimensions for accuracy.



Flange Thickness: 0.047 (1.19)

Materials

Header Cold Rolled Steel/Nickel/Gold
Cover MHF+ Series and FMH Filter
Kovar/Nickel
SMHF
Cold Rolled Steel/Nickel
Pins #52 alloy (all cases)
compression glass seal

Case dimensions in inches (mm)

Tolerance ±0.005 (0.13) for three decimal places
±0.01 (0.2) for two decimal places
unless otherwise specified

CAUTION

Heat from reflow or wave soldering may damage the device. Solder pins individually with heat application not exceeding 300°C for 10 seconds per pin.

FIGURE 23: CASE G MAXIMUM DIMENSIONS

BOTTOM VIEW CASE G1

Flanged cases: Designator "F" required in Case Option position of model number
SMHF Series Single and Dual

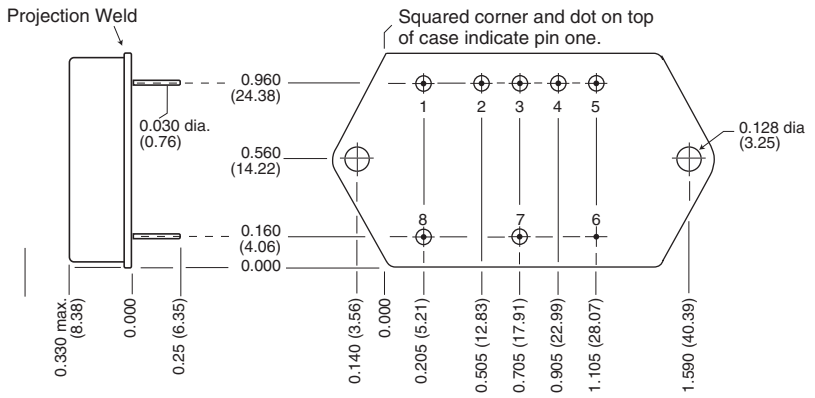


FIGURE 24: CASE G1

TABLE 1: ELEMENT EVALUATION

ELEMENT EVALUATION TEST PERFORMED (COMPONENT LEVEL)	SPACE PROTOTYPE (O) M/S	 P	CLASS H M/S	 P	CLASS K M/S	 P
Element Electrical	yes	no	yes	yes	yes	yes
Element Visual	no	no	yes	yes	yes	yes
Internal Visual	no	no	yes	no	yes	no
Temperature Cycling	no	no	no	no	yes	yes
Constant Acceleration	no	no	no	no	yes	yes
Interim Electrical	no	no	no	no	yes	no
Burn-in	no	no	no	no	yes	no
Post Burn-in Electrical	no	no	no	no	yes	no
Steady State Life	no	no	no	no	yes	no
Voltage Conditioning /Aging	no	no	no	no	no	yes
Visual Inspection	no	no	no	no	no	yes
Final Electrical	no	no	yes	yes	yes	yes
Wire Bond Evaluation	no	no	yes	yes	yes	yes
SEM	no	no	no	no	yes	no
SLAM™/C-SAM: Input capacitors only (Add'l test, not req. by H or K)	no	no	no	yes	no	yes

Notes
M/S Active components (Microcircuit and Semiconductor Die)
P Passive components

Definitions
Element Evaluation: Component testing/screening per MIL-STD-883 as determined by MIL-PRF-38534
SEM: Scanning Electron Microscopy
SLAM™: Scanning Laser Acoustic Microscopy
C-SAM: C - Mode Scanning Acoustic Microscopy

TABLE 2: PRODUCT ENVIRONMENTAL SCREENING

ENVIRONMENTAL SCREENING TEST PERFORMED (END ITEM LEVEL)	SPACE PROTOTYPE (O)	CLASS H	CLASS K
Non-destruct bond pull Method 2023	no	no	yes
Pre-cap inspection Method 2017, 2032	yes	yes	yes
Temperature cycle Method 1010, Cond. C	yes	yes	yes
Constant acceleration Method 2001, 3000 g	yes	yes	yes
PIND Test Method 2020, Cond. B	no	yes	yes
Radiography Method 2012	no	no	yes
Pre burn-in test	yes	yes	yes
Burn-in, Method 1015, 125°C			
96 hours	yes	no	no
160 hours	no	yes	no
2 x 160 hour (includes mid BI test)	no	no	yes
Final electrical test MIL-PRF-38534, Group A	yes	yes	yes
Hermeticity test			
Fine Leak, Method 1014, Cond. A	yes	yes	yes
Gross Leak, Method 1014, Cond. C	yes	yes	yes
Final visual inspection Method 2009	yes	yes	yes

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

TABLE 3: RADIATION HARDNESS LEVELS

PRODUCT LEVEL AVAILABILITY	ENVIRONMENTAL SCREENING LEVELS		
RADIATION HARDNESS LEVELS	SPACE PROTOTYPE (O)	CLASS H	CLASS K
O: Standard, no radiation guarantee For system evaluation, electrically and mechanically comparable to H and K level.	OO	HO	Not available
R: Radiation hardened – Tested lots Up to 100 k Rads (Si) total dose SEU guarantee up to 40 MeV	Not available	HR	KR

R is referenced to MIL-PRF-38534, appendix G, Radiation Hardness Assurance (RHA) levels.

TABLE 4:
REPORTS INCLUDED WITH PURCHASE OF PRODUCT HR or KR

1. Radiation Susceptibility Analysis
2. Electrical/Thermal Stress Analysis and Derating Report
3. MTBF Report
4. FMEA Report

HO option: Reports 2, 3, and 4 are included with purchase.
OO option: Select reports available as separate purchases.

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