



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 #011

**BHWL161 Super-Compact Low-Power Low Noise Amplifier
for Range Extension of 2.4GHz RC and IoT**

Rev. 1.7

www.bhw-tech.com

Background: Improving Rx Sensitivity of 2.4GHz Systems



Background & Challenges:

- The 2.4GHz ISM Band is the Most Widely Used Spectrum Today, from Wi-Fi, ZigBee, Thread and Other IoT Protocols, to Remote Controls, Game Consoles, Cordless Phones, Baby Monitors, as well as Microwave Ovens
- Most State-of-the-Art 2.4GHz SoCs/Transceivers Have Integrated LNAs with Good Rx Sensitivity up to $\sim -96\text{dBm}$
- For Certain Applications Especially those in Challenging RF Environments with Less-than-Perfect Antennas, it is Desirable to Improve Rx Sensitivity Further (Below -100dBm), if it can be Achieved Simply and Cost-Effectively

BHW Solutions & Benefits:

- Using Advanced GaAs HBT & ED-PHEMT Technologies, BHW has Developed a Broad Portfolio of High-Performance, Cost-Effect RF Front-End ICs for Various Wireless Applications Including the 2.4GHz ISM Band
- BHWM253 is a Common-Port Bi-Directional RF Front-End IC Integrating Amplifier and Switch into a 1.5x1.5mm DFN
- BHWA251 is a GaAs HBT PA with up to $+25\text{dBm}$ Output and Industry-Leading 50% Peak PAE in a 1.5x1.5mm DFN
- BHWM252 is a GaAs PHEMT LNA/SPDT Front-End IC with Industry-Leading 1.6dB NF in 1.5x1.5mm DFN
- Combination of BHWA251/M252 Enables up to 125dB Total Link Budget, Over 20dB Higher than that of a Standalone State-of-the-Art 2.4GHz SoC on the Market Today
- BHWL161 is a GaAs PHEMT LNA with Low NF of 1dB at Very Low-Voltage/Low-Current, in a Tiny 1x1mm DFN

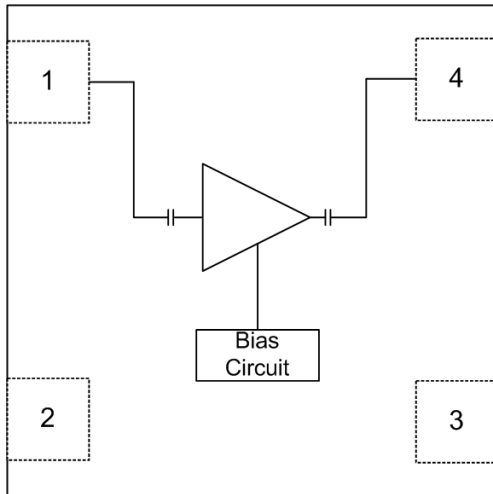
This AppNote Provides Detailed Information of BHWL161 at 2.4GHz, including Gain, Noise Figure, Input P1dB, as well as IIP3/OIP3/SFDR Analysis, as a Cost-Effective Alternative to Enhance Rx Sensitivity of 2.4GHz ISM Band Systems



BHWL161 Wideband GaAs Low Noise Amplifier

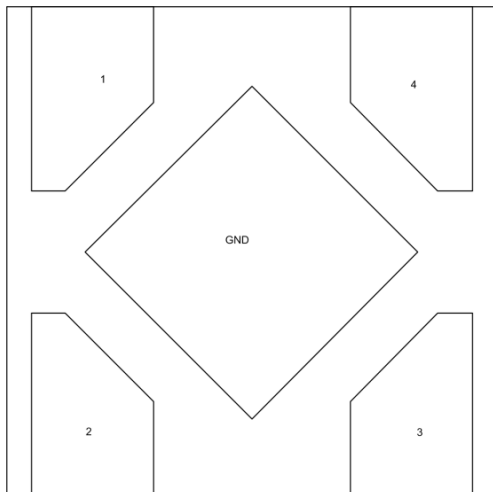


Functional Block Diagram

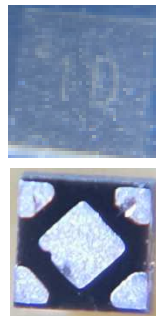


Package Pin-Out

(Top "See-Through" View)



DFN-4L 1.0x1.0x0.45mm



Product Overview:

- Advanced GaAs E/D-pHEMT Process
- Ultra-Wideband 700MHz~2.5GHz Operational
- Support Full-Band GNSS 1165~1610MHz
- Ultra-Low 0.45/0.4dB EVB/De-Embedded NF at L1
- NF <0.7dB at L1/L5; <0.8dB over Full GNSS Bands
- NF ~1dB when Tuned for 2.4GHz ISM Band
- Gain~12dB in 2.4GHz ISM Band
- Adjustable Current: 2~9mA at 1.2~3.6V
- ESD at All I/O Ports: 1kV HBM, >2KV CDM
- Ultra-Compact 1.0x1.0mm DFN-4L Package
- Relaxed Pin Pitch 0.65mm for Easy PCB Assembly

Applications:

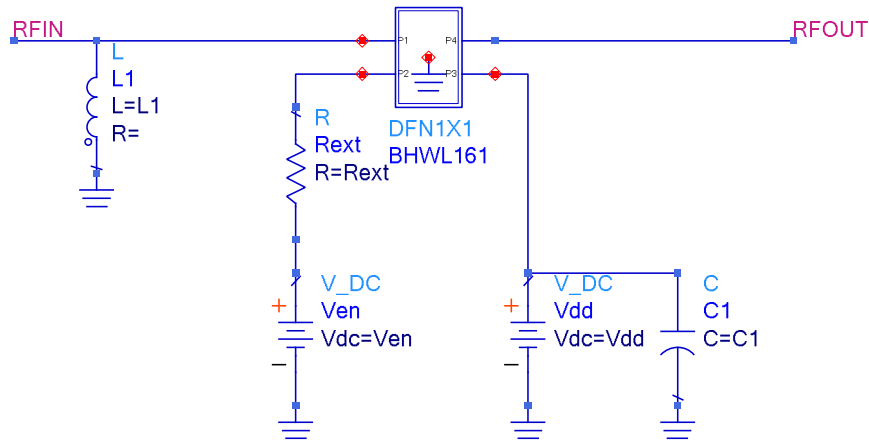
- GNSS for Smartphones, Smart Watches, Wearables
- GNSS for PNDs, UAVs and Drones
- GNSS for Vehicles, ADS Systems
- GNSS for Shared Rides, Asset Tracking
- Active GNSS Antennas & Modules
- UHF 700/868/915MHz Products
- 2.4GHz Angle-of-Arrival Systems
- 2.4GHz Remote Controls
- Other Generic Radios from Sub-GHz to 2.5GHz

BHWL161 Wideband GaAs Low Noise Amplifier

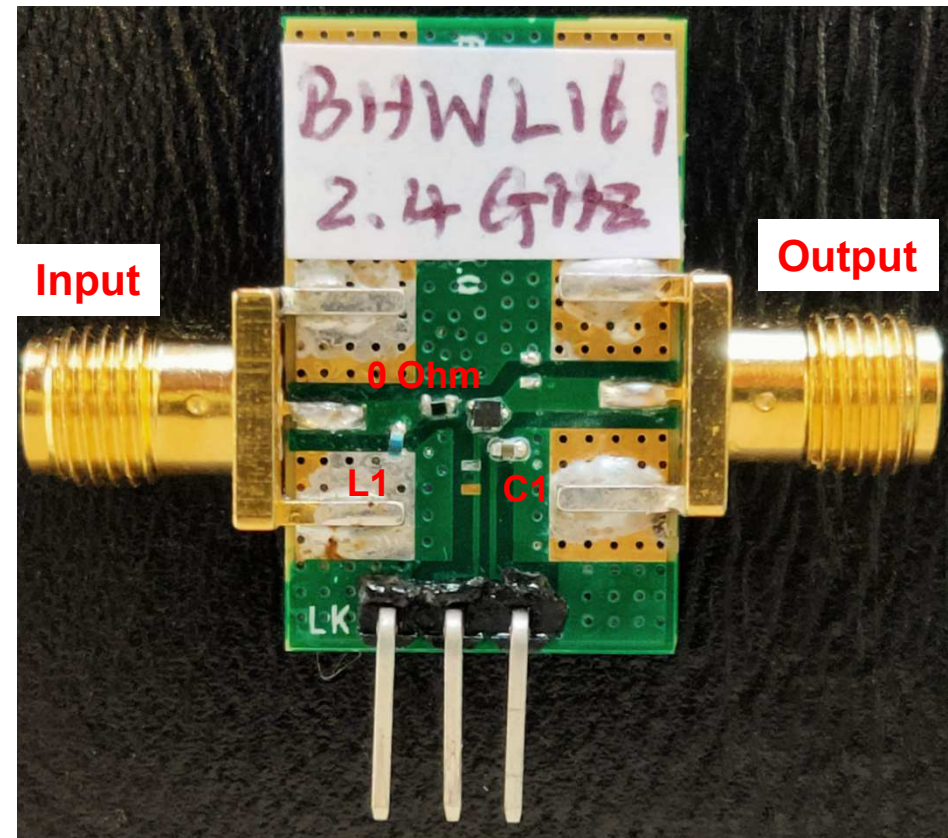


BHWL161 Tuned for 2.4GHz ISM Band

Application Schematic



Evaluation Board



GND
Ven
Vdd

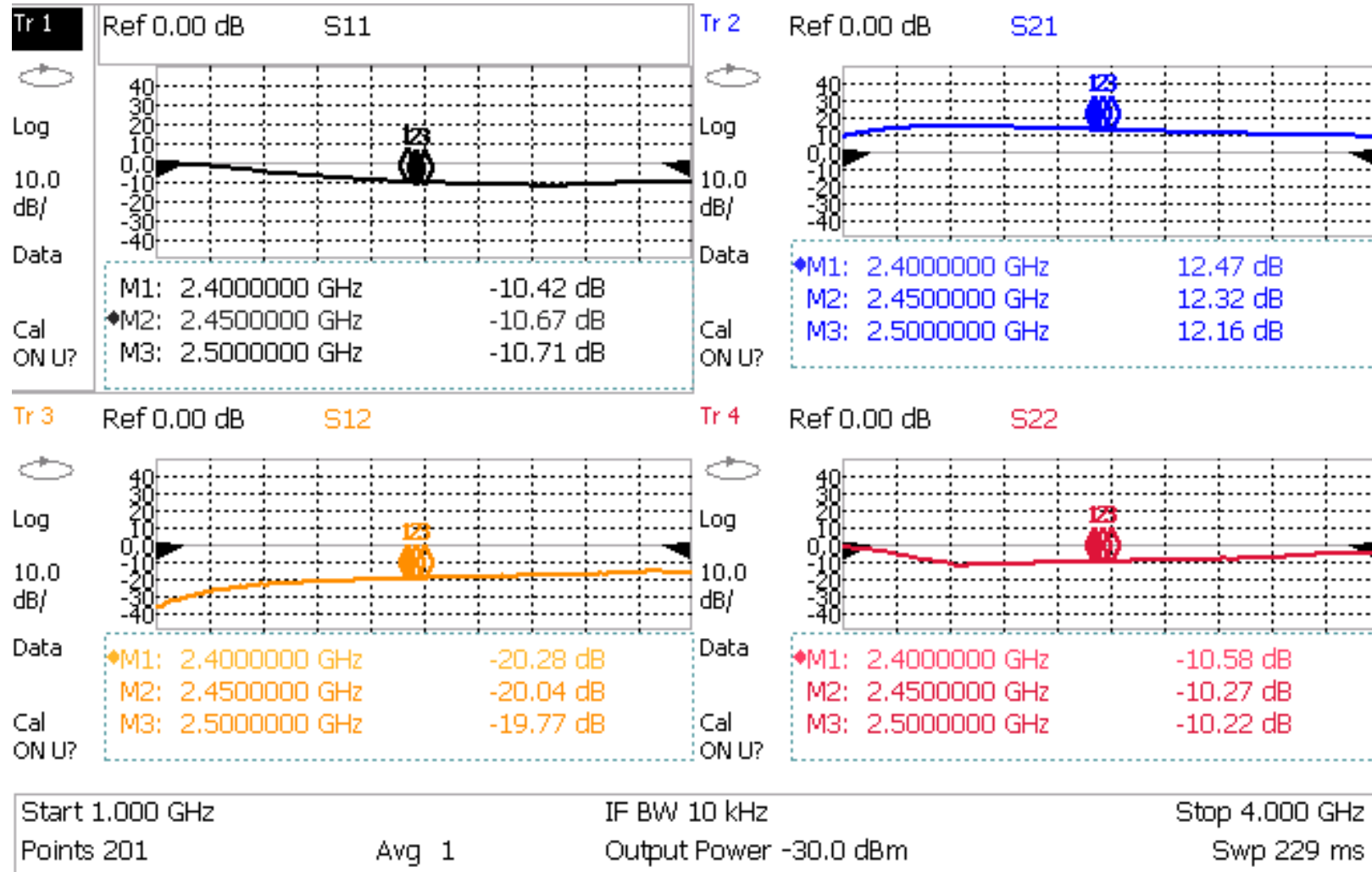
Notes:

- Nominal BOM: L1=7.5nH (Murata LQW15A Recommended), C1=1uF (0 Ohm jumper is not needed for new PCB design)
- For best gain, NF and input P1dB, please use DC bias Vdd=Ven=3.3V, Idd~7.5mA
- For low-power applications, please use DC bias Vdd=Ven=1.8V, Idd~3.5mA, with slight degradation in performance
- LNA current can be further reduced to ~2mA at any Vdd/Ven, by adding an optional serial resistor (Rext) to the Ven line

BHWL161 EVB for 2.4GHz: S-Parameters



Typical Small-Signal S-Parameters at Vdd=Ven=3.3V



Notes:

- L1=7.5nH, C1=1uF, Idq~7.5mA
- Measured S21 included SMA connector and PCB feedline losses (~0.2dB)

BHW RF Front-End AppNote Library



This is an abridged version of BHW AppNote #011. 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 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.