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FPD200P70

HIGH FREQUENCY PACKAGED pHEMT

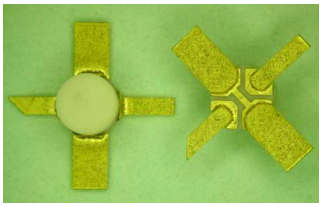
Package: P70

Product Description

The FPD200P70 is a packaged depletion mode AlGaAs/InGaAs pseudomorphic High Electron Mobility Transistor (pHEMT). It utilizes a 0.25mmx200mm Schottky barrier gate, defined by high-resolution stepper-based photolithography.

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

- 20dBm Output Power (P1dB)
- 17dB Gain at 5.8GHz
- 0.7dB Noise Figure at 5.8GHz
- 30dB Output IP_3
- 45% Power-Added Efficiency
- Usable Gain to 26GHz

Applications

- LNAs and Driver Amplifiers to 26GHz
- VCOs and Frequency Doublers

RF Parameter	Typical Performance			Unit	Condition
	1.85GHz	5.8GHz	18GHz		
P_{1dB} at Gain Compression	20	19	20	dBm	V_{DS}=5V, I_{DS}=30mA
Small-Signal Gain (SSG)	21	17	9	dB	V_{DS}=5V, I_{DS}=30mA
PAE	45	45	45	%	V_{DS}=5V, I_{DS}=30mA, P_{OUT}=P_{1dB}
Maximum Stable Gain (|S21/S12|)	24	21	14		V_{DS}=5V, I_{DS}=30mA
Noise Figure (NF)	0.3	0.7	2.2	dB	V_{DS}=5V, I_{DS}=30mA
OIP_3	29	28	28.5	dBm	V_{DS}=5V, I_{DS}=30mA
	31	30	31	dBm	V_{DS}=8V, I_{DS}=30mA, P_{OUT}=6dBm per tone

DC Parameter	Electrical Specification			Unit	Condition
	Min.	Typ.	Max.		
Saturated Drain-Source Current (I_{DSS})	45	60	75	mA	V_{DS}=1.3V, V_{GS}=0V
Maximum Drain-Source Current (I_{MAX})		120		mA	V_{DS}=1.3V, V_{GS}=+1V
Transconductance (GM)		80		ms	V_{DS}=1.3V, V_{GS}=0V
Gate-Source Leakage Current (I_{GSO})		1	10	µA	V_{GS}=0V
Pinch-Off Voltage (V_P)	|0.7|	|0.9|	|1.3|	V	V_{DS}=1.3V, I_{DS}=0.2mA
Gate-Source Breakdown Voltage (V_{BDGS})	|12|	|14|		V	I_{GS}=0.2mA
Gate-Drain Breakdown Voltage (V_{BDGD})	|12|	|16|		V	I_{DS}=0.2mA
Thermal Resistivity (θJC) *		325		°C/W	V_{DS}>3V

*Note: $T_{AMBIENT}$=22°C.

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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)	5	mA
RF Input Power (P_{IN})[2] (Under any acceptable bias state)	16	dBm
Channel Operating Temperature (T_{CH}) (Under any acceptable bias state)	175	°C
Storage Temperature (T_{STG}) (Non-Operating Storage)	-40 to 150	°C
Total Power Dissipation (P_{TOT})[3, 4, 5]	470	mW
Simultaneous Combination of Limits[6] (2 or more max. limits)	80	%

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}=0.17-(1/RθJC)xT_{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}=470mW-(3x(65-22))=341mW

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 EUDirective2002/95/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. Contact your Sales Representative for additional Information.

Dual-bias circuits are relatively simple to implement, but will require a regulated negative voltage supply for depletion-mode devices such as the FPD200P70.

For standard Class A operation, a 50% of I_{DSS} bias point is recommended. A small amount of RF gain expansion prior to the onset of compression is normal for this operating point. Note that pHEMTs, since they are “quasi- E/D mode” devices, exhibit Class AB traits when operated at 50% of I_{DSS}. To achieve a larger separation between P1dB and IP_3, an operating point in the 25% to 33% of I_{DSS} range is suggested. Such Class AB operation will not degrade the IP_3 performance.

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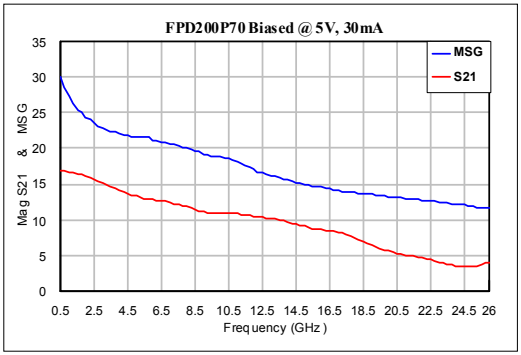
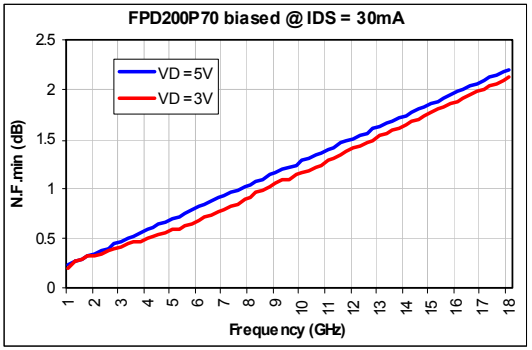
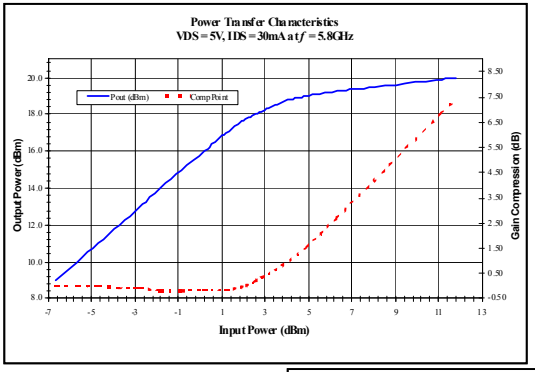
Typical Frequency Response

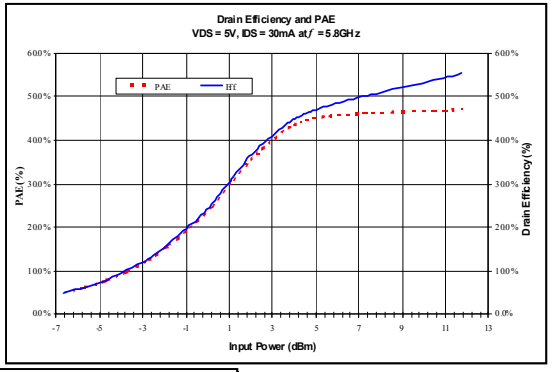


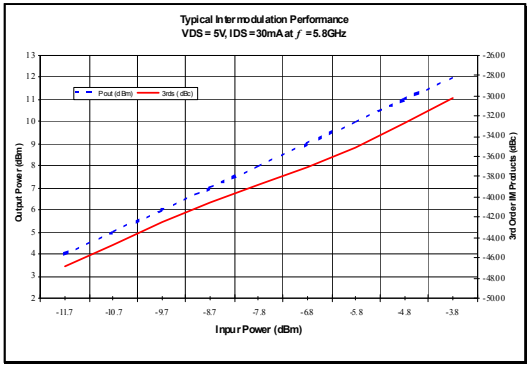


Note: Tuned noise figure variation against frequency is shown above. The devices were biased nominally at V_{DS}=5V, I_{DS}=30mA. The test devices were tuned for minimum noise figure and maximum gain using tuners at the device input and output ports. See noise parameters tables for tuned reflections coefficients.

Typical RF Performance

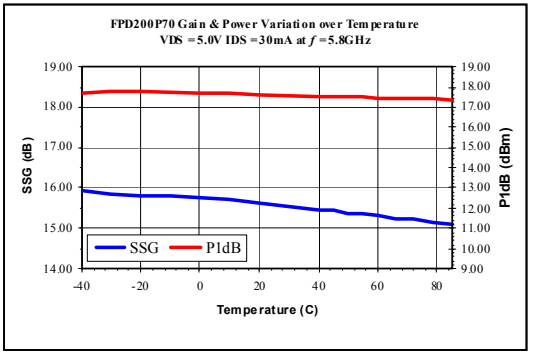


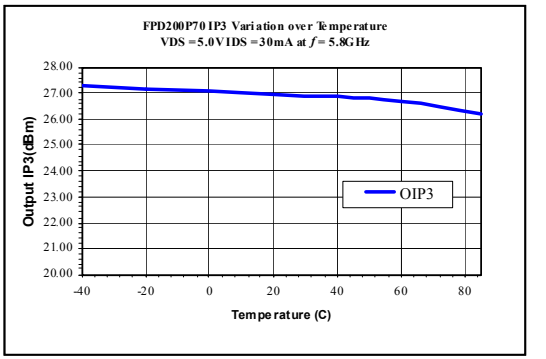




Note: Typical power, efficiency, and intermodulation performance is shown in the three plots. The devices were biased nominally at V_{DS}=5V, I_{DS}=30mA at a test frequency of 5.8GHz. The test devices were tuned using slide tuners at the input and the output ports of the device.

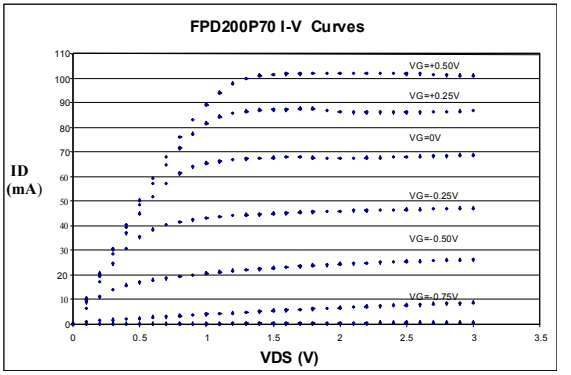
Temperature Response





Note: Typical power, gain, and intermodulation variation over temperature is shown above. The devices were biased nominally at V_{DS}=5V, I_{DS}=30mA at a test frequency of 5.8GHz on an evaluation board. The evaluation board is tuned for minimum noise and maximum gain. The 1dB compression point is lower than the typical number due to the change in matching.

Typical I-V Characteristics



Note: The recommended method for measuring I_{DSS}, 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).

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Noise Parameters

Biased at 5V, 30mA

Freq (GHz)	N.F.min. (dB)	Γopt Mag.	Γopt Angle	Rn/50
0.800	0.20	0.788	10.9	0.454
0.900	0.22	0.788	12.1	0.443
1.000	0.24	0.788	13.2	0.433
1.500	0.30	0.787	19.1	0.386
1.800	0.34	0.784	22.6	0.362
2.000	0.35	0.782	24.9	0.347
2.200	0.38	0.778	27.2	0.334
2.400	0.40	0.774	29.6	0.321
2.600	0.43	0.769	31.9	0.310
2.800	0.47	0.763	34.2	0.300
3.300	0.50	0.746	39.9	0.280
3.500	0.53	0.738	42.2	0.274
3.700	0.56	0.730	44.5	0.269
4.000	0.59	0.715	47.9	0.263
4.500	0.64	0.688	53.5	0.257
4.900	0.69	0.662	58.0	0.255
5.100	0.71	0.649	60.2	0.255
5.300	0.74	0.634	62.4	0.255
5.500	0.76	0.619	64.7	0.255
5.700	0.79	0.604	66.9	0.255
5.900	0.81	0.587	69.1	0.256
7.000	0.93	0.470	78.6	0.214
8.000	1.05	0.367	90.8	0.177
9.000	1.17	0.281	97.7	0.171
10.000	1.28	0.239	108.3	0.161
11.000	1.40	0.185	109.7	0.158
12.000	1.51	0.124	127.3	0.147
13.000	1.63	0.031	-152.8	0.174
14.000	1.75	0.118	-76.9	0.216
15.000	1.86	0.244	-41.0	0.290

Biased at 3V, 30mA

Freq (GHz)	N.F.min. (dB)	Γopt Mag.	Γopt Angle	Rn/50
0.800	0.15	0.795	12.2	0.356
0.900	0.18	0.782	13.5	0.352
1.000	0.21	0.769	14.8	0.349
1.500	0.29	0.708	21.2	0.330
1.800	0.33	0.675	25.0	0.320
2.000	0.34	0.654	27.6	0.313
2.200	0.35	0.634	30.1	0.307
2.400	0.37	0.615	32.7	0.301
2.600	0.39	0.598	35.2	0.295
2.800	0.42	0.581	37.7	0.290
3.300	0.44	0.544	43.9	0.277
3.500	0.46	0.531	46.4	0.273
3.700	0.48	0.519	48.9	0.268
4.000	0.50	0.504	52.6	0.262
4.500	0.54	0.483	58.7	0.253
4.900	0.57	0.470	63.6	0.247
5.100	0.59	0.466	66.0	0.245
5.300	0.61	0.463	68.4	0.242
5.500	0.63	0.460	70.8	0.240
5.700	0.65	0.459	73.2	0.237
5.900	0.68	0.459	75.6	0.235
7.000	0.79	0.455	81.4	0.202
8.000	0.92	0.355	94.7	0.167
9.000	1.06	0.267	102.9	0.161
10.000	1.17	0.222	114.1	0.154
11.000	1.28	0.164	116.6	0.153
12.000	1.41	0.103	138.1	0.147
13.000	1.53	0.043	-128.1	0.176
14.000	1.65	0.129	-72.4	0.223
15.000	1.77	0.249	-36.9	0.300

Note: Noise parameters are de-embedded to the package leads using precision fixturing and calibration standards. Noise parameter extraction is done on a Maury microwave NP system for RF and M.W. measurement.

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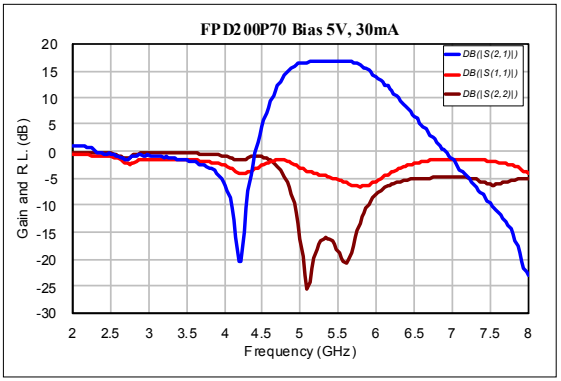
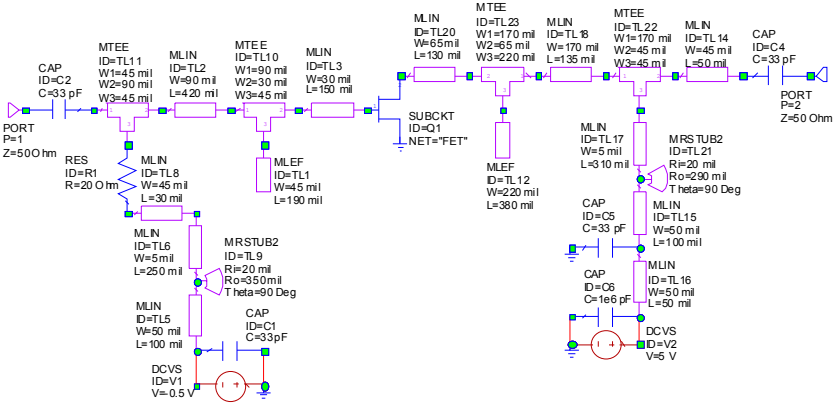
Reference Design (5.15GHz to 5.8GHz)

Parameter	Typical	Unit
Frequency	5.5	GHz
Gain	17	dB
NF	1.0	dB
P1dB	16.5	dBm
IP_3	28	dBm
V_D	5	V
V_G	-0.4 to -0.6	V
I_D	30	mA

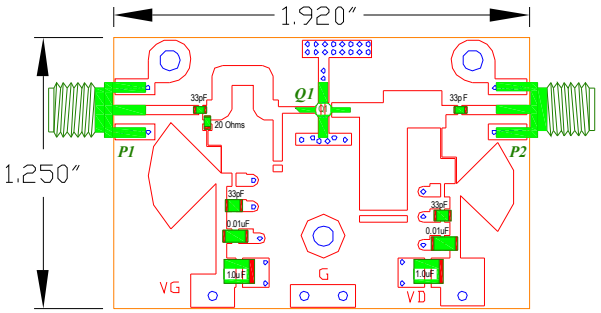
Board material is Rogers 4003 with a die electric thickness of 20mil and 1/2oz. Cu cladding on both sides.



Schematic



Evaluation Board Layout



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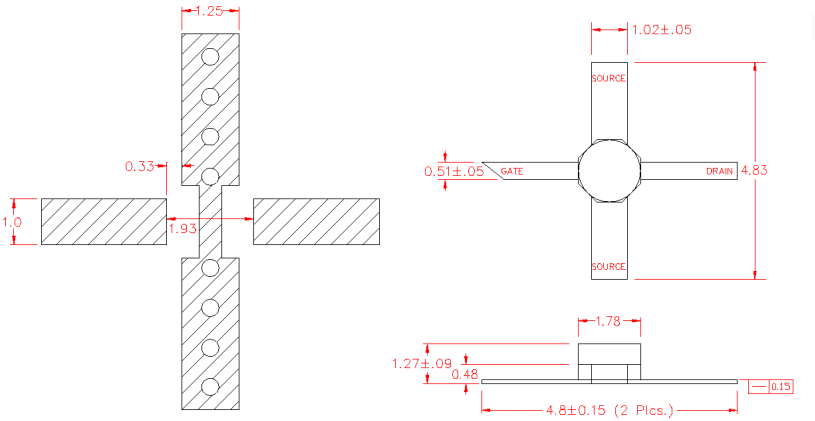
P70 Package Outline and Recommended PC Board Layout

(dimensions in millimeters)



Tape and Reel Dimensions and Part Orientation

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

PACKAGE MARKING CODE

Example:
ABC

A=product type
B=week code
C=year code
Reel:
Terminal tape=40mm (min)
Leader tape with empty cavities=350mm (min)
Trailer tape with empty cavities=160mm (min)
Devices per reel=1000

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S-Parameters

(Biased at 5V, 30mA)

FREQ[GHz]	S11m	S11a	S21m	S21a	S12m	S12a	S22m	S22a
0.500	0.987	-11.6	6.94	167.7	0.007	81.9	0.785	-7.3
1.000	0.967	-23.7	6.814	156.2	0.013	75.2	0.777	-14.5
1.500	0.936	-35.7	6.601	144.9	0.019	67.9	0.765	-21.1
2.000	0.899	-47.8	6.334	133.9	0.023	60.9	0.750	-27.1
2.500	0.857	-59.3	6.004	123.4	0.027	54.6	0.734	-32.3
3.000	0.817	-69.5	5.66	113.8	0.029	48.8	0.718	-37.6
3.500	0.771	-78.3	5.318	104.9	0.031	42.5	0.701	-42.5
4.000	0.735	-86.1	5.048	96.8	0.031	38.9	0.691	-47.2
4.500	0.701	-93.5	4.814	89.1	0.032	37.6	0.683	-51.4
5.000	0.663	-101.3	4.612	81.5	0.032	33.7	0.668	-55.2
5.500	0.628	-109.1	4.467	74.2	0.032	32.2	0.663	-58.3
6.000	0.594	-118.6	4.374	66.0	0.033	31.0	0.656	-63.4
6.500	0.555	-128.1	4.268	58.1	0.034	28.8	0.644	-67.9
7.000	0.516	-139.0	4.166	49.8	0.036	23.8	0.627	-73.1
7.500	0.471	-150.7	4.016	41.5	0.036	16.5	0.600	-78.4
8.000	0.433	-161.4	3.869	33.8	0.034	13.7	0.580	-82.7
8.500	0.395	-171.5	3.699	26.3	0.031	11.4	0.561	-87.4
9.000	0.366	-179.6	3.561	19.6	0.029	17.8	0.557	-91.7
9.500	0.350	173.1	3.511	13.7	0.032	26.8	0.571	-96.1
10.000	0.338	163.1	3.499	6.6	0.039	27.7	0.585	-102.2
10.500	0.324	151.4	3.496	-0.8	0.046	26.7	0.601	-108.3
11.000	0.322	136.9	3.478	-8.9	0.054	22.8	0.603	-115.7
11.500	0.334	121.1	3.437	-17.1	0.061	16.8	0.589	-123.4
12.000	0.360	106.5	3.385	-25.4	0.067	11.0	0.575	-131.2
12.500	0.391	94.3	3.331	-33.8	0.072	5.2	0.568	-139.5
13.000	0.425	84.5	3.268	-42.5	0.078	-0.9	0.571	-149.0
13.500	0.457	75.2	3.19	-51.5	0.082	-7.1	0.575	-158.9
14.000	0.491	66.5	3.108	-60.2	0.085	-13.0	0.578	-168.4
14.500	0.530	57.1	3.01	-68.7	0.088	-19.7	0.569	-177.0
15.000	0.561	47.5	2.924	-76.9	0.091	-24.9	0.559	175.2
15.500	0.588	37.8	2.852	-85.0	0.094	-31.0	0.557	167.7
16.000	0.597	29.2	2.797	-93.4	0.095	-37.5	0.569	157.6
16.500	0.611	21.1	2.736	-102.1	0.097	-42.9	0.576	146.2
17.000	0.634	12.5	2.672	-111.1	0.102	-50.7	0.574	134.2
17.500	0.660	4.7	2.578	-120.4	0.101	-58.3	0.572	122.2
18.000	0.683	-1.5	2.455	-129.5	0.099	-65.8	0.577	109.8
18.500	0.688	-4.7	2.307	-137.5	0.096	-72.3	0.593	98.4
19.000	0.673	-6.5	2.173	-144.8	0.093	-78.1	0.611	88.2
19.500	0.656	-8.0	2.056	-151.9	0.090	-84.1	0.623	79.9
20.000	0.646	-13.5	1.987	-158.5	0.090	-91.2	0.634	75.9
20.500	0.641	-22.8	1.929	-166.0	0.089	-98.8	0.639	73.7
21.000	0.647	-33.9	1.882	-174.5	0.089	-106.4	0.640	69.8
21.500	0.661	-43.2	1.839	176.4	0.088	-115.1	0.623	60.8
22.000	0.672	-50.7	1.788	166.3	0.089	-124.1	0.610	47.9
22.500	0.669	-57.0	1.722	156.4	0.088	-133.9	0.608	34.5
23.000	0.670	-62.2	1.647	147.6	0.088	-140.9	0.611	23.5
23.500	0.653	-69.2	1.594	140.0	0.087	-151.0	0.617	15.6
24.000	0.643	-77.0	1.56	131.3	0.090	-157.1	0.610	7.1
24.500	0.610	-81.0	1.538	123.8	0.089	-166.0	0.602	-1.1
25.000	0.586	-86.1	1.553	115.8	0.096	-175.0	0.586	-8.5
25.500	0.555	-92.5	1.586	107.4	0.103	175.2	0.561	-13.3
26.000	0.559	-105.7	1.612	96.8	0.110	165.6	0.527	-21.0

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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. Package leads are gold plated.

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. 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 1. 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.

Application Notes and Design Data

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

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.

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	FPD200P70
5.15GHz to 5.8GHz Evaluation Board	EB200P70-AJ

Quantity	Ordering Code
Reel of 1000	FPD200P70
Reel of 100	FPD200P70SR
Bag of 25	FPD200P70SQ
Bag of 5	FPD200P70SB

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