FEATURES

- **–55°C to +85°C operation**
- **19 to 36 VDC input or 16 to 36 VDC input typical**
- Fully isolated
- Magnetic feedback
- Fixed frequency, 375 kHz typical
- Topology – Single Ended Forward
- 50 V for 50 ms transient protection
- Inhibit function
- Output trim
- Indefinite short circuit protection
- Radiation hardened to
  10^{13} neutrons/sq cm neutron fluence
  10^{11} rads(Si)/sec dose rate
  10^{5} rads(Si) total dose
- Meets MIL-STD-704E emergency operation and transient standards

DC/DC CONVERTERS 28 VOLT INPUT

MRH SERIES 15 WATT



MODELS

VDC OUTPUT

SINGLE	DUAL	TRIPLE
5	±12	+5 & ±12
12	±15	+5 & ±15
15		

Size (max.): Non-flanged, case F3
1.950 x 1.350 x 0.455 inches (49.53 x 34.29 x 11.56 mm)
Flanged, case J3
2.720 x 1.350 x 0.455 inches (69.09 x 34.29 x 11.56 mm)
See Section B8, cases F3 and J3, for dimensions.
Weight: 50 grams typical
Screening: Standard or ES. See Section C2 for screening options and Section A5 for ordering information.

DESCRIPTION

The MRH Series™ of DC/DC converters offers up to 15 watts of power in a radiation hardened design. The low profile MRH converters are manufactured in Interpoint's fully certified and qualified MIL-STD-1772 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 hardening.

The MRH converters are switching regulators which use a quasi-square wave, single ended forward converter design with a nominal switching frequency of 375 kHz, typical. Close regulation (main output line regulation is 0.05%) is maintained with advanced constant frequency pulse width modulation design techniques. With a 16 to 36 VDC input range and triple outputs of +5 VDC and either ±12 or ±15 VDC, MRH converters are suitable for a wide range of airborne, naval, and ground based applications. The MRH's feed-forward compensation topology provides high levels (50 dB nominal) of input-to-output ripple rejection.

The MRH converters provide full power operation from –55°C to +85°C with derated operation to +125°C. Flanged and non-flanged package configurations are available with optional environmental screening.

INHIBIT FUNCTION

The MRH Series incorporates an inhibit terminal that can be used to disable internal switching. The converter is inhibited when a logic low (≤ 0.8 V) signal is applied to the TTL open collector compatible inhibit pin. In the inhibit mode the inhibit pin current requirement is less than –2 mA. The converter resumes normal operation when a logic high (≥ 2.4 V) signal or open circuit is applied to the inhibit pin. The open circuit voltage of the inhibit is 5 to 6 volts.

OUTPUT VOLTAGE TRIM

The output voltage on single output models can be trimmed upward by as much as 5% of nominal by connecting a resistor between pin 3 and 4.

RADIATION HARDENED

The MRH DC/DC converters are designed to provide continuous normal operation through radiation levels associated with proximity to thermonuclear events. The converters will operate normally in environments with up to 10^{13} neutrons per square centimeter neutron fluence, 10^{11} rads (Si) per second dose rate, and 10^{5} rads (Si) total dose. These levels of radiation tolerance make the MRH converters suitable for electronics in tactical programs where operation in high radiation environments is required.

At the highest dose rating (10^{11} rads (Si)/sec dose rate) there will be an upset resulting in a dip in the voltage. This is non-destructive to the unit. The converter will operate through the upset.

MRH SERIES 15 WATT

DC/DC CONVERTERS

ABSOLUTE MAXIMUM RATINGS

Power Dissipation (Pd)
- 5 W

Output Power
- 15 watts

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

Storage Temperature Range (Case)
- –65°C to +125°C

RECOMMENDED OPERATING CONDITIONS

Input Voltage Range
- Continuous
  16 to 40 VDC MRH28XXS and MRH2812D
  19 to 40 VDC MRH2815D
  16 to 36 VDC MRH285XXT
- 50 V for 50 msec transient

Case Operating Temperature (Tc)
- –55°C to +85°C full power
- –55°C to +125°C absolute

INHIBIT

Inhibit TTL Open Collector
- Logic low (output disabled)
  Inhibit pin current ≤ –2 mA
- Referenced to input common
- Logic high (output enabled)
  Open collector

TYPICAL CHARACTERISTICS

Output Voltage Temperature Coefficient
- 250 ppm/°C max

Input to Output Capacitance
- 100 p, typical

Current Limit
- 125% of full load typical

Isolation
- 100 megohm minimum at 500 V

Conversion Frequency
- 375 kHz. typical

Inhibit Pin Voltage (unit enabled)
- 5 to 6 V

Radiation (will operate through)
- Neutron fluence 10^{13} neutrons/ sq. cm.
- Radiation dose rate 10^{11} rads (Si) /sec
- Total dose 10^{5} rads (Si)

DERATING OUTPUT POWER/CURRENT AND INPUT VOLTAGE

Temperatures are referenced to the temperature at the converter's baseplate
- Linearly derate output power/current from 100% at 85°C to 0% at 125°C.
- Above 105°C linearly derate steady state input voltage to 33 V and transient voltage to 38 V, at 125°C.
- Operation below an input voltage of 19 volts, including operation in MIL-STD-704E emergency power conditions, is possible with derated output power. See Figures 9 and 10.

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

SINGLE OUTPUT MODELS		MRH2805S			MRH2812S			MRH2815S			
PARAMETER	CONDITIONS	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	UNITS
OUTPUT VOLTAGE		4.95	5.0	5.05	11.88	12	12.12	14.85	15	15.15	VDC
OUTPUT CURRENT	–55°C TO +85°C	0.05	—	3.0	0.02	—	1.25	0.016	—	1.0	A
OUTPUT POWER	MIN. TO MAX. V_{IN}	0.25	—	15	0.25	—	15	0.25	—	15	W
OUTPUT RIPPLE	10 kHz TO 2 MHz	—	40	70	—	25	50	—	25	50	mV p-p
LINE REGULATION	16 TO 40 V_{IN}	—	5	10	—	5	20	—	5	20	mV
LOAD REGULATION[1]	MIN. LOAD TO FULL	—	5	30	—	5	30	—	5	30	mV
INPUT VOLTAGE[2]	NO LOAD TO FULL	16	28	40	16	28	40	19	28	40	VDC
	TRANSIENT 50 ms	—	—	50	—	—	50	—	—	50	V
INPUT CURRENT	NO LOAD	—	50	60	—	50	60	—	50	60	mA
	FULL LOAD	—	—	750	—	—	730	—	—	720	
	INHIBITED	—	22	25	—	22	25	—	22	25	
INPUT RIPPLE CURRENT	10 kHz TO10 MHz	—	25	50	—	25	50	—	25	50	mA p-p
EFFICIENCY		73	75	—	76	78	—	78	80	—	%
LOAD FAULT[3] POWER DISSIPATION	SHORT CIRCUIT	—	5	—	—	5	—	—	5	—	W
	OVERLOAD	—	5	—	—	5	—	—	5	—	
START-UP	DELAY	—	3	10	—	3	10	—	3	10	ms

Notes
1. Load regulation is not guaranteed below minimum load.
2. Converter should not be inhibited or operated below 12 Vin above 10^{4} rads (Si) total dose.
3. Indefinite short circuit protection is not guaranteed above 85°C case.

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

DUAL AND TRIPLE OUTPUT MODELS		MRH2812D			MRH2815D			MRH2812T			MRH2815T			
PARAMETER	**CONDITION**	**MIN**	**TYP**	**MAX**	**MIN**	**TYP**	**MAX**	**MIN**	**TYP**	**MAX**	**MIN**	**TYP**	**MAX**	**UNITS**
OUTPUT VOLTAGE	MAIN	+11.88	+12.0	+12.12	+14.85	+15.0	+15.15	+4.95	+5.0	+5.05	+4.95	+5.0	+5.05	VDC
	AUX.	–11.82	–12.0	–12.18	–14.77	–15.0	–15.23	±11.50	±12.0	±12.50	±14.40	±15.0	±15.60	
OUTPUT CURRENT[1]	MAIN	+0.01	+0.625	+1.0	+0.008	+0.50	+0.8	+0.40	+1.80	+2.00	+0.40	+1.80	+2.00	A
–55°C TO +85°C	AUX.	–0.01	–0.625	–1.0	–0.008	–0.50	–0.8	±0.00	±0.25	±0.50	±0.00	±0.20	±0.40	
OUTPUT POWER[1]	MAIN	—	7.5	12	—	7.5	12	2	9	10	2	9	10	W
	AUX.	—	7.5	12	—	7.5	12	0	3	6	0	3	6	
	TOTAL	0.25	—	15	0.25	—	15	2	–	15	2	–	15	
OUTPUT RIPPLE	MAIN	—	40	60	—	40	60	–	50	75	–	30	50	mV p-p
VOLTAGE, 10 kHz - 2 MHz	AUX.	—	40	60	—	40	60	–	30	50	–	30	50	
LINE REGULATION	MAIN	—	5	20	—	5	20	—	5	10	—	5	10	mV
V_{IN} = MIN. TO MAX.	AUX.	—	20	100	—	20	100	—	200	400	—	250	500	
LOAD REGULATION[2]	MAIN	—	5	30	—	5	30	—	5	10	—	5	10	mV
NO LOAD TO FULL	AUX.	—	10	100	—	10	100	—	200	400	—	250	500	
INPUT VOLTAGE[3]	CONTINUOUS	16	28	40	19	28	40	16	28	36	16	28	36	VDC
	TRANSIENT 50 ms	—	—	50	—	—	50	—	—	40	—	—	40	V
INPUT CURRENT	NO LOAD	—	55	70	—	55	70	—	70	80	—	85	95	mA
	FULL LOAD	—	—	700	—	—	700	—	—	770	—	—	778	
	INHIBITED	—	22	25	—	22	25	—	23	25	—	23	25	
INPUT RIPPLE CURRENT	10 kHz TO 2 MHz	—	25	50	—	25	50	—	25	50	—	25	50	mA p-p
EFFICIENCY		76	78	—	76	78	—	70	72	—	70	72	—	%
LOAD FAULT[4]	SHORT CIRCUIT	—	5	—	—	5	—	—	5	—	—	5	—	W
POWER DISSIPATION	OVERLOAD	—	5	—	—	5	—	—	5	—	—	5	—	
START-UP	DELAY	—	3	10	—	3	10	—	3	10	—	3	10	ms

Notes
1. Maximum combined output power is 15 watts for both dual and triple models.
   Dual output models: The maximum specification is the total output current/power.
   Up to 80% of that total is available from either output provided the positive output maintains a minimum of 20% of the total power used.
   Triple output models: The maximum combined power of the auxiliaries is 6 watts, of which 100% is available from either output.
2. Load regulation is not guaranteed below minimum load.
3. Converter should not be inhibited or operated below 12 Vin above 10^4 rads (Si) total dose.
4. Indefinite short circuit protection is not guaranteed above 85°C case.

PIN OUT

Pin	Single Output	Dual Output	Triple Output
1	Positive Input	Positive Input	Positive Input
2	No connection	No connection	Main (+5) Output
3	Trim	Negative Output	Output Common
4	Output Common	Output Common	Neg. Aux. Output
5	Positive Output	Positive Output	Pos. Aux. Output
6	No connection	No connection	No connection
7	Case Ground	Case Ground	Case Ground
8	Inhibit	Inhibit	Inhibit
9	No connection	No connection	No connection
10	Input Common	Input Common	Input Common

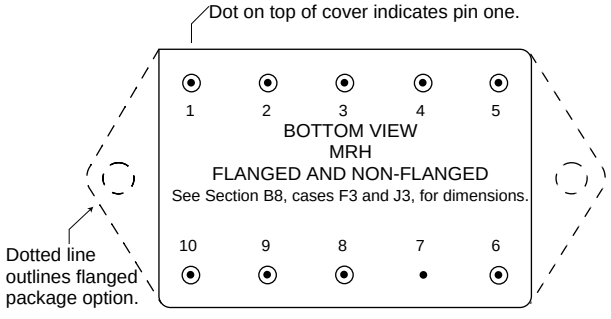


FIGURE 1: PIN OUT

MRH SERIES
15 WATT

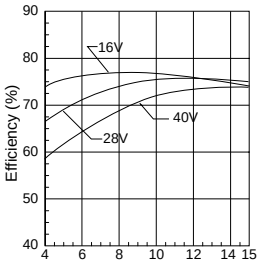
DC/DC CONVERTERS

MODEL NUMBERING KEY

MRH 28 12 T F / ES

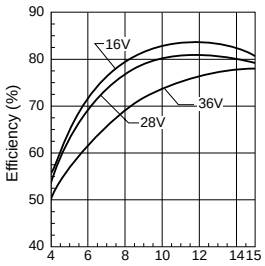
- MRH — Base Model
- 28 — Input Voltage
- 12 — Output Voltage (Aux. Vout for triple models)
- T — Number of Outputs (S = single, D = dual, T = triple)
- F — Case Option (Non-flanged case has no designator in this position)
- ES — Screening (Standard screening has no designator in this position.)

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



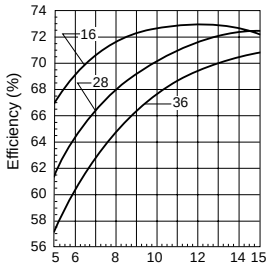
MRH2805S Efficiency

FIGURE 2



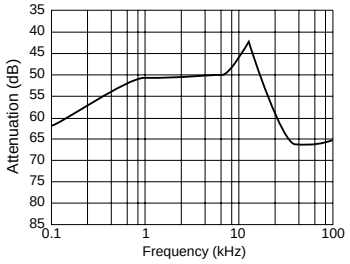
MRH2815D Efficiency

FIGURE 3



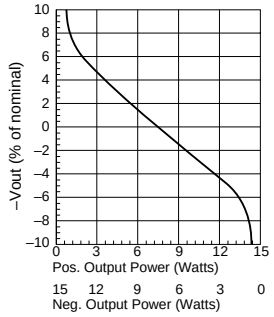
MRH2815T Efficiency

FIGURE 4



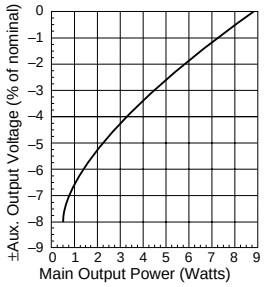
Audio Rejection, MRH Series

FIGURE 5



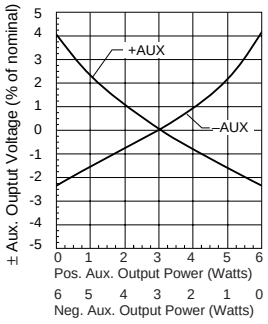
MRH2815D Neg. Output Cross Reg.

FIGURE 6



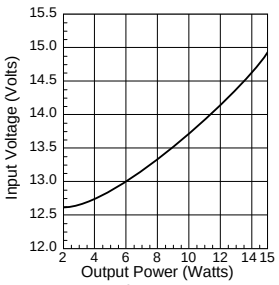
MRH2815T Aux. Reg. vs. Main Load

FIGURE 7



MRH2815T Aux. Output with Unbalanced Loads

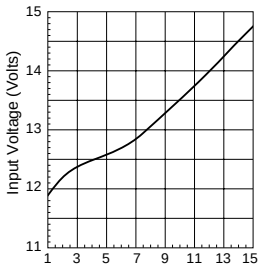
FIGURE 8



50 mV Drop

MRH2805S Low Line Dropout

FIGURE 9



MRH2815T Low Line Dropout

FIGURE 10

23821-001-DTS Rev A DQ# 1020

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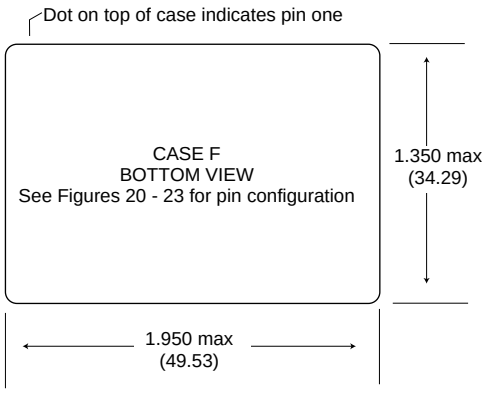

Materials

Header Case F1
Cold Rolled Steel/Nickel/Gold
Cases F2 - F4
Cold Rolled Steel/Nickel/Tin
Cover Case F1
Kovar/Nickel
Cases F2 - F4
Cold Rolled Steel/Nickel/Tin
Pins #52 alloy (all cases)
MHV Series Triple – compression glass seal
MTR Series Triple, case F1 – ceramic seal
MTR Series Triple, case F2 – compression glass seal
HUM40 – compression glass seal or ceramic seal
Case F3 – compression glass seal
Case F4 – compression glass seal or ceramic seal

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.

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

FIGURE 19: CASE F MAXIMUM DIMENSIONS

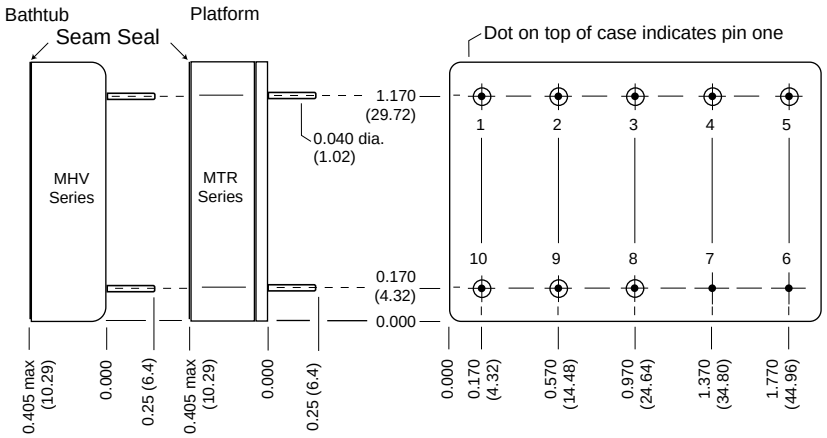

FIGURE 20: CASE F1

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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BOTTOM VIEW CASE F2
HUM-40: Screening – Standard or ES

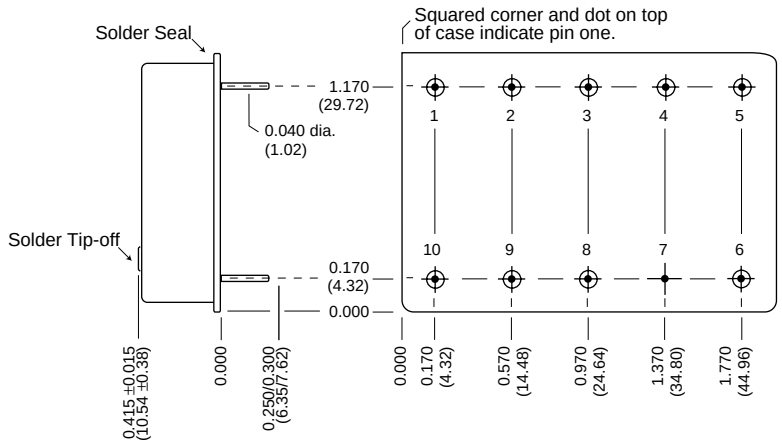


FIGURE 21: CASE F2

BOTTOM VIEW CASE F3
MRH Series: Screening – Standard or ES

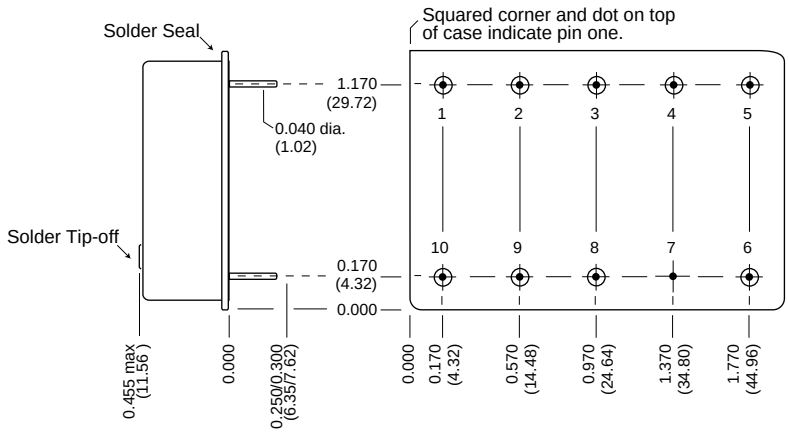
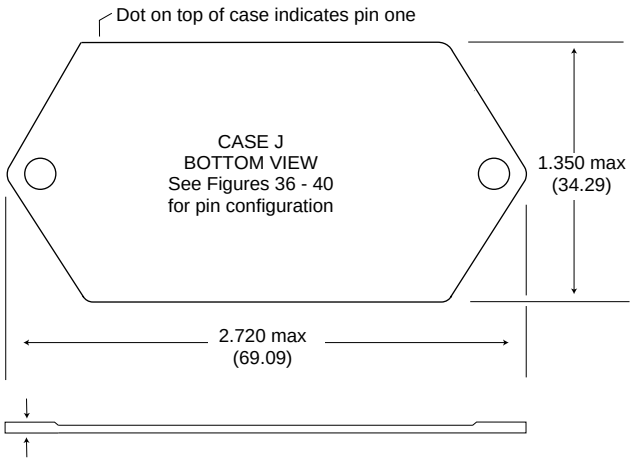


FIGURE 22: CASE F3

CASES



Flange Thickness:

Cases J1 and J5	0.060 (1.52)
Case J2	0.073 (1.85) max
Cases J3 and J4	0.067 +0.005/-0.007 (1.70 +0.13/-0.8)

Materials

Header Case J1
Cold Rolled Steel/Nickel/Gold
Cases J2 - J5
Cold Rolled Steel/Nickel/Tin
Cover Case J1
Kovar/Nickel
Case J2 - J5
Cold Rolled Steel/Nickel/Tin
Pins #52 alloy (all cases)
Case J1
MHV Series Triple – compression glass seal
MTR Series Triple – ceramic seal
Cases J2 - J5
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 35: CASE J MAXIMUM DIMENSIONS

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.

BOTTOM VIEW CASE J2

Flanged case: Designator required in Case Option position of model number.
HUM-40 Module: Screening – Standard or ES

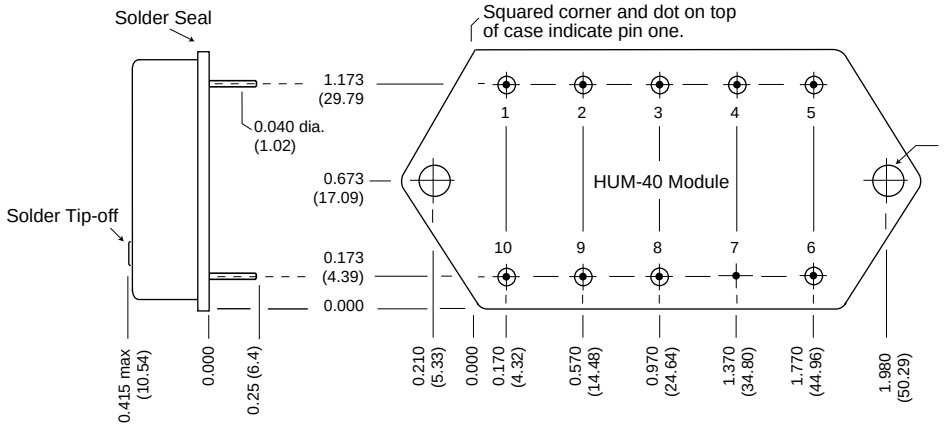


FIGURE 37: CASE J2

BOTTOM VIEW CASE J3

Flanged case: Designator required in Case Option position of model number.
MRH Series: Screening – Standard or ES

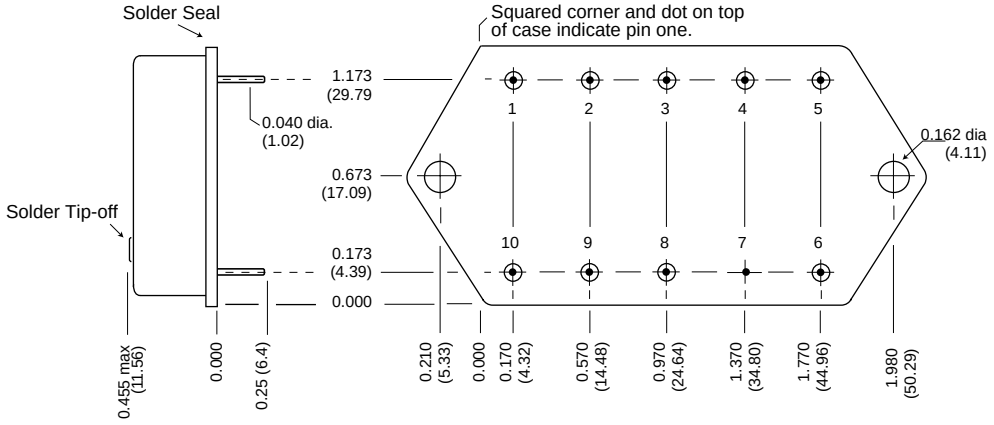


FIGURE 38: CASE J3

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85°C PRODUCTS

TEST (85°C Products excluding HR products)	STANDARD	/ES
PRE-CAP INSPECTION		
Method 2017	yes	yes
TEMPERATURE CYCLE (10 times)		
Method 1010, Cond. B, -55°C to 125°C	no	yes
CONSTANT ACCELERATION		
Method 2001, 500 g	no	yes
BURN-IN		
96 hours at 70°C ambient (typical)	no	yes
FINAL ELECTRICAL TEST MIL-PRF-38534, Group A		
Subgroups 1 and 4: +25°C case	yes	yes
HERMETICITY TESTING		
Fine Leak, Method 1014, Cond. A	no	yes
Gross Leak, Method 1014, Cond. C	no	yes
Gross Leak, Dip (1×10^{-3})	yes	no
FINAL VISUAL INSPECTION		
Method 2009	yes	yes

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

Applies to the following products:

MFW Series
MTW Series
MHE/MLP Series
MHL Series
MRH Series
MTO Series
MSR Series
DCH Series
FM/FMA/FMB EMI Filters
MSF EMI Filter