

# Low noise amplifier

## SPECIFICATION

### 1 FEATURES

- TSMC CMOS 65 nm
- Operating frequency range 65...3000 MHz
- Single differential input
- High linearity
- High dynamic range
- Wide range variable gain -25...+20 dB
- Supported foundries: TSMC, UMC, Global Foundries, SMIC

### 2 APPLICATION

- Front-end high frequency signal amplification in receivers

### 3 OVERVIEW

Low-noise amplifier (LNA) is used to amplify weak signal at receiver input. LNA has a commutator to select necessary frequency sub-band and adjustable resonant circuit to fine-tune. Amplifier includes an integrated inductors and uses minimum off-chip components. The LNA is designed using TSMC 65nm CRN65LP technology.

### 4 STRUCTURE

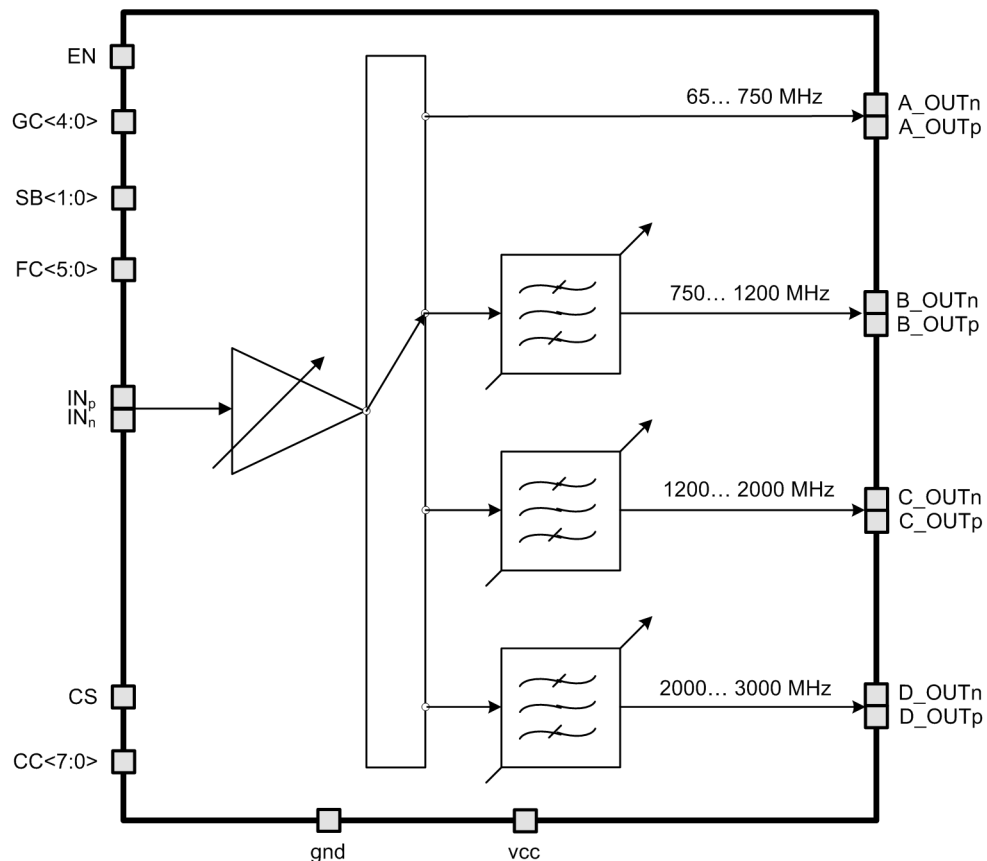


Figure 1: Low noise amplifier structure.

## 5 PIN DESCRIPTION

Name	Direction	Description
IREF_20u	IO	Reference current 20 $\mu$ A
IN <sub>p</sub>	I	Differential input (F = 65...3000 MHz)
IN <sub>n</sub>	I	
EN	I	LNA enable/disable
GC<4:0>	I	Gain control
CC<7:0>	I	LNA current control
CS	I	Digital code defined the current source type (temperature independent/temperature dependent)
SB<1:0>	I	Subband select bit
FC<5:0>	I	Resonant circuit adjustment
A_OUT <sub>n</sub>	O	LNA differential output (F = 65...750 MHz)
A_OUT <sub>p</sub>	O	
B_OUT <sub>n</sub>	O	LNA differential output (F = 750...1200 MHz)
B_OUT <sub>p</sub>	O	
C_OUT <sub>n</sub>	O	LNA differential output (F = 1200...2000 MHz)
C_OUT <sub>p</sub>	O	
D_OUT <sub>n</sub>	O	LNA differential output (F = 2000...3000 MHz)
D_OUT <sub>p</sub>	O	
vcc	IO	Supply voltage
gnd	IO	Ground

## 6 LAYOUT DESCRIPTION

The block dimensions are given in the table 1.

Table 1: Block dimensions.

Dimension	Value	Unit
Height	2625	$\mu\text{m}$
Width	2030	$\mu\text{m}$

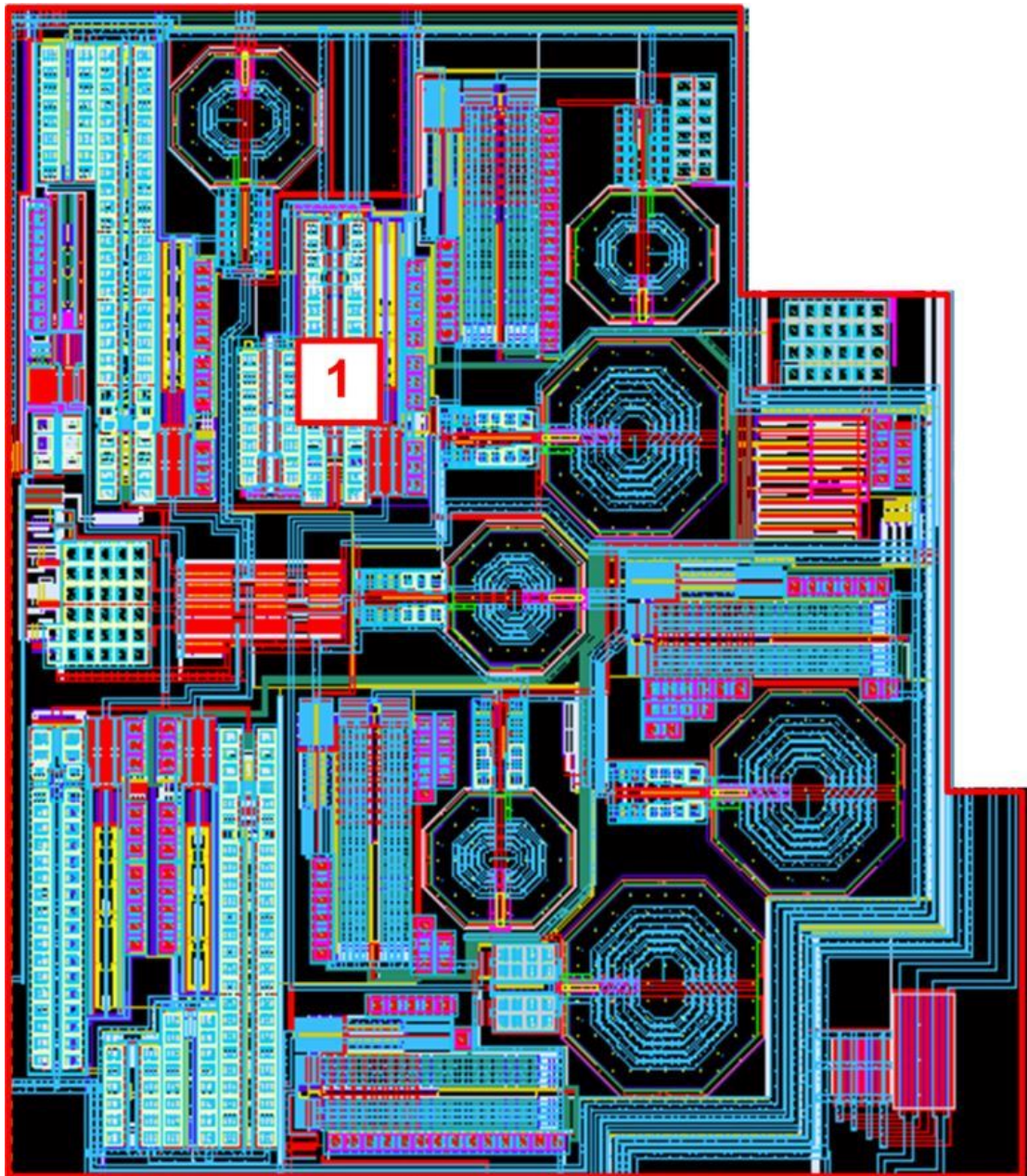


Figure 2: Low noise amplifier layout view.

1. LNA

## 7 OPERATING CHARACTERISTICS

### 7.1 TECHNICAL CHARACTERISTICS

Technology \_\_\_\_\_ TSMC CMOS 65 nm  
 Status \_\_\_\_\_ silicon proven  
 Area \_\_\_\_\_ 5.1 mm<sup>2</sup>

### 7.2 ELECTRICAL CHARACTERISTICS

The values of electrical characteristics are specified for  $V_{cc25} = 2.4 \div 2.6V$  and  $T = -40 \div +125^{\circ}C$ . Typical values are at  $V_{cc25} = 2.5V$ ,  $T = +85^{\circ}C$ , unless otherwise specified.

Parameter	Symbol	Condition	Value			Unit	
			min	typ	max		
Supply voltage	$V_{cc25}$	-	2.4	2.5	2.6	V	
Operating temperature range	T	-	-40	+85	+125	$^{\circ}C$	
Operating input frequency	$F_A$	-	65	-	750	MHz	
	$F_B$	-	750	-	1200		
	$F_C$	-	1200	-	2000		
	$F_D$	-	2000	-	3000		
Bandwidth	$B_w$	-	-	200	-	MHz	
Gain	G	GC="11111", 75 $\Omega$ *	$F_A$	14.3	17.8	19.2	dB
			$F_B$	14.2	19.7	23.2	
			$F_C$	13.5	18.7	23.8	
			$F_D$	14.2	20.8	27.4	
Gain control range	GC		$F_A$	27.2	29.7	32.3	dB
			$F_B$	42.5	44.9	48.1	
			$F_C$	40.5	43.2	45.7	
			$F_D$	45.0	47.2	50.3	
Noise figure	NF	GC="11111", 75 $\Omega$ *	$F_A$	3.4	3.7	4.5	dB
			$F_B$	3.7	4.2	5.2	
			$F_C$	4.6	5.1	6.0	
			$F_D$	4.9	5.3	7.2	
Input VSWR*	$VSWR_{IN}$	GC="11111", 75 $\Omega$ *	$F_A$	3	3.2	3.7	-
			$F_B$	1.5	2.0	2.7	
			$F_C$	1.1	1.9	3.5	
			$F_D$	1.3	1.9	3.1	
Output impedance	$R_{out}$	75 $\Omega$ *	-	800	-	$\Omega$	
Maximum input power		-	-	-	10	dBm	
Input 1dB compression point	$P_{1dB}$	GC="11111", 75 $\Omega$ *	$F_A$	-	-18	-	dBm
			$F_B$	-	-13	-	
			$F_C$	-	-15	-	
			$F_D$	-	-18	-	
Current consumption	$I_{cc}$	-	-	88.92	-	mA	

\* Measured with external components.

Note: Data in table are specified for the circuit with external transformer.

## 8 TYPICAL CHARACTERISTICS

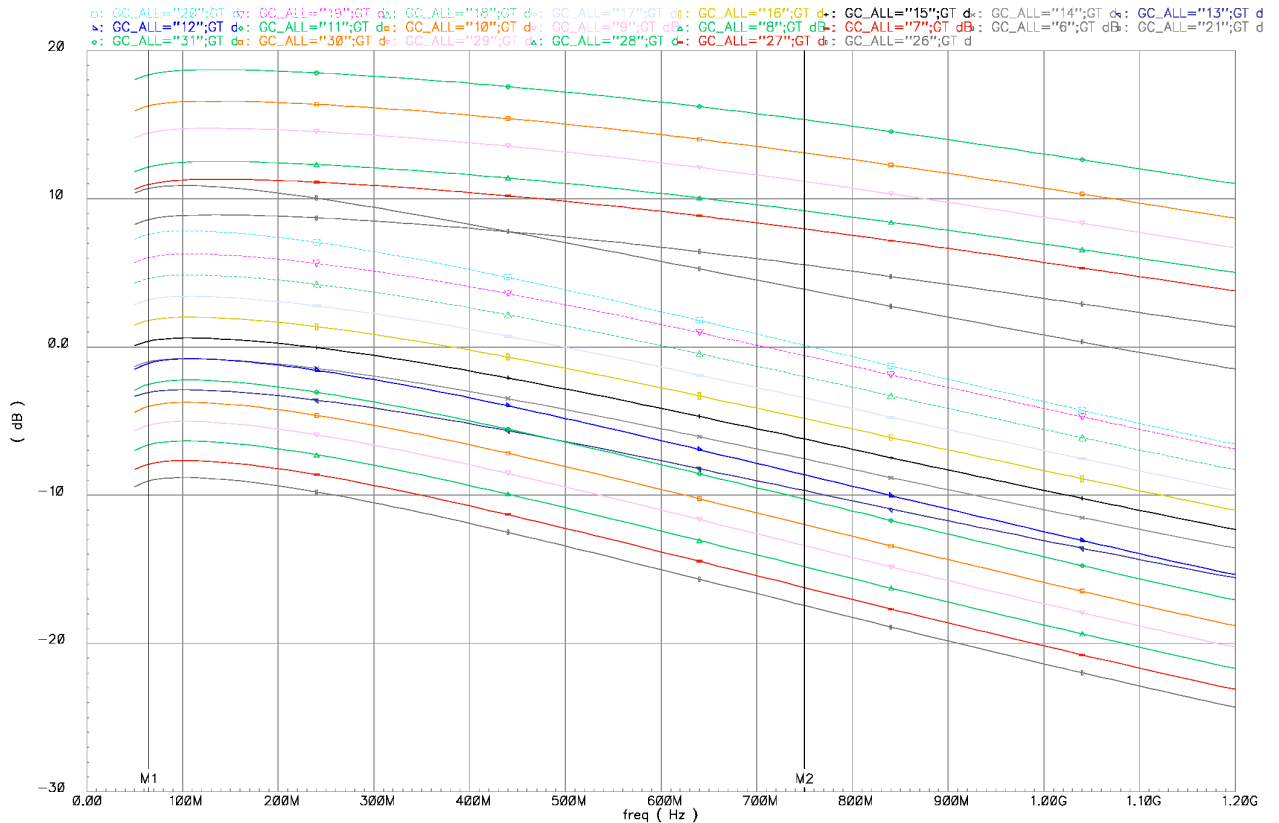


Figure 3: Gain vs gain control (GC) for  $F_A$  (65 – 750 MHz).

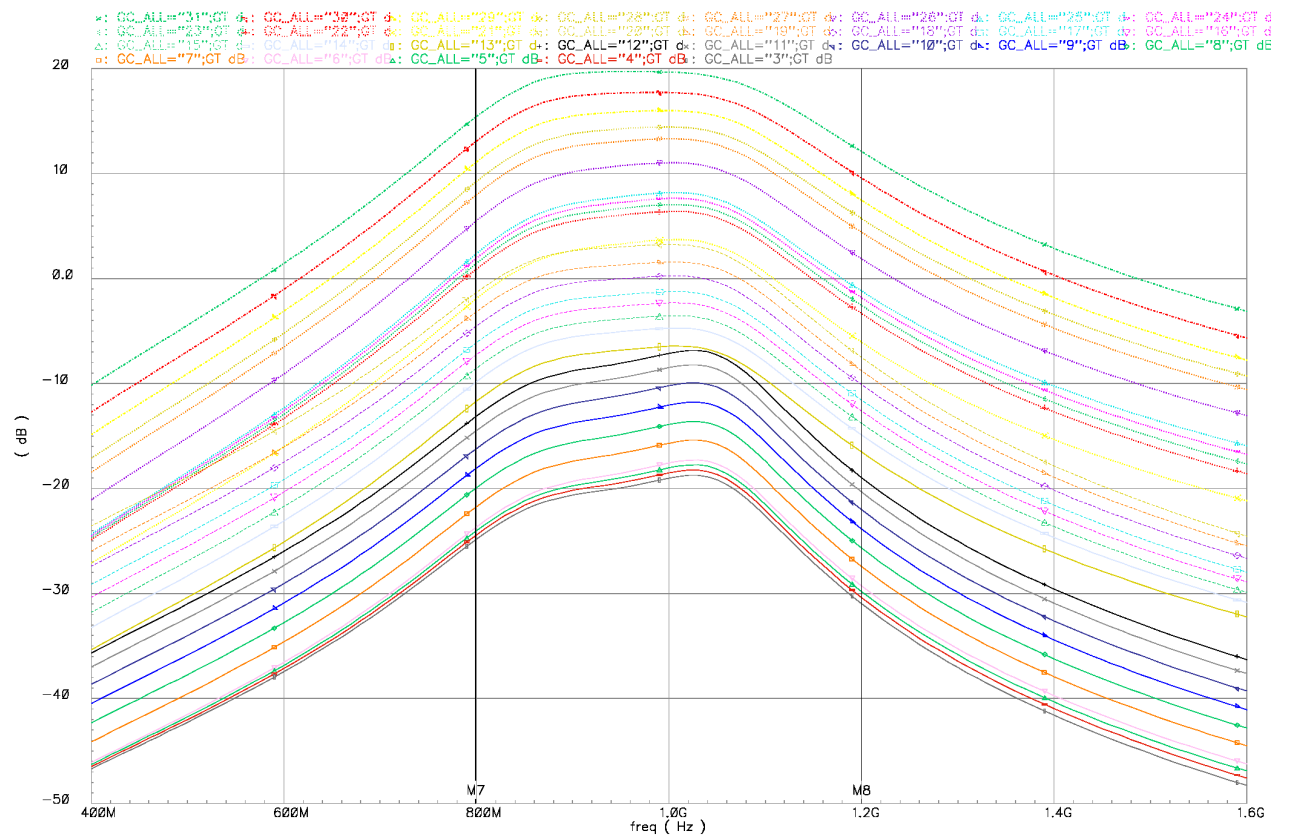


Figure 4: Gain vs gain control (GC) for  $F_B$  (750 – 1200 MHz).



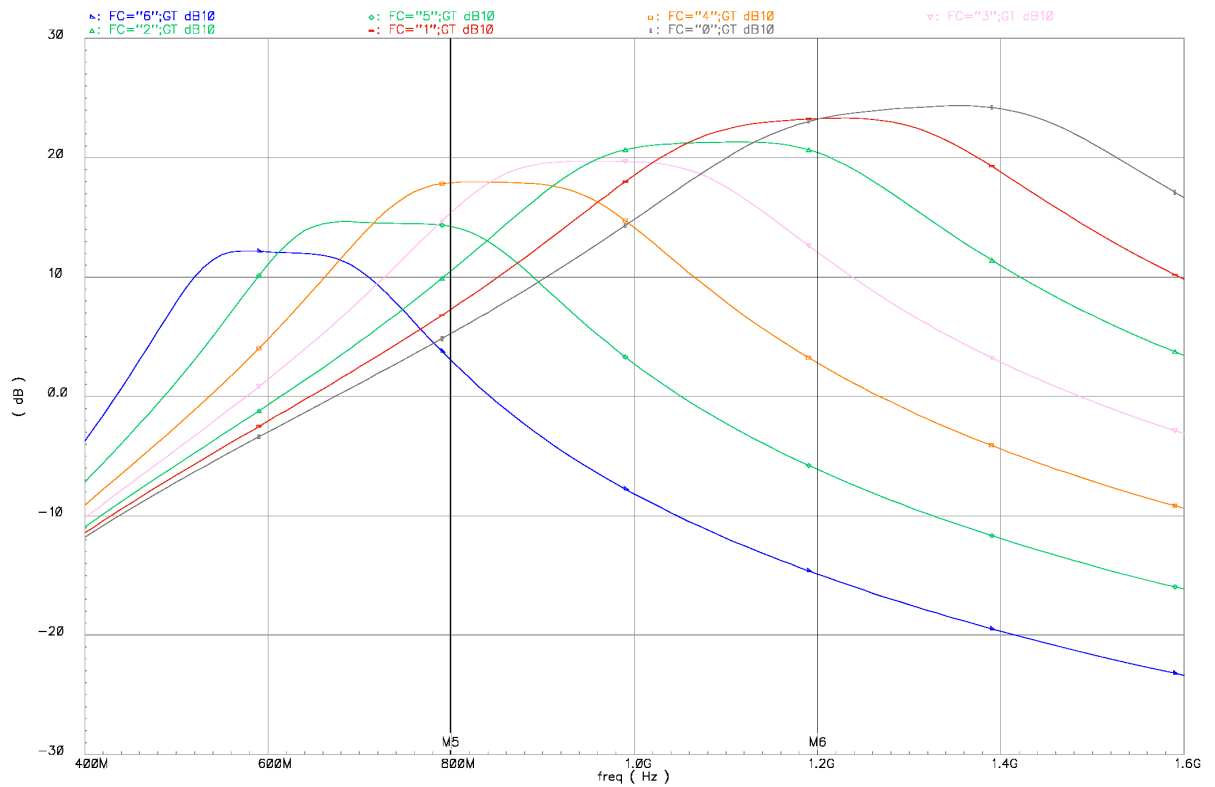


Figure 5: Gain vs resonant circuit adjustment (FC) for  $F_B$  (750 – 1200 MHz).

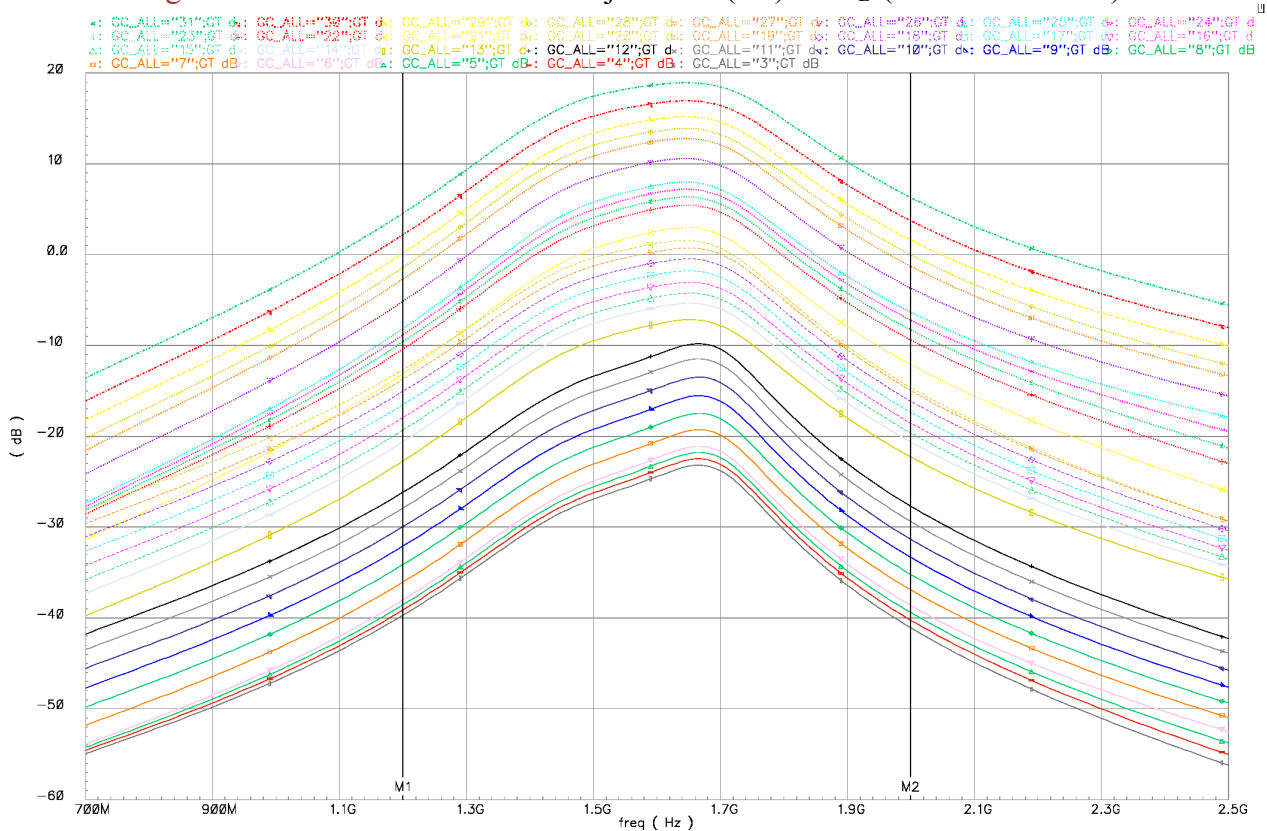


Figure 6: Gain vs gain control (GC) for  $F_C$  (1200 – 2000 MHz).

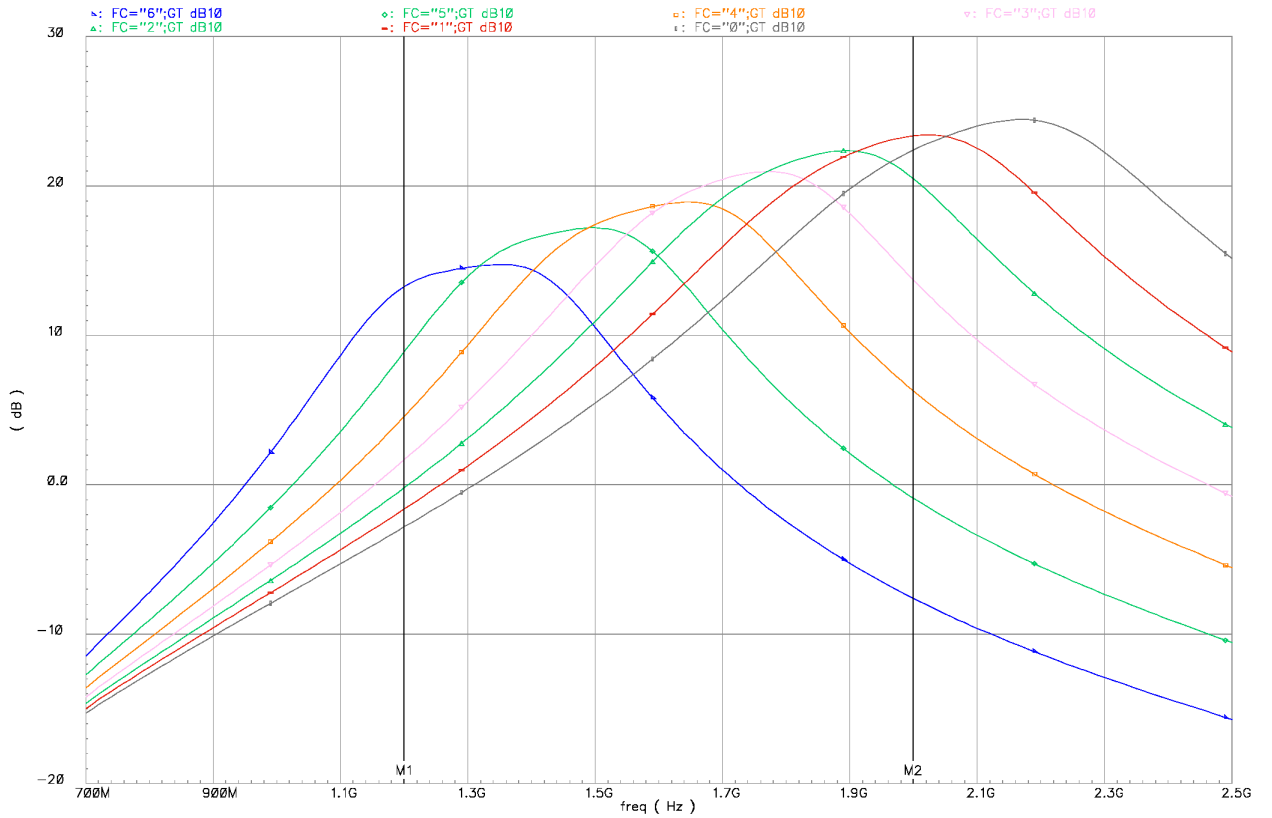


Figure 7: Gain vs resonant circuit adjustment (FC) for  $F_C$  (1200 – 2000 MHz).

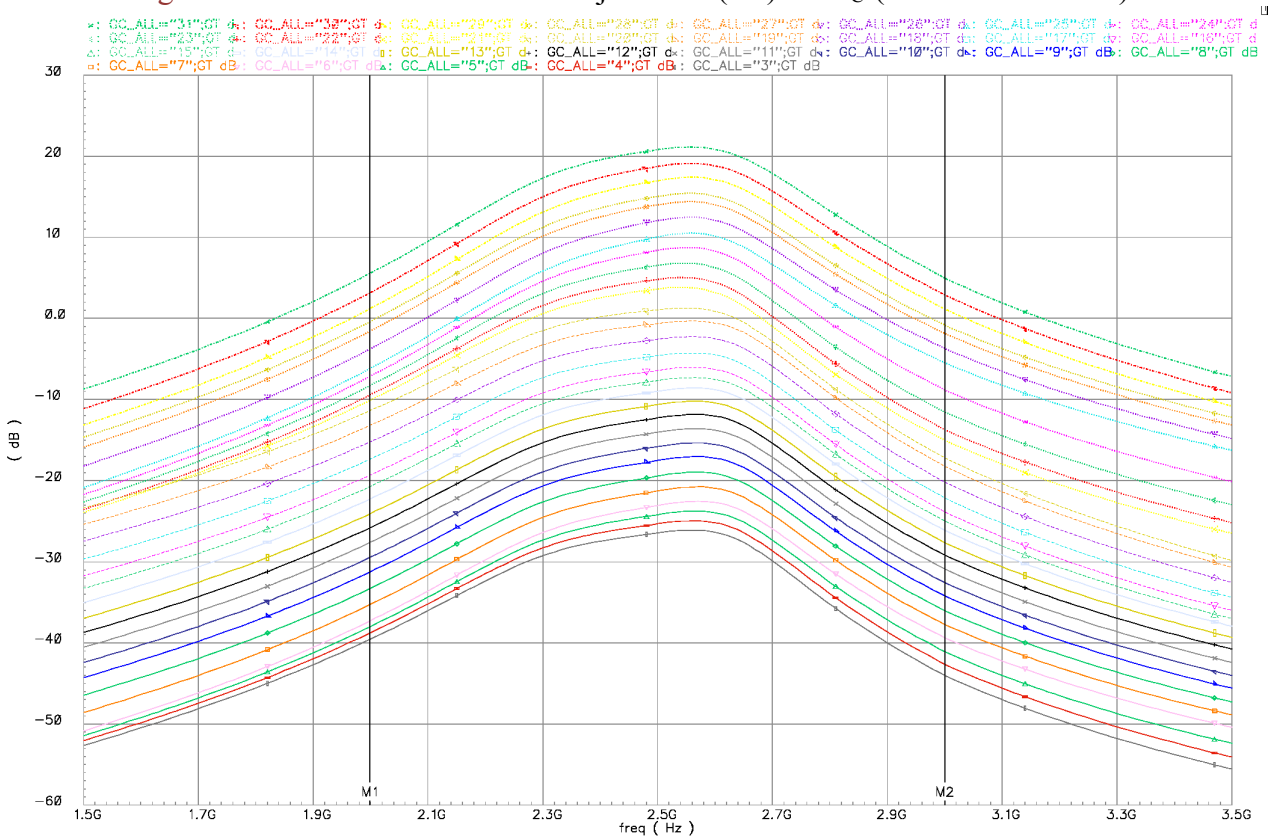


Figure 8: Gain vs gain control (GC) for  $F_D$  (2000 – 3000 MHz).

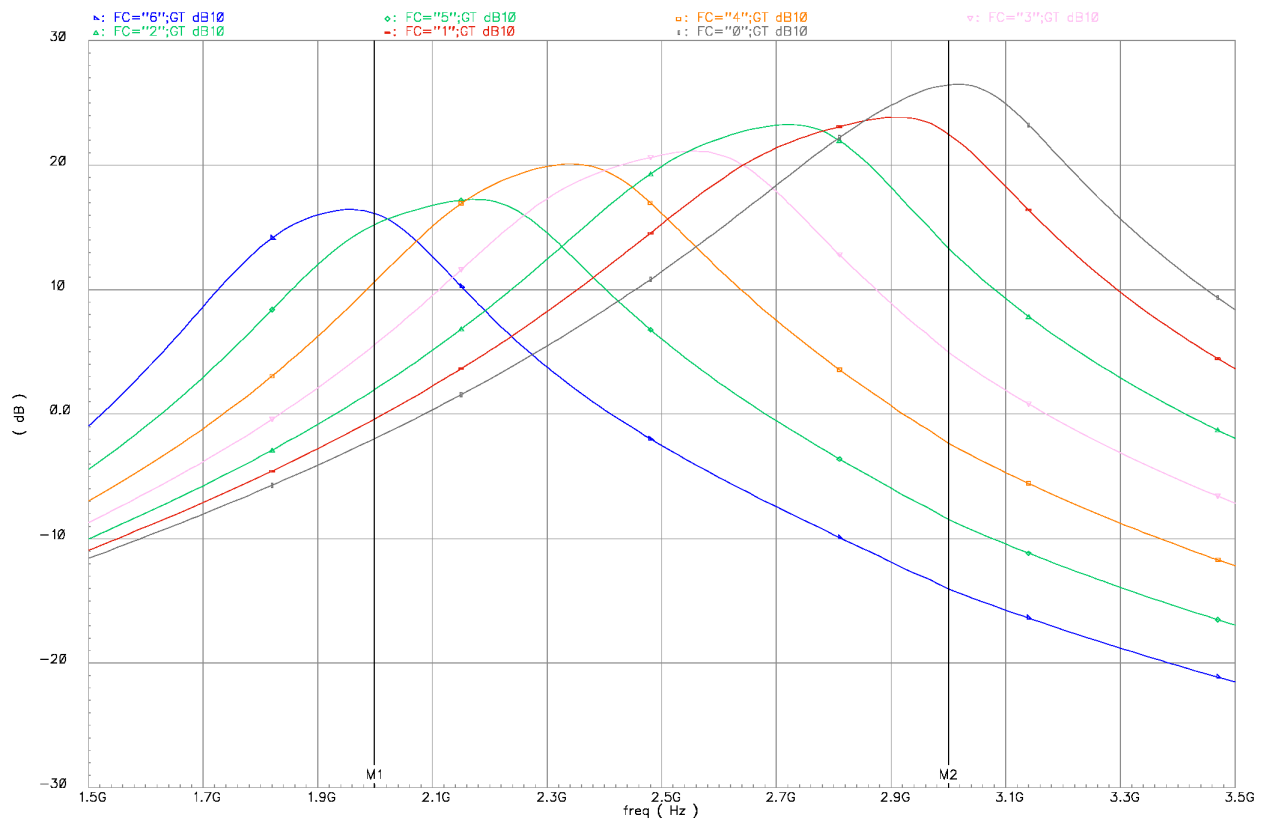


Figure 9: Gain vs resonant circuit adjustment (FC) for  $F_D$  (2000 – 3000 MHz).

## 9 DELIVERABLES

IP contents:

- Schematic or NetList
- Layout or blackbox
- Extracted view (optional)
- GDSII
- DRC, LVS, antenna report
- Test bench with saved configurations (optional)
- Documentation