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FPD2250SOT89CE

LOW-NOISE HIGH-LINEARITY PACKAGED pHEMT

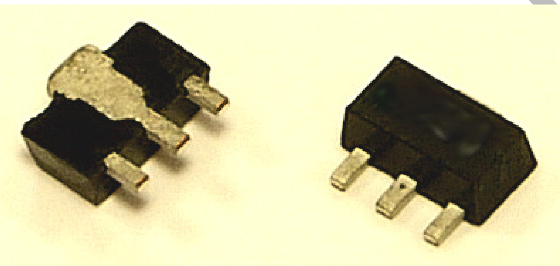
Package: SOT89

Product Description

The FPD2250SOT89CE is a packaged depletion mode AlGaAs/InGaAs pseudomorphic High Electron Mobility Transistor (pHEMT). It features a 0.25μmx1500μm Schottky barrier gate, defined by high-resolution stepper-based photolithography. The double recessed gate structure minimizes parasitics to optimize performance. The epitaxial structure is designed for improved linearity over a range of bias conditions and input power levels.

Optimum Technology Matching® Applied

- ☐ GaAs HBT
- ☐ GaAs MESFET
- ☐ InGaP HBT
- ☐ SiGe BiCMOS
- ☐ Si BiCMOS
- ☐ SiGe HBT
- ✓ GaAs pHEMT
- ☐ Si CMOS
- ☐ Si BJT
- ☐ GaN HEMT
- ☐ InP HBT
- ☐ RF MEMS
- ☐ LDMOS



Features

- Balanced Configuration
- 31dBm Output Power (P1dB)
- 15dB Small-Signal Gain (SSG)
- 0.9dB Noise Figure
- 44dBm OIP_3
- 60% Power-Added Efficiency
- FPD2250SOT89CE: RoHS Compliant

Applications

- Drivers or Output Stages in PCS/Cellular Base Station Transmitter Amplifiers
- High Intercept-point LNAs
- WLL, WLAN, and Other Types of Wireless Infrastructure Systems.

Typical RF Performance Parameter	Specification 0.9GHz	1.85GHz	2.4GHz	Unit	Condition
P_{1dB} Gain Compression	31.0	31.0	30.0	dBm	V_{DS}=5V, I_{DS}=300mA
Small-Signal Gain (SSG)	16.5	15	11	dB	V_{DS}=5V, I_{DS}=300mA
PAE	60	60	50	%	V_{DS}=5V, I_{DS}=300mA, P_{OUT}=P_{1dB}
Noise Figure (NF)	0.8	0.9	1.5	dB	V_{DS}=5V, I_{DS}=300mA
OIP_3	44	44	41	dBm	V_{DS}=5V, I_{DS}=300mA, P_{OUT}=16dBm per tone
Electrical Specification RF/DC Parameter	**Specification Min.**	**Typ.**	**Max.**	**Unit**	**Condition**
Frequency		1.85		GHz	
P_{1dB} Gain Compression	28			dBm	V_{DS}=5V, I_{DS}=300mA
Small-Signal Gain (SSG)	12			dB	V_{DS}=5V, I_{DS}=300mA
Saturated Drain-Source Current (I_{DSS})	560	700	825	mA	V_{DS}=1.3V, V_{GS}=0V
Transconductance (GM)		600		ms	V_{DS}=1.3V, V_{GS}=0V
Pinch-Off Voltage (V_P)	|0.7|	|1.0|	|1.3|	V	V_{DS}=1.3V, I_{DS}=2.25mA
Gate-Source Breakdown Voltage (V_{BDGS})	|12|	|16|		V	I_{GS}=2.25mA
Gate-Drain Breakdown Voltage (V_{BDGD})	|12|	|16|		V	I_{GD}=2.25mA
Thermal Resistivity (θJC) *		50		°C/W	V_{DS}>3V

*Note: $T_{AMBIENT}$=22°C, all devices are 100%,RF and DC test at f=1850GHz. Data at 0.9GHz and 1.85GHz is given for a balanced amplifier with I_{DS}=300mA the total current for two devices biased at 150mA per device. Data given at 2.4GHz is for a single-ended amplifier with I_{DS}=300mA the current for a single device.

Absolute Maximum Ratings[1]

Parameter	Rating	Unit
Drain-Source Voltage (V_{DS}) ($-3V<V_{GS}<0.5V$)	8	V
Gate-Source Voltage (V_{GS}) ($0V<V_{DS}<+8V$)	-3	V
Drain-Source Current (I_{DS}) (For $V_{DS}<2V$)	I_{DSS}	
Gate Current (I_G) (Forward or reverse)	22	mA
RF Input Power (P_{IN})[2] (Under any acceptable bias state)	525	mW
Channel Operating Temperature (T_{CH}) (Under any acceptable bias state)	175	°C
Storage Temperature (T_{STG}) (Non-Operating Storage)	-55 to 150	°C
Total Power Dissipation (P_{TOT})[3, 4]	2.5	W
Gain Compression (Under bias conditions)	5	dB
Simultaneous Combination of Limits[6] (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 (P_{TOT}) defined as ($P_{DC}+P_{IN}$) – 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:

$P_{TOT}=2.5-(0.02W/°C)\times T_{PACK}$, where T_{PACK} = source tab lead temperature above 22 °C. (Coefficient of de-rating formula is Thermal Conductivity.)

Exampe: For a 65 °C carrier temperature: $P_{TOT}=2.5W-(0.02\times(65-22))=1.64W$

Caution! ESD sensitive device.

Exceeding any one or a combination of the Absolute Maximum Rating conditions may cause permanent damage to the device. Extended application of Absolute Maximum Rating conditions to the device may reduce device reliability. Specified typical performance or functional operation of the device under Absolute Maximum Rating conditions is not implied.

RoHS status based on EU Directive 2002/95/EC (at time of this document revision).

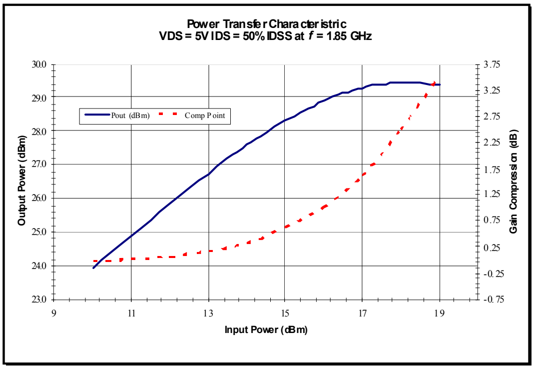
Biasing Guidelines

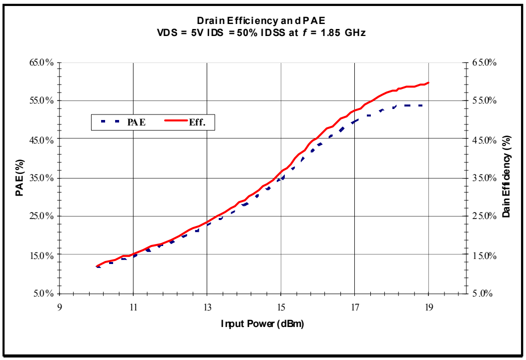
Active bias circuits provide good performance stabilization over variations of operating temperature, but require a larger number of components compared to self-bias or dual-biased. Such circuits should include provisions to ensure that gate bias is applied before drain bias, otherwise the pHEMT may 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.

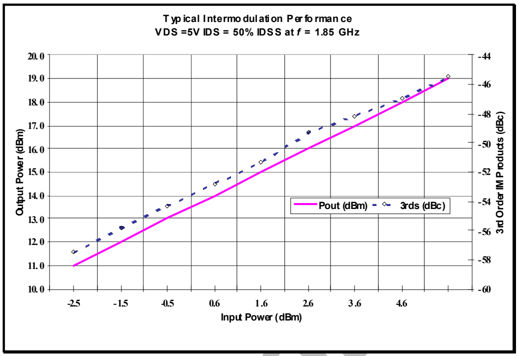
For standard Class A operation, an operating point of 50% of I_{DSS} is recommended. A small amount of RF gain expansion prior to the onset of compression is normal for this operating point. A class A/B Bias of 25% to 33% of I_{DSS} to achieve better OIP_3 and Noise Figure performance is suggested.

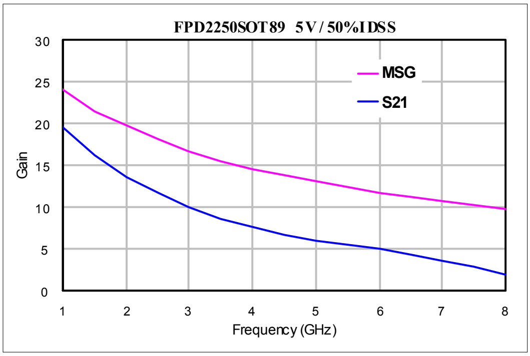
Typical Tuned RF Performance





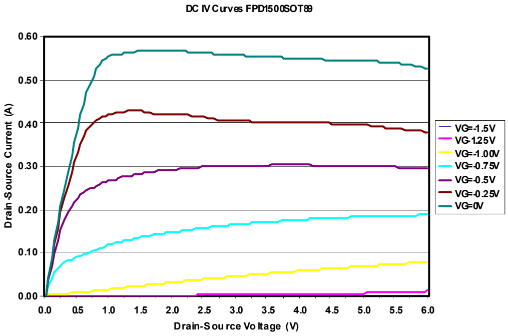
Note: Typical power and efficiency are shown above. The devices were biased nominally at V_{DS}=5V, I_{DS}=50% of I_{DSS}, at a test frequency of 1.85GHz. The test devices were tuned (input and output) for maximum output power at 1dB gain compression.





Note: pHEMT devices have enhanced intermodulation performance. This yields OIP3 values of about P1dB+14dBm. This IMD enhancement is affected by the quiescent bias and the matching applied to the device.

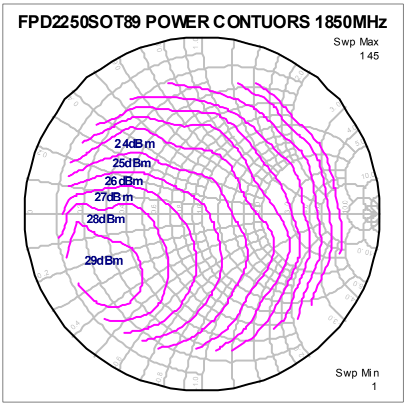
Typical I-V Characteristics



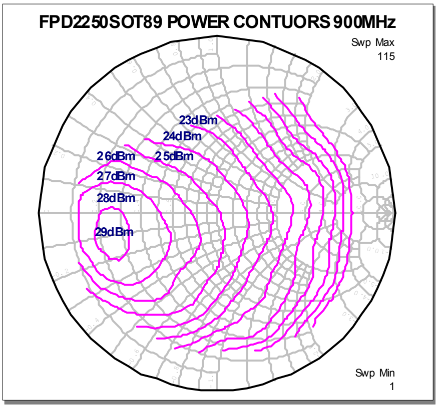
Note: The recommended method for measuring I_{DSS}, or any particular I_{DS}, is to set the Drain-Source voltage (V_{DS}) at 1.3V. This measurement point avoids the onset of spurious self-oscillation which would normally distort the current measurement (this effect has been filtered from the I-V curves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

Typical Output Plane Power Contours

($V_{DS}=5V$, $I_{DS}=50\%\ I_{DSS}$)



1850 MHz



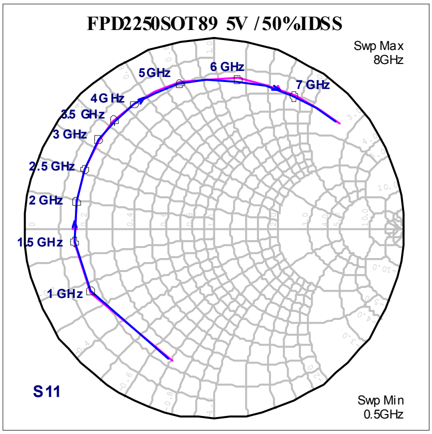
900 MHz

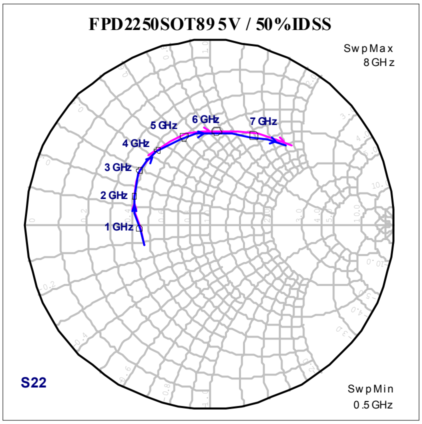
Contours swept with a constant input power, set so that optimum P1dB is achieved at the point of output match.
Input (Source plane) Γs:
0.59∠177.5°
0.25-j0.2 (normalized)
12.5-j1.0Ω
Nominal IP3 performance is obtained with this input plane match, and the output plane match as shown.

Contours swept with a constant input power, set so that optimum P1dB is achieved at the point of output match.
Input (Source plane) Γs:
0.67∠103.6°
0.30+j0.74 (normalized)
15+j37.0Ω
Nominal IP3 performance is obtained with this input plane match, and the output plane match as shown.

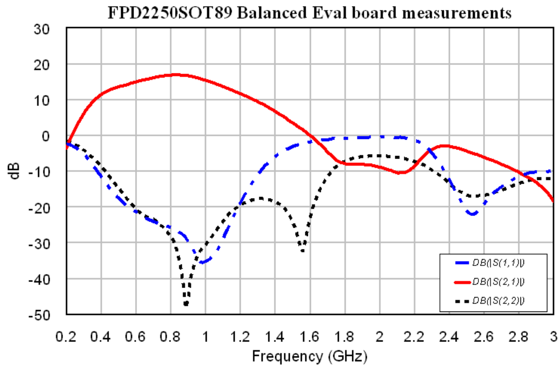
Typical Scattering Parameters

(50Ω System)





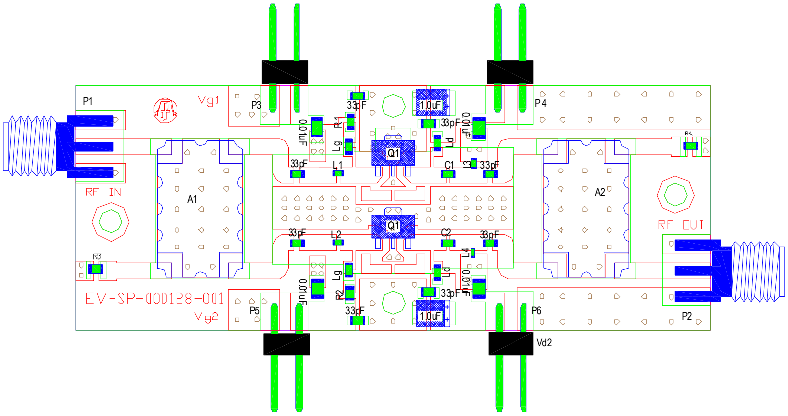
Reference Design (0.9 GHz)



Parameter	Typical	Unit
Gain	16.5	dB
P1dB	31.0	dBm
OIP_3	44	dBm
NF	0.8	dB
S11	-22	dB
S22	-30	dB
V_D	5	V
V_G	-0.4 to -0.6	V
I_D	150	mA

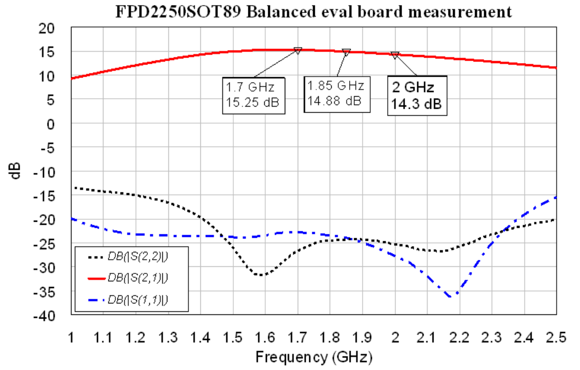
Note: OIP_3 measured at 16dBm per tone. NF includes input coupler loss of 0.12dB.

Evaluation Board Layout and Bill of Materials



Comp:	Description
C1&C2	Cap. 0603 3.3pF ATC 600S ±0.1pF Tol.
33pF x 8	Cap. 0603 ATC 600S
.01uF x 4	Cap. 0805 ATC805X103KL2AT
1.0uF x 2	SMD-B Tantallum x 2
L1 & L2	Inductor LL1005-FH 12nH TOKO ±0.3nH Tol.
L3 & L4	Inductor LL1005-FH 5.6nH TOKO ±0.3nH Tol.
Lg & Ld	Inductor LL1608-FH 56nH TOKO
Q1	FPD2250SOT89
R1, R2	20 Ohm 0603 size Chip Resistor
R3, R4	51 Ohm 0603 size CHip Resistor x 2
A1 & A2	Anaren XCD900A-03 Hybrid Coupler (900MHz)
P1 & P2	Edge mount RF Connector (Radial) R125.423.200
P3, P4, P5, P6	2-Pin Header.

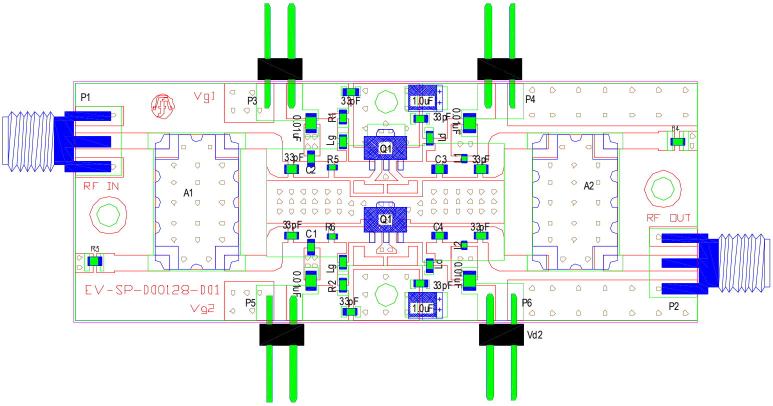
Reference Design (1.7 GHz to 2.0 GHz)

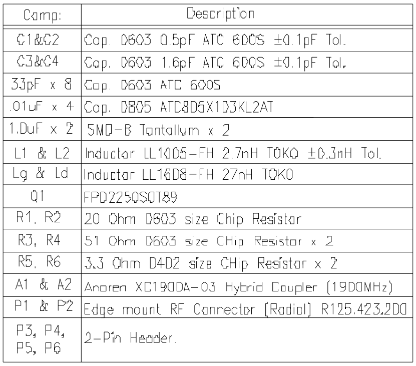


Parameter	Typical	Unit
Gain	15.2 @ 1.7GHz 14.8 @ 1.85GHz	dB
P1dB	31	dBm
OIP$_3$	43 @ 1.7GHz 44 @ 1.85GHz	dBm
NF	0.9	dB
S11	-20	dB
S22	-25	dB
V$_D$	5	V
V$_G$	-0.4 to -0.6	V
I$_D$	150	mA

Note: OIP$_3$ measured at 16dBm per tone. NF includes input coupler loss of 0.12dB.

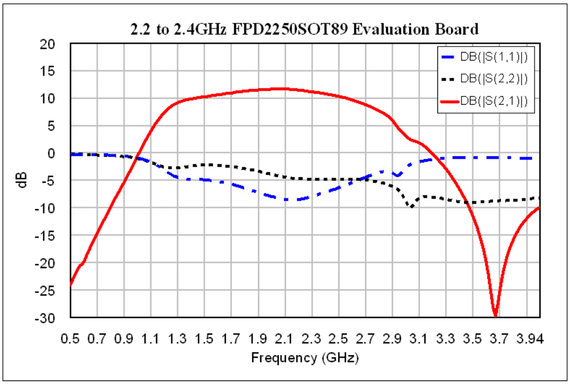
Evaluation Board Layout and Bill of Materials





Comp:	Description
C1&C2	Cap. 0603 0.5pF ATC 600S ±0.1pF Tol.
C3&C4	Cap. 0603 1.6pF ATC 600S ±0.1pF Tol.
33pF x 8	Cap. 0603 ATC 600S
.01uF x 4	Cap. 0805 ATC805X103KL2AT
1.0uF x 2	SMD-B Tantallum x 2
L1 & L2	Inductor LL1005-FH 2.7nH TOKO ±0.3nH Tol.
Lg & Ld	Inductor LL1608-FH 27nH TOKO
Q1	FPD2250SOT89
R1, R2	20 Ohm 0603 size Chip Resistor
R3, R4	51 Ohm 0603 size CHip Resistor x 2
R5, R6	3.3 Ohm 0402 size CHip Resistor x 2
A1 & A2	Anoren XC1900A-03 Hybrid Coupler (1900MHz)
P1 & P2	Edge mount RF Connector (Radial) R125.423.200
P3, P4, P5, P6	2-Pin Header.

Reference Design (2.2 GHz to 2.4 GHz)

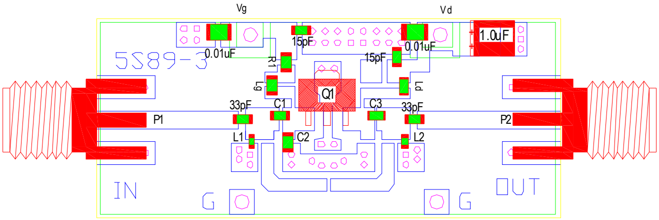


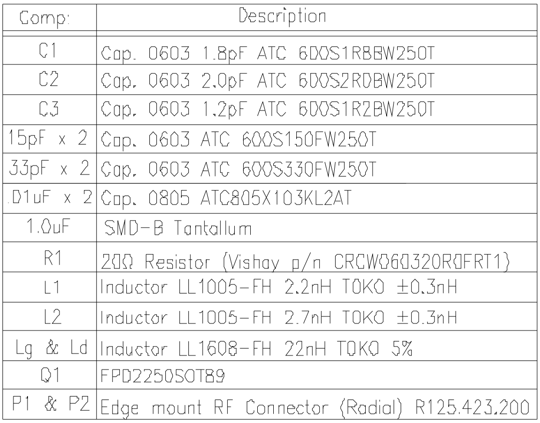
Parameter	Typical	Unit
Gain	11.5 @ 2.2GHz 11.0 @ 2.4GHz	dB
P1dB	30	dBm
OIP_3	41	dBm
NF	1.2 @ 2.2GHz 1.5 @ 2.4GHz	dB
S11	-8 @ 2.2GHz -5 @ 2.4GHz	dB
S22	-7 @ 2.2GHz -5 @ 2.4GHz	dB
V_D	5	V
V_G	-0.4 to -0.6	V
I_D	300	mA

Note: OIP_3 measured at P_{OUT} of 6dBm per tone.

Evaluation Board Layout and Bill of Materials

EB2250SOT89-BA @2.2-2.4GHz





Comp.	Description
C1	Cap. 0603 1.8pF ATC 600S1R8BW250T
C2	Cap. 0603 2.0pF ATC 600S2R0BW250T
C3	Cap. 0603 1.2pF ATC 600S1R2BW250T
15pF x 2	Cap. 0603 ATC 600S150FW250T
33pF x 2	Cap. 0603 ATC 600S330FW250T
.01uF x 2	Cap. 0805 ATC805X103KL2AT
1.0uF	SMD-B Tantallum
R1	20Ω Resistor (Vishay p/n CRCW060320R0FRT1)
L1	Inductor LL1005-FH 2.2nH TOKO ±0.3nH
L2	Inductor LL1005-FH 2.7nH TOKO ±0.3nH
Lg & Ld	Inductor LL1608-FH 22nH TOKO 5%
Q1	FPD2250SOT89
P1 & P2	Edge mount RF Connector (Radial) R125.423.200

S-Parameters

(Biased @ 5V, 50% I_{DSS})

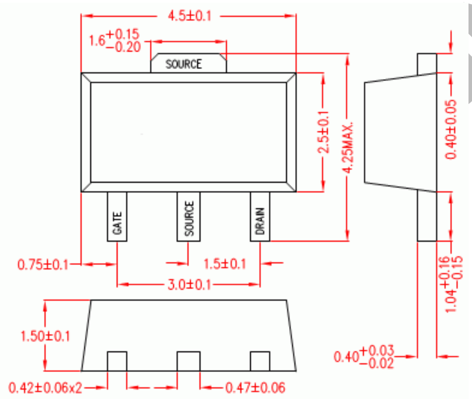
FREQ[GHz]	S11m	S11a	S21m	S21a	S12m	S12a	S22m	S22a
0.500	0.823	-119.1	16.103	109.2	0.027	46.5	0.459	-159.0
0.750	0.772	-142.8	11.584	97.3	0.033	44.3	0.450	-167.9
1.000	0.758	-157.5	9.092	87.6	0.038	42.7	0.455	-176.0
1.250	0.753	-168.0	7.526	79.7	0.044	41.6	0.445	178.5
1.500	0.752	-178.1	6.335	72.9	0.049	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

Branding Diagram

2250CE
Trace Code

Package Outline

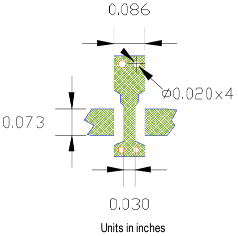
Dimensions in millimeters (mm)



Tape Dimensions and Part Orientation

Tape and reel for this material are in accordance with EIA-481-1 except where exceptions are identified.

Device Footprint



Preferred Assembly Instructions

This package is compatible with both lead-free and leaded solder reflow processes as defined within IPC/JEDEC J-STD-020C. The maximum package temperature should not exceed 260 °C.

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.

ESD Rating

These devices should be treated as Class 0 (0V to 250V) using the human body model 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.

MSL Rating

The device has an MSL rating of Level 2. To determine this rating, preconditioning was performed to the device per the Pb-free solder profile defined within IPC/JEDEC J-STD-020C, Moisture/Reflow sensitivity classification for non-hermetic solid state surface mount devices.

Reliability

An MTTF of 4.2 million hours at a channel temperature of 150 °C is achieved for the process used to manufacture this device.

Application Notes and Design Data

Application Notes and design data including S-parameters are available on request and from www.rfmd.com.

Disclaimers

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

Ordering Information

Description	Ordering Code
RoHS-Compliant Packaged pHEMT with enhanced passivation (recommended for new designs)	FPD2250SOT89CE
Evaluation board (2.0GHz)	EB2250SOT89CE-BC

Delivery Quantity	Ordering Code
Reel of 1000	FPD2250SOT89CECE
Reel of 100	FPD2250SOT89CECESR
Bag of 25	FPD2250SOT89CECESQ
Bag of 5	FPD2250SOT89CECESB