Abstract

Sirenza Microdevices' SHF-0186K is a high performance AlGaAs/GaAs Heterostructure FET (HFET) housed in a low-cost surface-mount plastic package. The HFET technology improves breakdown voltage while minimizing Schottky leakage current resulting in higher power added efficiency and improved linearity. The process has a BV_{GD}=BV_{GS}=-22V and an f_T=20 GHz. This application note illustrates several application circuits for key frequency bands in the 800-2500 MHz spectrum.

Introduction

The application circuits were designed to achieve the optimum combination of P1dB and OIP3 while maintaining flat gain and reasonable return losses. These designs were created to illustrate the general performance capabilities of the device under CW conditions. Users may wish to modify these designs to achieve optimum performance under specific input conditions and system requirements.

The circuits contain only surface mountable devices and were designed with automated manufacturing requirements in mind. All recommended components are standard values available from well-known manufacturers. The components specified in the bill of materials (BOM) have known parasitics which in some cases are critical to the circuit's performance. Deviating from the recommended BOM may result in a performance shift due to varying parasitics – primarily in the inductors and capacitors. Component placement is also critical to each circuit's performance.

Circuit Details

SMDI will provide the detailed layout (AutoCad format) to users wishing to use the exact same layout and material shown in the following circuits. The circuits recommended within this application note were designed using the following PCB stackup:

Material: GETEK™ ML200C
Core thickness: 0.031"
Copper cladding: 1oz both sides
Dielectric constant: 4.1
Dielectric loss tangent: 0.0089 (@ 1 GHz)

Customers not wishing to use the exact material and layouts shown in this application note can design their own PCB using the critical transmission line impedances and phase lengths shown in the BOMs and layouts.

SHF-0186K

0.05 - 6 GHz, 0.5 Watt GaAs HFET

Product Features

- +28 dBm P1dB Typical
- +40 dBm Output IP3 Typical
- High Drain Efficiency: Up to 46% at Class AB
- 18 dB Gain at 900 MHz (Application circuit)
- 14.5 dB Gain at 1960 MHz (Application circuit)

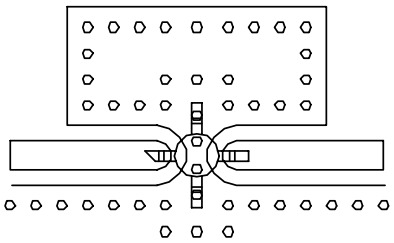
Applications

- Analog and Digital Wireless System
- Cellular PCS, CDPD, Wireless Data, Pagers

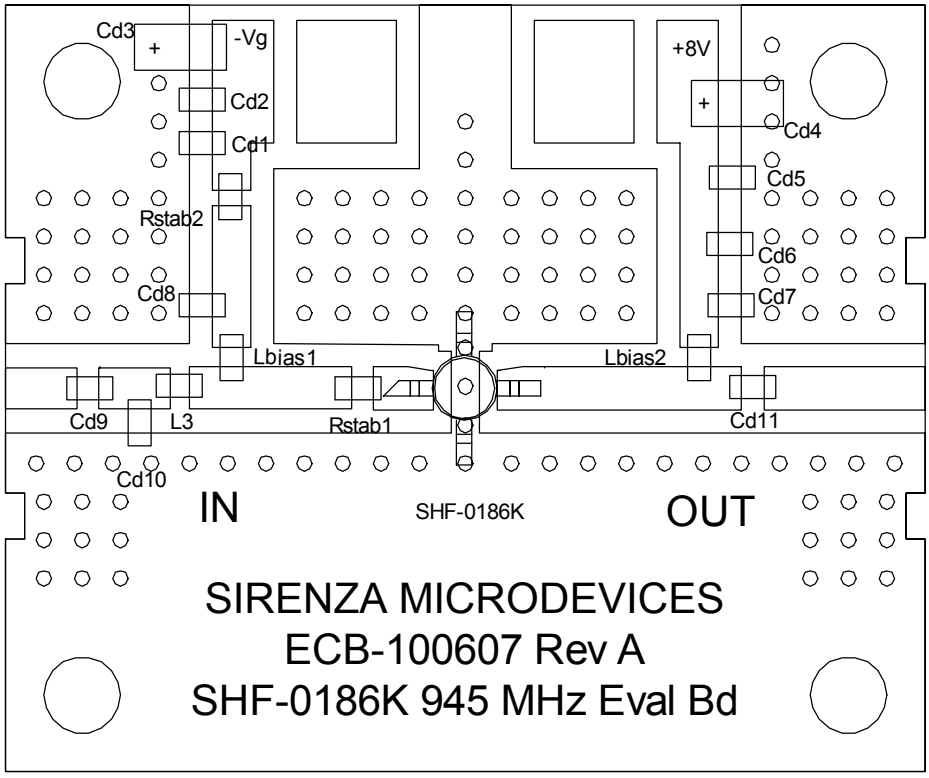
Mounting and Thermal Considerations

It is very important that adequate heat sinking be provided to minimize the device junction temperature. The following items should be implemented to maximize MTTF and RF performance:

1. Multiple solder-filled vias are required directly below the ground tab (pin 4). [CRITICAL]
2. Incorporate a large ground pad area with multiple plated-through vias around the device. [CRITICAL]
3. Use one-to-three point board seating to lower the thermal resistance between the PCB and mounting plate. Place machine screws as close to the ground tab (pin 4) as possible. [RECOMMENDED]
4. Use 2 ounce copper to improve the PCB's heat spreading capability. [RECOMMENDED]
5. Thermal transfer paste should be used between the PCB and the mounting plate. [RECOMMENDED]



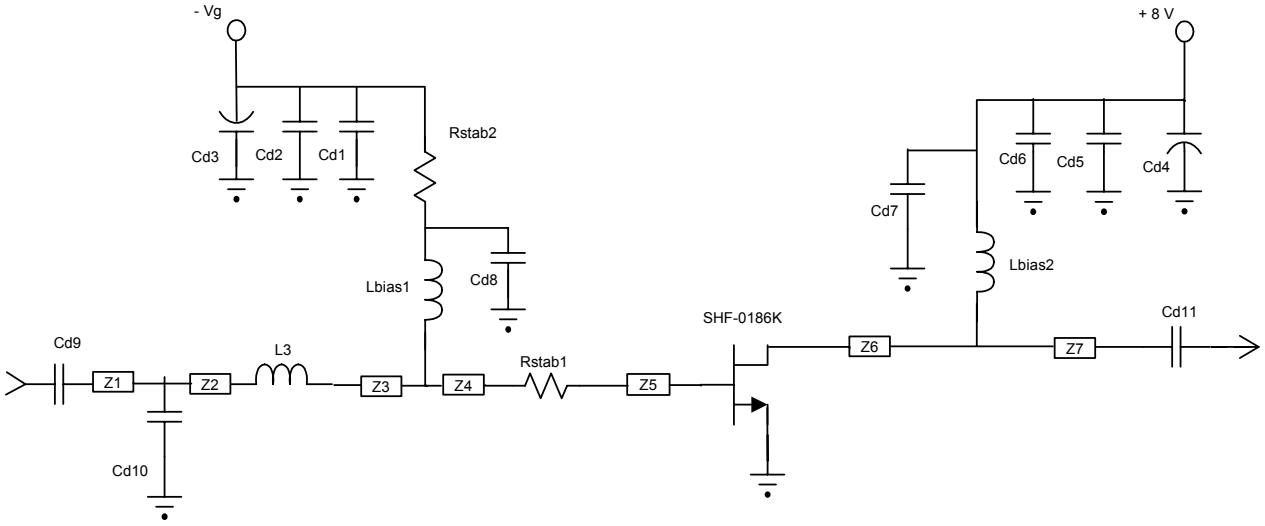
870-960 MHz Application Circuit (V_{DS}=8V, I_{DQ}=100mA, 25°C)



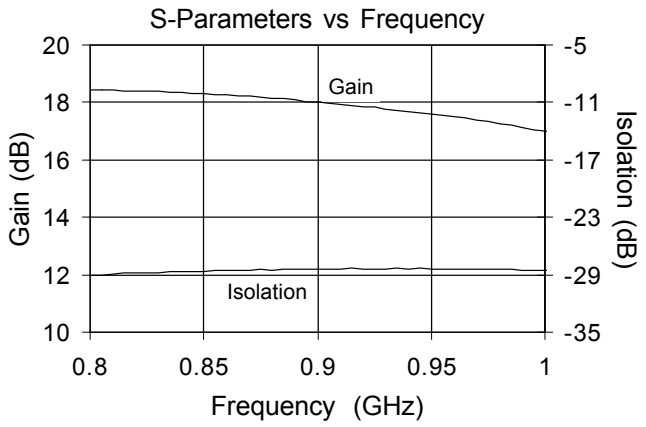
Note: Vias under device leads may be removed for improved manufacturability without risk of RF performance degradation.

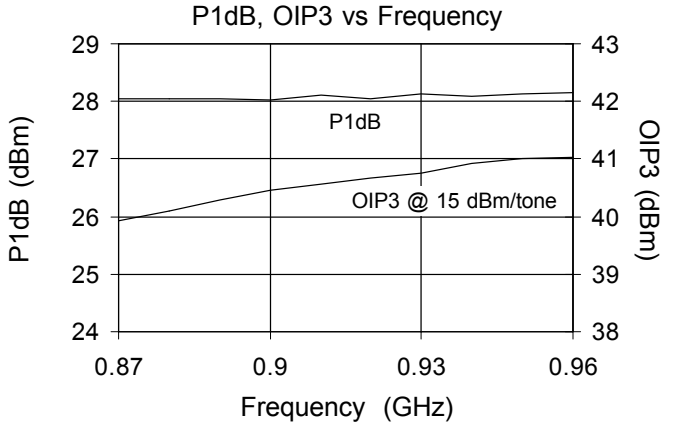
Ref Des.	Value	Part Number
Cd 1,6,9,11	68 pF	Rohm MCH18 series
Cd 10	2.7 pF	Rohm MCH18 series
Cd 7,8	18 pF	Rohm MCH18 series
Cd 3,4	.1 uF	TANTALUM, size "A", 35 volt
Cd 2,5	1000 pF	Rohm MCH18 series
Lbias 1,2	82 nH	TOKO LL1608-series
L3	10 nH	TOKO LL1608-series
Rstab 1,2	20 ohms	Rohm MCH18 series

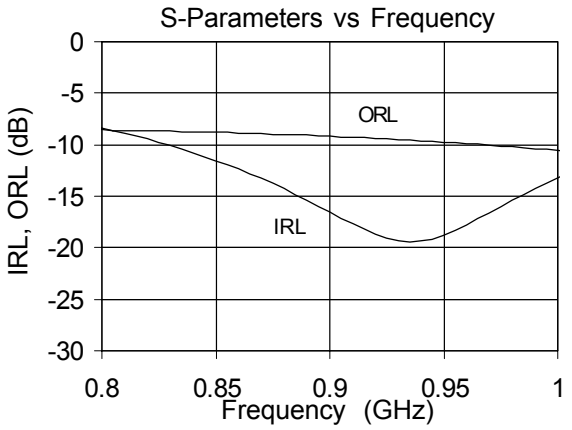
Ref. Des.	Value
Z1	50 Ohms, 2.6 deg. @ 945 MHz
Z2	50 Ohms, 2 deg. @ 945 MHz
Z3	50 Ohms, 2.8 deg. @ 945 MHz
Z4	50 Ohms, 8 deg. @ 945 MHz
Z5	50 Ohms, 4 deg. @ 945 MHz
Z6	50 Ohms, 13.4 deg. @ 945 MHz
Z7	50 Ohms, 2.8 deg. @ 945 MHz

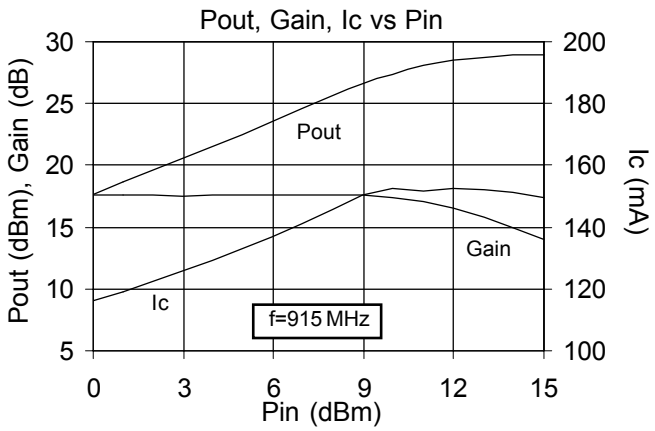


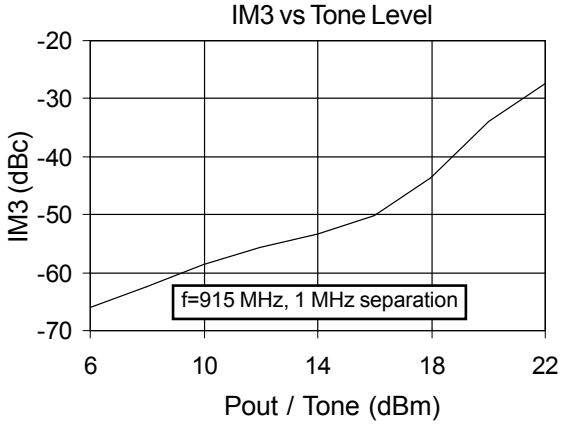
Typical Performance - 870-960 MHz Application Circuit (V_{DS}=8V, I_{DQ}=100mA, 25°C)

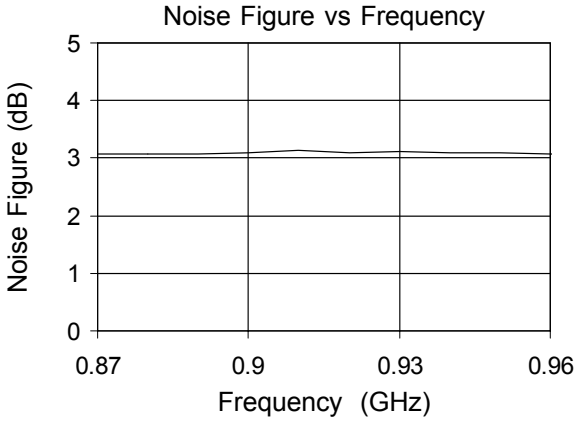






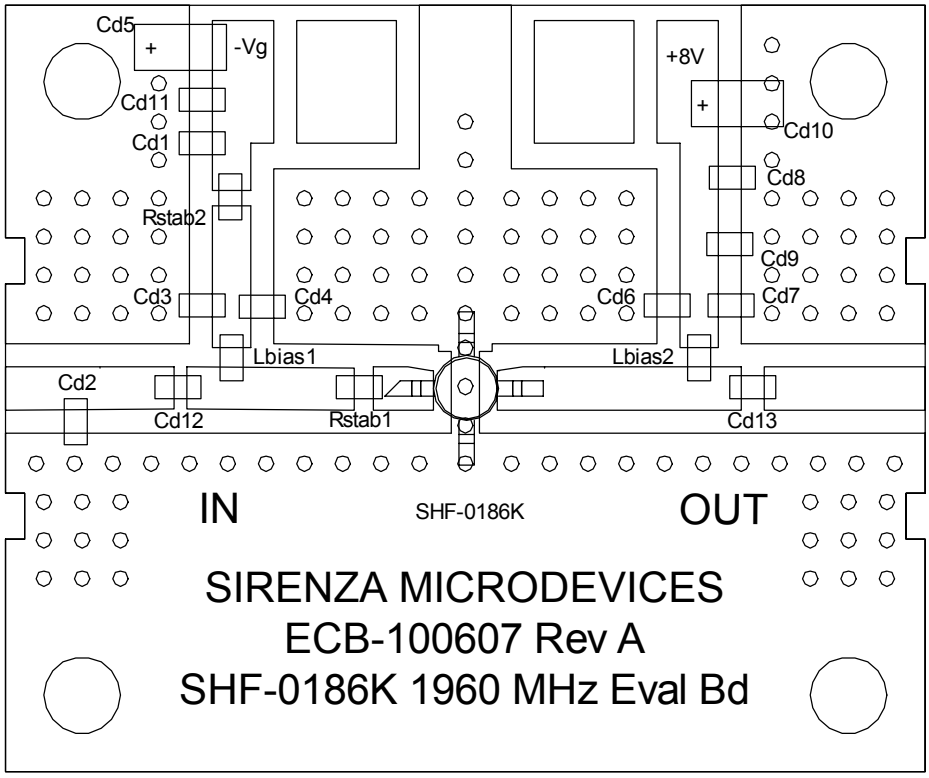






Freq (GHz)	P1dB (dBm)	OIP3 (dBm)	Gain (dB)	S11 (dB)	S22 (dB)	NF (dB)
0.880	28.1	40.1	18.5	-14.3	-9.0	3.1
0.915	28.1	40.6	18.3	-17.7	-9.3	3.1
0.945	28.1	40.9	18.0	-19.4	-9.6	3.1

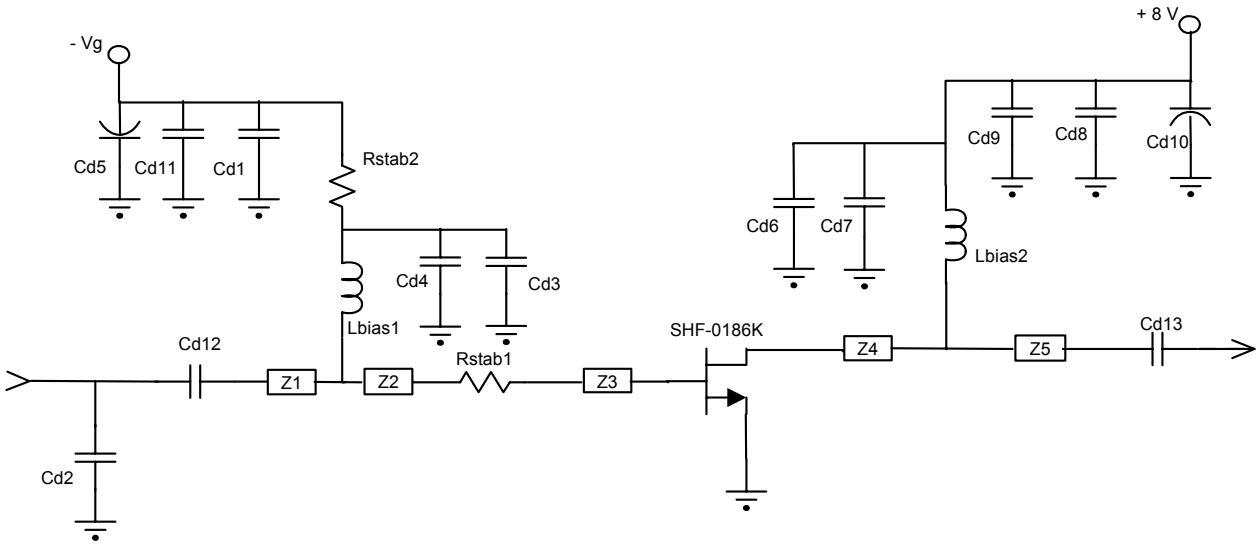
1930-1990 MHz Application Circuit (V_{DS}=8V, I_{DQ}=100mA, 25°C)



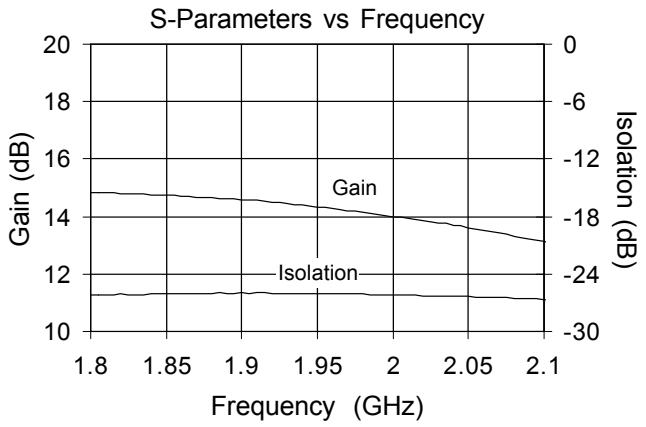
Note: Vias under device leads may be removed for improved manufacturability without risk of RF performance degradation.

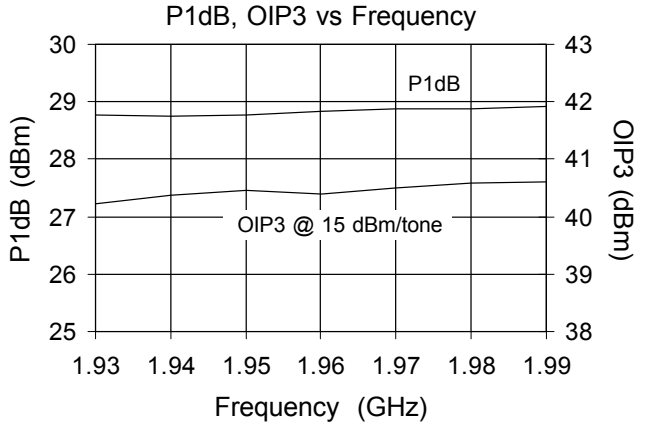
Ref Des.	Value	Part Number
Cd 1,9	100 pF	Rohm MCH18 series
Cd 2	1.8 pF	Rohm MCH18 series
Cd 3,6,12	39 pF	Rohm MCH18 series
Cd 4,7	8.2 pF	Rohm MCH18 series
Cd 5,10	.1 uF	TANTALUM, size "A", 35 volt
Cd 8,11	1000 pF	Rohm MCH18 series
Cd 13	3.3 pF	Rohm MCH18 series
Lbias 1,2	27 nH	TOKO LL1608-series
Rstab 1	5.1 ohms	Rohm MCH18 series
Rstab 2	10 ohms	Rohm MCH18 series

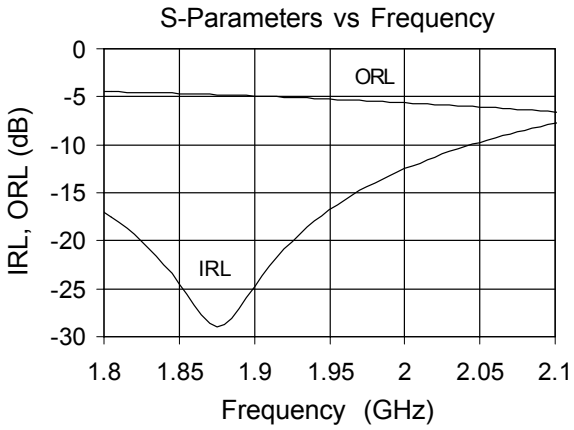
Ref. Des.	Value
Z1	50 Ohms, 6.1 deg. @ 1960 MHz
Z2	50 Ohms, 17 deg. @ 1960 MHz
Z3	50 Ohms, 8.1 deg. @ 1960 MHz
Z4	50 Ohms, 27.9 deg. @ 1960 MHz
Z5	50 Ohms, 5.8 deg. @ 1960 MHz

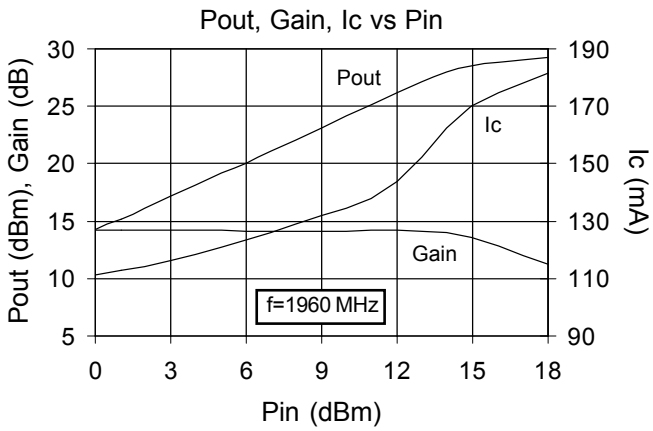


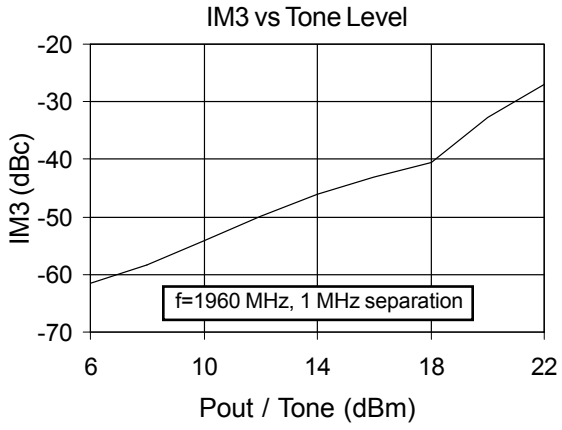
Typical Performance - 1930-1990 MHz Application Circuit (V_{DS}=8V, I_{DQ}=100mA, 25°C)

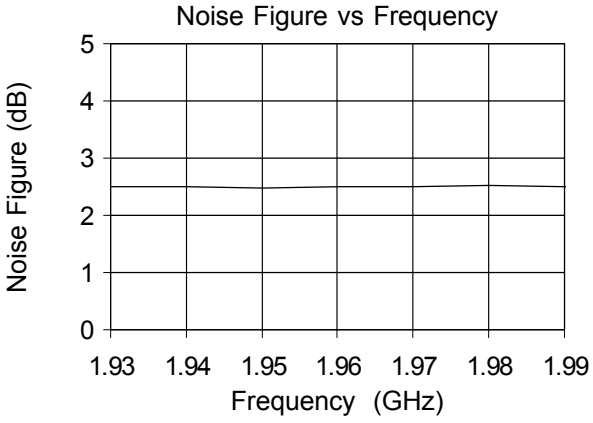






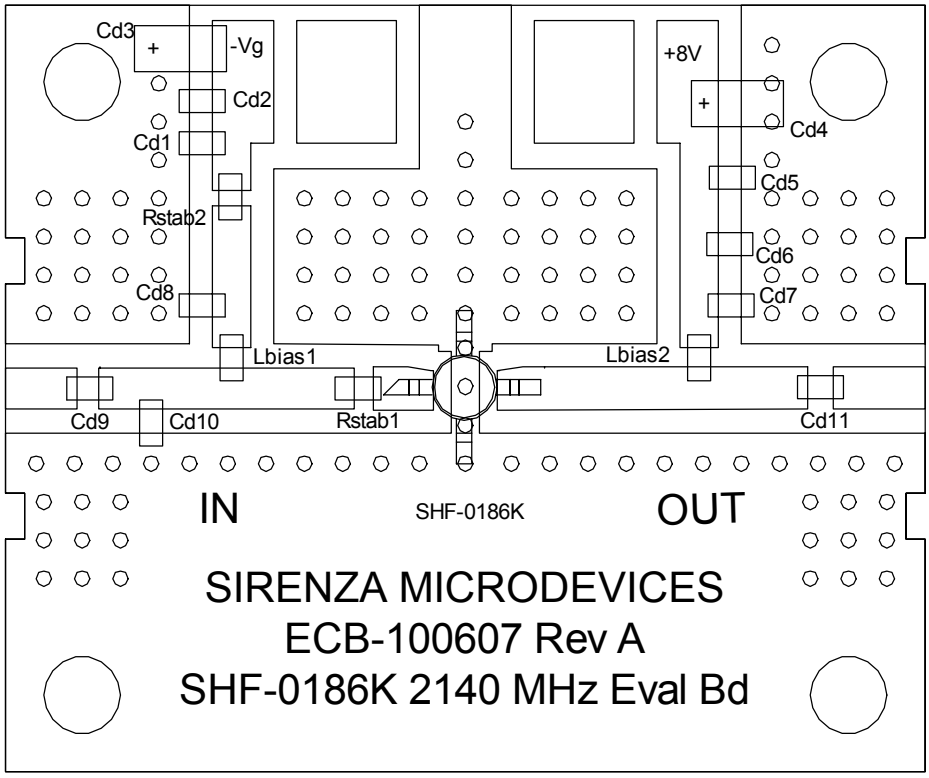






Freq (GHz)	P1dB (dBm)	OIP3 (dBm)	Gain (dB)	S11 (dB)	S22 (dB)	NF (dB)
1.93	28.7	40.2	14.9	-19.3	-5.1	2.5
1.96	28.8	40.4	14.7	-15.8	-5.3	2.5
1.99	28.9	40.6	14.4	-13.2	-5.6	2.5

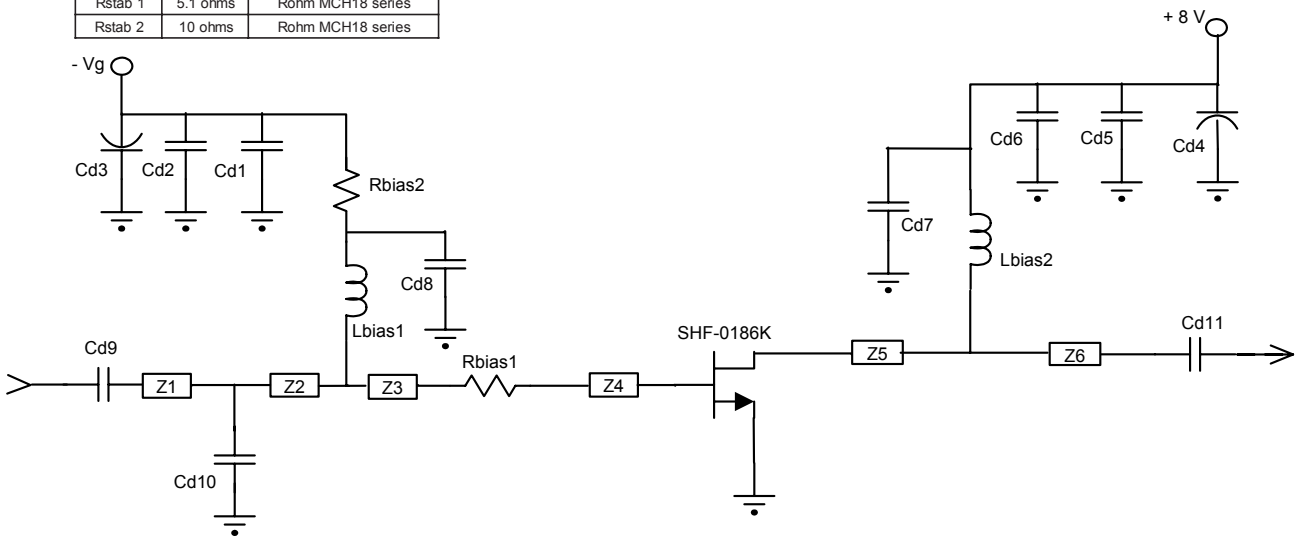
2110-2170 MHz Application Circuit (V_{DS}=8V, I_{DQ}=100mA, 25°C)



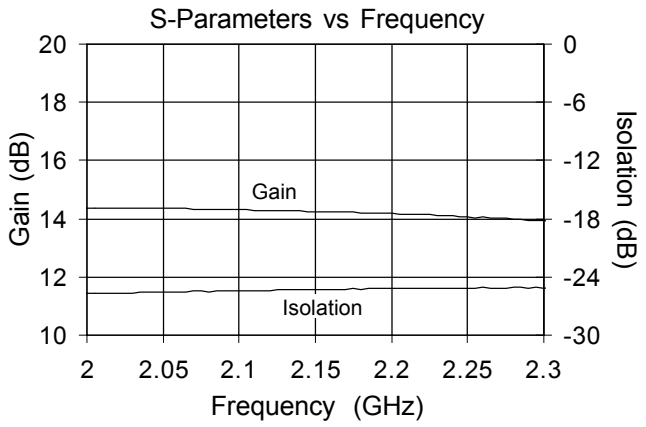
Note: Vias under device leads may be removed for improved manufacturability without risk of RF performance degradation.

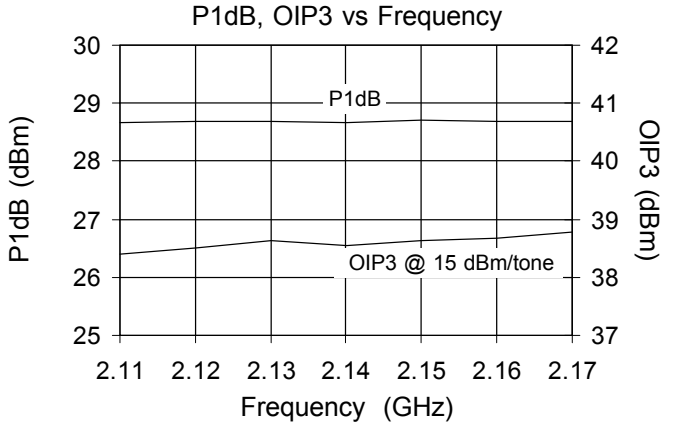
Ref Des.	Value	Part Number
Cd 1,6	100 pF	Rohm MCH18 series
Cd 10	1.8 pF	Rohm MCH18 series
Cd 7,8	22 pF	Rohm MCH18 series
Cd 11	2.7 pF	Rohm MCH18 series
Cd 3,4	.1 uF	TANTALUM, size "A", 35 volt
Cd 2,5	1000 pF	Rohm MCH18 series
Cd 9	27 pF	Rohm MCH18 series
Lbias 1	27 nH	TOKO LL1608-series
Lbias 2	22 nH	TOKO LL1608-series
Rstab 1	5.1 ohms	Rohm MCH18 series
Rstab 2	10 ohms	Rohm MCH18 series

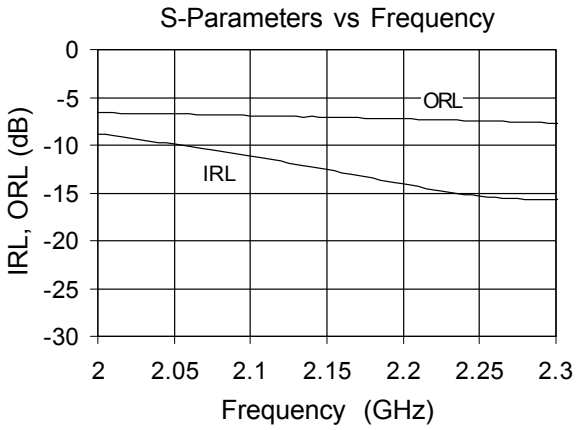
Ref. Des.	Value
Z1	50 Ohms, 7.8 deg. @ 2140 MHz
Z2	50 Ohms, 12.2 deg. @ 2140 MHz
Z3	50 Ohms, 18.5 deg. @ 2140 MHz
Z4	50 Ohms, 8.9 deg. @ 2140 MHz
Z5	50 Ohms, 30.4 deg. @ 2140 MHz
Z6	50 Ohms, 16.3 deg. @ 2140 MHz

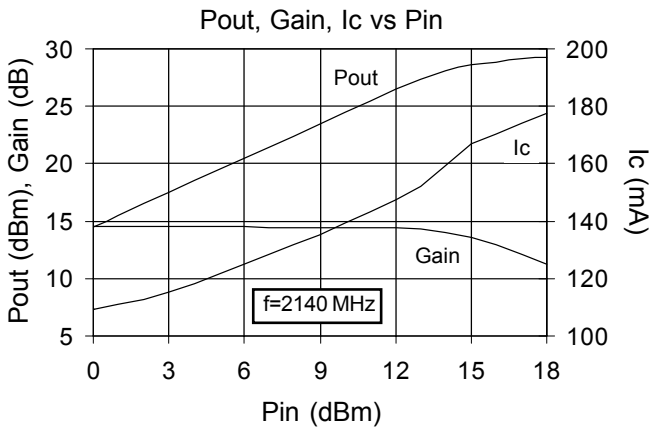


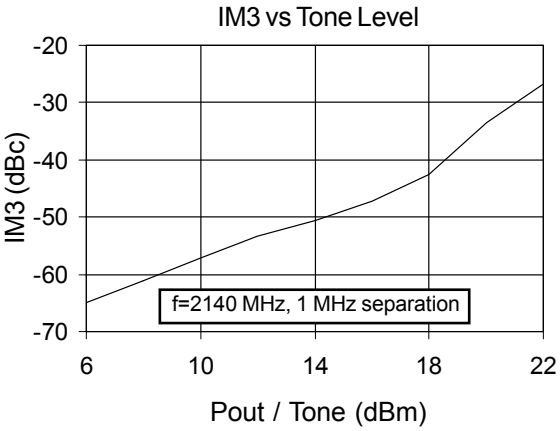
Typical Performance - 2110-2170 MHz Application Circuit (V_{DS}=8V, I_{DQ}=100mA, 25°C)

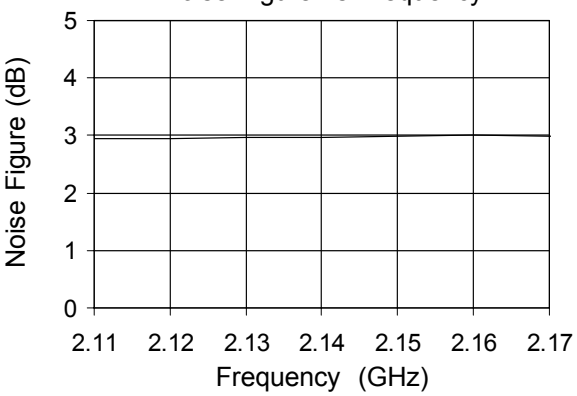






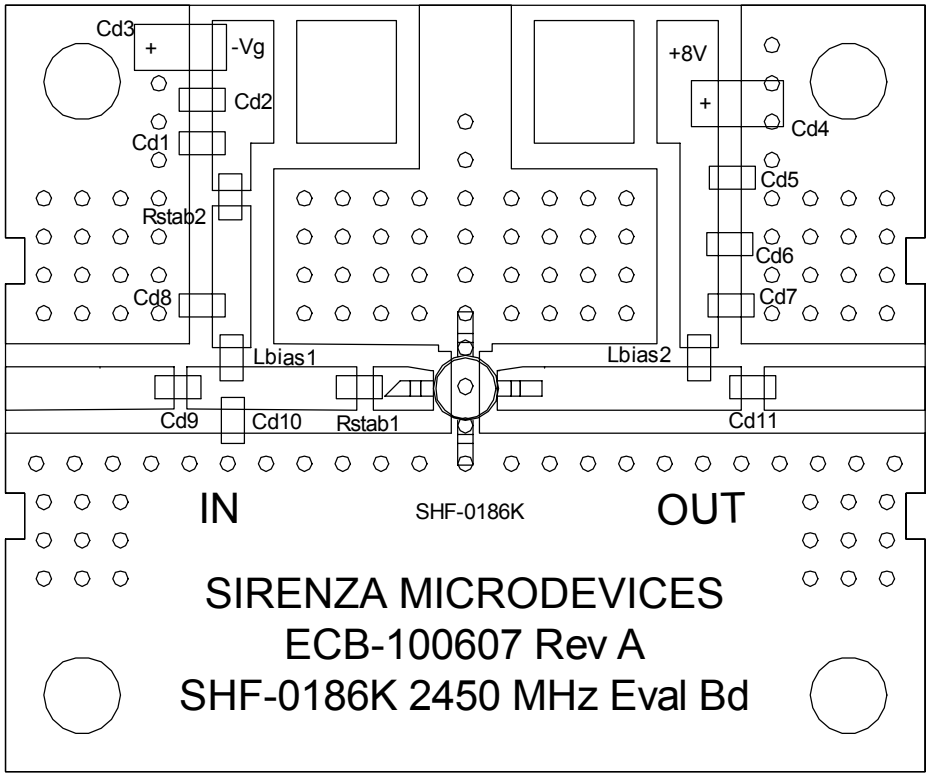






Freq (GHz)	P1dB (dBm)	OIP3 (dBm)	Gain (dB)	S11 (dB)	S22 (dB)	NF (dB)
2.11	28.7	38.4	14.4	-11.4	-6.9	2.9
2.14	28.7	38.5	14.4	-12.3	-7.0	3.0
2.17	28.7	38.8	14.3	-13.2	-7.1	3.0

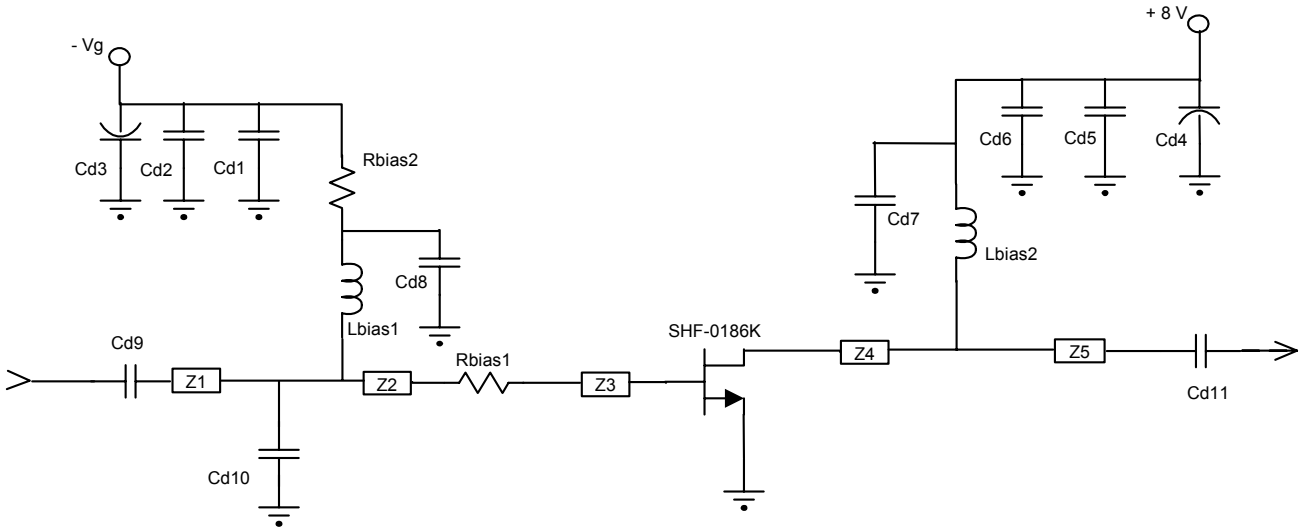
2400-2500 MHz Application Circuit (V_{DS}=8V, I_{DQ}=100mA, 25°C)



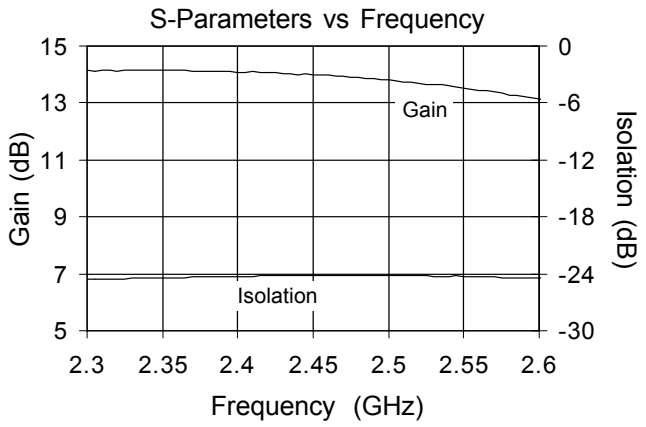
Note: Vias under device leads may be removed for improved manufacturability without risk of RF performance degradation.

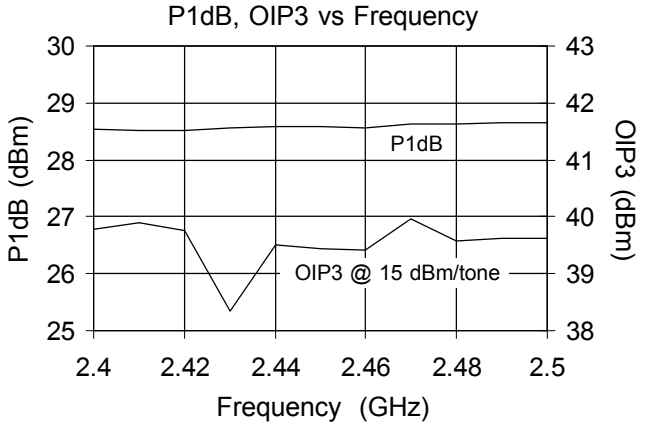
Ref Des.	Value	Part Number
Cd 1,6	100 pF	Rohm MCH18 series
Cd 10	1.8 pF	Rohm MCH18 series
Cd 7,8	22 pF	Rohm MCH18 series
Cd 11	3.3 pF	Rohm MCH18 series
Cd 3,4	.1 uF	TANTALUM, size "A", 35 volt
Cd 2,5	1000 pF	Rohm MCH18 series
Cd 9	39 pF	Rohm MCH18 series
Lbias 1,2	12 nH	TOKO LL1608-series
Rstab 1	2.7 ohms	Rohm MCH18 series
Rstab 2	10 ohms	Rohm MCH18 series

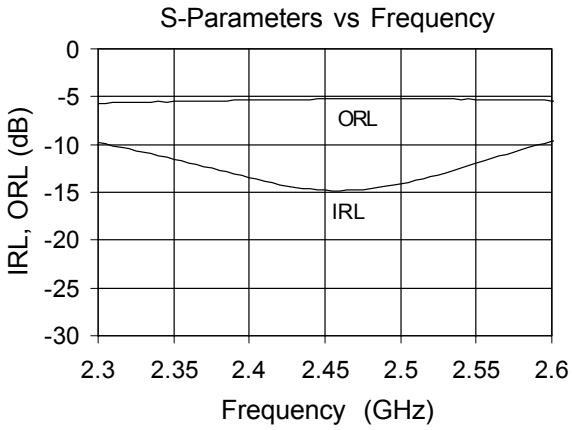
Ref. Des.	Value
Z1	50 Ohms, 7.8 deg. @ 2440 MHz
Z2	50 Ohms, 21.4 deg. @ 2440 MHz
Z3	50 Ohms, 10.2 deg. @ 2440 MHz
Z4	50 Ohms, 34.8 deg. @ 2440 MHz
Z5	50 Ohms, 7.2 deg. @ 2440 MHz

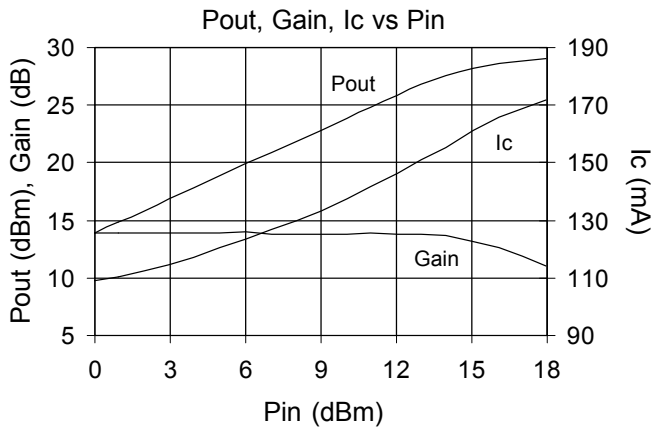


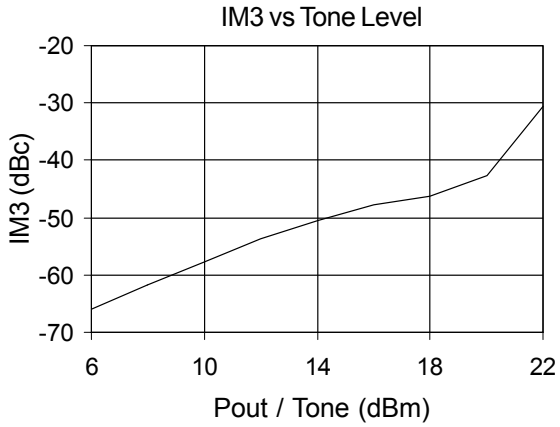
Typical Performance - 2400-2500 MHz Application Circuit (V_{DS}=8V, I_{DQ}=100mA, 25°C)

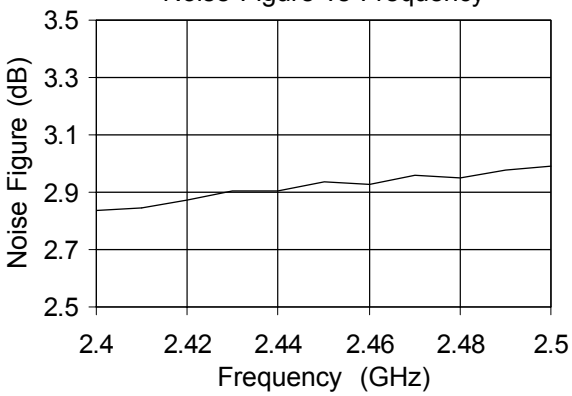












Freq (GHz)	P1dB (dBm)	OIP3 (dBm)	Gain (dB)	S11 (dB)	S22 (dB)	NF (dB)
2.40	28.5	39.8	14.2	-13.5	-5.4	2.8
2.45	28.6	39.5	13.9	-14.8	-5.3	2.9
2.50	28.6	39.6	13.8	-14.1	-5.3	3.0