FEATURES

- **–55° to +125°C operation**
- **16 to 40 VDC input**
- Fully isolated
- Optocoupler feedback
- Fixed frequency, 550 kHz typical
- Topology – Single Ended Forward
- 50 V for up to 50 ms transient protection
- Inhibit and sync functions
- Indefinite short circuit protection
- Undervoltage lockout
- Up to 84% efficiency, 28 W/in^3

DC/DC CONVERTERS 28 VOLT INPUT

MHF+ SERIES SINGLE & DUAL 15 WATT

MODELS

VDC OUTPUT

SINGLE	DUAL
3.3	±5
5	±12
5.2	±15
12	
15	
28	

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)
Weight: 30 grams maximum.
Screening: Standard, ES, or 883 (Class H).

DESCRIPTION

The MHF+ Series™ of high frequency 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, welded metal case. Flanged and non-flanged models are available.

CONVERTER DESIGN

The MHF+ 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 optical link in the feedback control loop.

For the MHF+ dual output models, good cross regulation is maintained by tightly coupled output magnetics. Up to 90% of the total output power (80% on 2805D) is available from either output, providing the opposite output is simultaneously carrying 10% of the total output power (20% on 2805D models). 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 MHF+ 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 28 watts per cubic inch.

LOW NOISE, HIGH AUDIO REJECTION

The MHF+ 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

MHF+ 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 V. In the inhibit mode, a maximum of 4 mA must be sunk from the inhibit pin.

SYNCHRONIZATION

A synchronization feature is included with the MHF+ 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 550 kHz 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

MHF+ 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 12 VDC input voltage to keep system current levels smooth, especially during initialization or re-start operations.

MHF+ SERIES SINGLE AND DUAL 15 WATT

DC/DC CONVERTERS

ABSOLUTE MAXIMUM RATINGS

Input Voltage
- 16 to 40 VDC

Power Dissipation (Pd)
- 6 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
- 50 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
  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 (55°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, free run, unless otherwise specified.

SINGLE OUTPUT MODELS		MHF+283R3S			MHF+2805S			MHF+285R2S			
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	UNITS
OUTPUT VOLTAGE		3.27	3.30	3.33	4.95	5.00	5.05	5.16	5.20	5.24	VDC
OUTPUT CURRENT	V_{IN} = 16 to 40 VDC	0	—	2.4	0	—	2.4	0	—	2.4	A
OUTPUT POWER	V_{IN} = 16 to 40 VDC	0	—	8	0	—	12	0	—	12.48	W
OUTPUT RIPPLE	10 kHz - 2 MHz	—	30	80	—	30	80	—	30	50	mV p-p
VOLTAGE	Tc = –55°C to +125°C	—	50	120	—	60	100	—	60	100	
LINE REGULATION	Vin = 16 to 40 VDC	—	5	100	—	5	50	—	5	35	mV
LOAD REGULATION	NO LOAD TO FULL	—	20	50	—	20	50	—	20	35	mV
INPUT VOLTAGE	CONTINUOUS	16	28	40	16	28	40	16	28	40	VDC
NO LOAD TO FULL	TRANSIENT 50 ms	—	—	50	—	—	50	—	—	50	V
INPUT CURRENT	NO LOAD	—	25	65	—	25	40	—	25	42	mA
	FULL LOAD	—	—	397	—	560	624	—	560	605	
	INHIBITED	—	5	12	—	5	12	—	5	12	
INPUT RIPPLE	10 kHz - 10 MHz	—	45	80	—	35	80	—	35	100	mA pp
CURRENT	Tc = –55°C to +125°C	—	—	120	—	—	100	—	—	100	
EFFICIENCY		72	75	—	75	77	—	75	77	—	%
LOAD FAULT[1]	SHORT CIRCUIT POWER DISSIPATION	—	5	8	—	3.5	6	—	3.5	6	W
	RECOVERY[2]	—	7.5	30	—	7.5	30	—	7.5	30	ms
STEP LOAD RESP.	50% – 100% – 50% TRANSIENT	–400	150	500	–400	150	400	–400	150	400	mV pk
	RECOVERY[2]	—	150	300	—	150	300	—	150	300	µs
STEP LINE RESP.	16 – 40 – 16 VDC TRANSIENT[3]	–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	ms
START-UP	DELAY	—	10	25	—	10	25	—	10	25	ms
	OVERSHOOT[4]	—	200	300	—	100	600	—	100	600	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 >10 µs.
4. Input step transition time <100 µs.

Electrical Characteristics: 25°C Tc, 28 VDC Vin, 100% load, free run, unless otherwise specified.

SINGLE OUTPUT MODELS		MHF+2812S			MHF+2815S			MHF+2828S			
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	UNITS
OUTPUT VOLTAGE		11.88	12.00	12.12	14.85	15.00	15.15	27.72	28.00	28.28	VDC
OUTPUT CURRENT	V_{IN} = 16 to 40 VDC	0	—	1.25	0	—	1.00	0	—	0.54	A
OUTPUT POWER	V_{IN} = 16 to 40 VDC	0	—	15	0	—	15	0	—	15	W
OUTPUT RIPPLE	10 kHz - 2 MHz	—	30	80	—	30	80	—	60	120	mV p-p
VOLTAGE	Tc = –55°C to +125°C	—	50	120	—	50	120	—	100	180	
LINE REGULATION	Vin = 16 to 40 VDC	—	5	50	—	5	50	—	50	150	mV
LOAD REGULATION	NO LOAD TO FULL	—	20	50	—	20	50	—	50	150	mV
INPUT VOLTAGE	CONTINUOUS	16	28	40	16	28	40	16	28	40	VDC
NO LOAD TO FULL	TRANSIENT 50 ms	—	—	50	—	—	50	—	—	50	V
INPUT CURRENT	NO LOAD	—	25	50	—	25	62	—	25	60	mA
	FULL LOAD	—	680	752	—	670	752	—	640	760	
	INHIBITED	—	5	12	—	5	12	—	5	12	
INPUT RIPPLE	10 kHz - 10 MHz	—	35	80	—	35	80	—	35	80	mA pp
CURRENT	Tc = –55°C to +125°C	—	—	120	—	—	120	—	—	120	
EFFICIENCY		78	79	—	78	80	—	82	84	—	%
LOAD FAULT[1]	SHORT CIRCUIT POWER DISSIPATION	—	3.5	6	—	3.5	6	—	3.5	6	W
	RECOVERY[2]	—	7.5	30	—	7.5	30	—	7.5	30	ms
STEP LOAD RESP.	50% – 100% – 50% TRANSIENT	–500	150	500	–600	200	600	–800	600	800	mV pk
	RECOVERY[2]	—	150	300	—	150	300	—	200	400	µs
STEP LINE RESP.	16 – 40 – 40 VDC TRANSIENT[3]	–800	550	800	–800	550	800	–1200	1100	1200	mV pk
	RECOVERY[2]	—	0.8	1.2	—	0.8	1.2	—	0.8	1.2	ms
START-UP	DELAY	0	10	25	0	10	25	0	10	25	ms
	OVERSHOOT[4]	0	200	1200	0	200	1500	0	200	280	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 point at which Vout is within regulation.
3. Input step transition time >10 µs.
4. Input step transition time <100 µs.

DC/DC CONVERTERS

Electrical Characteristics: 25°C Tc, 28 VDC Vin, 100% load, free run, unless otherwise specified.

DUAL OUTPUT MODELS		MHF+2805D			MHF+2812D			MHF+2815D			
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	1.92	—	±0.625	1.125	—	±0.500	0.900	A
OUTPUT POWER[1]	V_{IN} = 16 to 40 VDC	—	—	12	—	—	15	—	—	15	W
OUTPUT RIPPLE	10 kHz - 2 MHz	—	30	80	—	30	80	—	30	80	mV p-p
VOLTAGE $\pm V_{OUT}$	Tc = –55°C to +125°C	—	60	120	—	60	120	—	50	120	
LINE REGULATION	BALANCED $+V_{OUT}$	—	5	50	—	5	50	—	5	50	mV
Vin = 16 to 40 VDC	LOAD $-V_{OUT}$	—	—	80	—	—	100	—	—	100	
LOAD REGULATION	BALANCED $+V_{OUT}$	—	20	50	—	20	50	—	20	50	mV
	LOAD $-V_{OUT}$	—	—	100	—	—	100	—	—	100	
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	40	—	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	—	20	50	—	35	60	—	35	60	mA p-p
CURRENT	Tc = –55°C to +125°C	—	40	80	—	50	100	—	50	100	
EFFICIENCY		77	79	—	76	83	—	76	84	—	%
LOAD FAULT	SHORT CIRCUIT[3] POWER DISSIPATION	—	3	6	—	3	6	—	3	6	W
	RECOVERY[4]	—	7.5	30	—	7.5	50	—	7.5	50	ms
STEP LOAD RESP.[5] BALANCED LOADS	50% – 100% – 50% 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	400	—	200	500	µs
STEP LINE RESP. $\pm V_{OUT}$	16 – 40 – 40 VDC 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	20	—	12	25	—	12	25	ms
	OVERSHOOT[7]	0	100	250	0	200	750	0	200	750	mV pk

Notes

1. Up to 13.5 watts, 90% (9.6W, 80% for 2805D) of the total output power is available from either output providing the opposite output is simultaneously carrying 10% (20% for 2805D) of the total output power. Each output must carry a minimum of 10% (20% for 2805D) of the total output power in order to maintain regulation on the negative output.
2. Effect on –Vout for the following conditions:
   +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 >10 µs.
7. Input step transition time <100 µs.

BLOCK DIAGRAM

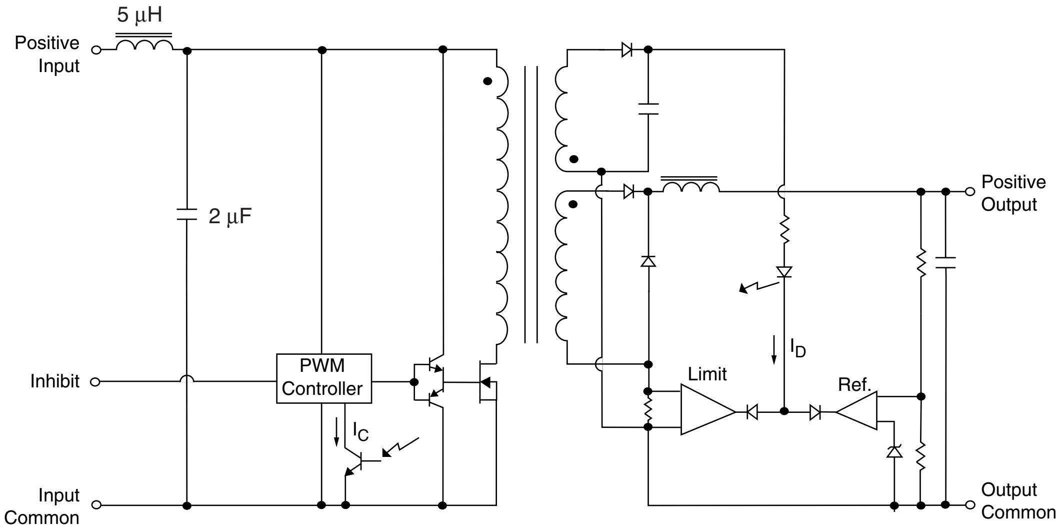
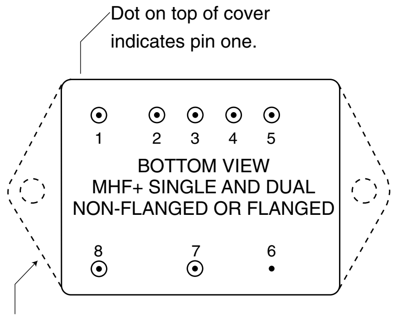


FIGURE 1: MHF+ SINGLE OUTPUT

PIN OUT

Pin	Single Output (Except MHF+2828S)	MHF+2828S	Dual Output
1	Inhibit	Inhibit	Inhibit
2	No connection	Positive Output	Positive Output
3	Output Common	(See note 1, below)	Output Common
4	Positive Output	Output Common	Negative Output
5[2]	Sync	Sync	Sync
6	Case Ground	Case Ground	Case Ground
7	Input Common	Input Common	Input Common
8	Positive Input	Positive Input	Positive Input

1. Pin 3 of MHF+2828S will provide 14 Vout referenced to output common (pin 4).
2. If Sync is not used, pin 5 should be connected to input common.

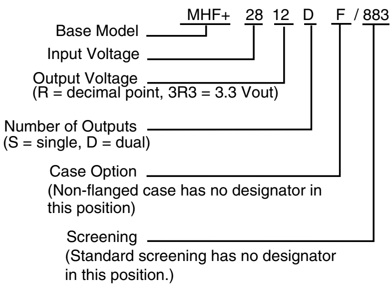


Dotted line outlines flanged package option.

See pages 9 and 10 for dimensions.

FIGURE 2: PIN OUT

MODEL NUMBERING KEY



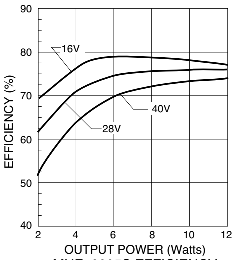
SMD NUMBERS

STANDARD MICROCIRCUIT DRAWING (SMD)	MHF+ SIMILAR PART
IN PROCESS	MHF+283R3S/883
5962-9213901HXC	MHF+2805S/883
IN PROCESS	MHF+285R2S/883
5962-9166401HXC	MHF+2812S/883
5962-9160101HXC	MHF+2815S/883
5962-9689801HXC	MHF+2828S/883
5962-9555901HXC	MHF+2805D/883
5962-9214401HXC	MHF+2812D/883
5962-9161401HXC	MHF+2815D/883

Flanged SMDs have the suffix HZC instead of HXC.

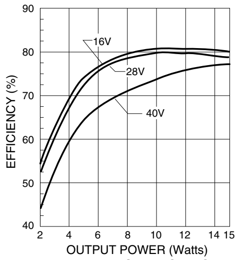
For exact specifications for an SMD product, refer to the SMD drawing. Call your Interpoint representative for status on the MHF+ SMD releases which are “in process”. SMDs can be downloaded from
http://www.dscc.dla.mil/programs/smcr

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



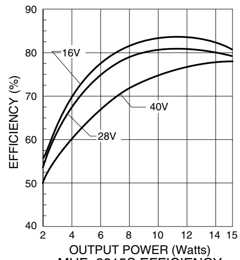
MHF+2805S EFFICIENCY

FIGURE 3



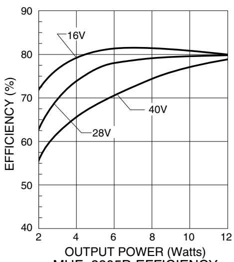
MHF+2812S EFFICIENCY

FIGURE 4



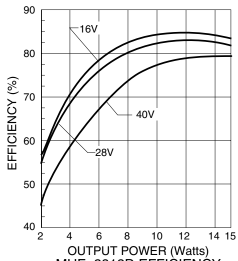
MHF+2815S EFFICIENCY

FIGURE 5



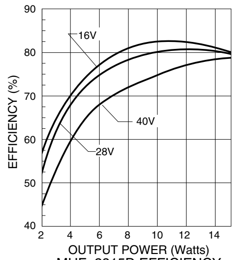
MHF+2805D EFFICIENCY

FIGURE 6



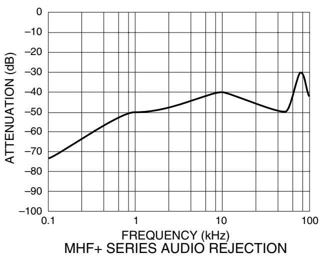
MHF+2812D EFFICIENCY

FIGURE 7



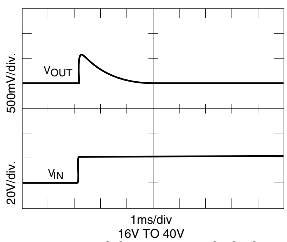
MHF+2815D EFFICIENCY

FIGURE 8



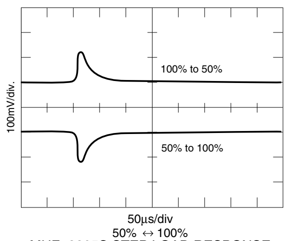
MHF+ SERIES AUDIO REJECTION

FIGURE 9



MHF+2805S STEP LINE RESPONSE

FIGURE 10

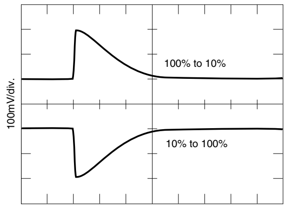


MHF+2805S STEP LOAD RESPONSE

FIGURE 11

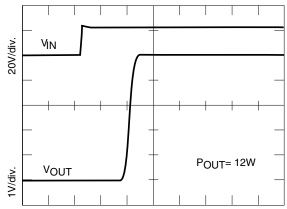
DC/DC CONVERTERS

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



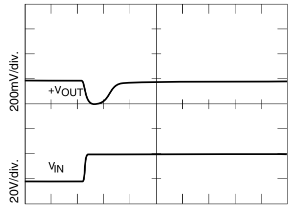
200µs/div
10% ↔100%
MHF+2805S STEP LOAD RESPONSE

FIGURE 12



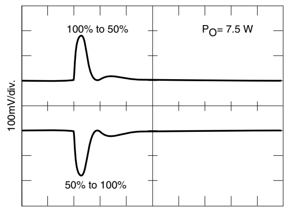
2 ms/div
MHF+2805S TURN-ON INTO FULL LOAD

FIGURE 13



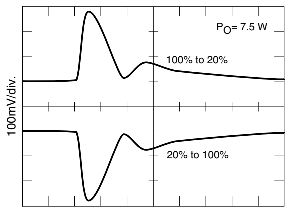
1 ms/div
16V TO 40V
MHF+2815D STEP LINE RESPONSE

FIGURE 14



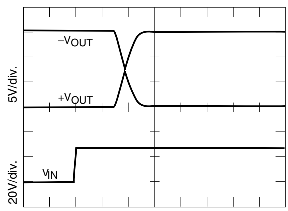
50µs/div
50% ↔ 100%
MHF+2815D $+V_{OUT}$ STEP LOAD RESPONSE

FIGURE 15



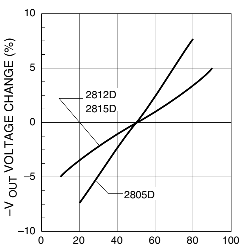
50µs/div
20% ↔100%
MHF+2815D $+V_{OUT}$ STEP LOAD RESPONSE

FIGURE 16



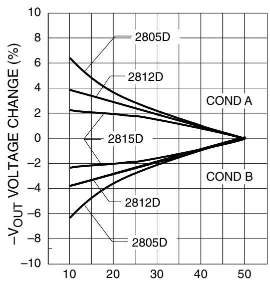
2 ms/div
MHF+2815D TURN-ON INTO FULL LOAD

FIGURE 17



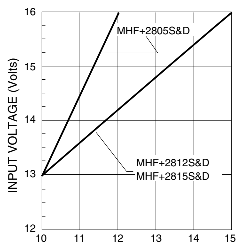
POSITIVE OUTPUT LOAD (% OF TOTAL LOAD)
$-V_{OUT}$ WITH SHIFT IN LOAD BALANCE
CROSS REGULATION

FIGURE 18



OUTPUT LOAD (%)
COND. A: 50% LOAD +V; 50% to 10% −V
COND. B: 50% LOAD −V; 50% to 10% +V
MHF+2805D/MHF+2812D/MHF+2815D
CROSS REGULATION

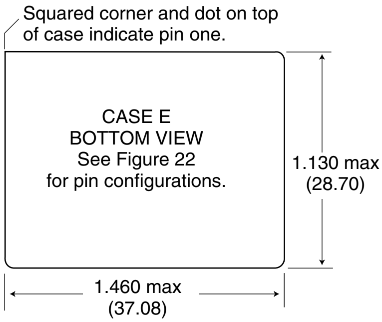
FIGURE 19



OUTPUT POWER (Watts)
50 mV DROP
LOW LINE DROPOUT VS. LOAD

FIGURE 20

CRANE interpoint
A CRANE CO. COMPANY



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

BOTTOM VIEW CASE E1
MHF+ Series Single and Dual: Screening – Standard, ES, or 883

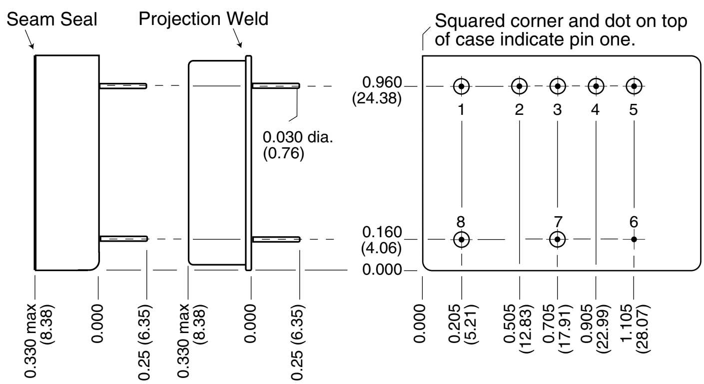
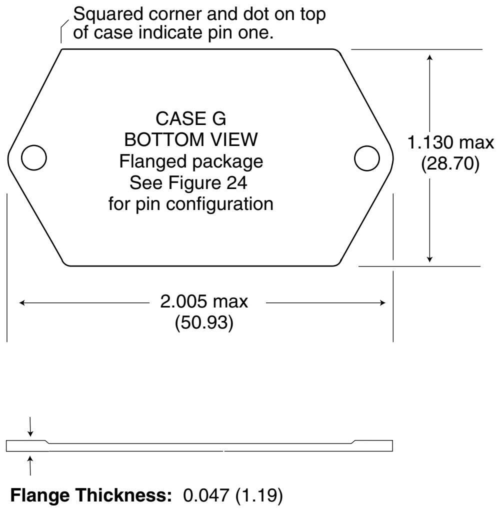


FIGURE 22: CASE E1

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.



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
MHF+ Series Single and Dual: Screening – Standard, ES, or 883

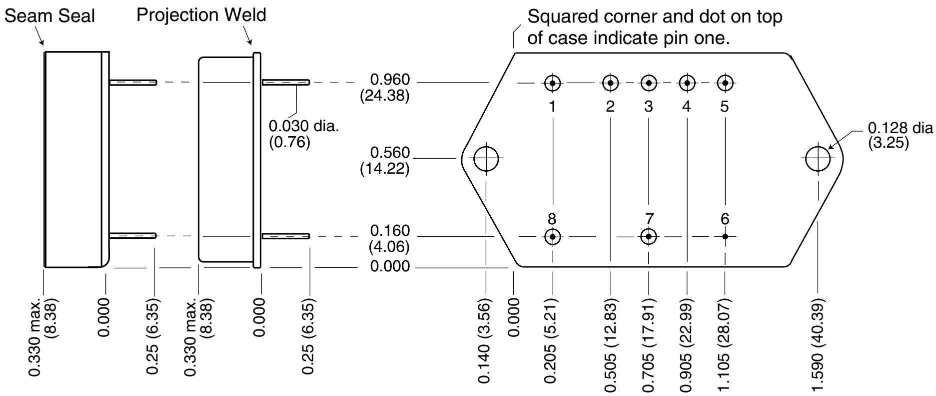


FIGURE 24: CASE G1

TABLE 1: ENVIRONMENTAL SCREENING

TEST	STANDARD	/ES	/883 (Class H)*
PRE-CAP INSPECTION			
Method 2017, 2032	yes	yes	yes
TEMPERATURE CYCLE (10 times)			
Method 1010, Cond. C, -65°C to 150°C	no	no	yes
Method 1010, Cond. B, -55°C to 125°C	no	yes	no
CONSTANT ACCELERATION			
Method 2001, 3000 g	no	no	yes
Method 2001, 500 g	no	yes	no
BURN-IN			
Method 1015, 160 hours at 125°C	no	no	yes
96 hours at 125°C case (typical)	no	yes	no
FINAL ELECTRICAL TEST MIL-PRF-38534, Group A			
Subgroups 1 through 6: -55°C, +25°C, +125°C	no	no	yes
Subgroups 1 and 4: +25°C case	yes	yes	no
HERMETICITY TESTING			
Fine Leak, Method 1014, Cond. A	no	yes	yes
Gross Leak, Method 1014, Cond. C	no	yes	yes
Gross Leak, Dip (1×10^{-3})	yes	no	no
FINAL VISUAL INSPECTION			
Method 2009	yes	yes	yes

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

*883 products are built with element evaluated components and are 100% tested and guaranteed over the full military temperature range of –55°C to +125°C.

Contact Information: **www.interpoint.com**

Interpoint Headquarters USA
Phone: 1-800-822-8782
+425-882-3100
Email: power@intp.com

Interpoint UK
Phone: +44-1252-815511
Email: poweruk@intp.com

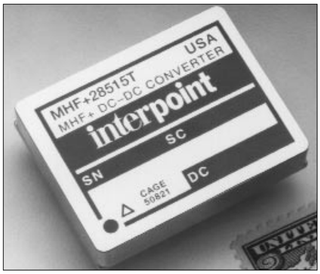
Interpoint France
Phone: +33-134285455
Email: powerfr@intp.com

21621-001-DTS Rev B This revision supercedes all previous releases.

FEATURES
- **–55° to +125°C operation**
- **16 to 48 VDC input**
- Fully Isolated
- Optocoupler feedback
- Fixed frequency 450 kHz
- Topology – Current Mode Flyback
- Transient protection 80 V/120 ms
- Inhibit and sync functions
- Indefinite short circuit protection
- Undervoltage lockout
- Up to 76% efficiency

DC/DC CONVERTERS 28 VOLT INPUT

MHF+ SERIES TRIPLE 15 WATT



MODELS
VDC OUTPUT
TRIPLE OUTPUT
+5 and ±12
+5 and ±15

Size (max.): Non flanged, case E2, 1.460 x 1.130 x 0.330 inches (37.08 x 28.70 x 8.38 mm)
Flanged , case G2, 2.005 x 1.130 x 0.330 inches (50.93 x 28.70 x 8.38 mm)
See Figures 13 - 16 for dimensions.
Weight: 32 grams maximum.
Screening: Standard, ES, or 883 (Class H). See Table 1 for screening options.

DESCRIPTION

Interpoint's MHF+ Series™ Triple DC/DC converters provide a wide input voltage range of 16 to 48 VDC delivering 15 watts of total output power with output voltages of +5 and ±12 or +5 and ±15 VDC. The main output, +5 VDC, will supply up to 7.5 watts and the auxiliaries will supply up to 7.5 watts of combined power. Full power operation at -55° C to +125°C plus the ability to withstand transients of up to 80 V for up to 120 milliseconds make these converters an ideal choice for your high reliability systems.

CONVERTER DESIGN

MHF+ Triple Series of DC/DC converters incorporate dual-phase, phase-shifted technology with a continuous flyback topology. This design eliminates a minimum load requirement on the main output and eliminates cross regulation effects between the main output voltage and the auxiliary output voltages. The phase-shifted design offers a further benefit in reduced input and output ripple.

INHIBIT FUNCTION

An open collector, TTL compatible, inhibit terminal (pin 1) provides shut-down and start-up control. Applying a logic level low (<0.8 V), referenced to input common, will disable the output of the converter. When inhibited input current is reduced to 5 mA or less and there is no generation of switching noise. The inhibit terminal typically sinks 3 mA when the converter is inhibited.

Leaving the terminal open or pulling it high will enable the converter. Use an open collector interface for logic high voltages of up to 11 volts. (Refer to Figure 2 for a connection diagram.) An open collector interface is not required if the logic high is in excess of the open circuit voltage of the inhibit terminal, 11 volts, but less than 40 volts.

SOFT START FEATURE

The soft-start feature provides a controlled 20 milliseconds turn-on to minimize inrush current and reduce overshoot at initial start-up or when inhibit is released.

SYNCHRONIZATION

To synchronize the converter's switching frequency to a system clock apply the clock signal to the sync terminal (pin 7). When multiple converters are powered from a single power source, asynchronous (free run) operation will result in lower peak noise for common spectral peaks, but synchronous operation will eliminate any possibility of interference frequencies in the low audio band. Source impedance of the signal should be less than 100 ohms and the transition time should be less than 100 nanoseconds. The capacitively coupled sync input will synchronize on a differential signal of as low as 4 volts to as high as 10 volts. If the sync function is not used, the terminal should be left open.

SHORT CIRCUIT PROTECTION

Internal current limiting circuitry protects all three outputs against short circuits. When output power exceeds approximately 130% of maximum output power, the output currents are limited. In addition, separate current limiting circuitry protects each output individually resulting in normal operation of either the main or the auxiliaries, whichever is not in a shorted condition.

PACKAGING

MHF+ Triple converters are packaged in hermetically sealed metal cases. MHF+ Triple converters can be purchased in a flanged or non-flanged case. The flanged option provides increased heat dissipation and also provides greater stability when mechanically secured.

DC/DC CONVERTERS

ABSOLUTE MAXIMUM RATINGS

Input Voltage
- 16 to 48 VDC

Power Dissipation (Pd)
- 12 watts

Output Power
- 15 watts

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

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

RECOMMENDED OPERATING CONDITIONS

Input Voltage Range
- 16 to 48 VDC continuous
- 80 V for up to 120 msec

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

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

SYNC AND INHIBIT

Sync 400 to 600 kHz
- Duty cycle 40% to 60%
- Logic low 0.8 V max
- Logic high 4.5 V min, 10.0 V max
- If not used, leave unconnected
- Referenced to input common

Inhibit: TTL Open Collector
- Logic low (output disabled)
  Logic low voltage ≤0.8 V max
  Inhibit pin current 3.0 typ, 5.0 max
- Referenced to input common

Logic high (output enabled)
  Open collector
  Unconnected or 11 to 40 V

TYPICAL CHARACTERISTICS

Output Voltage Temperature Coefficient
- 150 ppm/°C typical

Current Limit
- 130% typical

Isolation
- 100 megohm minimum at 500 V

Conversion Frequency
- Free run 375 minimum, 500 kHz maximum
- External sync range 400 to 600 kHz

Inhibit Pin Voltage (unit enabled)
- 10 V typical

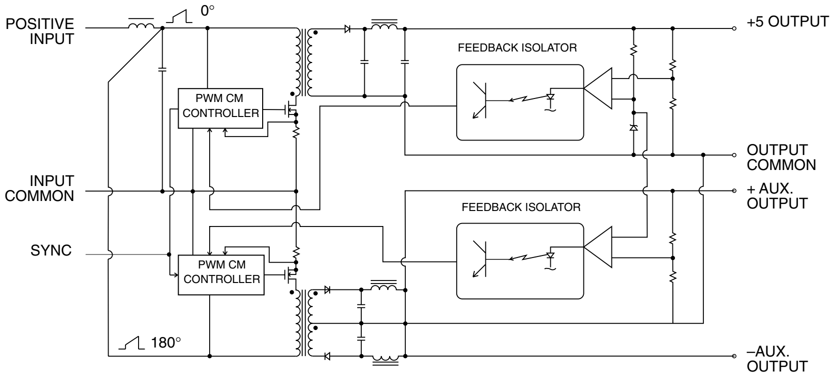


FIGURE 1: BLOCK DIAGRAM

Electrical Characteristics: 25°C Tc, 28 VDC Vin, 100% load, free run, unless otherwise specified.

		MHF+28512T			MHF+28515T			
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	UNITS
OUTPUT VOLTAGE	MAIN	4.95	5.0	5.05	4.925	5.0	5.05	VDC
	+ AUXILIARY	11.64	12.0	12.36	14.55	15.0	15.45	
	– AUXILIARY	11.64	12.0	12.36	14.55	15.0	15.45	
OUTPUT CURRENT[1]	MAIN	0	—	1.5	0	—	1.5	A
	+ AUXILIARY	—	—	0.416	—	—	0.333	
	– AUXILIARY	—	—	0.416	—	—	0.333	
	TOTAL	—	—	2.125	—	—	2.0	
OUTPUT POWER[2]	MAIN	—	—	7.5	—	—	7.5	W
	+ AUXILIARY	—	—	5	—	—	5	
	– AUXILIARY	—	—	5	—	—	5	
	TOTAL	—	—	15	—	—	15	
OUTPUT RIPPLE VOLTAGE	10 kHz to 2 MHz MAIN	—	20	75	—	20	75	mV p-p
	10 kHz to 2 MHz ± AUXILIARY	—	30	90	—	30	112	
LINE REGULATION[3] V_{IN} = MIN. TO MAX.	MAIN	—	25	75	—	25	75	mV
	±AUXILIARY	—	120	240	—	150	300	
LOAD REGULATION[3, 4]	MAIN	—	25	60	—	25	60	mV
	± AUXILIARY	—	120	240	—	150	300	
CROSS REGULATION[5]	– AUXILIARY	—	—	1200	—	—	1500	mV
INPUT VOLTAGE	CONTINUOUS	16	28	48	16	28	48	VDC
	TRANSIENT 120 ms	—	—	80	—	—	80	V
INPUT CURRENT	NO LOAD[3]	—	20	35	—	20	35	mA
	FULL LOAD	—	705	724	—	705	724	
	INHIBITED[3]	—	3	5	—	3	5	
INPUT RIPPLE CURRENT	10 kHz to 10 MHz	—	20	50	—	20	50	mA p-p
EFFICIENCY		74	76	—	74	76	—	%
LOAD FAULT[6]	POWER DISSIPATION MAIN[3]	—	—	12	—	—	12	W
	±AUXILIARY	—	—	12	—	—	12	
STEP LOAD RESPONSE[3, 7, 8]	TRANSIENT MAIN	—	—	850	—	—	850	mV pk
	± AUXILIARY	—	—	750	—	—	750	
	RECOVERY MAIN	—	5	8	—	5	8	ms
	RECOVERY ±AUX.	—	2	3	—	2	3	
START-UP[3,]	DELAY EACH OUTPUT	—	10	25	—	10	25	ms

Notes
1. The sum of the 12 volt auxiliary output currents may not exceed 625 mA. The sum of the 15 volt auxiliary output currents may not exceed 500 mA.
2. The sum of the auxiliary output power may not exceed 7.5 watts.
3. Case temperature –55°C to +125°C.
4. Load regulation for the +5 is specified at 0.0 to 1.5 A with the aux. both held at 3.76 W (313 mA for the ±12, 250 mA for the ±15). Load regulation for the aux. is specified as both aux. from 0.0 to 3.76 W (313 mA for ±12, 250 mA for ±15) at the same time with the +5 held at 1.5 A.
5. Cross regulation only occurs between the two auxiliaries and is measured on –aux. +5 is held constant at 1.0 A. Cross regulation is specified for two conditions:
   Negative aux.= 3.76 W; positive aux.= 0.37 W to 3.76 W.
   Negative aux. = 0.37 W to 3.76 W; positive aux. = 3.76 W.
6. Load fault = <0.05 Ω.
7. Transition time is 2 – 10 µs.
8. Time to settle to within 1% of Vout final value.

CONNECTION DIAGRAMS

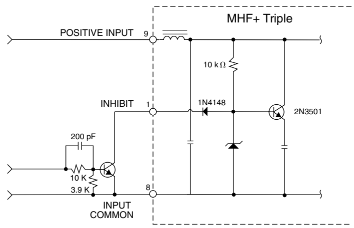
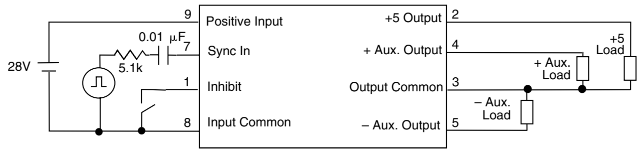
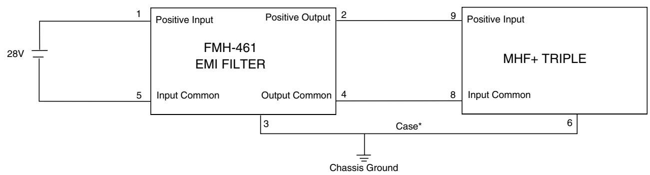


FIGURE 2: INHIBIT INTERFACE



If the sync terminal ([pin 7) is not used, it must be left floating.
The ac coupling shown will prevent sync signal failure.

FIGURE 3: AC COUPLING OF SYNC SIGNAL



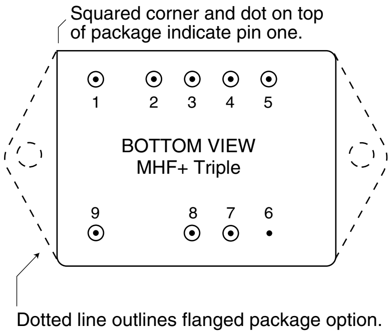
*The case ground connection should be as low an impedance as possible to minimize EMI.
Direct contact of baseplate to chassis ground provides the lowest impedance.

FIGURE 4: EMI FILTER CONNECTION

PIN OUT

Pin	Description
1	Inhibit
2	Main (+5 V) Output
3	Output Common
4	Positive Auxiliary Output
5	Negative Auxiliary Output
6	Case Ground
7	Sync In
8	Input Common
9	Positive Input

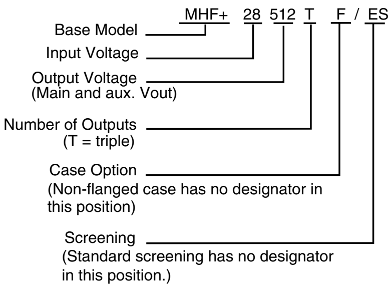
If Sync is not used, leave it unconnected.



Refer to Figures 13 - 16 for dimensions.

FIGURE 5: PIN OUT BOTTOM VIEW

MODEL NUMBERING KEY



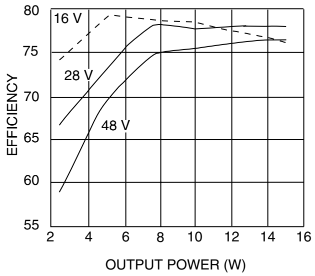
SMD NUMBERS

STANDARD MICROCIRCUIT DRAWING (SMD)	MHF+ SIMILAR PART
5962-9560101HXC	MHF+28512T/883
5962-9560201HXC	MHF+28515T/883

Flanged SMDs have the suffix HZC instead of HXC.

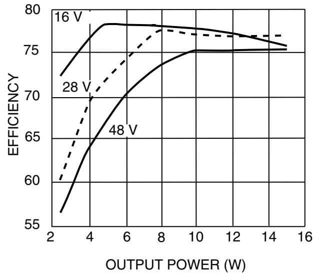
For exact specifications for an SMD product, refer to the SMD drawing. SMDs can be downloaded from http://www.dscc.dla.mil/programs/smcr

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



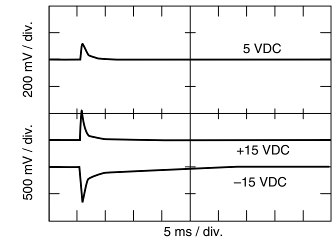
MHF+28512T EFFICIENCY

FIGURE 6



MHF+28515T EFFICIENCY

FIGURE 7

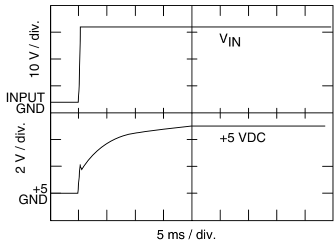


INPUT V: 16 TO 40 VDC, ±15 = 250 mA EACH, +5 = 1.5 A

MHF+ 28515T STEP LINE RESPONSE

MHF+28512T has a similar response

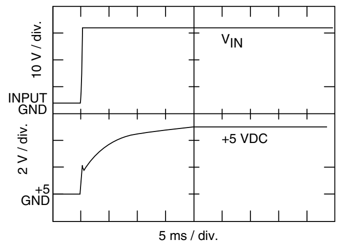
FIGURE 8



MHF+28512T TURN ON INTO FULL LOAD MAIN

MHF+28515T has a similar response

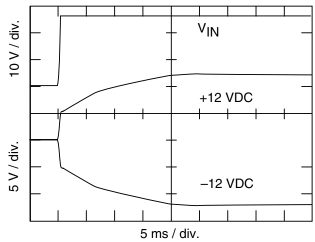
FIGURE 9



MHF+28512T TURN ON INTO FULL LOAD MAIN

MHF+28515T has a similar response

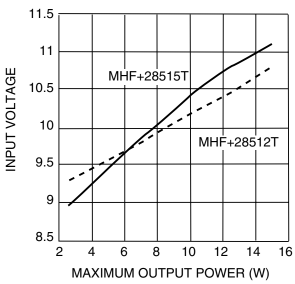
FIGURE 10



MHF+28512T TURN ON INTO FULL LOAD AUXILIARIES

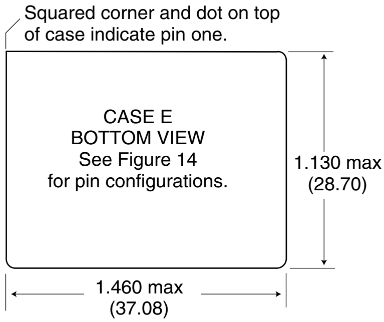
MHF+28515T has a similar response

FIGURE 11



LOW LINE DROPOUT

FIGURE 12



Materials

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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 13: CASE E MAXIMUM DIMENSIONS

BOTTOM VIEW CASE E2

MHF+ Series Triple: Screening – Standard, ES, or 883

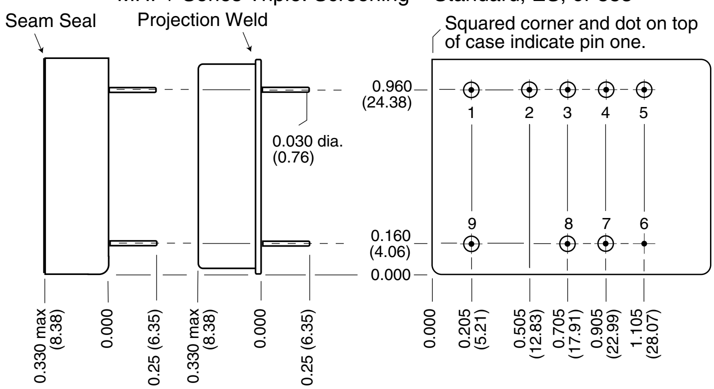

FIGURE 14: CASE E2

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.

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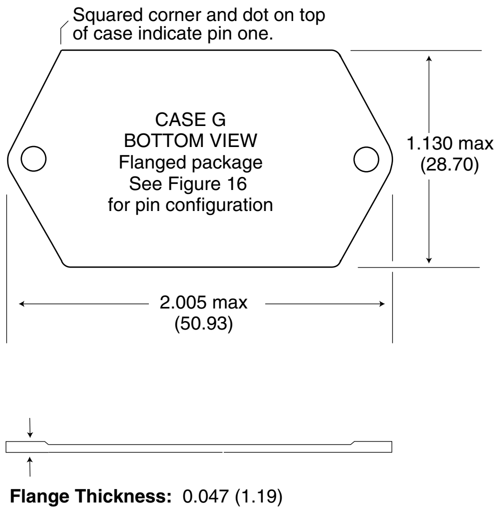

Materials

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Cover MHF+ Series and FMH Filter
Kovar/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 15: CASE G MAXIMUM DIMENSIONS

BOTTOM VIEW CASE G2

Flanged case: Designator (F) required in Case Option position of model number.
MHF+ Series Triple: Screening – Standard, ES, or 883

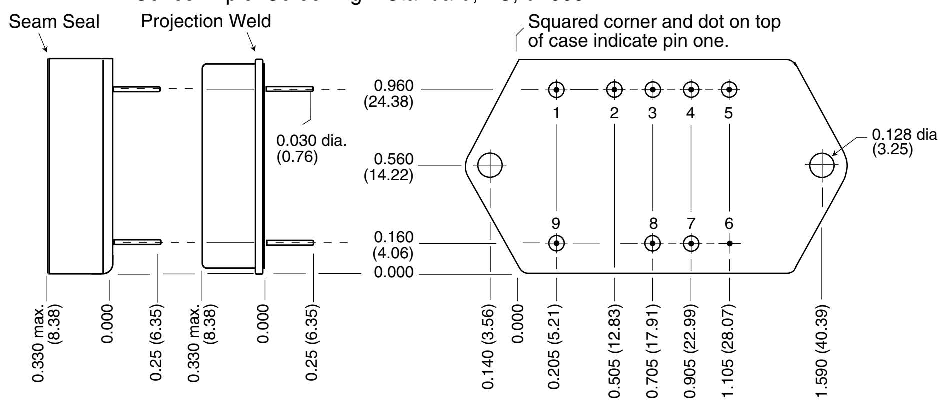

FIGURE 17: CASE G2

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.

TABLE 1: ENVIRONMENTAL SCREENING

TEST	STANDARD	/ES	/883 (Class H)*
PRE-CAP INSPECTION			
Method 2017, 2032	yes	yes	yes
TEMPERATURE CYCLE (10 times)			
Method 1010, Cond. C, -65°C to 150°C	no	no	yes
Method 1010, Cond. B, -55°C to 125°C	no	yes	no
CONSTANT ACCELERATION			
Method 2001, 3000 g	no	no	yes
Method 2001, 500 g	no	yes	no
BURN-IN			
Method 1015, 160 hours at 125°C	no	no	yes
96 hours at 125°C case (typical)	no	yes	no
FINAL ELECTRICAL TEST MIL-PRF-38534, Group A			
Subgroups 1 through 6: -55°C, +25°C, +125°C	no	no	yes
Subgroups 1 and 4: +25°C case	yes	yes	no
HERMETICITY TESTING			
Fine Leak, Method 1014, Cond. A	no	yes	yes
Gross Leak, Method 1014, Cond. C	no	yes	yes
Gross Leak, Dip (1×10^{-3})	yes	no	no
FINAL VISUAL INSPECTION			
Method 2009	yes	yes	yes

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

*883 products are built with element evaluated components and are 100% tested and guaranteed over the full military temperature range of –55°C to +125°C.

Contact Information:

www.interpoint.com

Interpoint Headquarters USA
Phone: 1-800-822-8782
+425-882-3100
Email: power@intp.com

Interpoint UK
Phone: +44-1252-815511
Email: poweruk@intp.com

Interpoint France
Phone: +33-134285455
Email: powerfr@intp.com