



Mini-Circuits

COAXIAL

# High Power Amplifier

**ZHL-5W-422+  
ZHL-5W-422X+**

50Ω 5 W 500 to 4200 MHz SMA Female

## THE BIG DEAL

- High Power, 5 Watts
- Excellent IP3, +45 dBm Typ.
- Excellent IP2, +55 dBm Typ.
- High Efficiency, 30% Typ. at Saturation
- Class A Amplifier
- No Damage With an Open or Short Output Load Even Under Full Output Power
- Shuts Off When Baseplate Temperature Exceeds +85 °C
- Over-Voltage Protection, Shuts Off Above +35 V
- Reverse Polarity Protected
- Unconditionally Stable



Generic photo used for illustration purposes only

| Model No.  | ZHL-5W-422+ | ZHL-5W-422X <sup>+</sup> |
|------------|-------------|--------------------------|
| Case Style | BT1896      |                          |
| Connectors | SMA female  |                          |

### +RoHS Compliant

The +Suffix identifies RoHS Compliance.  
See our website for methodologies and qualifications

## APPLICATIONS

- Transmitters
- Defense
- Amateur Radio, FM, TV
- Laboratory Use

## PRODUCT OVERVIEW

Mini-Circuits' ZHL-5W-422+ is a Class A, high-power amplifier providing very wide bandwidth for a broad array of military, commercial and testing applications. Excellent flatness across its entire operating frequency range makes it ideal for systems where consistent performance across frequency is required. The amplifier provides high efficiency while withstanding open and short loads under full CW output power. The unit is unconditionally stable and features robust protection from high temperature extremes, overvoltages, and reverse polarity errors, making it suitable for demanding lab environments, satellite communications, line-of-sight links, defense applications, radio and television broadcast transmissions and more. Housed in an aluminum alloy case measuring 9.85x7.3x6.4", it features SMA connectors at both ports and an optional heat sink and fan for cooling.

## KEY FEATURES

| Feature                                 | Advantages                                                                                                                                                                                                                                                                                                                                             |
|-----------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Very Wide Bandwidth                     | Supports a broad range of system and test lab applications.                                                                                                                                                                                                                                                                                            |
| Flat Gain, ±1 dB                        | Provides consistent performance across frequency, minimizing the need for external equalizing networks in wideband applications.                                                                                                                                                                                                                       |
| High Efficiency, 30% Typ. at Saturation | Delivers 5 W output power with low DC power consumption for reliable, cost-efficient performance.                                                                                                                                                                                                                                                      |
| Built-In Self Protection                | In instances of power supply overvoltage or excessive heat buildup within the housing, an automatic sensing feature signals the unit to power down. The unit is capable of withstanding potentially-damaging excessive drive current, "unshorting" (DC supply turn-on transients), power supply polarity reversal, and open/short loads at the output. |
| Unconditional Stability                 | Provides reliable performance independent of input and load conditions.                                                                                                                                                                                                                                                                                |

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## High Power Amplifier

**ZHL-5W-422+  
ZHL-5W-422X+**

50Ω 5 W 500 to 4200 MHz SMA Female

## ELECTRICAL SPECIFICATIONS AT +25 °C

| Parameter                                              | Condition (MHz) | ZHL-5W-422+<br>ZHL-5W-422X+ <sup>▲</sup> |      |      | Units |
|--------------------------------------------------------|-----------------|------------------------------------------|------|------|-------|
|                                                        |                 | Min.                                     | Typ. | Max. |       |
| Frequency Range                                        |                 | 500                                      |      | 4200 | MHz   |
| Gain <sup>1</sup>                                      | 500-4200        | 20                                       | 25   |      | dB    |
| Gain Flatness <sup>1</sup>                             | 500-4200        |                                          | ±1.0 | ±1.7 | dB    |
| Output Power at 1 dB Compression                       | 500-4200        | +34                                      | +35  |      | dBm   |
| Output Power at 3 dB Compression                       | 500-4200        | +36                                      | +37  |      | dBm   |
| Noise Figure                                           | 500-4200        |                                          | 7    | 12   | dB    |
| Output Third Order Intercept Point <sup>2</sup>        | 500-4200        | +40                                      | +45  |      | dBm   |
| Output Second Order Intercept Point <sup>2</sup>       | 500-4200        | +50                                      | +55  |      | dBm   |
| Input VSWR <sup>1</sup>                                | 500-4200        |                                          | 1.7  | 2.3  | :1    |
| Non-Harmonic Spurious at P <sub>OUT</sub> = 5 W        | 500-4200        |                                          |      | -60  | dBc   |
| Second and Third Harmonics at P <sub>OUT</sub> = 2.5 W | 500-4200        |                                          |      | -20  | dBc   |
| DC Supply Voltage                                      |                 |                                          | +28  | +30  | V     |
| Supply Current <sup>3</sup>                            |                 |                                          | 2    | 3    | A     |

1. Measurements with small signal, P<sub>IN</sub> = -15 dBm input.

2. Measured with 2 tones, 1 MHz apart, +20 dBm/tone.

3. Power supply should be capable of delivering 6 A at start up.

▲ Heat sink and fan not included. Alternative heat sinking and heat removal must be provided by the user to limit maximum base-plate temperature to +85 °C, in order to ensure proper performance. For reference, this requires thermal resistance of user's external heat sink to be 0.3°C/W max.

## ABSOLUTE MAXIMUM RATINGS

| Parameter                  | Ratings           |
|----------------------------|-------------------|
| Operating Temperature      | -20 °C to +50 °C  |
| Storage Temperature        | -55 °C to +100 °C |
| Base Plate Temperature     | +85 °C            |
| Input RF Power (No Damage) | +20 dBm           |

Permanent damage may occur if any of these limits are exceeded.



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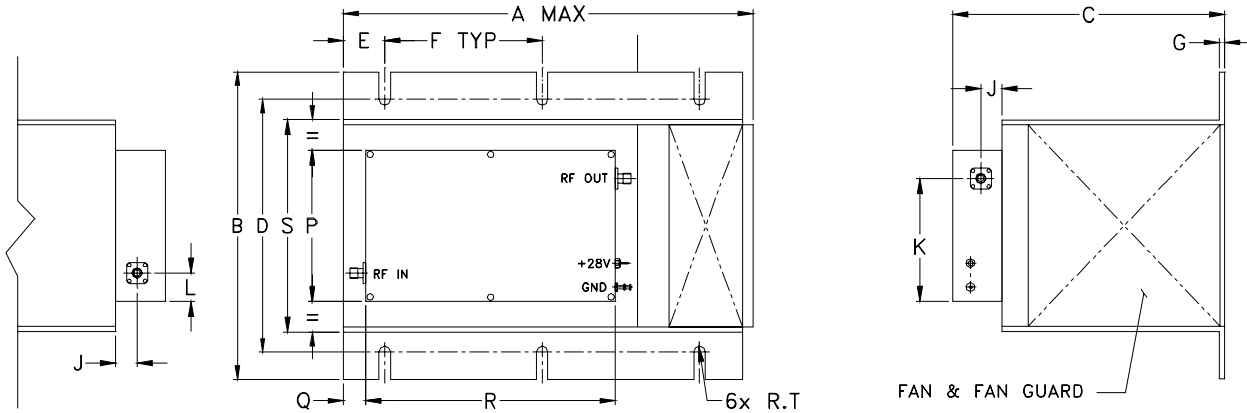
## High Power Amplifier

**ZHL-5W-422+**  
**ZHL-5W-422X+**

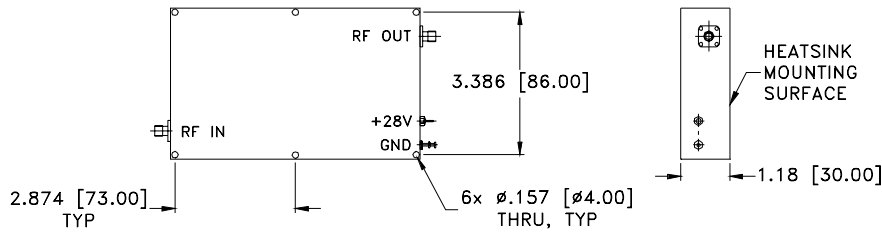
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50Ω 5 W 500 to 4200 MHz SMA Female

## OUTLINE DRAWING FOR MODELS WITH HEATSINK



## OUTLINE DRAWING FOR MODELS WITHOUT HEATSINK

OUTLINE DIMENSIONS (Inch  
mm)

| A      | B      | C      | D      | E     | F     | G    | J     | K     | L     | P     | Q     | R      | S      | T    | wt     |
|--------|--------|--------|--------|-------|-------|------|-------|-------|-------|-------|-------|--------|--------|------|--------|
| 9.85   | 7.3    | 6.4    | 6.43   | 1.00  | 3.75  | .13  | .51   | 2.91  | .67   | 3.58  | .53   | 5.94   | 5.1    | .135 | grams* |
| 250.19 | 185.42 | 162.56 | 163.32 | 25.40 | 95.25 | 3.30 | 12.95 | 73.91 | 17.02 | 90.93 | 13.46 | 150.88 | 129.54 | 3.43 | 4265   |

\*580 grams without heatsink





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## High Power Amplifier

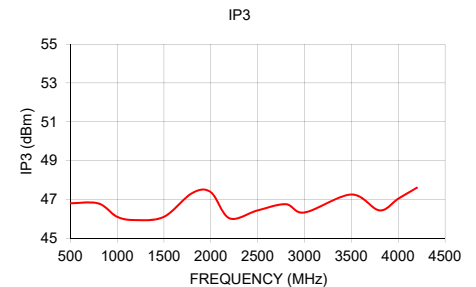
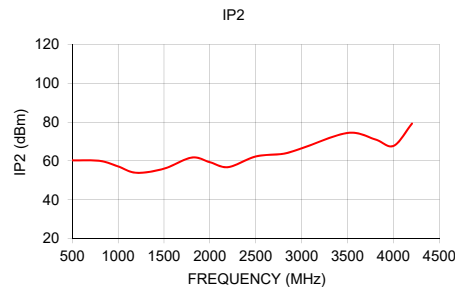
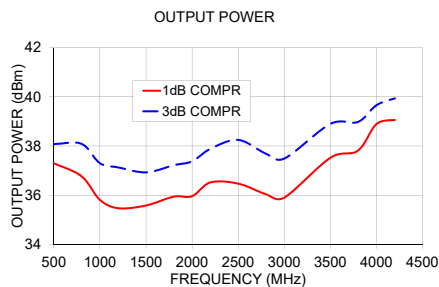
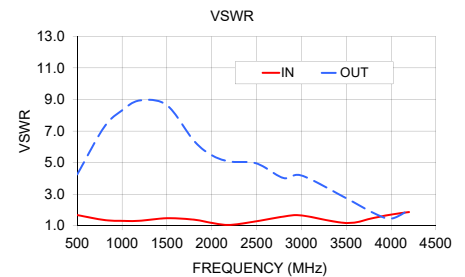
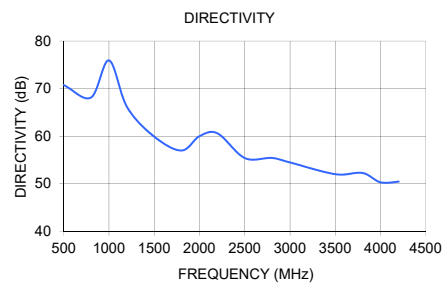
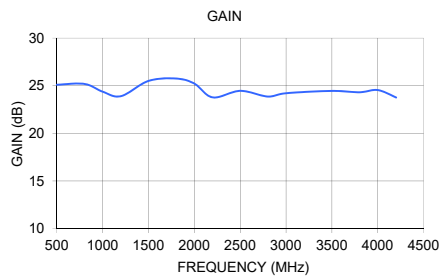
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50Ω 5 W 500 to 4200 MHz SMA Female

## TYPICAL PERFORMANCE DATA / GRAPHS

| FREQUENCY<br>(MHz) | GAIN<br>(dB) | DIRECTIVITY<br>(dB) | VSWR<br>(:1) |      | P <sub>OUT</sub> at 1 dB<br>COMPR.<br>(dBm) | P <sub>OUT</sub> at 3 dB<br>COMPR.<br>(dBm) | OUTPUT<br>IP2<br>(dBm) | OUTPUT<br>IP3<br>(dBm) |
|--------------------|--------------|---------------------|--------------|------|---------------------------------------------|---------------------------------------------|------------------------|------------------------|
|                    |              |                     | IN           | OUT  |                                             |                                             |                        |                        |
| 500                | 25.10        | 70.74               | 1.67         | 4.26 | 37.30                                       | 38.08                                       | 60.31                  | 46.80                  |
| 800                | 25.19        | 68.10               | 1.36         | 7.25 | 36.77                                       | 38.09                                       | 60.04                  | 46.79                  |
| 1000               | 24.37        | 75.92               | 1.31         | 8.31 | 35.81                                       | 37.30                                       | 57.19                  | 46.10                  |
| 1200               | 23.90        | 66.09               | 1.31         | 8.95 | 35.47                                       | 37.13                                       | 53.89                  | 45.93                  |
| 1500               | 25.50        | 59.88               | 1.47         | 8.64 | 35.58                                       | 36.93                                       | 56.01                  | 46.10                  |
| 1800               | 25.75        | 56.97               | 1.38         | 6.39 | 35.94                                       | 37.22                                       | 61.72                  | 47.32                  |
| 2000               | 25.22        | 59.99               | 1.18         | 5.47 | 35.96                                       | 37.38                                       | 59.35                  | 47.37                  |
| 2200               | 23.77        | 60.57               | 1.05         | 5.07 | 36.52                                       | 37.89                                       | 56.82                  | 46.02                  |
| 2500               | 24.46        | 55.38               | 1.28         | 4.95 | 36.47                                       | 38.25                                       | 62.31                  | 46.43                  |
| 2800               | 23.86        | 55.41               | 1.58         | 4.02 | 36.04                                       | 37.69                                       | 63.70                  | 46.75                  |
| 3000               | 24.21        | 54.46               | 1.65         | 4.19 | 35.90                                       | 37.49                                       | 66.50                  | 46.32                  |
| 3500               | 24.45        | 51.99               | 1.17         | 2.74 | 37.52                                       | 38.90                                       | 74.41                  | 47.25                  |
| 3800               | 24.31        | 52.25               | 1.49         | 1.82 | 37.81                                       | 38.98                                       | 71.07                  | 46.43                  |
| 4000               | 24.54        | 50.28               | 1.70         | 1.45 | 38.89                                       | 39.66                                       | 67.76                  | 47.03                  |
| 4200               | 23.76        | 50.43               | 1.86         | 2.01 | 39.06                                       | 39.94                                       | 79.22                  | 47.60                  |



## NOTES

- A. Performance and quality attributes and conditions not expressly stated in this specification document are intended to be excluded and do not form a part of this specification document.
- B. Electrical specifications and performance data contained in this specification document are based on Mini-Circuit's applicable established test performance criteria and measurement instructions.
- C. The parts covered by this specification document are subject to Mini-Circuits standard limited warranty and terms and conditions (collectively, "Standard Terms"); Purchasers of this part are entitled to the rights and benefits contained therein. For a full statement of the standard terms and the exclusive rights and remedies thereunder, please visit Mini-Circuits' website at [www.minicircuits.com/terms/viewterm.html](http://www.minicircuits.com/terms/viewterm.html)



# High Power Amplifier

ZHL-5W-422+

## Typical Performance Data

| FREQ.<br>(MHz) | GAIN<br>(dB)<br>28V | DIRECTIVITY<br>(dB)<br>28V | VSWR (:1) |      | NOISE<br>FIGURE<br>(dB)<br>28V | POUT @ 1 dB<br>COMPRESSION<br>(dBm)<br>28V | POUT @ 3 dB<br>COMPRESSION<br>(dBm)<br>28V | OUTPUT<br>IP2<br>(dBm)<br>28V | OUTPUT<br>IP3<br>(dBm)<br>28V |
|----------------|---------------------|----------------------------|-----------|------|--------------------------------|--------------------------------------------|--------------------------------------------|-------------------------------|-------------------------------|
| 500.0          | 25.10               | 70.74                      | 1.67      | 4.26 | 9.03                           | 37.30                                      | 38.08                                      | 60.31                         | 46.80                         |
| 550.0          | 24.86               | 82.68                      | 1.50      | 4.79 | 8.87                           | 37.38                                      | 37.95                                      | 60.58                         | 46.78                         |
| 600.0          | 24.79               | 75.82                      | 1.41      | 5.31 | 8.55                           | 37.31                                      | 38.03                                      | 59.86                         | 46.72                         |
| 650.0          | 24.86               | 73.86                      | 1.38      | 5.83 | 8.39                           | 37.28                                      | 38.11                                      | 59.12                         | 46.68                         |
| 700.0          | 24.99               | 71.95                      | 1.37      | 6.35 | 8.08                           | 37.15                                      | 38.17                                      | 59.44                         | 46.73                         |
| 750.0          | 25.13               | 71.35                      | 1.37      | 6.83 | 7.82                           | 36.81                                      | 37.92                                      | 59.47                         | 46.75                         |
| 800.0          | 25.19               | 68.10                      | 1.36      | 7.25 | 7.57                           | 36.77                                      | 38.09                                      | 60.04                         | 46.79                         |
| 850.0          | 25.12               | 66.45                      | 1.35      | 7.60 | 7.43                           | 36.59                                      | 37.82                                      | 59.38                         | 46.84                         |
| 900.0          | 24.93               | 68.20                      | 1.33      | 7.87 | 7.37                           | 36.35                                      | 37.66                                      | 59.66                         | 46.73                         |
| 950.0          | 24.67               | 69.01                      | 1.32      | 8.12 | 7.31                           | 36.11                                      | 37.49                                      | 58.56                         | 46.53                         |
| 1000.0         | 24.37               | 75.92                      | 1.31      | 8.31 | 7.22                           | 35.81                                      | 37.30                                      | 57.19                         | 46.10                         |
| 1050.0         | 24.15               | 69.35                      | 1.30      | 8.51 | 7.04                           | 35.53                                      | 37.34                                      | 55.58                         | 45.96                         |
| 1100.0         | 23.98               | 65.71                      | 1.29      | 8.72 | 7.04                           | 35.53                                      | 37.14                                      | 54.80                         | 45.83                         |
| 1150.0         | 23.90               | 66.27                      | 1.30      | 8.86 | 7.04                           | 35.56                                      | 37.11                                      | 54.31                         | 45.81                         |
| 1200.0         | 23.90               | 66.09                      | 1.31      | 8.95 | 7.09                           | 35.47                                      | 37.13                                      | 53.89                         | 45.93                         |
| 1250.0         | 23.99               | 66.55                      | 1.33      | 9.04 | 7.11                           | 35.42                                      | 36.99                                      | 53.98                         | 46.07                         |
| 1350.0         | 24.13               | 64.21                      | 1.40      | 8.90 | 7.33                           | 35.58                                      | 36.90                                      | 55.68                         | 46.27                         |
| 1400.0         | 24.66               | 63.30                      | 1.44      | 8.95 | 7.11                           | 35.48                                      | 36.69                                      | 55.69                         | 46.05                         |
| 1450.0         | 25.16               | 61.47                      | 1.46      | 8.81 | 7.15                           | 35.63                                      | 36.74                                      | 56.12                         | 46.05                         |
| 1500.0         | 25.50               | 59.88                      | 1.47      | 8.64 | 7.14                           | 35.58                                      | 36.93                                      | 56.01                         | 46.10                         |
| 1550.0         | 25.76               | 62.41                      | 1.47      | 8.27 | 7.28                           | 35.44                                      | 36.78                                      | 56.85                         | 46.27                         |
| 1600.0         | 25.87               | 61.91                      | 1.46      | 7.80 | 7.26                           | 35.71                                      | 37.07                                      | 58.08                         | 46.52                         |
| 1650.0         | 25.76               | 62.66                      | 1.44      | 7.34 | 7.31                           | 35.43                                      | 37.26                                      | 59.15                         | 46.77                         |
| 1700.0         | 26.02               | 61.99                      | 1.43      | 6.61 | 7.41                           | 36.01                                      | 37.56                                      | 60.70                         | 47.41                         |
| 1750.0         | 25.86               | 60.07                      | 1.41      | 6.61 | 7.43                           | 35.86                                      | 37.55                                      | 61.22                         | 47.41                         |
| 1800.0         | 25.75               | 56.97                      | 1.38      | 6.39 | 7.44                           | 35.94                                      | 37.22                                      | 61.72                         | 47.32                         |
| 1850.0         | 25.69               | 57.38                      | 1.34      | 6.15 | 7.45                           | 35.97                                      | 37.39                                      | 61.83                         | 47.24                         |
| 1900.0         | 25.62               | 57.23                      | 1.29      | 5.93 | 7.51                           | 36.24                                      | 37.56                                      | 61.08                         | 47.23                         |
| 1950.0         | 25.47               | 57.33                      | 1.23      | 5.70 | 7.55                           | 36.10                                      | 37.43                                      | 60.16                         | 47.34                         |
| 2000.0         | 25.22               | 59.99                      | 1.18      | 5.47 | 7.57                           | 35.96                                      | 37.38                                      | 59.35                         | 47.37                         |
| 2050.0         | 24.88               | 58.76                      | 1.12      | 5.28 | 7.44                           | 36.40                                      | 37.47                                      | 59.17                         | 47.43                         |
| 2100.0         | 24.47               | 59.90                      | 1.08      | 5.16 | 7.45                           | 36.35                                      | 37.69                                      | 58.69                         | 47.55                         |
| 2150.0         | 24.07               | 60.53                      | 1.05      | 5.09 | 7.52                           | 36.35                                      | 37.66                                      | 59.15                         | 47.69                         |
| 2200.0         | 23.77               | 60.57                      | 1.05      | 5.07 | 7.45                           | 36.52                                      | 37.89                                      | 56.82                         | 46.02                         |
| 2250.0         | 23.57               | 58.48                      | 1.07      | 5.13 | 7.46                           | 36.42                                      | 37.86                                      | 57.99                         | 46.19                         |
| 2300.0         | 23.58               | 60.88                      | 1.11      | 5.20 | 7.37                           | 36.09                                      | 37.72                                      | 59.64                         | 45.96                         |
| 2350.0         | 23.74               | 56.91                      | 1.15      | 5.25 | 7.34                           | 36.34                                      | 38.10                                      | 66.14                         | 45.97                         |
| 2400.0         | 24.02               | 57.72                      | 1.18      | 5.23 | 7.27                           | 36.50                                      | 38.43                                      | 60.79                         | 46.47                         |
| 2500.0         | 24.46               | 55.38                      | 1.28      | 4.95 | 7.32                           | 36.47                                      | 38.25                                      | 62.31                         | 46.43                         |
| 2600.0         | 24.69               | 55.44                      | 1.44      | 4.30 | 7.00                           | 36.52                                      | 38.05                                      | 61.52                         | 46.76                         |
| 2700.0         | 24.29               | 56.33                      | 1.52      | 4.01 | 6.98                           | 36.04                                      | 37.73                                      | 63.84                         | 47.04                         |
| 2750.0         | 24.02               | 55.90                      | 1.55      | 3.99 | 6.97                           | 36.25                                      | 38.07                                      | 64.16                         | 46.83                         |
| 2800.0         | 23.86               | 55.41                      | 1.58      | 4.02 | 7.00                           | 36.04                                      | 37.69                                      | 63.70                         | 46.75                         |
| 2900.0         | 23.91               | 55.08                      | 1.62      | 4.15 | 6.92                           | 36.12                                      | 37.52                                      | 66.56                         | 46.49                         |
| 3000.0         | 24.21               | 54.46                      | 1.65      | 4.19 | 6.91                           | 35.90                                      | 37.49                                      | 66.50                         | 46.32                         |
| 3100.0         | 24.20               | 54.19                      | 1.61      | 4.05 | 7.02                           | 36.36                                      | 37.55                                      | 67.36                         | 46.14                         |
| 3200.0         | 23.70               | 55.57                      | 1.50      | 3.89 | 7.14                           | 36.58                                      | 38.01                                      | 70.03                         | 47.01                         |
| 3300.0         | 23.78               | 55.33                      | 1.34      | 3.68 | 7.08                           | 36.76                                      | 38.38                                      | 71.92                         | 47.15                         |
| 3400.0         | 24.15               | 52.98                      | 1.21      | 3.36 | 7.21                           | 37.05                                      | 38.74                                      | 73.22                         | 47.33                         |
| 3500.0         | 24.45               | 51.99                      | 1.17      | 2.74 | 7.13                           | 37.52                                      | 38.90                                      | 74.41                         | 47.25                         |
| 3600.0         | 24.14               | 52.64                      | 1.19      | 2.24 | 6.98                           | 37.46                                      | 38.81                                      | 80.31                         | 46.33                         |
| 3700.0         | 24.21               | 52.01                      | 1.31      | 2.09 | 7.09                           | 37.99                                      | 39.04                                      | 79.61                         | 46.60                         |
| 3800.0         | 24.31               | 52.25                      | 1.49      | 1.82 | 7.08                           | 37.81                                      | 38.98                                      | 71.07                         | 46.43                         |
| 3850.0         | 24.42               | 50.92                      | 1.58      | 1.69 | 6.94                           | 38.28                                      | 39.01                                      | 72.41                         | 46.25                         |
| 3900.0         | 24.51               | 50.58                      | 1.64      | 1.57 | 7.03                           | 37.96                                      | 38.82                                      | 67.02                         | 46.14                         |
| 4000.0         | 24.54               | 50.28                      | 1.70      | 1.45 | 7.36                           | 38.89                                      | 39.66                                      | 67.76                         | 47.03                         |
| 4100.0         | 24.46               | 49.23                      | 1.76      | 1.61 | 7.48                           | 38.96                                      | 40.04                                      | 73.66                         | 47.48                         |
| 4200.0         | 23.76               | 50.43                      | 1.86      | 2.01 | 7.57                           | 39.06                                      | 39.94                                      | 79.22                         | 47.60                         |



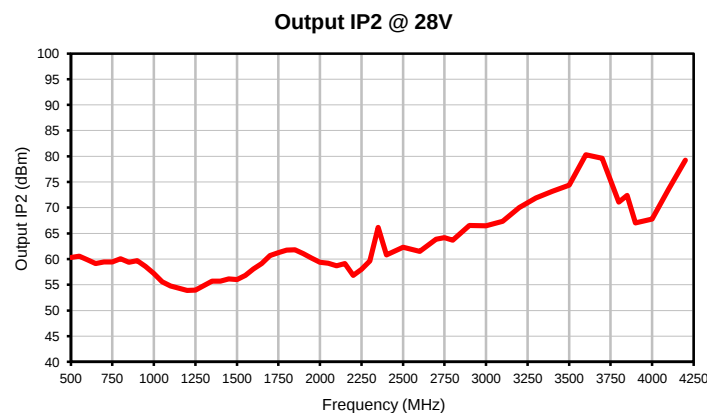
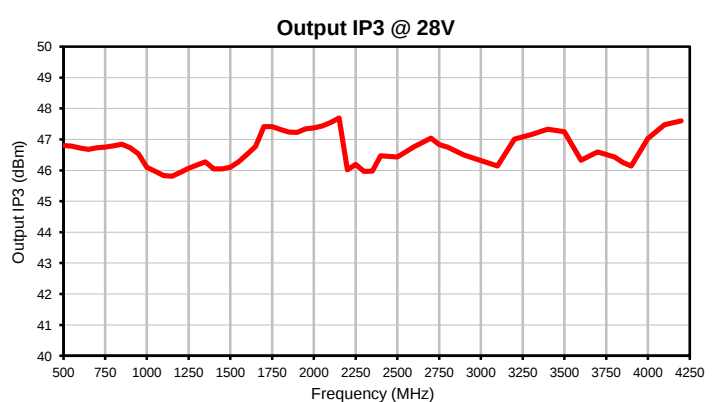
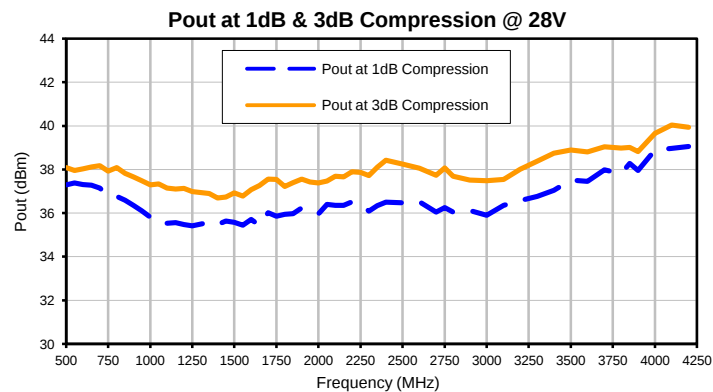
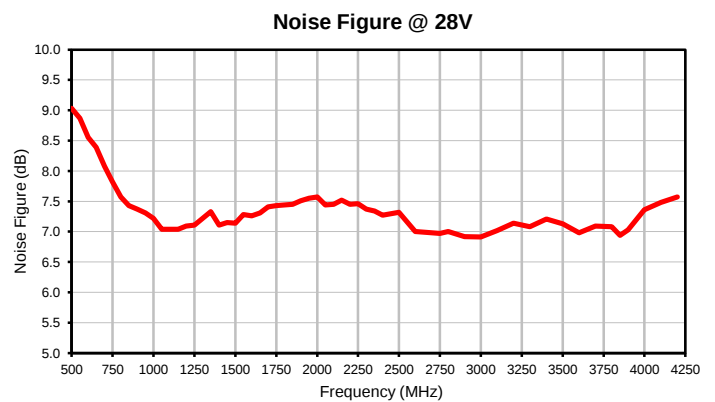
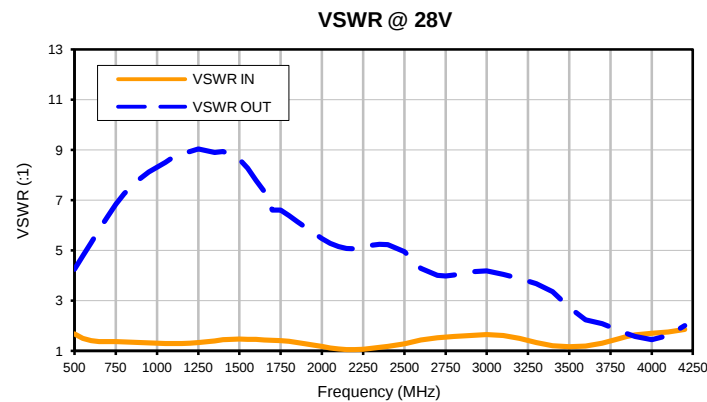
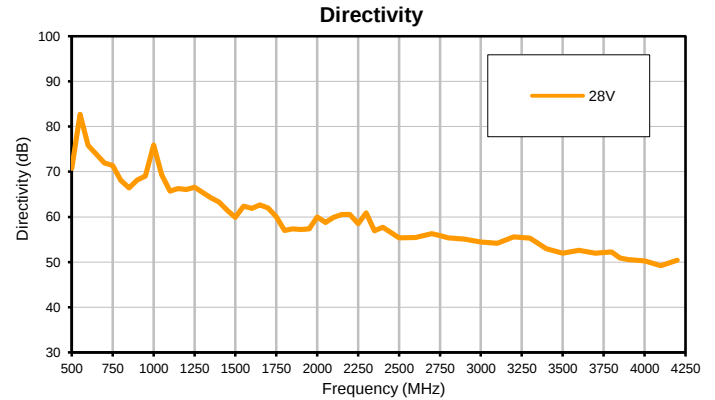
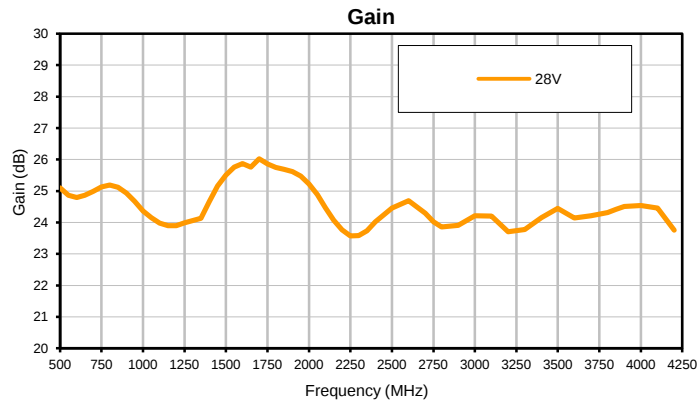
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The Design Engineers Search Engine Provides ACTUAL Data Instantly From MINI-CIRCUITS At: [www.minicircuits.com](http://www.minicircuits.com)



IF/RF MICROWAVE COMPONENTS

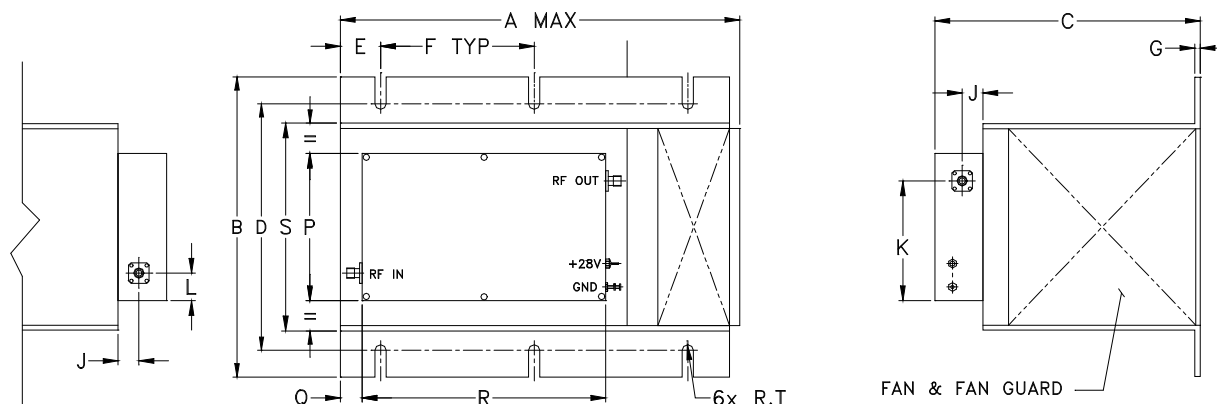
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## Typical Performance Curves

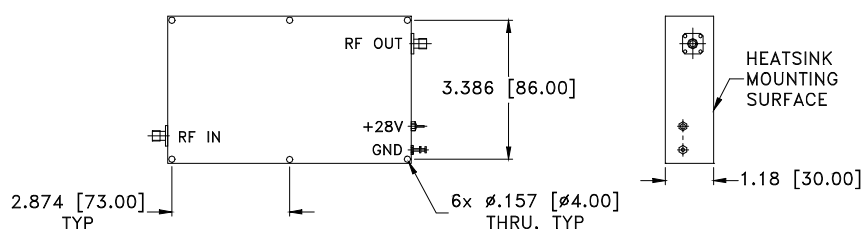


## Outline Dimensions

BT1896



**MOUNTING INFORMATION FOR MODELS WITHOUT HEATSINK.**



| CASE#  | A                | B               | C               | D                | E               | F               | G             | H      | J              | K               | L              | M      | N      |
|--------|------------------|-----------------|-----------------|------------------|-----------------|-----------------|---------------|--------|----------------|-----------------|----------------|--------|--------|
| BT1896 | 9.85<br>(250.19) | 7.3<br>(185.42) | 6.4<br>(162.56) | 6.00<br>(152.40) | 1.00<br>(25.40) | 3.75<br>(95.25) | .13<br>(3.30) | -<br>- | .51<br>(13.00) | 2.91<br>(74.00) | .67<br>(17.00) | -<br>- | -<br>- |

| CASE#  | P               | Q              | R                | S               | T              | WT, GRAM | WT WITHOUT HEATSINK, GRAM |
|--------|-----------------|----------------|------------------|-----------------|----------------|----------|---------------------------|
| BT1896 | 3.58<br>(91.00) | .53<br>(13.38) | 5.94<br>(151.00) | 5.1<br>(129.54) | .135<br>(3.43) | 4265     | 580                       |

Dimensions in inches (mm). Tolerances: 1 Pl.  $\pm .1$ ; 2Pl.  $\pm .03$ ; 3 Pl.  $\pm .015$

### Notes:

- Case material: Aluminum alloy.
- Finish:  
For RoHS Case Styles: Clear Chemical conversion coating, non-chrome or trivalent chrome based.
- Heatsink finish: Black anodize.
- Refer to the individual model data sheet for the type of connectors available.
- Recommended screws for mounting model without heat sink on 3/32" thick sheet: #6-32, 1.50" Length.



P.O. Box 350166, Brooklyn, New York 11235-0003 (718) 934-4500 Fax (718) 332-4661 For detailed performance specs & shopping online see Mini-Circuits web site



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RF/IF MICROWAVE COMPONENTS



All Mini-Circuits products are manufactured under exacting quality assurance and control standards, and are capable of meeting published specifications after being subjected to any or all of the following physical and environmental test.

| Specification             | Test/Inspection Condition                            | Reference/Spec                                     |
|---------------------------|------------------------------------------------------|----------------------------------------------------|
| Operating Temperature     | -20° to 50° C<br>Base plate Temperature              | Individual Model Data Sheet                        |
| Storage Temperature       | -55° to 100° C<br>Ambient Environment                | Individual Model Data Sheet                        |
| Stabilization Bake        | (non-operating)<br>125°C, 24 hours                   | - - -                                              |
| Burn-in at Elevated Temp. | (DC on)<br>160 hours at 50° C base plate Temperature | MIL-STD-202, Method 108                            |
| Thermal Shock             | -55° to 100°C, 5 cycles                              | MIL-STD-202, Method 107, Condition A, except 100°C |