# FPD2250SOT89

Datasheet v3.0

## LOW NOISE HIGH LINEARITY PACKAGED PHEMT

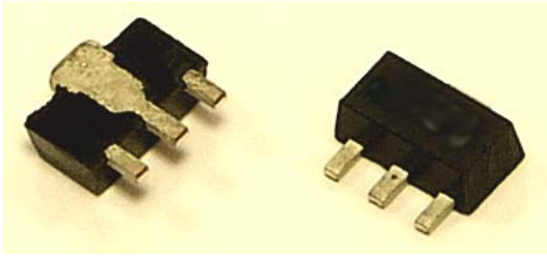
### FEATURES (1850MHZ):

- 29 dBm Output Power (P1dB)
- 14 dB Small-Signal Gain (SSG)
- 1.0 dB Noise Figure
- 44 dBm Output IP3
- 50% Power-Added Efficiency
- FPD2250SOT89E - RoHS compliant

### GENERAL DESCRIPTION:

The FPD2250SOT89 is a packaged depletion mode AlGaAs/InGaAs pseudomorphic High Electron Mobility Transistor (pHEMT). It utilizes a 0.25 µm x 2250 µm Schottky barrier gate, defined by high-resolution stepper-based photolithography. The double recessed gate structure minimizes parasitics to optimize performance, with an epitaxial structure designed for improved linearity over a range of bias conditions and i/p power levels.

### PACKAGE:



### TYPICAL APPLICATIONS:

- Drivers or output stages in PCS/Cellular base station transmitter amplifiers
- High intercept-point LNAs
- WLL and WLAN systems, and other types of wireless infrastructure systems.

### ELECTRICAL SPECIFICATIONS:

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|
| Power at 1dB Gain Compression | P1dB | VDS = 5 V; IDS = 50% IDSS | 28 | 29 | | dBm |
| Small-Signal Gain | SSG | VDS = 5 V; IDS = 50% IDSS | 12 | 14 | | dB |
| Power-Added Efficiency | PAE | VDS = 5 V; IDS = 50% IDSS;<br>POUT = P1dB | | 50 | | % |
| Noise Figure | NF | VDS = 5 V; IDS = 50% IDSS<br>VDS = 5 V; IDS = 25% IDSS | | 1.2<br>1.0 | 1.4 | dB |
| Output Third-Order Intercept Point<br>(from 15 to 5 dB below P1dB) | IP3 | VDS = 5V; IDS = 50% IDSS<br>Matched for optimal power<br>Matched for best IP3 | | <br>43<br>44 | | dBm |
| Saturated Drain-Source Current | IDSS | VDS = 2 V; VGS = 0 V | 560 | 700 | 825 | mA |
| Maximum Drain-Source Current | IMAX | VDS = 2 V; VGS ≅ +1 V | | 1.1 | | mA |
| Transconductance | GM | VDS = 2 V; VGS = 0 V | | 600 | | mS |
| Gate-Source Leakage Current | IGSO | VGS = -5 V | | 1 | 10 | µA |
| Pinch-Off Voltage | \|VP\| | VDS = 2 V; IDS = 2.25 mA | 0.7 | 1.0 | 1.3 | V |
| Gate-Source Breakdown Voltage | \|VBDGS\| | IGS = 2.25 mA | 12 | 18 | | V |
| Gate-Drain Breakdown Voltage | \|VBDGD\| | IGD = 2.25 mA | 12 | 16 | | V |
| Thermal Resistance | $R_{\theta JC}$ | | | 50 | | °C/W |

Note: $T_{AMBIENT}$ = 22°; RF specification measured at f = 1850 MHz using CW signal (except as noted)



*Specifications subject to change without notice*
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## ABSOLUTE MAXIMUM RATING[1]:

| PARAMETER | SYMBOL | TEST CONDITIONS | ABSOLUTE MAXIMUM |
|---|---|---|---|
| Drain-Source Voltage | VDS | -3V < VGS < +0V | 8V |
| Gate-Source Voltage | VGS | 0V < VDS < +8V | -3V |
| Drain-Source Current | IDS | For VDS < 2V | IDss |
| Gate Current | IG | Forward or reverse current | 22mA |
| RF Input Power[2] | PIN | Under any acceptable bias state | 525mW |
| Channel Operating Temperature | TCH | Under any acceptable bias state | 175°C |
| Storage Temperature | TSTG | Non-Operating Storage | -55°C to 150°C |
| Total Power Dissipation | PTOT | See De-Rating Note below | 2.5W |
| Gain Compression | Comp. | Under any bias conditions | 5dB |
| Simultaneous Combination of Limits[3] | | 2 or more Max. Limits | |

Notes:
[1]$T_{Ambient}$ = 22°C unless otherwise noted; exceeding any one of these absolute maximum ratings may cause permanent damage to the device
[2]Max. RF Input Limit must be further limited if input VSWR > 2.5:1
[3]Users should avoid exceeding 80% of 2 or more Limits simultaneously
[4]Total Power Dissipation defined as: $P_{TOT} \equiv (P_{DC} + P_{IN}) - P_{OUT}$,
where $P_{DC}$: DC Bias Power, $P_{IN}$: RF Input Power, $P_{OUT}$: RF Output Power
Total Power Dissipation to be de-rated as follows above 22°C:
$P_{TOT}$= 2.5 - (0.02W/°C) x $T_{PACK}$
where $T_{PACK}$= source tab lead temperature above 22°C
(coefficient of de-rating formula is the Thermal Conductivity)
Example: For a 65°C carrier temperature: $P_{TOT}$ = 2.5W – (0.02 x (65 – 22)) = 1.64W

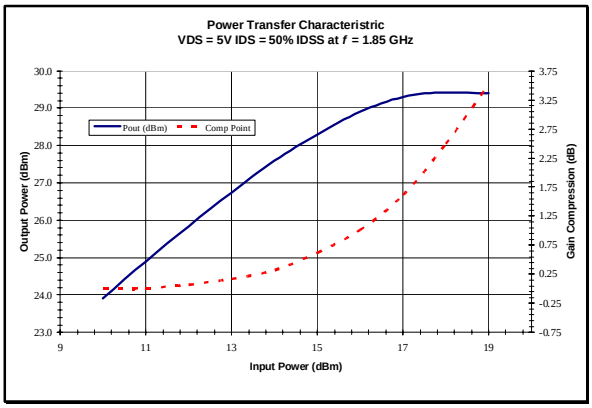
## BIASING GUIDELINES:

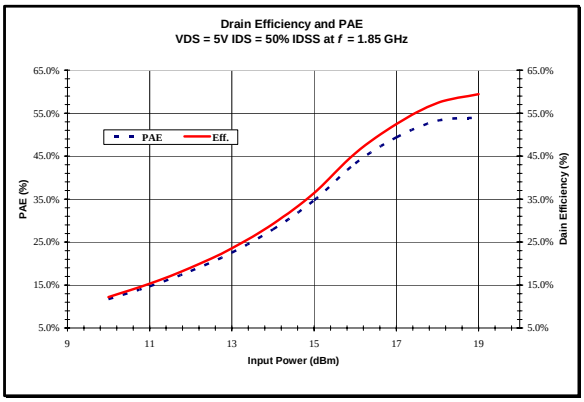
- Active bias circuits provide good performance stabilization over variations of operating temperature, but require a larger number of components compared to self-bias or dual-biased. Such circuits should include provisions to ensure that Gate bias is applied before Drain bias, otherwise the pHEMT may be induced to self-oscillate
- Dual-bias circuits are relatively simple to implement, but will require a regulated negative voltage supply for depletion-mode devices.
- For standard class A operation, a 50% of IDSS bias point is recommended. A small amount of RF gain expansion prior to the onset of compression is normal for this operating point. A class A/B bias of 25-33% of IDSS to achieve better OIP3 and Noise Figure performance is suggested.



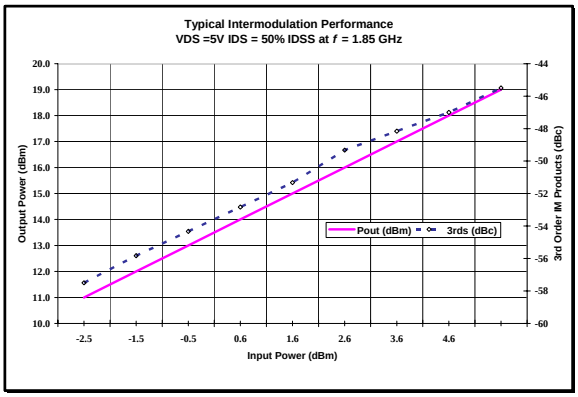
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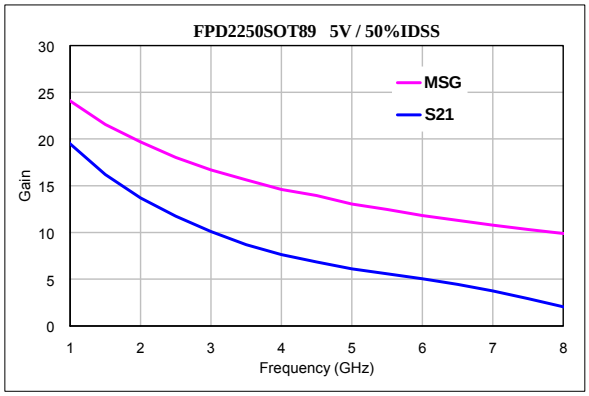
## TYPICAL TUNED RF PERFORMANCE:



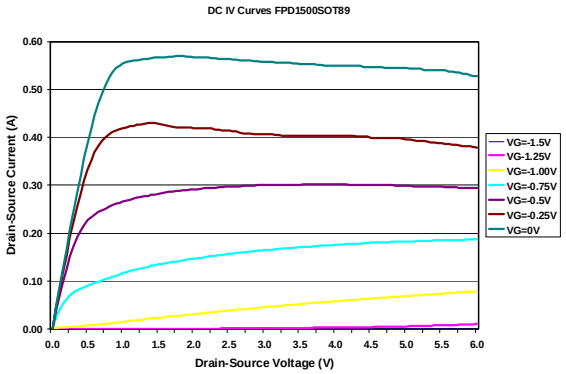

NOTE: Typical power and efficiency is shown above. The devices were biased nominally at $V_{DS}$ = 5V, $I_{DS}$ = 50% of $I_{DSS}$, at a test frequency of 1.85 GHz. The test devices were tuned (input and output tuning) for maximum output power at 1dB gain compression.




Note: pHEMT devices have enhanced intermodulation performance. This yields OIP3 values of about $P_{1dB}$ + 14dBm. This IMD enhancement is affected by the quiescent bias and the matching applied to the device.

## TYPICAL I-V CHARACTERISTICS:

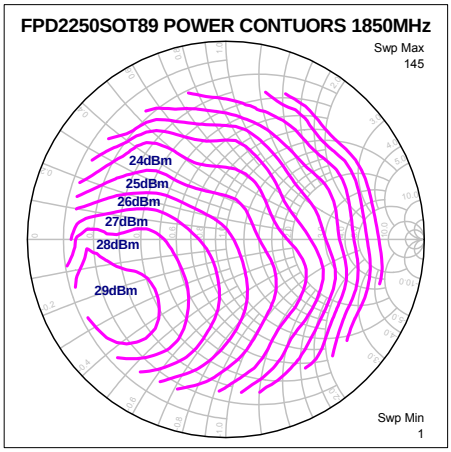



Note: The recommended method for measuring $I_{DSS}$, or any particular $I_{DS}$, is to set the Drain-Source voltage ($V_{DS}$) at 1.3V. This measurement point avoids the onset of spurious self-oscillation which would normally distort the current measurement (this effect has been filtered from the I-V curves presented above). Setting the $V_{DS}$ > 1.3V will generally cause errors in the current measurements, even in stabilized circuits.



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## TYPICAL OUTPUT PLANE POWER CONTOURS: (VDS = 5v, IDS = 50%IDSS)




1850 MHz

Contours swept with a constant input power, set so that optimum $P_{1dB}$ is achieved at the point of output match.

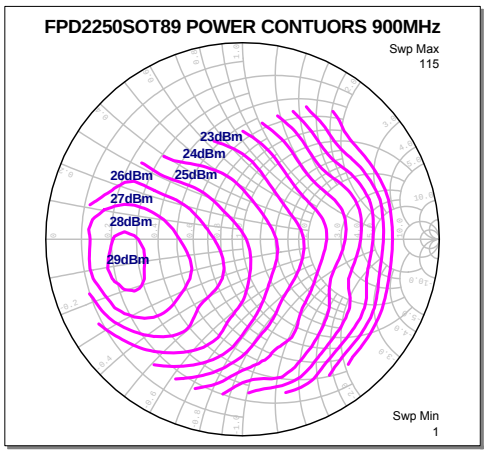
Input (Source plane) $\Gamma_s$:

0.59 ∠ -177.5º

0.25 - j0.02 (normalized)

12.5 – j1.0 Ω

*Nominal IP3 performance is obtained with this input plane match, and the output plane match as shown.*




900 MHz

Contours swept with a constant input power, set so that optimum $P_{1dB}$ is achieved at the point of output match.

Input (Source plane) $\Gamma_s$:

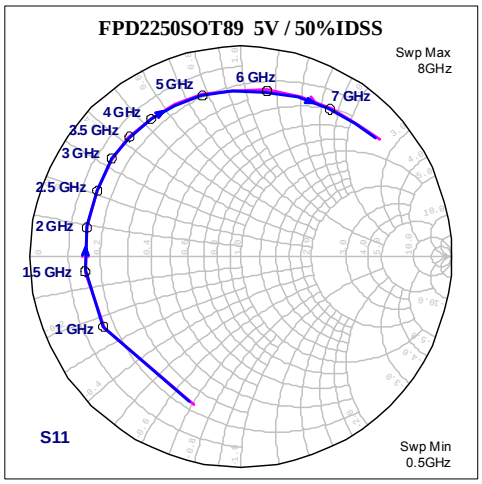
0.67 ∠ 103.6º

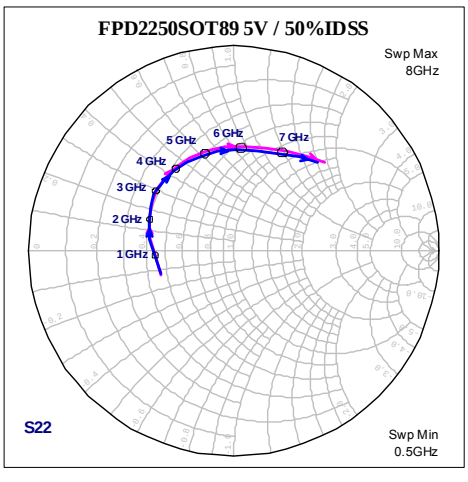
0.30 + j0.74 (normalized)

15 + j37.0 Ω

*Nominal IP3 performance is obtained with this input plane match, and the output plane match as shown.*

## TYPICAL SCATTERING PARAMETERS (50Ω SYSTEM):






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## S-PARAMETERS: BIASED @ 5V, 50%IDSS

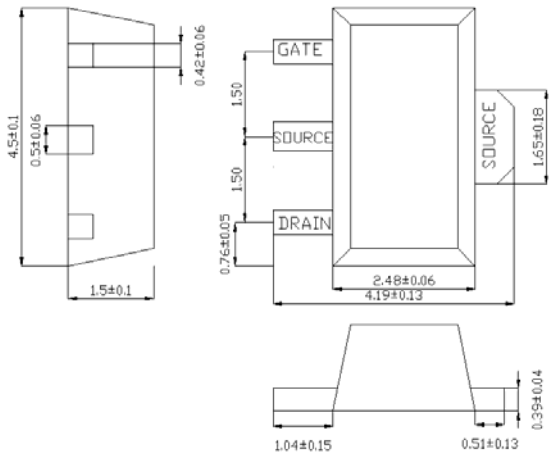
| FREQ[GHz] | S11m | S11a | S21m | S21a | S12m | S12a | S22m | S22a |
|---|---|---|---|---|---|---|---|---|
| 0.500 | 0.823 | -119.1 | 16.103 | 109.2 | 0.027 | 46.5 | 0.459 | -159.0 |
| 0.750 | 0.772 | -142.8 | 11.584 | 97.3 | 0.033 | 44.3 | 0.450 | -167.9 |
| 1.000 | 0.758 | -157.5 | 9.092 | 87.6 | 0.038 | 42.7 | 0.455 | -176.0 |
| 1.250 | 0.753 | -168.0 | 7.526 | 79.7 | 0.044 | 41.6 | 0.445 | 178.5 |
| 1.500 | 0.752 | -178.1 | 6.335 | 72.9 | 0.049 | 40.2 | 0.445 | 172.0 |
| 1.750 | 0.745 | 174.3 | 5.505 | 65.7 | 0.054 | 37.8 | 0.447 | 167.4 |
| 2.000 | 0.746 | 166.8 | 4.905 | 59.1 | 0.060 | 35.6 | 0.439 | 162.5 |
| 2.250 | 0.740 | 159.4 | 4.410 | 52.7 | 0.066 | 32.8 | 0.439 | 157.4 |
| 2.500 | 0.743 | 152.6 | 4.030 | 46.3 | 0.072 | 29.4 | 0.433 | 152.2 |
| 2.750 | 0.744 | 145.5 | 3.702 | 40.4 | 0.078 | 26.8 | 0.436 | 146.2 |
| 3.000 | 0.740 | 138.4 | 3.409 | 33.7 | 0.083 | 22.5 | 0.436 | 140.8 |
| 3.250 | 0.751 | 132.4 | 3.173 | 27.4 | 0.089 | 18.7 | 0.436 | 134.3 |
| 3.500 | 0.750 | 125.7 | 2.953 | 21.2 | 0.095 | 14.7 | 0.450 | 128.5 |
| 3.750 | 0.755 | 119.7 | 2.753 | 15.0 | 0.100 | 10.7 | 0.459 | 122.9 |
| 4.000 | 0.762 | 113.4 | 2.573 | 9.1 | 0.104 | 6.4 | 0.473 | 117.7 |
| 4.250 | 0.762 | 107.4 | 2.408 | 2.9 | 0.108 | 2.1 | 0.487 | 112.8 |
| 4.500 | 0.781 | 102.3 | 2.260 | -2.7 | 0.112 | -1.8 | 0.497 | 108.0 |
| 4.750 | 0.788 | 97.0 | 2.119 | -8.2 | 0.115 | -5.8 | 0.512 | 103.2 |
| 5.000 | 0.803 | 92.1 | 2.000 | -13.6 | 0.118 | -9.6 | 0.521 | 98.7 |
| 5.250 | 0.809 | 86.7 | 1.896 | -18.9 | 0.122 | -13.3 | 0.532 | 94.6 |
| 5.500 | 0.810 | 82.3 | 1.801 | -24.3 | 0.125 | -17.2 | 0.537 | 90.5 |
| 5.750 | 0.828 | 78.1 | 1.718 | -29.3 | 0.129 | -20.8 | 0.548 | 86.8 |
| 6.000 | 0.880 | 71.8 | 1.701 | -35.9 | 0.137 | -26.3 | 0.589 | 82.7 |
| 6.250 | 0.862 | 67.8 | 1.610 | -40.7 | 0.138 | -29.6 | 0.583 | 79.0 |
| 6.500 | 0.878 | 62.1 | 1.540 | -47.5 | 0.142 | -35.4 | 0.599 | 72.5 |
| 6.750 | 0.853 | 58.8 | 1.452 | -51.7 | 0.142 | -38.2 | 0.589 | 67.5 |
| 7.000 | 0.854 | 55.3 | 1.385 | -56.3 | 0.144 | -41.7 | 0.584 | 61.7 |
| 7.250 | 0.851 | 51.5 | 1.337 | -60.9 | 0.147 | -45.3 | 0.578 | 56.7 |
| 7.500 | 0.847 | 47.7 | 1.283 | -65.9 | 0.148 | -49.2 | 0.580 | 51.6 |
| 7.750 | 0.856 | 43.8 | 1.247 | -71.0 | 0.153 | -53.4 | 0.591 | 46.6 |
| 8.000 | 0.869 | 39.4 | 1.203 | -76.8 | 0.155 | -58.3 | 0.602 | 41.0 |
| 8.250 | 0.873 | 33.4 | 1.145 | -82.4 | 0.155 | -62.8 | 0.620 | 36.4 |
| 8.500 | 0.868 | 28.1 | 1.094 | -87.5 | 0.155 | -67.5 | 0.634 | 31.8 |
| 8.750 | 0.878 | 23.1 | 1.043 | -92.9 | 0.155 | -72.2 | 0.655 | 28.2 |
| 9.000 | 0.885 | 17.4 | 0.995 | -97.9 | 0.155 | -76.6 | 0.671 | 24.5 |
| 9.250 | 0.886 | 12.5 | 0.949 | -102.8 | 0.154 | -81.1 | 0.687 | 22.0 |
| 9.500 | 0.894 | 7.8 | 0.897 | -107.9 | 0.153 | -85.9 | 0.702 | 19.5 |
| 9.750 | 0.897 | 3.5 | 0.851 | -112.4 | 0.151 | -90.3 | 0.715 | 17.2 |
| 10.000 | 0.899 | 0.0 | 0.812 | -116.8 | 0.149 | -95.2 | 0.724 | 14.2 |
| 10.250 | 0.902 | -3.1 | 0.771 | -121.0 | 0.146 | -100.3 | 0.731 | 11.1 |
| 10.500 | 0.905 | -6.0 | 0.743 | -125.0 | 0.142 | -104.9 | 0.733 | 8.5 |
| 10.750 | 0.906 | -8.5 | 0.711 | -129.0 | 0.137 | -109.0 | 0.743 | 5.9 |
| 11.000 | 0.907 | -10.9 | 0.684 | -132.7 | 0.135 | -112.4 | 0.746 | 3.1 |
| 11.250 | 0.912 | -13.0 | 0.662 | -136.8 | 0.133 | -115.3 | 0.749 | 0.1 |
| 11.500 | 0.916 | -15.8 | 0.644 | -140.1 | 0.133 | -118.3 | 0.739 | -3.4 |
| 11.750 | 0.915 | -18.3 | 0.632 | -144.0 | 0.133 | -121.2 | 0.734 | -6.9 |
| 12.000 | 0.912 | -21.2 | 0.620 | -147.9 | 0.136 | -124.8 | 0.723 | -11.4 |



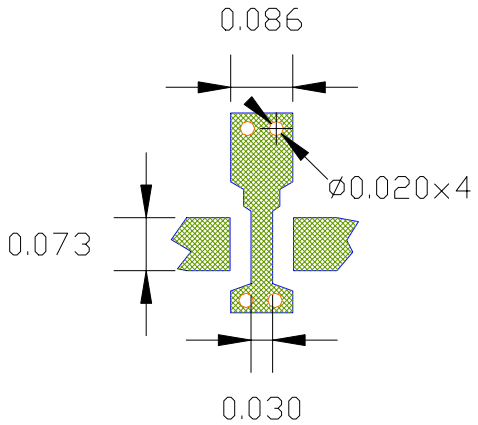
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## PACKAGE OUTLINE:

(dimensions in millimeters – mm)




## PCB Foot Print




Units in inches

## PREFERRED ASSEMBLY INSTRUCTIONS:

Available on request.

## HANDLING PRECAUTIONS:




To avoid damage to the devices care should be exercised during handling. Proper Electrostatic Discharge (ESD) precautions should be observed at all stages of storage, handling, assembly, and testing. These devices should be treated as Class 0 (0-250 V) as defined in JEDEC Standard No. 22-A114. Further information on ESD control measures can be found in MIL-STD-1686 and MIL-HDBK-263.

## APPLICATION NOTES & DESIGN DATA:

Application Notes and design data including S-parameters are available on request.

## DISCLAIMERS:

This product is not designed for use in any space based or life sustaining/supporting equipment.

## ORDERING INFORMATION:

| PART NUMBER | DESCRIPTION |
|---|---|
| FPD2250SOT89 | Packaged pHEMT |
| FPD2250SOT89E | RoHS Compliant Packaged pHEMT |
| FPD2250SOT89CE | RoHS Compliant Packaged pHEMT with enhanced passivation (Recommended for New Designs) |



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