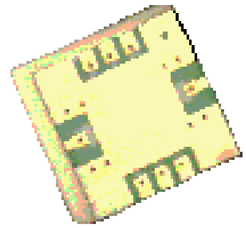
# AMMP-6220

6-20 GHz Low Noise Amplifier

## Data Sheet



### Description

Avago's AMMP-6220 is a high gain, low-noise amplifier that operates from 6 GHz to 20 GHz. The LNA is designed to be a easy-to-use component for any surface mount PCB application. The broad and unconditionally stable performance makes this LNA ideal for primary, sub-sequential or driver low noise gain stages. Intended applications include microwave radios, 802.16, automotive radar, VSAT, and satellite receivers. Since one part can cover several bands, the AMMP-6220 can reduce part inventory and increase volume purchase options. The LNA has integrated 50 Ω I/O match, DC blocking, self-bias and choke to eliminate complex tuning and assembly processes typically required by hybrid (discrete-FET) amplifiers. The package is full SMT compatible with backside grounding and I/O to simplify assembly.

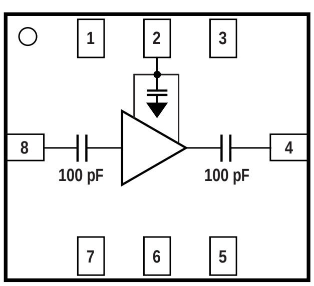
### Features

- 5x5 mm surface mount package
- Broad Band performance 6-20 GHz
- Low 2.5 dB typical noise figure
- High 22 dB typical gain
- 50 Ω input and output match
- Single 3 V (55 mA) supply bias

### Applications

- Microwave radio systems
- Satellite VSAT, DBS up / down link
- LMDS & Pt-Pt mmW Long Haul
- Broadband Wireless Access (including 802.16 and 802.20 WiMax)
- WLL and MMDS loops
- Commercial grade military

### Functional Diagram




| PIN | FUNCTION |
|---|---|
| 1 | |
| 2 | $V_d$ |
| 3 | |
| 4 | $RF_{out}$ |
| 5 | |
| 6 | |
| 7 | |
| 8 | $RF_{in}$ |

PACKAGE
BASE
GND

*Attention: Observe precautions for handling electrostatic sensitive devices.*

**ESD Machine Model (Class 1A)**

**ESD Human Body Model (Class 0)**

**Refer to Avago Application Note A004R:** ***Electrostatic Discharge Damage and Control.***

### AMMP-6220 Absolute Maximum Ratings [1]

| Symbol | Parameters / Conditions | Units | Min. | Max. |
|---|---|---|---|---|
| $V_d$ | Positive Drain Voltage | V | | 7 |
| $I_d$ | Drain Current | mA | | 100 |
| $P_{in}$ | CW Input Power | dBm | | 15 |
| $T_{ch}$ | Operating Channel Temp. | °C | | +150 |
| $T_{stg}$ | Storage Case Temp. | °C | -65 | +150 |
| $T_{max}$ | Maximum Assembly Temp. (60 sec max.) | °C | | +300 |

**Note:**

1. Operation in excess of any one of these conditions may result in permanent damage to this device.

### AMMP-6220 DC Specifications / Physical Properties [1]

| Symbol | Parameters and Test Conditions | Units | Min. | Typ. | Max. |
|---|---|---|---|---|---|
| $I_d$ | Drain Supply Current (under any RF power drive and temperature) ($V_d$ = 3.0 V) | mA | | 55 | 70 |
| $\theta_{ch-b}$ | Thermal Resistance[2] (Backside temperature, $T_b$ = 25°C) | °C / W | | 27 | |

**Notes:**

1. Ambient operational temperature $T_A$ = 25°C unless otherwise noted.
2. Channel-to-backside Thermal Resistance ($T_{channel}$ ($T_c$) = 34°C) as measured using infrared microscopy. Thermal Resistance at backside temperature ($T_b$) = 25°C calculated from measured data.

### AMMP-6220 RF Specifications [3, 4, 6]

$T_A$= 25°C, $V_d$ = 3.0 V, $I_{d(Q)}$ = 55 mA, $Z_o$ = 50 Ω

| Symbol | Parameters and Test Conditions | Units | Typical | Sigma |
|---|---|---|---|---|
| Gain | Small-signal Gain[5] | dB | 22 | 0.5 |
| NF | Noise Figure into 50 Ω[5] | dB | 2.5 | 0.2 |
| $P_{-1dB}$ | Output Power at 1dB Gain Compression | dBm | +10 | 0.8 |
| OIP3 | Third Order Intercept Point; Δf = 100 MHz; Pin = -20 dBm | dBm | +20 | 1.1 |
| RLin | Input Return Loss | dB | -12 | 0.3 |
| RLout | Output Return Loss | dB | -16 | 0.7 |
| Isol | Reverse Isolation | dB | -45 | 0.5 |

**Notes:**

3. Small / Large -signal data measured in a fully de-embedded test fixture form $T_A$ = 25°C.
4. Pre-assembly into package performance verified 100% on-wafer per AMMC-6220 published specifications.
5. This final package part performance is verified by a functional test correlated to actual performance at one or more frequencies.
6. Specifications are derived from measurements in a 50 Ω test environment. Aspects of the amplifier performance may be improved over a more narrow bandwidth by application of additional conjugate, linearity, or low noise (Γopt) matching.

**AMMP-6220 Typical Performances** ($T_A$ = 25°C, $V_d$ =3 V, $I_D$ = 55 mA, $Z_{in}$ = $Z_{out}$ = 50 Ω unless otherwise stated)

**Note:** These measurements are in 50 Ω test environment. Aspects of the amplifier performance may be improved over a narrower bandwidth by application of additional conjugate, linearity or low noise (Γopt) matching.

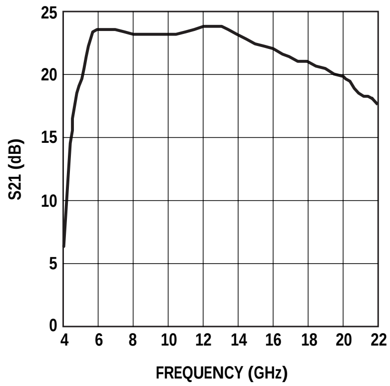



**Figure 1. Gain.**

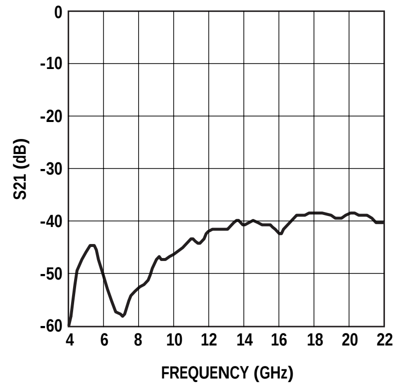



**Figure 2. Isolation.**

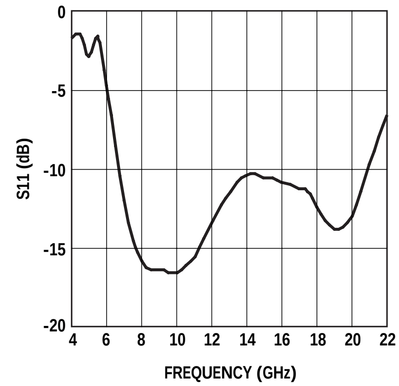



**Figure 3. Input return loss.**

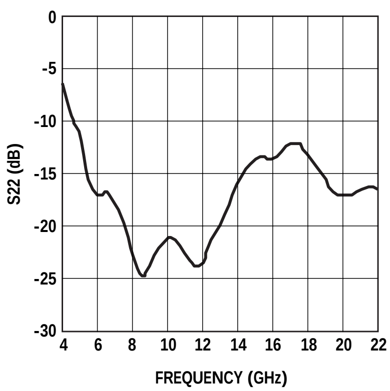



**Figure 4. Output return loss.**

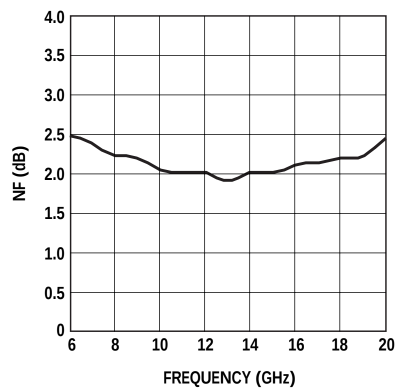



**Figure 5. Noise figure.**

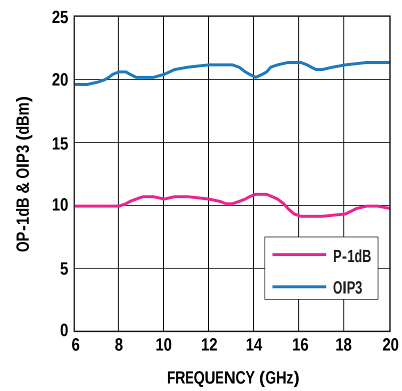



**Figure 6. Typical power, OP-1dB and OIP3.**

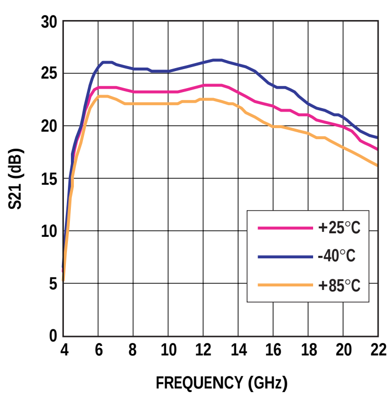



**Figure 7. Gain over temperature.**

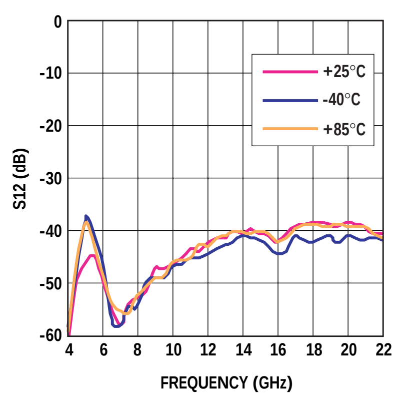



**Figure 8. Isolation over temperature.**

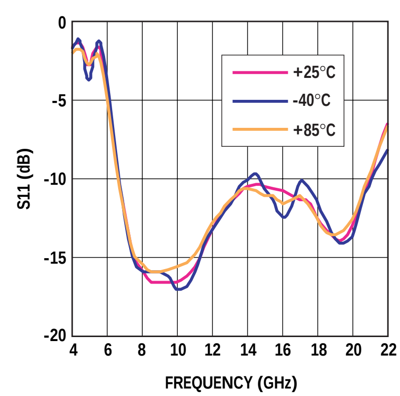



**Figure 9. Input return loss over temperature.**

## AMMP-6220 Typical Performances ($T_A$ = 25°C, $V_d$ = 3 V, $I_D$ = 55 mA, $Z_{in}$ = $Z_{out}$ = 50 Ω unless otherwise stated)

**Note:** These measurements are in 50 Ω test environment. Aspects of the amplifier performance may be improved over a narrower bandwidth by application of additional conjugate, linearity or low noise (Γopt) matching.

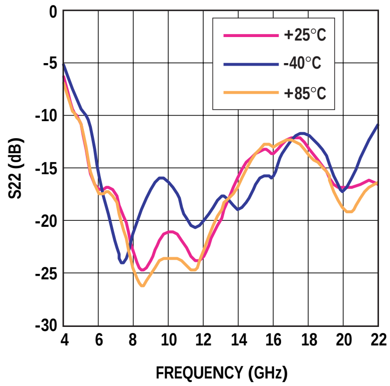



**Figure 10. Output return loss over temperature.**

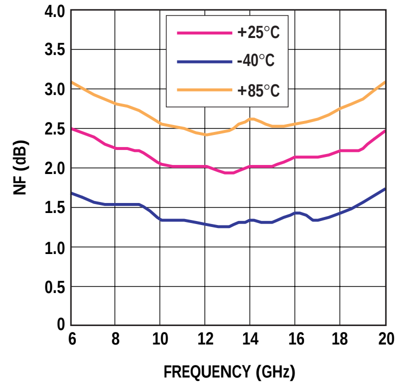



**Figure 11. NF over temperature.**

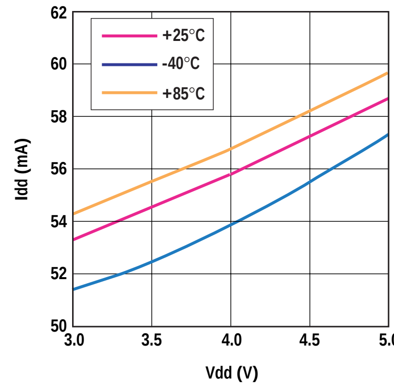



**Figure 12. Bias current over temperature.**

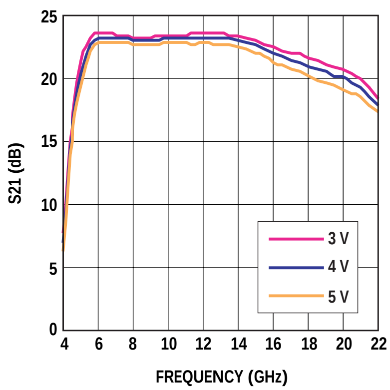



**Figure 13. Gain over Vdd.**

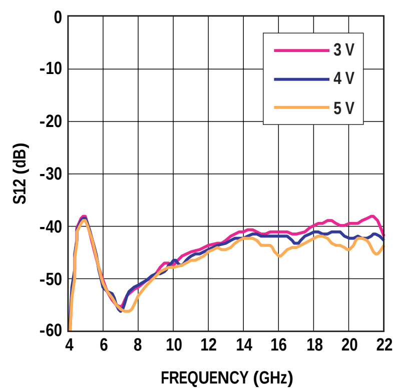



**Figure 14. Isolation over Vdd.**

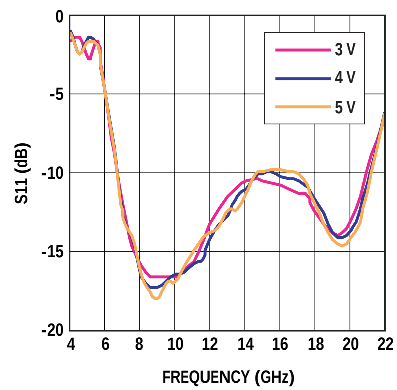



**Figure 15. Input RL over Vdd.**

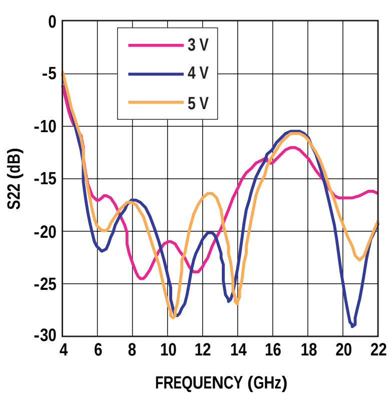



**Figure 16. Output return loss over temperature.**

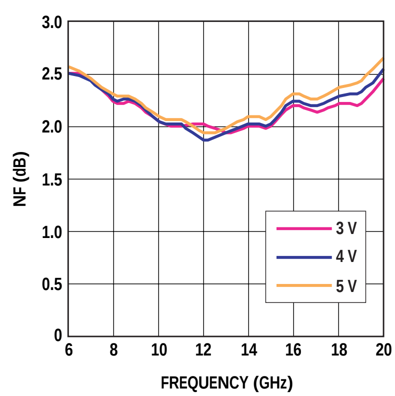



**Figure 17. Noise figure over Vdd.**

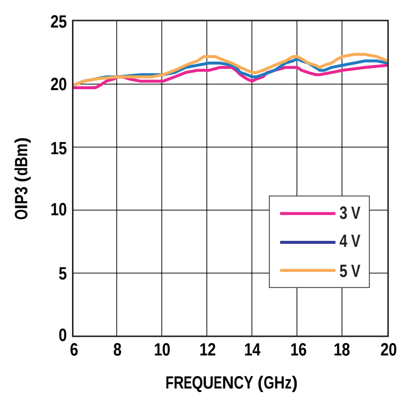
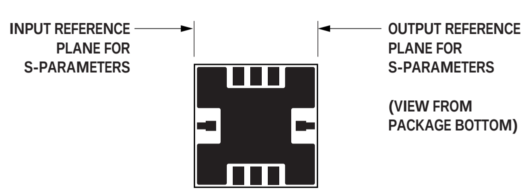



**Figure 18. OIP3 over Vdd.**

**AMMP-6220 Typical Scattering Parameters**[1] ($T_A$ = 25°C, $V_d$ = 3 V, Zo = 50 Ω)

| | S11 | | | S21 | | | S12 | | | S22 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Freq GHz** | **DB** | **Mag** | **Phase** | **dB** | **Mag** | **Phase** | **dB** | **Mag** | **Phase** | **dB** | **Mag** | **Phase** |
| 2.0 | -1.46 | 0.845 | 65.6 | -28.9 | 0.036 | -62.0 | -60 | 0.001 | 70.9 | -4.8 | 0.570 | 85.5 |
| 2.5 | -1.03 | 0.888 | -4.4 | -10.6 | 0.292 | -147.1 | -51 | 0.003 | 12.1 | -9.6 | 0.330 | 38.7 |
| 3.0 | -0.40 | 0.955 | -83.9 | 6.1 | 2.027 | 96.8 | -46 | 0.005 | -72. | -8.8 | 0.361 | 18.1 |
| 3.5 | -4.65 | 0.585 | -150.2 | 10.6 | 3.420 | -71.3 | -56 | 0.001 | 136.7 | -6.3 | 0.483 | -46.1 |
| 4.0 | -1.67 | 0.825 | 153.6 | 6.2 | 2.051 | -104.2 | -61 | 0.001 | 143.5 | -6.1 | 0.491 | -118.9 |
| 4.5 | -1.39 | 0.851 | 72.8 | 16.6 | 6.764 | -178.3 | -49 | 0.003 | -86.3 | -9.3 | 0.342 | 174.4 |
| 5.0 | -2.80 | 0.724 | 18.7 | 19.6 | 9.563 | 93.3 | -45 | 0.005 | 140.2 | -10.8 | 0.286 | 125.8 |
| 5.5 | -1.59 | 0.832 | -65.0 | 22.8 | 13.836 | 9.3 | -44 | 0.006 | 26.4 | -15.5 | 0.166 | 79.4 |
| 6.0 | -4.66 | 0.585 | -144.6 | 23.5 | 15.077 | -72.4 | -50 | 0.003 | -66.8 | -16.9 | 0.141 | 64.2 |
| 6.5 | -8.62 | 0.370 | 148.4 | 23.6 | 15.218 | -145.1 | -55 | 0.002 | -116.2 | -16.7 | 0.146 | 31.4 |
| 7.0 | -11.96 | 0.252 | 93.4 | 23.6 | 15.198 | 150.4 | -58 | 0.001 | 153.4 | -17.5 | 0.132 | -8.7 |
| 7.5 | -14.57 | 0.187 | 48.4 | 23.3 | 14.717 | 90.5 | -54 | 0.002 | 89.9 | -19.5 | 0.106 | -51.8 |
| 8.0 | -15.90 | 0.160 | 12.5 | 23.2 | 14.575 | 33.6 | -52 | 0.002 | 33.2 | -22.7 | 0.073 | -103.7 |
| 8.5 | -16.48 | 0.150 | -21.7 | 23.1 | 14.429 | -20.9 | -51 | 0.003 | -16.5 | -24.6 | 0.059 | -172.2 |
| 9.0 | -16.49 | 0.150 | -58.8 | 23.1 | 14.408 | -74.7 | -47 | 0.004 | -46.2 | -23.7 | 0.065 | 119.7 |
| 9.5 | -16.53 | 0.149 | -100.8 | 23.2 | 14.455 | -126.9 | -47 | 0.004 | -85.8 | -21.9 | 0.080 | 70.3 |
| 10.0 | -16.56 | 0.149 | -147.1 | 23.2 | 14.462 | -178.2 | -46 | 0.005 | -121.8 | -21.0 | 0.089 | 31.0 |
| 10.5 | -16.19 | 0.155 | 161.1 | 23.3 | 14.624 | 131.2 | -45 | 0.006 | -155.9 | -21.3 | 0.086 | -3.6 |
| 11.0 | -15.63 | 0.165 | 108.2 | 23.4 | 14.926 | 80.4 | -43 | 0.007 | 159.4 | -22.6 | 0.074 | -29.9 |
| 11.5 | -14.36 | 0.191 | 54.8 | 23.6 | 15.226 | 29.4 | -44 | 0.006 | 130.7 | -23.8 | 0.064 | -46.2 |
| 12.0 | -13.22 | 0.218 | 3.0 | 23.8 | 15.497 | -20.8 | -42 | 0.008 | 88.0 | -23.4 | 0.067 | -59.0 |
| 12.5 | -12.30 | 0.242 | -50.7 | 23.7 | 15.483 | -72.0 | -41 | 0.008 | 49.2 | -21.3 | 0.086 | -90.7 |
| 13.0 | -11.45 | 0.268 | -102.0 | 23.7 | 15.450 | -122.8 | -41 | 0.008 | 14.5 | -19.7 | 0.102 | -130.4 |
| 13.5 | -10.83 | 0.287 | -154.6 | 23.6 | 15.143 | -173.1 | -40 | 0.010 | -26.9 | -17.8 | 0.127 | 179.7 |
| 14.0 | -10.47 | 0.299 | 153.2 | 23.2 | 14.518 | 135.7 | -40 | 0.009 | -66.8 | -16.0 | 0.157 | 128.3 |
| 14.5 | -10.32 | 0.305 | 101.7 | 22.7 | 13.724 | 87.2 | -39 | 0.010 | -104.7 | -14.4 | 0.189 | 79.9 |
| 15.0 | -10.53 | 0.297 | 52.2 | 22.3 | 13.168 | 38.7 | -40 | 0.009 | -146.3 | -13.5 | 0.211 | 34.8 |
| 15.5 | -10.62 | 0.294 | 8.9 | 22.1 | 12.858 | -8.5 | -40 | 0.009 | 174.6 | -13.2 | 0.218 | -4.6 |
| 16.0 | -10.79 | 0.289 | -33.2 | 21.9 | 12.536 | -56.2 | -42 | 0.008 | 138.1 | -13.6 | 0.208 | -38.0 |
| 16.5 | -10.97 | 0.283 | -67.4 | 21.5 | 11.970 | -102.6 | -40 | 0.009 | 116.4 | -12.7 | 0.231 | -65.0 |
| 17.0 | -11.25 | 0.274 | -109.8 | 21.4 | 11.796 | -151.3 | -39 | 0.011 | 77.9 | -12.1 | 0.247 | -101.8 |
| 17.5 | -11.47 | 0.267 | -152.2 | 21.0 | 11.331 | 162.1 | -38 | 0.012 | 38.0 | -12.1 | 0.246 | -140.0 |
| 18.0 | -12.36 | 0.241 | 168.0 | 20.9 | 11.208 | 115.8 | -38 | 0.012 | -5.3 | -13.1 | 0.220 | 179.3 |
| 18.5 | -13.30 | 0.217 | 132.5 | 20.6 | 10.720 | 69.0 | -38 | 0.012 | -40.0 | -14.2 | 0.194 | 139.1 |
| 19.0 | -13.86 | 0.203 | 99.5 | 20.4 | 10.474 | 21.3 | -38 | 0.012 | -82.3 | -15.4 | 0.170 | 94.9 |
| 19.5 | -13.77 | 0.205 | 67.3 | 20.1 | 10.158 | -25.9 | -39 | 0.011 | -118.5 | -16.5 | 0.148 | 44.7 |
| 20.0 | -12.94 | 0.225 | 32.0 | 19.8 | 9.847 | -74.5 | -38 | 0.012 | -161.5 | -16.8 | 0.144 | -5.1 |
| 20.5 | -11.42 | 0.268 | -6.3 | 19.4 | 9.413 | -121.1 | -39 | 0.011 | 162.1 | -16.8 | 0.143 | -51.5 |
| 21.0 | -9.73 | 0.326 | -49.1 | 18.5 | 8.500 | -169.0 | -39 | 0.011 | 124.7 | -16.5 | 0.148 | -92.9 |
| 21.5 | -8.00 | 0.398 | -94.4 | 18.2 | 8.140 | 142.8 | -40 | 0.010 | 79.8 | -16.1 | 0.156 | -132.8 |
| 22.0 | -6.54 | 0.471 | -140.6 | 17.7 | 7.703 | 93.3 | -40 | 0.010 | 35.1 | -16.5 | 0.149 | -167.4 |
| 22.5 | -5.44 | 0.534 | 173.4 | 16.9 | 7.055 | 45.0 | -41 | 0.009 | 2.9 | -17.3 | 0.136 | 159.4 |
| 23.0 | -5.12 | 0.554 | 128.5 | 16.3 | 6.535 | -3.1 | -43 | 0.007 | -41.2 | -21.9 | 0.080 | 138.2 |
| 23.5 | -4.72 | 0.581 | 86.1 | 15.3 | 5.881 | -54.0 | -45 | 0.005 | -84.6 | -18.0 | 0.126 | 178.1 |
| 24.0 | -4.17 | 0.618 | 44.3 | 13.7 | 4.894 | -102.8 | -47 | 0.004 | -136.3 | -11.5 | 0.265 | 141.6 |
| 24.5 | -3.40 | 0.675 | 0.9 | 12.6 | 4.288 | -147.1 | -49 | 0.003 | -162.8 | -9.0 | 0.355 | 100.9 |
| 25.0 | -2.65 | 0.737 | -44.6 | 11.6 | 3.822 | 168.3 | -50 | 0.003 | 134.1 | -7.7 | 0.409 | 61.8 |

**Note:** Data obtained from ICM fixture measurements fully de-embedded to package edge.



## Biasing and Operation

The AMMC-6220 is normally biased with a single positive drain supply connected to both $V_D$ pin through bypass capacitors as shown in Figure 19. The recommended supply voltage is 3 V. It is important to have 0.1 µF bypass capacitor, and the capacitor should be placed as close to the component as possible.

The AMMC-6220 does not require a negative gate voltage to bias any of the three stages. No ground wires are needed because all ground connections are made with plated through-holes to the backside of the package.

Refer the Absolute Maximum Ratings table for allowed DC and thermal conditions.

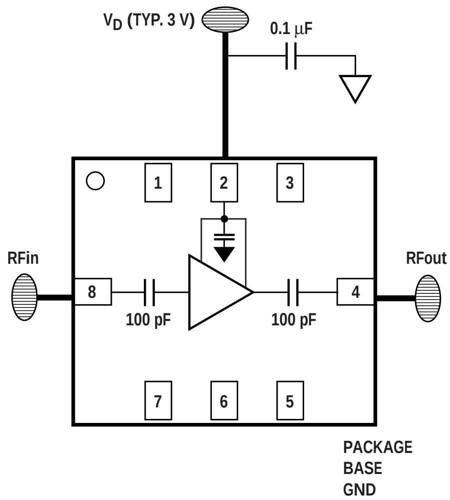



Figure 19. Typical application.

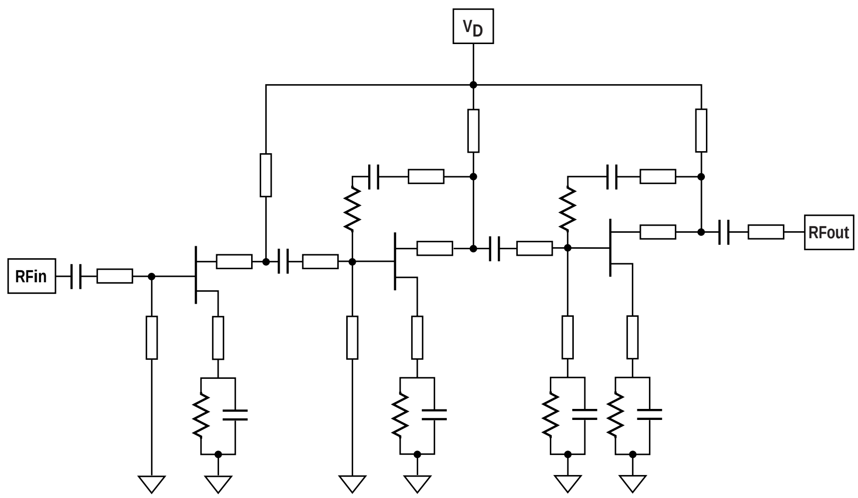



Figure 20. Simplified MMIC schematic.

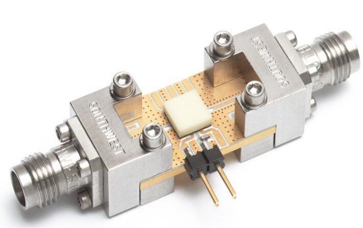
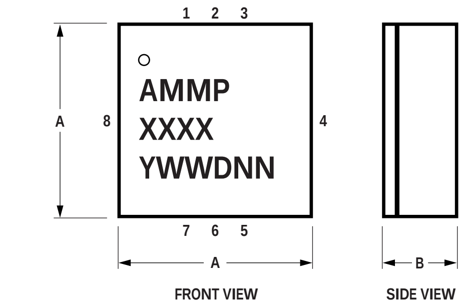


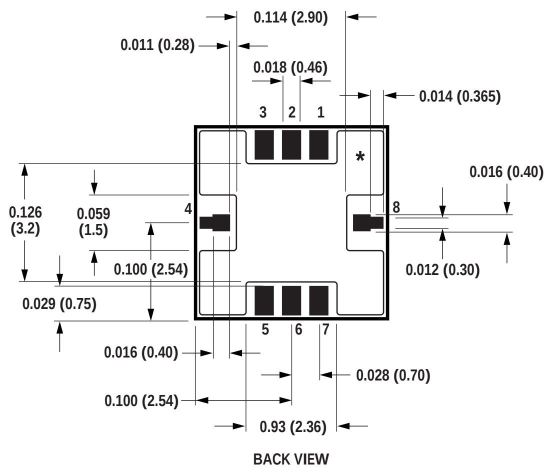
Figure 21. Demonstration board (available upon request).

## Outline Drawing




| SYMBOL | MIN. | MAX. |
|---|---|---|
| A | 0.198 (5.03) | 0.213 (5.4) |
| B | 0.0685 (1.74) | 0.088 (2.25) |

DIMENSIONS ARE IN INCHES (MM)

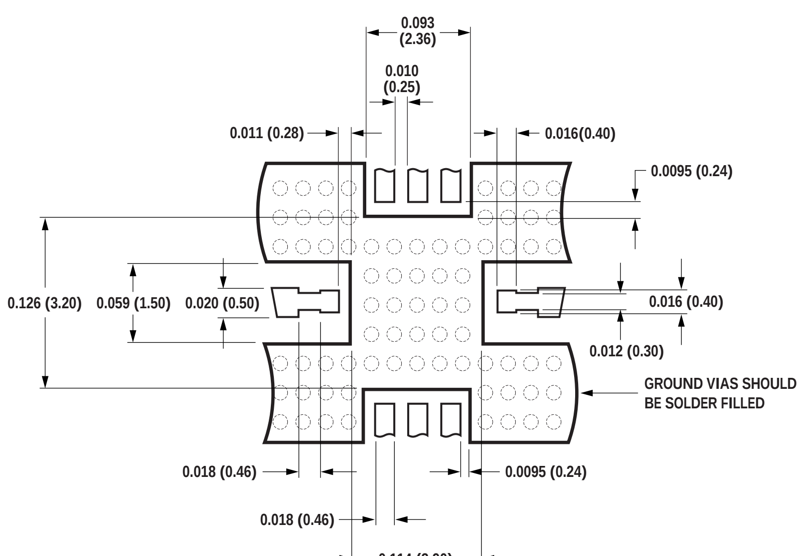



DIMENSIONAL TOLERANCE FOR BACK VIEW: 0.002" (0.05 mm)

NOTES:
1. * INDICATES PIN 1
2. DIMENSIONS ARE IN INCHES (MILLIMETERS)
3. ALL GROUNDS MUST BE SOLDERED TO PCB RF GROUND

Figure 22. Outline Drawing.

## Suggested PCB Material and Land Pattern




INCHES (MILLIMETERS).
MATERIAL IS ROGERS RO4350, 0.010-INCH THICK.

Figure 23.

## Recommended SMT Attachment

The AMMP Packaged Devices are compatible with high volume surface mount PCB assembly processes.

The PCB material and mounting pattern, as defined in the data sheet, optimizes RF performance and is strongly recommended. An electronic drawing of the land pattern is available upon request from Avago Sales & Application Engineering.

## Manual Assembly

1. Follow ESD precautions while handling packages.
2. Handling should be along the edges with tweezers.
3. Recommended attachment is conductive solder paste. Please see recommended solder reflow profile. Conductive epoxy is not recommended. Hand soldering is not recommended.
4. Apply solder paste using a stencil printer or dot placement. The volume of solder paste will be dependent on PCB and component layout and should be controlled to ensure consistent mechanical and electrical performance.
5. Follow solder paste and vendor's recommendations when developing a solder reflow profile. A standard profile will have a steady ramp up from room temperature to the pre-heat temperature to avoid damage due to thermal shock.
6. Packages have been qualified to withstand a peak temperature of 260°C for 20 seconds. Verify that the profile will not expose device beyond these limits.

## Solder Reflow Profile

The most commonly used solder reflow method is accomplished in a belt furnace using convection heat transfer. The suggested reflow profile for automated reflow processes is shown in Figure 25. This profile is designed to ensure reliable finished joints. However, the profile indicated in Figure 25 will vary among different solder pastes from different manufacturers and is shown here for reference only.

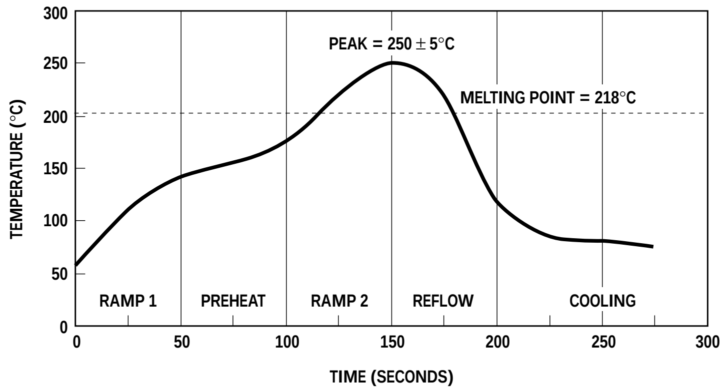



Figure 24. Suggested lead-free reflow profile for SnAgCu solder paste.

## Stencil Design Guidelines

A properly designed solder screen or stencil is required to ensure optimum amount of solder paste is deposited onto the PCB pads. The recommended stencil layout is shown in Figure 26. The stencil has a solder paste deposition opening approximately 70% to 90% of the PCB pad. Reducing stencil opening can potentially generate more voids underneath. On the other hand, stencil openings larger than 100% will lead to excessive solder paste smear or bridging across the I/O pads. Considering the fact that solder paste thickness will directly affect the quality of the solder joint, a good choice is to use a laser cut stencil composed of 0.127 mm (5 mils) thick stainless steel which is capable of producing the required fine stencil outline. The combined PCB and stencil layout is shown in Figure 27.

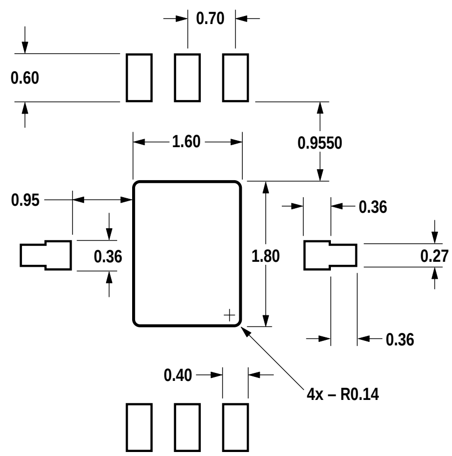



Figure 25. Stencil outline drawing (mm).

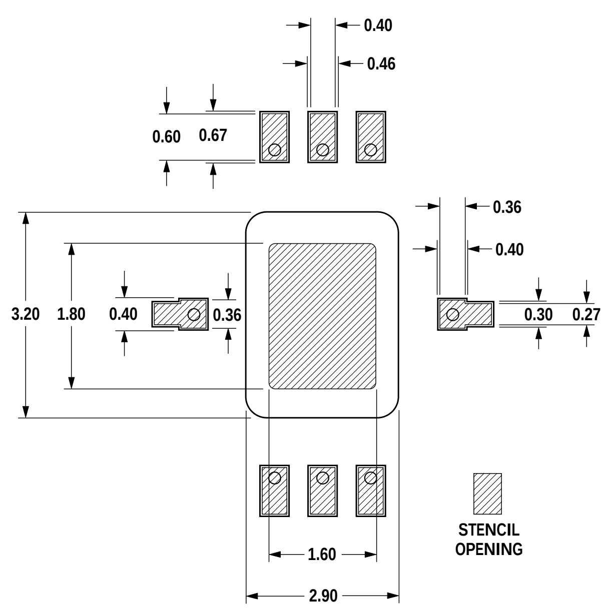
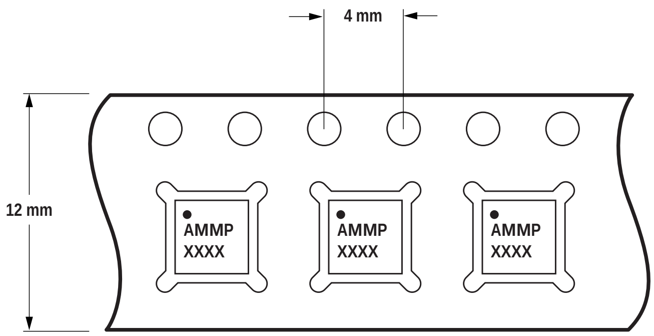



Figure 26. Combined PCB and stencil layouts (mm).

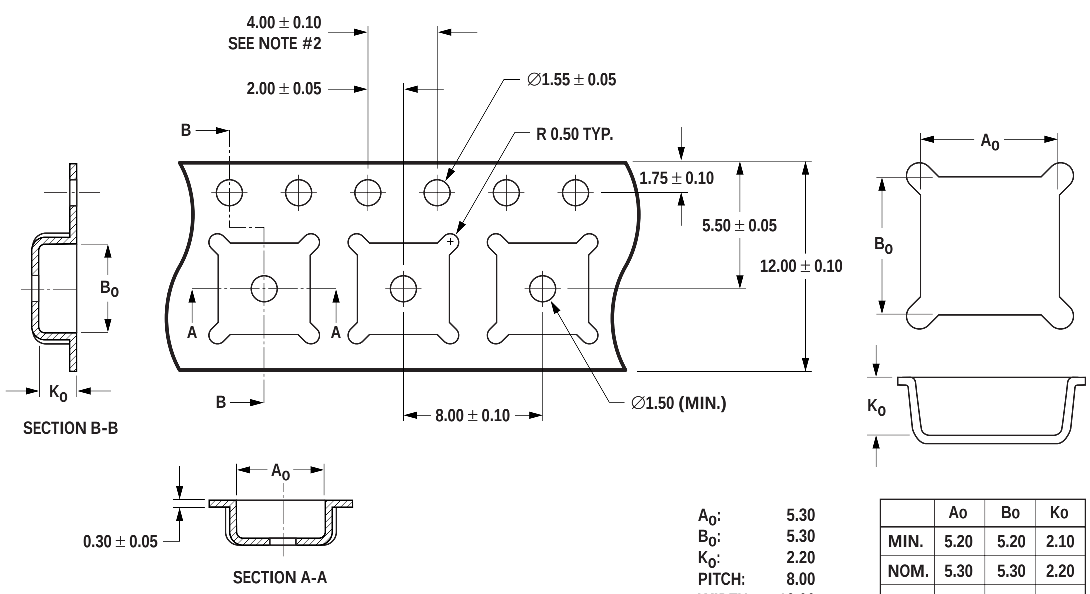
## AMMP-6220 Part Number Ordering Information

| Part Number | Devices Per Container | Container |
|---|---|---|
| AMMP-6220-BLK | 10 | Antistatic bag |
| AMMP-6220-TR1 | 100 | 7” Reel |
| AMMP-6220-TR2 | 500 | 7” Reel |

## Device Orientation (Top View)




## Carrier Tape and Pocket Dimensions




| | |
|---|---|
| $A_0$: | 5.30 |
| $B_0$: | 5.30 |
| $K_0$: | 2.20 |
| PITCH: | 8.00 |
| WIDTH: | 12.00 |

| | Ao | Bo | Ko |
|---|---|---|---|
| MIN. | 5.20 | 5.20 | 2.10 |
| NOM. | 5.30 | 5.30 | 2.20 |
| MAX. | 5.40 | 5.40 | 2.30 |

NOTES:
1. $A_0$ AND $B_0$ MEASURED AT 0.3 mm ABOVE BASE OF POCKET.
2. 10 PITCHES CUMULATIVE TOLERANCE IS ± 0.2 mm.
3. DIMENSIONS ARE IN MILLIMETERS (mm).

For product information and a complete list of distributors, please go to our website: **www.avagotech.com**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