



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 #014

Designing Ultra Low-Power High-Performance GNSS Products Using BHWL160 GaAs PHEMT LNA

Rev. 1.5

www.bhw-tech.com

Background: High Precision GNSS at Low Power



Background & Technical Challenges:

- GNSS with Low Power Consumption is Critical for Smart Phones, Smart Watches and other Battery-Based Positioning/Navigation Devices
- LNA Power Consumption is Facing New Challenges for Next-Generation High-Precision GNSS Designs
- Most Current Dual/Multi-Band GNSS Modules Employ a Split-Path Architecture which Goes Against the Philosophy of Low Power Design
- One Key Reason for Separate High/Low-Band Architecture is the Lack of Broadband LNA that Covers All GNSS Frequencies (1165-1610MHz) without Any Compromise in Performance. Another is Antenna.

BHW Solutions & Benefits:

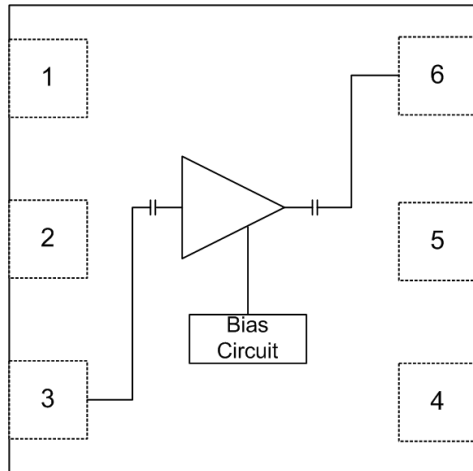
- Using Advanced GaAs ED-PHEMT Technology, BHW Has Developed the Industry's Leading GNSS LNA with Full-Band Operation and Best-Class Performance
- BHWL160 Provides Simultaneous Coverage of All GNSS Bands over 1165-1610MHz, Eliminating the Need for Dual-LNA Design and Cutting Power Consumption by Half Immediately
- BHWL160 Can Operate Over a Wide Range of DC Voltage (1~5V) and Current (sub-2mA to 10mA) and Enabling >50dB C/N0 in Both Low (L5) and High (L1) GNSS Bands at Default DC Bias (2.8/3.3V, 7/8mA)
- BHWL160 is Fully Functional at Extremely Low Voltage (~1V) and Low Current (~1.5mA), while Still Providing Sufficient Performance for Many Real-World Applications

This AppNote provides details on how to set up the DC voltage and bias current of BHWL160 to meet your module/system design requirements. The purpose is to help you achieve the best possible C/N0 results as well as other specs, based on the supply/control voltage and current budget available for your specific project.

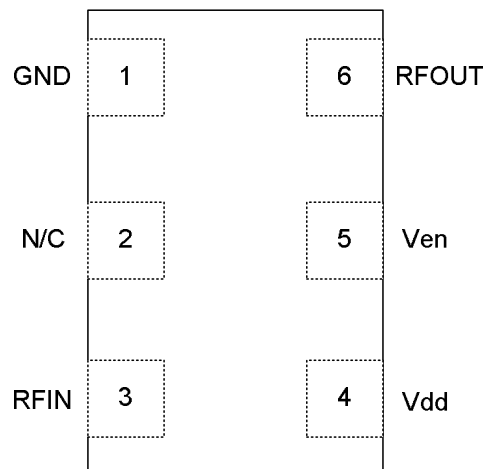
BHWL160 Full-Band GNSS Low Noise Amplifier



Functional Block Diagram



Package Pin-Out (Top "See-Through" View)



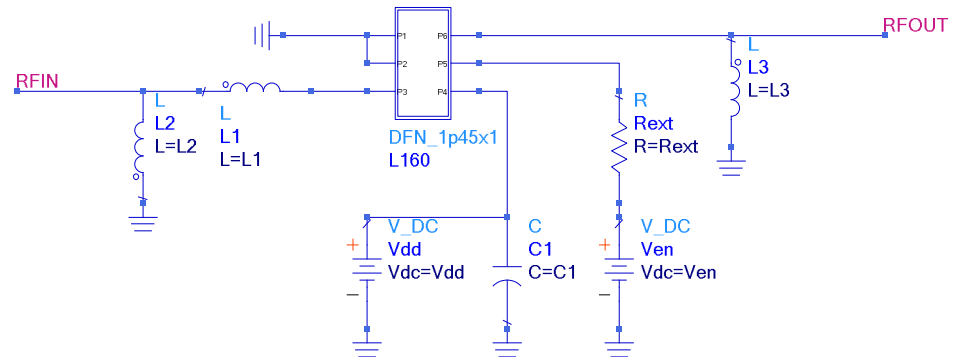
DFN-6L 1.45x1.0x0.55mm



Product Overview:

- Advanced GaAs pHEMT Process
- Triple-Frequency Operation for All Major GNSS
- Low Noise Figure over Broadband:
~0.5dB(High-Band); ~0.7dB(Full-Band)
- Power Gain: 15.5/16.5dB (High/Low-Band)
- High Input P1dB: -5.5dBm at 1575MHz/2.8V
- Industry-Leading In-Band/OOB IIP3 & IIP2
- Low Current: 8mA/7mA/2mA at 3.3V/2.8V/1.2V
- Adjustable Current: 2~9mA at 1.2~3.6V
- ESD at All I/O Ports: 1kV HBM, >2KV CDM
- Ultra-Small 1.45x1.0mm DFN-6L Package

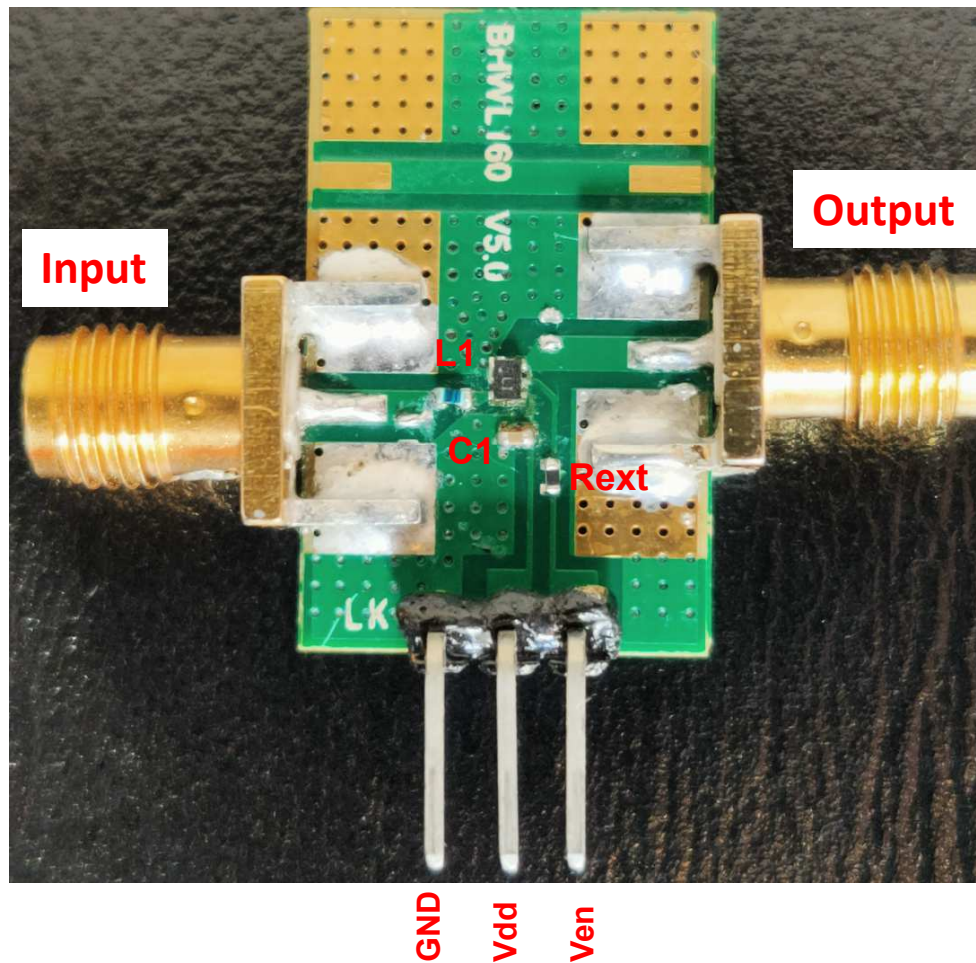
Application Schematic



Notes:

- For High-Band (1550-1610MHz), Use Only L1=9.1nH,C1=1uF
- For Full-Band (1165-1610MHz), Use L1=7.5nH, L2=10nH,L3=8.2nH,C1=1uF
- Rext is optional to further reduce current consumption for low-power applications

BHWL160 EVB for GNSS High-Band



Notes:

- BOM for High-Band GNSS (1165-1610MHz): L1=9.1nH (Murata LQW15A Recommended), C1=1uF.
- Rext: Default is None. Optional resistor to further reduce current for specific applications. See Page 8 for details.
- Nominal bias: Vdd=Ven=2.8V, Idq~6.5mA.
- Refer to BHWL160 Application Note for full-band operation over 1165-1610MHz.

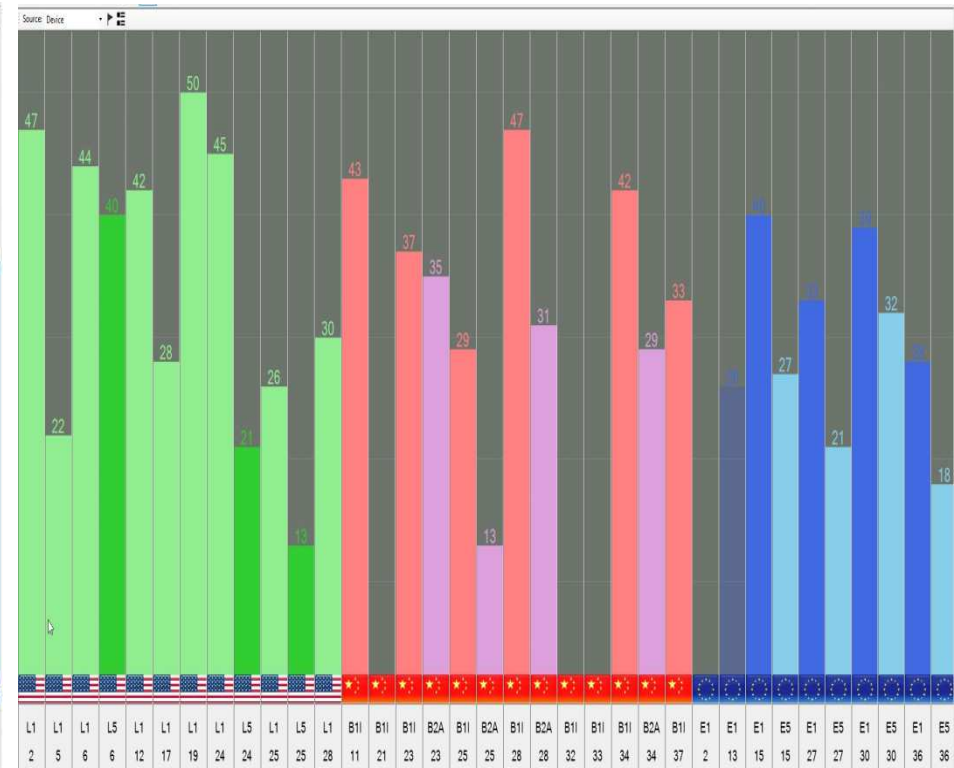
Case Study: BHWL160 Replacement on ublox ANN-MB



Test Results of Ultra Low-Power Operation of BHWL160

Original Biasing for All 3 BHWL160
Vdd=2.9V, Idq~6.5mA for each LNA

Low Voltage/Current for All 3 BHWL160
Vdd=1.2V, Idq~2mA for each LNA



Comments & Summary:

- With original voltage/current (2.9V/6.5mA), BHWL160 enables up to 53dB C/N0 at GPS L1 band.
- With ultra-low voltage/current (1.2V/2mA), BHWL160 is fully functional and provides up to 50dB C/N0 in GPS L1 band.
- Low-voltage/low-current operation was realized by inserting a 300-Ohm resistor at the output of the on-module LDO.
- Low-band GNSS L5 is not supported on this module due to antenna spec limitation. Still up to 40dB C/N0 was measured.
- More rigorous test of C/N0 with the Power-Splitter Method is planned when proper hardware/software become available.

BHW RF Front-End AppNote Library



This is an abridged version of BHW AppNote #014. Please contact BHW Support or your local sales rep/distributor for a complete copy of the document and other related information.

BHW RF Front-End Solutions AppNote Library



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 2.4GHz Systems
- BHW AppNote #002 - Accurate Benchmark of GNSS CNO 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 RC and IoT
- BHW AppNote #012 - Enabling Cost-Effective High-Precision GNSS Using BHWL161 and Linear-Polarization PCB Antenna
- BHW AppNote #013 - GNSS Noise Floor vs Receiver Architecture
- 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 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 - Multiplying the Range for 2.4GHz Music Streaming with BHWR250L Active Integrated Antenna (AiA)
- BHW AppNote #021 - Range Extension for 2.4GHz Wireless Systems with BHWR250M Active Integrated Antenna (AiA)
- BHW AppNote #022 - Enabling Long-Range Angle-of-Arrival for High-Precision Indoor Positioning with BHWR250N RF AiA
- BHW AppNote #023 - Extend the Range for 5.8GHz Audio/Video Streaming with BHWR580M Active Integrated Antenna (AiA)
- BHW AppNote #024 - Improving 5.8GHz Radio Link Budget with BHWR580L Active Integrated Antenna (AiA)
- BHW AppNote #025 - Improving Range and Throughput of 2.4GHz Wi-Fi with BHWR250 Array Antenna
- BHW AppNote #026 - Improving Range and Throughput of 5GHz Wi-Fi with BHWR550 Array Antenna
- BHW AppNote #027 - Multi-Band High-Accuracy GNSS Solutions Using BHWP150 DFN1x1 Ultra-Compact Power Divider & Combiner
- BHW AppNote #028 - Use BHWM252 Cascade to Extend Range of 2.4GHz Wireless Systems with Single-Port SoCs
- BHW AppNote #029 - Improving Range of 2.4GHz Wireless Microphones and Audio Systems with BHWR250A Active Integrated Antenna (AiA)
- BHW AppNote #030 - Simultaneous Improvement in Range and Battery Life of 2.4GHz Wireless Systems with BHWR250M AiA

Contact support@bhwtechnologies.com or BHW distributors/representatives for your copy of the above and new up-coming documents.