BHW Technologies (博泓微科技有限公司)

Advanced RF IC, Antenna, Filter, RF Front-End and Wireless System Solutions

BHW Application Note #016

Improving GNSS NF Measurement Accuracy Using Broadband LNA BHWL161 as Pre-Amp

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Background: Ultra-Low LNA for Next-Gen GNSS

Technical Challenges:

- LNA with Ultra-Low Noise Figure (NF) is Critical to Achieve High C/N0 for GNSS Receivers, Especially for Emerging Multi-Band Multi-Constellation GNSS Systems
- Many LNA Vendors Have Published NF Specs in Second-Digit Accuracy such as 0.55dB, 0.53dB and 0.37dB
- A Survey of State-of-the-Art RF Test Equipment Vendors Indicates that Current NF Measurement Systems Are Difficult to Guarantee Second-Digit Accuracy in NF Test Results

Proposed Solutions:

- A Detailed Investigation and Analysis of Measurement Uncertainties in GNSS LNA Noise Figure Has Been Conducted
- A Broadband LNA Based on Advanced GaAs ED-PHEMT Technology, BHWL161, Has Been Used to Show Significant Improvement in Calibration Accuracy and Stability
- Case Study of Third-Party LNA Product Indicates Potential for ~0.05dB Accuracy in NF Measurement
- The Proposed Test Approach Enables Accurate, High-Confidence Measurement of NF without Having to Use the Most-Expensive Test Equipment

In this AppNote we compared 3 different methods of measuring the NF of a GNSS LNA, showing their limitations and advantages, and finally suggested a cost-effect approach to measure sub-0.5dB ultra low NF products with high accuracy.

Case Study: NXP BGU8109 NF Test with Method C

NXP Semiconductors **BGU8019**

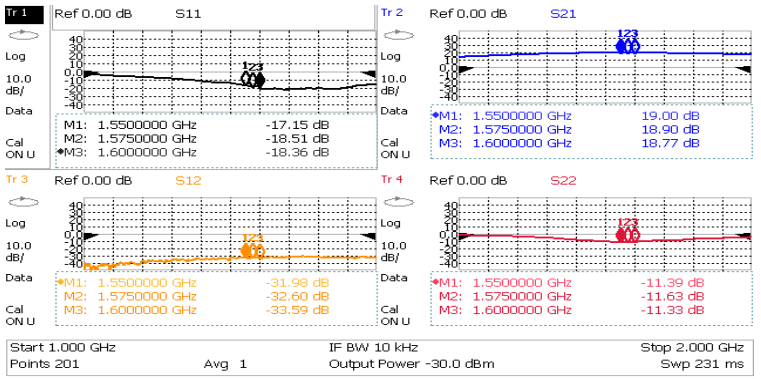
SiGe:C Low Noise Amplifier MMIC for GPS, GLONASS, Galileo, and Compass

Table 9. Characteristics at V_{CC} = 2.85 V

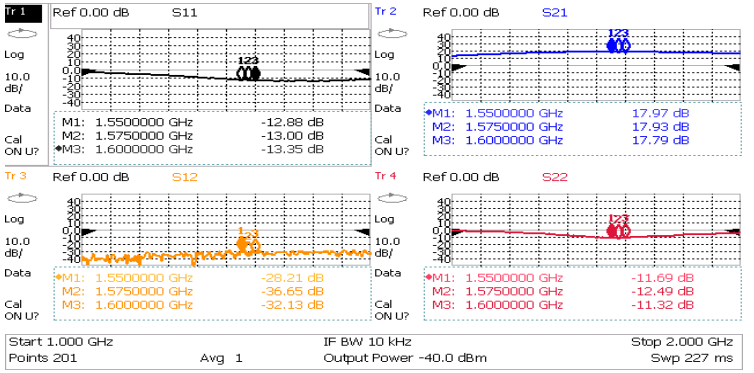
f = 1575 MHz; V_{CC} = 2.85 V; $V_{I(ENABLE)} \geq 0.8$ V; $P_i < -40$ dBm; T_{amb} = 25 °C; input matched to 50 Ω using a 6.8 nH inductor, see Figure 1; unless otherwise specified.

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
I_{CC}	supply current	$V_{I(ENABLE)} \geq 0.8$ V					
		$P_i < -40$ dBm		-	4.6	-	mA
		$P_i = -20$ dBm		-	10	-	mA
		$V_{I(ENABLE)} \leq 0.3$ V		-	-	1	µA
G_p	power gain	no jammer		-	18.5	-	dB
		$P_{jam} = -20$ dBm; f_{jam} = 850 MHz		-	20.0	-	dB
		$P_{jam} = -20$ dBm; f_{jam} = 1850 MHz		-	20.5	-	dB
RL_{in}	input return loss	$P_i < -40$ dBm		-	13	-	dB
		$P_i = -20$ dBm		-	22	-	dB
RL_{out}	output return loss	$P_i < -40$ dBm		-	13	-	dB
		$P_i = -20$ dBm		-	12	-	dB
ISL	isolation			-	30	-	dB
NF	noise figure	$P_i = -40$ dBm, no jammer	[1]	-	0.55	-	dB
		$P_i = -40$ dBm, no jammer	[2]	-	0.60	-	dB
		$P_{jam} = -20$ dBm; f_{jam} = 850 MHz	[2]	-	0.9	-	dB
		$P_{jam} = -20$ dBm; f_{jam} = 1850 MHz	[2]	-	1.3	-	dB
$P_{i(1dB)}$	input power at 1 dB gain compression			-	-7	-	dBm

S-Parameters at Pin=-40dBm



S-Parameters at Pin=-30dBm



- **DC Bias: Vdd=Ven=2.85V, Idq~5.3mA, Ta~25 Deg C.**
- **Assuming 0.05dB EVB loss, the measured NF is consistent with BGU8019 datasheet spec.**
- **The test result indicates ~0.05dB measurement uncertainty by using a BHWL161 broadband LNA as Pre-Amp.**

BHW RF Front-End AppNote Library

For further information, please email to support@bhwtechnologies.com, or contact your local BHW Sales Rep or Distributor. We will send you the complete AppNote as well as additional related information.

In addition to standard datasheets and EVB/BOM info, BHW publishes an AppNote series that address various topics on RF front-end design and performance over a wide frequency range from 300MHz to 6GHz, as an effort to assist customers in developing cutting-edge, cost-competitive products:

- **BHW AppNote #001 - Cross-Over Cascade of BHWM253 to Boost Tx Power and Rx Sensitivity of BLE and 2.4GHz IoT**
- **BHW AppNote #002 - Accurate Benchmark of GNSS CN0 Using the Power-Splitter Method**
- **BHW AppNote #003 - Boosting Wi-Fi Tx Power and Rx Sensitivity with BHWA251 and BHWM252**
- **BHW AppNote #004 - UHF 900MHz RF Front-End Solution Using BHWA251 Half-Watt PA and BHWL160 Sub-1dB-NF LNA**
- **BHW AppNote #005 - Sub-1GHz Applications of BHWA350 2-in-1 Wideband Fully Matched Amplifier**
- **BHW AppNote #006 - Low-Noise High-IIP3 LNB Architecture for Dual-Band High-Precision GNSS Using Cascade of BHWL160**
- **BHW AppNote #007 - UWB RF Front-End Solution Using BHWA350 and BHWM552**
- **BHW AppNote #008 - High-Power 5.8GHz RF Front-End Solution Using BHWA555 and BHWM552 for ETC, V2X and Wireless Video**
- **BHW AppNote #009 - 5.8GHz RF Front-End Using BHWA350 and BHWM552 for Wireless Audio**
- **BHW AppNote #010 - Multi-Constellation GNSS Active Antenna Using BHWL161 Cascade and Single-Fed Dual-Band Antenna**
- **BHW AppNote #011 - BHWL161 Super-Compact Low-Power Low Noise Amplifier for Range Extension of 2.4GHz BLE, RC and IoT**
- **BHW AppNote #012 - Enabling Cost-Effective High-Precision GNSS Using BHWL160 and Linear-Polarization PCB Antenna**
- **BHW AppNote #013 - Enabling Long-Range BLE AoA&AoD for High-Precision Indoor Positioning with BHW GaAs RF Front-End ICs**
- **BHW AppNote #014 - Designing Ultra Low-Power High-Performance GNSS Products Using BHWL160 GaAs PHEMT LNA**
- **BHW AppNote #015 - BHWL161 GNSS Full-Band High-Performance LNA in Super-Compact 1x1mm DFN with Relaxed Pin Pitch**
- **BHW AppNote #016 - Improving GNSS NF Measurement Accuracy Using Broadband LNA BHWL161 as Pre-Amp**
- **BHW AppNote #017 - High-Efficiency, Low-NF 2.4GHz Front-End Solution for BLE & IoT Using BHWA251 and BHWM252**
- **BHW AppNote #018 - Optimizing BHWA555 Wideband One-Watt PA for Long-Range 5.8GHz Transmitter Applications**
- **BHW AppNote #019 - Miniature 2.4GHz RF Front-End with Integrated Chip Antenna and BHWM253 for TWS and IoT**
- **BHW AppNote #020 - Doubling the Range for BLE Music Streaming with BHWR250L Active Integrated Antenna (AIA)**