

# Multiband multiaimed GPS/Galileo/GLONASS & TV receiver

## SPECIFICATION

### 1 FEATURES

#### Overall

- GPS/Galileo/GLONASS & TV signals simultaneous reception
- “TV only” and “Navigation only” modes
- A few number of external components
- Selectable type of serial interface: individual I<sup>2</sup>C for TV and individual 3-wire SPI for GPS/Galileo/GLONASS or I<sup>2</sup>C for both
- 0.18 μm SiGe BiCMOS TSMC technology

#### GPS/Galileo/GLONASS receiver

- Single conversion superheterodyne receiver
- Active antenna detector
- Selectable front end modes: IQ GPS/Galileo/GLONASS, IQ GPS/Galileo only, IQ GLONASS only, GPS/Galileo and GLONASS with image-rejection
- Integrated 50 Ω output matched LNA
- Integrated IF filter with automatic passband adjustment to maintain the cut-off frequency over all process variations
- Selectable channel output type: differential linear output or digital CMOS output with built-in 2-bit ADC
- Fully integrated frequency synthesizer with internal PLL filter and clock driver for correlator
- PLL lock indicator

#### TV tuner

- Direct conversion superheterodyne receiver
- Single antenna input for UHF/VHF/FM bands with integrated Low Noise Diplexer matched to 50 Ω
- Single antenna input for L/S bands with integrated Low Noise Diplexer matched to 50 Ω
- Bandpass tracking filters
- Integrated tunable bandwidth channel filters (1...5 MHz)
- Dual AGC (RF & Baseband)
- Fully integrated fractional-N frequency synthesizer
- PLL lock indicator
- Less than 15 mW power consumption in DVB-H mode with 10:1 time slicing

### 2 APPLICATION

- Navigation systems
- Portable receivers
- Mobile communication
- Measuring equipment

### 3 OVERVIEW

The NT2022 integrates GPS/Galileo/GLONASS receiver with TV-tuner intended to perform a simultaneous reception, down conversion, filtering and amplifying of both television and GNSS GPS/Galileo/GLONASS signals. The receiver supports DVB-H, DVB-T, IP-DAB, T-DMB, FM standards and covers FM (75 MHz to 108 MHz), VHF-III (170 MHz to 230 MHz), UHF (470 MHz to 860 MHz) bands, L-band (both 1450 MHz to 1490 MHz and 1660 MHz to 1685 MHz) and S-band (2170 MHz to 2200 MHz). So it is the optimal solution for navigation and TV reception on portable devices almost anywhere in the world. IC is fabricated in SiGe BiCMOS TSMC 0.18 μm technology.

## 4 PAD DESCRIPTION

<b>Pad number</b>	<b>Name</b>	<b>Description</b>
2A	G <sup>3</sup> _LNAgnd	LNA ground
2B		
3	G <sup>3</sup> _LNOut	LNA output
4	G <sup>3</sup> _LNAVcc	LNA supply voltage
5A	G <sup>3</sup> _LNAgnd	LNA ground
5B		
6A	G <sup>3</sup> _LNAgnd	LNA ground
6B		
7	G <sup>3</sup> _LNAIN	LNA input
8	G <sup>3</sup> _LNAgnd	LNA ground
9	ResRef	Reference current source external resistor
10A	T <sup>V</sup> _RFgnd	TV RF circuits ground
10B		
11	T <sup>V</sup> _SLin	TV L/S band LNA input
12	T <sup>V</sup> _HFin	TV UHF/VHF/FM LNA input
13A	T <sup>V</sup> _RFgnd	TV RF circuits ground
13B		
14	T <sup>V</sup> _RFVCC	TV RF circuits supply voltage
15	T <sup>V</sup> _TRFuhf	TV bandpass tracking filter (UHF)
16	T <sup>V</sup> _RFVCC	TV RF circuits supply voltage
17	T <sup>V</sup> _TRFfm	TV bandpass tracking filter (FM)
18	T <sup>V</sup> _TRFvhf	TV bandpass tracking filter (VHF)
19	T <sup>V</sup> _RFAGC	RF AGC capacitor
20A	T <sup>V</sup> _VCOgnd	VCO ground
20B		
21	T <sup>V</sup> _VCOVCC	VCO supply voltage
22	T <sup>V</sup> _PLLVCC	PLL supply voltage
23	T <sup>V</sup> _LDOout	LDO output
24A	T <sup>V</sup> _PLLgnd	PLL ground
24B		
25	T <sup>V</sup> _CPout	Charge pump output
26	T <sup>V</sup> _STM	Slice time mode input
27	T <sup>V</sup> _BBVCC	IFA & LPF supply voltage
28A	T <sup>V</sup> _BBgnd	IFA & LPF ground
28B		
29	T <sup>V</sup> _BBAGCQ	Q channel BB AGC capacitor
30	T <sup>V</sup> _BBAGCI	I channel BB AGC capacitor
31	T <sup>V</sup> _DCOC_Q	Q channel DC offset compensation circuit (DCOC) capacitor
32	T <sup>V</sup> _DCOC_I	I channel DCOC capacitor
33	T <sup>V</sup> _Qp	
34	T <sup>V</sup> _Qn	Q channel differential output
35	T <sup>V</sup> _RST	TV reset
36	T <sup>V</sup> _In	
37	T <sup>V</sup> _Ip	I channel differential outputs
38	T <sup>V</sup> _SDA	Serial interface data

Table “Pad description” (continue).

<b>Pad number</b>	<b>Name</b>	<b>Description</b>
39	N.C.	-
40	T <sup>V</sup> _SCL	Serial interface clock
41	T <sup>V</sup> _CLK	TV clock frequency output
42	G <sup>3</sup> _CLKn	Clock driver differential output
43	G <sup>3</sup> _CLKp	
44	G <sup>3</sup> _SCLK	Serial interface clock
45	G <sup>3</sup> _DATA_IO	Serial interface input/output data
46	G <sup>3</sup> _EN	Serial interface enable
47	G <sup>3</sup> _GLOp (Sign)	
48	G <sup>3</sup> _GLOn (Magn)	GLONASS differential signal output
49	G <sup>3</sup> _RST	Navigation reset
50	G <sup>3</sup> _GPSn (Magn)	
51	G <sup>3</sup> _GPSp (Sign)	GPS/Galileo differential signal output
52A	G <sup>3</sup> _ADCgnd	ADC ground
52B		
53	G <sup>3</sup> _ADCvcc	ADC supply voltage
54	G <sup>3</sup> _IFAvcc	IFA supply voltage
55A	G <sup>3</sup> _IFAgnd	IFA supply ground
55B		
56	I <sup>2</sup> C	Serial interface type select
57	I <sup>2</sup> C_ADR	Slave address
58	REFin	Reference frequency input
59A	G <sup>3</sup> _PLLgnd	PLL ground
59B		
60A	G <sup>3</sup> _PLLvcc	PLL supply voltage
60B		
61	G <sup>3</sup> _AAD	Active antenna supply voltage
62A	G <sup>3</sup> _LPFgnd	LPF ground
62B		
63	G <sup>3</sup> _LPFvcc	LPF supply voltage
64	G <sup>3</sup> _MIXvcc	Mixer supply voltage
65	G <sup>3</sup> _MIXin	Mixer input
66	G <sup>3</sup> _MIXgnd	Mixer ground
1		

## 5 TYPICAL APPLICATION CIRCUIT

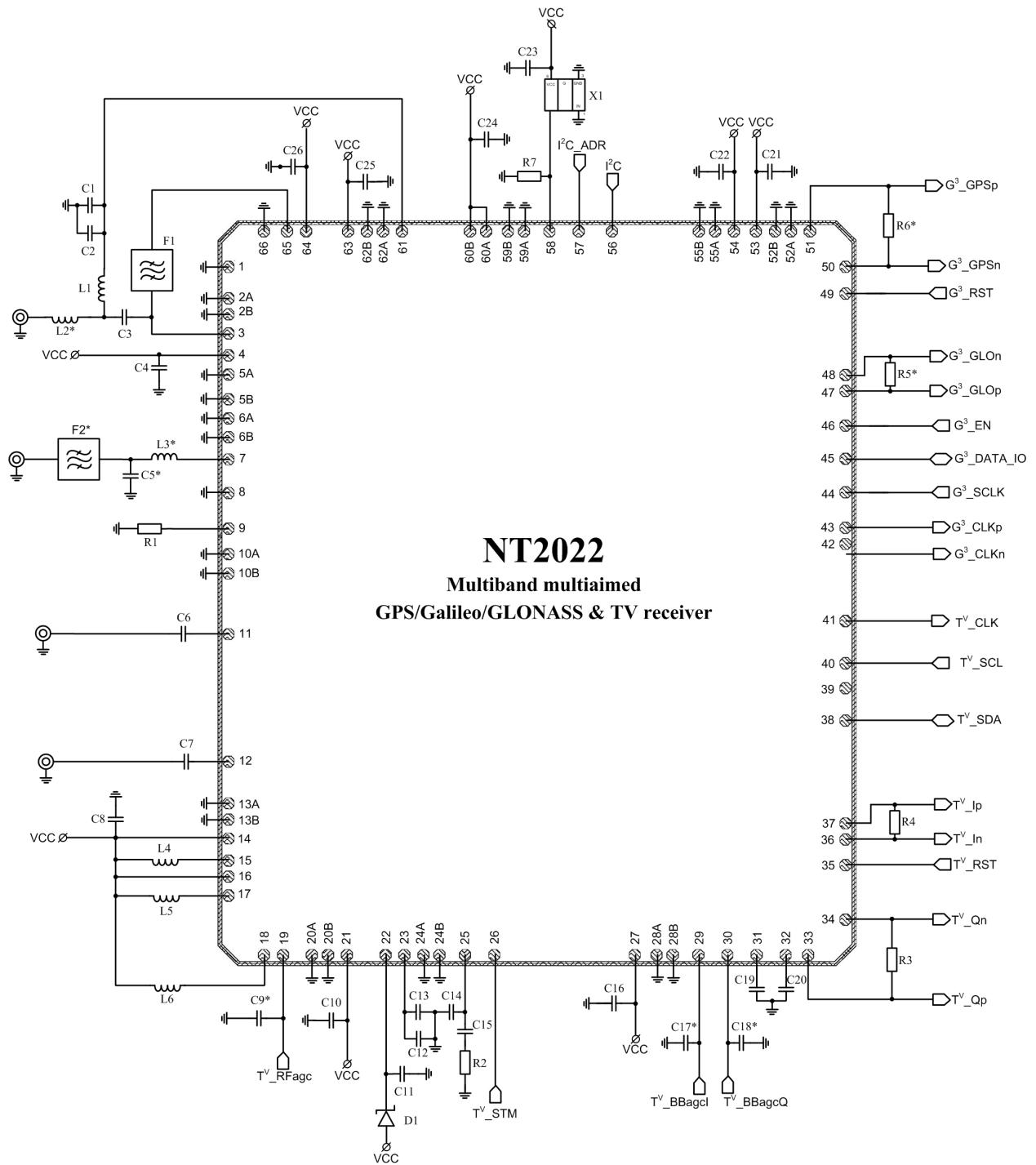


Figure 1: NT2022 application circuit.

**Table 1:** External component description.

<b>Component</b>	<b>Nominal value</b>	<b>Tolerance</b>	<b>Notes</b>
C1	1 $\mu$ F	$\pm 10\%$	filter capacitor
C2	1 nF	$\pm 10\%$	filter capacitor
C3	100 pF	$\pm 10\%$	blocking capacitor
C4	0.1 $\mu$ F	$\pm 10\%$	supply voltage filter capacitor
C5*	1.5 nF	$\pm 5\%$	matching network element
C6	220 pF	$\pm 10\%$	blocking capacitor
C7	1 nF	$\pm 10\%$	blocking capacitor
C8	0.1 $\mu$ F	$\pm 10\%$	supply voltage filter capacitor
C9*	470 nF	$\pm 5\%$	RF AGC filter capacitor
C10	0.1 $\mu$ F	$\pm 10\%$	supply voltage filter capacitor
C11	0.1 $\mu$ F	$\pm 10\%$	supply voltage filter capacitor
C12	0.1 $\mu$ F	$\pm 10\%$	supply voltage filter capacitor
C13	100 pF	$\pm 10\%$	supply voltage filter capacitor
C14	4.7 pF	$\pm 5\%$	PLL filter element
C15	180 pF	$\pm 5\%$	PLL filter element
C16	0.1 $\mu$ F	$\pm 10\%$	supply voltage filter capacitor
C17*	0.47 $\mu$ F	$\pm 10\%$	IF AGC filter capacitor
C18*	0.47 $\mu$ F	$\pm 10\%$	IF AGC filter capacitor
C19	4.7 $\mu$ F	$\pm 10\%$	X7R DCOC capacitor
C20	4.7 $\mu$ F	$\pm 10\%$	X7R DCOC capacitor
C21	0.1 $\mu$ F	$\pm 10\%$	supply voltage filter capacitor
C22	0.1 $\mu$ F	$\pm 10\%$	supply voltage filter capacitor
C23	0.1 $\mu$ F	$\pm 10\%$	supply voltage filter capacitor
C24	0.1 $\mu$ F	$\pm 10\%$	supply voltage filter capacitor
C25	0.1 $\mu$ F	$\pm 10\%$	supply voltage filter capacitor
C26	0.1 $\mu$ F	$\pm 10\%$	supply voltage filter capacitor
L1	56 nH ( $Q \geq 40$ )	$\pm 5\%$	filter inductance
L2*	5.1 nH ( $Q \geq 40$ )	$\pm 5\%$	matching network element
L3*	8.2 nH ( $Q \geq 40$ )	$\pm 5\%$	matching network element
L4	4.3 nH ( $Q \geq 40$ )	$\pm 5\%$	tracking filter element
L5	220 nH ( $Q \geq 40$ )	$\pm 5\%$	tracking filter element
L6	56 nH ( $Q \geq 40$ )	$\pm 5\%$	tracking filter element
R1	61.9 k $\Omega$	$\pm 1\%$	high precision resistor
R2	15 k $\Omega$	$\pm 5\%$	PLL filter element
R3	1.5 k $\Omega$	$\pm 5\%$	load resistor
R4	1.5 k $\Omega$	$\pm 5\%$	load resistor
R5**	510 k $\Omega$	$\pm 5\%$	load resistor
R6**	510 k $\Omega$	$\pm 5\%$	load resistor
R7	10 k $\Omega$	$\pm 10\%$	load resistor
D1	MBR052	-	diode
F1	MA09582	-	SAW filter
F2*	B9000	-	SAW filter
X1	IT2205BE DSA321SC	-	Reference oscillator

Note:

\* – defined depending on PCB construction and purpose.

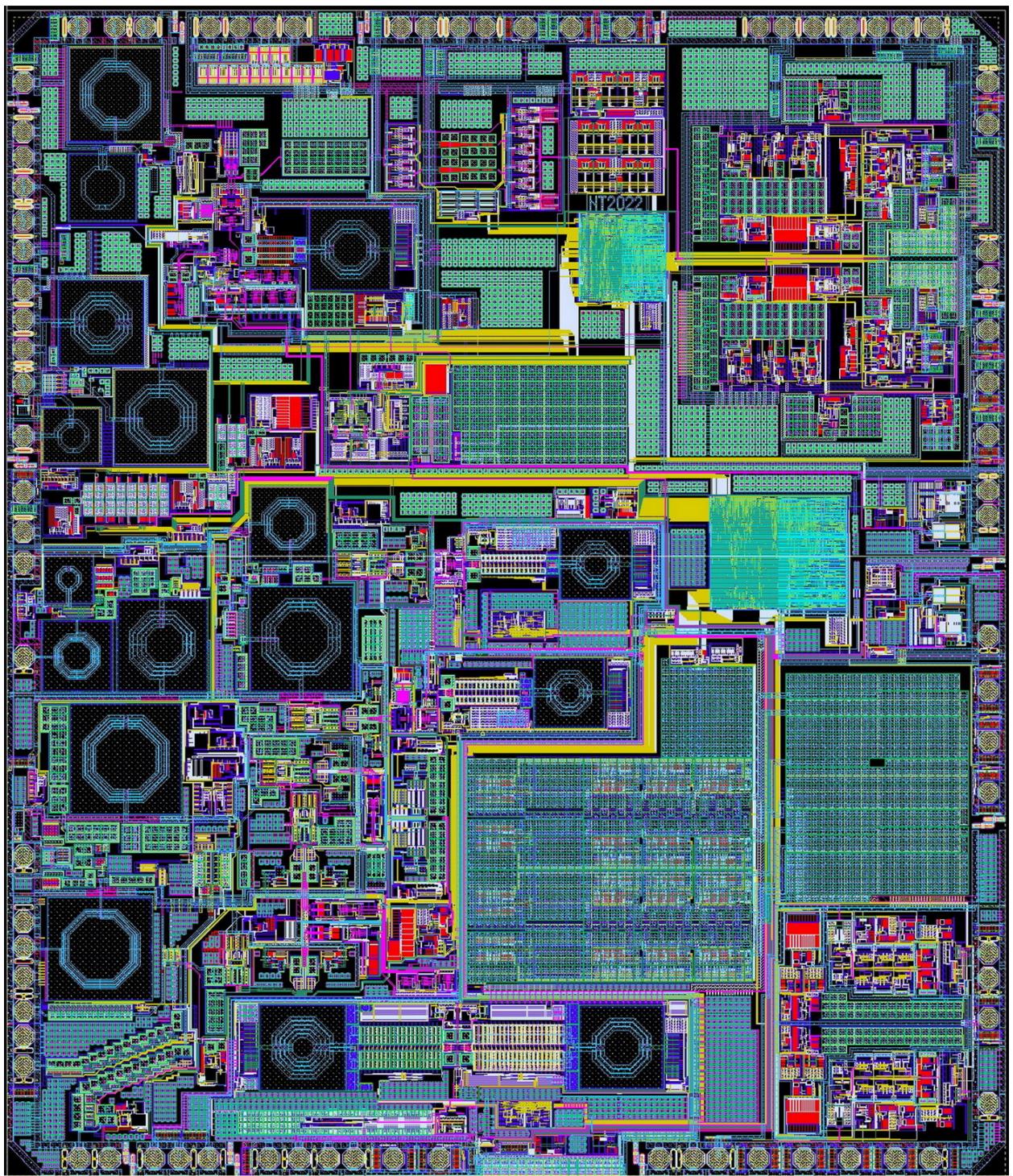
 \*\* – the elements are mounted only in case of using the configuration with differential linear outputs I\_OUT\_P and G<sup>3</sup>\_GLOn and G<sup>3</sup>\_GLOp, G<sup>3</sup>\_GPSn and G<sup>3</sup>\_GPSp.

## 6 LAYOUT DESCRIPTION

IC dimensions are given in the table 2.

**Table 2:** Block dimensions.

Dimension	Value	Unit
Height	3984.94	μm
Width	4650.22	μm



**Figure 2:** Block layout view.

## 7 OPERATING CHARACTERISTICS

### 7.1 ABSOLUTE MAXIMUM RATING

Supply voltage	-0.5...+3.6 V
Maximum input signal level	+10 dBmW
Operating temperature range	-40...+85°C
Storage temperature	-55...+125 °C
Junction temperature	+150 °C
Soldering temperature	+260 °C
Thermal resistance:	
▪ crystal-package	+28 °C/W

### 7.2 DC ELECTRICAL CHARACTERISTICS

The values of electrical characteristics are specified for  $V_{cc} = 2.8$  V to 3.6V,  $T_A = -40 \dots +85^\circ\text{C}$ . Typical values are at  $V_{cc} = 3.0$  V,  $T_A = +25^\circ\text{C}$ , unless otherwise specified.

Parameter	Symbol	Condition	Value			Unit
			min	typ	max	
<b>Overall</b>						
Supply voltage	$V_{cc}$	-	2.8	3.0	3.6	V
Supply current	$I_{cc}$	Active mode, default settings	-	91.0	-	mA
	$I_{stb}$	Stand-by mode	-	-	2	μA
Input logic-level low	$V_{IL}$	-	-0.25	-	0.3	V
Input logic-level high	$V_{IH}$	-	0.7 $V_{cc}$	-	$V_{cc} + 0.25$	V
<b>GPS/Galileo/GLONASS receiver</b>						
Supply current	$I_{cc\_G3}$	<u>Mode1</u>	-	27.7	-	mA
		<u>Mode2</u>	-	29.3	-	
		<u>Mode3</u>	-	27.0	-	
		<u>Mode4</u>	-	28.6	-	
	$I_{stb\_G3}$	Stand-by mode	-	-	1	μA
Output logic-level high (digital output)	$V_{OH\_dig}$	For outputs G <sup>3</sup> _GLOp (Sign), G <sup>3</sup> _GLOn (Magn), G <sup>3</sup> _GPSp (Sign), G <sup>3</sup> _GPSn (Magn).	$V_{cc}-0.5$	$V_{cc}-0.2$	$V_{cc}$	mV
Output logic-level low (digital output)	$V_{OL\_dig}$	Load current 2 mA	0	0.04	0.2	mV
<b>TV receiver</b>						
Supply current	$I_{cc\_TV}$	FM band	-	63.3	-	mA
		VHF band	-	63.6	-	
		UHF band	-	63.7	-	
		L band	-	73.2	-	
		S band	-	71.9	-	
	$I_{TSM}$	Time slice mode, 10:1	-	7	-	mA
RF AGC control voltage	$V_{AGCRF}$	Stand-by mode	-	-	1	μA
		Maximum gain	-	$V_{cc}-0.3$	-	V
Baseband AGC control voltage	$V_{AGCBB}$	Minimum gain	-	0.3	-	
		Maximum gain	-	$V_{cc}-0.3$	-	V
		Minimum gain	-	0.3	-	

## 7.3 AC ELECTRICAL CHARACTERISTICS

The values of electrical characteristics are specified for  $V_{cc} = 2.8 \text{ V}$  to  $3.6\text{V}$ ,  $T_A = -40 \dots +85^\circ\text{C}$ . Typical values are at  $V_{cc} = 3.0 \text{ V}$ ,  $T_A = +25^\circ\text{C}$ , unless otherwise specified.

Parameter	Symbol	Condition	Value			Unit			
			min	typ	max				
<b>GPS/Galileo/GLONASS receiver</b>									
<b>Overall</b>									
Operating frequency range	$F_{IN\_G3}$	L1 band for GNSS GLONASS	1593	-	1606 1587 1587	MHz			
		L1 band for GNSS GPS and SBAS	1571						
		L1 band for GNSS Galileo	1571						
Noise figure referred to LNA input	$NF_{G3}$	<a href="#">Model1</a>	-	1.85	2.3	dB			
		<a href="#">Mode2</a>	-	2.1	2.5				
Noise figure referred to mixer input	$NF_{G3\_MIXin}$	<a href="#">Model1</a>	-	6.0	-	dB			
		<a href="#">Mode2</a>	-	9.0	-				
Noise figure referred to active antenna input	$NF_{G3\_AAin}$	<a href="#">Model1</a>	-	10.2	-	dB			
		<a href="#">Mode2</a>	-	12	-				
Input VSWR	$VSWR_{IN\_G3}$	$50 \Omega$	-	1.6	2.0	dB			
1dB compression point referred to LNA input	$P_{1dB\_G3}$	<a href="#">Note 1</a>	-55	-51	-	dBm			
1dB compression point referred to mixer input	$P_{1dB\_G3\_MIXin}$	<a href="#">Note 1</a>	-37	-34	-	dBm			
1dB compression point referred to active antenna input	$P_{1dB\_G3\_AAin}$	<a href="#">Note1</a>	-34	-31	-	dBm			
Intercept point 3 <sup>rd</sup> order referred to LNA input	IIP3	In band	-45	-42	-	dBm			
		Out of band	-8	-5	-				
Intercept point 3 <sup>rd</sup> order referred to active antenna input	IIP3 <sub>AA</sub>	In band	-24	-21	-	dBm			
Overall voltage gain	$G_{MAX\_G3}$	-	-	80	-	dB			
IQ phase accuracy	$\Delta\phi_{G3}$	-	-	$\pm 0.2$	$\pm 5$	degrees			
IQ amplitude accuracy	$\Delta A_{G3}$	-	-	$\pm 0.2$	$\pm 1$	dB			
<b>LNA</b>									
LNA noise figure	$NFLNA$	-	-	1.6	-	dB			
LNA gain	$G_{LNA}$	-	-	19	-	dB			
LNA input VSWR	$VSWR_{LNA\_IN}$	$50 \Omega$	-	1.6	2.0	-			
LNA output VSWR	$VSWR_{LNA\_OUT}$	$50 \Omega$	-	2.0	2.5	-			
LNA input 1dB compression point	$P_{1dB\_LNA}$	-	-	-20	-	dBm			
Intercept point 3 <sup>rd</sup> order	IIP3 <sub>LNA</sub>	<a href="#">Note 2</a>	-	-8	-	dBm			
<b>Mixer</b>									
Mixer input VSWR	$VSWR_{Mix\_IN}$	$50 \Omega$	-	1.4	2.0	-			
Image rejection	IR	GPS/Galileo	32	38	-	dB			
		GLONASS	32	38	-				
Intercept point 3 <sup>rd</sup> order	IIP3	-	-27	-24	-	dBm			
<b>LPF&amp;IFA</b>									
Output frequency range	$F_{IF}$	-	3	-	18	MHz			
Sinusoidal/noise signal peak-to-peak voltage at the differential linear outputs	$V_m$	$510 \Omega$	-	200/480	-	mV			
LPF cut-off frequency	$F_{cut\_LPF}$	-1 dB	-	18.1	-	MHz			
AGC range	$\Delta G$	-	50	-	-	dB			
<b>ADC</b>									
ADC output signal level	$V_{OUT}$	Preset 1	-	1.2	-	-			
		Preset 2		1.8					
		Preset 3		2.4					
		Preset 4		$V_{cc}$					

Table “AC electrical characteristics” (continue).

Parameter	Symbol	Condition	Value			Unit
			min	typ	max	
Resolution	R <sub>ADC</sub>	-	-	2	-	bit
<b>Synthesizer</b>						
Reference frequency	F <sub>REF_G3</sub>	-	-	24.84	-	MHz
LO frequency	F <sub>LO_G3</sub>	-	-	1589.76	-	MHz
LO phase noise	PN <sub>LO_G3</sub>	At 100 kHz offset relative to carrier frequency At 1 MHz offset relative to carrier frequency	-90 -110	-95 -115	-	dBc/Hz
Clock frequency	F <sub>CLK_G3</sub>	-	-	49.68	-	MHz
PLL dividing ratio	D <sub>RPLL</sub>	-	-	128	-	-
Comparison frequency suppression	S <sub>FC</sub>	-	80	-	-	dB
Peak-to-peak voltage at the clock output	V <sub>CLK_G3</sub>	Preset1, harmonic differential Preset2, harmonic differential Preset3, harmonic differential Preset4, harmonic differential Preset5, CMOS single-ended Preset6, CMOS single-ended Preset7, CMOS single-ended Preset8, CMOS single-ended	- - - - - - - -	0.30 0.40 0.49 0.55 0.26 1.16 2.00 2.66	-	V
<b>TV receiver</b>						
<b>Overall</b>						
Operating frequency range	F <sub>IN_TV</sub>	FM VHF UHF L1 L2 S	75 170 470 1450 1660 2170	-	108 240 860 1490 1685 2200	MHz
Noise figure (DSB)	NF <sub>TV</sub>	FM VHF UHF L1, L2 S	-	4.0 4.0 4.3 5.2 4.4	-	dB
Input VSWR	VSWR <sub>IN_TV</sub>	50 Ω	-	3	4	-
Input 1dB compression point	P <sub>1dB_TV</sub>	FM VHF UHF L1 L2 S	Maximum gain Minimum gain Maximum gain Minimum gain Maximum gain Minimum gain Maximum gain Minimum gain Maximum gain Minimum gain	- - - - - - - - - -	-37 -14 -38 -16 -37 -17 -35 -16 -37 -17 -38 -13	dBm

Table “AC electrical characteristics” (continue).

Parameter	Symbol	Condition	Value			Unit
			min	typ	max	
Intercept point 3 <sup>rd</sup> order	IIP3 <sub>TV</sub>	FM	Maximum gain	-20	-	dBm
			Minimum gain	2	-	
		VHF	Maximum gain	-23	-	
			Minimum gain	-3	-	
		UHF	Maximum gain	-22	-	
			Minimum gain	-5	-	
		L1	Maximum gain	-19	-	
			Minimum gain	2	-	
		L2	Maximum gain	-18	-	
			Minimum gain	1	-	
		S	Maximum gain	-25	-	
			Minimum gain	-3	-	
Overall voltage gain	G <sub>TV</sub>	-	-	90	-	dB
IQ phase accuracy	Δφ <sub>TV</sub>	I/Q phase error at 1 MHz	-3	-	+3	degrees
IQ amplitude accuracy	ΔA <sub>TV</sub>	-	-	25	-	mV <sub>p-p</sub>
RF AGC range	ΔG <sub>RF</sub>	-	25	-	-	dB
BB AGC range	ΔG <sub>BB</sub>	-	65	-	-	dB
<b>IFA&amp;LPF</b>						
Output frequency range	F <sub>BB</sub>	-	0	-	5	MHz
Nominal output voltage	V <sub>out</sub>	Preset 1-	7 mV step	-	0.47	V <sub>p-p</sub>
		Preset 2			0.72	
		Preset 3			0.99	
		Preset 4			1.24	
Insertion loss	A <sub>cut</sub>	6 MHz	18	20	-	dB
		8 MHz	34	36	-	
Output impedance	R <sub>out</sub>	Differential	-	1.5	-	kΩ
LPF bandwidth	BW <sub>LPF</sub>	-	1.5	4	5	MHz
<b>Synthesizer</b>						
LO phase noise	PN <sub>LO_TV</sub>	At 10 kHz frequency offset	FM	-	-104	dBc/Hz
			VHF	-	-100	
			UHF	-	-92	
			L1, L2	-	-80	
			S	-	-80	
		At 100 kHz frequency offset	FM	-	-105	
			VHF	-	-101	
			UHF	-	-93	
			L1, L2	-	-87	
			S	-	-90	
Reference frequency	F <sub>ref_TV</sub>	-	1	24.84	30	MHz
N divider ratio	N	-	64	-	2047	-
R divider ratio	R	-	1	-	31	-
Fractional-N resolution	Res	-	-	24	-	Bit
Frequency comparison	F <sub>FC</sub>	-	1	24.84	30	MHz
Charge-pump output current	I <sub>CP</sub>	Preset 1	-	42.5...72.5	-	μA
		Preset 2	-	85...145	-	
		Preset 3	-	170...290	-	
		Preset 4	-	340...580	-	

Table “AC electrical characteristics” (continue).

Parameter	Symbol	Condition	Value			Unit
			min	typ	max	
VCO frequency range	F <sub>VCO</sub>	VCO 1	880	-	1313	MHz
		VCO 2	1282		1841	
		VCO 3	2868		3445	
		VCO 4	4309		4457	
Output clock frequency	F <sub>clk_TV</sub>	-	1	24.84	30	MHz
Clock frequency output peak-to-peak voltage	A <sub>clk</sub>	Preset 1	-	0.16	-	V <sub>p-p</sub>
		Preset 2	-	0.22	-	
		Preset 3	-	0.27	-	
		Preset 4	-	0.31	-	
		Preset 5, CMOS	-	0.41	-	
		Preset 6, CMOS	-	1.27	-	
		Preset 7, CMOS	-	1.77	-	
		Preset 8, CMOS	-	2.26	-	

Modes:

1. IQ GPS/Galileo/GLONASS mode, differential liner output
2. GPS/Galileo/GLONASS with image rejection mode, differential liner output
3. IQ GPS/Galileo/GLONASS mode, digital CMOS 1.8V output
4. GPS/Galileo/GLONASS with image rejection mode, digital CMOS 1.8V output

Notes:

1. IFA minimum gain
2. Two tones are located at 1576 MHz and 1574 MHz at -60dBm/tone

## 7.4 TYPICAL OPERATING CHARACTERISTICS

### 7.4.1 GPS/GALILEO/GLONASS RECIEVER CHARACHTERISTICS

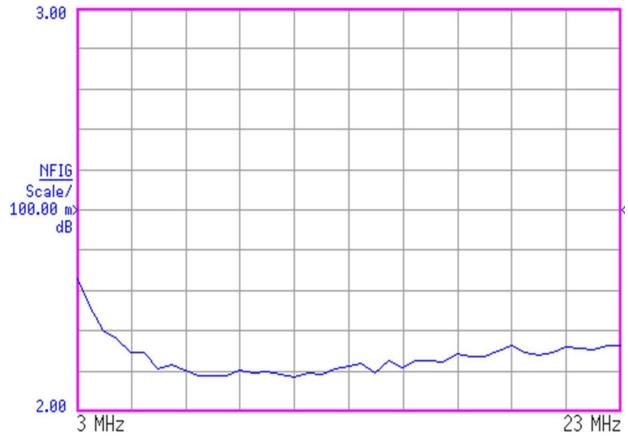
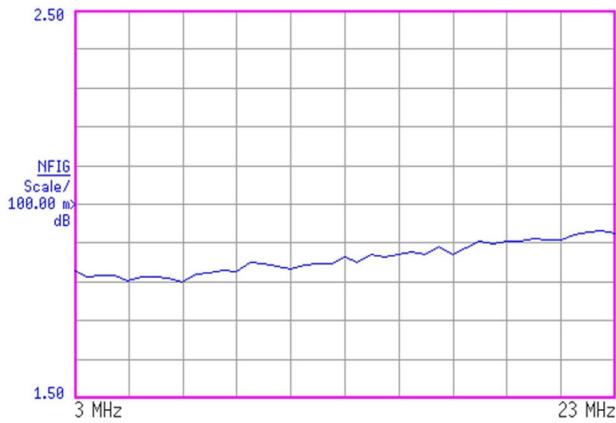


Figure 3: Noise figure referred to LNA input in mode 1.

Figure 4: Noise figure referred to LNA input in mode 2.

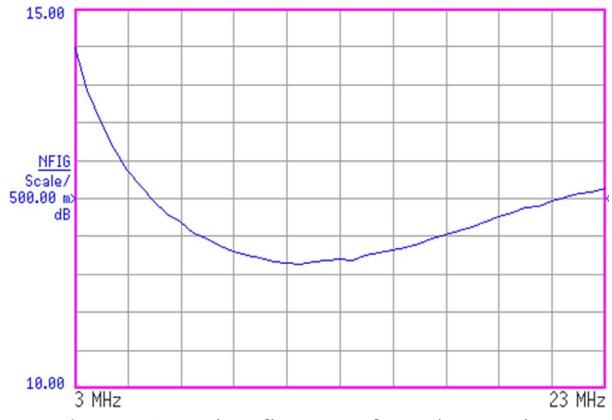
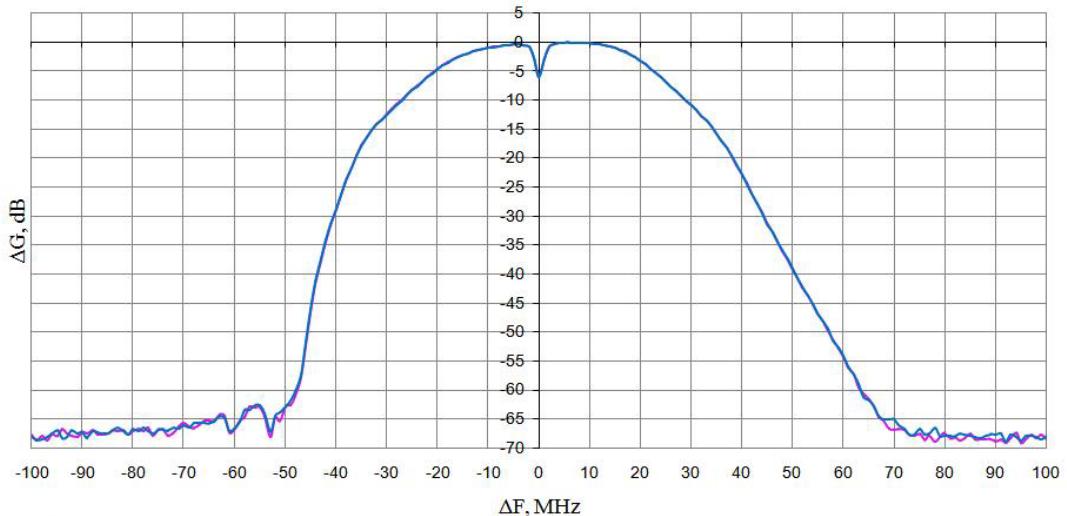


Figure 5: Noise figure referred to active antenna input in mode 1.

Figure 6: Noise figure referred to active antenna input in mode 2.



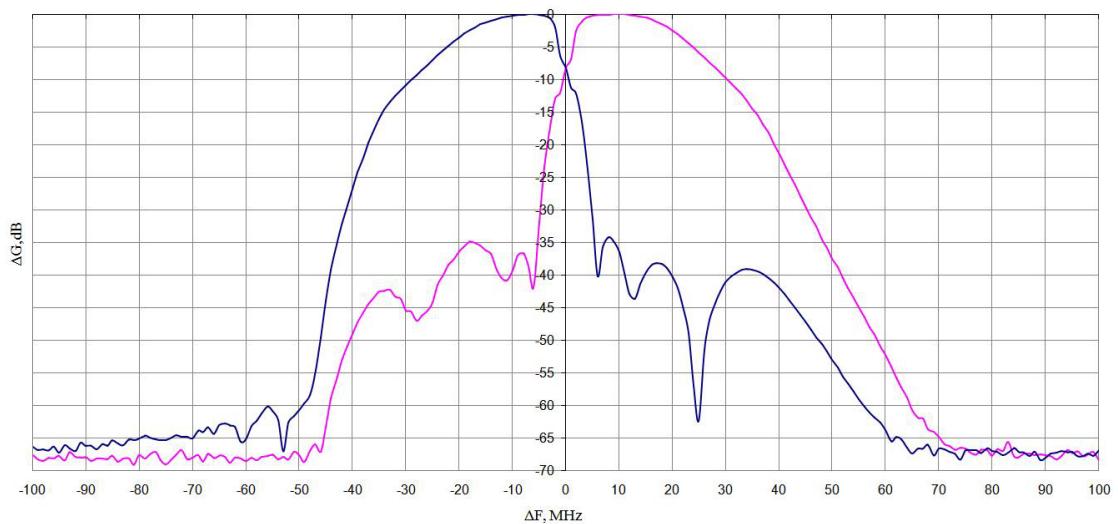


Figure 8: Relative amplitude-frequency characteristic in [mode 2](#).

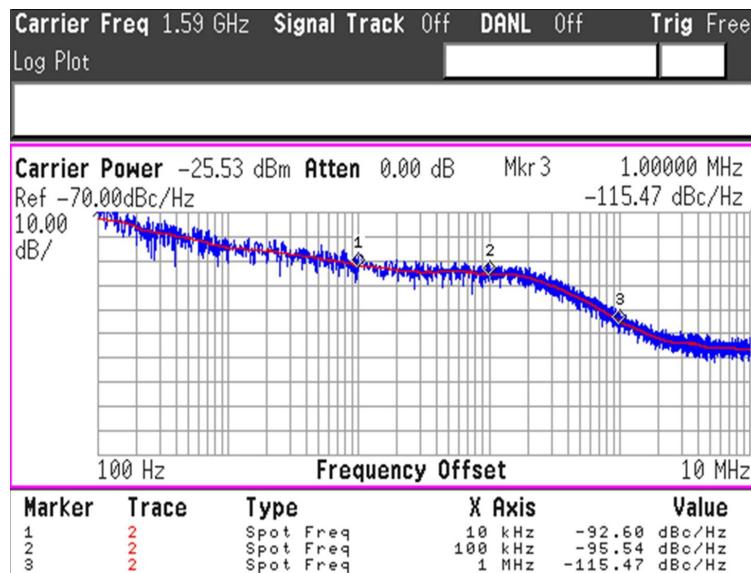


Figure 9: LO noise spectral density.

### 7.4.2 TV TUNER CHARACHTERISTICS

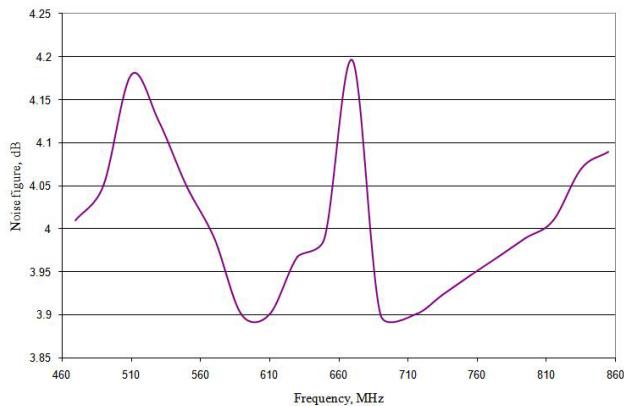


Figure 10: Noise figure (UHF band).

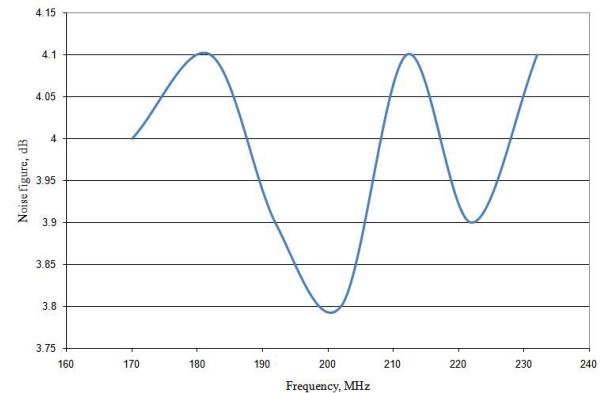


Figure 11: Noise figure (VHF band).

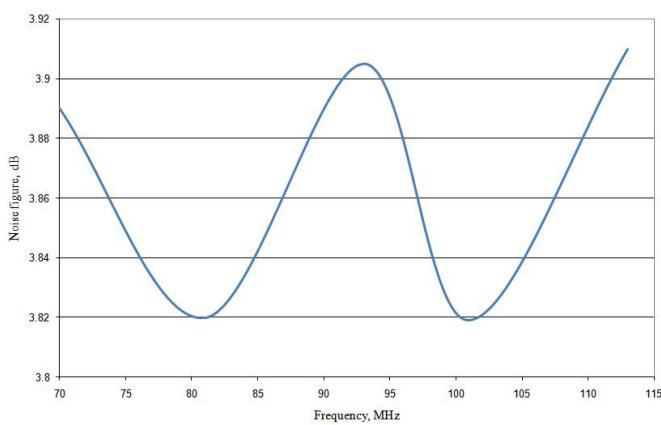


Figure 12: Noise figure (FM band).

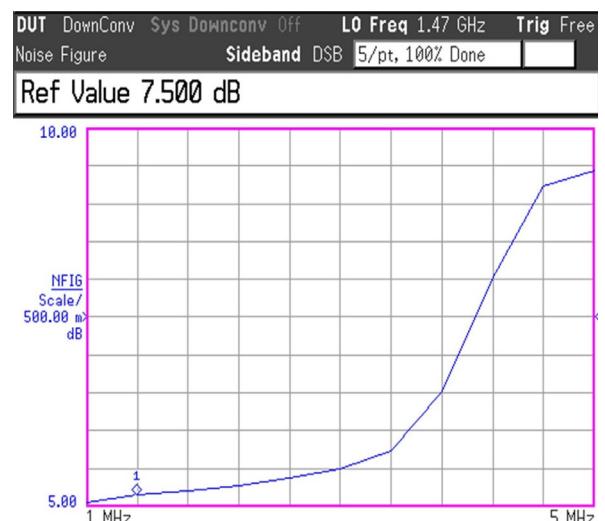


Figure 13: Noise figure (L1 band).

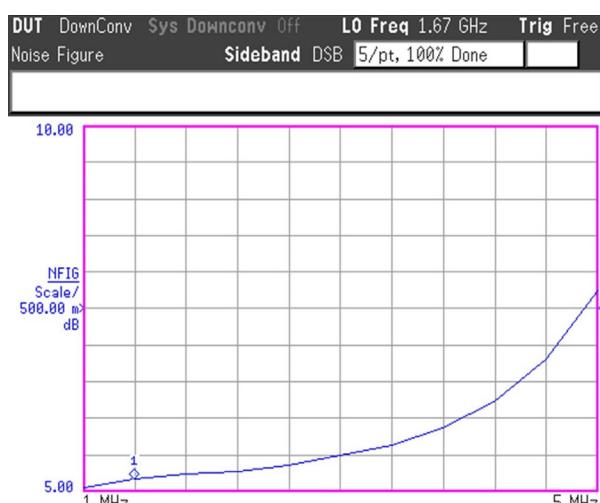


Figure 14: Noise figure (L2 band).

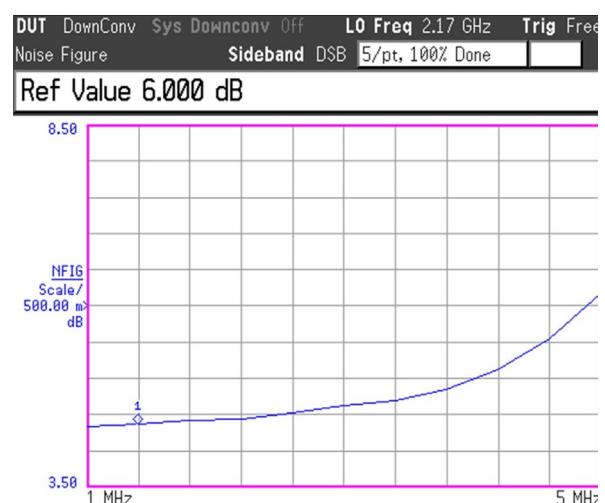


Figure 15: Noise figure (S band).

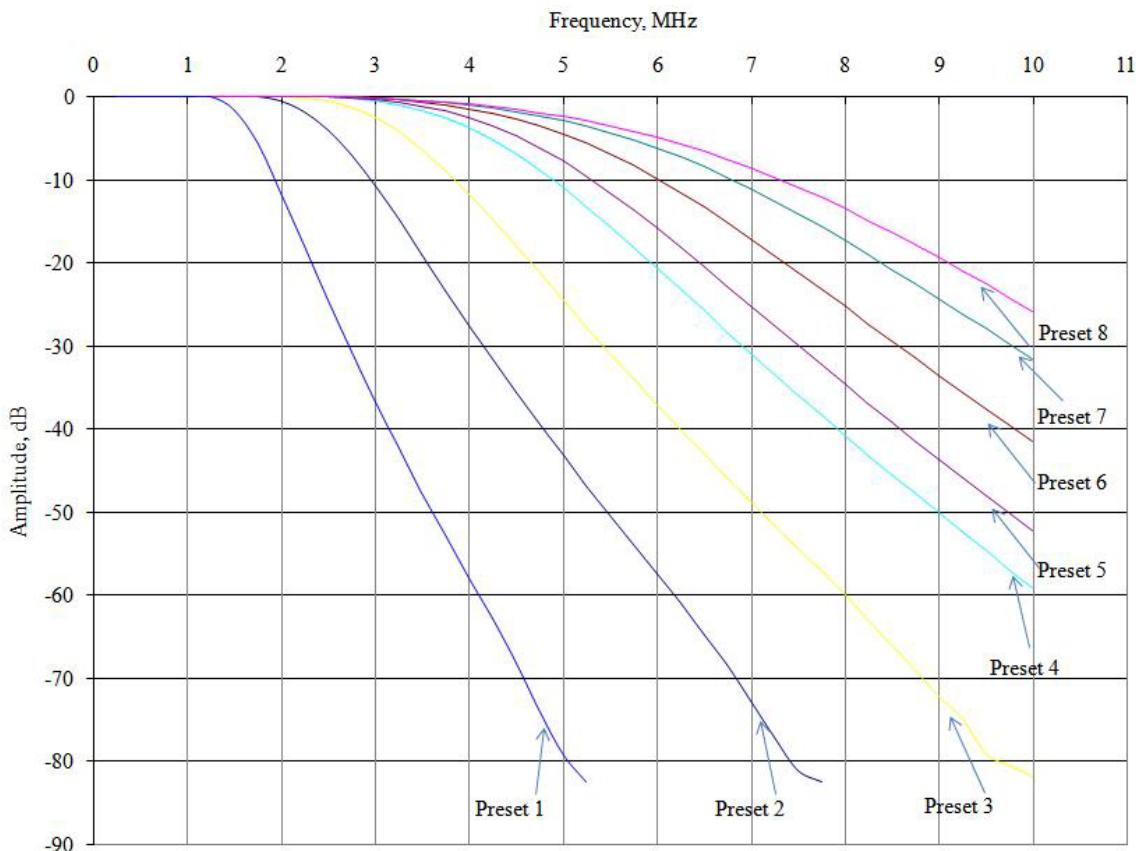


Figure 16: LPF Amplitude-frequency response.

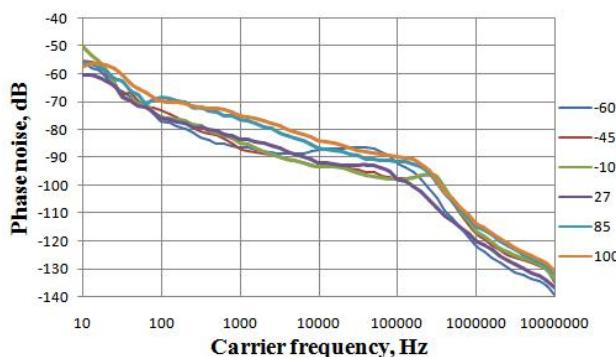


Figure 17: LO phase noise under different temperatures.

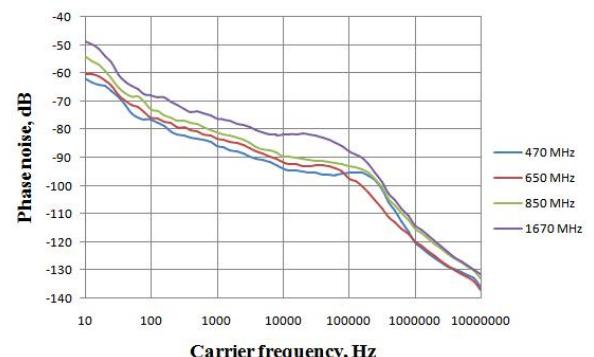


Figure 18: LO phase noise under different frequency band.

## 8 DELIVERABLES

IP contents:

- Datasheet
- Layout View (GDSII)
- Evaluation kit based on packaged IC
- Characterization Report
- Behavioral Model
- SPICE netlist (.cdl)
- Integration Support

## REVISION HISTORY

### 1. From version 1.0:

- The section “Layout description” was added (refer to [p.6](#))
- The table “DC electrical characteristic” (refer to [p.7](#))