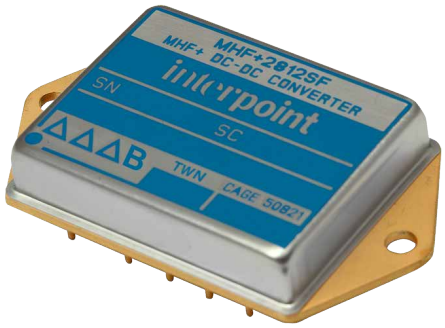
# MHF+ Single, Dual and Triple DC-DC Converters

## 28 VOLT INPUT – 15 WATT

## FEATURES

- Hermetically sealed case, 0.33 inches (8.38 mm) high
- Operating temperature –55° to +125°C
- Input voltage 16 to 40 volts
- MHF+281R9S 20 to 32 volts
  - Triple output models 16 to 48 volts
- Transient protection
  - Single and dual: 50 volts for 50 ms
  - MHF+281R9S: 35 volts for 50 ms
  - Triple: 80 volts for 120 ms
- Fully isolated
- Fixed high frequency switching
- Inhibit and synchronization functions
- Indefinite short circuit protection
- Under voltage lockout




| MODELS<br>OUTPUT VOLTAGE (V) | | |
|---|---|---|
| SINGLE | DUAL | TRIPLE |
| 1.9 | ±5 | +5 & ±12 |
| 3.3 | ±12 | +5 & ±15 |
| 5 | ±15 | |
| 5.2 | | |
| 5.3 | | |
| 12 | | |
| 15 | | |
| 28 | | |

## MHF+ SERIES™ SINGLES AND DUALS

### DESCRIPTION

The Interpoint® MHF+ Series™ single and dual DC-DC converters offer up to 15 watts of power in a low profile package. The MHF+ converters are manufactured in our fully certified and qualified MIL-PRF-38534 Class H production facility and packaged in hermetically sealed steel cases. They are ideal for use in programs requiring high reliability, small size, and high efficiency.

MHF+ Series singles and duals are high frequency DC-DC converters offering an wide input voltage range of 16 to 40 volts (MHF+281R9S, 20 to 32 volts)with transient protection up to 50 volts for up to 50 ms. Choose from standard screening, “ES” screening, or fully compliant to “883” MIL-PRF-38534 Class H screening. See Table 14 on page 24. Standard Microcircuit Drawings (SMD) are available, see Table 3 on page 7.

### CONVERTER DESIGN

The MHF+ Series single and dual converters are switching regulators that use a quasi-square wave, single-ended forward converter design with a constant switching frequency of 550 kHz typical. 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. See Figure 1 and Figure 2 on page 3.

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.

### INHIBIT FUNCTION

MHF+ converters provide an inhibit terminal that can be used to disable internal switching, resulting in no output current and very low quiescent input current. The converter is inhibited when the inhibit pin is pulled low (≤0.8 V = output disabled).

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 volts. In the inhibit mode with 28 volts in, a maximum of 5 mA must be sunk from the inhibit pin. See Figure 6 on page 5

### SYNCHRONIZATION

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 signal input of the desired frequency to pin 5. The capacitively coupled sync input will synchronize on a differential signal of as low as 4 volts to as high as 5 volts. For single and dual output models, if the sync function is not used, connect the terminal to input common.

### SHORT CIRCUIT PROTECTION

MHF+ Series single and dual output 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.

# MHF+ Single, Dual and Triple DC-DC Converters

## 28 VOLT INPUT – 15 WATT

### MHF+ SERIES™ SINGLES AND DUALS (CONTINUED)

#### Undervoltage Lockout
Undervoltage lockout prevents the single and dual output converters from operating below approximately 14 Volts input voltage to keep system current levels smooth, especially during initialization or re-start operations.

#### Packaging
MHF+ Series of converters are packaged in hermetically sealed metal cases and 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.

### MHF+ SERIES™ TRIPLE DC-DC CONVERTERS

#### DESCRIPTION
The Interpoint® MHF+ Series™triple DC-DC converters offer up to 15 watts of power in a low profile package. The MHF+X converters are manufactured in our fully certified and qualified MIL-PRF-38534 Class H production facility and packaged in hermetically sealed steel cases. They are ideal for use in programs requiring high reliability, small size, and high efficiency.
MHF+ Series™ Triple DC-DC converters provide a wide input voltage range of 16 to 48 volts delivering 15 watts of total output power with output voltages of +5 and ±12 or +5 and ±15 volts. The main output, +5 volts, 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 auxiliary output voltages. See Figure 3 on page 4.

The phase-shifted design offers reduced input and output ripple. To meet MIL-STD-461 requirements use an EMI filter, see Figure 4 on page 4. FMCE-0328 is the recommended filter.

#### Inhibit Function
MHF+ converters provide an inhibit terminal that can be used to disable internal switching, resulting in no output current and very low quiescent input current. The converter is inhibited when the inhibit pin is pulled low (≤0.8 V = output disabled). The unit is enabled when the inhibit pin, which is internally connected to a pull-up resistor, is left unconnected or is connected to an open-collector gate. When inhibited, input current is reduced to 5 mA or less and there is no generation of switching noise. The inhibit terminal typically sinks 5 mA when the converter is inhibited. See Figure 7 on page 5.

#### Soft Start Feature
The soft-start feature provides a controlled 25 milliseconds maximum 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 5 V. For triple output models, if the sync function is not used, the terminal should be left open. See Figure 5 on page 4.

#### Short Circuit Protection
On the triple output models, internal current limiting circuitry protects on all three outputs against short circuits. When output power exceeds approximately 130% of maximum output power, the output power is 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.

#### Undervoltage Lockout
Undervoltage lockout prevents the triple output models units from operating below approximately 8.5 volts input voltage to keep system current levels smooth, especially during initialization or re-start operations.

#### Packaging
MHF+ Series of converters are packaged in hermetically sealed metal cases and 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.

# MHF+ Single, Dual and Triple DC-DC Converters

## 28 VOLT INPUT – 15 WATT

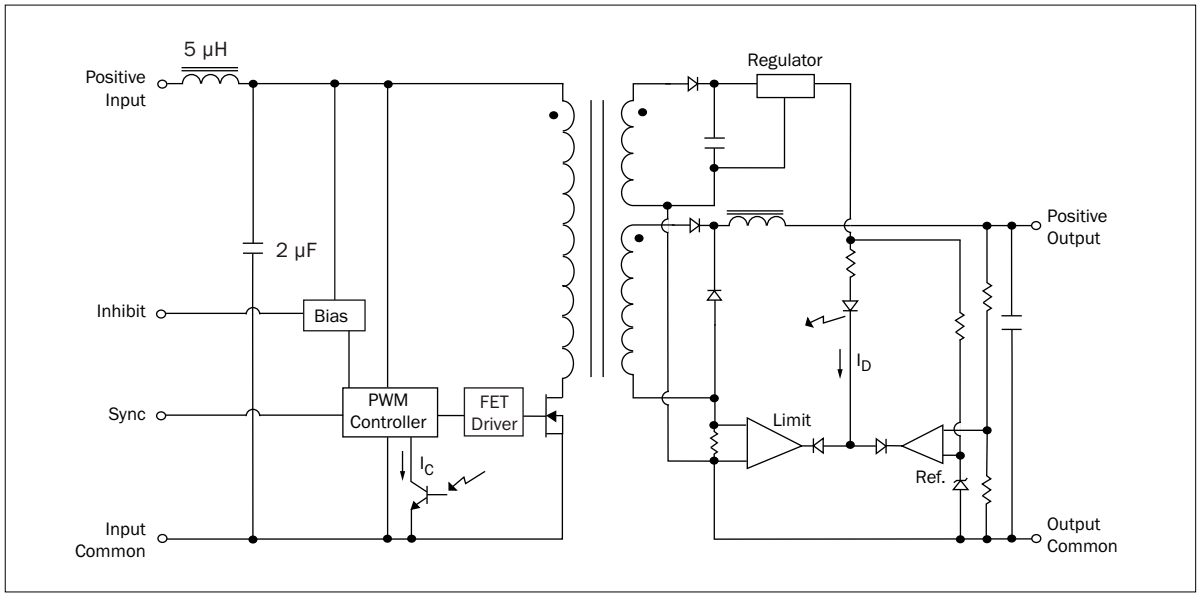



FIGURE 1: MHF+ SINGLE OUTPUT BLOCK DIAGRAM

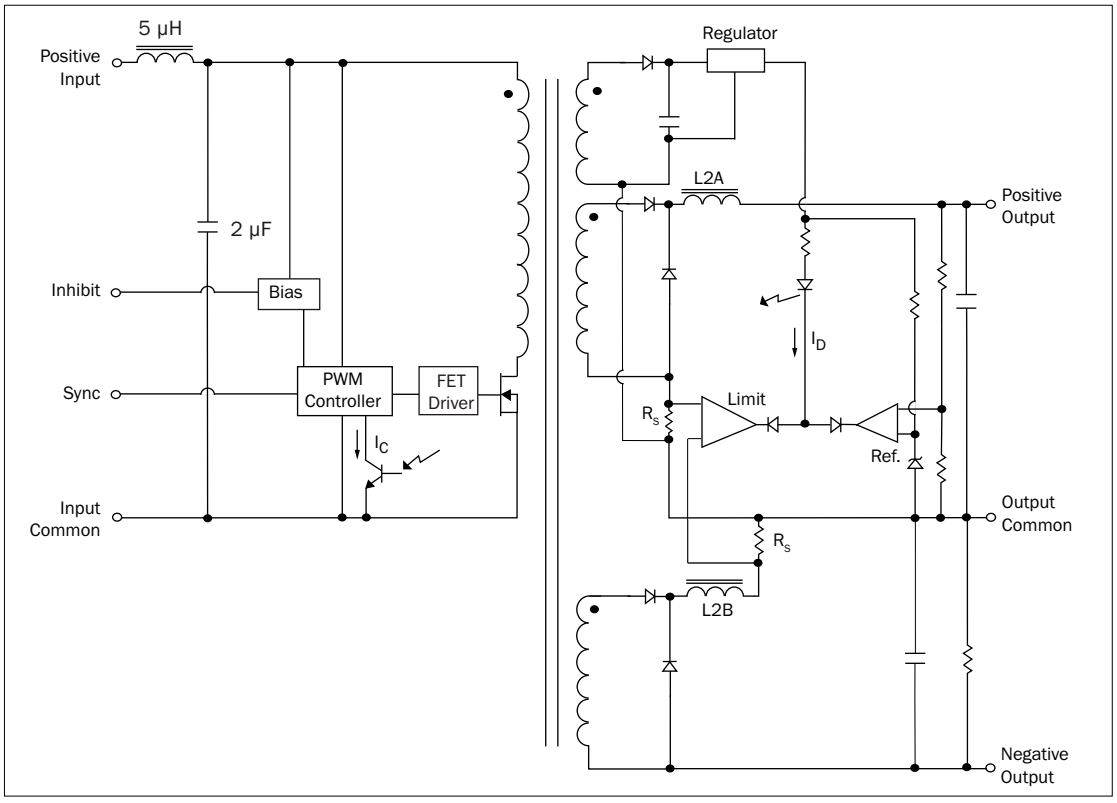



FIGURE 2: MHF+ DUAL OUTPUT BLOCK DIAGRAM

# MHF+ Single, Dual and Triple DC-DC Converters

## 28 VOLT INPUT – 15 WATT

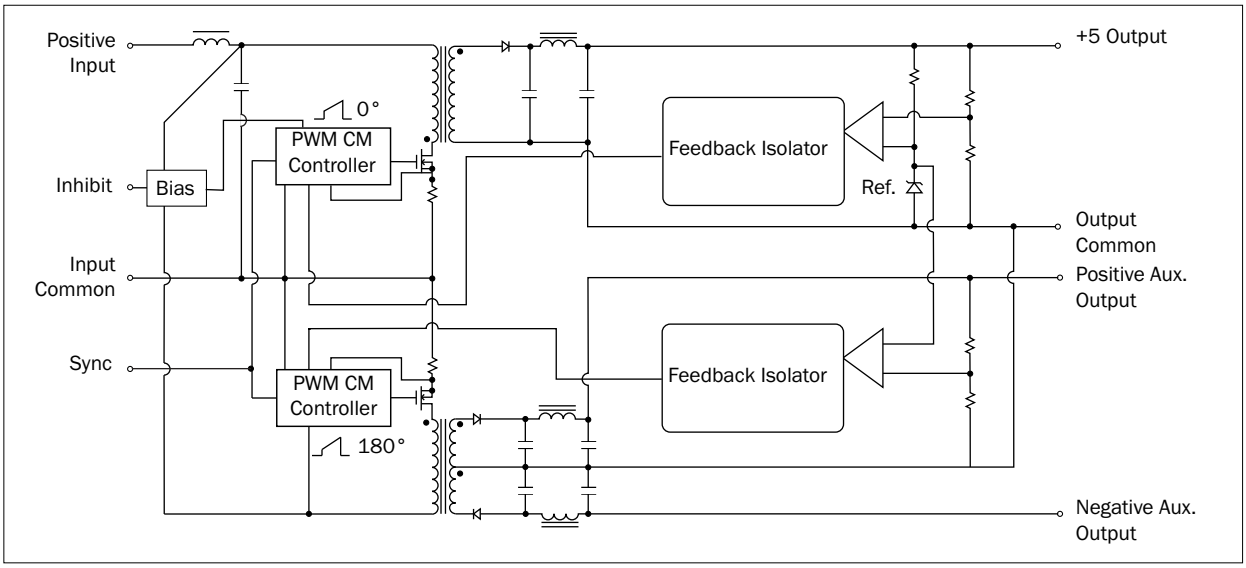



FIGURE 3: MHF+ TRIPLE OUTPUT BLOCK DIAGRAM

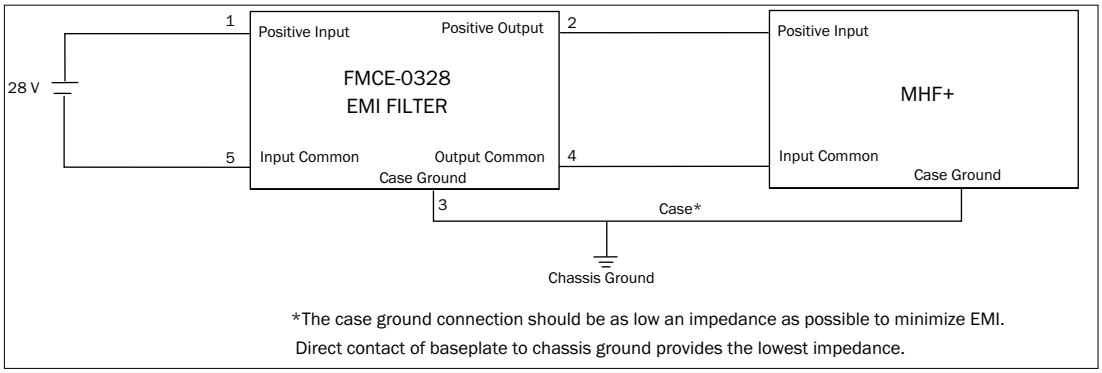
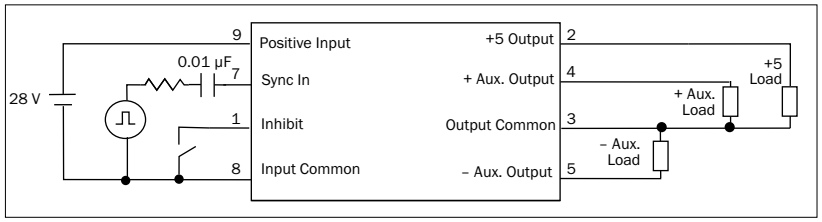



FIGURE 4: EMI FILTER CONNECTION




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

FIGURE 5: AC COUPLING OF SYNC SIGNAL, TRIPLE MODELS

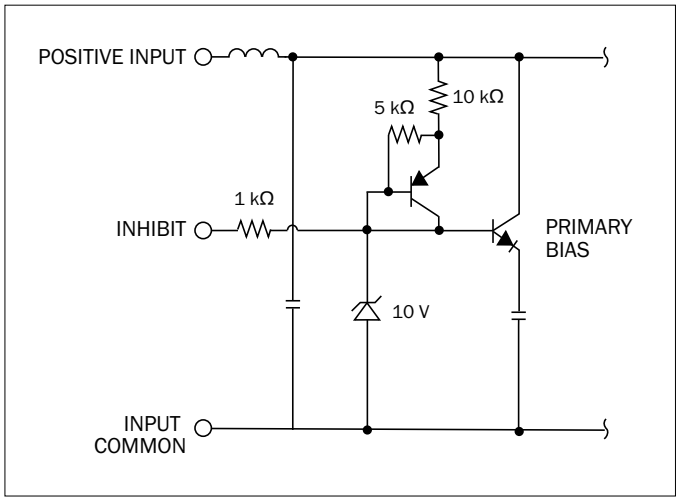



FIGURE 6: INHIBIT INTERFACE SINGLES AND DUALS

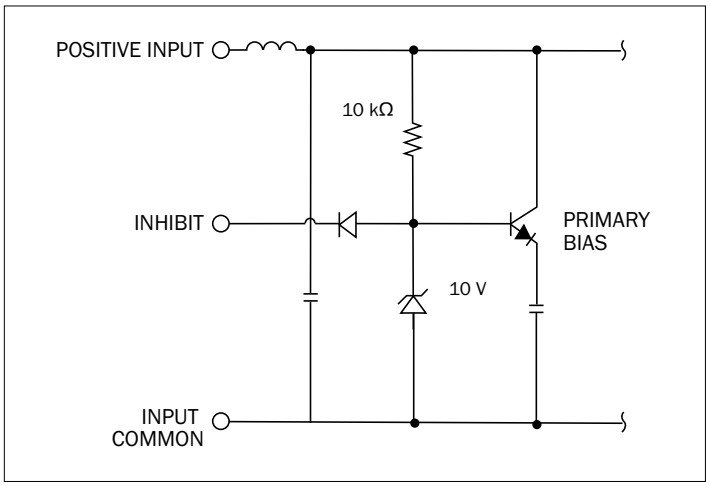



FIGURE 7: INHIBIT INTERFACE TRIPLES

# MHF+ Single, Dual and Triple DC-DC Converters

## 28 VOLT INPUT – 15 WATT

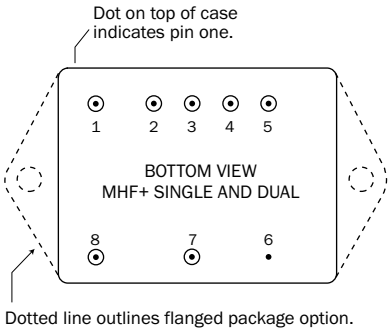
| PIN OUT | | | | |
|---|---|---|---|---|
| **Pin** | **Single Output** | **MHF+2828S** | **Dual Output** | **Triple Output** |
| 1 | Inhibit | Inhibit | Inhibit | Inhibit |
| 2 | No Connection | Positive Output | Positive Output | Main (+5) Output |
| 3 | Output Common | (See note 1) | Output Common | Output Common |
| 4 | Positive Output | Output Common | Negative Output | Pos. Aux. Output |
| 5 | Sync In | Sync In | Sync In | Neg. Aux. Output |
| 6 | Case Ground | Case Ground | Case Ground | Case Ground |
| 7 | Input Common | Input Common | Input Common | Sync |
| 8 | Positive Input | Positive Input | Positive Input | Input Common |
| 9 | — | — | — | Positive Input |

1. Pin 3 of MHF+2828S will provide 14 $V_{OUT}$ referenced to output common (pin 4).

TABLE 1: PIN OUT

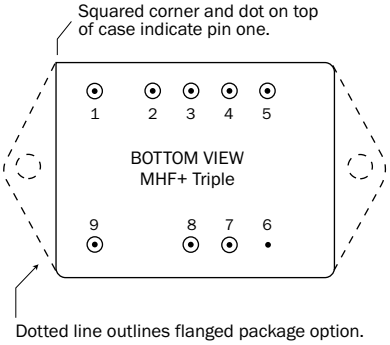
| PINS NOT IN USE | |
|---|---|
| Inhibit: single, dual and triple, pin 1 | Leave unconnected |
| MHF+2828S, pin 3 | Leave unconnected |
| Sync: single and dual, pin 5 | Connect to input common |
| Sync: triple, pin 7 | Leave unconnected |

TABLE 2: PINS NOT IN USE




See Figure 34 on page 19 and Figure 36 on page 21 for dimensions.

FIGURE 8: MHF+ SINGLE AND DUAL PIN OUT




See Figure 35 on page 20 and Figure 37 on page 22 for dimensions.

FIGURE 9: MHF+ TRIPLE PIN OUT

# MHF+ Single, Dual and Triple DC-DC Converters

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### MODEL NUMBERING KEY

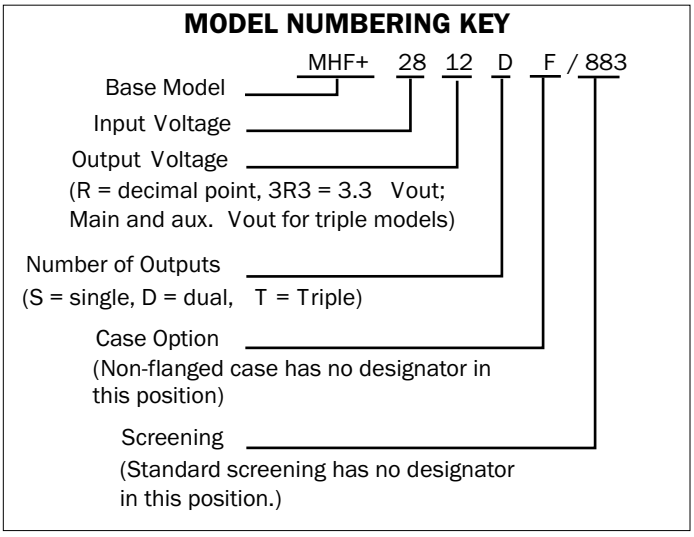



FIGURE 10: MODEL NUMBERING KEY

| SMD NUMBERS | |
|---|---|
| **STANDARD MICROCIRCUIT DRAWING (SMD)** | **MHF+ SIMILAR PART** |
| 5962-0251001HXC | MHF+283R3S/883 |
| 5962-9213901HXC | MHF+2805S/883 |
| 5962-0325301HXC | 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 |
| 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 https://landandmaritimeapps.dla.mil/programs/smcr | |

TABLE 3: SMD CROSS REFERENCE

### MODEL NUMBER OPTIONS [1]

**TO DETERMINE THE MODEL NUMBER ENTER ONE OPTION FROM EACH CATEGORY IN THE FORM BELOW.**

| CATEGORY | Base Model and Input Voltage | Output Voltage [2] | Number of Outputs [3] | Case Option [4] | Screening [5] |
|---|---|---|---|---|---|
| **OPTIONS** | **MHF+28** | 1R9, 3R3, 05, 5R2, 5R3, 12, 15, 28 | S | (non-flanged, leave blank) | Standard (leave blank) |
| | | 05, 12, 15 | D | F (flanged) | /ES |
| | | 512, 515 | T | | /883 (Class H) |
| **FILL IN FOR MODEL # [6]** | **MHF+28** | _____ | _____ | _____ | / _____ |

Notes
1. See Figure 10 on page 7 above for an example of a model number.
2. Output Voltage: An R indicates a decimal point. 1R9 is 1.9 volts out. The values of 1R9, 3R3, 5R2 and 5R3 are only available in single output models. The 512 and 515 triple output converters are +5 volt main and ±12 or ±15 volt auxiliaries.
3. Number of Outputs: S is a single output, D is a dual output, and T is a triple output
4. Case Options: For the standard, non-flanged, case leave the case option blank. See non-flanged cases Figure 34 on page 19 and Figure 35 on page 20. For the flanged case use an F in the case option position. See flanged cases Figure 36 on page 21 and Figure 37 on page 22).
5. Screening: For standard screening leave the screening option blank. For other screening options, insert the desired screening level. For more information see Table 13 on page 23 and Table 14 on page 24.
6. If ordering by model number add suffix "-Q" to request solder dipped leads (MHF+2805S/ES-Q).

TABLE 4: MODEL NUMBER OPTIONS

# MHF+ Single, Dual and Triple DC-DC Converters

## 28 VOLT INPUT – 15 WATT

TABLE 5: OPERATING CONDITIONS, ALL MODELS : 25°C CASE, 28 VIN, 100% LOAD, UNLESS OTHERWISE SPECIFIED.

| | | ALL MODELS | | | UNITS |
|---|---|---|---|---|---|
| PARAMETER (Operating Conditions Table continued on next page) | CONDITIONS | MIN | TYP | MAX | |
| LEAD SOLDERING TEMPERATURE [1] | 10 SECONDS MAX. | — | — | 300 | °C |
| STORAGE TEMPERATURE [1] | | -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-STD-883, METHOD 3015 | >8000 | | | V |
| MIL-PRF-38534, 3.9.5.8.2 | CLASS 3 | | | | |
| ISOLATION: INPUT TO OUTPUT, INPUT TO | @ 500 VDC AT 25°C | 100 | — | — | Megohms |
| CASE, OUTPUT TO CASE [2] | | | | | |
| UNDERVOLTAGE LOCKOUT | SINGLES AND DUALS | — | 14 | — | V |
| | TRIPLES | — | 8.5 | — | |
| INPUT TO OUTPUT CAPACITANCE [1] | | — | 60 | — | pF |
| CURRENT LIMIT [3] | SINGLES AND DUALS | — | 115 | — | % |
| % OF FULL LOAD | TRIPLES | — | 130 | — | |
| AUDIO REJECTION [1] | | — | 50 | — | dB |

Notes
1. Guaranteed by design and/or analysis. Not an in-line test.
2. When testing isolation, input pins are tied together and output pins are tied together. They are tested against each other and against case. Discharge the pins before and after testing.
3. Dual and triple outputs: The over-current limit will trigger when the sum of the currents from both dual outputs or both auxiliary outputs (triple)reaches the maximum rated “total” current of both outputs. Typical values are stated in the table.

# MHF+ Single, Dual and Triple DC-DC Converters

## 28 VOLT INPUT – 15 WATT

TABLE 6: OPERATING CONDITIONS, ALL MODELS : 25°C CASE, 28 VIN, 100% LOAD, UNLESS OTHERWISE SPECIFIED.

| | | ALL MODELS | | | UNITS |
|---|---|---|---|---|---|
| PARAMETER (Operating Conditions Table continued) | CONDITIONS | MIN | TYP | MAX | |
| SWITCHING FREQUENCY | SINGLES AND DUALS | 480 | — | 620 | kHz |
| -55°C TO +125°C | TRIPLES | 375 | — | 500 | |
| SYNCHRONIZATION [2] | INPUT FREQUENCY | | | | |
| | SINGLES AND DUALS | 500 | — | 600 | kHz |
| | TRIPLES | 400 | — | 600 | |
| | DUTY CYCLE [1] | 40 | — | 60 | % |
| | ACTIVE LOW | — | — | 0.8 | V |
| | ACTIVE HIGH [1] | 4.0 | — | 5.0 | |
| | REFERENCED TO | INPUT COMMON | | | |
| | IF NOT USED, SINGLES AND DUALS | CONNECT TO INPUT COMMON | | | |
| | IF NOT USED, TRIPLES | LEAVE UNCONNECTED | | | |
| INHIBIT ACTIVE LOW (OUTPUT DISABLED) | INHIBIT PIN PULLED LOW | — | — | 0.8 | V |
| Do not apply a voltage to the inhibit pin. [3] | INHIBIT PIN SOURCE CURRENT [1, 4] | — | — | 5 | mA |
| | REFERENCED TO | INPUT COMMON | | | |
| INHIBIT ACTIVE HIGH (OUTPUT ENABLED) | INHIBIT PIN CONDITION | OPEN COLLECTOR OR UNCONNECTED | | | |
| Do not apply a voltage to the inhibit pin. [3] | OPEN INHIBIT PIN VOLTAGE [1] | | | | |
| | SINGLE AND DUAL | 8.5 | 10 | 12 | V |
| | TRIPLE | — | 11 | — | |

For mean time between failures (MTBF) contact Applications Engineering at powerapps@craneae.com or +1 425.882.31000.

Notes
1. Guaranteed by design and/or analysis. Not an in-line test.
2. Triple models: Source impedance should be <100 ohms and the transition times should be <100 nanoseconds.
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.
4. Inhibit source current is equal to $V_{IN}$ / 10 k ohms.

# MHF+ Single, Dual and Triple DC-DC Converters

## 28 VOLT INPUT – 15 WATT

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

| SINGLE OUTPUT MODELS | | MHF+281R9S | | | MHF+283R3S | | | MHF+2805S | | | UNITS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| PARAMETER | CONDITIONS | MIN | TYP | MAX | MIN | TYP | MAX | MIN | TYP | MAX | |
| OUTPUT VOLTAGE | | 1.84 | 1.90 | 1.96 | 3.20 | 3.30 | 3.40 | 4.85 | 5.00 | 5.15 | V |
| OUTPUT CURRENT [2] | $V_{IN}$ = 16 TO 40 V | 0 | – | 3.5 | 0 | — | 2.4 | 0 | — | 2.4 | A |
| OUTPUT POWER [2] | $V_{IN}$ = 16 TO 40 V | 0 | — | 6.65 | 0 | — | 8 | 0 | — | 12 | W |
| OUTPUT RIPPLE | $T_C$ = 25°C | — | 7 | 30 | — | 30 | 80 | — | 30 | 80 | mV p-p |
| 10 KHZ - 2 MHZ | $T_C$ = -55°C TO +125°C | — | 12 | 40 | — | 50 | 240 | — | 60 | 100 | |
| LINE REGULATION | $V_{IN}$ = 16 TO 40 V | — | 1 | 40 | – | 5 | 100 | — | 5 | 50 | mV |
| LOAD REGULATION [3] | NO LOAD TO FULL | — | 35 | 55 | – | 20 | 50 | — | 20 | 50 | mV |
| INPUT VOLTAGE | CONTINUOUS | 20 | 28 | 32 | 16 | 28 | 40 | 16 | 28 | 40 | V |
| NO LOAD TO FULL | TRANSIENT 50 MS [1] | — | — | 35 | — | — | 50 | — | — | 50 | V |
| INPUT CURRENT | NO LOAD | — | 16 | 35 | — | 25 | 40 | — | 25 | 40 | mA |
| | INHIBITED | — | 2 | 7 | — | 5 | 12 | — | 5 | 12 | |
| INPUT RIPPLE CURRENT | 10 KHZ - 10 MHZ | — | 30 | 70 | – | 45 | 120 | — | 35 | 100 | mA p-p |
| EFFICIENCY | $T_C$ = 25°C | 58 | 62 | — | 70 | 75 | – | 75 | 77 | — | % |
| | $T_C$ = -55°C TO +125°C | 56 | — | — | 67 | — | — | 72 | — | — | |
| LOAD FAULT [4, 5] | POWER DISSIPATION | — | 4 | 8 | — | 5 | 8 | — | 3.5 | 6 | W |
| SHORT CIRCUIT | RECOVERY [1] | — | 5 | 30 | — | 7.5 | 30 | — | 7.5 | 30 | ms |
| STEP LOAD RESPONSE [5, 6] | TRANSIENT | — | ±75 | ±500 | — | ±150 | ±400 | — | ±150 | ±400 | mV pk |
| 50% - 100% - 50% | RECOVERY | — | 500 | 2000 | — | 150 | 300 | — | 150 | 300 | µs |
| STEP LINE RESPONSE [1, 5, 7, 8] | TRANSIENT | — | ±300 | ±600 | — | ±550 | ±800 | — | ±550 | ±800 | mV pk |
| $V_{IN}$ = 16 - 40 - 16 V | RECOVERY | — | 0.5 | 1.2 | — | 0.8 | 1.2 | — | 0.8 | 1.2 | ms |
| START-UP [9, 5] | DELAY | — | 12 | 35 | – | 10 | 25 | — | 10 | 25 | ms |
| | OVERSHOOT [1] | — | 500 | 850 | — | 200 | 300 | — | 100 | 600 | mV pk |
| CAPACITIVE LOAD [1, 10] | $T_C$ = 25°C | — | — | 100 | – | – | 300 | – | – | 300 | µF |

Notes
1. Guaranteed by qualification test and/or analysis. Not an in-line test.
2. $V_{IN}$ is 20 to 32 volts for MHF+281R9S.
3. For MHF+281R9, load regulation is tested from a 10 mA load to full load.
4. Indefinite short circuit protection not guaranteed above 125°C (case).
5. Recovery time is measured from application of the transient to the point at which $V_{OUT}$ is within regulation.
6. Step load test is performed at 10 microseconds typical.
7. Step line characterization test is performed at 100 microseconds ± 20 microseconds.
8. Step line is 20 - 32 - 20 volts for MHF+281R39S.
9. Measured on release from inhibit.
10. No effect on dc performance.

# MHF+ Single, Dual and Triple DC-DC Converters

## 28 VOLT INPUT – 15 WATT

TABLE 8: ELECTRICAL CHARACTERISTICS -55°C TO +125°C CASE, 28 VIN, 100% LOAD, UNLESS OTHERWISE SPECIFIED.

| SINGLE OUTPUT MODELS | | MHF+285R2S | | | MHF+285R3S | | | MHF+2812S | | | UNITS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| PARAMETER | CONDITIONS | MIN | TYP | MAX | MIN | TYP | MAX | MIN | TYP | MAX | |
| OUTPUT VOLTAGE | | 5.04 | 5.20 | 5.36 | 5.19 | 5.30 | 5.51 | 11.76 | 12.00 | 12.24 | V |
| OUTPUT CURRENT | $V_{IN}$ = 16 TO 40 V | 0 | — | 2.4 | 0 | — | 2.83 | 0 | — | 1.25 | A |
| OUTPUT POWER | $V_{IN}$ = 16 TO 40 V | 0 | — | 12.48 | 0 | — | 15 | 0 | — | 15 | W |
| OUTPUT RIPPLE | $T_C$ = 25°C | — | 30 | 50 | — | 30 | 50 | — | 30 | 80 | mV p-p |
| 10 kHz - 2 MHz | $T_C$ = -55°C TO +125°C | — | 60 | 100 | — | 60 | 100 | — | 50 | 120 | |
| LINE REGULATION | $V_{IN}$ = 16 TO 40 V | — | 5 | 50 | — | 5 | 50 | — | 5 | 50 | mV |
| LOAD REGULATION | NO LOAD TO FULL | — | 20 | 50 | — | 20 | 50 | — | 20 | 50 | mV |
| INPUT VOLTAGE | CONTINUOUS | 16 | 28 | 40 | 16 | 28 | 40 | 16 | 28 | 40 | V |
| NO LOAD TO FULL | TRANSIENT 50 MS [1] | — | — | 50 | — | — | 50 | — | — | 50 | V |
| INPUT CURRENT | NO LOAD | — | 25 | 43 | — | 24 | 43 | — | 25 | 50 | mA |
| | INHIBITED | — | 5 | 12 | — | 5 | 12 | — | 5 | 12 | |
| INPUT RIPPLE CURRENT | 10 KHZ - 10 MHZ | — | 35 | 120 | — | 35 | 120 | — | 35 | 120 | mA p-p |
| EFFICIENCY | $T_C$ = 25°C | 75 | 77 | — | 75 | 77 | — | 78 | 79 | — | % |
| | $T_C$ = -55°C TO +125°C | 72 | — | — | 72 | — | — | 74 | — | — | |
| LOAD FAULT [2, 3] | POWER DISSIPATION | — | 3.5 | 6 | — | 3.5 | 6 | — | 3.5 | 6 | W |
| SHORT CIRCUIT | RECOVERY [1] | — | 7.5 | 30 | — | 7.5 | 30 | — | 7.5 | 30 | ms |
| STEP LOAD RESPONSE [3, 4] | TRANSIENT | — | ±150 | ±400 | — | ±150 | ±400 | — | ±150 | ±500 | mV pk |
| 50% - 100% - 50% | RECOVERY | — | 150 | 300 | — | 150 | 300 | — | 150 | 300 | µs |
| STEP LINE RESPONSE [1, 3, 5] | TRANSIENT | — | ±550 | ±800 | — | ±550 | ±800 | — | ±550 | ±800 | mV pk |
| $V_{IN}$ = 16 - 40 - 16 V | RECOVERY | — | 0.8 | 1.2 | — | 0.8 | 1.2 | — | 0.8 | 1.2 | ms |
| START-UP [3, 6] | DELAY | — | 10 | 25 | — | 10 | 25 | — | 10 | 25 | ms |
| | OVERSHOOT [1] | — | 100 | 600 | — | 100 | 600 | — | 200 | 1200 | mV pk |
| CAPACITIVE LOAD [1, 7] | $T_C$ = 25°C | — | — | 300 | — | — | 300 | — | — | 100 | µF |

Notes
1. Guaranteed by qualification test and/or analysis. Not an in-line test.
2. Indefinite short circuit protection not guaranteed above 125°C case.
3. Recovery time is measured from application of the transient to the point at which $V_{OUT}$ is within regulation.
4. Step load test is performed at 10 microseconds typical.
5. Step line characterization test is performed at 100 microseconds ± 20 microseconds.
6. Measured on release from inhibit.
7. No effect on dc performance.

# MHF+ Single, Dual and Triple DC-DC Converters

## 28 VOLT INPUT – 15 WATT

TABLE 9: ELECTRICAL CHARACTERISTICS -55°C TO +125°C CASE, 28 VIN, 100% LOAD, UNLESS OTHERWISE SPECIFIED.

| SINGLE OUTPUT MODELS | | MHF+2815S | | | MHF+2828S | | | UNITS |
|---|---|---|---|---|---|---|---|---|
| PARAMETER | CONDITIONS | MIN | TYP | MAX | MIN | TYP | MAX | |
| OUTPUT VOLTAGE | | 14.70 | 15.00 | 15.30 | 27.44 | 28.00 | 28.56 | V |
| OUTPUT CURRENT | $V_{IN}$ = 16 TO 40 V | 0 | — | 1.00 | 0 | — | 0.536 | A |
| OUTPUT POWER | $V_{IN}$ = 16 TO 40 V | 0 | — | 15 | 0 | — | 15 | W |
| OUTPUT RIPPLE | $T_C$ = 25°C | — | 30 | 80 | — | 60 | 120 | mV p-p |
| 10 kHz - 2 MHz | $T_C$ = -55°C TO +125°C | — | 50 | 120 | — | 100 | 180 | |
| LINE REGULATION | $V_{IN}$ = 16 TO 40 V | — | 5 | 50 | — | 50 | 150 | mV |
| LOAD REGULATION | NO LOAD TO FULL | — | 20 | 50 | — | 50 | 150 | mV |
| INPUT VOLTAGE | CONTINUOUS | 16 | 28 | 40 | 16 | 28 | 40 | V |
| NO LOAD TO FULL | TRANSIENT 50 MS [1] | — | — | 50 | — | — | 50 | V |
| INPUT CURRENT | NO LOAD | — | 25 | 62 | — | 25 | 60 | mA |
| | INHIBITED | — | 5 | 12 | — | 5 | 12 | |
| INPUT RIPPLE CURRENT | 10 KHZ - 10 MHZ | — | 35 | 120 | — | 35 | 120 | mA p-p |
| EFFICIENCY | $T_C$ = 25°C | 78 | 80 | — | 82 | 84 | — | % |
| | $T_C$ = -55°C TO +125°C | 74 | — | — | 78 | — | — | |
| LOAD FAULT [2, 3] | POWER DISSIPATION | — | 3.5 | 6 | — | 3.5 | 6 | W |
| SHORT CIRCUIT | RECOVERY [1] | — | 7.5 | 30 | — | 7.5 | 30 | ms |
| STEP LOAD RESPONSE [3, 4] | TRANSIENT | — | ±200 | ±600 | — | ±600 | ±800 | mV pk |
| 50% - 100% - 50% | RECOVERY | — | 150 | 300 | — | 200 | 400 | µs |
| STEP LINE RESPONSE [1, 3, 5] | TRANSIENT | — | ±550 | ±800 | — | ±1100 | ±1200 | mV pk |
| $V_{IN}$ = 16 - 40 - 16 V | RECOVERY | — | 0.8 | 1.2 | — | 0.8 | 1.2 | ms |
| START-UP [3, 6] | DELAY | — | 10 | 25 | — | 10 | 25 | ms |
| | OVERSHOOT [1] | — | 200 | 1500 | — | 200 | 280 | mV pk |
| CAPACITIVE LOAD [1, 7] | $T_C$ = 25°C | — | — | 100 | — | — | 100 | µF |

Notes
1. Guaranteed by qualification test and/or analysis. Not an in-line test.
2. Indefinite short circuit protection not guaranteed above 125°C case.
3. Recovery time is measured from application of the transient to the point at which $V_{OUT}$ is within regulation.
4. Step load test is performed at 10 microseconds typical.
5. Step line characterization test is performed at 100 microseconds ± 20 microseconds.
6. Measured on release from inhibit.
7. No effect on dc performance.

# MHF+ Single, Dual and Triple DC-DC Converters

## 28 VOLT INPUT – 15 WATT

TABLE 10: ELECTRICAL CHARACTERISTICS -55°C TO +125°C CASE, 28 VIN, 100% LOAD, UNLESS OTHERWISE SPECIFIED.

| DUAL OUTPUT MODELS | | MHF+2805D | | | MHF+2812D | | | MHF+2815D | | | UNITS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| PARAMETER | CONDITIONS | MIN | TYP | MAX | MIN | TYP | MAX | MIN | TYP | MAX | |
| OUTPUT VOLTAGE | + $V_{OUT}$ | 4.85 | 5.00 | 5.15 | 11.76 | 12.00 | 12.24 | 14.70 | 15.00 | 15.30 | V |
| | - $V_{OUT}$ | 4.82 | 5.00 | 5.18 | 11.70 | 12.00 | 12.30 | 14.63 | 15.00 | 15.38 | |
| OUTPUT CURRENT [2, 3] | EITHER OUTPUT | 0 | ±1.2 | 1.92[1] | 0 | ±0.625 | 1.125[1] | 0 | ±0.50 | 0.90[1] | A |
| $V_{IN}$ = 16 TO 40 V | TOTAL OUTPUT | — | — | 2.4 | — | — | 1.25 | — | — | 1.0 | |
| OUTPUT POWER [2, 3] | EITHER OUTPUT | 0 | ±6 | 9.6[1] | 0 | ±7.5 | 13.5[1] | 0 | ±7.5 | 13.5[1] | W |
| $V_{IN}$ = 16 TO 40 V | TOTAL OUTPUT | — | — | 12 | — | — | 15 | — | — | 15 | |
| OUTPUT RIPPLE | $T_C$ = 25°C | — | 30 | 80 | — | 30 | 80 | — | 30 | 60 | mV p-p |
| ±$V_{OUT}$, 10 kHz - 2 MHz | $T_C$ = -55°C TO +125°C | — | 60 | 80 | — | 60 | 120 | — | 50 | 120 | |
| LINE REGULATION | + $V_{OUT}$ | — | 5 | 50 | — | 5 | 50 | — | 5 | 50 | mV |
| $V_{IN}$ = 16 TO 40 V | - $V_{OUT}$ | — | — | 80 | — | — | 100 | — | — | 100 | |
| LOAD REGULATION | + $V_{OUT}$ | — | 20 | 50 | — | 20 | 50 | — | 20 | 50 | mV |
| NL TO FULL, BALANCED | - $V_{OUT}$ | — | — | 100 | — | — | 100 | — | — | 100 | |
| CROSS REGULATION [4] | $T_C$ = 25°C | — | — | 375 | — | — | 720 | — | — | 900 | mV |
| INPUT VOLTAGE | CONTINUOUS | 16 | 28 | 40 | 16 | 28 | 40 | 16 | 28 | 40 | V |
| NO LOAD TO FULL | TRANSIENT 50 MS [1] | — | — | 50 | — | — | 50 | — | — | 50 | V |
| INPUT CURRENT | NO LOAD | — | 20 | 40 | — | 25 | 50 | — | 25 | 50 | mA |
| | INHIBITED | — | 6 | 12 | — | 5 | 12 | — | 5 | 12 | |
| INPUT RIPPLE CURRENT | 10 KHZ - 10 MHZ | — | 20 | 80 | — | 35 | 100 | — | 35 | 100 | mA p-p |
| EFFICIENCY | $T_C$ = 25°C | 77 | 79 | — | 76 | 83 | — | 76 | 84 | — | % |
| | $T_C$ = -55°C TO +125°C | 75 | — | — | 74 | — | — | 74 | — | — | |
| LOAD FAULT [5, 6] | POWER DISSIPATION | — | 3 | 6 | — | 3 | 6 | — | 3 | 6 | W |
| SHORT CIRCUIT | RECOVERY [1] | — | 7.5 | 30 | — | 7.5 | 50 | — | 7.5 | 50 | ms |
| STEP LOAD RESPONSE [6, 7] | TRANSIENT +$V_{OUT}$ | — | ±200 | ±600 | — | ±300 | ±700 | — | ±300 | ±700 | mV pk |
| 50% - 100% - 50% | TRANSIENT -$V_{OUT}$ | — | ±200 | ±600 | — | ±300 | ±700 | — | ±300 | ±700 | |
| BALANCED LOADS | RECOVERY | — | 150 | 500 | — | 200 | 500 | — | 200 | 500 | µs |
| STEP LINE RESPONSE [1, 6, 8] | TRANSIENT | — | ±600 | ±800 | — | ±550 | ±750 | — | ±550 | ±750 | mV pk |
| $V_{IN}$ = 16 - 40 - 16 V ±$V_{OUT}$ | RECOVERY | — | 0.8 | 1.2 | — | 0.8 | 1.2 | — | 0.8 | 1.2 | ms |
| START-UP [6, 9] | DELAY | — | 12 | 20 | — | 12 | 25 | — | 12 | 25 | ms |
| $V_{IN}$ = 40 V | OVERSHOOT [1] | — | 80 | 250 | — | 200 | 750 | — | 200 | 750 | mV pk |
| CAPACITIVE LOAD [1, 10, 11] | $T_C$ = 25°C | — | — | 47 | — | — | 10 | — | — | 10 | µF |

Notes
1. Guaranteed by qualification test and/or analysis. Not an in-line test.
2. Up to 90% (80% 2805D) of the total output current/power is available from either output providing the opposite output is carrying at least 10% (20% 2805D) of the total output power. Loads that are both very light and unbalanced between the outputs may create higher output ripple voltage in some applications. Please contact Applications Engineering (powerapps@crane-eg.com) for additional information.
3. The "total" specification is the maximum combined current/power of both outputs.
4. Effect on negative $V_{OUT}$ referenced to 50%/50% loads. 50% to 10% with the opposite output held at 50% (applied to both outputs), see Figure 21 on page 17. Simultaneously 30%-70% 70%-30%.
5. Indefinite short circuit protection not guaranteed above 125°C (case). Both outputs shorted at the same time.
6. Recovery time is measured from application of the transient to point at which $V_{OUT}$ is within regulation.
7. Step load test is performed at 10 microseconds typical.
8. Step line characterization test is performed at 100 microseconds ± 20 microseconds.
9. Measured on release from inhibit.
10. Applies to each output.
11. No effect on dc performance.

# MHF+ Single, Dual and Triple DC-DC Converters

## 28 VOLT INPUT – 15 WATT

TABLE 11: ELECTRICAL CHARACTERISTICS -55°C TO +125°C CASE, 28 VIN, 100% LOAD, UNLESS OTHERWISE SPECIFIED.

| TRIPLE OUTPUT MODEL – MHF+28512T | | 5 (MAIN) | | | ±12 (AUXILIARIES) | | | UNITS |
|---|---|---|---|---|---|---|---|---|
| PARAMETER | CONDITIONS | MIN | TYP | MAX | MIN | TYP | MAX | |
| OUTPUT VOLTAGE [2] | $V_{OUT}$ | 4.85 | 5.00 | 5.15 | ±11.52 | ±12.00 | ±12.48 | V |
| OUTPUT CURRENT [3] | EITHER OUTPUT | — | — | 1.5 | 0 | ±0.313 | 0.416 [1] | A |
| $V_{IN}$ = 16 TO 48 V | TOTAL | — | — | 1.5 | — | — | 0.625 | |
| OUTPUT POWER [4] | EITHER OUTPUT | — | — | 7.5 | — | ±3.75 | 5 [1] | W |
| $V_{IN}$ = 16 TO 48 V | TOTAL | — | — | 7.5 | — | — | 7.5 | |
| OUTPUT RIPPLE | $T_C$ = 25°C | — | 20 | 60 | — | ±30 | ±90 | mV p-p |
| 10 KHZ - 2 MHZ | $T_C$ = -55°C TO +125°C | — | — | 90 | — | — | ±180 | |
| LINE REGULATION | $V_{IN}$ = 16 TO 48 V | — | 25 | 75 | — | ±120 | ±240 | mV |
| LOAD REGULATION [5] | NO LOAD TO FULL | — | 22 | 75 | — | ±120 | ±240 | mV |
| CROSS REGULATION [6] $T_C$ = 25°C | EFFECT ON NEGATIVE AUXILIARY | — | — | — | — | — | 750 | mV |
| INPUT VOLTAGE | CONTINUOUS | 16 | 28 | 48 | — | — | — | V |
| NO LOAD TO FULL | TRANSIENT [1] 120 MS | — | — | 80 | — | — | — | V |
| INPUT CURRENT | NO LOAD | — | 30 | 45 | — | — | — | mA |
| | INHIBITED | — | 3 | 5 | — | — | — | |
| INPUT RIPPLE CURRENT | 10 KHZ - 10 MHZ | — | 20 | 50 | — | — | — | mA p-p |
| EFFICIENCY | $T_C$ = 25°C | 74 | 76 | — | — | — | — | % |
| | $T_C$ = -55°C TO +125°C | 72 | — | — | — | — | — | |
| LOAD FAULT [7, 8, 9] | POWER DISSIPATION | — | — | 12 | — | — | ±12 | W |
| SHORT CIRCUIT | RECOVERY [1] | — | — | 25 | — | — | 25 | ms |
| STEP LOAD RESPONSE [9, 10] | TRANSIENT | — | — | ±850 | — | — | ±950 | mV pk |
| | RECOVERY | — | 5 | 8 | — | 2 | 3 | ms |
| STEP LINE RESPONSE [1, 9, 11] | TRANSIENT | — | — | ±800 | — | — | ±800 | mV pk |
| $V_{IN}$ = 16 - 40 - 16 V | RECOVERY | — | — | 5 | — | — | 5 | ms |
| START-UP [9, 12] | DELAY | — | 10 | 25 | — | 10 | ±25 | ms |
| | OVERSHOOT [1] | — | — | 500 | — | — | ±500 | mV pk |
| CAPACITIVE LOAD [1, 13, 14] | $T_C$ = 25°C | — | — | 150 | — | — | 50 | µF |

Notes
1. Guaranteed by qualification test and/or analysis. Not an in-line test.
2. If running with external sync, at temperature extremes $V_{OUT}$ main may be a minimum of 4.80 volts to a maximum of 5.20 volts.
3. The sum of the 12 volt auxiliary output currents may not exceed 625 mA.
4. The maximum power available from either auxiliary output is 5 watts and the sum of the auxiliary outputs may not exceed 7.5 watts.
5. Load regulation for the +5 is specified at 0.0 to 1.5 A with the auxiliaries both held at 3.75 W (313 mA). Load regulation for the auxiliaries is specified as both auxiliaries from 0.0 to 3.75 W (313 mA) at the same time with the +5 held at 1.5 A.
6. 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: Condition 1: Negative auxiliary = 0.417 A and positive auxiliary = 0.178 A Condition 2: Negative auxiliary = 0.178 A and positive auxiliary = 0.417 A
7. Load fault = < 0.100 Ω. All three outputs shorted simultaneously.
8. Indefinite short circuit protection not guaranteed above 125°C case.
9. Time to settle to within 1% of $V_{OUT}$ final value.
10. Step load test is performed at 10 microseconds typical.
11. Step line characterization test is performed at 100 microseconds ± 20 microseconds.
12. Measured on release from inhibit.
13. Auxiliary capacitive load applies to each output.
14. No effect on dc performance.

# MHF+ Single, Dual and Triple DC-DC Converters

## 28 VOLT INPUT – 15 WATT

TABLE 12: ELECTRICAL CHARACTERISTICS -55°C TO +125°C CASE, 28 VIN, 100% LOAD, UNLESS OTHERWISE SPECIFIED.

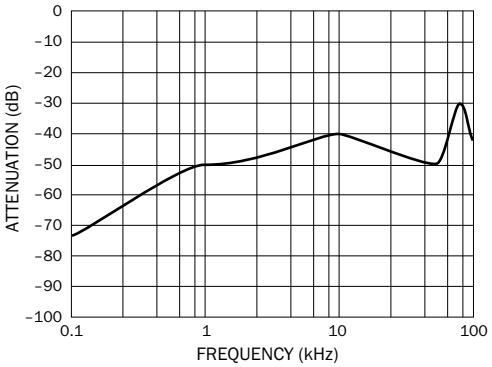
| TRIPLE OUTPUT MODEL – MHF+28515T | | 5 (MAIN) | | | ±15 (AUXILIARIES) | | | UNITS |
|---|---|---|---|---|---|---|---|---|
| PARAMETER | CONDITIONS | MIN | TYP | MAX | MIN | TYP | MAX | |
| OUTPUT VOLTAGE [2] | $V_{OUT}$ | 4.85 | 5.00 | 5.15 | 14.40 | 15.00 | 15.60 | V |
| OUTPUT CURRENT [3] | EITHER OUTPUT | – | – | 1.5 | 0 | ±0.250 | 0.333 [1] | A |
| $V_{IN}$ = 16 TO 48 V | TOTAL | – | – | 1.5 | – | – | 0.500 | |
| OUTPUT POWER [4] | EITHER OUTPUT | – | – | 7.5 | – | ±3.75 | 5 [1] | W |
| $V_{IN}$ = 16 TO 48 V | TOTAL | – | – | – | – | – | 7.5 | |
| OUTPUT RIPPLE | $T_C$ = 25°C | – | 20 | 60 | – | ±30 | ±112 | mV p-p |
| 10 KHZ - 2 MHZ | $T_C$ = -55°C TO +125°C | – | – | 90 | – | – | ±225 | |
| LINE REGULATION | $V_{IN}$ = 16 TO 48 V | – | 25 | 75 | – | ±150 | ±300 | mV |
| LOAD REGULATION [5] | NO LOAD TO FULL | – | 25 | 75 | – | ±150 | ±300 | mV |
| CROSS REGULATION [6] $T_C$ = 25°C | EFFECT ON NEGATIVE AUXILIARY | – | – | – | – | – | 750 | mV |
| INPUT VOLTAGE | CONTINUOUS | 16 | 28 | 48 | – | – | – | V |
| | TRANSIENT [1] 120 MS | – | – | 80 | – | – | – | V |
| INPUT CURRENT | NO LOAD | – | 30 | 45 | – | – | – | mA |
| | INHIBITED | – | 3 | 5 | – | – | – | |
| INPUT RIPPLE CURRENT | 10 KHZ - 10 MHZ | – | 20 | 50 | – | – | – | mA p-p |
| EFFICIENCY | $T_C$ = 25°C | 74 | 76 | – | – | – | – | % |
| | $T_C$ = -55°C TO +125°C | 72 | – | – | – | – | – | |
| LOAD FAULT [7, 8, 9] | POWER DISSIPATION SHORT CIRCUIT | – | – | 12 | – | – | ±12 | W |
| | RECOVERY [1] | – | – | 25 | – | – | 25 | ms |
| STEP LOAD RESPONSE [9, 10] | TRANSIENT | – | – | ±850 | – | – | ±950 | mV pk |
| | RECOVERY | – | 5 | 8 | – | 2 | 3 | ms |
| STEP LINE RESPONSE [1, 9, 11] | TRANSIENT | – | – | ±800 | – | – | ±800 | mV pk |
| $V_{IN}$ = 16 - 40 - 16 V | RECOVERY | – | – | 5 | – | – | 5 | ms |
| START-UP [9, 12] | DELAY | – | 10 | 25 | – | 10 | 25 | ms |
| | OVERSHOOT [1] | – | – | 500 | – | – | ±500 | mV pk |
| CAPACITIVE LOAD [1, 13, 14] | $T_C$ = 25°C | – | – | 150 | – | – | 50 | µF |

Notes
1. Guaranteed by qualification test and/or analysis. Not an in-line test.
2. If running with external sync, at temperature extremes $V_{OUT}$ main may be a minimum of 4.80 volts to a maximum of 5.20 volts.
3. The sum of the 12 volt auxiliary output currents may not exceed 625 mA.
4. The maximum power available from either auxiliary output is 5 watts and the sum of the auxiliary outputs may not exceed 7.5 watts.
5. Load regulation for the +5 is specified at 0.0 to 1.5 A with the auxiliaries both held at 3.75 W (313 mA). Load regulation for the auxiliaries is specified as both auxiliaries from 0.0 to 3.75 W (313 mA) at the same time with the +5 held at 1.5 A.
6. 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: Condition 1: Negative auxiliary = 0.333 A and positive auxiliary = 0.143 A Condition 2: Negative auxiliary = 0.143 A and positive auxiliary = 0.333 A
7. Load fault = < 0.100 Ω. All three outputs shorted simultaneously.
8. Indefinite short circuit protection not guaranteed above 125°C case.
9. Time to settle to within 1% of $V_{OUT}$ final value.
10. Step load test is performed at 10 microseconds typical.
11. Step line characterization test is performed at 100 microseconds ± 20 microseconds.
12. Measured on release from inhibit.
13. Auxiliary capacitive load applies to each output.
14. No effect on dc performance.

# MHF+ Single, Dual and Triple DC-DC Converters

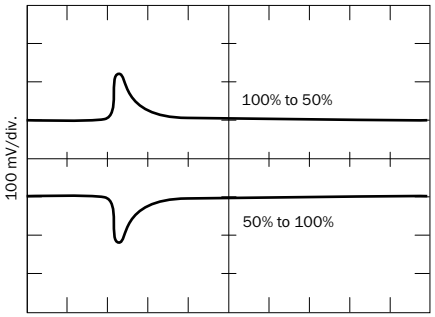
## 28 VOLT INPUT – 15 WATT

Typical Performance Plots: 28 Vin, 25°C case, 100% load, unless otherwise specified.
These are examples for reference only and are not guaranteed specifications.



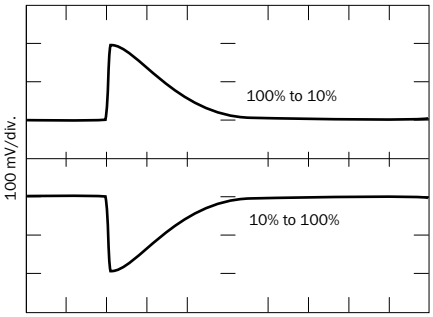

MHF+ SINGLE AND DUAL AUDIO REJECTION

FIGURE 11



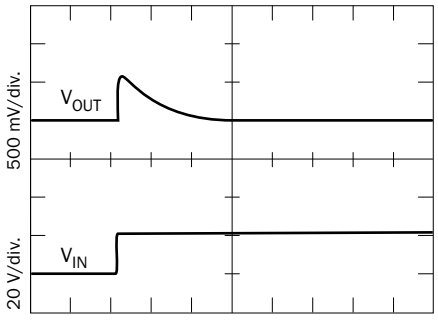

50 µs/div
50% ↔ 100%
MHF+2805S STEP LOAD RESPONSE

FIGURE 12



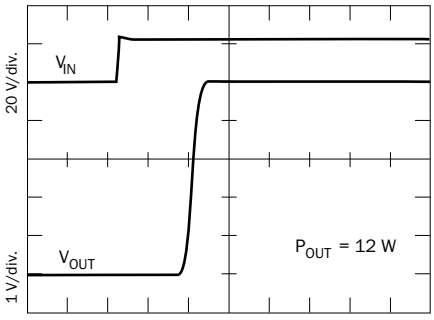

200 µs/div
10% ↔ 100%
MHF+2805S STEP LOAD RESPONSE

FIGURE 13



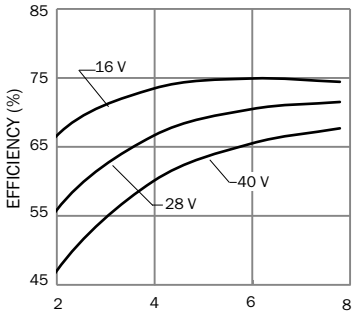

1 ms/div
16 V TO 40 V
MHF+2805S STEP LINE RESPONSE

FIGURE 14



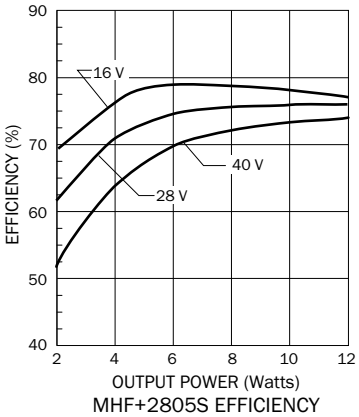

2 ms/div
MHF+2805S TURN-ON INTO FULL LOAD

FIGURE 15



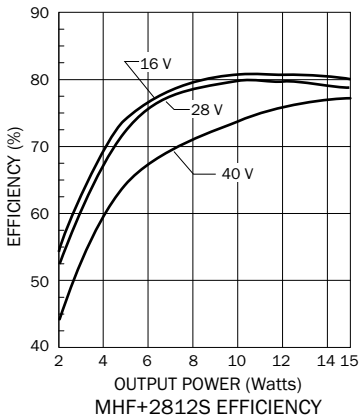

MHF+283R3S EFFICIENCY

FIGURE 16



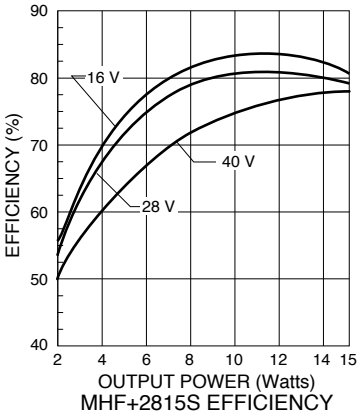

MHF+2805S EFFICIENCY

FIGURE 17




MHF+2812S EFFICIENCY

FIGURE 18




MHF+2815S EFFICIENCY

FIGURE 19

# MHF+ Single, Dual and Triple DC-DC Converters

## 28 VOLT INPUT – 15 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.

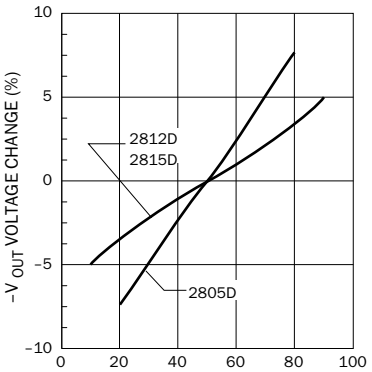



FIGURE 20

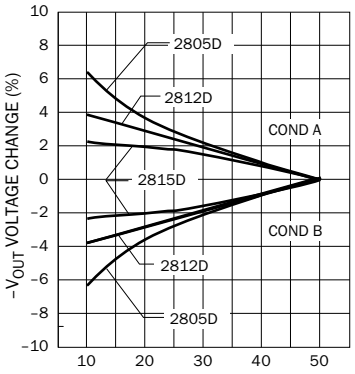



FIGURE 21

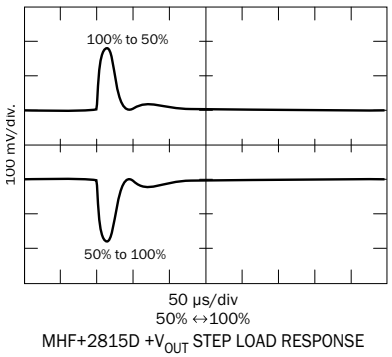



FIGURE 22

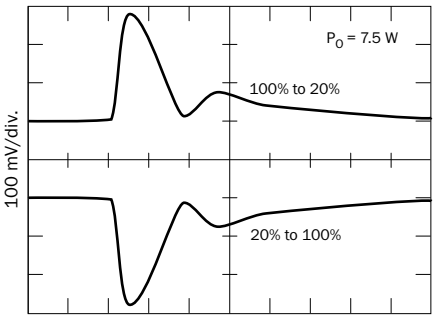



FIGURE 23

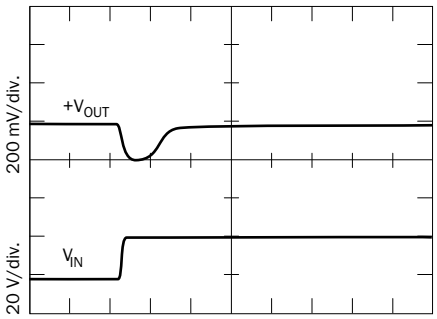



FIGURE 24

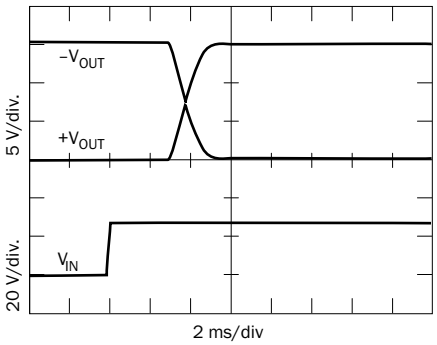



FIGURE 25

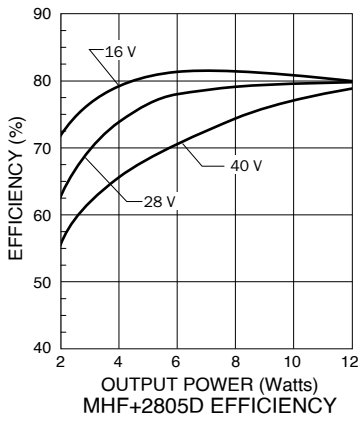



FIGURE 26

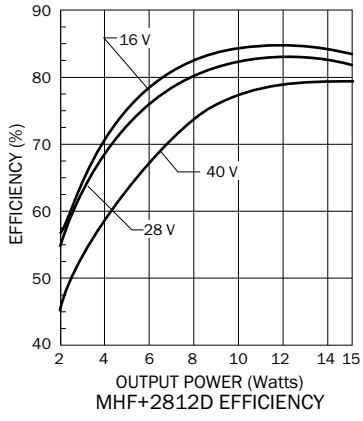



FIGURE 27

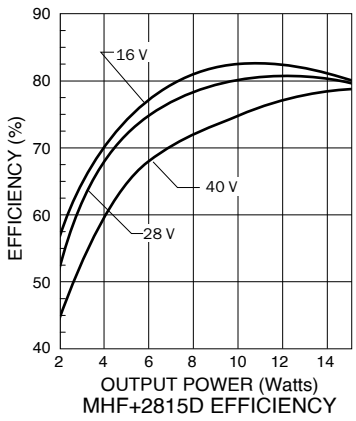
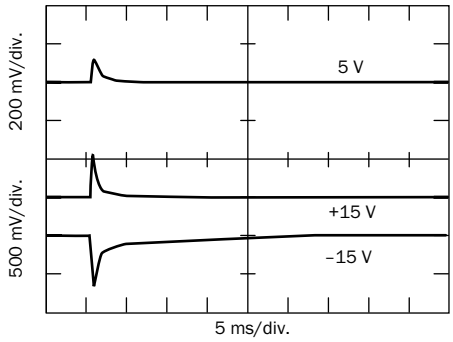



FIGURE 28

# MHF+ Single, Dual and Triple DC-DC Converters

## 28 VOLT INPUT – 15 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.

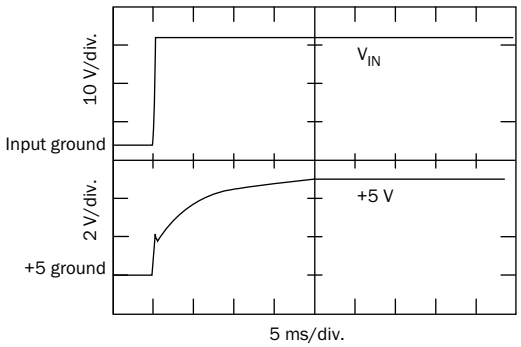



16 TO 40 $V_{IN}$,15 = 250 mA EACH, +5 = 1.5 A

MHF+ 28515T STEP LINE RESPONSE

MHF+28512T has a similar response

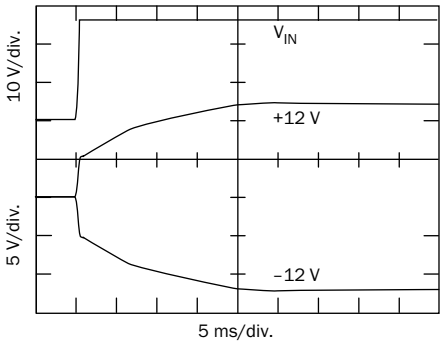
FIGURE 29




MHF+28512T TURN ON INTO FULL LOAD MAIN

MHF+28515T has a similar response

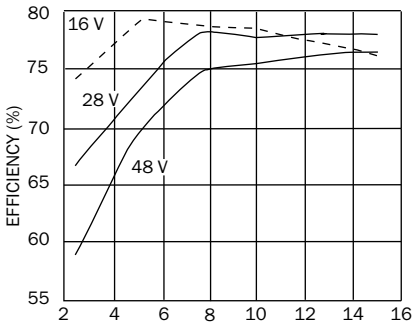
FIGURE 30




MHF+28512T TURN ON INTO FULL LOAD AUXILIARIES

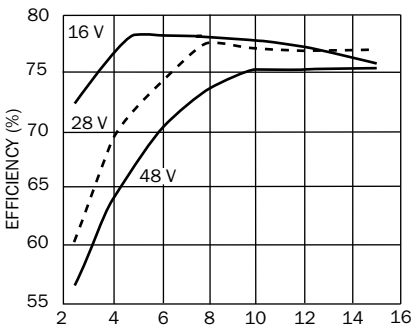
MHF+28515T has a similar response

FIGURE 31




MHF+28512T EFFICIENCY

FIGURE 32



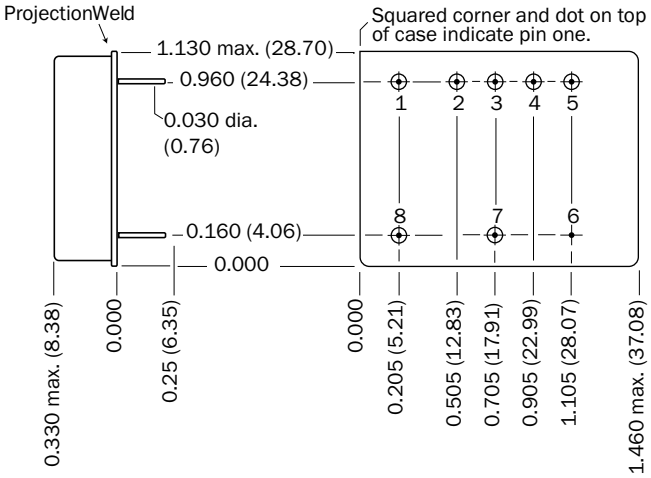

MHF+28515T EFFICIENCY

FIGURE 33

# MHF+ Single, Dual and Triple DC-DC Converters

## 28 VOLT INPUT – 15 WATT

BOTTOM VIEW CASE E1




Weight: 30 grams maximum

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.

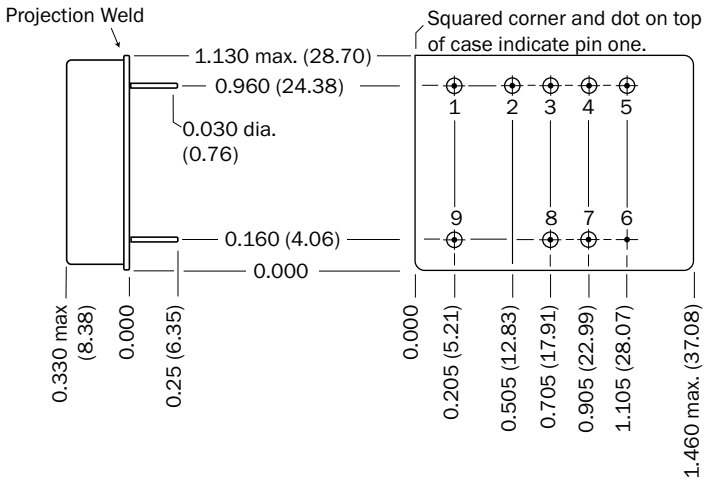
Materials
Header Cold Rolled Steel/Nickel/Gold
Cover Kovar/Nickel
Pins #52 alloy/Gold compression glass seal.
Gold plating of 50 - 150 microinches included in pin diameter
Seal Hole: 0.080 ±0.002 (2.03 ±0.05)

Please refer to the numerical dimensions for accuracy.

FIGURE 34: CASE E1– SINGLE AND DUAL MODELS

## 28 VOLT INPUT – 15 WATT

BOTTOM VIEW CASE E2




Weight: 35 grams maximum

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.

Materials

| | |
|---|---|
| Header | Cold Rolled Steel/Nickel/Gold |
| Cover | Kovar/Nickel |
| Pins | #52 alloy/Gold compression glass seal.<br>Gold plating of 50 - 150 microinches included in pin diameter<br>Seal Hole: 0.080 ±0.002 (2.03 ±0.05) |

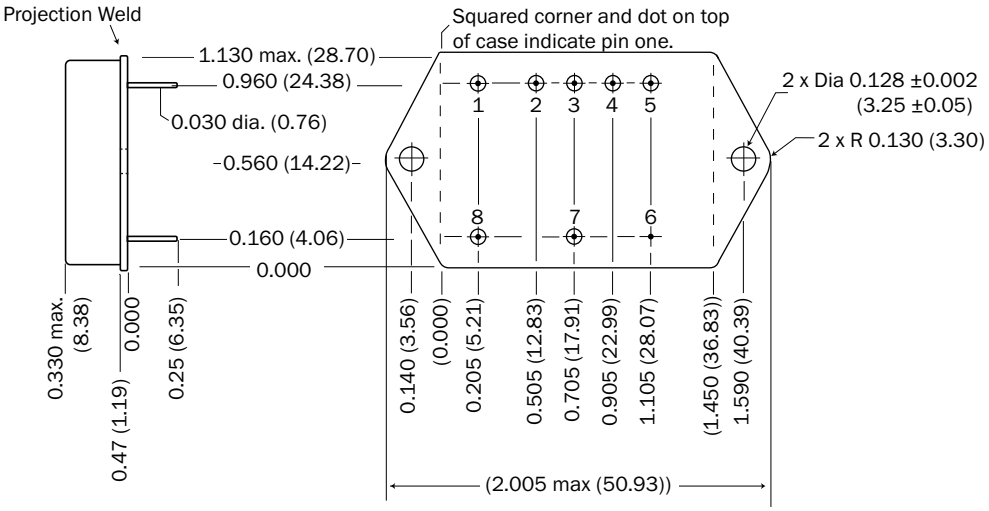
Please refer to the numerical dimensions for accuracy.

FIGURE 35: CASE E2 — TRIPLE MODELS

# MHF+ Single, Dual and Triple DC-DC Converters

## 28 VOLT INPUT – 15 WATT

BOTTOM VIEW CASE G1
Flanged cases: Designator "F" required in Case Option position of model number




Weight: 30 grams maximum

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.

Materials
Header Cold Rolled Steel/Nickel/Gold
Cover Kovar/Nickel
Pins #52 alloy/Gold compression glass seal
Gold plating of 50 - 150 microinches included in pin diameter
Seal Hole: 0.080 ±0.002 (2.03 ±0.05)

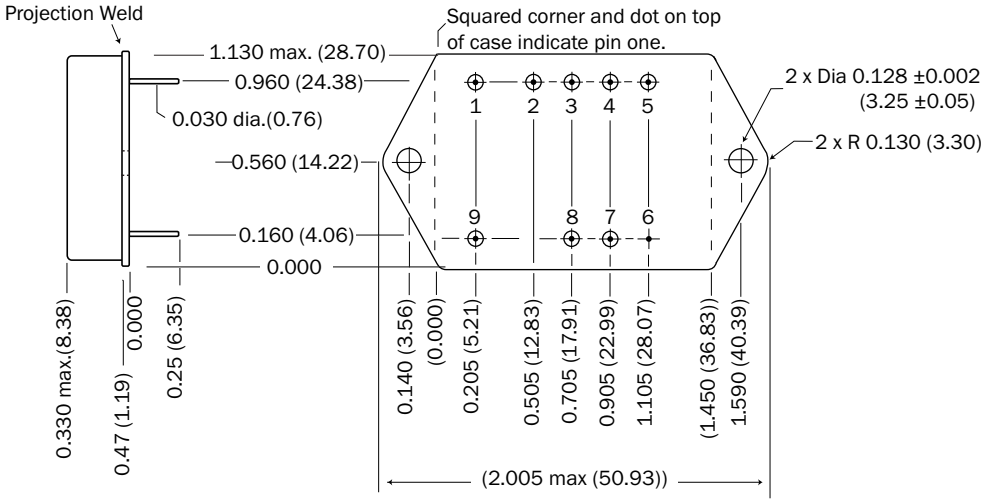
Please refer to the numerical dimensions for accuracy.

FIGURE 36: CASE G1 — SINGLE AND DUAL MODELS

# MHF+ Single, Dual and Triple DC-DC Converters

## 28 VOLT INPUT – 15 WATT

BOTTOM VIEW CASE G2
Flanged cases: Designator "F" required in Case Option position of model number




Weight: 35 grams maximum

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.

Materials

| | |
|---|---|
| Header | Cold Rolled Steel/Nickel/Gold |
| Cover | Kovar/Nickel |
| Pins | #52 alloy/Gold compression glass seal.<br>Gold plating of 50 - 150 microinches included in pin diameter<br>Seal Hole: 0.080 ±0.002 (2.03 ±0.05) |

Please refer to the numerical dimensions for accuracy.

FIGURE 37: CASE G2 — TRIPLE MODELS

# ELEMENT EVALUATION [1] HIGH RELIABILITY DC-DC CONVERTERS AND EMI FILTERS /883 (CLASS H)

| | QML | |
|---|---|---|
| | CLASS H /883 | |
| COMPONENT-LEVEL TEST PERFORMED | M/S [2] | P [3] |
| Element Electrical | ■ | ■ |
| Visual | ■ | ■ |
| Internal Visual | ■ | |
| Final Electrical | ■ | ■ |
| Wire Bond Evaluation | ■ | ■ |

Notes
1. Element evaluation does not apply to standard and /ES product.
2. M/S = Active components (microcircuit and semiconductor die).
3. P = Passive components, Class H element evaluation. Not applicable to standard and /ES element evaluation.

TABLE 13: ELEMENT EVALUATION

# MHF+ Single, Dual and Triple DC-DC Converters

## 28 VOLT INPUT – 15 WATT

## ENVIRONMENTAL SCREENING HIGH RELIABILITY DC-DC CONVERTERS AND EMI FILTERS STANDARD, /ES AND /883 (CLASS H)

| TEST PERFORMED | NON-QML [1] | | CLASS H QML [2] |
|---|---|---|---|
| | STANDARD | /ES | /883 QML [3] |
| **Pre-cap Inspection, Method 2017, 2032** | ■ | ■ | ■ |
| **Temperature Cycle (10 times)** | | | |
| Method 1010, Cond. C, -65°C to +150°C, ambient | | | ■ |
| Method 1010, Cond. B, -55°C to +125°C, ambient | | ■ | |
| **Constant Acceleration** | | | |
| Method 2001, 3000 g | | | ■ |
| Method 2001, 500 g | | ■ | |
| **PIND, Test Method 2020, Cond. A** | | | ■ [4] |
| **Burn-in Method 1015, +125°C case, typical [5]** | | | |
| 96 hours | | ■ | |
| 160 hours | | | ■ |
| **Final Electrical Test, MIL-PRF-38534, Group A,** | | | |
| Subgroups 1 through 6, -55°C, +25°C, +125°C case | | | ■ |
| Subgroups 1 and 4, +25°C case | ■ | ■ | |
| **Hermeticity Test, Method 1014** | | | |
| Gross Leak, Cond. $C_1$, fluorocarbon | | ■ | ■ |
| Fine Leak, Cond. $A_2$, helium | | ■ | ■ |
| Gross Leak, Dip | ■ | | |
| **Final visual inspection, Method 2009** | ■ | ■ | ■ |

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

Notes
1. Non-QML products may not meet all of the requirements of MIL-PRF-38534.
2. All processes are QML qualified and performed by certified operators.
3. Class H QML products have an SMD number
4. Not required by DLA but performed to assure product quality.
5. Burn-in temperature designed to bring the case temperature to +125°C minimum. Burn-in is a powered test.

TABLE 14: ENVIRONMENTAL SCREENING