# AP501

## PCS-band 4W HBT Amplifier Module

## Product Features

- 1930 – 1990 MHz
- 32.5 dB Gain
- +36 dBm P1dB
- -62 dBc ACPR
  @ 27 dBm IS-95A linear power
- -55 dBc ACLR
  @ 26.5 dBm wCDMA linear power
- +12 V Single Supply
- Power Down Mode
- Bias Current Adjustable
- RoHS-compliant flange-mount pkg

## Applications

- Final stage amplifiers for repeaters
- Optimized for driver amplifier PA mobile infrastructure

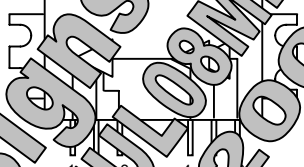
## Product Description

The AP501 is a high dynamic range power amplifier in a RoHS-compliant flange-mount package. The multi-stage amplifier module has 32.5 dB gain, while being able to achieve high performance for PCS-band applications with +36 dBm of compressed 1dB power. The module has been internally optimized for driver applications provide -62 dBc ACPR at 27 dBm for IS-95A applications or -55 dBc ACLR at 26.5 for wCDMA applications. The module can be bia[illegible] down for current when higher efficiency is required.

The AP501 uses a high reliability InGaP/GaAs HBT pr[illegible]s technology and does not require any externa[illegible] matching components. The module operates off a +12[illegible]ly and does not requiring any negative biasing volta[illegible] intern[illegible] active bias allows the amplifier to main[illegible]high linea[illegible] over temperature. It has the added feature[illegible]+5V powe[illegible] down control pin. A low-cost met[illegible]ing a[illegible]e device to have a low thermal resista[illegible]e to ensur[illegible]ong lifetimes. All devices are 100% R[illegible] and DC tested.

The AP501 is targeted for [illegible]e a[illegible]ver or fi[illegible]s amplifi[illegible] in wireless infrastructure w[illegible]inearity [illegible]igh po[illegible]s required. This combination [illegible]kes the [illegible]ce an [illegible]llent candidate for next gene[illegible]n multi-carrier [illegible]ase stat[illegible]

## Functional Diagram



Top View

| Pin No. | Function |
|---|---|
| 1 | RF Output |
| 2 / 4 | Vcc |
| 3 / 5 | Vpd |
| [illegible] | RF Input |
| [illegible] | Ground |

## Specifications

**25 ºC, $V_{cc}$=12V, $V_{pd}$=5V, $I_{cq}$=820mA, R7=0Ω, 50Ω unmatc[illegible]e**

| Parameter | Units | Min | Typ | Max |
|---|---|---|---|---|
| Operational Bandwidth | MHz | 19[illegible] | [illegible]990 | |
| Test Frequency | MHz | | 1960 | |
| Power Gain | dB | [illegible] | 32.4 | [illegible] |
| IS-95A ACPR @ 27dBm [1] | dBc | | -61.8 | [illegible]5 |
| wCDMA ACLR @ 26.5dBm [2] | dBc | | -5[illegible] | |
| Input Return Loss | dB | | [illegible] | |
| Output Return Loss | [illegible] | | [illegible] | |
| Output P1dB | [illegible]m | | [illegible]36 | |
| Output IP3 | [illegible]m | | +52 | |
| Operating Current @ 27 dBm | mA | | 84[illegible] | 940 |
| Quiescent Current, Icq | mA | [illegible]0 | [illegible] | 920 |
| Device Voltage, Vcc | [illegible] | | [illegible]2 | |
| Device Voltage, Vpd | [illegible] | | +5 | |
| Load Stability | [illegible]VSWR | [illegible] | | |

1. IS-95A signal mod[illegible]on, [illegible]annels forw[illegible]d, [illegible]23 MHz BW, [illegible]5 kHz offset.
2. 3GPP wCDMA [illegible]nal [illegible]dulation, Test[illegible]32 DPCH, 3.84 MHz BW, ±5 MHz offset.
3. Pull-down [illegible]tage[illegible]V, "OFF", [illegible]

## Typical Performance [4]

| Parameter | Units | Config1 | Config2 |
|---|---|---|---|
| Operating Current @ 27 dBm | mA | 840 | 420 |
| Quiescent Current, Icq | mA | 820 | 250 |
| Device Voltage, Vcc | V | +12 | +12 |
| R7 value | Ω | 0 | 730 |
| Test Frequency | MHz | 1960 | 1960 |
| Power Gain | dB | 32.4 | 30.5 |
| IS-95A ACPR @ 27dBm [1] | dBc | -61.8 | -53 |
| wCDMA ACLR @ 26.5dBm [2] | dBc | -55 | -49 |
| Input Return Loss | dB | 22 | 20 |
| Output Return Loss | dB | 6 | 8 |
| Output P1dB | dBm | +36 | +36 |
| Output IP3 | dBm | +52 | +52 |

4. Configuration 1 has the module biased in Class AB and is detailed on page 2 of the datasheet. Performance is shown at 25 ºC, Vcc=12V, Vpd=5V, Icq=820mA, R7=0Ω, 50Ω unmatched fixture. Configuration 2 has the module biased in near Class B and is detailed on page 3 of the datasheet. Performance is shown at 25 ºC, Vcc=12V, Vpd=5V, Icq=250mA, R7=730Ω, 50Ω tuned fixture.

## Absolute Maximum Rating

| Parameter | Rating |
|---|---|
| Operating Case Temperature | -40 to +85 °C |
| Storage Temperature | -55 to +150 °C |
| RF Input Power (continuous) [3] | +15 dBm |

3. Output terminated in 50 Ω

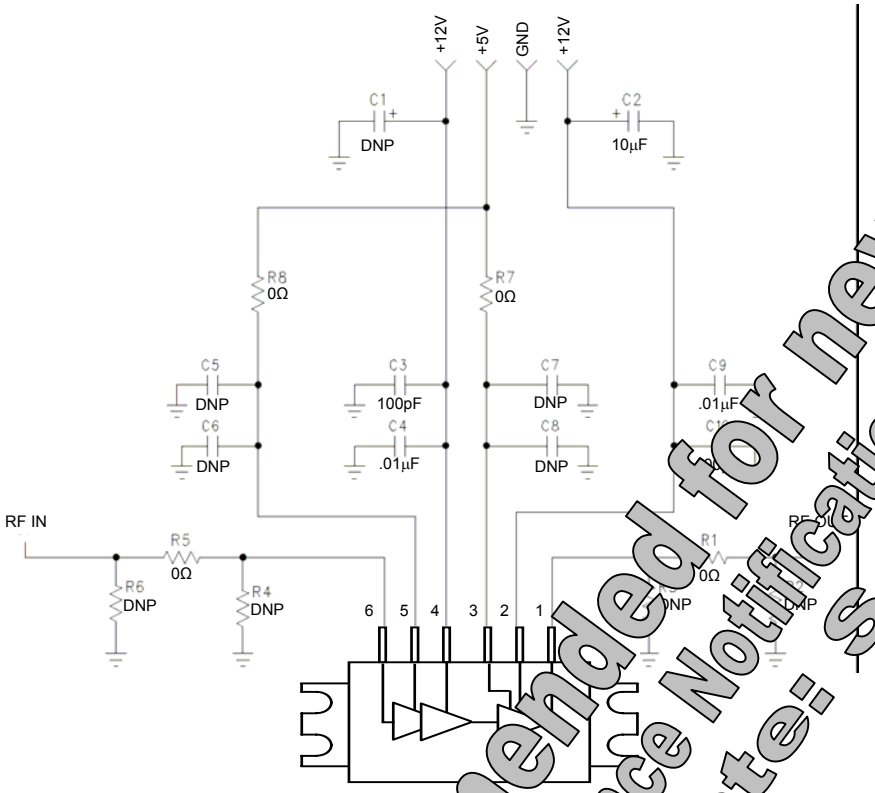
[illegible]ation of this [illegible] above any of these parameters may cause permanent damage.

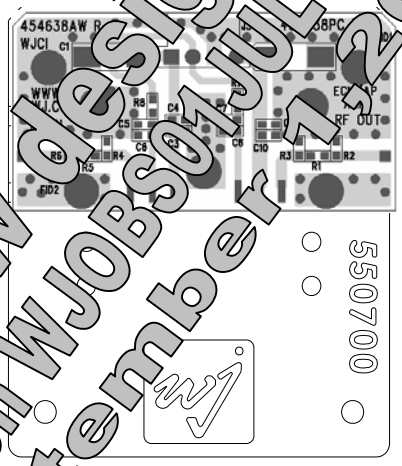
## Ordering Information

| Part No. | Description |
|---|---|
| AP501 | PCS-band 4W HBT Amplifier Module |
| AP501-PCB | Fully-Assembled Evaluation Board (Class AB configuration, Icq=820mA) |

## Performance Graphs – Class AB Configuration (AP501-PCB)

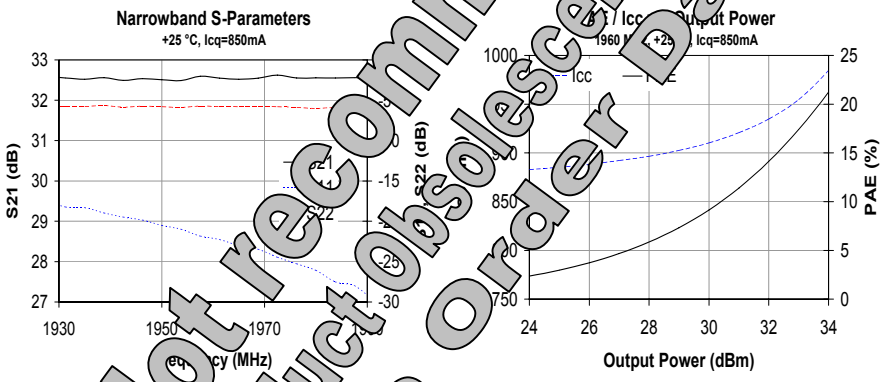
The AP501-PCB and AP501 module is configured for Class AB by default. The resistor – R7 – which sets the current flow for the amplifier is set at 0 Ω in this configuration. Increasing that value will decrease the quiescent and operating current of the amplifier module, as described on the next page.



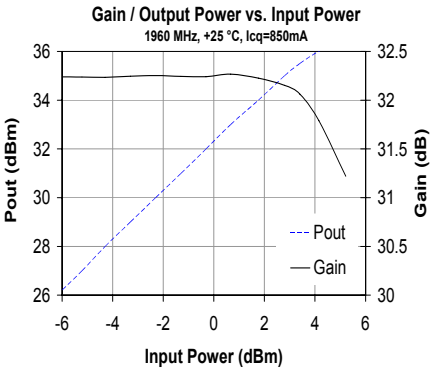

Notes:

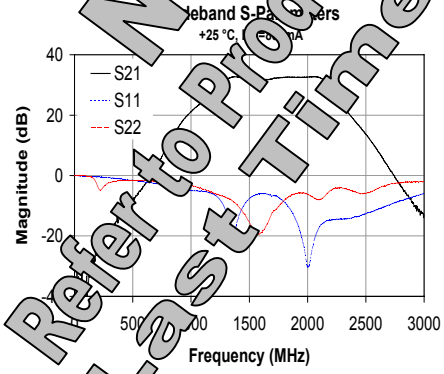
1. Please note that for reliable operation, the evaluation board will have to be mounted to a much larger heat sink during operation and in laboratory environments to dissipate the power consumed by the device. The use of a convection fan is also recommended in laboratory environments. Details of the mounting holes used in the WJ heatsink are given on the last page of this datasheet.
2. The area around the module underneath the PCB should not contain any soldermask in order to maintain good RF grounding.
3. For proper and safe operation in the laboratory, the power-on sequencing should be followed:
   a. Connect RF In and Out
   b. Connect the voltages and ground pins as shown in the circuit.
   c. Apply the RF signal
   d. Power down with the reverse sequence

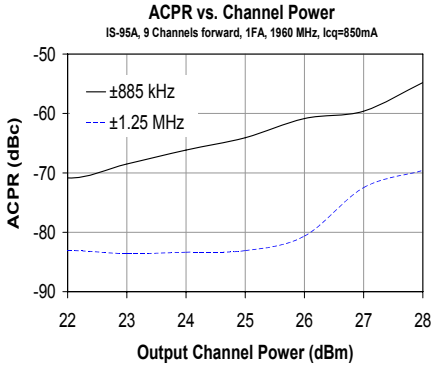


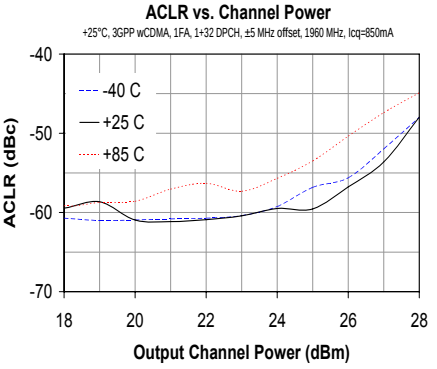






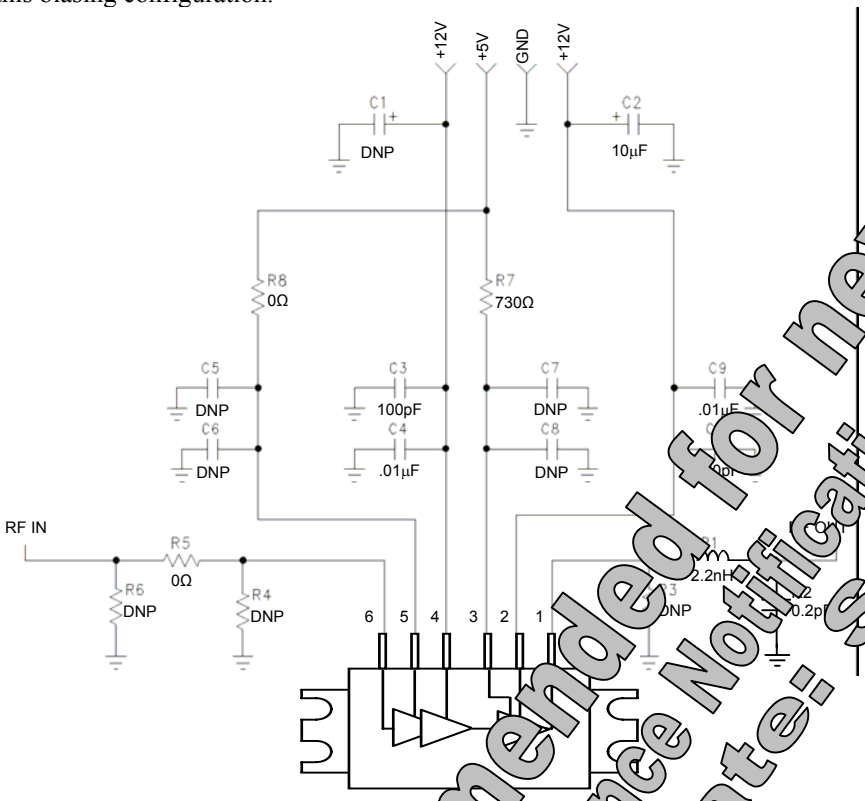



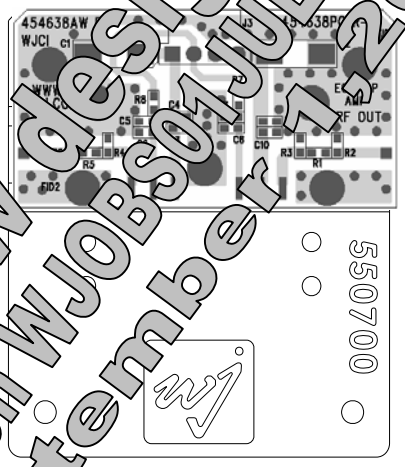



Specifications and information are subject to change without notice

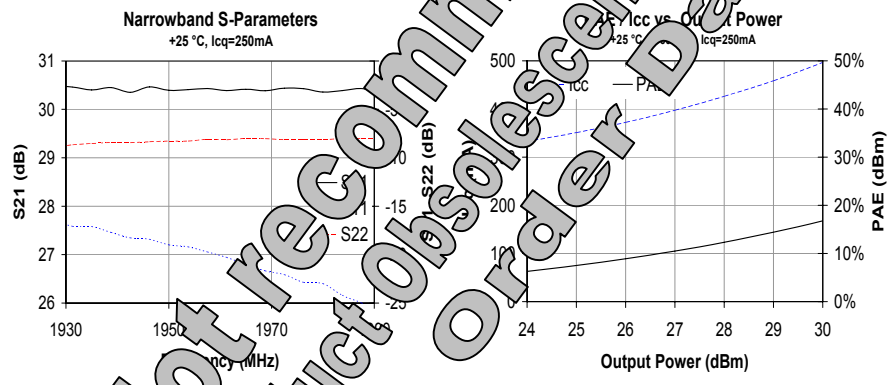
## Performance Graphs – Class B Configuration

The AP501 can be adjusted to operate at lower current biasing levels by modifying the R7 resistor f[illegible] improve [illegible] performance. The configuration shown on this page has the AP501 operating with Icq = 250 mA (Ic[illegible]00 mA [illegible] dBm Output L-C matching components have been added externally on the circuit to optimize the amplifier [illegible] ACPR p[illegible] this biasing configuration.



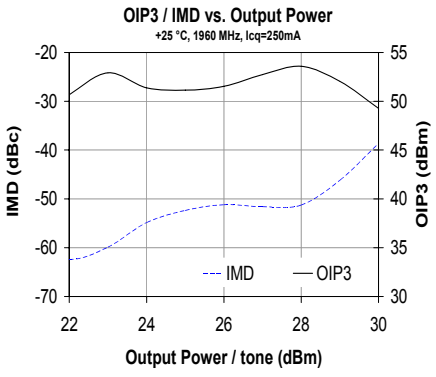



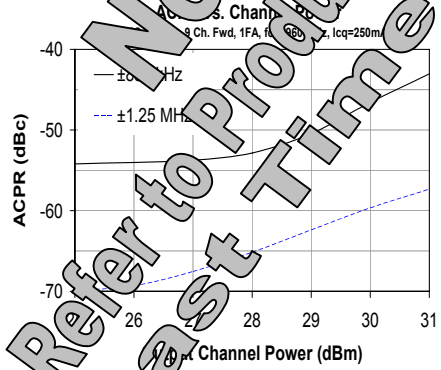

Notes:
1. Please note that for reliable operation, the evaluation board will have to be attached to a much larger heat sink during operation and in laboratory environments to dissipate the power consumed by the device. The use of a convection fan is also recommended in laboratory environments. Details of the mounting holes used in the WJ heatsink are given on the last page of this datasheet.
2. The area around the module underneath the PCB should not contain any soldermask in order to maintain good RF grounding.
3. For proper and safe operation in the laboratory, the power-on sequencing should be followed:
   a. Connect RF In and Out
   b. Connect the voltages and ground pins as shown in the circuit.
   c. Apply the RF signal
   d. Power down with the reverse sequence

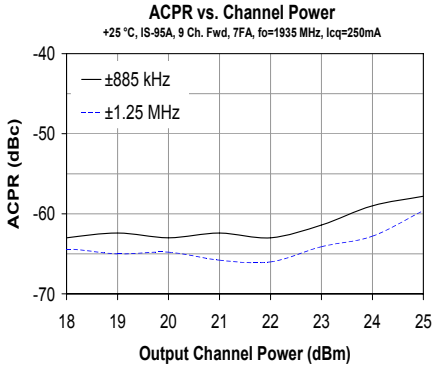


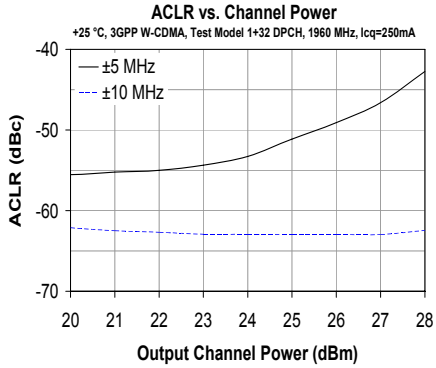






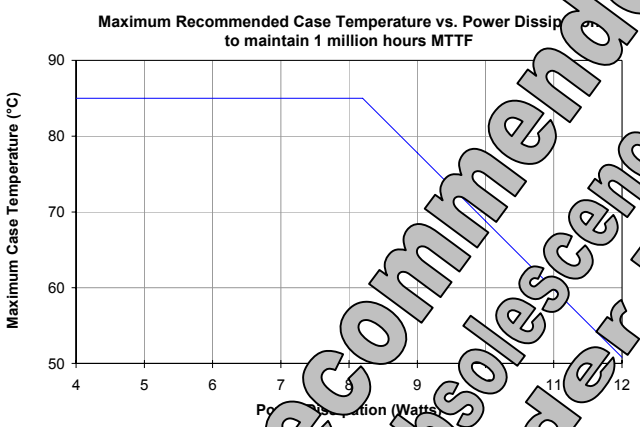
## MTTF Calculation

The MTTF of the AP501 can be calculated by first determining how much power is being dissipated by the amplifier module. Because the device's intended application is to be a power amplifier pre-driver or final stage output amplifier, the output RF power of the amplifier will help lower the overall power dissipation. In addition, the amplifier can be biased with different quiescent currents, so the calculation of the MTTF is custom to each application.

The power dissipation of the device can be calculated with the following equation:

$P_{diss} = V_{cc} * I_{cc}$ – (Output RF Power – Input RF Power),
$V_{cc}$ = Operating supply voltage = **12V**
$I_{cc}$ = Operating current
{The RF power is converted to Watts}

While the maximum recommended case temperature on the datasheet is listed at 85 ˚C, it is suggested that customers maintain an MTTF above 1 million hours. This would convert to a derating curve for maximum case temperature vs. power dissipation as shown in the plot below.



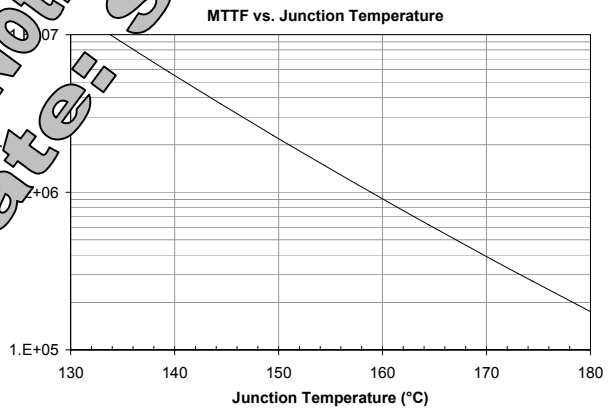

To calculate the MTTF for the module, the junction temperature needs to be determined. This can be easily calculated with the module's power dissipation, the thermal resistance value, and the case temperature of operation.

$T_j = P_{diss} * R_{th} + T_{case}$
$T_j$ = Junction Temperature
$P_{diss}$ = Power Dissipation (calculated from above)
$R_{th}$ = Thermal resistance = **9 °C/W**
$T_{case}$ = Case Temperature of module's heat sink

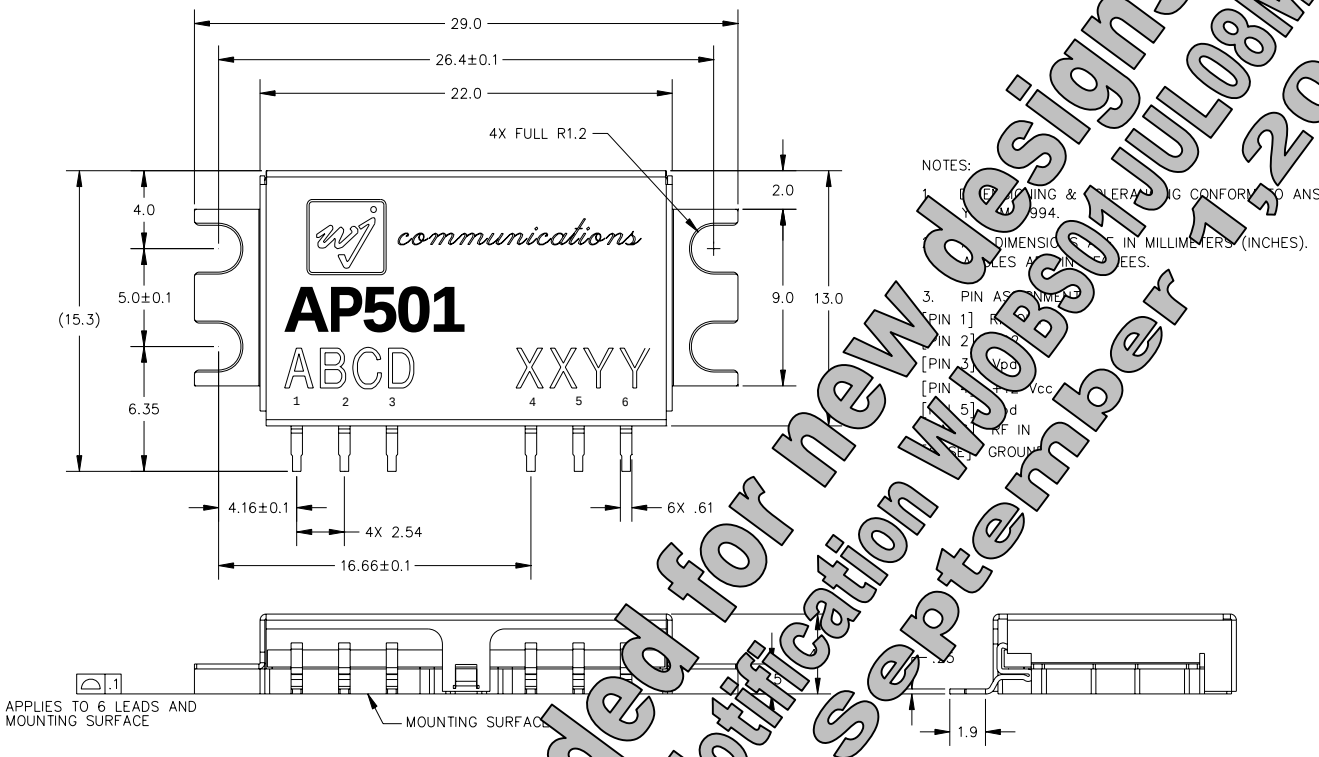
From a numerical standpoint, the MTTF can be calculated using the Arrhenius equation:

$MTTF = A * e^{(Ea/kTj)}$
A = Pre-exponential Factor = **6.087 x $10^{-11}$ hours**
Ea = Activation Energy = **1.39 eV**
k = Boltzmann's Constant = **8.617 x $10^{-5}$ eV/ ºK**
$T_j$ = Junction Temperature (ºK) = $T_j$ (ºC) + 273

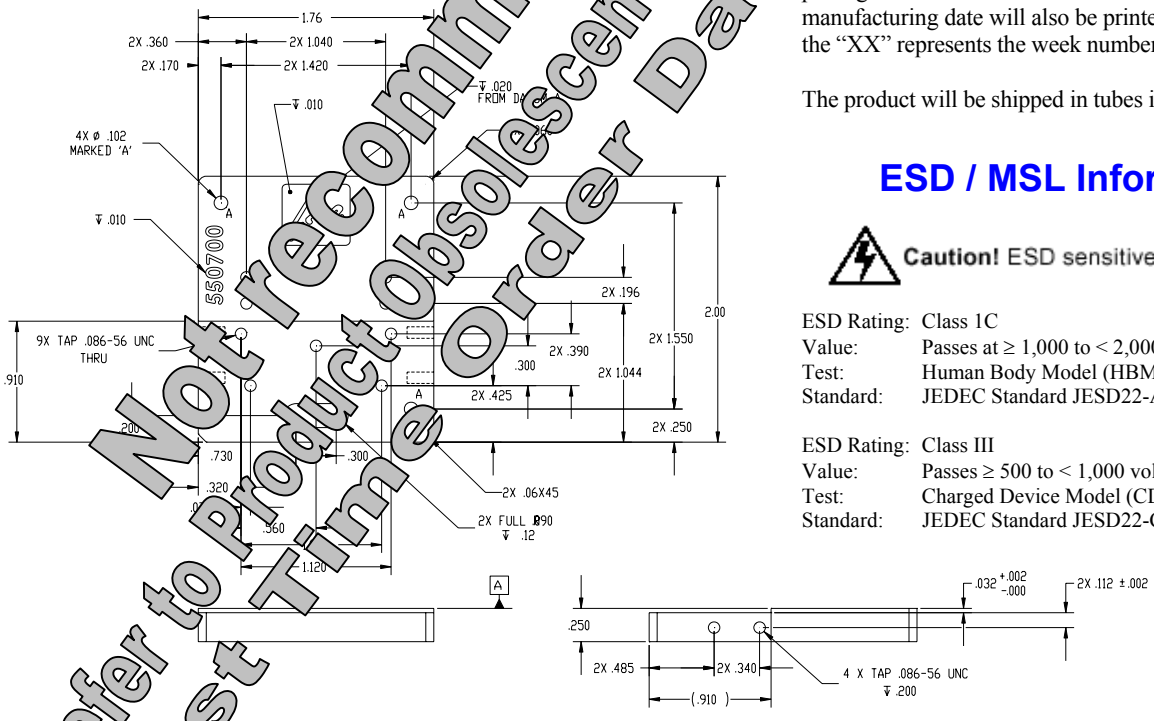
A graphical view of the MTTF can be shown in the plot below:



## Outline Drawing




## Outline Drawing for the Heatsink with the WJ Evaluation Board




## Product Marking

The device will be marked with an "AP501" designator with an alphanumeric lot code on the top surface of the package noted as "ABCD" on the drawing. A manufacturing date will also be printed as "XXYY", where the "XX" represents the week number from 1 – 52.

The product will be shipped in tubes in multiples of 15.

## ESD / MSL Information

**Caution!** ESD sensitive device.

| | |
|---|---|
| ESD Rating: | Class 1C |
| Value: | Passes at ≥ 1,000 to < 2,000 volts |
| Test: | Human Body Model (HBM) |
| Standard: | JEDEC Standard JESD22-A114 |

| | |
|---|---|
| ESD Rating: | Class III |
| Value: | Passes ≥ 500 to < 1,000 volts |
| Test: | Charged Device Model (CDM) |
| Standard: | JEDEC Standard JESD22-C101 |