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RF3866

WIDE BANDWIDTH, HIGH LINEARITY LOW NOISE AMPLIFIER/LINEAR DRIVER

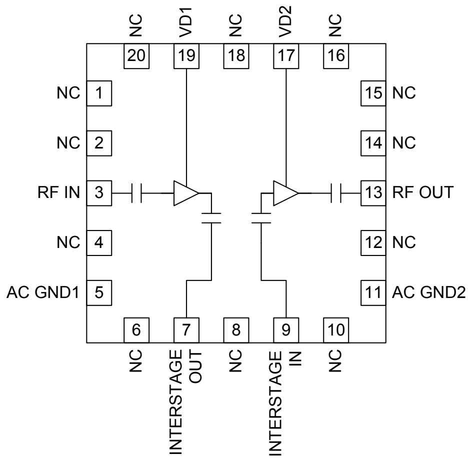
Package Style: QFN, 20-Pin, 5mmx5mm

Features

- Low Noise and High Intercept Point
- Adjustable Bias Current for Enhanced IP3
- Single 2.5V to 6.0V Power Supply
- 400MHz to 3800MHz Operation
- QFN20, 5mmx5mm Package

Applications

- First Stage WiMAX LNA/Linear Driver
- GSM900, CDMA, PCS, UMTS LNA/Linear Drive
- WLAN LNA
- High Gain Linear Amplification



Functional Block Diagram

Product Description

The RF3866 is a low noise amplifier with a high output IP3. The amplifier is self-biased from a single voltage supply with 50Ω input and output ports. The useful frequency range is from 400MHz to 3800MHz. A 0.8dB noise figure and 36dBm OIP3 performance is achieved with a 5V V_{DD}, 180mA. Current can be increased to raise OIP3 while having minimal effect on noise figure. The IC is featured in a standard QFN, 20-pin, 5mmx5mm package.

Ordering Information

RF3866	Wide Bandwidth, High Linearity Low Noise Amplifier/Linear Driver
RF3866PCK-410	Fully Assembled Evaluation Board with 5 Sample Parts 1.8GHz to 3.8GHz

Optimum Technology Matching® Applied

☐ GaAs HBT	☐ SiGe BiCMOS	☑ GaAs pHEMT	☐ GaN HEMT
☐ GaAs MESFET	☐ Si BiCMOS	☐ Si CMOS	☐ RF MEMS
☐ InGaP HBT	☐ SiGe HBT	☐ Si BJT	☐ LDMOS

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Absolute Maximum Ratings

Parameter	Rating	Unit
Supply Voltage	6	V
Input RF Level (See Note 1)	+10	dBm
Current Drain, I_{DD}	150 per stage	mA
Operating Ambient Temperature	-40 to +85	°C
Storage Temperature	-40 to +150	°C
Junction Temperature (T_J)	150	°C
ESD Rating - Human Body Model (HBM)	Class 1B	
Moisture Sensitivity Level	MSL2	

Note 1. Max continuous RF IN is +10dBm. The max transient RF IN is +20dBm.

Caution! ESD sensitive device.

Parameter	Specification			Unit	Condition
	Min.	Typ.	Max.		
High Band					
Frequency	3300		3800	MHz	
Current		180	220	mA	V_{DD}=5V
Gain		20		dB	+25°C, V_{DD}=5V, I_{DD}=180mA, 3500MHz unless specified
Noise Figure		0.9		dB	
Output IP3		37		dBm	f_1=3500MHz, f_2=3501MHz
Output P1dB		22		dBm	
S11		-15		dB	
S22		-17		dB	
S12		-33		dB	
Mid Band					
Frequency	1800		2700	MHz	
Current		180	220	mA	V_{DD}=5V
Gain	28	30	32	dB	+25°C, V_{DD}=5V, I_{DD}=180mA, 2000MHz unless specified
Noise Figure		0.8	1.0	dB	
Output IP3	34	36		dBm	f_1=2000MHz, f_2=2001MHz
Output P1dB	21.0	22.5	25.0	dBm	
S11		-10		dB	
S22		-16		dB	
S12		-40		dB	
Low Band					
Frequency	700		1100	MHz	
Current		180	220	mA	V_{DD}=5V
Gain		32		dB	+25°C, V_{DD}=5V, I_{DD}=180mA, 850MHz unless specified
Noise Figure		1.0		dB	
OIP3		37		dBm	f_1=850MHz, f_2=851MHz
OP1dB		22.5		dBm	
S11		-10		dB	
S22		-12		dB	

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S12		-48		dB	
Thermal					
$Theta_{JC}$		30		°C/W	Dissipated power=V_{DD}*(I_{DD1}+I_{DD2})

Parameter	Specification			Unit	Condition
	Min.	Typ.	Max.		
Thermal					
$Theta_{JC}$		30		°C/W	Dissipated power=V_{DD}*(I_{DD1}+I_{DD2})
Power Supply					
Device Operating Voltage	2.5	5.0	6.0	V	
Operating Current	130	180	220	mA	V_{DD}=5V, R3=open

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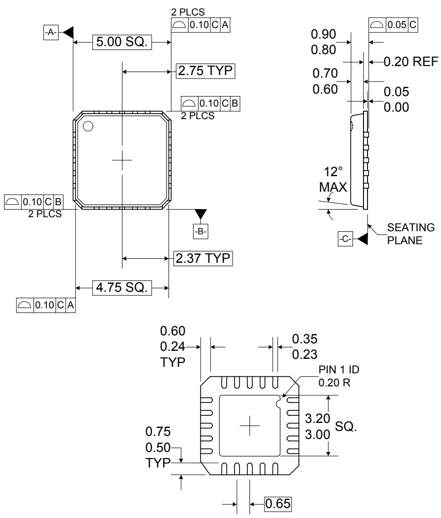
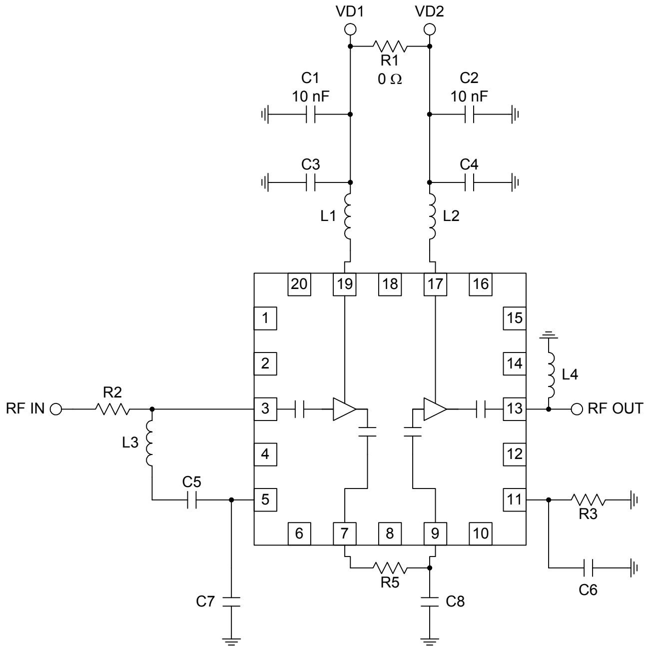
Pin	Function	Description
1	NC	Not connected.
2	NC	Not connected.
3	RF IN	RF input pin. 50Ω matched. This pin is DC-blocked.
4	NC	Not connected.
5	AC GND1	AC ground. Shunt cap may be added for tuning.
6	NC	Not connected.
7	INTERSTAGE OUT	Interstage RF output. This signal is brought off-chip in case a bandpass filter is needed.
8	NC	Not connected.
9	INTERSTAGE IN	Interstage RF input.
10	NC	Not connected.
11	AC GND2	AC ground. Shunt resistor may be added to increase I_{DD} and OIP3.
12	NC	Not connected.
13	RF OUT	RF output pin. 50Ω matched. This pin is DC-blocked
14	NC	Not connected.
15	NC	Not connected.
16	NC	Not connected.
17	VD2	Bias voltage. 2.5V to 6.0V applied through bias inductor.
18	NC	Not connected.
19	VD1	Bias voltage. 2.5V to 6.0V applied through bias inductor.
20	NC	Not connected.
Pkg Base	GND	Ground connection and heat sink.

Package Drawing



Dimensions in mm.

Evaluation Board Schematic



R3 is DNP for standard 180mA current draw. If R3 is added, the I_{DD} will increase. A 20Ω R3 will raise the current to achieve higher linearity.

Components	700MHz to 1100MHz	1.8GHz to 3.8GHz
L1 (nH)	12	8.2
L2 (nH)	8.2	4.7
L3 (nH)	18	4.7
L4 (nH)	DNP	DNP
C3 (pF)	10	18
C4 (pF)	10	18
C5 (pF)	100	100
C6 (pF)	DNP	DNP
C7 (pF)	DNP	10
C8 (pF)	DNP	0.5
R2 (Ω)	0	0
R3 (Ω)	DNP	DNP
R5 (Ω)	6.8pF	15pF

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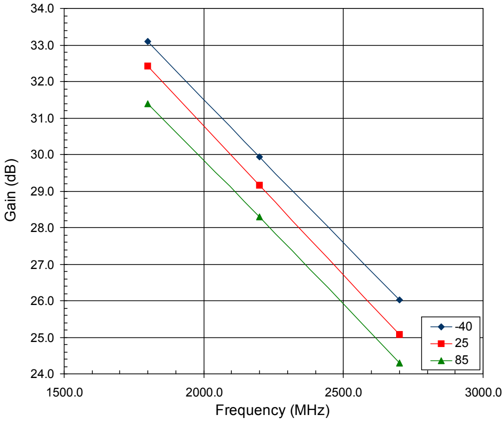
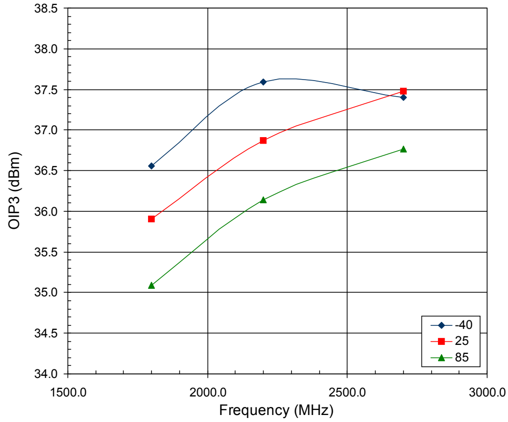
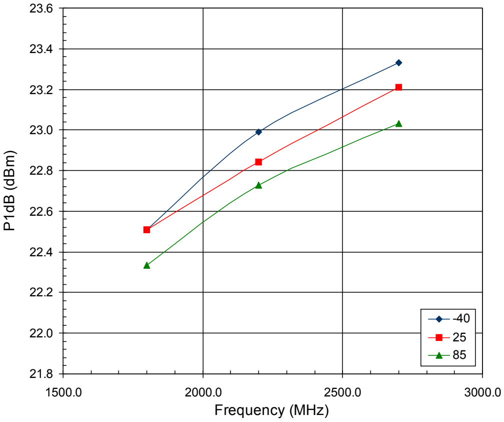
5V Gain versus Temperature



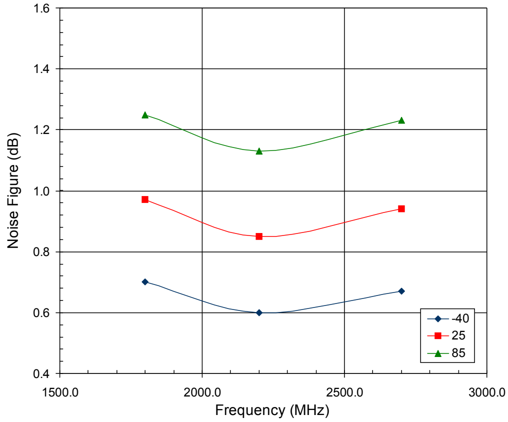
5V OIP3 versus Temperature



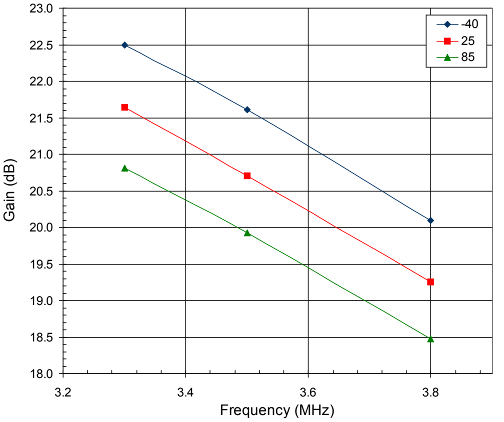
5V P1dB versus Temperature



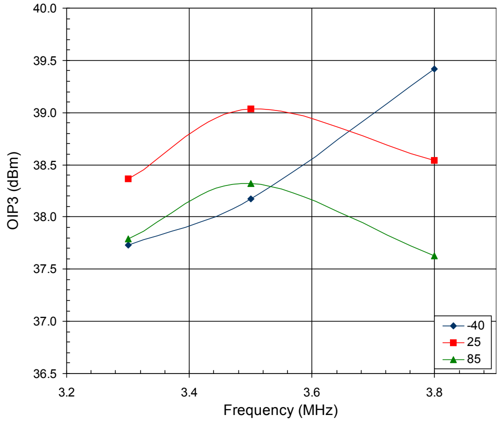
5V Noise Figure versus Temperature



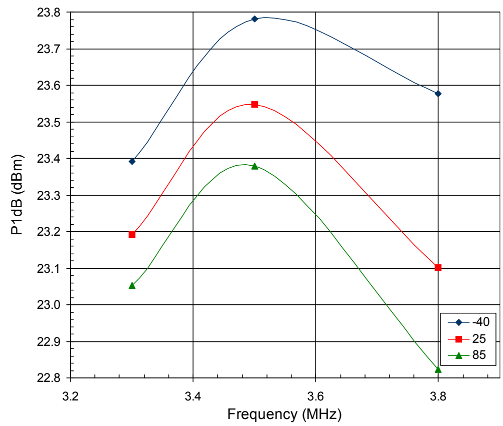
5V Gain versus Temperature



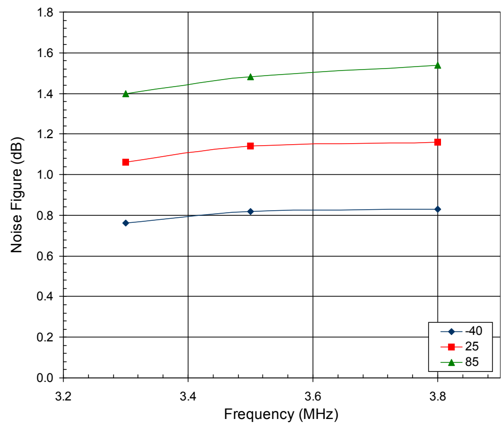
5V OIP3 versus Temperature



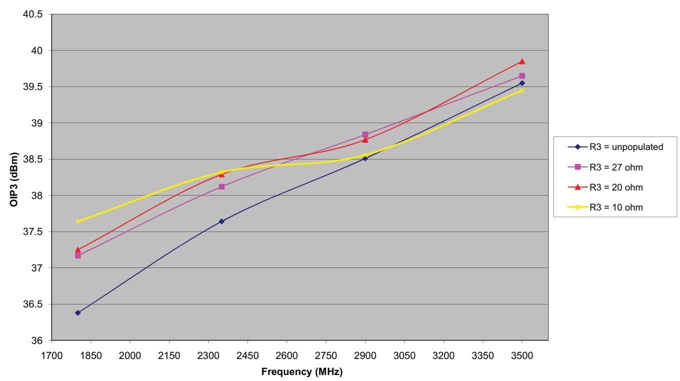
5V P1dB versus Temperature



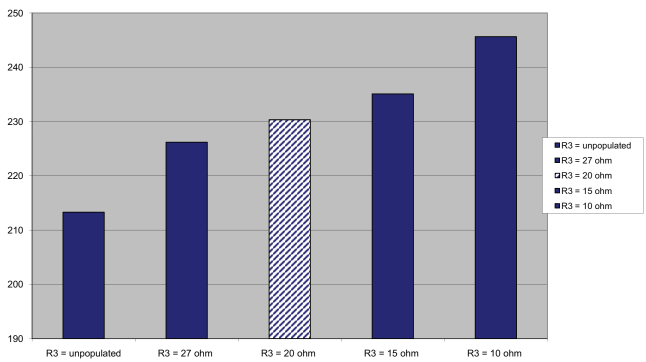
5V Noise Figure versus Temperature



RF3866-410 1800 - 3800 MHz Evaluation Board
OIP3 vs R3 value
R3 = 20 ohm sees best trade-off vs frequency



RF3866-410 1800 - 3800 MHz Evaluation Board
Icc vs R3 value
R3 = 20 ohm for optimum IP3 vs Frequency



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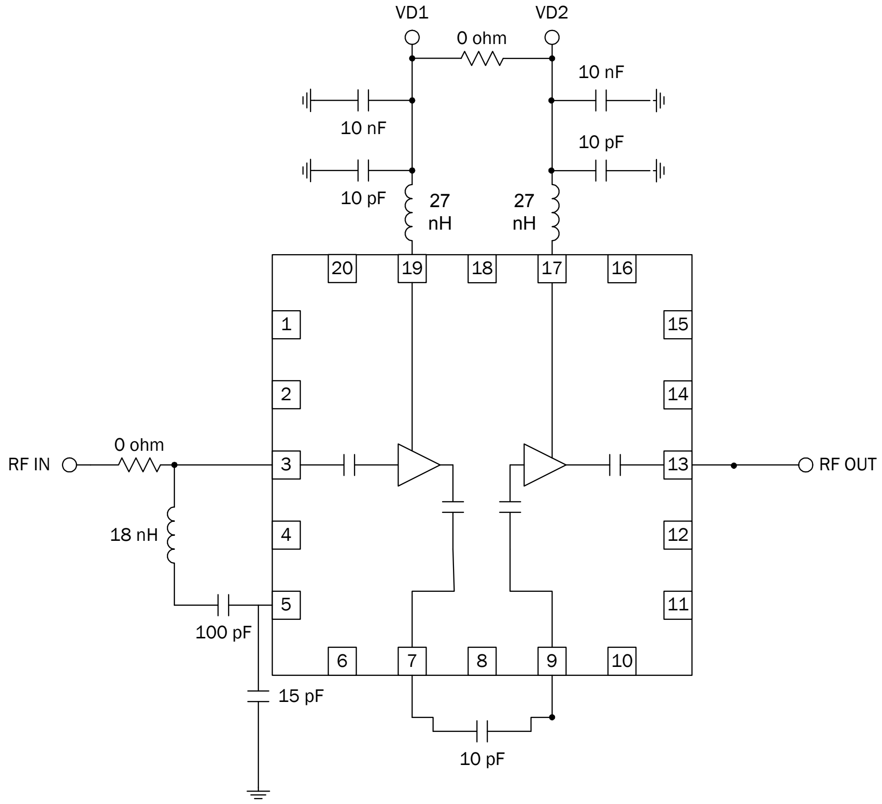
400MHz to 1000MHz Application Schematic



Frequency	VCC	ICC	Gain	OIP3	OP1dB	NF
MHz	V	mA	dB	dBm	dBm	dB
400	5	174.532	32.69	36.02	22.08	1.75
600	5	174.513	34.48	37.93	22.31	1.45
800	5	174.456	33.06	37.89	21.9	1.1
1000	5	174.585	30.77	37.17	22	1.25

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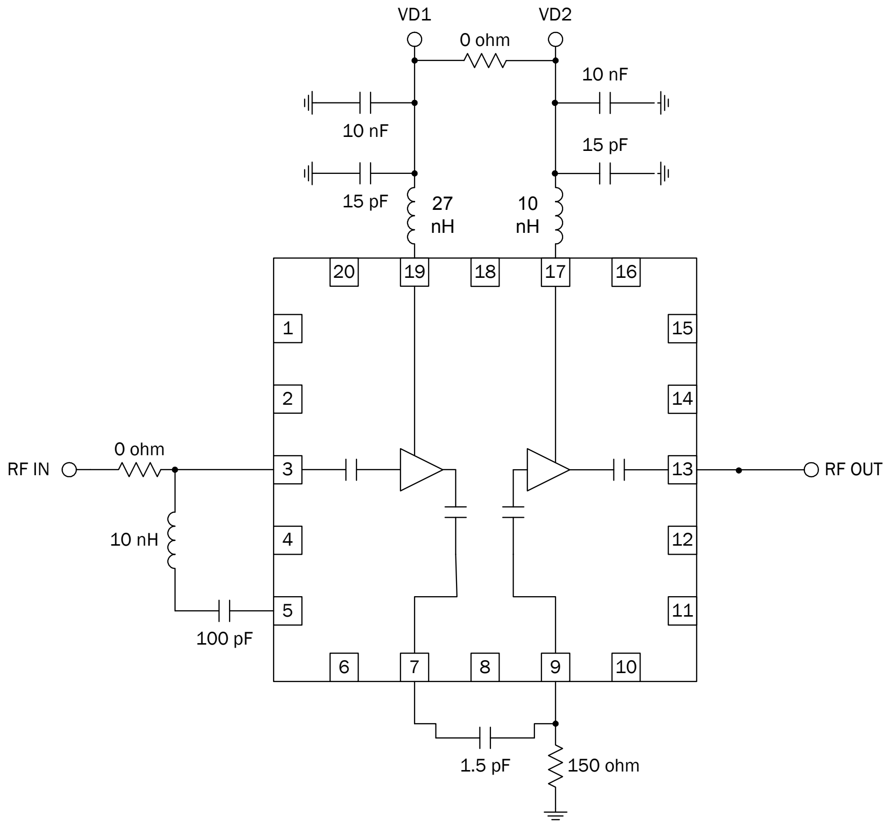
700 MHz to 2200 MHz Application Schematic



Frequency	VCC	ICC	Gain	OIP3	OP1dB	NF
MHz	V	mA	dB	dBm	dBm	dB
700	5	174.687	27.02	35.53	22.15	1.45
1200	5	174.876	26.14	36.76	21.99	1
1700	5	174.903	26.22	35.49	21.38	0.85
2200	5	174.918	24.99	36.13	22.15	0.85

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Theory of Operation

Low noise figure and high gain/IP3 make RF3866 ideal for use as both a receive LNA and a transmit driver for cellular/DCS/PCS/UMTS and WiMax platforms, in addition to many other general purpose applications. Standard evaluation boards cover 700MHz to 1100MHz and 1800MHz to 3800MHz. Viewing the data sheet evaluation board schematic, refer below for purpose and function of external components:

- R2/L4/C6 (0Ω/unpopulated/unpopulated on standard evaluation boards): These unused components were placed for convenience and flexibility when needed to optimize matching for an out of band application.
- L3/C5/C7: Place to optimize input match and enhance out of band low frequency stability.
- R3: Optionally placed to increase bias current and IP3. 20Ω value is found to be the best case (see graph section).
- L1/C3/R5/C8: Interstage tuning.
- L2/C4: Influence output return loss.

RF3866 has internal DC-blocking capacitors at RFin/RFout. In addition, it has been shown that impedance seen looking out at pins 7/9/17/19 influence response. As a result, two port s-parameters become non-applicable. if matching is desired for frequency bands outside of those provided with standard evaluation boards, application schematics within this data sheet for 400MHz to 1000MHz and 700MHz to 2200MHz serve as examples.

Detailed discussion of each begins here with the 400MHz to 1000MHz schematic. In this application the design goals were as follows:

- Input and output return loss better than 10dB over the entire 600MHz bandwidth.
- IP3 and compression point in line with standard evaluation board performance.

These goals were attained, with additional specifications shown in tabular data accompanying schematic:

- Noise figure = 1.75dB to 1.25dB versus frequency
- Gain = 32.7dB to 30.8dB at band edges.

To extend the standard 700MHz to 1100MHz evaluation board response down to 400MHz, the following components were changed (refer to reference designators in evaluation board schematic):

- C7 adjusted from unpopulated to 15pF
- L1 adjusted from 12nH to 27nH
- L2 adjusted from 8.2nH to 27nH
- “R5” adjusted from 6.8pF to 10pF

In effect, all components were placed or increased in value to shift response down in frequency. Broadband characteristic of the part allowed return loss/performance to extend out to 1000MHz.

Next, consider the application schematic shown for 700MHz to 2200MHz. The design goals in this case:

- Maintain noise figure/IP3/OP1dB within reason to that seen on standard board.
- Obtain 2dB gain flatness over the 1500MHz bandwidth, along with better than 10dB input/output return loss.

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Again, start with the standard 700MHz to 1100MHz evaluation board and make the following changes:

- L3 adjusted from 18nH to 10nH
- L1 adjusted from 12nH to 27nH
- L2 adjusted from 8.2nH to 10nH
- “R5” adjusted from 6.8pF to 1.5pF
- “C8” adjusted from unpopulated to 150Ω
- C3 and C4 adjusted from 10pF to 15pF

Intuitive changes were made at L3 and R5. Lowering L3 extends input match higher in frequency. Lowering “R5” to 1.5pF helps meet gain flatness specification by reducing gain on the low end of the band.

Non-intuitive changes:

- “C8” value of 150Ω optimized interstage match for gain flatness.
- L1/L2/C3/ C4 chosen via trial and error to further influence gain and meet return loss specification.

The above matching discussion should be helpful when considering use in frequency bands outside of those covered by standard evaluation boards. it can be noted here that application schematics and standard boards collectively cover 100% of the usable bandwidth from 400MHz to 3800MHz. As such, choosing from these available schematics should accommodate the majority of applications that come about.

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