

HIGH FREQUENCY PACKAGED PHEMT

FEATURES:

- 20 dBm Output Power (P_{1dB})
- 17 dB Gain at 5.8 GHz
- 0.7 dB Noise Figure at 5.8 GHz
- 30 dBm Output IP3
- 45% Power-Added Efficiency
- Useable Gain to 26 GHz

PACKAGE



RoHS



GENERAL DESCRIPTION:

The FPD200P70 is a packaged depletion mode AlGaAs/InGaAs pseudomorphic High Electron Mobility Transistor (pHEMT). It utilizes a 0.25 mm x 200 mm Schottky barrier Gate, defined by high-resolution stepper-based photolithography.

TYPICAL APPLICATIONS:

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

TYPICAL PERFORMANCE:

RF PARAMETER	SYMBOL	CONDITIONS	1.85GHz	5.8GHz	18GHz	UNITS
Power at 1dB Gain Compression	P1dB	VDS = 5 V; IDS = 30mA	20	19	20	dBm
Small Signal Gain	SSG	VDS = 5 V; IDS = 30mA	21	17	9	dB
Power-Added Efficiency	PAE	VDS = 5 V; IDS = 30mA POUT = P1dB	45	45	45	%
Maximum Stable Gain (S21/S12)	MSG	VDS = 5 V; IDS = 30mA	24	21	14	
Minimum Noise Figure	NFmin	VDS = 5 V; IDS = 30mA	0.3	0.7	2.2	dB
Output Third-Order Intercept Point POUT = 9 dBm per Tone	IP3	VDS = 5V; IDS = 30mA VDS = 8V; IDS = 30mA	29 31	28 30	28.5 31	dBm

ELECTRICAL SPECIFICATIONS:

DC PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Saturated Drain-Source Current	IDSS	VDS = 1.3 V; VGS = 0 V	45	60	75	mA
Maximum Drain-Source Current	IMAX	VDS = 1.3 V; VGS \cong +1 V		120		mA
Transconductance	GM	VDS = 1.3 V; VGS = 0 V		80		mS
Gate-Source Leakage Current	IGSO	VGS = -5 V		1	10	μ A
Pinch-Off Voltage	VP	VDS = 1.3 V; IDS = 0.2 mA	0.7	0.9	1.3	V
Gate-Source Breakdown Voltage	VBDGS	IGS = 0.2 mA	12	14		V
Gate-Drain Breakdown Voltage	VBDGD	IGD = 0.2 mA	14.5	16		V
Thermal Resistivity (see Notes)	θ_{JC}	VDS > 3V		325		$^{\circ}$ C/W

Note: $T_{AMBIENT} = 22^{\circ}$

ABSOLUTE MAXIMUM RATING¹:

PARAMETER	SYMBOL	TEST CONDITIONS	ABSOLUTE MAXIMUM
Drain-Source Voltage	VDS	-3V < VGS < -0.5V	8V
Gate-Source Voltage	VGS	0V < VDS < +8V	-3V
Drain-Source Current	IDS	For VDS > 2V	IDSS
Gate Current	IG	Forward or reverse current	5mA
RF Input Power ²	PIN	Under any acceptable bias state	16dBm
Channel Operating Temperature	TCH	Under any acceptable bias state	175°C
Storage Temperature	TSTG	Non-Operating Storage	-40°C to 150°C
Total Power Dissipation	PTOT	See De-Rating Note below	470mW
Simultaneous Combination of Limits ⁴		2 or more Max. Limits	80%

Notes:

¹T_{Ambient} = 22°C unless otherwise noted; exceeding any one of these absolute maximum ratings may cause permanent damage to the device

²Max. RF Input Limit must be further limited if input VSWR > 2.5:1

³Users should avoid exceeding 80% of 2 or more Limits simultaneously

⁴Total 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:

$$P_{TOT} = 0.47 - (1/R\theta_{JC}) \times T_{PACK}$$

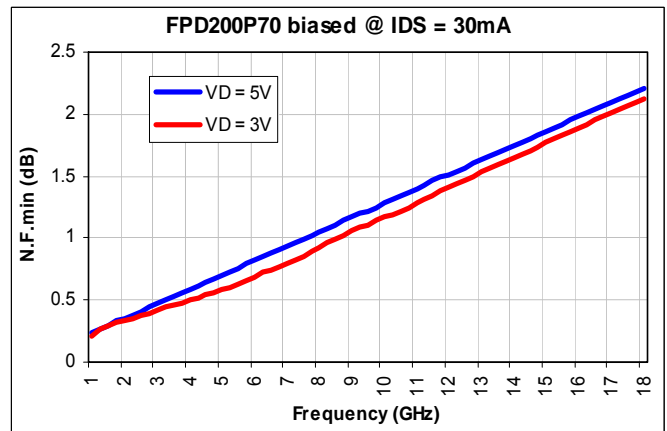
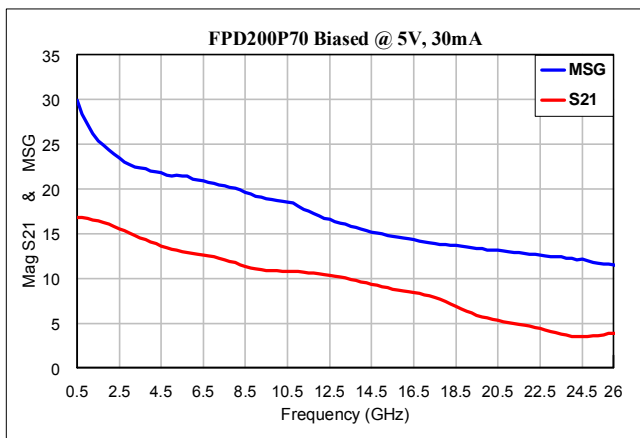
where T_{PACK} = source tab lead temperature above 22°C

(coefficient of de-rating formula is the Thermal Conductivity)

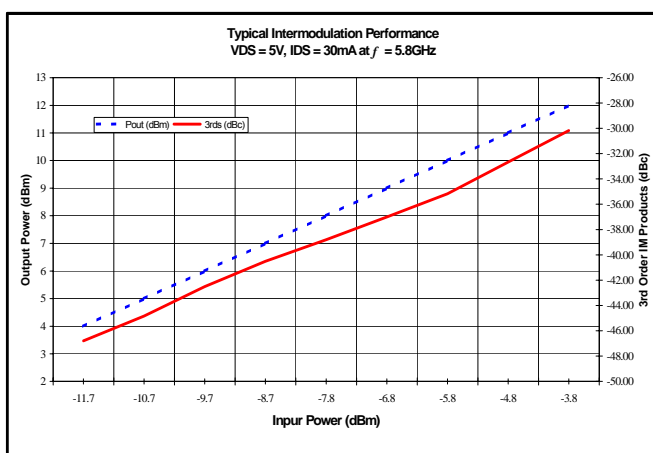
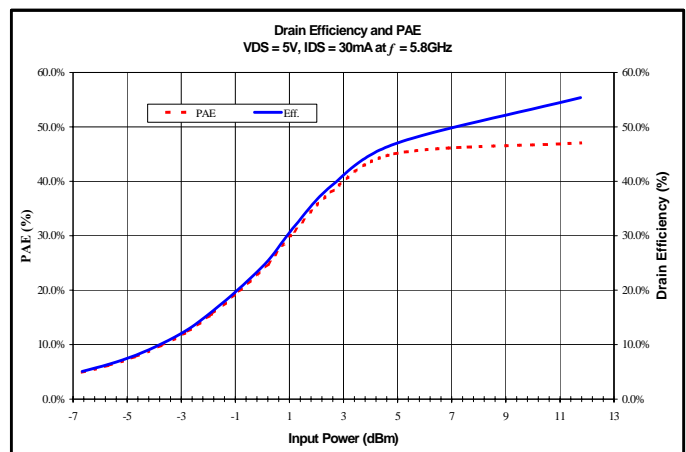
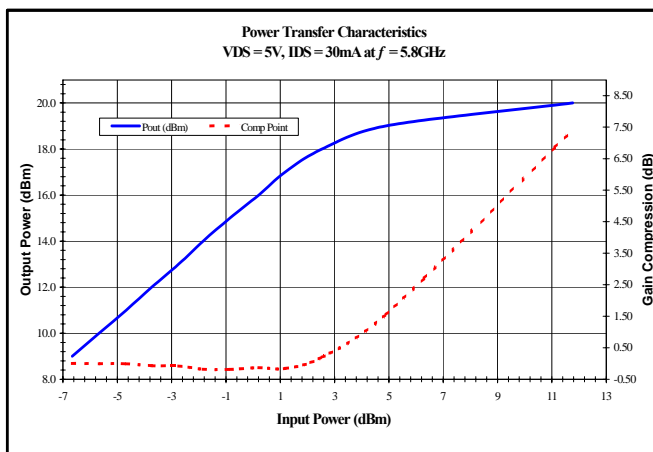
Example: For a 65°C carrier temperature: $P_{TOT} = 470mW - (3 \times (65 - 22)) = 341mW$

BIASING GUIDELINES:

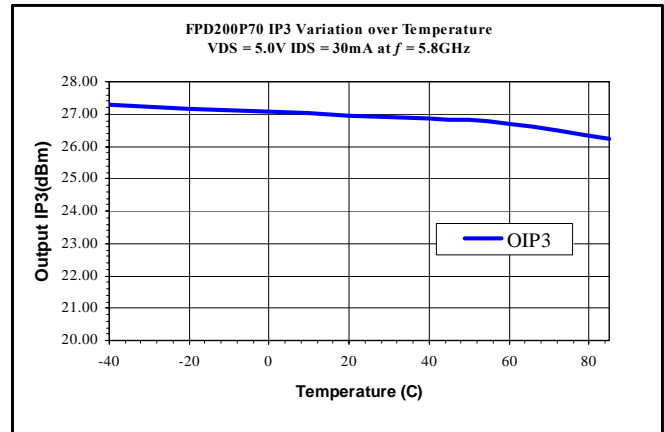
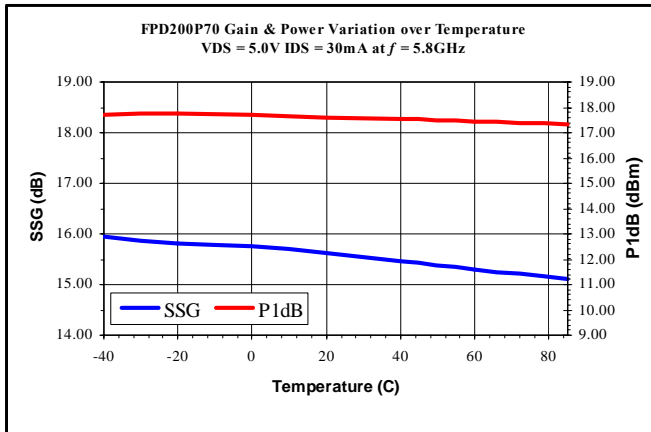
- Active bias circuits provide good performance stabilization over variations of operating temperature, but require a larger number of components compared to self-bias or dual-biased. Such circuits should include provisions to ensure that Gate bias is applied before Drain bias, otherwise the pHEMT may 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 IDSS 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 IDSS. To achieve a larger separation between P1dB and IP3, an operating point in the 25% to 33% of IDSS range is suggested. Such Class AB operation will not degrade the IP3 performance.

TYPICAL FREQUENCY RESPONSE


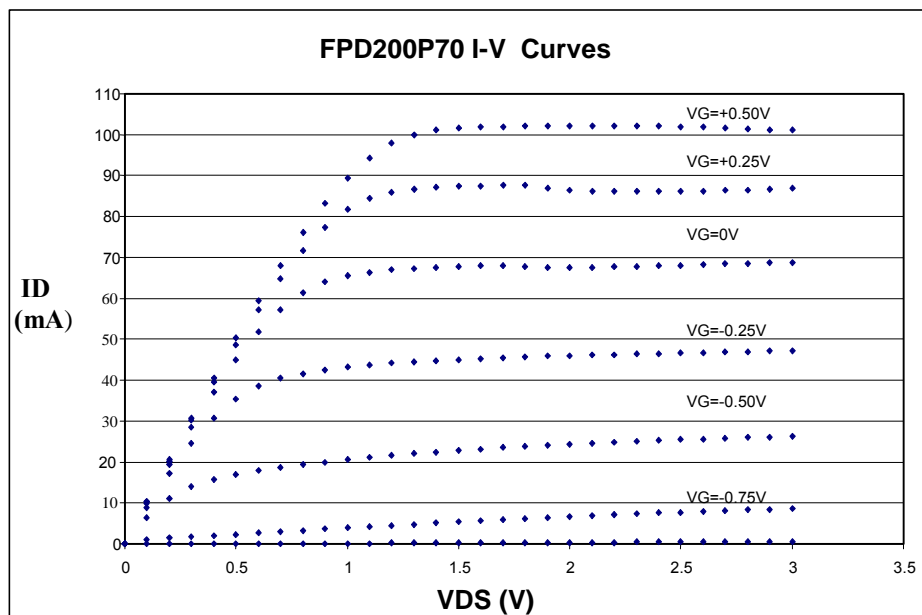
NOTE: Tuned Noise figure variation against frequency is shown above. The devices were biased nominally at $V_{DS} = 5V$, $I_{DS} = 30mA$. The test devices were tuned for minimum noise figure using tuners at the device input and output ports. See Noise Parameter tables for tuned reflection coefficients.

TYPICAL RF PERFORMANCE


NOTE: Typical Power, Efficiency and Intermodulation is shown above. The devices were biased nominally at $V_{DS} = 5V$, $I_{DS} = 30mA$ at a test frequency of 5.8 GHz. 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 5.8 GHz on eval board. The eval 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).

NOISE PARAMETERS

Biased at 5V, 30mA

Freq (GHz)	Γ_{opt}		Rn/50
	Mag.	Angle	
0.800	0.788	10.9	0.454
0.900	0.788	12.1	0.443
1.000	0.788	13.2	0.433
1.500	0.787	19.1	0.386
1.800	0.784	22.6	0.362
2.000	0.782	24.9	0.347
2.200	0.778	27.2	0.334
2.400	0.774	29.6	0.321
2.600	0.769	31.9	0.310
2.800	0.763	34.2	0.300
3.300	0.746	39.9	0.280
3.500	0.738	42.2	0.274
3.700	0.730	44.5	0.269
4.000	0.715	47.9	0.263
4.500	0.688	53.5	0.257
4.900	0.662	58.0	0.255
5.100	0.649	60.2	0.255
5.300	0.634	62.4	0.255
5.500	0.619	64.7	0.255
5.700	0.604	66.9	0.255
5.900	0.587	69.1	0.256
7.000	0.470	78.6	0.214
8.000	0.367	90.8	0.177
9.000	0.281	97.7	0.171
10.000	0.239	108.3	0.161
11.000	0.185	109.7	0.158
12.000	0.124	127.3	0.147
13.000	0.031	-152.8	0.174
14.000	0.118	-76.9	0.216
15.000	0.244	-41.0	0.290

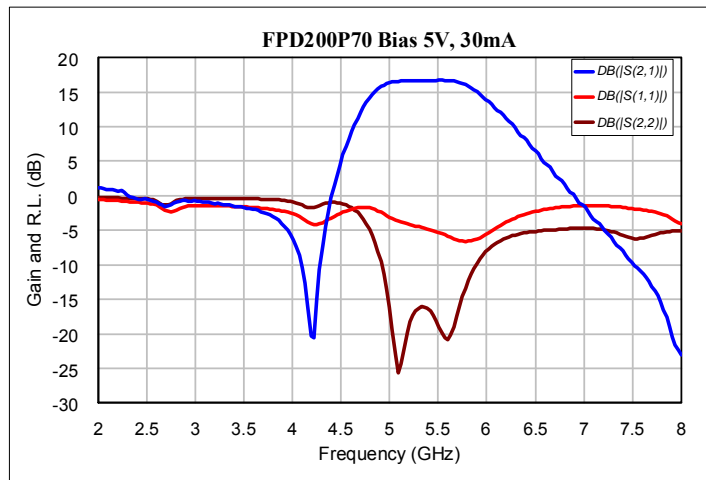
Biased at 3V, 30mA

Freq (GHz)	Γ_{opt}		Rn/50
	Mag.	Angle	
0.800	0.795	12.2	0.356
0.900	0.782	13.5	0.352
1.000	0.769	14.8	0.349
1.500	0.708	21.2	0.330
1.800	0.675	25.0	0.320
2.000	0.654	27.6	0.313
2.200	0.634	30.1	0.307
2.400	0.615	32.7	0.301
2.600	0.598	35.2	0.295
2.800	0.581	37.7	0.290
3.300	0.544	43.9	0.277
3.500	0.531	46.4	0.273
3.700	0.519	48.9	0.268
4.000	0.504	52.6	0.262
4.500	0.483	58.7	0.253
4.900	0.470	63.6	0.247
5.100	0.466	66.0	0.245
5.300	0.463	68.4	0.242
5.500	0.460	70.8	0.240
5.700	0.459	73.2	0.237
5.900	0.459	75.6	0.235
7.000	0.455	81.4	0.202
8.000	0.355	94.7	0.167
9.000	0.267	102.9	0.161
10.000	0.222	114.1	0.154
11.000	0.164	116.6	0.153
12.000	0.103	138.1	0.147
13.000	0.043	-128.1	0.176
14.000	0.129	-72.4	0.223
15.000	0.249	-36.9	0.300

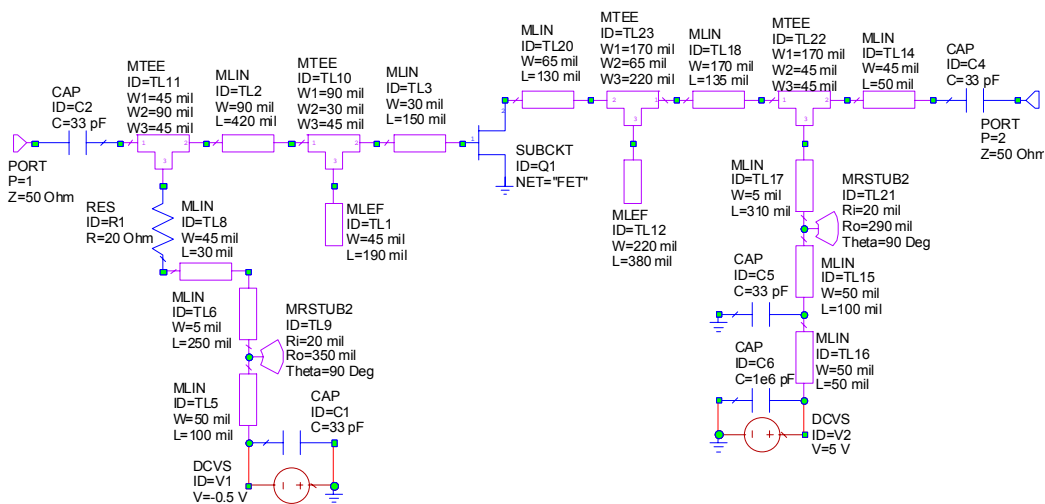
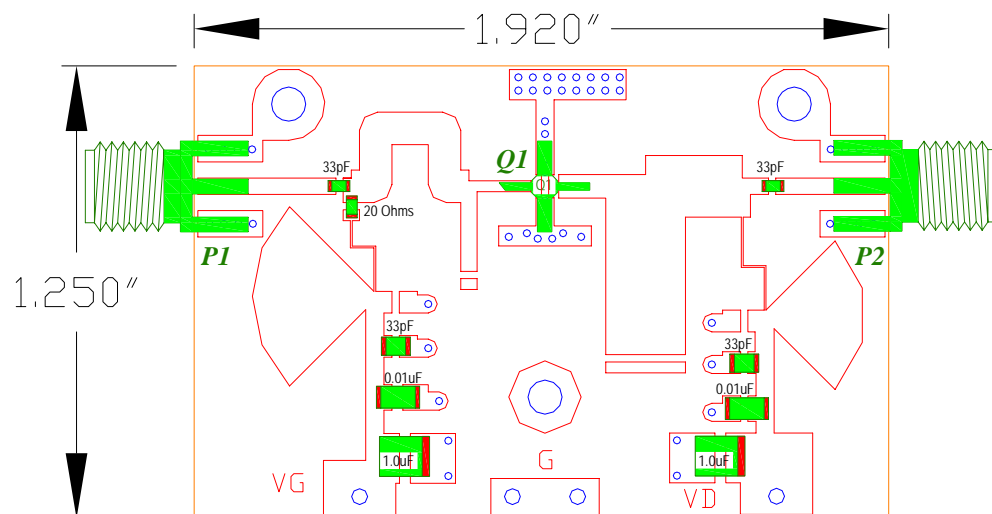
REFERENCE DESIGN 5.15 TO 5.8 GHz

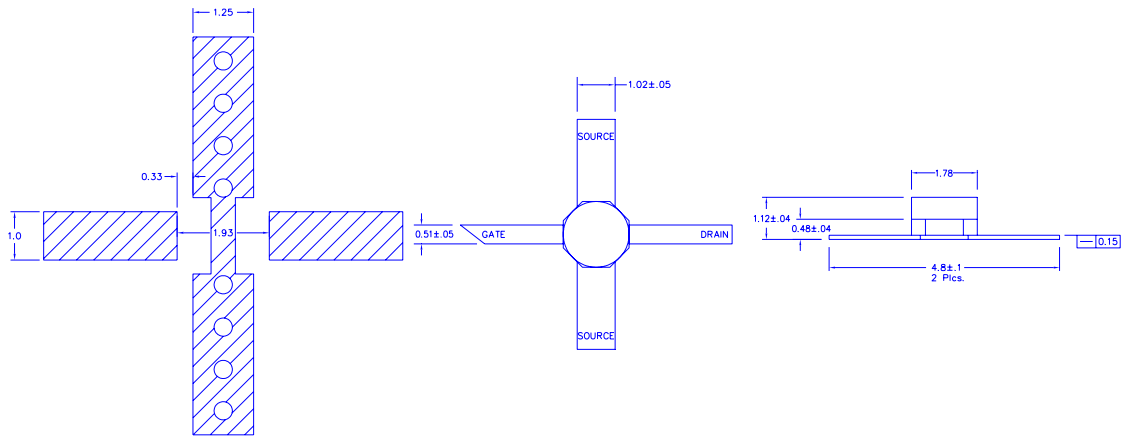
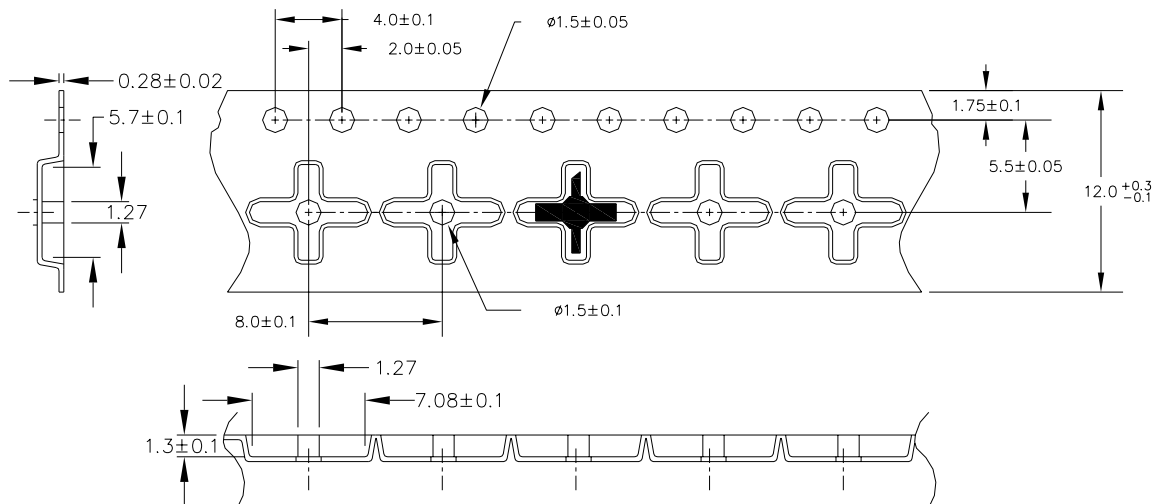
FREQUENCY	GHZ	5.5
Gain	dB	17
N.F.	dB	1.0
P1dB	dBm	16.5
IP3	dBm	28
Vd	V	5
Vg	V	-0.4 to -0.6
Id	mA	30

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



Measured Evaluation board gain and return Loss

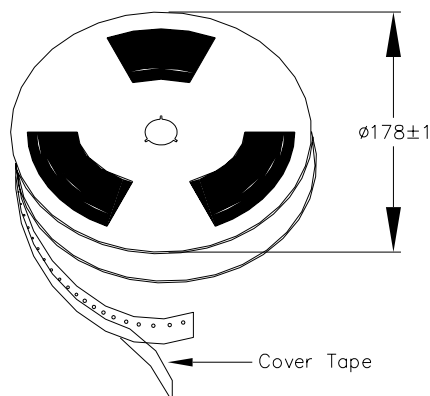
SCHEMATIC

BOARD LAYOUT


P70 PACKAGE OUTLINE AND RECOMMENDED PC BOARD LAYOUT

TAPE AND REEL DIMENSIONS AND PART ORIENTATION


DIMENSIONS ARE IN MM

Product Marking

The device is marked ABC where :-

 A = Product type
 B = Week code
 C = Year code


- Terminal tape = 40mm(min.)
- Leader tape with empty Cavities = 350mm(min.)
- Trailer tape with empty Cavities = 160mm(min.)
- Devices per reel = 1000

S-PARAMETERS BIASED @ 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

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.


ESD/MSL RATING:

These devices should be treated as Class 0 (0V - 250V) using the human body model as defined in JEDEC Standard No. 22-A114.

The device has a 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 & DESIGN DATA:

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

RELIABILITY:

A 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:

PART NUMBER	DESCRIPTION
FPD200P70	Packaged pHEMT
EB200P70-AJ	5.15 to 5.8GHz evaluation board