SGA-8343 Amplifier Application Circuits

Abstract

RFMD SGA-8343 is a high performance SiGe amplifier designed for operation from DC to 6 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 NF, input return loss, and stability. All recommended components are standard values available from well-known manufacturers. 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. Matching component placement is critical to each circuit's performance.

Circuit Details

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

Material: GETEK^{TM} ML 200C
Core thickness: 0.031"
Copper cladding: 1 oz. 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.

NOTE: Many of our sample evaluation boards may come with an additional substrate & copper layer for mechanical stability. It has been assumed that the backside layer has no effect on the RF performance or circuit design.

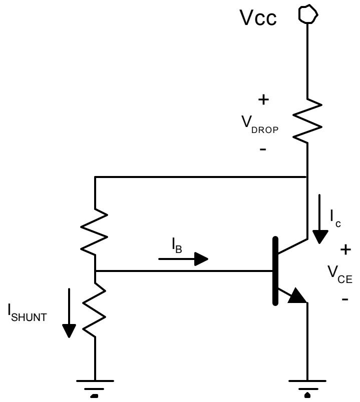
Design Considerations and Trade-offs - Biasing Techniques

All HBT amplifiers are subject to device current variation due to the decreasing nature of the internal V_{BE} with increasing temperature. In the absence of an active bias circuit or resistive feedback, the decreasing V_{BE} will result in increased base and collector currents. As the collector current continues to increase under constant V_{CE} conditions, the device may eventually exceed its maximum dissipated power limit resulting in permanent device damage. The designs included in this application note contain passive bias circuits that stabilize the device current over temperature and desensitize the circuit to device process variation.

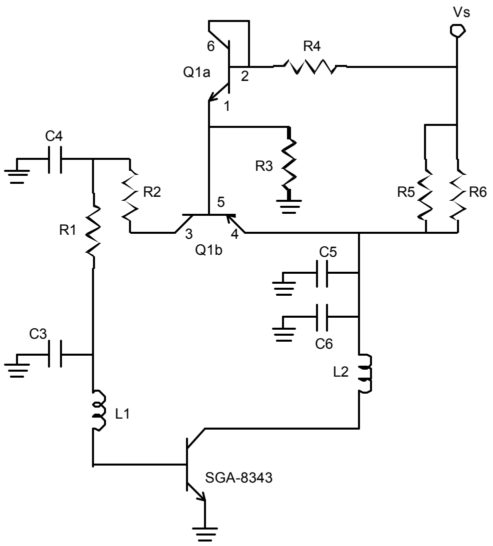
The passive bias circuits used in these designs include a dropping resistor in the collector bias line and a voltage divider from the collector-to-base. Using this scheme, the amplifier can be biased from a single supply voltage. The collector dropping resistor is sized to drop >20% V_{CE}, depending on the desired V_{CE}. The voltage divider from collector-to-base, in conjunction with the dropping resistor, will stabilize the device current over temperature. The effectiveness increases with increasing voltage drop in collector bias line. Configuring the voltage divider such that the shunt current is 5-10 times larger than the desired base current desensitizes the circuit to beta variation. These two feedback mechanisms are sufficient to insure consistent performance over temperature and device process variations. Note that the voltage drop is clearly dependent on the nominal collector current and can be adjusted to generate the desired V_{CE} from a fixed supply rail. The user should test the circuit over the operational extremes to guarantee adequate performance. An active bias circuit can be implemented if the user does not wish to sacrifice the voltage required by the aforementioned passive circuit. There are various active bias schemes suitable for HBTs. The user should choose an active bias circuit that best meets his/her cost, complexity, and performance requirements.

Application Circuits Now Available

1. 800-1000 MHz, single-ended with series feedback, optimized for NF and S11< -10 dB.
2. 1800-2000 MHz, single-ended, optimized for NF and S11< -8 dB.
3. 2400-2500 MHz, single-ended, optimized for NF and S11< -10 dB.
4. 1575 MHz, GPS Application Circuits: see AN-061.

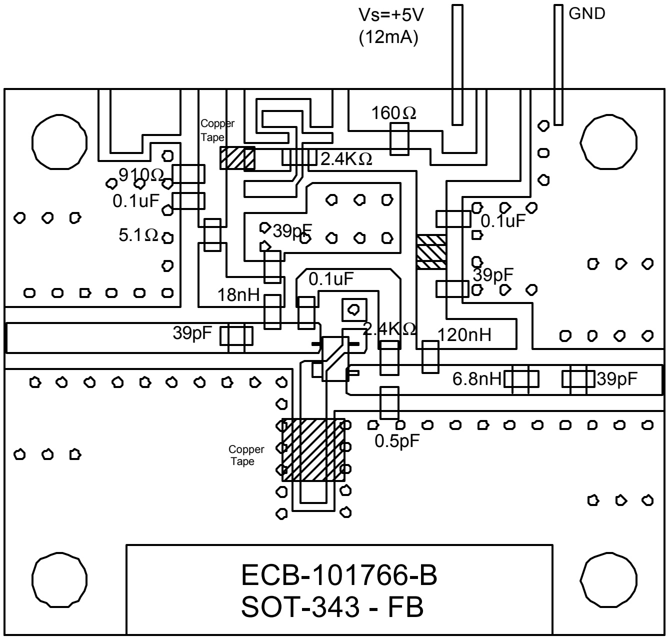


Passive Bias Circuit Topology



Active Bias Circuit Topology

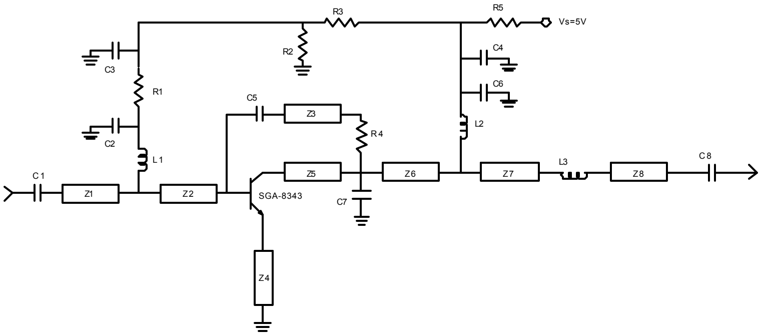
800-1000 MHz Application Circuit (V_S=5V, I_{CQ}=12mA)



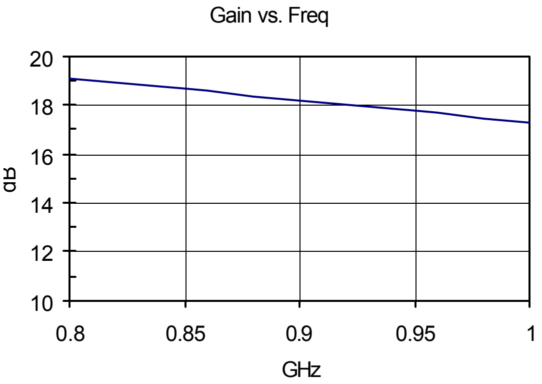
Ref. Des.	Part Number	Value
C1, 2, 6, 8	ROHM MCH185A390J	39 pF
C7	ROHM MCH185A0R5C	0.5 pF
C3, 4, 5	Samsung CL10B104KONC	0.1 uF
L1	TOKO LL1608-FS18NJ	18 nH
L2	TOKO LL1608-FSR12J	120 nH
L3	TOKO LL1608-FS6N8J	6.8 nH
R1	ROHM MCR03J5R1	5.1 Ω
R2	ROHM MCR03J911	910 Ω
R3, 4	ROHM MCR03J242	2.4KΩ

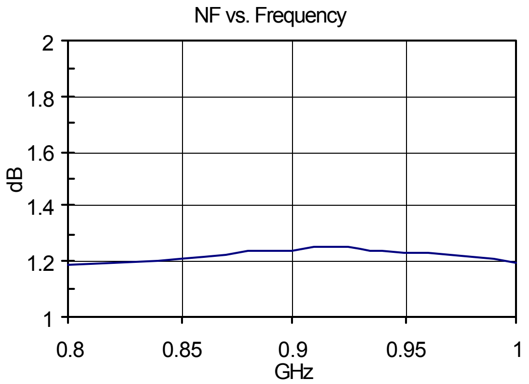
Ref. Des.	Part Number	Value
R5	ROHM MCR03J161	160 Ω
Z1	non-critical	50 Ω
Z2	4.0 degrees @ 900 MHz	50 Ω
Z3	11.5 degrees @ 900 MHz	63 Ω
Z4	5.0 degrees @ 900 MHz	50 Ω
Z5	3.6 degrees @ 900 MHz	50 Ω
Z6	3.7 degrees @ 900 MHz	50 Ω
Z7	7.1 degrees @ 900 MHz	50 Ω
Z8	non-critical	50 Ω

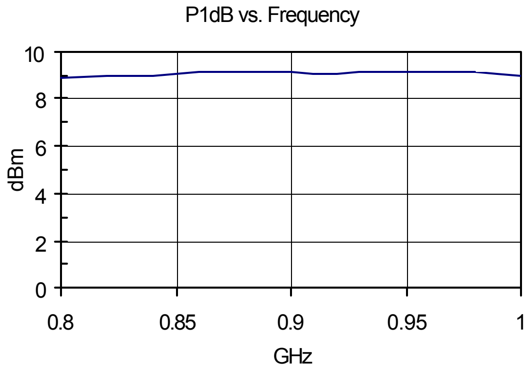
SGA-8343 800-1000 MHz Schematic

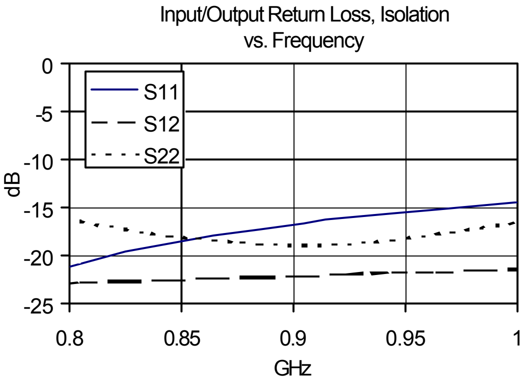


Typical Performance: 800-1000 MHz Application Circuit (V_S=5V, I $_{CQ}$=12mA, 25C)



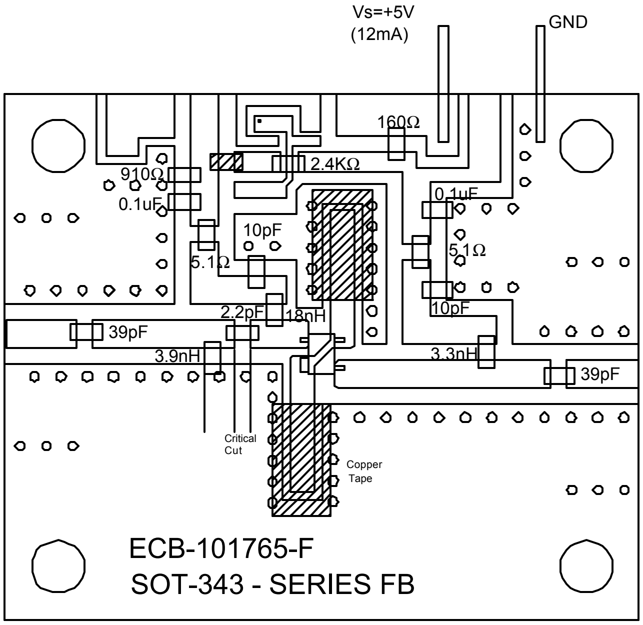






Freq (GHz)	P1dB (dBm)	OIP3 (dBm)	Gain (dB)	S11 (dB)	S22 (dB)	NF (dB)
0.800	8.8	27.0	19.1	-20	-16	1.20
0.900	9.0	27.3	18.2	-16	-18	1.25
1.000	9.0	27.5	17.3	-14	-16	1.20

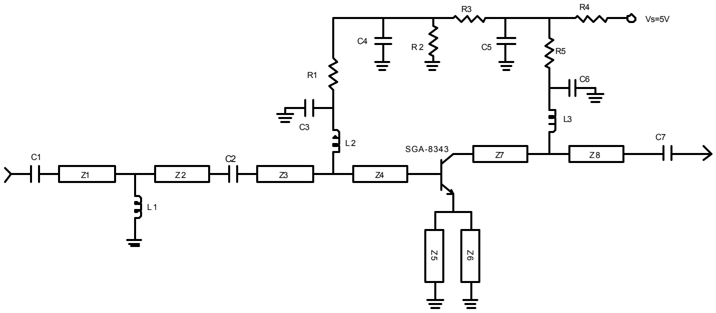
1800-2000 MHz Application Circuit (V_S=5V, I_{CQ}=12mA)



Ref. Des.	Part Number	Value
C1, 7	ROHM MCH185A390J	39 pF
C2	ROHM MCH185A2R2C	2.2 pF
C3, 6	ROHM MCH185A100D	10 pF
C4, 5	Samsung CL10B104KONC	0.1uF
L1	TOKO LL1608-FS3N9S	3.9 nH
L2	TOKO LL1608-FS18NJ	18 nH
L3	TOKO LL1608-FS3N3S	3.3 nH
R1, 5	ROHM MCR03J5R1	5.1 Ω
R2	ROHM MCR03J911	910 Ω
R3	ROHM MCR03J242	2.4K Ω

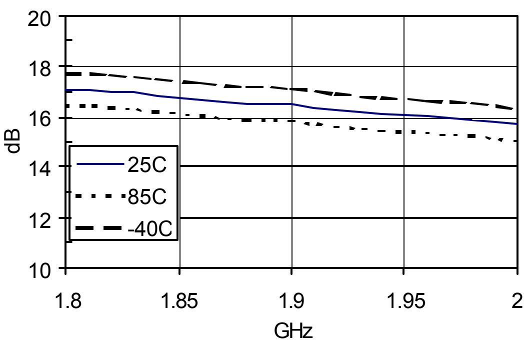
Ref. Des.	Part Number	Value
R4	ROHM MCR03J161	160 Ω
Z1	non-critical	50 Ω
Z2	3.9 degrees @ 1900 MHz	50 Ω
Z3	4.7 degrees @ 1900 MHz	50 Ω
Z4	6.4 degrees @ 1900 MHz	50 Ω
Z5	9.8 degrees @ 1900 MHz	50 Ω
Z6	9.8 degrees @ 1900 MHz	50 Ω
Z7	28.7 degrees @ 1900 MHz	50 Ω
Z8	non-critical	50 Ω

SGA-8343 1800-2000 MHz Schematic

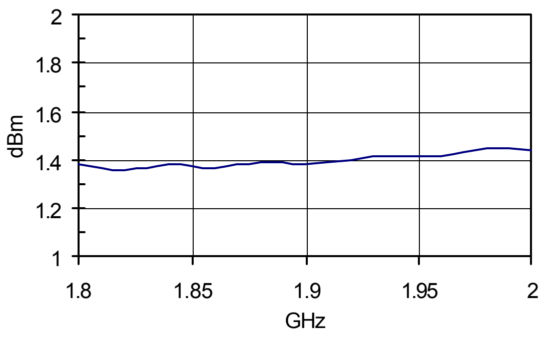


Typical Performance: 1800-2000 MHz Application Circuit (V_S=5V, I_{CQ}=12mA)

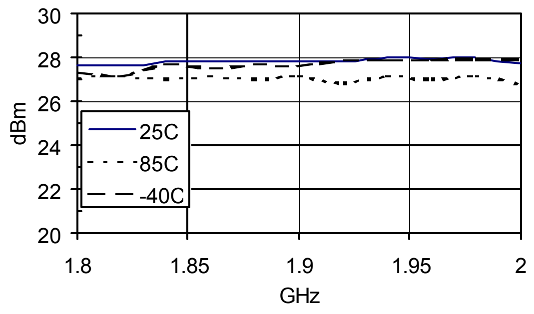
Gain vs. Frequency



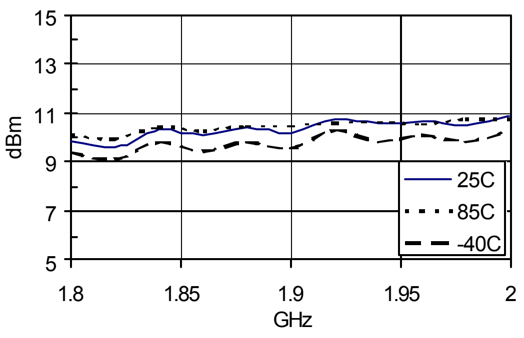
NF vs. Frequency (25C)



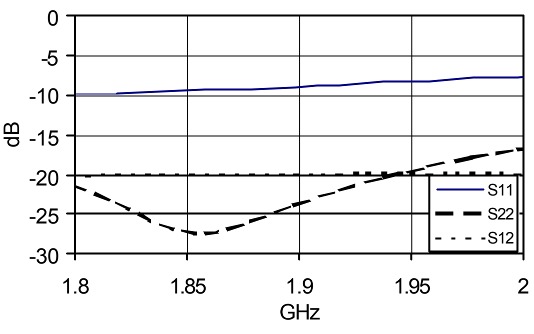
Third Order Intercept vs. Frequency
(Pout per tone = 0dBm)



P1dB vs. Frequency

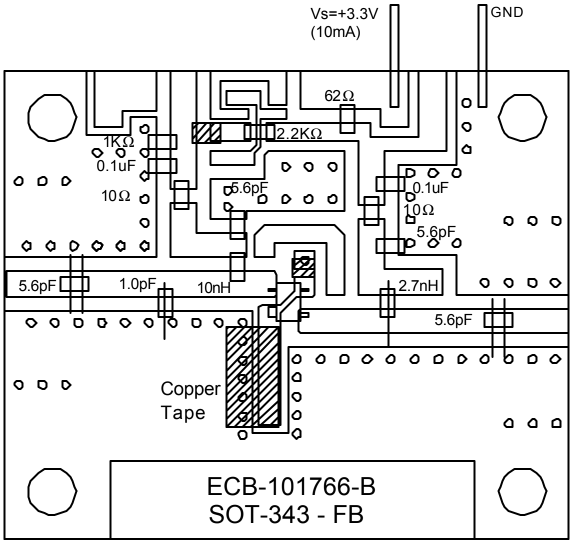


Input/Output Return Loss, Isolation vs. Frequency



Freq (GHz)	P1dB (dBm)	OIP3 (dBm)	Gain (dB)	S11 (dB)	S22 (dB)	NF (dB)
1.8	9.8	27.5	17.0	-10	-26	1.40
1.9	10.0	27.8	16.5	-9	-24	1.40
2.0	10.5	27.7	15.6	-8	-17	1.45

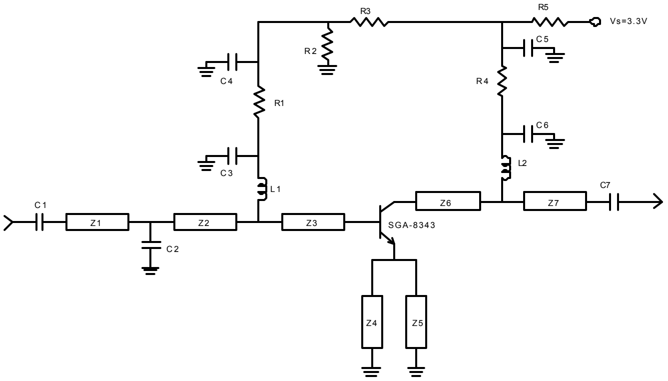
2400-2500 MHz Application Circuit (V_S=3.3V, I_{CQ}=10mA)



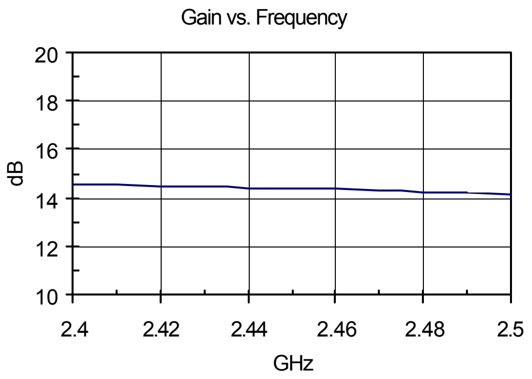
Ref. Des.	Part Number	Value
C1, 3, 6, 7	ROHM MCH185A5R6D	5.6 pF
C2	ROHM MCH185A010C	1.0 pF
C4, 5	Samsung CL10B104KONC	0.1uF
L1	TOKO LL1608-FS10NJ	10 nH
L2	TOKO LL1608-FS2N7S	2.7 nH
R1, 4	ROHM MCR03J100	10 Ω
R2	ROHM MCR03J102	1K Ω
R3	ROHM MCR03J222	2.2K Ω

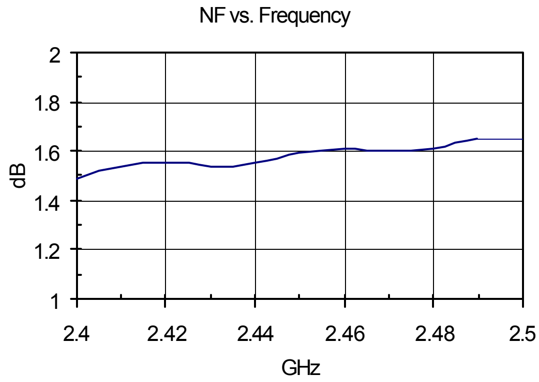
Ref. Des.	Part Number	Value
R5	ROHM MCR50J620	62 Ω
Z1	non-critical	50 Ω
Z2	8.2 degrees @ 2440 MHz	50 Ω
Z3	21.7 degrees @ 2440 MHz	50 Ω
Z4	6.2 degrees @ 2440 MHz	50 Ω
Z5	6.2 degrees @ 2440 MHz	50 Ω
Z6	23.8 degrees @ 2440 MHz	50 Ω
Z7	non-critical	50 Ω

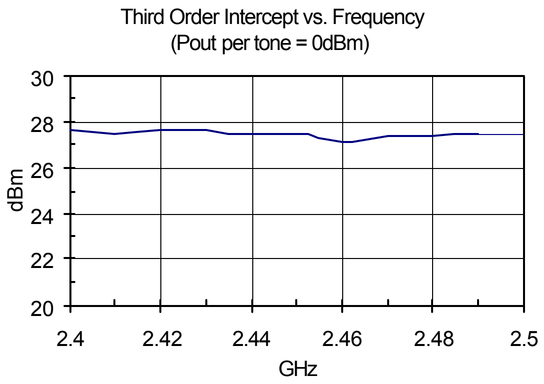
SGA-8343 2400-2500 MHz Schematic

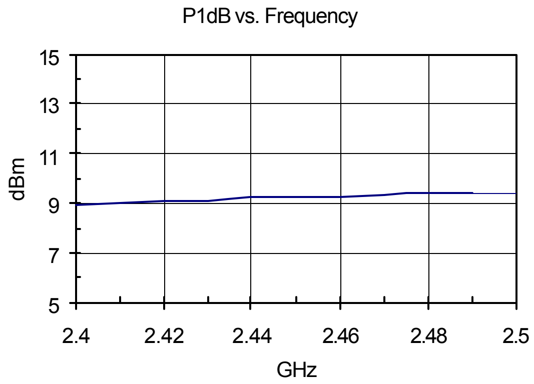


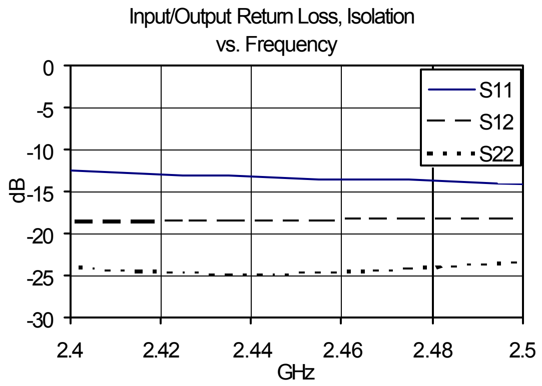
Typical Performance: 2400-2500 MHz Application Circuit (V_S=3.3 V, I_{CQ}=10mA, 25C)











Freq (GHz)	P1dB (dBm)	OIP3 (dBm)	Gain (dB)	S11 (dB)	S22 (dB)	NF (dB)
2.40	9.0	27.5	14.6	-12	-24	1.50
2.45	9.2	27.5	14.4	-13	-24	1.60
2.50	9.4	27.5	14.2	-14	-23	1.65