

## FEATURES

- -55° to +125°C operation
- 16 to 40 VDC input
- Fully isolated
- Optocoupler feedback
- Fixed frequency, 550 kHz typical (400 kHz typ. 60 V output model)
- Topology – Flyback
- 50 V for up to 50 ms transient protection
- Inhibit function
- Indefinite short circuit protection
- Up to 76% efficiency, 16 W/in<sup>3</sup>

# DC/DC CONVERTERS

## 28 VOLT INPUT



## MSA SERIES

### 5 WATT

#### MODELS

##### VDC OUTPUT

| SINGLE | DUAL |
|--------|------|
| 5      | ±5   |
| 5.2    | ±12  |
| 12     | ±15  |
| 15     |      |
| 60     |      |

Size (max.): 1.075 x 1.075 x 0.270 inches (27.31 x 27.31 x 6.86 mm)

Weight: 15 grams maximum.

Screening: Standard, ES, or 883 (Class H).

## DESCRIPTION

The MSA Series™ of high frequency DC/DC converters offers a new standard of performance for low power, military/aerospace grade DC/DC converters. MSA parts provide up to 5 watts output power over the full military temperature range with up to 76% efficiency. Thick-film hybrid techniques provide military/aerospace reliability levels and optimum miniaturization. The hermetically sealed case is only 1.075 by 1.075 inches — with a height of only 0.270 inches. Power density for the MSA Series parts is 16 watts per cubic inch.

The MSA Series' small size, low height, and hermetically sealed metal enclosures make them ideal for use in military, aerospace and other high reliability applications. Units are available with standard, screening, "ES", and fully compliant SMD "883" screening. See page 8 for screening options and descriptions.

## CONVERTER DESIGN

The MSA converters are switching regulators that use a flyback converter design with a constant switching frequency of 550 kHz. They are regulated, isolated units using a pulse width modulated topology and built as high reliability thick-film hybrids. Isolation between input and output circuits is provided with a transformer in the forward power path and an optical link in the feedback control loop. Excellent input line transient response and audio rejection is achieved by an advanced feed-forward compensation technique. Negative output regulation is maintained by tightly coupled magnetics. Up to 4 watts, 80% of the total output power, is available from either output, provided that the opposite output is simultaneously carrying 20% of the total power. Each output must carry a minimum of 20% of the total output power in order to maintain specified regulation on the negative output. Predictable current limit is accomplished by direct monitoring of the output load current, which results in a constant current output above the overload point. Internal input and output filters eliminate the need for external capacitors.

## WIDE VOLTAGE RANGE

The MSA converters are designed to provide full power operation over a full 16 to 40 VDC voltage range. Operation below 16 volts, including MIL-STD-704E emergency power conditions is possible with derated power. Please refer to the low line dropout graphs (Figures 17 and 18) for details. A low voltage lockout feature keeps the converter shutdown below approximately 13 VDC to ensure smooth initialization.

## IMPROVED DYNAMIC RESPONSE

The MSA feed-forward compensation system provides excellent dynamic response and noise rejection. Audio rejection is typically 50 dB. The minimum to maximum step line transient response is typically less than 1%.

## INHIBIT FUNCTION

MSA converters provide a TTL open collector-compatible inhibit feature that can be used to disable internal switching and inhibit the unit's output. Inhibiting in this manner results in low standby current, and no generation of switching noise.

The converter is inhibited when the TTL compatible low ( $\leq 0.8$  V) 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 9 to 11 V. In the inhibit mode, a maximum of 4 mA must be sunk from the inhibit pin.

## UNDERVOLTAGE LOCKOUT AND TRANSIENT PROTECTION

Undervoltage lockout helps keep system current levels low during initialization or re-start operations. They can withstand short term transients of up to 50 volts without damage.

# MSA SERIES 5 WATT

# DC/DC CONVERTERS

## ABSOLUTE MAXIMUM RATINGS

- Input Voltage**
  - 16 to 40 V
- Output Power**
  - 5 watts
- Lead Soldering Temperature (10 sec per lead)**
  - 300°C
- Storage Temperature Range (Case)**
  - -65°C to +135°C

## INHIBIT

- Inhibit TTL Open Collector**
  - Logic low (output disabled)
  - Logic low voltage  $\leq 0.8$  V max
  - Inhibit pin current 4 mA max
  - Referenced to input common
  - Logic high (output enabled)
  - Open collector

## 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

## TYPICAL CHARACTERISTICS

- Output Voltage Temperature Coefficient**
  - 100 ppm/°C typical
- Input to Output Capacitance**
  - 50 pF typical
- Isolation**
  - 100 megohm minimum at 500 V
- Audio Rejection**
  - 50 dB typical
- Conversion Frequency**
  - 550 kHz typical (400 kHz 60 V model)
  - 450 kHz min, 600 kHz max
  - 350 kHz min, 450 kHz max 60 V model
- Inhibit Pin Voltage (unit enabled)**
  - 9 to 11 V

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

| SINGLE OUTPUT MODELS               |  | MSA2805S           |      |                 | MSA285R2S          |      |      | MSA2812S           |       |       | MSA2815S           |       |       | MSA2860S <sup>1</sup> |       |      | UNITS  |
|------------------------------------|--|--------------------|------|-----------------|--------------------|------|------|--------------------|-------|-------|--------------------|-------|-------|-----------------------|-------|------|--------|
| PARAMETER                          | CONDITIONS                                 | MIN                | TYP  | MAX             | MIN                | TYP  | MAX  | MIN                | TYP   | MAX   | MIN                | TYP   | MAX   | MIN                   | TYP   | MAX  |        |
| OUTPUT VOLTAGE                     | Tc = -55°C TO +125°C                       | 4.95               | 5.00 | 5.05            | 5.15               | 5.20 | 5.25 | 11.88              | 12.00 | 12.12 | 14.85              | 15.00 | 15.15 | 59.1                  | 60.00 | 60.9 | VDC    |
| OUTPUT CURRENT                     | Tc = -55°C TO +125°C                       | VIN = 16 TO 40 VDC |      |                 | VIN = 16 TO 40 VDC |      |      | VIN = 16 TO 40 VDC |       |       | VIN = 16 TO 40 VDC |       |       | VIN = 16 TO 40 VDC    |       |      | mA     |
| OUTPUT POWER                       | Tc = -55°C TO +125°C                       | —                  | —    | 5               | —                  | —    | 5    | —                  | —     | 5     | —                  | —     | 5     | —                     | —     | 1.2  | W      |
| OUTPUT RIPPLE VOLTAGE              | 10 kHz - 2 MHz                             | —                  | 125  | 350             | —                  | 110  | 335  | —                  | 50    | 200   | —                  | 50    | 170   | —                     | —     | 300  | mV p-p |
| LINE REGULATION                    | VIN = 16 TO 40 VDC<br>Tc = -55°C TO +125°C | —                  | 10   | 50 <sup>2</sup> | —                  | 10   | 50   | —                  | 10    | 50    | —                  | 10    | 50    | —                     | —     | 300  | mV     |
| LOAD REGULATION                    | NO LOAD TO FULL<br>Tc = -55°C TO +125°C    | —                  | 10   | 50              | —                  | 10   | 50   | —                  | 10    | 50    | —                  | 10    | 50    | —                     | —     | 300  | mV     |
| INPUT VOLTAGE NO LOAD TO FULL      | Tc = -55°C TO +125°C<br>CONTINUOUS         | 16                 | 28   | 40              | 16                 | 28   | 40   | 16                 | 28    | 40    | 16                 | 28    | 40    | 16                    | 28    | 40   | VDC    |
| INPUT CURRENT                      | TRANSIENT 50 ms                            | 0                  | —    | 50              | 0                  | —    | 50   | 0                  | —     | 50    | 0                  | —     | 50    | 0                     | —     | 50   | V      |
|                                    | NO LOAD                                    | —                  | 27   | 40              | —                  | 28   | 40   | —                  | 29    | 42    | —                  | 31    | 44    | —                     | —     | 30   | mA     |
|                                    | FULL LOAD                                  | —                  | 250  | —               | —                  | 250  | —    | —                  | 235   | —     | —                  | 235   | —     | —                     | 72    | —    |        |
| INPUT RIPPLE CURRENT               | INHIBITED                                  | —                  | 3    | 5               | —                  | 3    | 5    | —                  | 3     | 5     | —                  | 3     | 5     | —                     | 3     | 5    | mA p-p |
|                                    | 10 kHz - 10 MHz                            | —                  | 25   | 100             | —                  | 25   | 100  | —                  | 25    | 100   | —                  | 25    | 100   | —                     | —     | 90   |        |
|                                    | Tc = -55°C TO +125°C                       | —                  | 30   | 150             | —                  | 30   | 150  | —                  | 30    | 150   | —                  | 30    | 150   | —                     | —     | —    |        |
| EFFICIENCY                         |  | 66                 | 71   | —               | 66                 | 71   | —    | 70                 | 76    | —     | 71                 | 76    | —     | 70                    | 75    | —    | %      |
| LOAD FAULT <sup>3, 4</sup>         | POWER DISSIPATION                          | —                  | 1.5  | 2.0             | —                  | 1.5  | 2.0  | —                  | 1.2   | 1.9   | —                  | 1.2   | 1.8   | —                     | —     | —    | W      |
| SHORT CIRCUIT                      | RECOVERY                                   | —                  | 12.5 | 25              | —                  | 1.5  | 25   | —                  | 1     | 10    | —                  | 1     | 10    | —                     | —     | —    | ms     |
| STEP LOAD RESPONSE <sup>4, 5</sup> | 50% - 100% - 50%<br>TRANSIENT              | —                  | 100  | 250             | —                  | 100  | 250  | —                  | 150   | 375   | —                  | 200   | 500   | —                     | —     | —    | mV pk  |
| STEP LINE RESPONSE <sup>4, 5</sup> | RECOVERY                                   | —                  | 100  | 250             | —                  | 100  | 250  | —                  | 200   | 500   | —                  | 200   | 500   | —                     | —     | —    | μs     |
|                                    | TRANSIENT                                  | —                  | 50   | 150             | —                  | 50   | 150  | —                  | 80    | 200   | —                  | 50    | 125   | —                     | —     | —    | mV pk  |
|                                    | 16 TO 40 VIN                               | —                  | 50   | 150             | —                  | 50   | 150  | —                  | 100   | 250   | —                  | 50    | 125   | —                     | —     | —    |        |
|                                    | 40 TO 16 VIN                               | —                  | 50   | 150             | —                  | 50   | 150  | —                  | 100   | 250   | —                  | 50    | 125   | —                     | —     | —    | μs     |
|                                    | RECOVERY                                   | —                  | 100  | 250             | —                  | 100  | 250  | —                  | 250   | 625   | —                  | 250   | 625   | —                     | —     | —    |        |
|                                    | 16 TO 40 VIN                               | —                  | 100  | 250             | —                  | 100  | 250  | —                  | 250   | 625   | —                  | 250   | 625   | —                     | —     | —    |        |
|                                    | 40 TO 16 VIN                               | —                  | 200  | 500             | —                  | 200  | 500  | —                  | 250   | 625   | —                  | 250   | 625   | —                     | —     | —    |        |
| START-UP                           | DELAY                                      | —                  | 10   | 25              | —                  | 10   | 25   | —                  | 3     | 10    | —                  | 3     | 10    | —                     | —     | —    | ms     |
|                                    | OVERSHOOT                                  | —                  | 0    | 50              | —                  | 0    | 50   | —                  | 0     | 120   | —                  | 0     | 150   | —                     | —     | —    | mV pk  |

### Notes

- MSA2860S specifications are at 25°C Tc only, contact your Interpoint representative for more information on over temperature specs.
- Line regulation for /ES and non /ES 2805S models at 16 to 17 VIN and 110 °C to 125°C (case) is 5% (max).
- Indefinite short circuit protection not guaranteed above 125°C (case).
- Recovery time is measured from application of the transient to point at which VOUT is within 1% of VOUT at final value.
- Transition time >10μs.

# DC/DC CONVERTERS

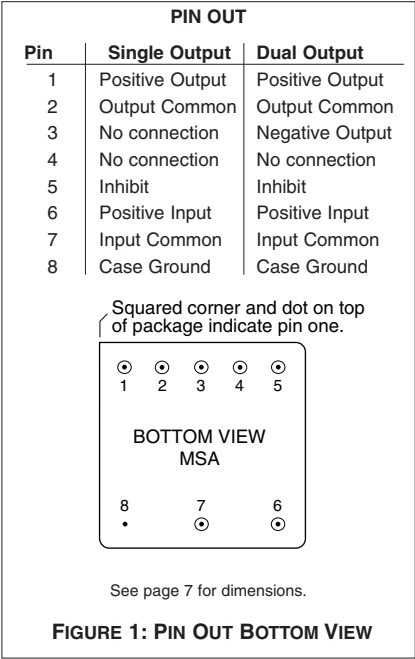
## MSA SERIES 5 WATT

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

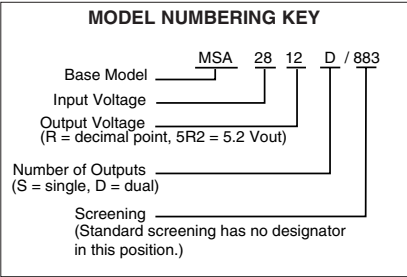
| DUAL OUTPUT MODELS                    |  | MSA 2805D    |      |      | MSA2812D |       |       | MSA2815D |       |       | UNITS  |
|---------------------------------------|--|--------------|------|------|----------|-------|-------|----------|-------|-------|--------|
| PARAMETER                             | CONDITIONS   | MIN          | TYP  | MAX  | MIN      | TYP   | MAX   | MIN      | TYP   | MAX   |        |
| OUTPUT VOLTAGE                        | +V <sub>OUT</sub>  | 4.95         | 5.00 | 5.05 | 11.88    | 12.00 | 12.12 | 14.85    | 15.00 | 15.15 | VDC    |
|                                       | -V <sub>OUT</sub>  | 4.9          | 5.0  | 5.1  | 11.76    | 12.00 | 12.24 | 14.70    | 15.00 | 15.30 |        |
| OUTPUT CURRENT <sup>1</sup>           | V <sub>IN</sub> = 16 to 40 VDC<br>Tc = -55°C to +125°C   | —            | ±500 | 800  | —        | ±208  | 333   | —        | ±167  | 267   | mA     |
| OUTPUT POWER <sup>1</sup>             | V <sub>IN</sub> = 16 to 40 VDC<br>Tc = -55°C to +125°C   | —            | —    | 5    | —        | —     | 5     | —        | —     | 5     | W      |
| OUTPUT RIPPLE VOLT.                   | 10 kHz - 2 MHz   | —            | —    | 150  | —        | 40    | 140   | —        | 60    | 150   | mV p-p |
| LINE REGULATION<br>Vin = 16 to 40 VDC | Tc = -55°C to +125°C<br>+V <sub>OUT</sub>  | —            | 10   | 25   | —        | 10    | 50    | —        | 10    | 50    | mV     |
|                                       | -V <sub>OUT</sub>  | —            | 40   | 75   | —        | 40    | 180   | —        | 40    | 180   |        |
| LOAD REGULATION<br>NO LOAD TO FULL    | Tc = -55°C to +125°C<br>+V <sub>OUT</sub>  | —            | 10   | 50   | —        | 10    | 50    | —        | 10    | 50    | mV     |
|                                       | -V <sub>OUT</sub>  | —            | 50   | 200  | —        | 50    | 200   | —        | 50    | 200   |        |
| CROSS REGULATION <sup>2</sup>         | +P <sub>O</sub> = 20 - 80 %, -P <sub>O</sub> = 80 - 20%<br>-P <sub>O</sub> = 20 - 80 %, +P <sub>O</sub> = 80 - 20% | —            | 10   | 20   | —        | 8     | 15    | —        | 7     | 15    | %      |
|                                       | +P <sub>O</sub> = 50 - 10 %, -P <sub>O</sub> = 50%<br>-P <sub>O</sub> = 50 - 10 %, +P <sub>O</sub> = 50%           | —            | 5    | 8    | —        | 3.7   | 6     | —        | 3     | 6     |        |
| INPUT VOLTAGE<br>Tc = -55°C to +125°  | NO LOAD TO FULL<br>CONTINUOUS  | 16           | 28   | 40   | 16       | 28    | 40    | 16       | 28    | 40    | VDC    |
|                                       | TRANSIENT 50 msec  | —            | —    | 50   | —        | —     | 50    | —        | —     | 50    | V      |
| INPUT CURRENT<br>Tc = -55°C to +125°C | NO LOAD  | —            | 30   | 35   | —        | 33    | 58    | —        | 38    | 60    | mA     |
|                                       | FULL LOAD  | —            | 248  | —    | —        | 235   | —     | —        | 235   | —     |        |
|                                       | INHIBITED  | —            | 3    | 5    | —        | 3     | 5     | —        | 3     | 5     |        |
| INPUT RIPPLE<br>CURRENT               | 10 kHz TO 10 MHz   | —            | 25   | 80   | —        | 25    | 100   | —        | 25    | 100   | mA p-p |
|                                       | Tc = -55°C to +125°C   | —            | 30   | 160  | —        | 30    | 150   | —        | 30    | 150   |        |
| EFFICIENCY                            |  | 68           | 72   | —    | 69       | 75    | —     | 70       | 75    | —     | %      |
| LOAD FAULT <sup>3, 4</sup>            | POWER DISSIPATION<br>SHORT CIRCUIT   | —            | 1.3  | 1.8  | —        | 1.3   | 1.7   | —        | 1.3   | 1.6   | W      |
|                                       | RECOVERY   | —            | —    | 50   | —        | 1     | 10    | —        | 1     | 10    | ms     |
| STEP LOAD<br>RESPONSE <sup>4, 5</sup> | 50% - 100% - 50% BALANCED<br>TRANSIENT   | —            | —    | ±150 | —        | ±300  | ±750  | —        | ±300  | ±750  | mV     |
|                                       | RECOVERY   | —            | —    | 100  | —        | 200   | 500   | —        | 500   | 1250  | µs     |
| STEP LINE RESP. <sup>4, 5</sup>       | TRANSIENT  | 16 TO 40 VDC | —    | —    | ±750     | —     | ±50   | ±125     | —     | ±150  | mV pk  |
|                                       |  | 40 TO 16 VDC | —    | —    | ±500     | —     | ±50   | ±125     | —     | ±100  |        |
|                                       | RECOVERY   | 16 TO 40 VDC | —    | —    | 1200     | —     | 150   | 375      | —     | 250   | µs     |
|                                       |  | 40 TO 16 VDC | —    | —    | 1200     | —     | 400   | 1000     | —     | 800   |        |
| START-UP                              | DELAY  | —            | —    | 25   | —        | 3     | 10    | —        | 3     | 10    | ms     |
|                                       | OVERSHOOT  | —            | —    | 500  | —        | 0     | 120   | —        | 0     | 150   | mV pk  |

### Notes

- Up to 4 watts (80% of full power) is available from either output providing the opposite output is carrying 20% of total power.
- Shows regulation effect on the minus output during the defined cross loading conditions. See Figures 15 and 16.
- Indefinite short circuit protection not guaranteed above 125°C (case).
- Recovery time is measured from application of the transient to point at which V<sub>OUT</sub> is within 1% of V<sub>OUT</sub> at final value.
- Transition time >10µs.



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| SMD NUMBERS                            |                            |
|--|----------------------------|
| STANDARD MICROCIRCUIT<br>DRAWING (SMD) | MSA SERIES<br>SIMILAR PART |
| 5962-9309201HXC                        | MSA2805S/883               |
| IN PROCESS                             | MSA285R2S/883              |
| 5962-9309301HXC                        | MSA2812S/883               |
| 5962-9309401HXC                        | MSA2815S/883               |
| 5962-0052201HXC                        | MSA2860S/883               |
| 5962-9308901HXC                        | MSA2812D/883               |
| 5962-9309001HXC                        | MSA2815D/883               |

For exact specifications for an SMD product, refer to the SMD drawing. Call your Interpoint representative for status on MSA SMD releases. "883" suffix indicates SMD similar part. SMDs can be downloaded from:  
<http://www.dscclia.mil/programs/smcr>

# DC/DC CONVERTERS

## MSA SERIES 5 WATT

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

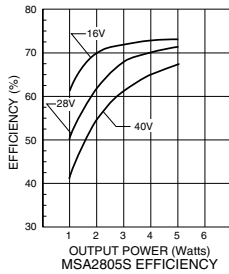


FIGURE 2

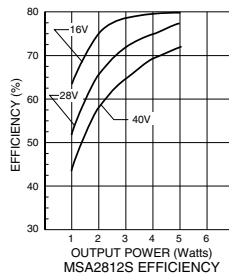


FIGURE 3

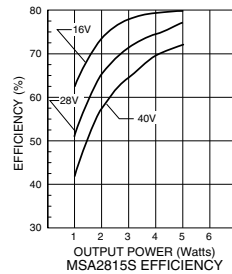


FIGURE 4

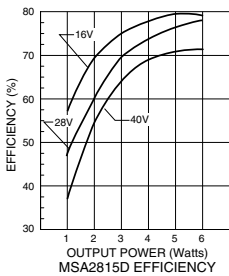


FIGURE 5

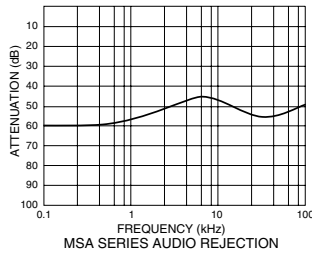


FIGURE 6

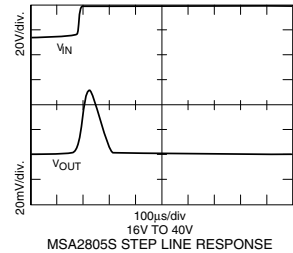


FIGURE 7

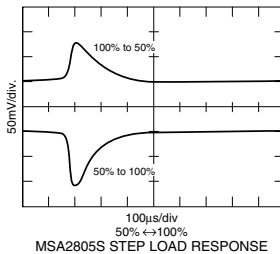


FIGURE 8

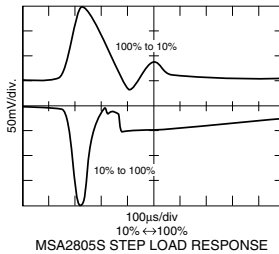


FIGURE 9

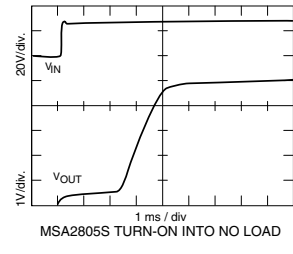


FIGURE 10

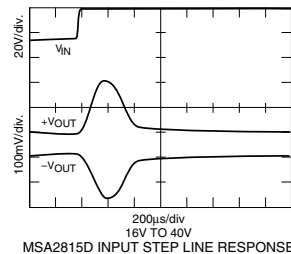


FIGURE 11

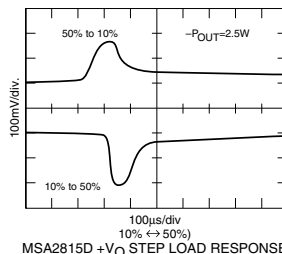


FIGURE 12

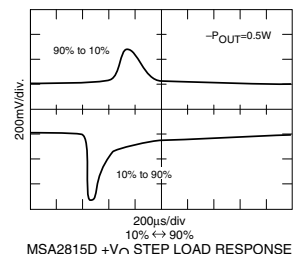
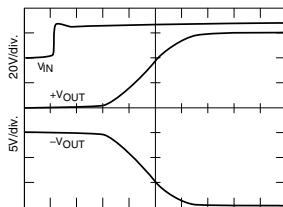


FIGURE 13

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



MSA2815D TURN-ON INTO NO LOAD

FIGURE 14

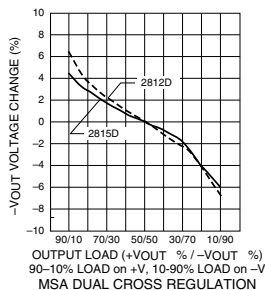


FIGURE 15

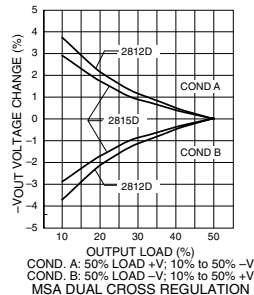
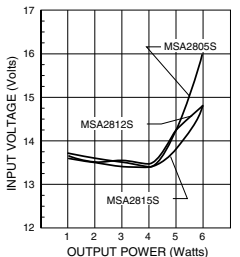
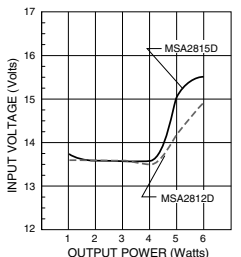


FIGURE 16



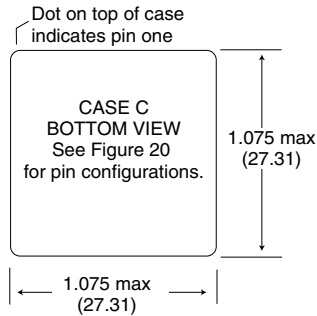
LOW LINE DROPOUT VS. LOAD

FIGURE 17



LOW LINE DROPOUT VS. LOAD

FIGURE 18



### Materials

|        |  |
|--------|--|
| Header | Cold Rolled Steel/Nickel/Gold                |
| Cover  | Cold Rolled Steel/Nickel                     |
| Pins   | Copper/Nickel/Gold<br>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 19: CASE C MAXIMUM DIMENSIONS

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BOTTOM VIEW CASE C1  
MSA Series: Screening – Standard, ES, or 883

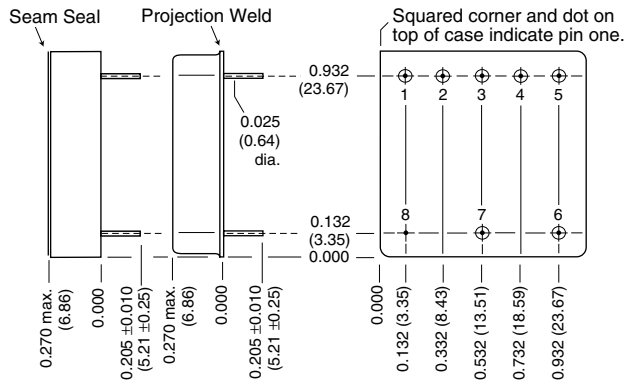


FIGURE 20: CASE C1

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.

**ENVIRONMENTAL SCREENING**

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

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