General Purpose MMIC: BGB707L7ESD

GPS LNA for L1 Band (1545 MHz - 1605 MHz)

Application Note AN396

About this document

Scope and purpose

This application note describes Infineon's General Purpose MMIC: BGB707L7ESD as a GPS LNA for L1 band applications.

1. This application note documents the design of a GPS band L1 LNA intended for use with a SAW prefilter.
2. The BGB707L7ESD is used in this documented design.
3. GPS receiver for L1 band is the primary application of this document.
4. This design along with AN397 provides a solution to both L1 & L2s GPS band recievers where a single type of LNA MMIC is required.
5. Key performance parameters include Gan = 18 dB, Return Loss < -10 dB and OP1dB = 2.1 dBm.

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1) The graphs are generated with the simulation program AWR Microwave Office®.

1 Introduction

The GPS satellites are at an orbit altitude of more than 20,000 km away from earth's surface and transmit power in the range of +47 dBm. After taking losses (atmospheric, antenna etc.) into account, the received signal strength at the GPS device input is very low in the range of -130 dBm. The ability of the GPS device to receive such a low signal strength and provide meaningful information to the end-user depends strongly on the noise figure of the GPS receive chain. This ability which is called receiver sensitivity can be improved by using a low-noise amplifier with low noise figure and high gain at the input of the receiver chain. The improved sensitivity results in a shorter Time-To-First-Fix (TTFF), which is the time required for a GPS receiver to acquire satellite signals and navigation data, and calculate a position. Noise figure of the LNA defines the overall noise figure of the GPS receiver system. This is where the BGB707L7ESD (as outlined in this application note) along with a SAW filter on its input, can provide a GPS LNA with good noise figure and high gain thereby improving the receiver sensitivity significantly.

2 BGB707L7ESD Overview

2.1 Features

- High performance general purpose wideband MMIC LNA
- ESD protection integrated for all pins (3 kV for RF input vs. GND, 2 kV for all other pin combinations, HBM)
- Integrated active biasing circuit enables stable operating point against temperature and processing variations.
- Excellent noise figure from Infineon´s reliable high volume SiGe:C technology
- High gain and linearity at low current consumption
- Supply voltage: 1.8 V to 4.0 V
- Adjustable operating current 2.1 mA to 25 mA by external resistor
- Power-off function
- Very small and leadless package TSLP-7-1, 2.0 x 1.3 x 0.4 mm3
- Pb-free (RoHS compliant) and halogen-free package
- Qualification report according to AEC-Q101 available

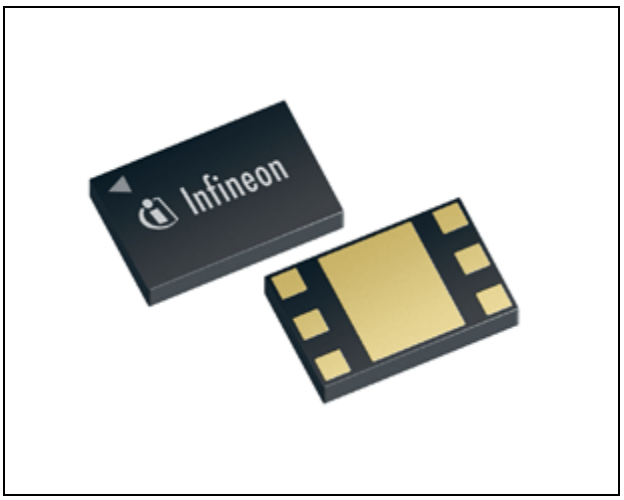

Figure 1 BGB707L7ESD in TSLP-7-1

2.2 Key Applications of BGB707L7ESD

- Mobile, portable and fixed connectivity applications: WLAN 802.11a/b/g/n, WiMax 2.5/3.5/5 GHz, UWB, WiFi, Bluetooth
- Satellite communication systems: Navigation systems (GPS, Glonass), satellite radio (SDARs, DAB) and C-band LNB
- Multimedia applications such as mobile/portable TV, CATV, FM Radio
- 3G/4G UMTS/LTE mobile phone applications
- ISM applications like RKE, AMR and Zigbee, as well as for emerging wireless applications

2.3 Description

The BGB707L7ESD is a Silicon Germanium Carbon (SiGe:C) low noise amplifier MMIC with integrated ESD protection and active biasing. The device is as flexible as a discrete transistor and features high gain, reduced power consumption and very low distortion for a very wide range of applications. The device is based on Infineon Technologies' cost effective SiGe:C technology and comes in a low profile TSLP-7-1 leadless green package.

Please visit the product page of **BGB707L7ESD** for more information.

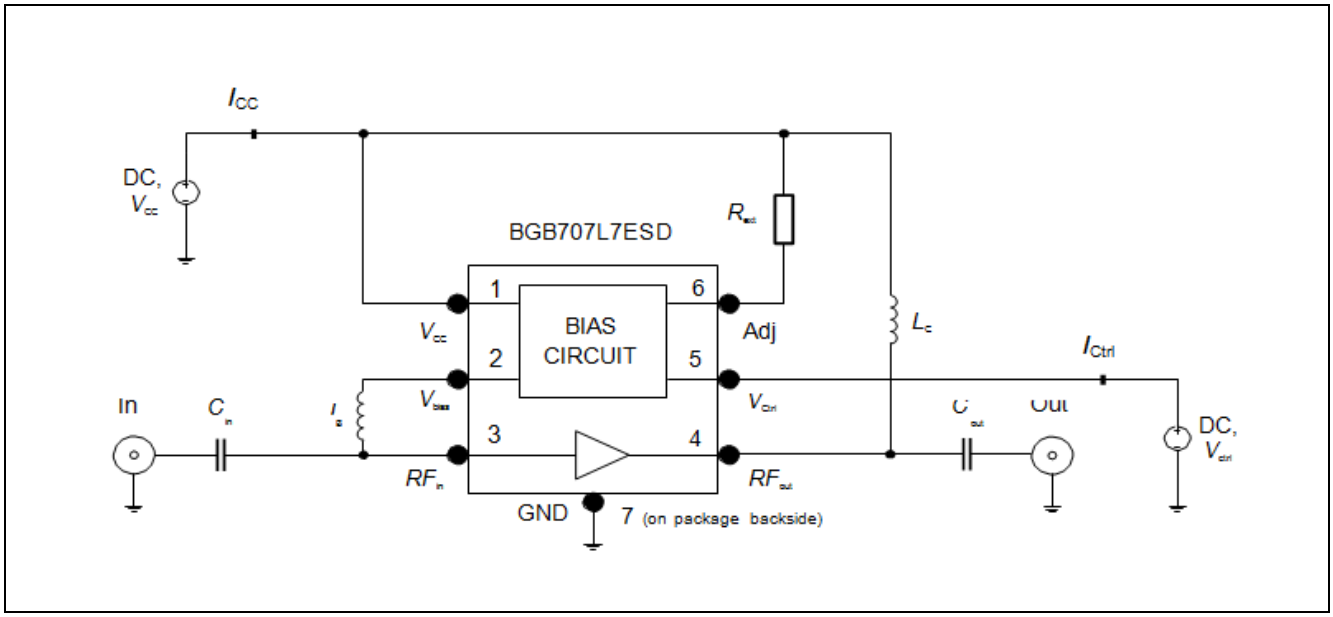

Figure 1 Equivalent Circuit of BGB707L7ESD

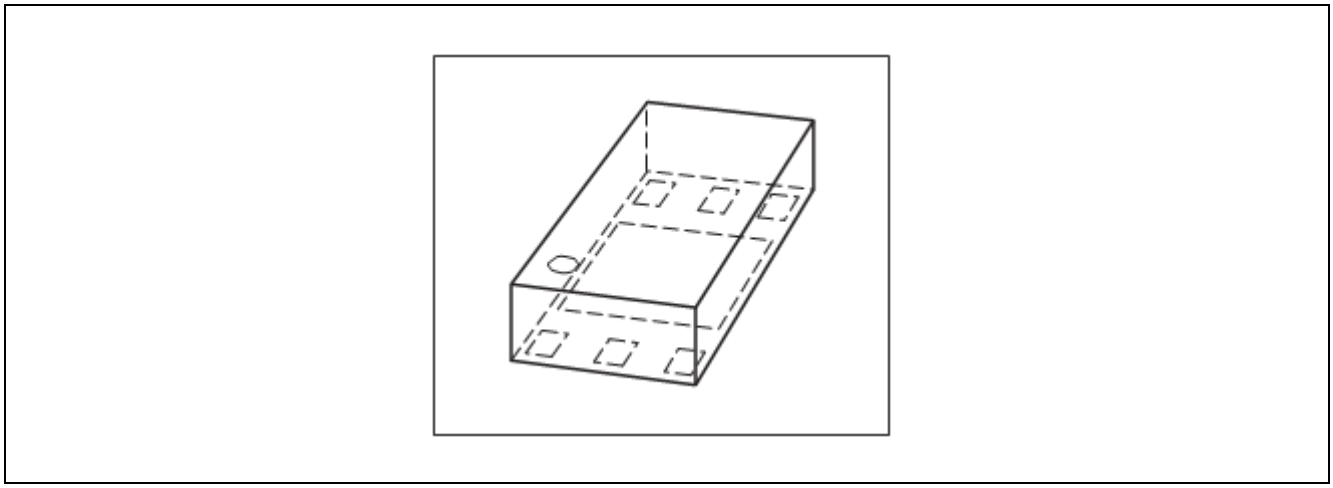

Figure 2 Package and pin connections of BGB707L7ESD

Table 1 Pin Assignment of BGB707L7ESD

Pin No.	Symbol	Function
1	Vcc	Supply voltage
2	Vbias	Bias reference voltage
3	RFin	RF input
4	RFout	RF output
5	Vctrl	On/Off control voltage
6	Adj	Current adjustment pin
7	GND	DC/RF GND

3 Application Circuit and Performance Overview

In this chapter the performance of the application circuit, the schematic and bill-on-materials are presented.

Device: **BGB707L7ESD**
Application: **GPS LNA**
PCB Marking: **BGB7-Family v3.1**
EVB Order No.: **AN396**

3.1 Summary of Measurement Results

The performance of BGB707L7ESD for GPS Band L1 LNA is summarized in the following table.

Table 2 Electrical Characteristics (at room temperature)
Text

Parameter	Symbol	Value	Unit	Comment/Test Condition
Frequency Range	Freq	1575	MHz	
DC Voltage	Vcc	3	V	
DC Current	Icc	10	mA	
Gain	G	18.2	dB	Loss of input/output line of 0.1 dB included
Noise Figure	NF	1.2	dB	Loss of input line of 0.1 dB is deembeded
Input Return Loss	RLin	13.2	dB	
Output Return Loss	RLout	11.6	dB	
Reverse Isolation	IRev	27.2	dB	
Input P1dB	IP1dB	-15.1	dBm	
Output P1dB	OP1dB	2.1	dBm	
Input IP3	IIP3	0.5	dBm	
Output IP3	OIP3	18.7	dBm	Pin= -30 dBm, f1=1575 MHz, f2=1576 MHz
Stability	k	>1	--	Measured up to 10 GHz

3.2 Schematics and Bill-of-Materials

Ther schematic of BGB707L7ESD for GPS LNA is presented in **Figure 3** and its bill-of-materials is shown in **Table 3**.

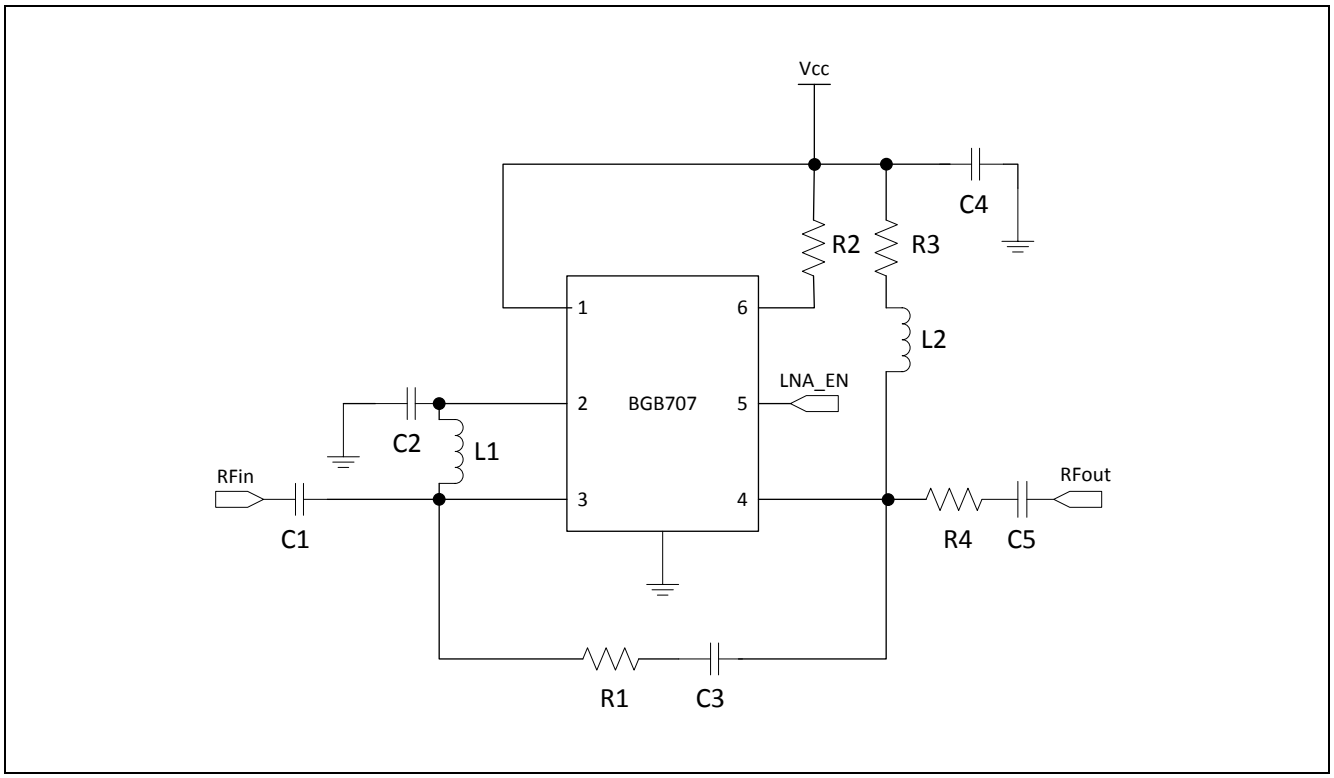

Figure 3 Schematics of the BGB707L7ESD Application Circuit

Table 3 Bill-of-Materials

Symbol	Value	Unit	Size	Manufacturer	Comment
R1	1	kΩ	0402	Any	Negative feedback
R2	820	Ω	0402	Any	Base bias
R3	51	Ω	0402	Any	Stability
R4	15	Ω	0402	Any	Stability
C1	4.7	pF	0402	KOA NPO	Input DC block
C2	1	nF	0402	KOA NPO	RF decoupling
C3	1	pF	0402	KOA NPO	RF decoupling/DC blocking
C4	1	nF	0402	KOA NPO	RF decoupling
C5	10	pF	0402	KOA NPO	Output DC block
L1	4.3	nH	0402	muRata LQG	RF chock/DC bias
L2	5.1	nH	0402	muRata LQG	RF chock/DC bias

4 Measurement Graphs

The performance of the application circuit is presented with the following graphs.

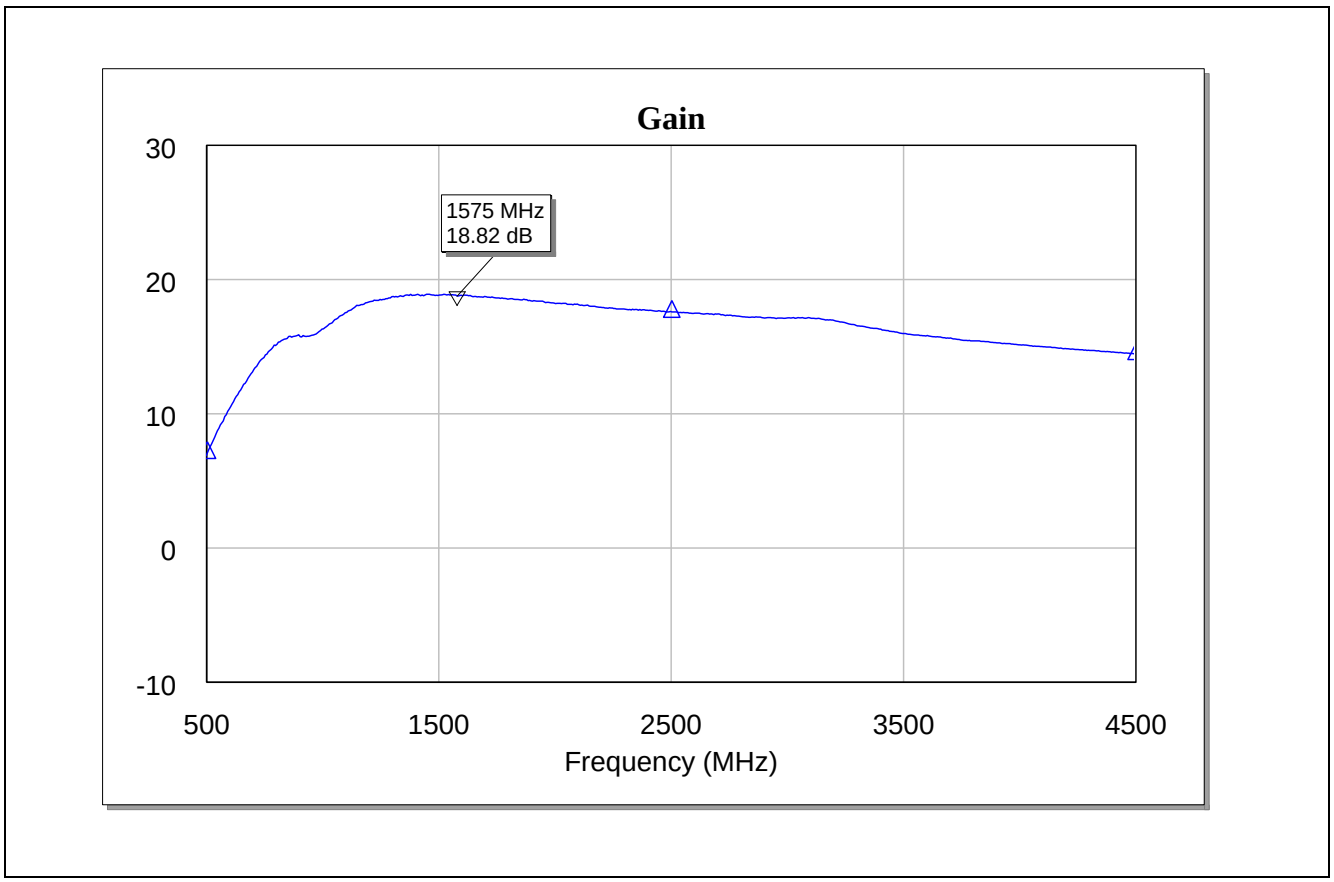

Figure 4 Gain of BGB707L7 for GPS L1 Band

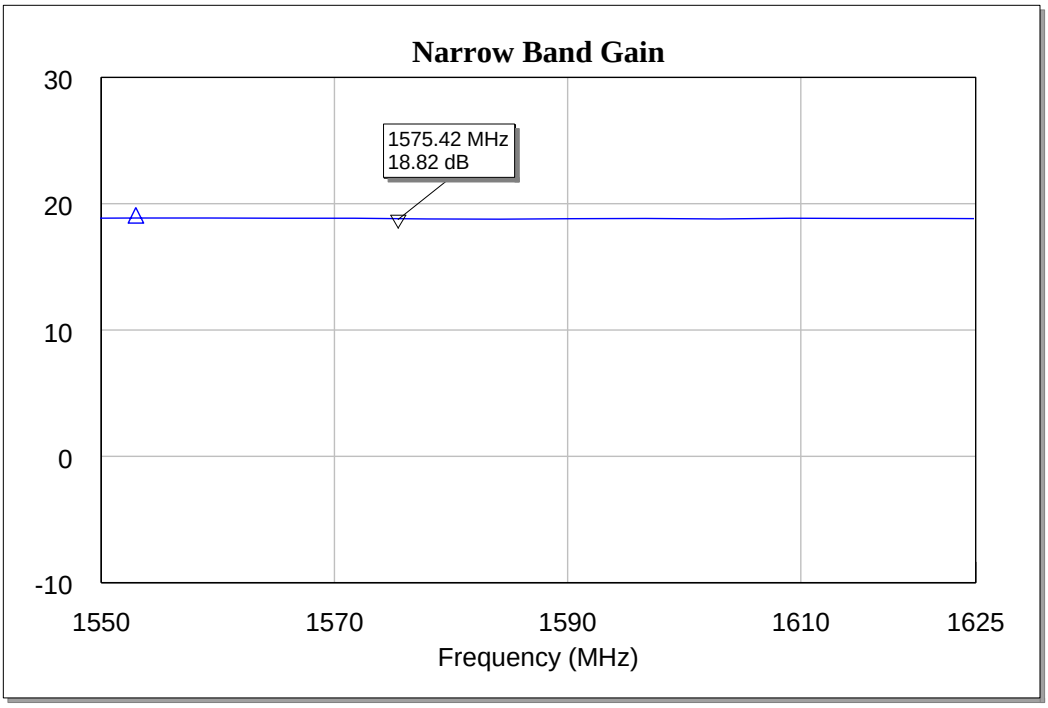

Figure 5 Narrow Band Gain of BGB707L7 for GPS L1 Band

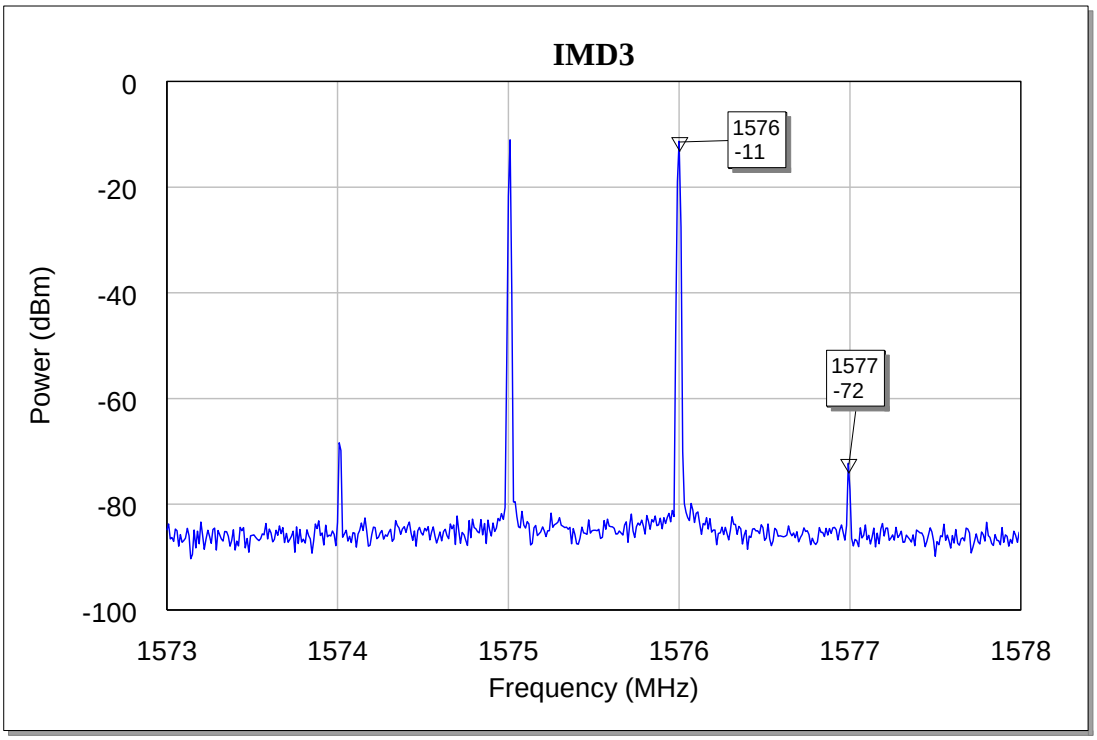

Figure 6 IMD3 of BGB707L7 for GPS L1 Band

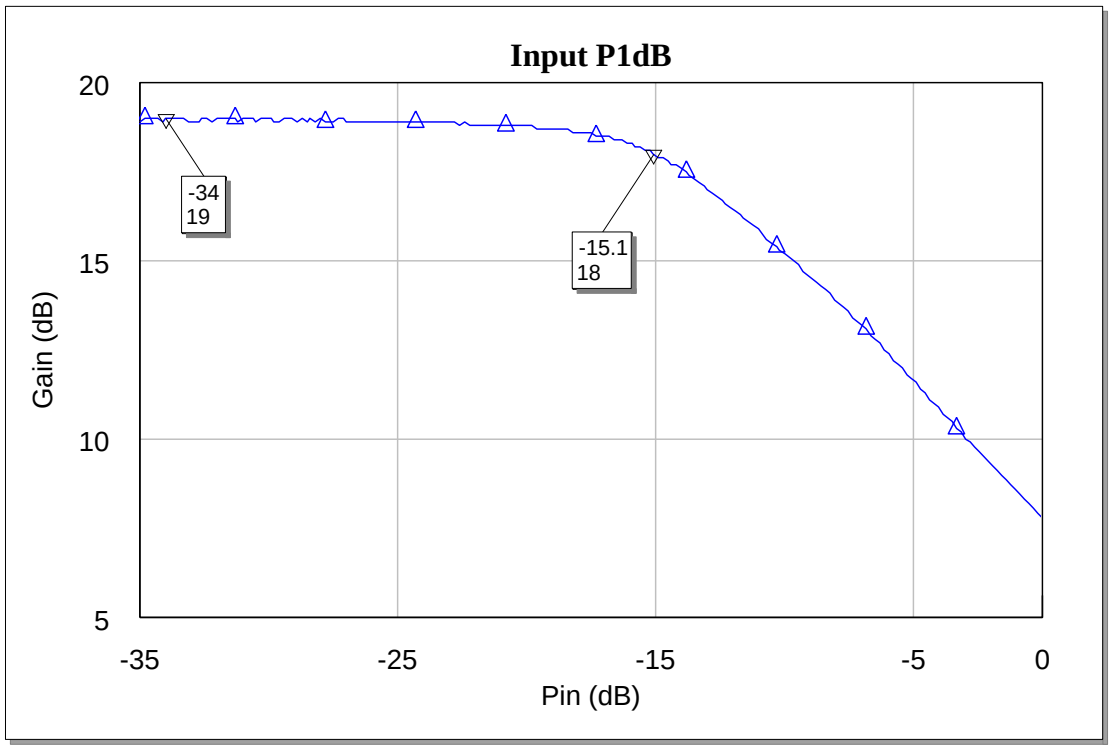

Figure 7 Input P1dB of BGB707L7 for GPS L1 Band

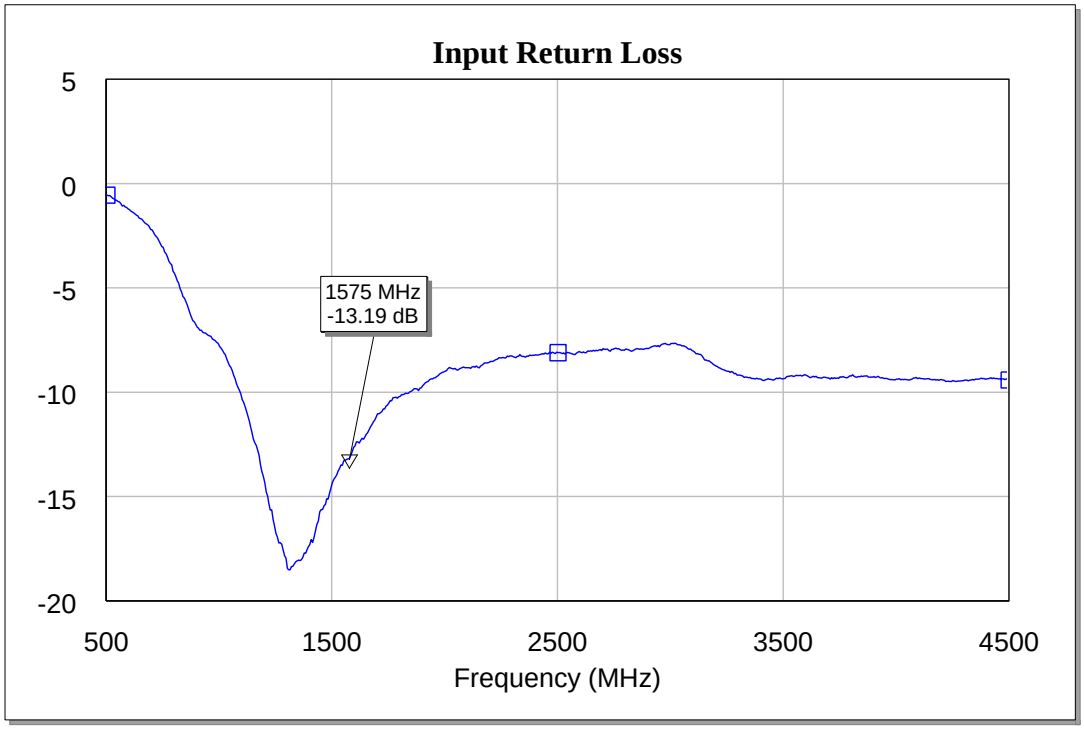

Figure 8 Input Return Loss of BGB707L7 for GPS L1 Band

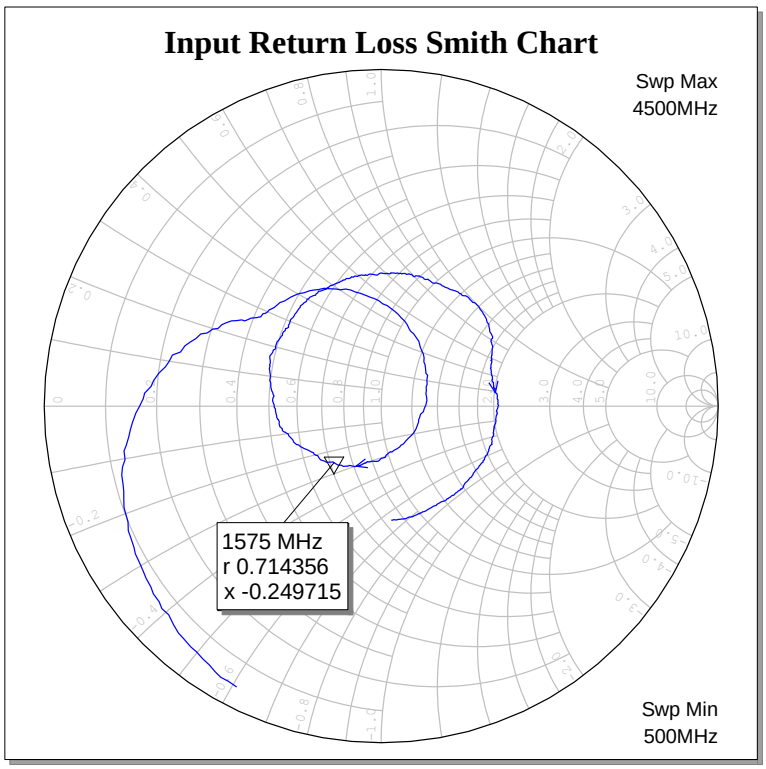

Figure 9 Input Return Loss Smith Chart of BGB707L7 for GPS L1 Band

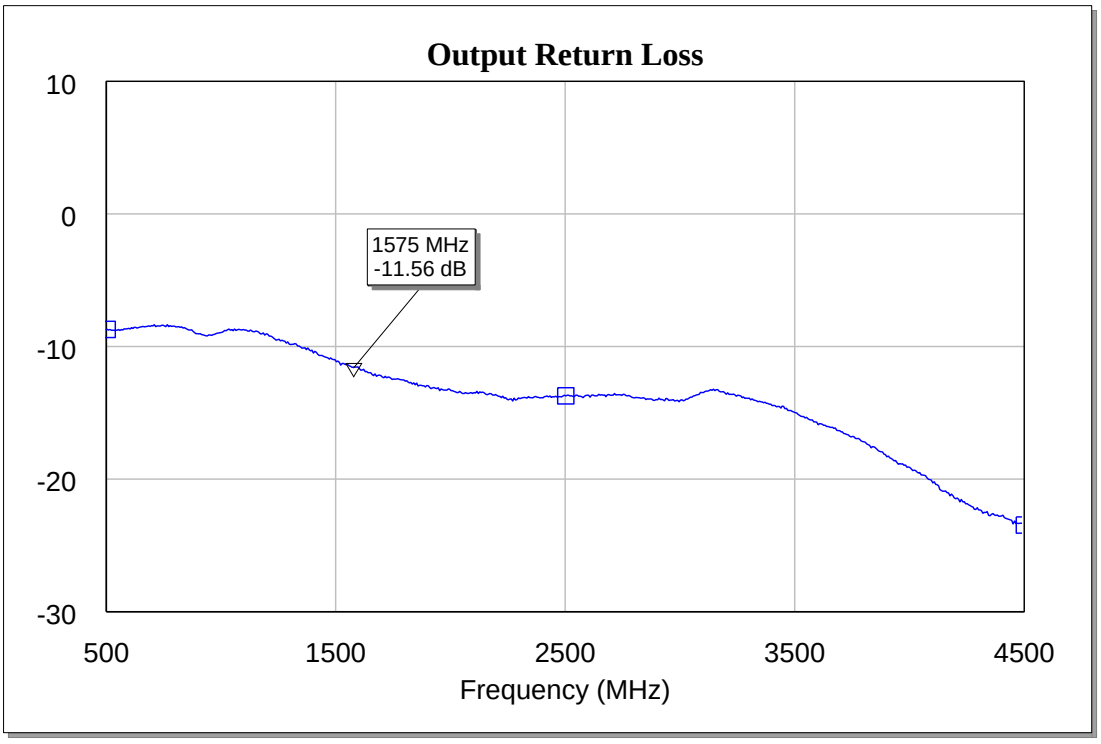

Figure 10 Output Return Loss of BGB707L7 for GPS L1 Band

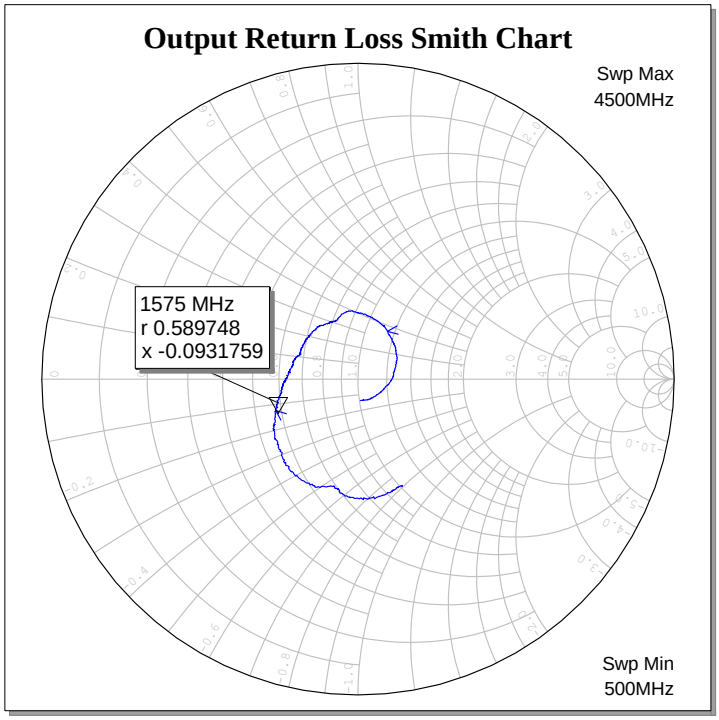

Figure 11 Output Return Loss Smith Chart of BGB707L7 for GPS L1 Band

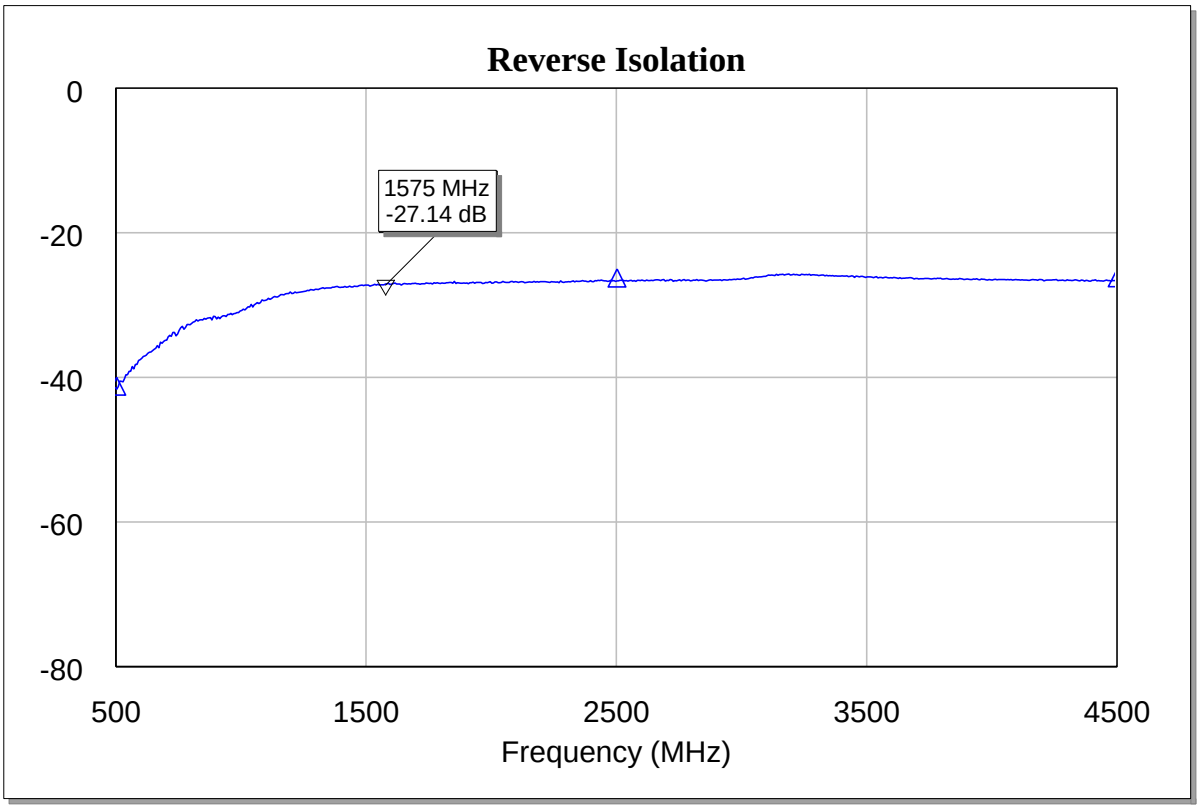

Figure 12 Reverse Isolation of BGB707L7 for GPS L1 Band

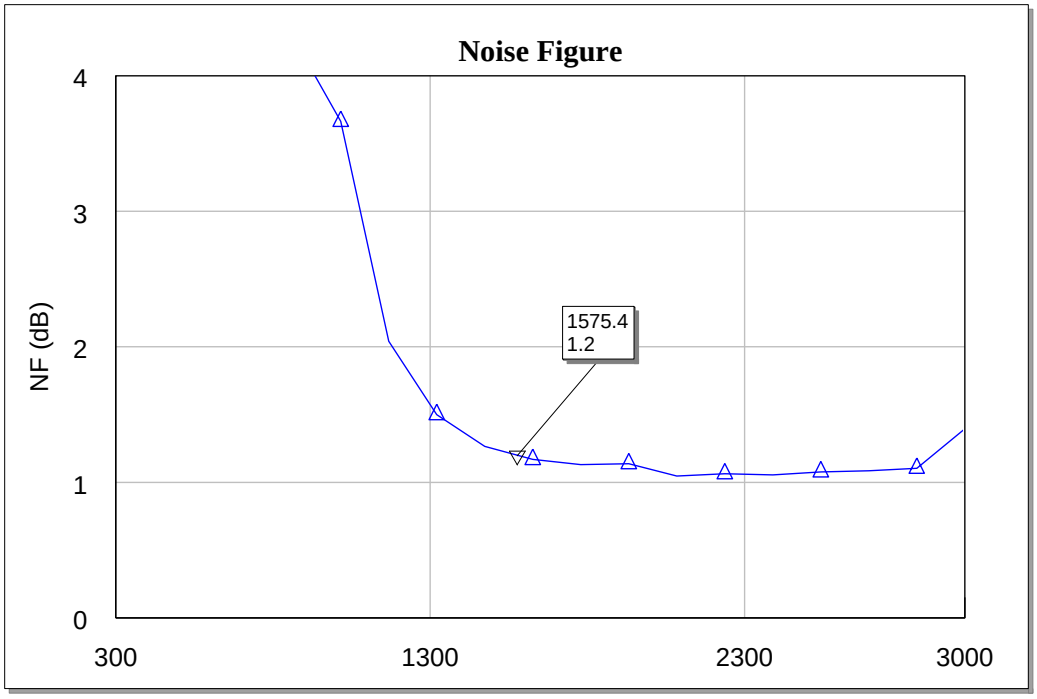

Figure 13 Noise Figure of BGB707L7 for GPS L1 Band

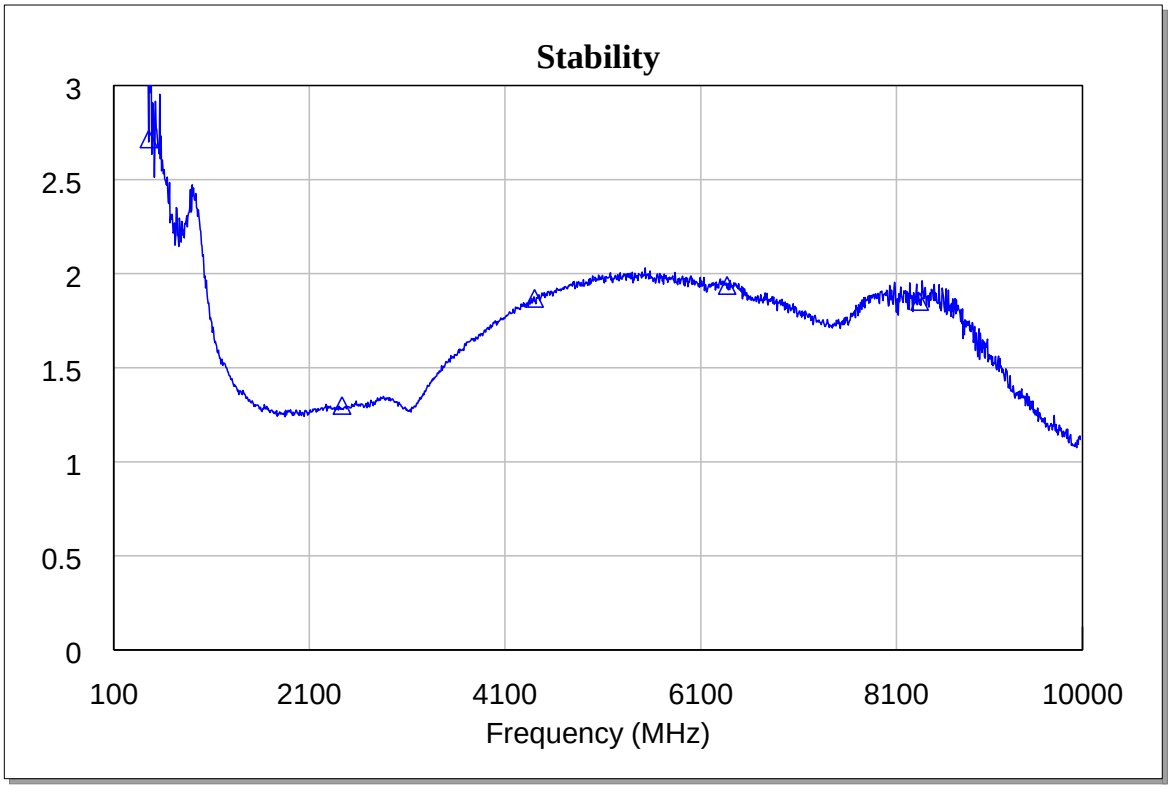

Figure 14 Stability of BGB707L7 for GPS L1 Band

5 Evaluation Board and Layout Information

In this application note, the following PCB is used:

PCB Marking: **BGB7-Family v3.1**

PCB material: **FR4**

ε_r of PCB material: **4.8**

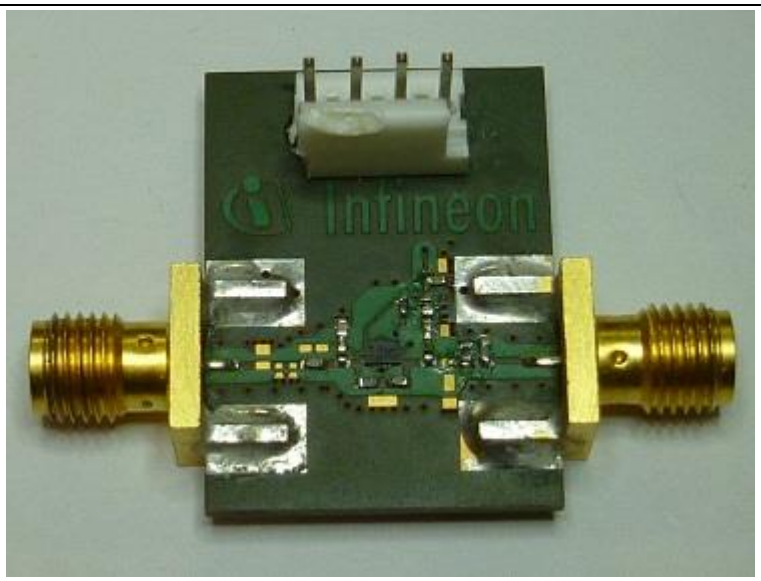

Figure 15 Photo Picture of Evaluation Board (overview)

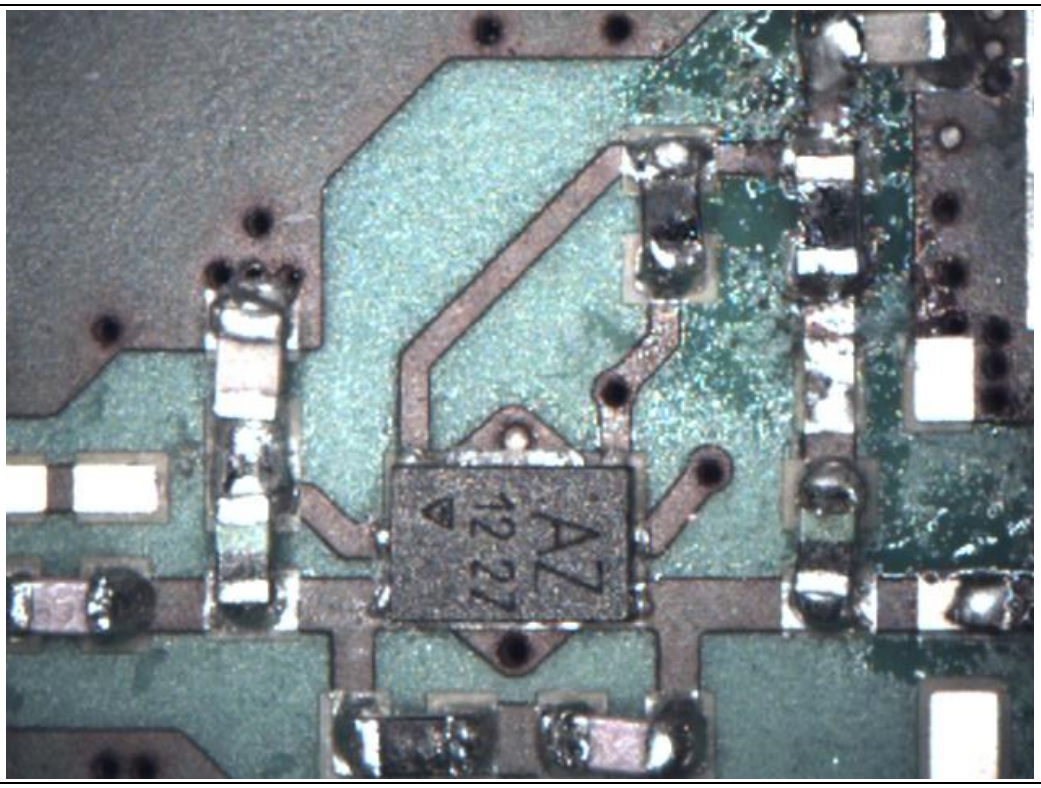

Figure 16 Photo Picture of Evaluation Board (detailed view)

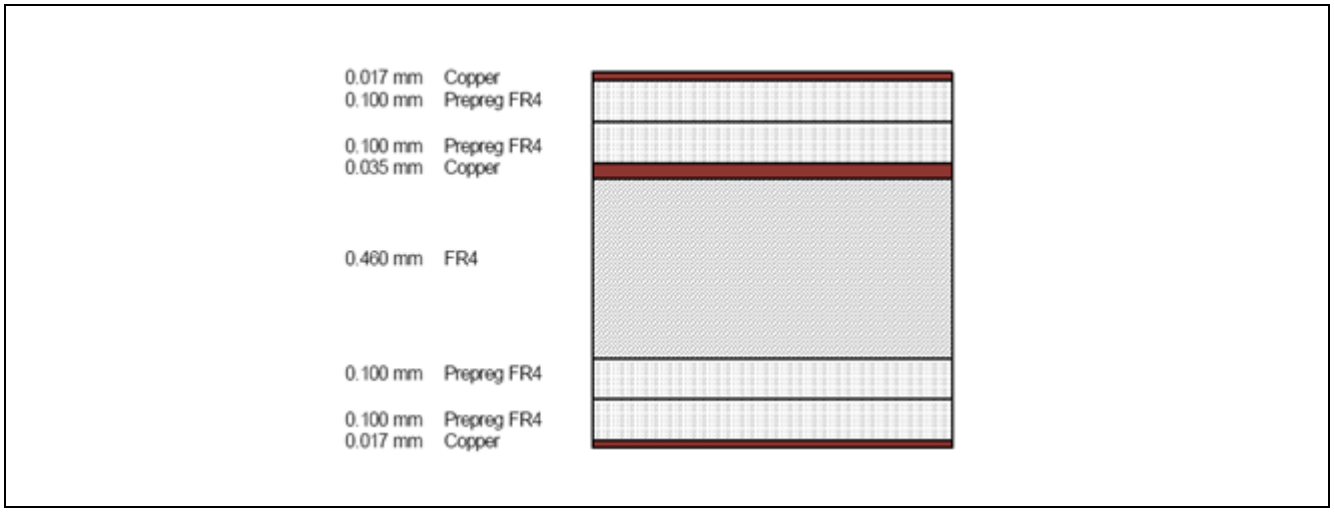

Figure 17 PCB Layer Information

6 Authors

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Revision History

Major changes since the last revision

Page or Reference	Description of change

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