



### Product Description

The FPD6836P70 is a low parasitic, surface mountable packaged depletion mode pseudomorphic High Electron Mobility Transistor (pHEMT) optimised for low-noise, high-frequency applications.

#### 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

- 22dBm Output Power (P1dB)
- 15dB Gain at 5.8GHz
- 0.8dB Noise Figure at 5.8GHz
- 32dB Output IP<sub>3</sub> at 5.8GHz
- 45% Power-Added Efficiency at 5.8GHz
- Usable Gain to 18GHz

### Applications

- Gain blocks and medium power stages
- WiMax (2GHz to 11GHz)
- WLAN 802.11a (5.8GHz)
- Point-to-Point Radio (to 18GHz)

Parameter	Specification			Unit	Condition
	Min.	Typ.	Max.		
P <sub>1dB</sub> at Gain Compression		22		dBm	V <sub>DS</sub> =5V, I <sub>DS</sub> =55mA
Small-Signal Gain (SSG)	14	16		dB	V <sub>DS</sub> =5V, I <sub>DS</sub> =55mA
PAE		45		%	V <sub>DS</sub> =5V, I <sub>DS</sub> =55mA, P <sub>OUT</sub> =P <sub>1dB</sub>
Maximum Stable Gain ( S <sub>21</sub> /S <sub>12</sub>  )		15			V <sub>DS</sub> =5V, I <sub>DS</sub> =55mA, f=12GHz
		12			V <sub>DS</sub> =5V, I <sub>DS</sub> =55mA, f=18GHz
Noise Figure (NF)		0.8		dB	V <sub>DS</sub> =5V, I <sub>DS</sub> =55mA
OIP <sub>3</sub>		32		dBm	V <sub>DS</sub> =5V, I <sub>DS</sub> =55mA, P <sub>OUT</sub> =10dBm SCL
Saturated Drain-Source Current (I <sub>DSS</sub> )	90	105	135	mA	V <sub>DS</sub> =1.3V, V <sub>GS</sub> =0V
Maximum Drain-Source Current (I <sub>MAX</sub> )		215		mA	V <sub>DS</sub> =1.3V, V <sub>GS</sub> =+1V
Transconductance (GM)		140		ms	V <sub>DS</sub> =1.3V, V <sub>GS</sub> =0V
Gate-Source Leakage Current (I <sub>GSO</sub> )		1	10	µA	V <sub>GS</sub> =-5V
Pinch-Off Voltage (V <sub>P</sub> )	0.7	1.0	1.3	V	V <sub>DS</sub> =1.3V, I <sub>DS</sub> =0.2mA
Gate-Source Breakdown Voltage (V <sub>BDS</sub> )	12	14		V	I <sub>GS</sub> =0.36mA
Gate-Drain Breakdown Voltage (V <sub>BGD</sub> )	14.5	16		V	I <sub>GD</sub> =0.36mA
Thermal Resistivity (θJC) *		275		°C/W	

\*Note: T<sub>AMBIENT</sub>=22°C, RF specification measured at f=5.8GHz using CW signal (except as noted).

## Absolute Maximum Ratings<sup>1</sup>

Parameter	Rating	Unit
Drain-Source Voltage ( $V_{DS}$ ) ( $-3V < V_{GS} < 0V$ )	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)	10	mA
RF Input Power ( $P_{IN}$ ) <sup>2</sup> (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 ( $P_{TOT}$ ) <sup>3, 4, 5</sup>	550	mW
Simultaneous Combination of Limits <sup>6</sup> (2 or more max. limits)	80	%

Notes:

<sup>1</sup> $T_{AMBIENT}$  = 22 °C unless otherwise noted; exceeding any one of these absolute maximum ratings may cause permanent damage to the device.

<sup>2</sup>Max. RF input limit must be further limited if input VSWR > 2.5:1.

<sup>3</sup>Users should avoid exceeding 80% of 2 or more Limits simultaneously.

<sup>4</sup>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:

$P_{TOT} = 550 \text{ mW} - (1/R\theta_{JC}) \times T_{PACK}$ , where  $T_{PACK}$  = source tab lead temperature above 22 °C.

Example: For a 65 °C carrier temperature:  $P_{TOT} = 550 \text{ mW} - (3.6 \times (65 - 22)) = 323 \text{ mW}$



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).

The information in this publication is believed to be accurate and reliable. However, no responsibility is assumed by RF Micro Devices, Inc. ("RFMD") for its use, nor for any infringement of patents, or other rights of third parties, resulting from its use. No license is granted by implication or otherwise under any patent or patent rights of RFMD. RFMD reserves the right to change component circuitry, recommended application circuitry and specifications at any time without prior notice.

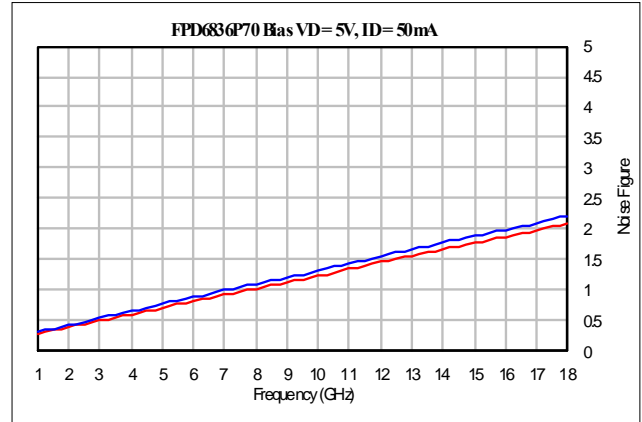
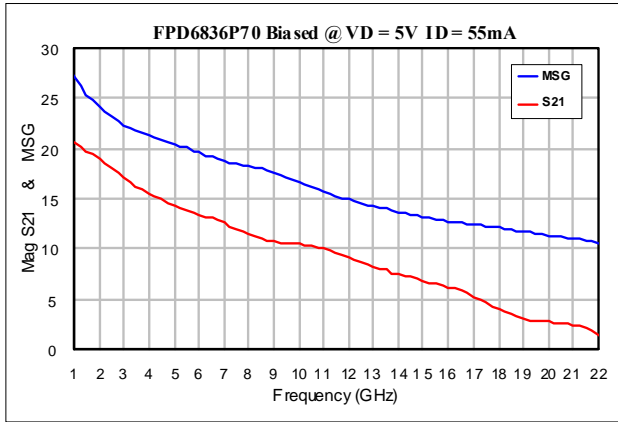
## Biassing Guidelines

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 such as the FPD6836P70.

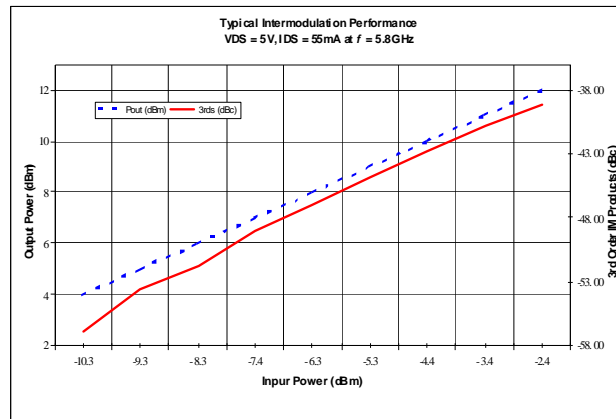
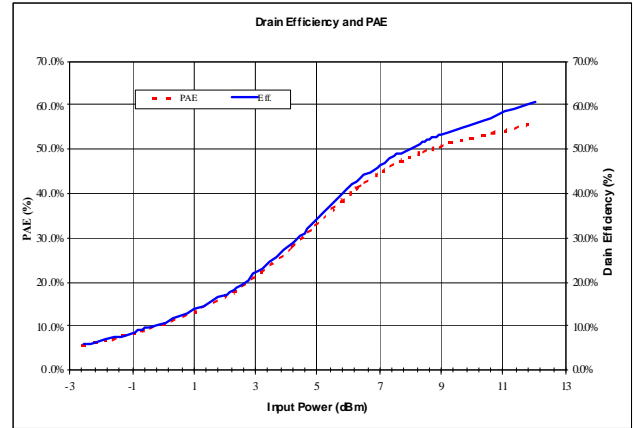
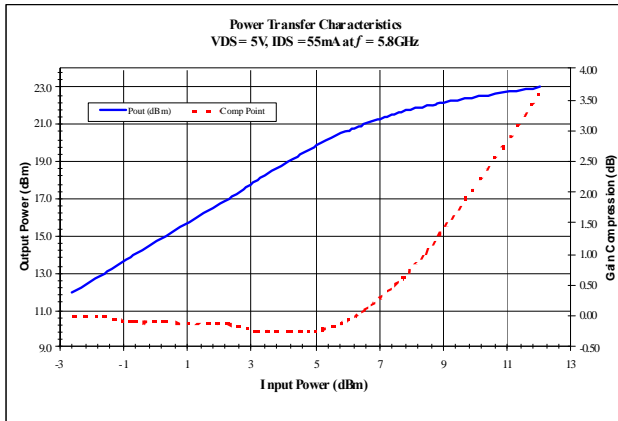
For standard Class A operation, a 50% of  $I_{DSS}$  bias point is recommended. A small amount of RF gain expansion prior to the onset of compression is normal for this operating point. Class AB bias of 25% to 33% of  $I_{DSS}$  offers an optimized solution for NF and OIP<sub>3</sub>.

### Typical Frequency Response



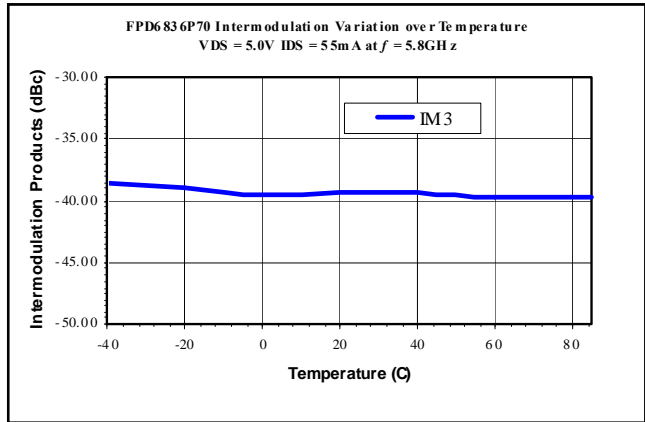
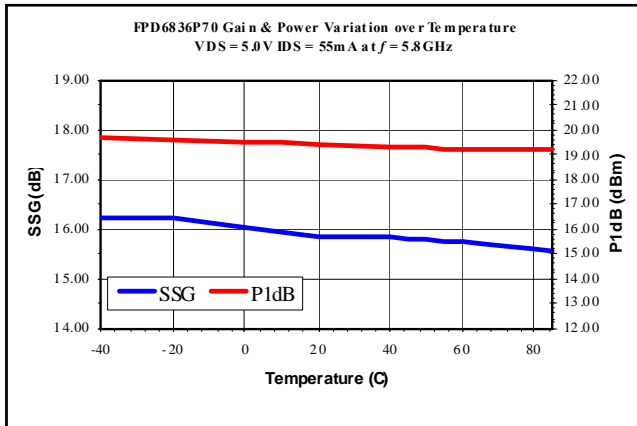
Note: Tuned noise figure variation against frequency is shown above. The devices were biased nominally at  $V_{DS}=5V$ ,  $I_{DS}=50mA$ . The test devices were tuned for minimum noise figure and maximum gain using tuners at the device input and output ports.

### Typical RF Performance



Note: Typical Power, efficiency, and intermodulation is shown above. The devices were biased nominally at  $V_{DS}=5V$ ,  $I_{DS}=55mA$  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  $V_{DS}=5V$ ,  $I_{DS}=55mA$  at a test frequency of 5.8GHz on eval 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.

## Noise Parameters

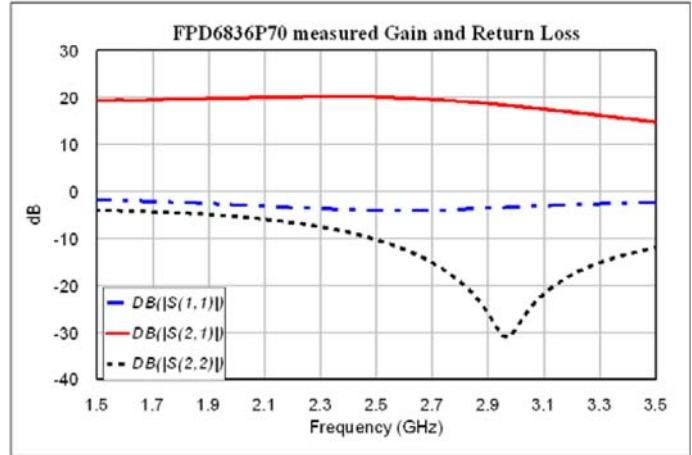
Biased at 5V, 50mA

Freq (GHz)	F(min) (dB)	$\Gamma_{Opt}$ Mag	$\Gamma_{Opt}$ Angle	Normalized Rn (Z0=50)
0.800	0.22	0.752	13.7	0.227
0.900	0.25	0.747	15.1	0.221
1.000	0.28	0.741	16.6	0.216
1.800	0.36	0.696	28.4	0.180
2.000	0.39	0.684	31.4	0.173
2.200	0.41	0.671	34.5	0.166
2.400	0.44	0.659	37.6	0.160
2.600	0.46	0.646	40.7	0.155
2.800	0.48	0.633	43.9	0.150
3.000	0.49	0.619	47.1	0.146
3.300	0.52	0.599	51.9	0.140
3.500	0.55	0.584	55.1	0.136
3.700	0.56	0.570	58.4	0.133
4.000	0.60	0.548	63.4	0.129
4.500	0.65	0.510	71.8	0.123
4.900	0.68	0.478	78.7	0.119
5.100	0.72	0.462	82.2	0.117
5.300	0.74	0.445	85.7	0.115
5.500	0.76	0.428	89.2	0.114
5.700	0.78	0.411	92.8	0.112
5.900	0.81	0.394	96.4	0.111
7.000	0.92	0.279	118.1	0.095
8.000	1.02	0.198	147.4	0.097
9.000	1.13	0.127	-175.9	0.117
10.000	1.24	0.146	-136.3	0.128
11.000	1.34	0.152	-90.8	0.171
12.000	1.45	0.233	-71.2	0.211
13.000	1.55	0.312	-50.7	0.317
14.000	1.66	0.392	-46.8	0.400
15.000	1.77	0.535	-28.5	0.526
18.000	2.09	0.948	83.1	0.655

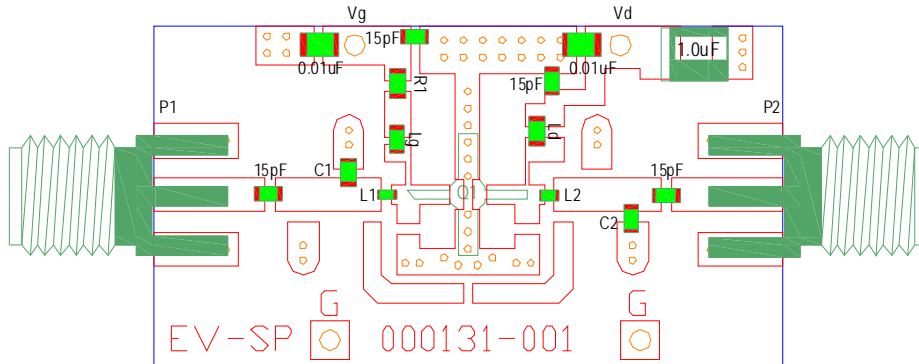
**Reference Design (2.6GHz)**

Parameter	Typical	Unit
Gain	20	dB
P1dB	17	dBm
IP <sub>3</sub>	30	dBm
NF	0.65	dB
S <sub>11</sub>	-4	
S <sub>22</sub>	-12	
V <sub>D</sub>	3	V
V <sub>G</sub>	-0.4 to -0.6	V
I <sub>D</sub>	50	mA

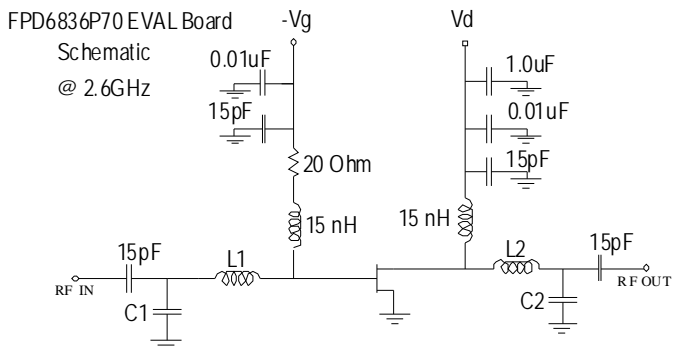
OIP<sub>3</sub> measured at POUT of 6 dBm per tone.



**Evaluation Board Layout**



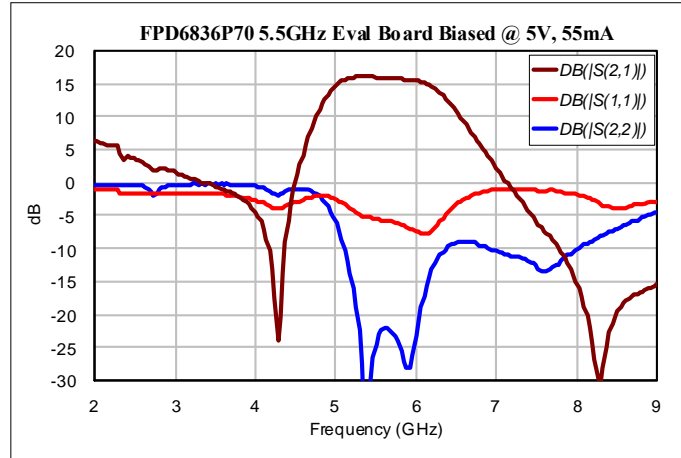
Component	Value	Description
Lg, Ld	15 nH	LQW18AN Murata chip inductor
L1	2.2 nH	LL1005FHL Toko chip inductor
L2	1.5 nH	LL1005FHL Toko chip inductor
C1, C2	0.5 pF	ATC 600S Chip Capacitor
15pFx4	15 pF	ATC 600S Chip Capacitor
0.01uFx4	0.01 uF	ATC 0805X7R Chip Capacitor
1.0uF	1.0 uF	B-Case Tantallum Chip Capacitor
R1	20 Ω	0402 size chip resistor (100mW)
P1, P2		PCB Edge mount RF connector



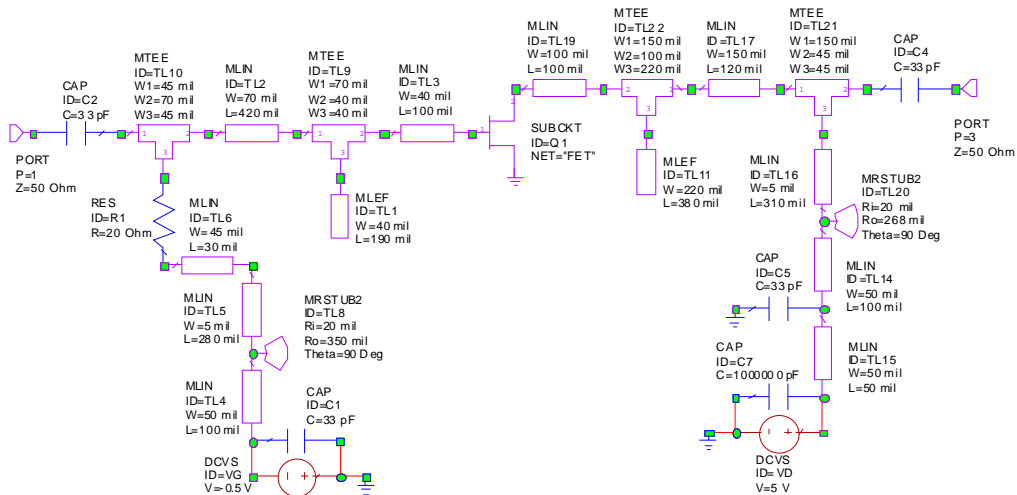
Evaluation board material: 31mil thick FR4 with 1/2 ounce Cu on both sides.

## Reference Design (5.15GHz to 5.85 GHz)

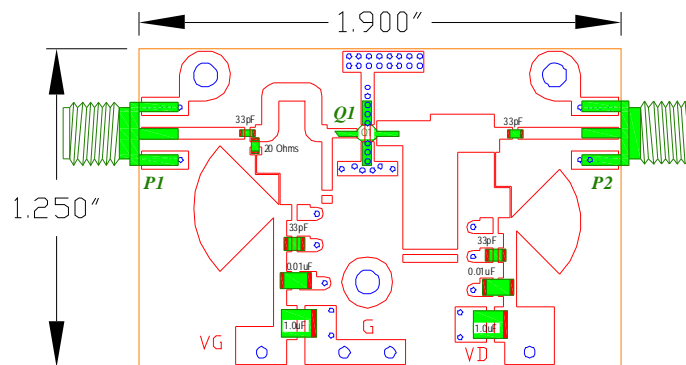
Parameter	Typical	Unit
Frequency	5.5	GHz
Gain	16	dB
NF	1.0	dB
P1dB	19.5	dBm
IP <sub>3</sub>	30	dBm
S <sub>11</sub>	-6	
S <sub>22</sub>	-26	
V <sub>D</sub>	5	V
V <sub>G</sub>	-0.4 to -0.6	V
I <sub>D</sub>	55	mA



## Schematic



## Evaluation Board Layout



**S-Parameters**  
(Biased at 5V, 55mA)

FREQ[GHz]	S11m	S11a	S21m	S21a	S12m	S12a	S22m	S22a
0.500	0.976	-20.9	11.395	161.5	0.011	78.3	0.635	-11.5
0.750	0.953	-31.4	11.087	153.2	0.016	72.8	0.626	-17.0
1.000	0.925	-41.3	10.729	145.1	0.021	67.8	0.614	-22.2
1.250	0.894	-51.2	10.279	137.3	0.025	62.9	0.598	-26.9
1.500	0.860	-60.7	9.807	130.0	0.029	58.6	0.583	-30.9
1.750	0.827	-69.7	9.315	123.1	0.032	54.8	0.567	-34.6
2.000	0.796	-78.2	8.842	116.7	0.034	51.4	0.553	-37.9
2.250	0.767	-86.3	8.385	110.6	0.036	48.1	0.540	-40.8
2.500	0.742	-93.6	7.951	104.9	0.038	46.0	0.528	-43.6
2.750	0.718	-100.5	7.554	99.5	0.040	42.6	0.517	-46.2
3.000	0.694	-106.8	7.180	94.5	0.041	40.4	0.506	-48.9
3.250	0.672	-112.6	6.833	89.6	0.042	38.5	0.496	-51.2
3.500	0.650	-117.8	6.521	85.1	0.043	36.3	0.487	-53.5
3.750	0.629	-122.6	6.232	80.9	0.043	34.7	0.479	-55.5
4.000	0.614	-127.3	6.002	76.7	0.044	33.9	0.475	-57.7
4.250	0.600	-132.1	5.788	72.7	0.045	33.4	0.471	-59.5
4.500	0.587	-136.8	5.605	68.5	0.046	32.1	0.467	-62.3
4.750	0.571	-142.0	5.418	64.2	0.048	30.0	0.460	-64.6
5.000	0.555	-147.0	5.249	60.3	0.048	28.4	0.453	-66.4
5.250	0.540	-152.4	5.096	56.3	0.048	26.8	0.447	-68.2
5.500	0.529	-158.0	4.967	52.3	0.049	26.0	0.443	-70.0
5.750	0.521	-163.8	4.850	48.1	0.051	25.4	0.441	-72.6
6.000	0.511	-170.2	4.729	43.7	0.052	23.3	0.438	-76.0
6.250	0.504	-176.6	4.606	39.5	0.054	21.1	0.428	-78.8
6.500	0.499	177.0	4.498	35.3	0.055	19.2	0.418	-81.2
6.750	0.496	170.4	4.377	31.0	0.056	17.0	0.405	-84.3
7.000	0.493	163.9	4.261	26.8	0.057	14.0	0.391	-87.6
7.250	0.492	157.5	4.135	22.5	0.057	11.9	0.376	-90.7
7.500	0.491	151.2	4.007	18.4	0.058	9.4	0.361	-93.6
7.750	0.483	145.5	3.876	14.8	0.057	7.6	0.348	-96.1
8.000	0.486	140.4	3.784	11.2	0.057	6.4	0.340	-99.1
8.250	0.483	135.3	3.679	7.5	0.057	4.8	0.333	-101.7
8.500	0.479	130.8	3.588	4.1	0.058	5.0	0.331	-104.6
8.750	0.475	126.5	3.509	0.9	0.058	4.5	0.330	-107.2
9.000	0.473	122.5	3.448	-2.4	0.059	5.2	0.332	-109.6
9.250	0.473	118.4	3.415	-5.6	0.062	5.6	0.340	-112.7
9.500	0.476	114.1	3.397	-9.1	0.066	5.0	0.347	-116.0
9.750	0.483	109.1	3.376	-13.2	0.070	3.1	0.354	-120.7
10.000	0.488	103.4	3.339	-17.3	0.073	0.9	0.355	-124.8
10.250	0.495	97.7	3.312	-21.4	0.077	-1.5	0.360	-129.3
10.500	0.507	91.7	3.279	-25.9	0.080	-3.5	0.360	-134.3
10.750	0.521	85.7	3.229	-30.4	0.083	-6.7	0.357	-139.9
11.000	0.539	79.8	3.166	-35.0	0.086	-10.1	0.349	-145.6
11.250	0.560	74.3	3.091	-39.4	0.089	-12.3	0.338	-151.3
11.500	0.581	69.2	3.021	-43.7	0.091	-15.6	0.327	-157.2
11.750	0.603	64.8	2.945	-47.8	0.093	-18.5	0.316	-163.3
12.000	0.626	60.8	2.877	-51.9	0.095	-21.4	0.307	-169.6
12.250	0.645	57.1	2.804	-56.0	0.096	-24.2	0.300	-176.1
12.500	0.662	53.7	2.738	-60.1	0.097	-26.8	0.295	177.6
12.750	0.675	50.5	2.666	-64.2	0.098	-29.7	0.293	171.3
13.000	0.685	47.6	2.604	-68.2	0.100	-32.5	0.295	165.3

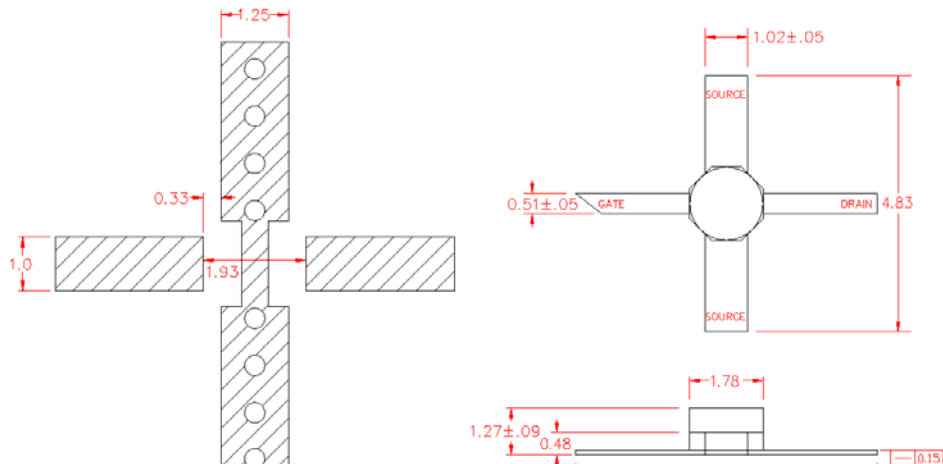
## S-Parameters, continued

(Biased at 5V, 55 mA)

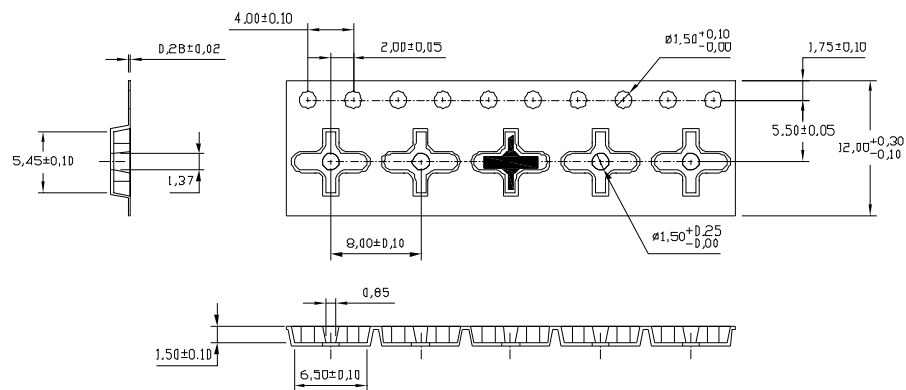
FREQ[GHz]	S11m	S11a	S21m	S21a	S12m	S12a	S22m	S22a
13.250	0.693	44.9	2.545	-72.1	0.101	-35.0	0.299	159.0
13.500	0.701	42.1	2.488	-76.1	0.102	-37.8	0.302	153.3
13.750	0.711	39.3	2.434	-79.9	0.103	-40.4	0.308	147.9
14.000	0.724	36.2	2.392	-83.8	0.106	-43.3	0.312	142.7
14.250	0.738	32.8	2.347	-87.7	0.107	-46.7	0.314	138.2
14.500	0.755	29.1	2.307	-91.8	0.107	-48.9	0.317	133.8
14.750	0.771	25.2	2.262	-95.7	0.109	-51.8	0.318	129.6
15.000	0.787	20.9	2.225	-99.7	0.109	-55.1	0.320	125.4
15.250	0.800	17.0	2.184	-103.8	0.110	-58.6	0.323	120.5
15.500	0.808	13.2	2.144	-107.9	0.112	-61.9	0.326	115.7
15.750	0.813	9.2	2.110	-112.2	0.112	-65.3	0.334	110.0
16.000	0.818	5.2	2.067	-116.6	0.112	-68.4	0.340	103.9
16.250	0.822	1.3	2.024	-121.1	0.113	-71.6	0.348	97.3
16.500	0.822	-2.4	1.973	-125.6	0.112	-75.7	0.357	90.3
16.750	0.824	-5.9	1.915	-130.0	0.111	-78.8	0.366	82.9
17.000	0.831	-9.6	1.855	-134.4	0.108	-83.5	0.373	76.1
17.250	0.839	-12.5	1.788	-138.4	0.108	-86.4	0.379	69.3
17.500	0.845	-15.3	1.721	-142.1	0.106	-88.7	0.387	63.5
17.750	0.852	-17.6	1.663	-145.7	0.105	-92.6	0.396	58.6
18.000	0.852	-19.5	1.603	-148.6	0.103	-94.2	0.406	54.7
18.250	0.848	-20.5	1.553	-151.4	0.102	-96.3	0.418	51.6
18.500	0.841	-20.9	1.508	-154.2	0.102	-98.6	0.429	48.5
18.750	0.829	-20.6	1.473	-156.6	0.100	-100.6	0.437	46.0
19.000	0.815	-20.5	1.440	-159.3	0.102	-103.0	0.449	43.1
19.250	0.805	-20.7	1.415	-161.9	0.102	-105.7	0.456	40.7
19.500	0.796	-21.6	1.398	-164.8	0.102	-107.4	0.456	39.3
19.750	0.786	-23.6	1.389	-167.6	0.104	-110.4	0.460	38.7
20.000	0.780	-26.8	1.382	-171.2	0.106	-113.5	0.460	37.9
20.250	0.778	-30.7	1.375	-175.1	0.107	-118.2	0.455	36.9
20.500	0.776	-35.6	1.369	-179.4	0.109	-121.5	0.452	35.7
20.750	0.777	-41.3	1.356	175.9	0.109	-126.2	0.444	34.4
21.000	0.779	-46.8	1.333	171.2	0.109	-130.7	0.438	31.4
21.250	0.782	-52.0	1.309	166.1	0.110	-135.0	0.432	26.9
21.500	0.784	-56.4	1.279	161.1	0.108	-140.3	0.424	20.6
21.750	0.785	-59.8	1.241	156.3	0.109	-144.2	0.421	13.6
22.000	0.786	-62.1	1.195	152.0	0.110	-148.4	0.417	6.0
22.250	0.783	-63.5	1.162	147.9	0.108	-152.0	0.420	-1.5
22.500	0.777	-65.4	1.124	144.2	0.108	-155.3	0.426	-7.9
22.750	0.772	-67.7	1.098	140.5	0.108	-159.3	0.428	-12.7
23.000	0.774	-70.1	1.073	137.2	0.108	-162.4	0.428	-16.5
23.250	0.771	-73.2	1.054	133.8	0.109	-164.5	0.436	-19.5
23.500	0.755	-76.1	1.043	130.5	0.112	-169.1	0.434	-22.0
23.750	0.750	-79.2	1.028	127.1	0.110	-171.7	0.443	-25.3
24.000	0.744	-81.7	1.025	123.5	0.112	-175.2	0.433	-29.0
24.250	0.741	-84.1	1.027	120.0	0.116	-178.7	0.429	-33.5
24.500	0.732	-86.5	1.031	116.1	0.120	178.5	0.418	-36.8
24.750	0.718	-89.2	1.047	112.0	0.127	174.2	0.407	-41.2
25.000	0.704	-90.9	1.061	107.3	0.132	170.0	0.396	-46.5
25.250	0.688	-95.1	1.074	102.3	0.135	165.2	0.372	-50.7
25.500	0.677	-99.6	1.080	97.0	0.143	159.3	0.349	-57.2
25.750	0.673	-105.6	1.086	90.9	0.146	154.0	0.327	-64.2
26.000	0.677	-111.1	1.065	85.8	0.148	147.8	0.298	-71.0



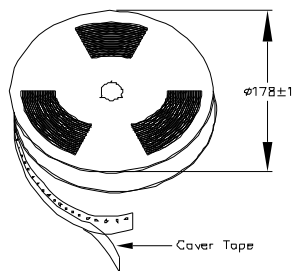
**Package Outline**  
(dimensions in millimeters)



**Tape and Reel Dimensions and Part Orientation**



DIMENSIONS ARE IN mm



**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)

## 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 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.

## 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 are available on request and from [www.rfmd.com](http://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
Packaged pHEMT	FPD6836P70
2.6GHz Evaluation Board	FPD6836P70-AG
5.5GHz Evaluation Board	FPD6836P70-AJ

Quantity	Ordering Code
Reel of 1000	FPD6836P70
Reel of 100	FPD6836P70SR
Bag of 25	FPD6836P70SQ
Bag of 5	FPD6836P70SB