# ATF-531P8

## High Linearity Enhancement Mode[1] Pseudomorphic HEMT in 2x2 mm$^2$ LPCC[3] Package

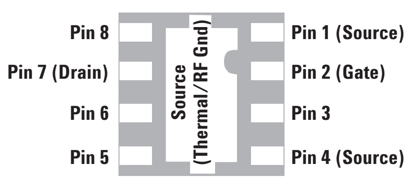
# Data Sheet

### Description

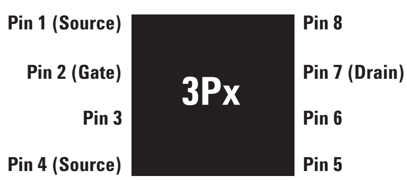
Avago Technologies' ATF-531P8 is a single-voltage high linearity, low noise E-pHEMT housed in an 8-lead JEDEC-standard leadless plastic chip carrier (LPCC[3]) package. The device is ideal as a high linearity, low-noise, medium-power amplifier. Its operating frequency range is from 50 MHz to 6 GHz.

The thermally efficient package measures only 2 mm x 2 mm x 0.75 mm. Its backside metalization provides excellent thermal dissipation as well as visual evidence of solder reflow. The device has a Point MTTF of over 300 years at a mounting temperature of +85°C. All devices are 100% RF & DC tested.

### Pin Connections and Package Marking




Bottom View




Top View

**Note:**
Package marking provides orientation and identification:
"3P" = Device Code
"x" = Date code indicates the month of manufacture.

### Features

- Single voltage operation
- High linearity and gain
- Low noise figure
- Excellent uniformity in product specifications
- Small package size: 2.0 x 2.0 x 0.75 mm
- Point MTTF > 300 years[2]
- MSL-1 and lead-free
- Tape-and-reel packaging option available

### Specifications

2 GHz; 4V, 135 mA (Typ.)

- 38 dBm output IP3
- 0.6 dB noise figure
- 20 dB gain
- 10.7 dB LFOM[4]
- 24.5 dBm output power at 1 dB gain compression

### Applications

- Front-end LNA Q1 and Q2 driver or pre-driver amplifier for Cellular/PCS and WCDMA wireless infrastructure
- Driver amplifier for WLAN, WLL/RLL and MMDS applications
- General purpose discrete E-pHEMT for other high linearity applications

**Notes:**
1. Enhancement mode technology employs a single positive $V_{gs}$, eliminating the need of negative gate voltage associated with conventional depletion mode devices.
2. Refer to reliability datasheet for detailed MTTF data.
3. Conforms to JEDEC reference outline MO229 for DRP-N
4. Linearity Figure of Merit (LFOM) is essentially OIP3 divided by DC bias power.

## ATF-531P8 Absolute Maximum Ratings[1]

| Symbol | Parameter | Units | Absolute Maximum |
|---|---|---|---|
| $V_{DS}$ | Drain–Source Voltage[2] | V | 7 |
| $V_{GS}$ | Gate–Source Voltage[2] | V | -7 to 1 |
| $V_{GD}$ | Gate Drain Voltage[2] | V | -7 to 1 |
| $I_{DS}$ | Drain Current[2] | mA | 300 |
| $I_{GS}$ | Gate Current | mA | 20 |
| $P_{diss}$ | Total Power Dissipation[3] | W | 1 |
| $P_{in\ max.}$ | RF Input Power | dBm | +24 |
| $T_{CH}$ | Channel Temperature | °C | 150 |
| $T_{STG}$ | Storage Temperature | °C | -65 to 150 |
| $\theta_{ch\_b}$ | Thermal Resistance[4] | °C/W | 63 |

**Notes:**
1. Operation of this device in excess of any one of these parameters may cause permanent damage.
2. Assumes DC quiescent conditions.
3. Board (package belly) temperature$T_B$ is 25°C. Derate 16 mW/°C for $T_B$ > 87°C.
4. Thermal resistance measured using 150°C Liquid Crystal Measurement method.
5. Device can safely handle +24 dBm RF Input Power provided IGS is limited to 20mA. IGS at P1dB drive level is bias circuit dependent.

## Product Consistency Distribution Charts at 2 GHz, 4V, 135 mA [5,6]

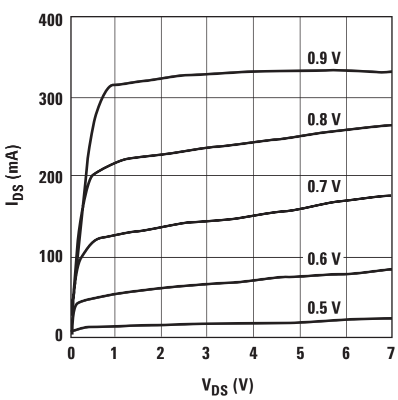



**Figure 1. Typical I-V Curves ($V_{gs}$ = 0.1 per step).**

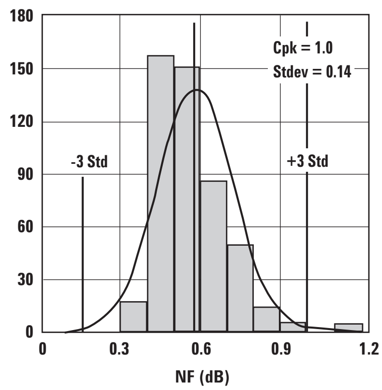



**Figure 2. NF**
**Nominal = 0.6, USL = 1.0.**

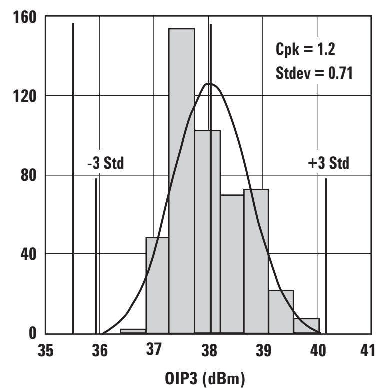



**Figure 3. OIP3**
**LSL = 35.5, Nominal = 38.1.**

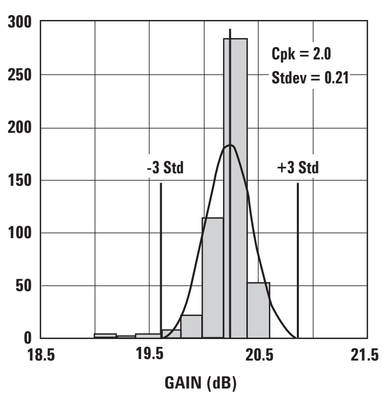



**Figure 4. Small Signal Gain**
**LSL = 18.5, Nominal = 20.2 dB, USL = 21.5.**

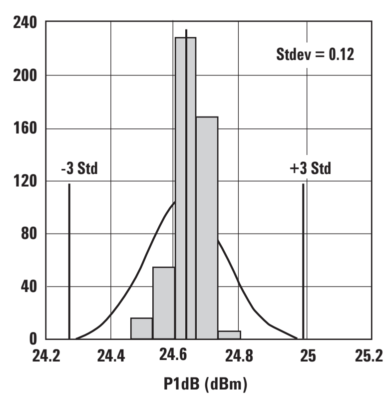



**Figure 5. P1dB**
**Nominal = 24.6.**

**Notes:**
5. Distribution data sample size is 500 samples taken from 5 different wafers and 3 different lots. Future wafers allocated to this product may have nominal values anywhere between the upper and lower limits.
6. Measurements are made on production test board, which represents a trade-off between optimal OIP3, NF and VSWR. Circuit losses have been de-embedded from actual measurements.

## ATF-531P8 Electrical Specifications

$T_A$ = 25°C, DC bias for RF parameters is Vds = 4V and Ids = 135 mA unless otherwise specified.

| Symbol | Parameter and Test Condition | | Units | Min. | Typ. | Max. |
|---|---|---|---|---|---|---|
| Vgs | Operational Gate Voltage | Vds = 4V, Ids = 135 mA | V | — | 0.68 | — |
| Vth | Threshold Voltage | Vds = 4V, Ids = 8 mA | V | — | 0.3 | — |
| Idss | Saturated Drain Current | Vds = 4V, Vgs = 0V | μA | — | 3.7 | — |
| Gm | Transconductance | Vds = 4.5V, Gm = ΔIdss/ΔVgs;<br>ΔVgs = Vgs1 - Vgs2<br>Vgs1 = 0.6V, Vgs2 = 0.55V | mmho | — | 650 | — |
| Igss | Gate Leakage Current | Vds = 0V, Vgs = -4V | μA | -10 | -0.34 | — |
| NF | Noise Figure[1] | f = 2 GHz<br>f = 900 MHz | dB<br>dB | —<br>— | 0.6<br>0.6 | 1<br>— |
| G | Gain[1] | f = 2 GHz<br>f = 900 MHz | dB<br>dB | 18.5<br>— | 20<br>25 | 21.5<br>— |
| OIP3 | Output 3rd Order<br>Intercept Point[1,2] | f = 2 GHz<br>f = 900 MHz | dBm<br>dBm | 35.5<br>— | 38<br>37 | —<br>— |
| P1dB | Output 1dB<br>Compressed[1] | f = 2 GHz<br>f = 900 MHz | dBm<br>dBm | —<br>— | 24.5<br>23 | —<br>— |
| PAE | Power Added Efficiency | f = 2 GHz<br>f = 900 MHz | %<br>% | —<br>— | 57<br>45 | —<br>— |
| ACLR | Adjacent Channel Leakage<br>Power Ratio[1,3] | Offset BW = 5 MHz<br>Offset BW = 10 MHz | dBc<br>dBc | —<br>— | -68<br>-64 | —<br>— |

**Notes:**
1. Measurements obtained using production test board described in Figure 6.
2. F1 = 2.00 GHz, F2 = 2.01 GHz and Pin = -10 dBm per tone.
3. ACLR test spec is based on 3GPP TS 25.141 V5.3.1 (2002-06)
   – Test Model 1
   – Active Channels: PCCPCH + SCH + CPICH + PICH + SCCPCH + 64 DPCH (SF=128)
   – Freq = 2140 MHz
   – Pin = -5 dBm
   – Chan Integ Bw = 3.84 MHz

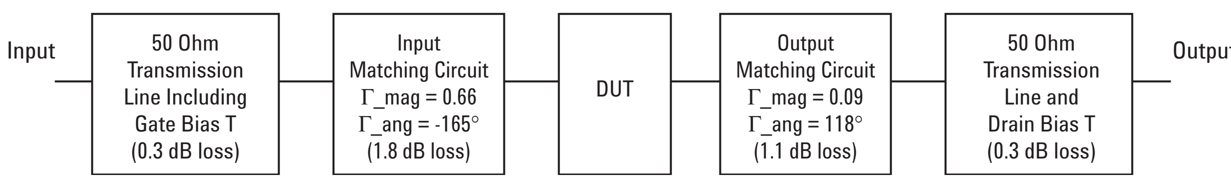



**Figure 6. Block diagram of the 2 GHz production test board used for NF, Gain, OIP3 , P1dB and PAE and ACLR measurements. This circuit achieves a trade-off between optimal OIP3, NF and VSWR. Circuit losses have been de-embedded from actual measurements.**

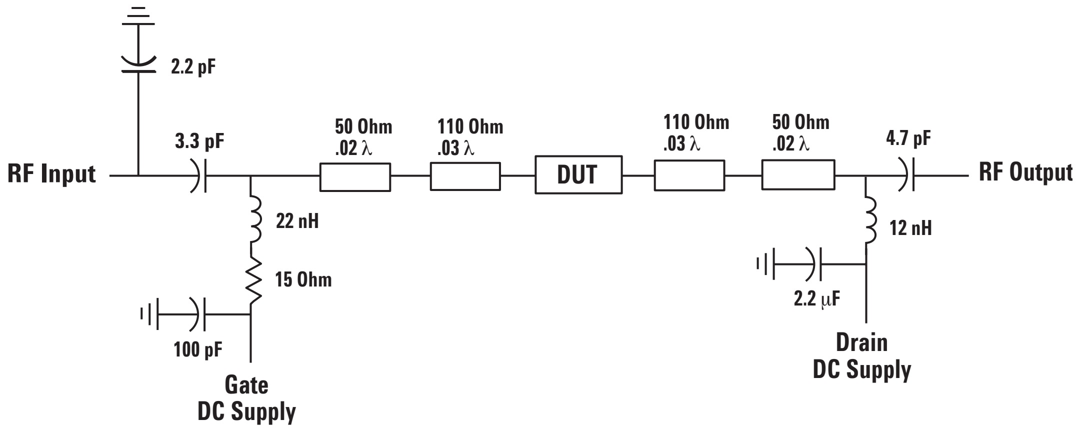



**Figure 7. Simplified schematic of production test board. Primary purpose is to show 15 Ohm series resistor placement in gate supply. Transmission line tapers, tee intersections, bias lines and parasitic values are not shown.**

## Gamma Load and Source at Optimum OIP3 Tuning Conditions

The device's optimum OIP3 measurements were determined using a Maury load pull system at 4V, 135 mA quiesent bias. The gamma load and source over frequency are shown in the table below:

| Freq (GHz) | Gamma Source Mag | Gamma Source Ang | Gamma Load Mag | Gamma Load Ang | OIP3 (dBm) | Gain (dB) | P1dB (dBm) | PAE (%) |
|---|---|---|---|---|---|---|---|---|
| 0.9 | 0.616 | -37.1 | 0.249 | 130.0 | 40.3 | 16.5 | 23.4 | 43.2 |
| 2.0 | 0.310 | 34.5 | 0.285 | 168.3 | 41.5 | 13.4 | 24.8 | 51.9 |
| 3.9 | 0.421 | 167.5 | 0.437 | -161.6 | 41.5 | 10.5 | 24.7 | 42.8 |
| 5.8 | 0.402 | -162.8 | 0.418 | -134.1 | 41.0 | 7.9 | 24.7 | 36.6 |

## ATF-531P8 Typical Performance Curves (at 25°C unless specified otherwise)
## Tuned for Optimal OIP3

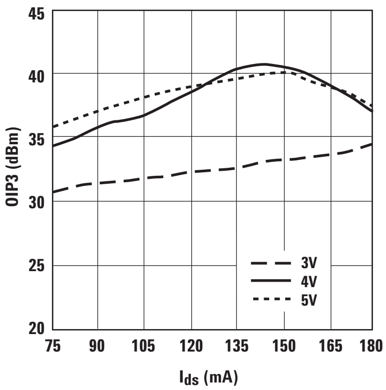



Figure 8. OIP3 vs. $I_{ds}$ and $V_{ds}$ at 900 MHz.

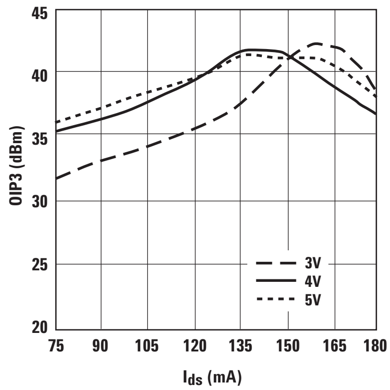



Figure 9. OIP3 vs. $I_{ds}$ and $V_{ds}$ at 2 GHz.

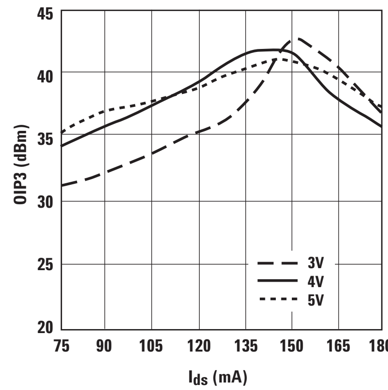



Figure 10. OIP3 vs. $I_{ds}$ and $V_{ds}$ at 3.9 GHz.

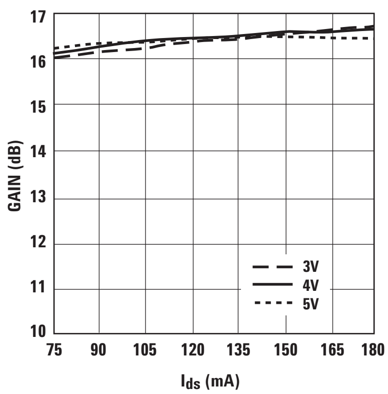



Figure 11. Small Signal Gain vs. $I_{ds}$ and $V_{ds}$ at 900 MHz.

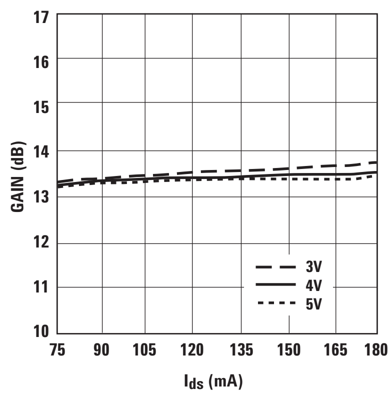



Figure 12. Small Signal Gain vs. $I_{ds}$ and $V_{ds}$ at 2 GHz.

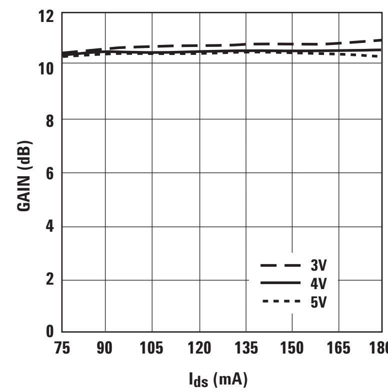



Figure 13. Small Signal Gain vs. $I_{ds}$ and $V_{ds}$ at 3.9 GHz.

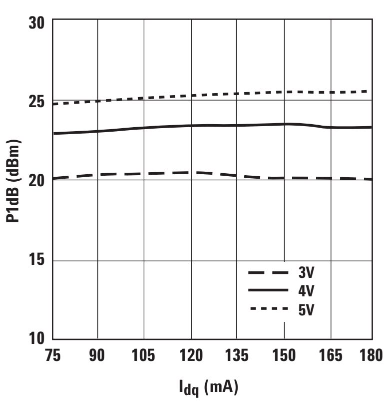



Figure 14. P1dB vs. $I_{dq}$ and $V_{ds}$ at 900 MHz.

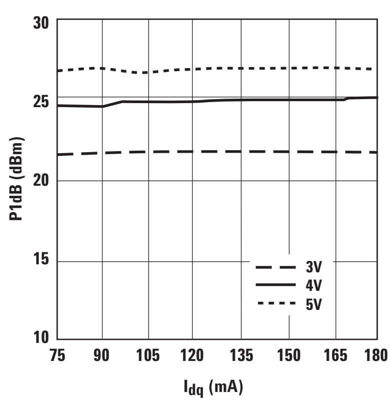



Figure 15. P1dB vs. $I_{dq}$ and $V_{ds}$ at 2 GHz.

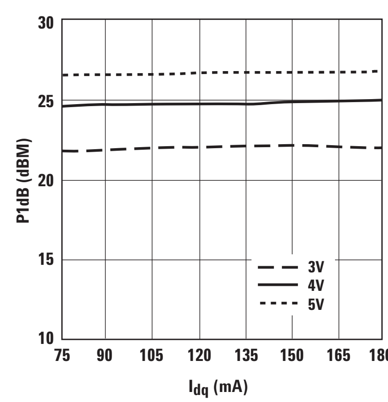



Figure 16. P1dB vs. $I_{dq}$ and $V_{ds}$ at 3.9 GHz.

**Note:**
Bias current for the above charts are quiescent conditions. Actual level may increase or decrease depending on amount of RF drive. The objective of load pull is to optimize OIP3 and therefore may trade-off Small Signal Gain, P1dB and VSWR.

## ATF-531P8 Typical Performance Curves, continued (at 25°C unless specified otherwise)
## Tuned for Optimal OIP3

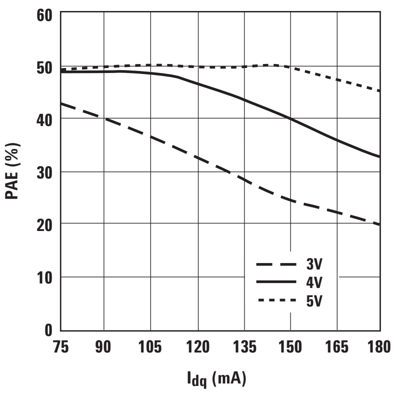



Figure 17. PAE vs. $I_{dq}$ and $V_{ds}$ at 900 MHz.

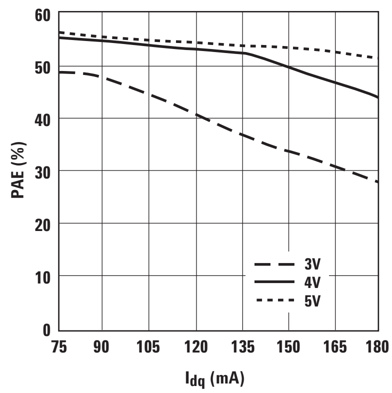



Figure 18. PAE vs. $I_{dq}$ and $V_{ds}$ at 2 GHz.

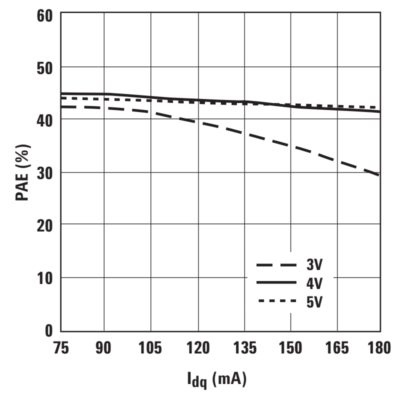



Figure 19. PAE vs. $I_{dq}$ and $V_{ds}$ at 3.9 GHz.

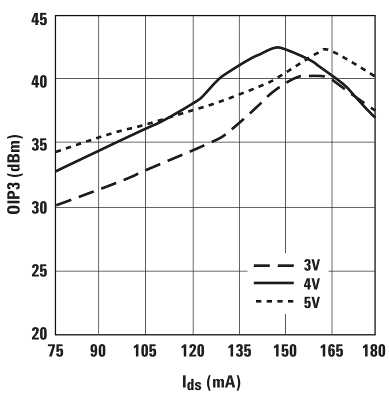



Figure 20. OIP3 vs. $I_{ds}$ and $V_{ds}$ at 5.8 GHz.

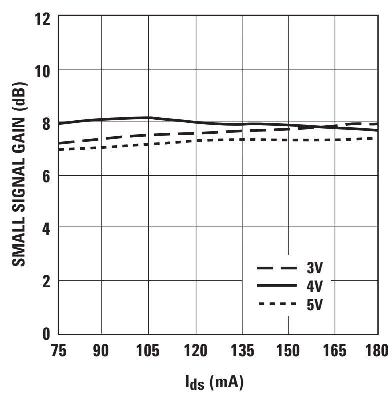



Figure 21. Small Signal Gain vs. $I_{ds}$ and $V_{ds}$ at 5.8 GHz.

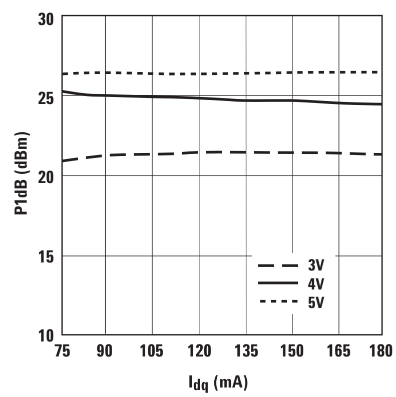



Figure 22. P1dB vs. $I_{dq}$ and $V_{ds}$ at 5.8 GHz.

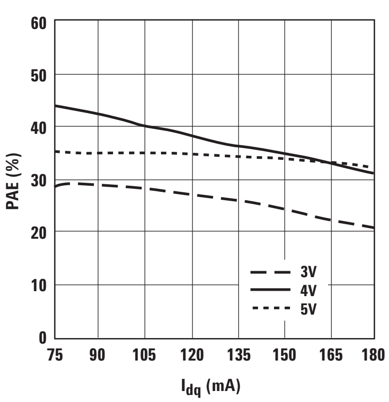



Figure 23. PAE vs. $I_{dq}$ and $V_{ds}$ at 5.8 GHz.

**Note:**
Bias current for the above charts are quiescent conditions. Actual level may increase or decrease depending on amount of RF drive. The objective of load pull is to optimize OIP3 and therefore may trade-off Small Signal Gain, P1dB and VSWR.

## ATF-531P8 Typical Performance Curves (at 25°C unless specified otherwise) Tuned for Optimal OIP3, continued

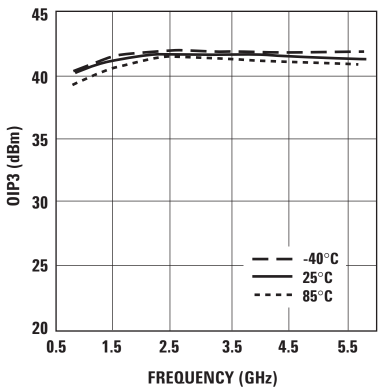



**Figure 24. OIP3 vs. Temp and Freq. (Tuned for optimal OIP3 at 4V, 135 mA)**

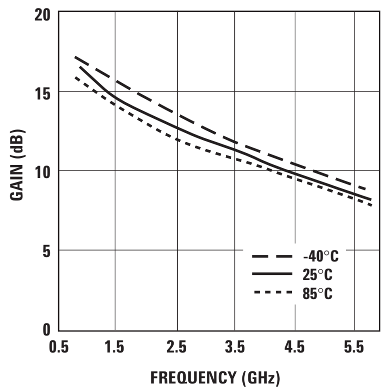



**Figure 25. Small Signal Gain vs. Temp and Freq. (Tuned for optimal OIP3 at 4V, 135 mA)**

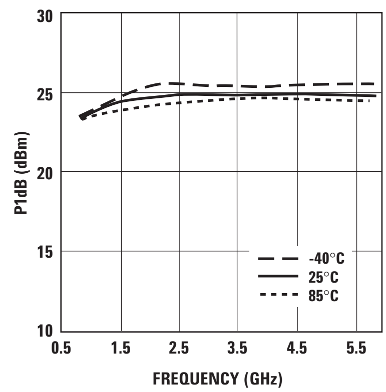



**Figure 26. P1dB vs. Temp and Freq. (Tuned for optimal OIP3 at 4V, 135 mA)**

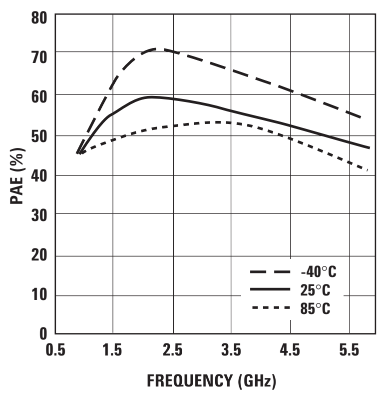



**Figure 27. PAE vs. Temp and Freq. (Tuned for optimal OIP3 at 4V, 135 mA)**

**Note:**

Bias current for the above charts are quiescent conditions. Actual level may increase or decrease depending on amount of RF drive. The objective of load pull is to optimize OIP3 and therefore may trade-off Small Signal Gain, P1dB and VSWR.

## ATF-531P8 Typical Scattering Parameters at 25°C, $V_{DS}$ = 4V, $I_{DS}$ = 180 mA

| Freq. GHz | $S_{11}$ Mag. | $S_{11}$ Ang. | $S_{21}$ dB | $S_{21}$ Mag. | $S_{21}$ Ang. | $S_{12}$ dB | $S_{12}$ Mag. | $S_{12}$ Ang. | $S_{22}$ Mag. | $S_{22}$ Ang. | MSG/MAG dB |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.1 | 0.626 | -59.4 | 33.20 | 45.702 | 154.5 | -40.00 | 0.010 | 62.6 | 0.410 | -44.4 | 36.60 |
| 0.2 | 0.704 | -97.4 | 31.41 | 37.192 | 135.8 | -35.92 | 0.016 | 48.8 | 0.384 | -79.2 | 33.66 |
| 0.3 | 0.761 | -119.4 | 29.53 | 29.950 | 123.5 | -34.42 | 0.019 | 39.1 | 0.370 | -101.8 | 31.98 |
| 0.4 | 0.794 | -133.8 | 27.78 | 24.477 | 114.8 | -33.56 | 0.021 | 33.7 | 0.360 | -117.6 | 30.67 |
| 0.5 | 0.815 | -142.5 | 26.32 | 20.693 | 108.9 | -32.77 | 0.023 | 30.0 | 0.355 | -127.1 | 29.54 |
| 0.6 | 0.824 | -149.6 | 24.99 | 17.760 | 103.9 | -32.77 | 0.023 | 27.4 | 0.351 | -135.5 | 28.88 |
| 0.7 | 0.834 | -155.1 | 23.82 | 15.516 | 99.9 | -32.40 | 0.024 | 25.8 | 0.349 | -141.9 | 28.11 |
| 0.8 | 0.840 | -159.7 | 22.76 | 13.742 | 96.6 | -32.40 | 0.024 | 24.6 | 0.349 | -146.9 | 27.58 |
| 0.9 | 0.845 | -163.3 | 21.83 | 12.346 | 93.6 | -32.04 | 0.025 | 24.2 | 0.349 | -151.1 | 26.94 |
| 1 | 0.848 | -166.4 | 20.96 | 11.164 | 91.0 | -32.04 | 0.025 | 23.8 | 0.347 | -154.3 | 26.50 |
| 1.5 | 0.854 | -177.7 | 17.59 | 7.579 | 80.6 | -31.37 | 0.027 | 23.5 | 0.344 | -165.8 | 24.48 |
| 1.9 | 0.857 | 175.9 | 15.60 | 6.024 | 73.9 | -30.75 | 0.029 | 24.4 | 0.344 | -171.2 | 23.17 |
| 2 | 0.853 | 174.4 | 15.36 | 5.863 | 72.6 | -30.46 | 0.030 | 24.9 | 0.335 | -171.8 | 22.91 |
| 2.4 | 0.853 | 168.9 | 13.79 | 4.894 | 66.5 | -29.90 | 0.032 | 25.8 | 0.339 | -176.8 | 21.85 |
| 3 | 0.855 | 161.6 | 11.83 | 3.902 | 57.9 | -29.12 | 0.035 | 26.6 | 0.337 | 177.0 | 19.60 |
| 4 | 0.858 | 150.8 | 9.27 | 2.906 | 44.6 | -27.74 | 0.041 | 26.5 | 0.356 | 168.5 | 16.23 |
| 5 | 0.864 | 140.7 | 7.20 | 2.292 | 31.6 | -26.56 | 0.047 | 24.3 | 0.378 | 160.6 | 14.19 |
| 6 | 0.871 | 131.7 | 5.48 | 1.879 | 19.4 | -25.35 | 0.054 | 21.2 | 0.402 | 152.4 | 12.69 |
| 7 | 0.869 | 123.5 | 4.04 | 1.593 | 7.5 | -24.29 | 0.061 | 17.4 | 0.427 | 144.6 | 11.18 |
| 8 | 0.880 | 115.2 | 2.73 | 1.370 | -4.3 | -23.35 | 0.068 | 12.6 | 0.449 | 136.1 | 10.39 |
| 9 | 0.883 | 106.8 | 1.77 | 1.226 | -16.1 | -22.27 | 0.077 | 7.0 | 0.465 | 127.4 | 9.70 |
| 10 | 0.884 | 95.7 | 0.70 | 1.084 | -29.0 | -21.41 | 0.085 | -0.8 | 0.489 | 116.6 | 8.70 |
| 11 | 0.874 | 85.1 | -0.34 | 0.962 | -41.6 | -20.63 | 0.093 | -8.8 | 0.505 | 106.0 | 7.20 |
| 12 | 0.874 | 74.1 | -1.39 | 0.852 | -52.8 | -19.91 | 0.101 | -16.6 | 0.544 | 97.2 | 6.30 |
| 13 | 0.877 | 63.3 | -2.52 | 0.748 | -64.5 | -19.49 | 0.106 | -24.6 | 0.596 | 85.9 | 5.46 |
| 14 | 0.884 | 57.9 | -3.64 | 0.658 | -74.6 | -19.02 | 0.112 | -31.9 | 0.638 | 74.7 | 4.95 |
| 15 | 0.894 | 46.8 | -4.81 | 0.575 | -85.4 | -18.71 | 0.116 | -39.8 | 0.662 | 65.9 | 4.29 |
| 16 | 0.896 | 43.3 | -5.66 | 0.521 | -93.6 | -18.49 | 0.119 | -47.8 | 0.699 | 56.1 | 4.06 |
| 17 | 0.898 | 31.9 | -7.25 | 0.434 | -102.6 | -18.49 | 0.119 | -55.1 | 0.748 | 47.7 | 2.82 |
| 18 | 0.918 | 20.8 | -8.61 | 0.371 | -110.5 | -18.94 | 0.113 | -62.6 | 0.718 | 39.3 | 1.75 |

## Typical Noise Parameters at 25°C, $V_{DS}$ = 4V, $I_{DS}$ = 180 mA

| Freq GHz | $F_{min}$ dB | $\Gamma_{opt}$ Mag. | $\Gamma_{opt}$ Ang. | $R_{n/50}$ | $G_a$ dB |
|---|---|---|---|---|---|
| 0.5 | 0.50 | 0.20 | 166.00 | 0.041 | 28.26 |
| 0.9 | 0.59 | 0.25 | 169.00 | 0.044 | 24.27 |
| 1 | 0.60 | 0.35 | 171.00 | 0.036 | 24.15 |
| 1.5 | 0.72 | 0.40 | 173.00 | 0.039 | 21.14 |
| 2 | 0.81 | 0.57 | -173.50 | 0.029 | 20.07 |
| 2.4 | 0.90 | 0.61 | -167.70 | 0.033 | 18.73 |
| 3 | 1.01 | 0.63 | -163.50 | 0.041 | 16.91 |
| 3.5 | 1.10 | 0.67 | -158.20 | 0.054 | 15.86 |
| 3.9 | 1.13 | 0.70 | -153.90 | 0.068 | 15.12 |
| 5 | 1.34 | 0.72 | -142.70 | 0.139 | 13.08 |
| 5.8 | 1.48 | 0.75 | -135.40 | 0.229 | 12.04 |
| 6 | 1.58 | 0.76 | -133.30 | 0.278 | 11.82 |
| 7 | 1.68 | 0.80 | -125.00 | 0.470 | 10.69 |
| 8 | 1.89 | 0.84 | -116.10 | 0.860 | 9.97 |
| 9 | 2.15 | 0.82 | -106.90 | 1.170 | 8.96 |
| 10 | 2.34 | 0.85 | -95.10 | 2.010 | 8.09 |

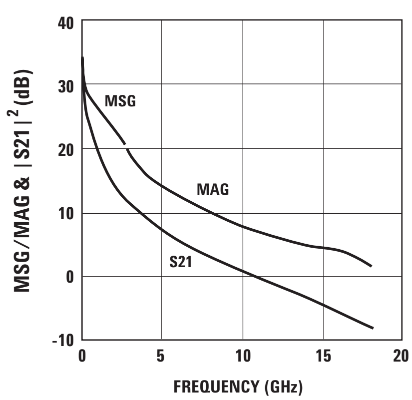



**Figure 28. MSG/MAG & $|S21|^2$ (dB) @ 4V, 180 mA.**

**Notes:**

1. $F_{min}$ values at 2 GHz and higher are based on measurements while the $F_{mins}$ below 2 GHz have been extrapolated. The $F_{min}$ values are based on a set of 16 noise figure measurements made at 16 different impedances using an ATN NP5 test system. From these measurements a true $F_{min}$ is calculated.
2. S and noise parameters are measured on a microstrip line made on 0.025 inch thick alumina carrier. The input reference plane is at the end of the gate lead. The output reference plane is at the end of the drain lead.

## ATF-531P8 Typical Scattering Parameters, $V_{DS} = 4V$, $I_{DS} = 135$ mA

| Freq. GHz | S11 Mag. | S11 Ang. | S21 dB | S21 Mag. | S21 Ang. | S12 dB | S12 Mag. | S12 Ang. | S22 Mag. | S22 Ang. | MSG/MAG dB |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.1 | 0.812 | -56.4 | 34.07 | 50.547 | 151.8 | -38.42 | 0.012 | 62.6 | 0.449 | -49.1 | 36.25 |
| 0.2 | 0.820 | -94.6 | 31.95 | 39.582 | 132.2 | -34.89 | 0.018 | 45.8 | 0.425 | -85.0 | 33.42 |
| 0.3 | 0.834 | -117.3 | 29.87 | 31.147 | 120.2 | -33.15 | 0.022 | 36.5 | 0.397 | -108.1 | 31.51 |
| 0.4 | 0.842 | -132.4 | 27.99 | 25.104 | 111.8 | -32.40 | 0.024 | 30.5 | 0.385 | -123.7 | 30.20 |
| 0.5 | 0.846 | -141.4 | 26.46 | 21.036 | 106.3 | -32.04 | 0.025 | 27.0 | 0.379 | -132.5 | 29.25 |
| 0.6 | 0.849 | -148.7 | 25.08 | 17.954 | 101.6 | -31.70 | 0.026 | 24.8 | 0.375 | -140.4 | 28.39 |
| 0.7 | 0.853 | -154.4 | 23.88 | 15.628 | 97.9 | -31.70 | 0.026 | 23.2 | 0.372 | -146.4 | 27.79 |
| 0.8 | 0.853 | -159.0 | 22.80 | 13.809 | 94.8 | -31.37 | 0.027 | 22.4 | 0.372 | -151.0 | 27.09 |
| 0.9 | 0.855 | -162.7 | 21.85 | 12.376 | 92.0 | -31.37 | 0.027 | 21.7 | 0.371 | -154.9 | 26.61 |
| 1 | 0.857 | -166.0 | 20.97 | 11.186 | 89.6 | -31.37 | 0.027 | 21.2 | 0.369 | -157.9 | 26.17 |
| 1.5 | 0.857 | -177.3 | 17.58 | 7.568 | 79.7 | -30.75 | 0.029 | 21.4 | 0.366 | -168.7 | 24.17 |
| 1.9 | 0.857 | 176.2 | 15.57 | 6.007 | 73.3 | -30.17 | 0.031 | 21.7 | 0.366 | -174.2 | 22.87 |
| 2 | 0.853 | 174.7 | 15.34 | 5.847 | 72.0 | -29.90 | 0.032 | 22.5 | 0.347 | -174.8 | 22.62 |
| 2.4 | 0.852 | 169.2 | 13.77 | 4.879 | 66.0 | -29.37 | 0.034 | 23.0 | 0.351 | -179.7 | 21.57 |
| 3 | 0.853 | 161.7 | 11.80 | 3.889 | 57.6 | -28.64 | 0.037 | 24.1 | 0.358 | 174.2 | 20.22 |
| 4 | 0.857 | 150.8 | 9.24 | 2.896 | 44.6 | -27.54 | 0.042 | 23.9 | 0.375 | 165.7 | 16.28 |
| 5 | 0.861 | 140.9 | 7.18 | 2.285 | 31.8 | -26.38 | 0.048 | 22.2 | 0.396 | 157.8 | 14.11 |
| 6 | 0.866 | 131.6 | 5.45 | 1.873 | 19.7 | -25.19 | 0.055 | 18.6 | 0.417 | 149.6 | 12.50 |
| 7 | 0.867 | 123.5 | 4.02 | 1.589 | 7.9 | -24.29 | 0.061 | 15.1 | 0.440 | 141.8 | 11.10 |
| 8 | 0.875 | 115.1 | 2.72 | 1.367 | -3.8 | -23.22 | 0.069 | 10.4 | 0.459 | 133.4 | 10.16 |
| 9 | 0.877 | 106.9 | 1.76 | 1.224 | -15.3 | -22.16 | 0.078 | 4.8 | 0.474 | 124.8 | 9.40 |
| 10 | 0.884 | 95.6 | 0.71 | 1.085 | -28.2 | -21.31 | 0.086 | -2.6 | 0.496 | 114.1 | 8.69 |
| 11 | 0.889 | 85.3 | -0.34 | 0.962 | -41.0 | -20.63 | 0.093 | -10.7 | 0.511 | 103.7 | 7.93 |
| 12 | 0.872 | 73.9 | -1.33 | 0.858 | -51.7 | -19.91 | 0.101 | -18.3 | 0.548 | 95.1 | 6.24 |
| 13 | 0.878 | 63.6 | -2.48 | 0.752 | -64.0 | -19.58 | 0.105 | -26.2 | 0.600 | 84.0 | 5.55 |
| 14 | 0.886 | 57.6 | -3.57 | 0.663 | -73.7 | -19.02 | 0.112 | -33.3 | 0.640 | 73.1 | 5.05 |
| 15 | 0.902 | 47.2 | -4.66 | 0.585 | -84.8 | -18.79 | 0.115 | -42.0 | 0.663 | 64.4 | 4.93 |
| 16 | 0.902 | 43.7 | -5.56 | 0.527 | -91.3 | -18.49 | 0.119 | -49.2 | 0.698 | 54.7 | 4.37 |
| 17 | 0.895 | 32.1 | -6.99 | 0.447 | -101.9 | -18.49 | 0.119 | -56.7 | 0.746 | 46.5 | 2.93 |
| 18 | 0.932 | 20.6 | -8.75 | 0.365 | -109.6 | -18.94 | 0.113 | -63.9 | 0.716 | 38.2 | 2.36 |

## Typical Noise Parameters, $V_{DS} = 4V$, $I_{DS} = 135$ mA

| Freq GHz | $F_{min}$ dB | $\Gamma_{opt}$ Mag. | $\Gamma_{opt}$ Ang. | $R_{n/50}$ | $G_a$ dB |
|---|---|---|---|---|---|
| 0.5 | 0.18 | 0.20 | 166.00 | 0.014 | 28.57 |
| 0.9 | 0.26 | 0.25 | 169.00 | 0.018 | 24.42 |
| 1 | 0.35 | 0.35 | 171.00 | 0.021 | 24.32 |
| 1.5 | 0.40 | 0.40 | 173.00 | 0.021 | 21.25 |
| 2 | 0.51 | 0.47 | 177.20 | 0.022 | 19.35 |
| 2.4 | 0.56 | 0.51 | -174.50 | 0.022 | 17.66 |
| 3 | 0.60 | 0.56 | -169.30 | 0.023 | 16.37 |
| 3.5 | 0.73 | 0.60 | -162.90 | 0.030 | 15.09 |
| 3.9 | 0.83 | 0.66 | -157.60 | 0.040 | 14.82 |
| 5 | 1.03 | 0.68 | -145.50 | 0.085 | 12.76 |
| 5.8 | 1.15 | 0.72 | -137.10 | 0.140 | 11.55 |
| 6 | 1.20 | 0.72 | -135.20 | 0.160 | 11.31 |
| 7 | 1.34 | 0.78 | -126.70 | 0.300 | 10.55 |
| 8 | 1.57 | 0.83 | -117.00 | 0.630 | 9.81 |
| 9 | 1.78 | 0.82 | -107.90 | 0.880 | 8.86 |
| 10 | 1.83 | 0.85 | -95.70 | 1.460 | 8.17 |

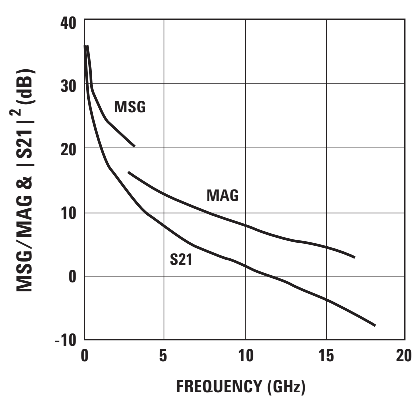



**Figure 29. MSG/MAG & $|S21|^2$ (dB) @ 4V, 135 mA.**

**Notes:**

1. $F_{min}$ values at 2 GHz and higher are based on measurements while the $F_{mins}$ below 2 GHz have been extrapolated. The $F_{min}$ values are based on a set of 16 noise figure measurements made at 16 different impedances using an ATN NP5 test system. From these measurements a true $F_{min}$ is calculated.
2. S and noise parameters are measured on a microstrip line made on 0.025 inch thick alumina carrier. The input reference plane is at the end of the gate lead. The output reference plane is at the end of the drain lead.

## ATF-531P8 Typical Scattering Parameters, $V_{DS} = 4V$, $I_{DS} = 75$ mA

| Freq. GHz | S11 Mag. | S11 Ang. | S21 dB | S21 Mag. | S21 Ang. | S12 dB | S12 Mag. | S12 Ang. | S22 Mag. | S22 Ang. | MSG/MAG dB |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.1 | 0.930 | -51.3 | 33.70 | 48.399 | 152.3 | -37.08 | 0.014 | 63.6 | 0.524 | -45.7 | 35.39 |
| 0.2 | 0.889 | -88.3 | 31.65 | 38.230 | 132.6 | -32.77 | 0.023 | 46.8 | 0.467 | -80.7 | 32.21 |
| 0.3 | 0.876 | -111.6 | 29.58 | 30.121 | 120.6 | -31.37 | 0.027 | 36.1 | 0.436 | -103.2 | 30.48 |
| 0.4 | 0.867 | -127.3 | 27.71 | 24.294 | 112.2 | -30.75 | 0.029 | 29.5 | 0.415 | -119.1 | 29.23 |
| 0.5 | 0.862 | -137.0 | 26.18 | 20.379 | 106.6 | -30.46 | 0.030 | 25.9 | 0.405 | -128.4 | 28.32 |
| 0.6 | 0.858 | -144.7 | 24.81 | 17.405 | 101.9 | -30.17 | 0.031 | 23.1 | 0.397 | -136.8 | 27.49 |
| 0.7 | 0.857 | -151.0 | 23.62 | 15.165 | 98.2 | -29.90 | 0.032 | 21.1 | 0.392 | -143.2 | 26.76 |
| 0.8 | 0.856 | -156.0 | 22.54 | 13.404 | 95.0 | -29.90 | 0.032 | 19.9 | 0.390 | -148.2 | 26.22 |
| 0.9 | 0.854 | -160.0 | 21.59 | 12.005 | 92.2 | -29.63 | 0.033 | 18.3 | 0.387 | -152.3 | 25.61 |
| 1 | 0.857 | -163.5 | 20.72 | 10.859 | 89.8 | -29.63 | 0.033 | 18.2 | 0.384 | -155.6 | 25.17 |
| 1.5 | 0.853 | -175.7 | 17.33 | 7.351 | 79.8 | -29.12 | 0.035 | 16.3 | 0.380 | -167.2 | 23.22 |
| 1.9 | 0.853 | 177.6 | 15.33 | 5.839 | 73.3 | -28.87 | 0.036 | 16.5 | 0.379 | -173.2 | 22.10 |
| 2 | 0.848 | 176.2 | 15.09 | 5.681 | 72.0 | -28.64 | 0.037 | 16.7 | 0.360 | -173.8 | 21.86 |
| 2.4 | 0.846 | 170.3 | 13.52 | 4.742 | 66.0 | -28.18 | 0.039 | 17.0 | 0.363 | -179.0 | 20.85 |
| 3 | 0.848 | 162.4 | 11.55 | 3.780 | 57.5 | -27.74 | 0.041 | 17.0 | 0.369 | 174.6 | 19.65 |
| 4 | 0.850 | 151.6 | 8.98 | 2.813 | 44.3 | -26.94 | 0.045 | 16.7 | 0.385 | 165.7 | 16.29 |
| 5 | 0.853 | 141.4 | 6.93 | 2.220 | 31.5 | -25.85 | 0.051 | 15.4 | 0.405 | 157.5 | 13.90 |
| 6 | 0.861 | 132.3 | 5.22 | 1.824 | 19.4 | -25.04 | 0.056 | 12.9 | 0.426 | 149.2 | 12.31 |
| 7 | 0.861 | 123.8 | 3.78 | 1.546 | 7.5 | -24.01 | 0.063 | 9.8 | 0.447 | 141.3 | 10.85 |
| 8 | 0.868 | 115.6 | 2.50 | 1.334 | -4.3 | -23.22 | 0.069 | 5.5 | 0.467 | 132.8 | 9.85 |
| 9 | 0.873 | 107.1 | 1.51 | 1.190 | -15.9 | -22.16 | 0.078 | 0.4 | 0.481 | 124.1 | 9.15 |
| 10 | 0.875 | 95.8 | 0.50 | 1.059 | -28.8 | -21.41 | 0.085 | -6.6 | 0.501 | 113.3 | 8.19 |
| 11 | 0.881 | 85.6 | -0.57 | 0.937 | -41.2 | -20.63 | 0.093 | -13.8 | 0.515 | 102.9 | 7.40 |
| 12 | 0.871 | 74.2 | -1.56 | 0.836 | -52.5 | -20.00 | 0.100 | -21.4 | 0.553 | 94.5 | 6.12 |
| 13 | 0.873 | 63.7 | -2.65 | 0.737 | -63.9 | -19.66 | 0.104 | -28.8 | 0.604 | 83.4 | 5.28 |
| 14 | 0.885 | 57.0 | -3.80 | 0.646 | -74.0 | -19.17 | 0.110 | -36.3 | 0.644 | 72.5 | 4.89 |
| 15 | 0.891 | 47.0 | -4.72 | 0.581 | -85.2 | -18.79 | 0.115 | -43.7 | 0.666 | 63.7 | 4.38 |
| 16 | 0.912 | 43.7 | -5.76 | 0.515 | -93.5 | -18.56 | 0.118 | -51.7 | 0.700 | 54.2 | 5.43 |
| 17 | 0.895 | 32.2 | -7.15 | 0.439 | -102.3 | -18.49 | 0.119 | -58.5 | 0.748 | 46.0 | 2.90 |
| 18 | 0.933 | 21.2 | -8.66 | 0.369 | -110.5 | -19.02 | 0.112 | -65.8 | 0.718 | 37.8 | 2.74 |

## Typical Noise Parameters, $V_{DS} = 4V$, $I_{DS} = 75$ mA

| Freq GHz | $F_{min}$ dB | $\Gamma_{opt}$ Mag. | $\Gamma_{opt}$ Ang. | $R_{n/50}$ | $G_a$ dB |
|---|---|---|---|---|---|
| 0.5 | 0.15 | 0.10 | 130.00 | 0.016 | 27.97 |
| 0.9 | 0.20 | 0.15 | 135.00 | 0.019 | 23.50 |
| 1 | 0.22 | 0.20 | 143.00 | 0.019 | 23.02 |
| 1.5 | 0.30 | 0.30 | 148.00 | 0.022 | 20.07 |
| 2 | 0.36 | 0.35 | 154.10 | 0.024 | 17.85 |
| 2.4 | 0.44 | 0.43 | 168.70 | 0.022 | 16.35 |
| 3 | 0.50 | 0.47 | 179.30 | 0.022 | 15.29 |
| 3.5 | 0.55 | 0.58 | -170.80 | 0.019 | 14.11 |
| 3.9 | 0.63 | 0.60 | -164.80 | 0.024 | 14.01 |
| 5 | 0.80 | 0.67 | -150.90 | 0.050 | 11.92 |
| 5.8 | 0.90 | 0.72 | -140.80 | 0.095 | 11.00 |
| 6 | 0.91 | 0.72 | -139.50 | 0.100 | 10.56 |
| 7 | 1.14 | 0.71 | -129.10 | 0.180 | 9.80 |
| 8 | 1.24 | 0.74 | -119.90 | 0.285 | 9.31 |
| 9 | 1.49 | 0.74 | -109.70 | 0.460 | 8.41 |
| 10 | 1.61 | 0.76 | -97.30 | 0.720 | 7.73 |

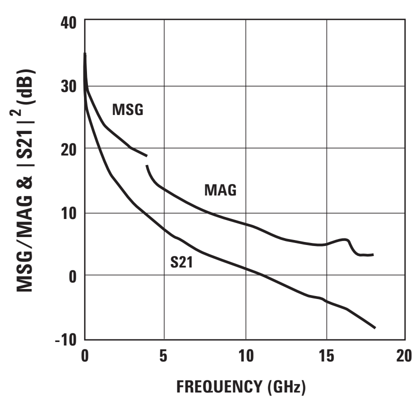



**Figure 30. MSG/MAG & $|S21|^2$ (dB) @ 4V, 75 mA.**

**Notes:**

1. $F_{min}$ values at 2 GHz and higher are based on measurements while the $F_{mins}$ below 2 GHz have been extrapolated. The $F_{min}$ values are based on a set of 16 noise figure measurements made at 16 different impedances using an ATN NP5 test system. From these measurements a true $F_{min}$ is calculated.
2. S and noise parameters are measured on a microstrip line made on 0.025 inch thick alumina carrier. The input reference plane is at the end of the gate lead. The output reference plane is at the end of the drain lead.

## ATF-531P8 Typical Scattering Parameters, $V_{DS} = 5V$, $I_{DS} = 135$ mA

| Freq. GHz | $S_{11}$ Mag. | $S_{11}$ Ang. | $S_{21}$ dB | $S_{21}$ Mag. | $S_{21}$ Ang. | $S_{12}$ dB | $S_{12}$ Mag. | $S_{12}$ Ang. | $S_{22}$ Mag. | $S_{22}$ Ang. | MSG/MAG dB |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.1 | 0.805 | -56.0 | 34.11 | 50.734 | 152.1 | -39.17 | 0.011 | 62.6 | 0.468 | -45.2 | 36.64 |
| 0.2 | 0.815 | -94.0 | 32.03 | 39.967 | 132.6 | -34.89 | 0.018 | 46.6 | 0.419 | -79.7 | 33.46 |
| 0.3 | 0.831 | -116.9 | 29.97 | 31.517 | 120.5 | -33.56 | 0.021 | 36.3 | 0.387 | -102.0 | 31.76 |
| 0.4 | 0.839 | -131.7 | 28.10 | 25.418 | 112.1 | -32.77 | 0.023 | 30.7 | 0.364 | -117.9 | 30.43 |
| 0.5 | 0.844 | -140.9 | 26.58 | 21.322 | 106.4 | -32.40 | 0.024 | 27.2 | 0.354 | -127.0 | 29.49 |
| 0.6 | 0.846 | -148.3 | 25.20 | 18.207 | 101.8 | -32.04 | 0.025 | 24.9 | 0.346 | -135.4 | 28.62 |
| 0.7 | 0.850 | -154.0 | 24.00 | 15.852 | 98.0 | -31.70 | 0.026 | 23.3 | 0.342 | -141.6 | 27.85 |
| 0.8 | 0.852 | -158.7 | 22.93 | 14.014 | 94.8 | -31.70 | 0.026 | 22.3 | 0.339 | -146.5 | 27.32 |
| 0.9 | 0.855 | -162.5 | 21.98 | 12.559 | 92.0 | -31.70 | 0.026 | 21.6 | 0.337 | -150.5 | 26.84 |
| 1 | 0.854 | -165.6 | 21.10 | 11.351 | 89.6 | -31.37 | 0.027 | 20.9 | 0.335 | -153.9 | 26.24 |
| 1.5 | 0.855 | -177.1 | 17.71 | 7.681 | 79.5 | -31.06 | 0.028 | 21.1 | 0.331 | -165.0 | 24.38 |
| 1.9 | 0.857 | 176.3 | 15.71 | 6.099 | 73.0 | -30.46 | 0.030 | 22.3 | 0.331 | -170.4 | 23.08 |
| 2 | 0.851 | 174.9 | 15.46 | 5.931 | 71.7 | -30.17 | 0.031 | 22.3 | 0.336 | -170.9 | 22.82 |
| 2.4 | 0.851 | 169.4 | 13.89 | 4.946 | 65.6 | -29.63 | 0.033 | 23.3 | 0.315 | -175.8 | 21.76 |
| 3 | 0.852 | 161.8 | 11.92 | 3.943 | 57.1 | -29.12 | 0.035 | 24.3 | 0.323 | 178.2 | 19.82 |
| 4 | 0.857 | 151.1 | 9.35 | 2.935 | 43.9 | -27.74 | 0.041 | 24.4 | 0.343 | 169.9 | 16.43 |
| 5 | 0.859 | 141.0 | 7.30 | 2.318 | 30.9 | -26.56 | 0.047 | 22.8 | 0.367 | 162.1 | 14.19 |
| 6 | 0.870 | 131.8 | 5.57 | 1.899 | 18.5 | -25.51 | 0.053 | 19.7 | 0.391 | 154.0 | 12.82 |
| 7 | 0.867 | 123.6 | 4.11 | 1.605 | 6.5 | -24.44 | 0.060 | 16.3 | 0.417 | 146.2 | 11.24 |
| 8 | 0.877 | 115.6 | 2.80 | 1.381 | -5.2 | -23.48 | 0.067 | 11.8 | 0.440 | 137.7 | 10.41 |
| 9 | 0.881 | 106.7 | 1.82 | 1.233 | -17.0 | -22.38 | 0.076 | 6.1 | 0.458 | 129.1 | 9.75 |
| 10 | 0.885 | 95.6 | 0.75 | 1.090 | -30.1 | -21.41 | 0.085 | -1.3 | 0.482 | 118.1 | 8.94 |
| 11 | 0.892 | 85.2 | -0.30 | 0.966 | -42.9 | -20.72 | 0.092 | -9.1 | 0.500 | 107.5 | 8.31 |
| 12 | 0.875 | 74.2 | -1.33 | 0.858 | -54.3 | -20.00 | 0.100 | -17.0 | 0.540 | 98.6 | 6.52 |
| 13 | 0.883 | 63.8 | -2.49 | 0.751 | -65.9 | -19.66 | 0.104 | -24.8 | 0.593 | 87.1 | 5.87 |
| 14 | 0.886 | 57.9 | -3.58 | 0.662 | -76.4 | -19.09 | 0.111 | -31.8 | 0.636 | 75.8 | 5.23 |
| 15 | 0.913 | 47.4 | -4.78 | 0.577 | -86.8 | -18.71 | 0.116 | -40.3 | 0.660 | 66.8 | 6.01 |
| 16 | 0.908 | 43.1 | -5.81 | 0.512 | -94.4 | -18.56 | 0.118 | -47.8 | 0.699 | 57.0 | 4.78 |
| 17 | 0.891 | 32.2 | -6.99 | 0.447 | -105.1 | -18.49 | 0.119 | -54.9 | 0.747 | 48.4 | 2.98 |
| 18 | 0.928 | 20.6 | -8.64 | 0.370 | -112.1 | -18.86 | 0.114 | -62.6 | 0.717 | 39.9 | 2.41 |

## Typical Noise Parameters, $V_{DS} = 5V$, $I_{DS} = 135$ mA

| Freq GHz | $F_{min}$ dB | $\Gamma_{opt}$ Mag. | $\Gamma_{opt}$ Ang. | $R_{n/50}$ | $G_a$ dB |
|---|---|---|---|---|---|
| 0.5 | 0.45 | 0.20 | 154.00 | 0.037 | 28.85 |
| 0.9 | 0.48 | 0.32 | 160.00 | 0.032 | 25.13 |
| 1 | 0.50 | 0.35 | 166.00 | 0.030 | 24.43 |
| 1.5 | 0.55 | 0.40 | 170.00 | 0.030 | 21.26 |
| 2 | 0.65 | 0.46 | 177.40 | 0.030 | 19.38 |
| 2.4 | 0.70 | 0.49 | -175.10 | 0.032 | 17.90 |
| 3 | 0.77 | 0.55 | -168.90 | 0.031 | 16.33 |
| 3.5 | 0.84 | 0.58 | -162.60 | 0.037 | 15.23 |
| 3.9 | 0.90 | 0.62 | -158.20 | 0.043 | 14.60 |
| 5 | 1.06 | 0.66 | -145.80 | 0.085 | 12.66 |
| 5.8 | 1.20 | 0.69 | -137.30 | 0.140 | 11.60 |
| 6 | 1.19 | 0.69 | -135.40 | 0.150 | 11.38 |
| 7 | 1.40 | 0.77 | -126.50 | 0.320 | 10.55 |
| 8 | 1.52 | 0.81 | -117.90 | 0.550 | 9.84 |
| 9 | 1.75 | 0.82 | -107.50 | 0.890 | 9.05 |
| 10 | 1.88 | 0.85 | -95.60 | 1.530 | 8.29 |

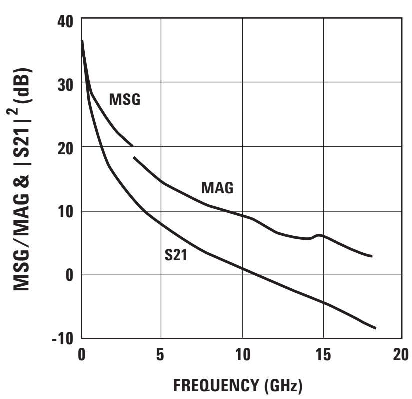



**Figure 31. MSG/MAG & $|S21|^2$ (dB) @ 5V, 135 mA.**

**Notes:**

1. $F_{min}$ values at 2 GHz and higher are based on measurements while the $F_{mins}$ below 2 GHz have been extrapolated. The $F_{min}$ values are based on a set of 16 noise figure measurements made at 16 different impedances using an ATN NP5 test system. From these measurements a true $F_{min}$ is calculated.
2. S and noise parameters are measured on a microstrip line made on 0.025 inch thick alumina carrier. The input reference plane is at the end of the gate lead. The output reference plane is at the end of the drain lead.

## ATF-531P8 Typical Scattering Parameters, $V_{DS} = 3V$, $I_{DS} = 135$ mA

| Freq. GHz | S11 Mag. | S11 Ang. | S21 dB | S21 Mag. | S21 Ang. | S12 dB | S12 Mag. | S12 Ang. | S22 Mag. | S22 Ang. | MSG/MAG dB |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.1 | 0.823 | -57.1 | 33.96 | 49.888 | 151.3 | -37.72 | 0.013 | 62.6 | 0.427 | -55.1 | 35.84 |
| 0.2 | 0.826 | -95.6 | 31.82 | 38.989 | 131.6 | -33.98 | 0.020 | 45.7 | 0.418 | -92.8 | 32.90 |
| 0.3 | 0.842 | -118.2 | 29.66 | 30.415 | 119.6 | -32.77 | 0.023 | 36.0 | 0.421 | -115.9 | 31.21 |
| 0.4 | 0.846 | -133.1 | 27.75 | 24.416 | 111.4 | -32.04 | 0.025 | 30.1 | 0.420 | -130.7 | 29.90 |
| 0.5 | 0.851 | -142.0 | 26.21 | 20.452 | 105.9 | -31.70 | 0.026 | 26.8 | 0.419 | -139.0 | 28.96 |
| 0.6 | 0.850 | -149.2 | 24.83 | 17.443 | 101.4 | -31.37 | 0.027 | 24.4 | 0.419 | -146.4 | 28.10 |
| 0.7 | 0.855 | -154.9 | 23.62 | 15.178 | 97.7 | -31.37 | 0.027 | 22.9 | 0.419 | -151.9 | 27.50 |
| 0.8 | 0.856 | -159.5 | 22.55 | 13.405 | 94.7 | -31.06 | 0.028 | 22.1 | 0.420 | -156.1 | 26.80 |
| 0.9 | 0.859 | -163.2 | 21.59 | 12.012 | 92.0 | -31.06 | 0.028 | 21.4 | 0.421 | -159.7 | 26.32 |
| 1 | 0.857 | -166.3 | 20.71 | 10.853 | 89.6 | -30.75 | 0.029 | 21.1 | 0.419 | -162.6 | 25.73 |
| 1.5 | 0.857 | -177.7 | 17.32 | 7.342 | 79.9 | -30.46 | 0.030 | 21.0 | 0.418 | -172.9 | 23.89 |
| 1.9 | 0.858 | 175.8 | 15.31 | 5.828 | 73.6 | -29.90 | 0.032 | 21.6 | 0.418 | -178.2 | 22.60 |
| 2 | 0.855 | 174.4 | 15.08 | 5.676 | 72.3 | -29.37 | 0.034 | 22.1 | 0.410 | -179.1 | 22.23 |
| 2.4 | 0.855 | 168.8 | 13.51 | 4.738 | 66.4 | -29.12 | 0.035 | 22.6 | 0.403 | 176.0 | 21.32 |
| 3 | 0.854 | 161.4 | 11.54 | 3.774 | 58.2 | -28.40 | 0.038 | 22.8 | 0.409 | 169.8 | 19.97 |
| 4 | 0.858 | 150.7 | 8.98 | 2.812 | 45.3 | -27.13 | 0.044 | 22.7 | 0.423 | 161.0 | 16.15 |
| 5 | 0.860 | 140.4 | 6.92 | 2.219 | 32.8 | -26.02 | 0.050 | 20.7 | 0.440 | 152.8 | 13.82 |
| 6 | 0.868 | 131.4 | 5.21 | 1.821 | 21.0 | -24.88 | 0.057 | 17.2 | 0.457 | 144.4 | 12.31 |
| 7 | 0.866 | 123.2 | 3.79 | 1.547 | 9.4 | -23.88 | 0.064 | 13.4 | 0.475 | 136.6 | 10.81 |
| 8 | 0.877 | 114.8 | 2.52 | 1.337 | -2.0 | -22.85 | 0.072 | 8.5 | 0.490 | 128.0 | 10.00 |
| 9 | 0.876 | 106.3 | 1.57 | 1.198 | -13.7 | -21.83 | 0.081 | 2.6 | 0.502 | 119.3 | 9.09 |
| 10 | 0.880 | 95.1 | 0.56 | 1.066 | -26.0 | -21.11 | 0.088 | -5.0 | 0.519 | 108.7 | 8.20 |
| 11 | 0.883 | 84.7 | -0.46 | 0.948 | -38.2 | -20.35 | 0.096 | -12.9 | 0.530 | 98.4 | 7.31 |
| 12 | 0.874 | 73.6 | -1.51 | 0.840 | -49.6 | -19.83 | 0.102 | -20.7 | 0.566 | 90.7 | 6.06 |
| 13 | 0.878 | 62.9 | -2.56 | 0.745 | -61.1 | -19.41 | 0.107 | -28.5 | 0.613 | 79.7 | 5.32 |
| 14 | 0.884 | 56.9 | -3.54 | 0.665 | -71.0 | -18.94 | 0.113 | -35.9 | 0.652 | 69.3 | 4.87 |
| 15 | 0.906 | 46.7 | -4.70 | 0.582 | -80.8 | -18.71 | 0.116 | -43.9 | 0.670 | 60.8 | 4.76 |
| 16 | 0.907 | 42.9 | -5.61 | 0.524 | -88.0 | -18.49 | 0.119 | -51.4 | 0.704 | 51.6 | 4.29 |
| 17 | 0.893 | 32.2 | -6.80 | 0.457 | -99.8 | -18.42 | 0.120 | -58.7 | 0.747 | 43.7 | 2.90 |
| 18 | 0.925 | 20.7 | -8.38 | 0.381 | -107.2 | -18.86 | 0.114 | -66.3 | 0.717 | 35.8 | 2.20 |

## Typical Noise Parameters, $V_{DS} = 3V$, $I_{DS} = 135$ mA

| Freq GHz | $F_{min}$ dB | $\Gamma_{opt}$ Mag. | $\Gamma_{opt}$ Ang. | $R_{n/50}$ | $G_a$ dB |
|---|---|---|---|---|---|
| 0.5 | 0.25 | 0.20 | 166.00 | 0.020 | 28.47 |
| 0.9 | 0.30 | 0.25 | 169.00 | 0.022 | 24.36 |
| 1 | 0.30 | 0.35 | 171.00 | 0.018 | 24.24 |
| 1.5 | 0.36 | 0.40 | 173.00 | 0.019 | 21.17 |
| 2 | 0.45 | 0.46 | 176.80 | 0.020 | 19.30 |
| 2.4 | 0.52 | 0.52 | -174.70 | 0.021 | 18.08 |
| 3 | 0.66 | 0.56 | -169.80 | 0.025 | 16.26 |
| 3.5 | 0.70 | 0.62 | -162.80 | 0.028 | 15.33 |
| 3.9 | 0.87 | 0.65 | -157.90 | 0.042 | 14.62 |
| 5 | 1.02 | 0.67 | -145.70 | 0.082 | 12.52 |
| 5.8 | 1.13 | 0.71 | -136.80 | 0.140 | 11.53 |
| 6 | 1.24 | 0.73 | -135.10 | 0.175 | 11.40 |
| 7 | 1.34 | 0.82 | -126.20 | 0.380 | 10.57 |
| 8 | 1.58 | 0.83 | -116.90 | 0.645 | 9.67 |
| 9 | 1.78 | 0.81 | -107.50 | 0.870 | 8.59 |
| 10 | 1.88 | 0.83 | -95.40 | 1.350 | 7.76 |

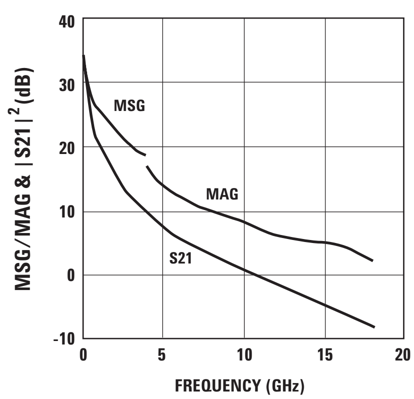



Figure 32. MSG/MAG & $|S21|^2$ (dB) @ 3V, 135 mA.

**Notes:**

1. $F_{min}$ values at 2 GHz and higher are based on measurements while the $F_{mins}$ below 2 GHz have been extrapolated. The $F_{min}$ values are based on a set of 16 noise figure measurements made at 16 different impedances using an ATN NP5 test system. From these measurements a true $F_{min}$ is calculated.
2. S and noise parameters are measured on a microstrip line made on 0.025 inch thick alumina carrier. The input reference plane is at the end of the gate lead. The output reference plane is at the end of the drain lead.

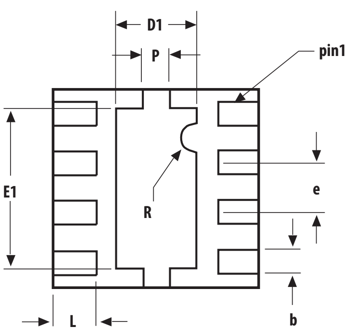
### Device Models

Refer to Avago Technologies' Web Site
www.avagotech.com/rf

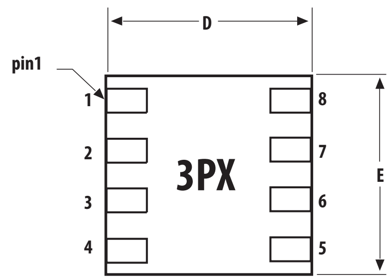
### Ordering Information

| Part Number | No. of Devices | Container |
|---|---|---|
| ATF-531P8-TR1 | 3000 | 7" Reel |
| ATF-531P8-TR2 | 10000 | 13"Reel |
| ATF-531P8-BLK | 100 | antistatic bag |

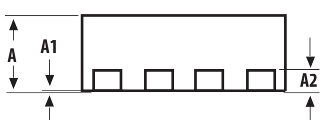
### 2 x 2 LPCC (JEDEC DFP-N) Package Dimensions



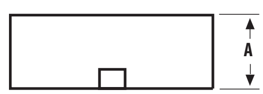
Bottom View



Top View



Side View

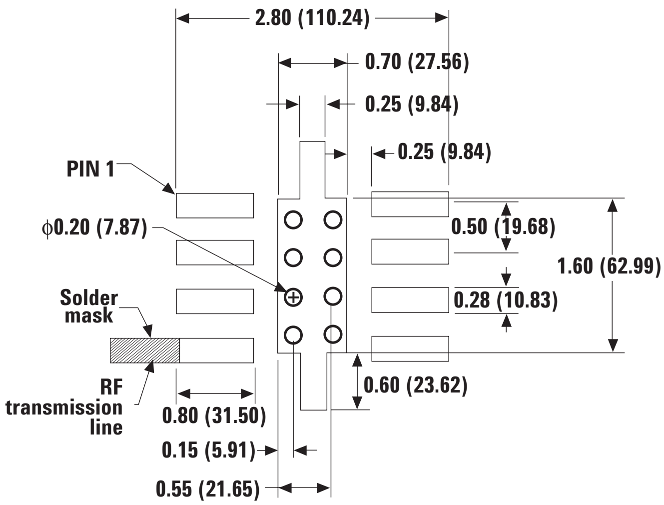


End View

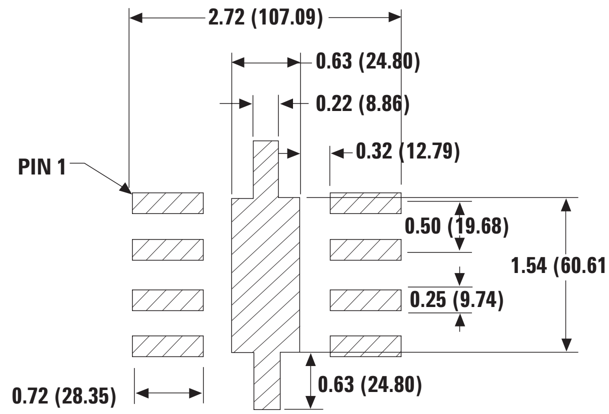
| SYMBOL | DIMENSIONS | | |
|---|---|---|---|
| | MIN. | NOM. | MAX. |
| A | 0.70 | 0.75 | 0.80 |
| A1 | 0 | 0.02 | 0.05 |
| A2 | | 0.203 REF | |
| b | 0.225 | 0.25 | 0.275 |
| D | 1.9 | 2.0 | 2.1 |
| D1 | 0.65 | 0.80 | 0.95 |
| E | 1.9 | 2.0 | 2.1 |
| E1 | 1.45 | 1.6 | 1.75 |
| e | | 0.50 BSC | |
| P | 0.20 | 0.25 | 0.30 |
| L | 0.35 | 0.40 | 0.45 |

DIMENSIONS ARE IN MILLIMETERS

## PCB Land Pattern and Stencil Design

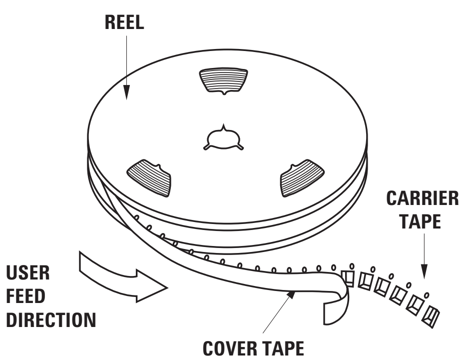


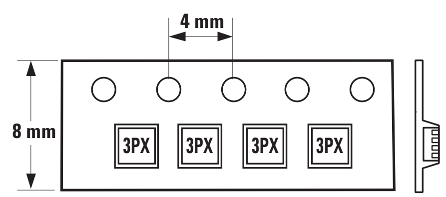

PCB Land Pattern (top view)



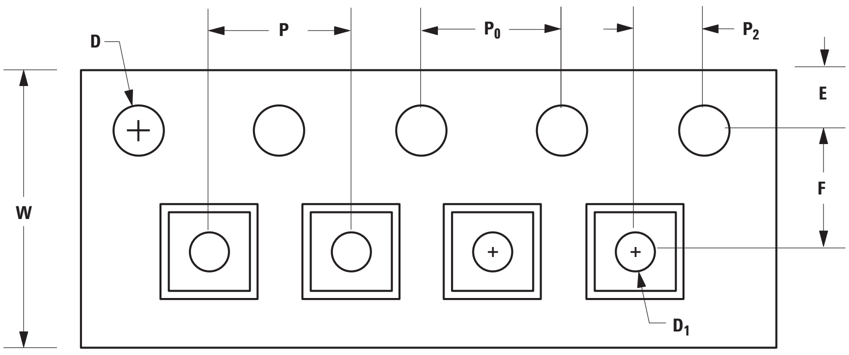

Stencil Layout (top view)

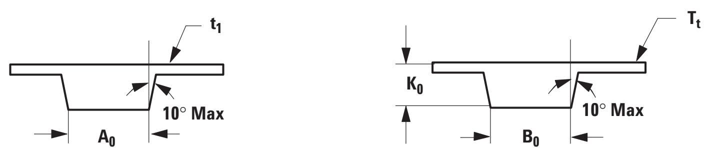
## Device Orientation



## Tape Dimensions




| DESCRIPTION | | SYMBOL | SIZE (mm) | SIZE (inches) |
|---|---|---|---|---|
| CAVITY | LENGTH | $A_0$ | 2.30 ± 0.05 | 0.091 ± 0.004 |
| | WIDTH | $B_0$ | 2.30 ± 0.05 | 0.091 ± 0.004 |
| | DEPTH | $K_0$ | 1.00 ± 0.05 | 0.039 ± 0.002 |
| | PITCH | P | 4.00 ± 0.10 | 0.157 ± 0.004 |
| | BOTTOM HOLE DIAMETER | $D_1$ | 1.00 + 0.25 | 0.039 + 0.002 |
| PERFORATION | DIAMETER | D | 1.50 ± 0.10 | 0.060 ± 0.004 |
| | PITCH | $P_0$ | 4.00 ± 0.10 | 0.157 ± 0.004 |
| | POSITION | E | 1.75 ± 0.10 | 0.069 ± 0.004 |
| CARRIER TAPE | WIDTH | W | 8.00 + 0.30<br>8.00 – 0.10 | 0.315 ± 0.012<br>0.315 ± 0.004 |
| | THICKNESS | $t_1$ | 0.254 ± 0.02 | 0.010 ± 0.0008 |
| COVER TAPE | WIDTH | C | 5.4 ± 0.10 | 0.205 ± 0.004 |
| | TAPE THICKNESS | $T_t$ | 0.062 ± 0.001 | 0.0025 ± 0.0004 |
| DISTANCE | CAVITY TO PERFORATION (WIDTH DIRECTION) | F | 3.50 ± 0.05 | 0.138 ± 0.002 |
| | CAVITY TO PERFORATION (LENGTH DIRECTION) | $P_2$ | 2.00 ± 0.05 | 0.079 ± 0.002 |

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



AV02-0845EN - August 26, 2008


AVAGO TECHNOLOGIES