AN11086

BGU7003 LNA application for GPS L2 band

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Document information

Info	Content
Keywords	BGU7003, LNA, GPS L2 band.
Abstract	This application note provides circuit simulation, schematic, layout, BOM and typical EVB performance for GPS L2 LNA based on BGU7003.

Revision history

Rev	Date	Description
v.1	20120105	Initial version

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1. Introduction

The BGU7003 is a wideband low noise amplifier in a plastic, leadless 6 pin extremely thin small outline SOT891 package. It can be used for various LNA applications up to 6 GHz such as GPS, satellite radio, cordless phone and E-metering.

The BGU7003 contains 1 RF stage and an internal bias that is temperature stabilized. It also contains an enable function to shut down the amplifier with a logic signal on the ENABLE pin.

The BGU7003 is ideal for use where size and low power are most critical. Typical usages are mobile phones, Personal Digital Assistants (PDA), Personal Navigation Devices (PND), E-metering and remote controllers.

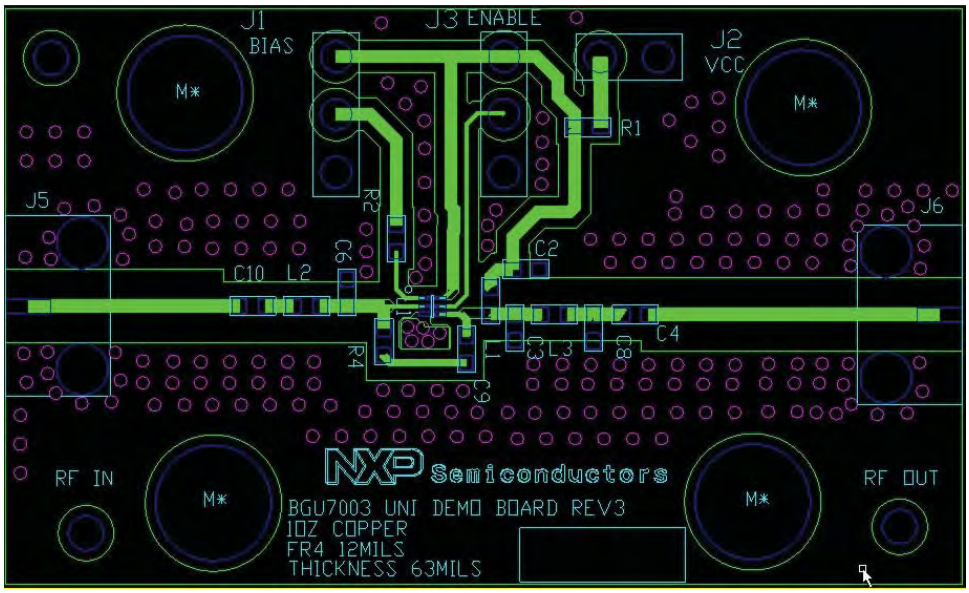

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Fig 1. BGU7003 EVB demo board

2. General description

This universal LNA evaluation board (EVB) is optimized to evaluate the performance of the BGU7003 applied in multiband GPS L2 band. In this document, circuit simulations and result in ADS, the application schematic, board layout, bill of material, and typical test results are given.

Due to the flexibility of external matching, the BGU7003 can be retuned and optimized to meet LNA requirements of future navigation systems.

3. Application circuit simulation

3.1 BGU7003 GPS L2 band LNA simulation

Assumptions:

- 50 Ω termination at input and output
- 5 mA at 2.5 V S2P file is used
- 2.5 V supply voltage

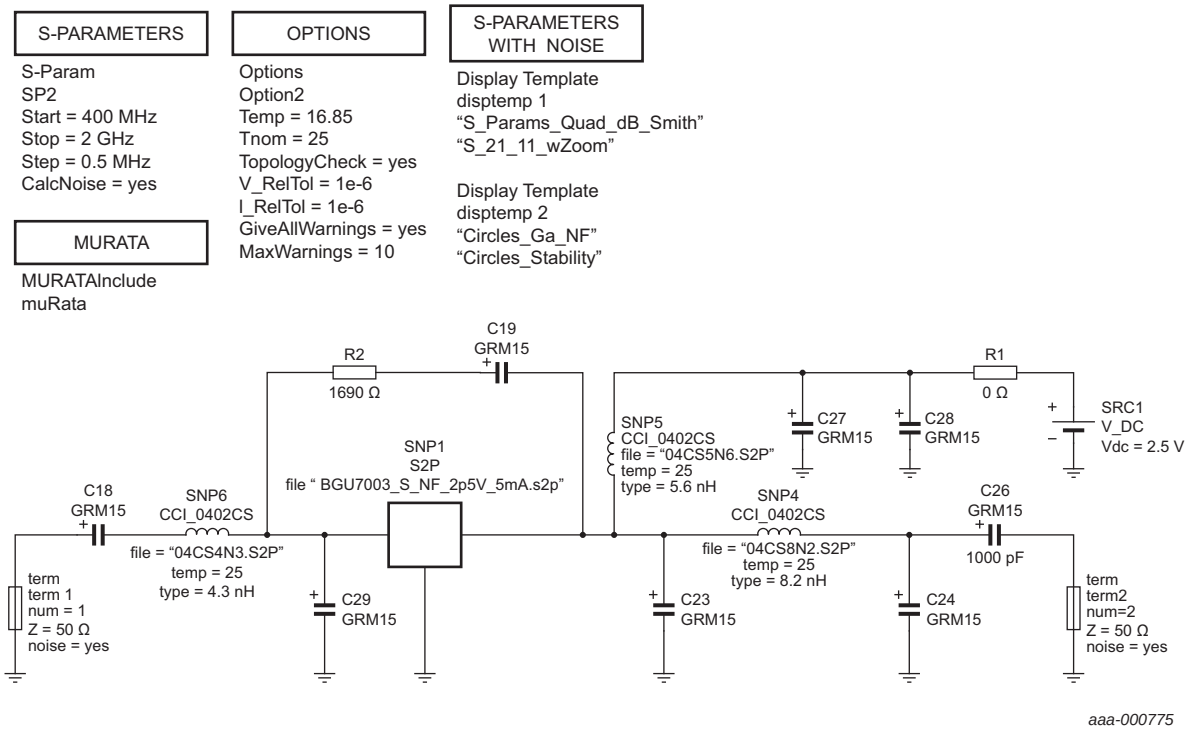

Fig 2. BGU7003 GPS L2 band LNA simulation: circuit

3.2 BGU7003 GPS L2 band LNA simulation result

3.2.1 Input and output match in GPS L2 band

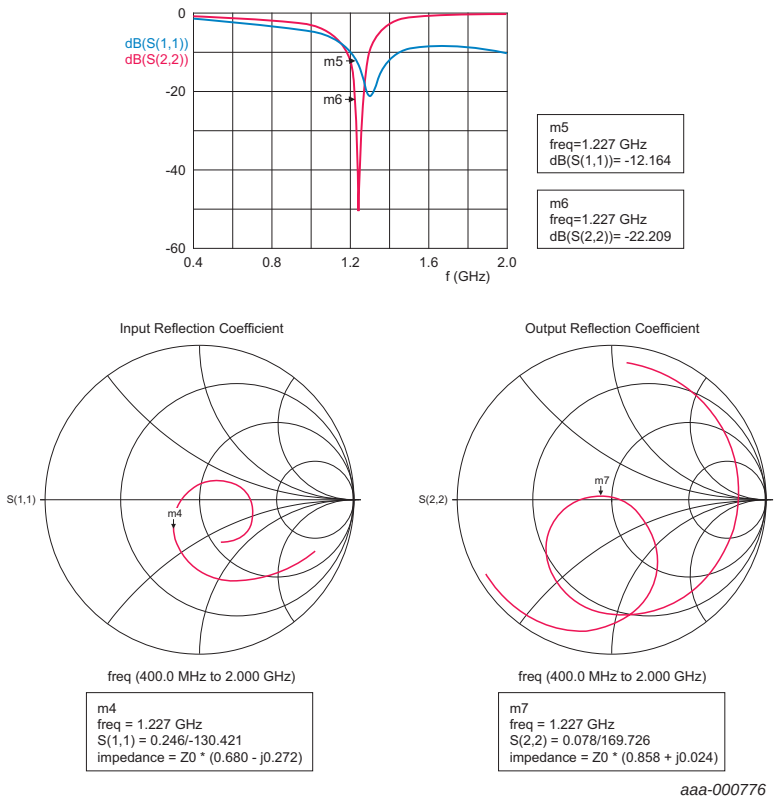

Fig 3. BGU7003 GPS L2 band LNA simulation: input and output match

3.2.2 Gain in GPS L2 band

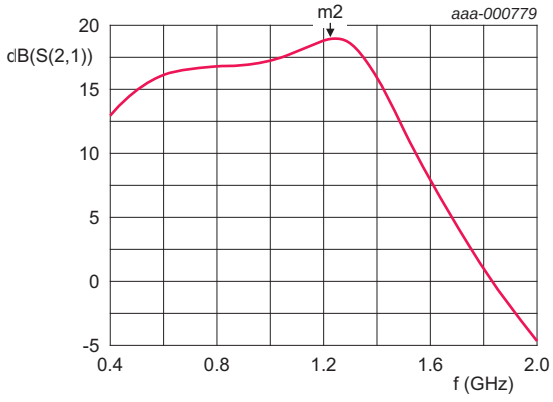

Fig 4. BGU7003 GPS L2 band LNA simulation: gain

3.2.3 Noise figure in GPS L2 band

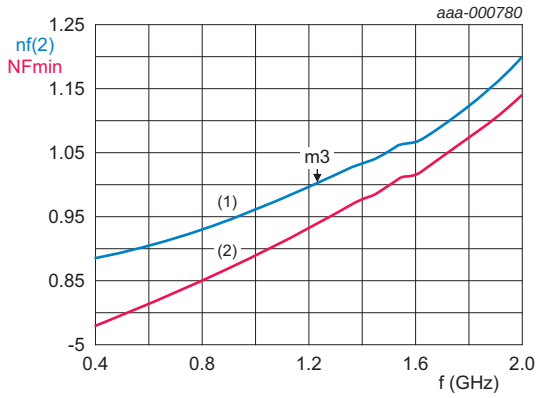

Fig 5. BGU7003 GPS L2 band LNA simulation: noise figure

3.2.4 Stability

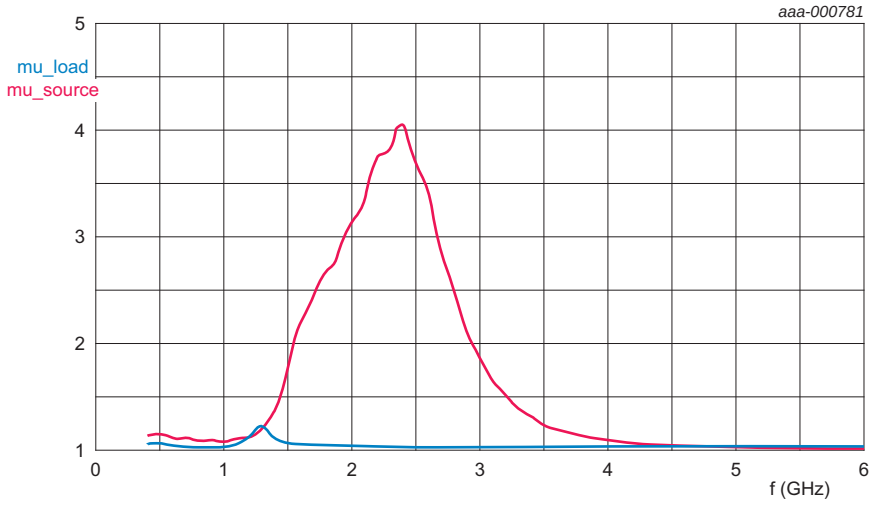

Fig 6. BGU7003 GPS L2 band LNA simulation: stability

4. Application board

The BGU7003 GPS L2 band LNA evaluation board simplifies the evaluation of the BGU7003 in the GPS application area. The evaluation board enables testing of the device performance and requires no additional support circuitry. The board is fully assembled with the BGU7003 IC, including input and output matching, to optimize the performance.

The board is supplied with two SMA connectors for input and output connection to RF test equipment.

The BGU7003 is designed to operate at 2.5 V with optimal performance, and not to exceed 2.85 V. When it is used with varying supply voltages (3.3 V to 3.7 V for E-metering), the enable function is not used and LNA is always on. An ENABLE pin jumper is installed, which avoids the voltage on the V_{CC}, ENABLE and RF_OUT pins exceeding 2.85 V.

4.1 Application circuit schematic (GPS L2 band)

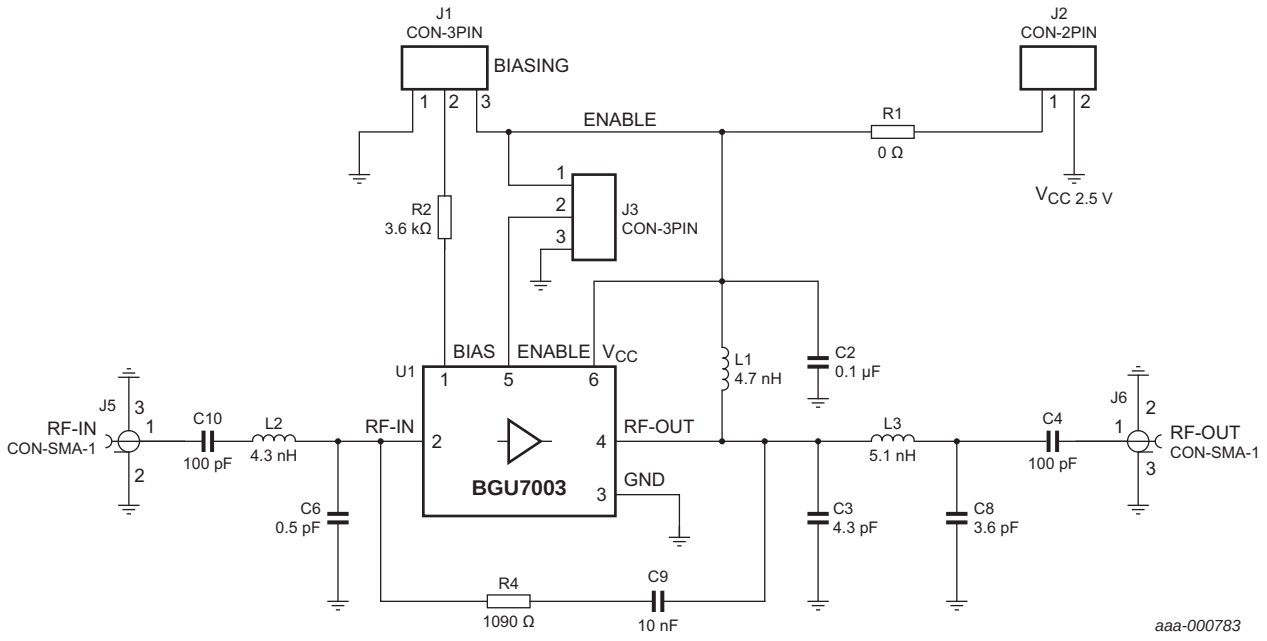

Fig 7. BGU7003 GPS L2 band LNA: schematic

4.2 Application board Bill Of Materials BOM (GPS L2 band)

Table 1. BGU7003 400 MHz band LNA EVB parts List

Item	Quantity	Part reference	Part number	Vendor	Value
1	1	C2	GRM155R71C104KA88	Murata	0.1 pF
2	1	C3	GRM1555C1H4R3CZ01	Murata	4.3 pF
3	2	C4	GRM1555C1H101JZ01	Murata	100 pF
		C10	GRM1555C1H101JZ01	Murata	100 pF
4	1	C6	GRM1555C1HR50CZ01	Murata	0.5 pF
5	1	C8	GRM1555C1H3R6CZ01	Murata	3.6 pF
6	1	C9	GRM155R71C103KA01D	Murata	10 nF
7	2	J1	90120-0763	Molex	CON-3PIN
		J3	90120-0763	Molex	CON-3PIN
8	1	J2	90120-0762	Molex	CON-2PIN
9	2	J5	901-10110	Amphenol	CON-SMA-1
		J6	901-10110	Amphenol	CON-SMA-1
10	1	L1	0402CS-4N7X_LU	Coilcraft	4.7 nH
11	1	L2	0402CS-4N3X_LU	Coilcraft	4.3 nH
12	1	L3	0402CS-5N1X_LU	Coilcraft	5.1 nH
13	1	R1	CRCW04020000Z0ED	Vishay/Dale	0
14	1	R2	ERJ-2RKF3601X	Panasonic - ECG	3.6 kΩ
15	1	R4	ERJ-2RKF1691X	Panasonic - ECG	1.69 kΩ
16	1	U1	BGU7003	NXP	BGU7003

4.3 Typical application board test result (GPS L2 band)

4.3.1 S-parameter gain and match

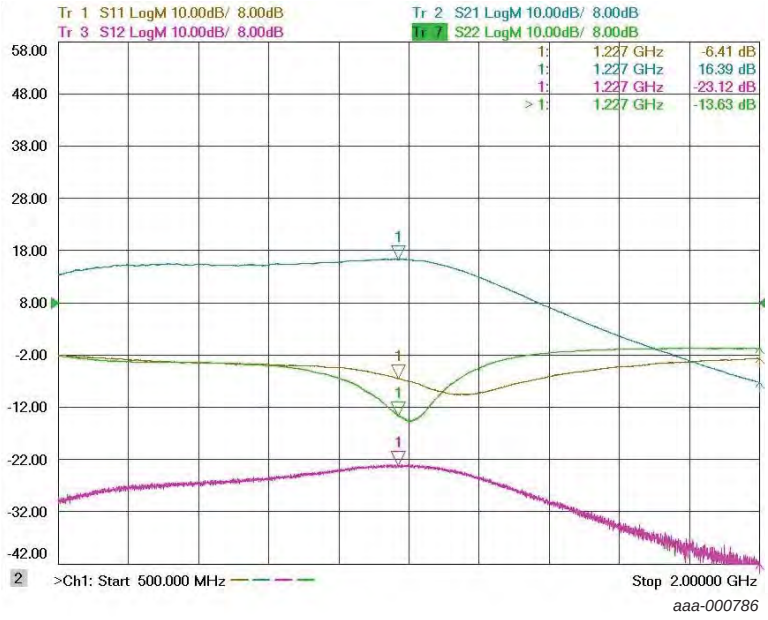

Fig 8. BGU7003 GPS L2 band LNA demo board: S-parameter

4.3.2 P1dB

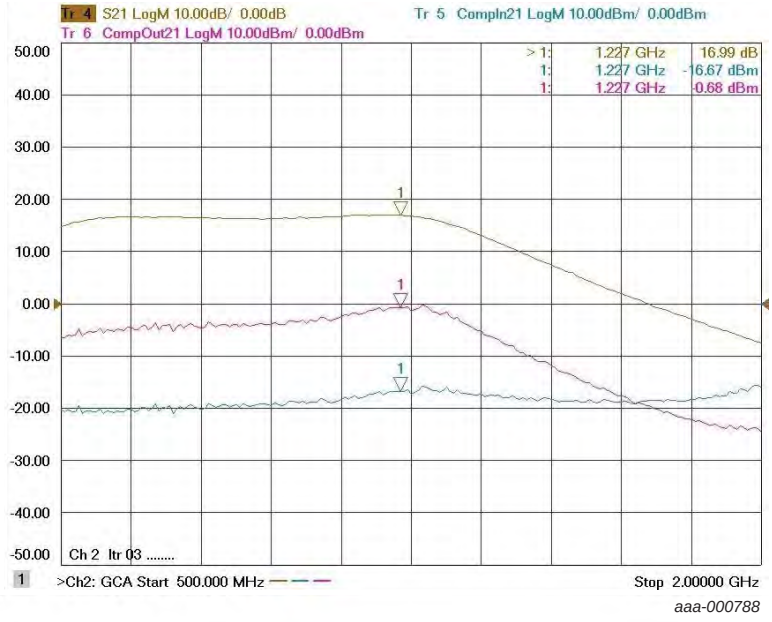

Fig 9. BGU7003 GPS L2 band LNA demo board: P1dB

4.3.3 Linearity/IP3

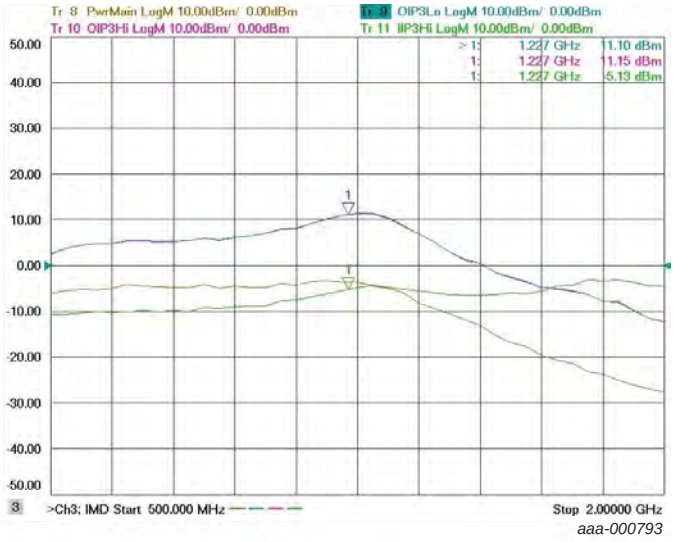

Fig 10. BGU7003 GPS L2 band LNA demo board: IP3

4.3.4 Stability

K-factor

Fig 11. BGU7003 GPS L2 band LNA demo board: stability

4.3.5 Noise figure measurement

A 6 dB pad is inserted between the noise source and RF input to improve the NF measurement accuracy. The 6 dB pad is measured on a network analyzer to be 5.8 dB at 1.227 GHz.

A network analyzer is used to measure the loss between the connector and microstrip line which is shorted to ground before the first matching component. The measured return loss is 0.21 dB. Therefore, to obtain true noise, a 0.1 dB input loss is de-embedded.

Overall, a 5.9 dB loss at input and 0.1 dB loss at output are subtracted on the noise figure analyzer.

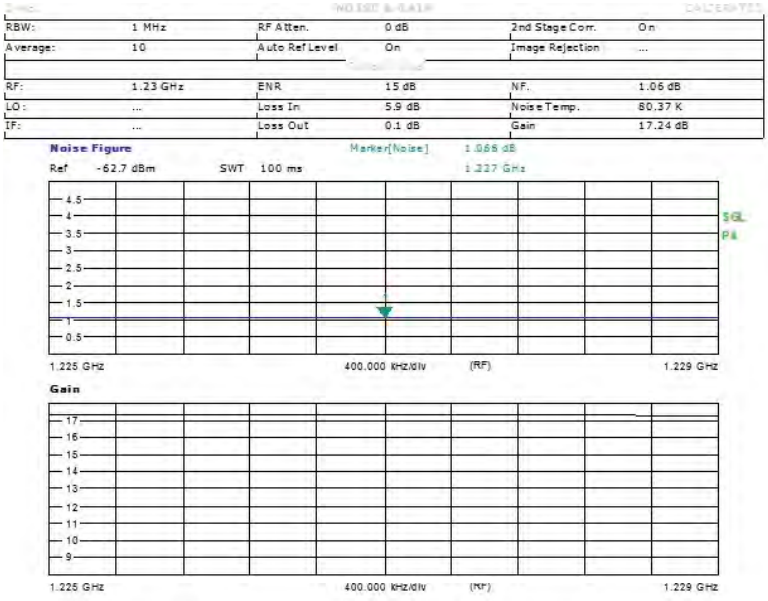

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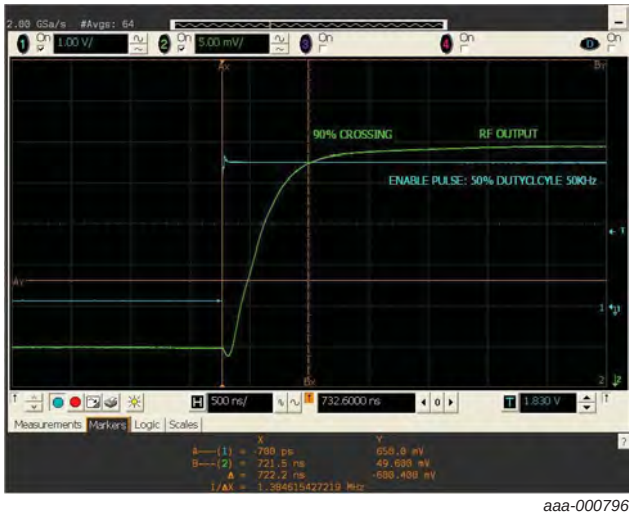
Fig 12. BGU7003 GPS L2 band LNA demo board: noise figure

4.3.6 ON/OFF switching time



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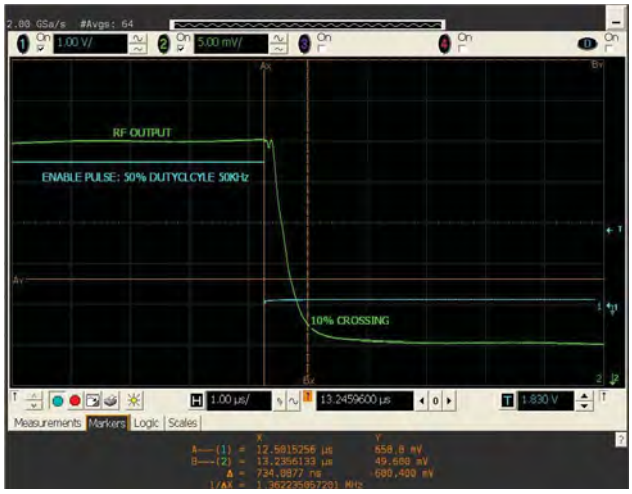
50 kHz, 50 % pulse on ENBALE pin, measured from 50 % of pulse to 90 % of maximum power

Fig 13. Switching ON time



aaa-000797

50 kHz, 50 % pulse on ENABLE pin, measured from 50 % of pulse to 10 % maximum power

Fig 14. Switching OFF time

4.3.7 Summary of typical evaluation board test results

Table 2. Typical results measured on the 400 MHz band evaluation board

Operating frequency 400 MHz to 450 MHz, testing at 425 MHz unless otherwise specified, Temp = 25 °C

Symbol	Description	Conditions	Value	Unit
V_{CC}	supply voltage	-	2.5	V
I_{CC}	supply current	-	4.9	mA
NF	noise figure	-	1.01	dB
G_p	power gain	1.227 GHz	16.4	dB
RL_{in}	input return loss	-	6.4	dB
RL_{out}	output return loss	-	13.6	dB
$\alpha_{isol(r)}$	reverse isolation	-	23.1	dB
$P_{i(1dB)}$	input power at 1 dB gain compression	-	−16.67	dBm
$P_{L(1dB)}$	output power at 1 dB gain compression	-	−0.68	dBm
$IP3_I$	input third-order intercept point	-	−5.13	dBm
$IP3_O$	output third-order intercept point	-	11.15	dBm
K	Rollett stability factor	0 to 26 GHz	>1	-
t_{sw}	switching time	ON	722	nS
		OFF	734	nS

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6. Tables

7. Figures

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