



# 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 #002

### Accurate Benchmark of GNSS C/N0 Using the Power-Splitter Method

Rev. 1.5

[www.bhw-tech.com](http://www.bhw-tech.com)

# Background: Next-Gen High-Precision GNSS



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## Dual-Band Precision GNSS Market Moving from Insignificant to Billions in Less Than Five Years

Oyster Bay, New York - 06 Dec 2018

After many years of development at the fringe of the Global Navigation Satellite System (GNSS) industry, dual-frequency GNSS devices are finally ready to hit the mass market and will account for more than a billion chipset shipments in 2023, according to a new market data report by **ABI Research**, a market-foresight advisory firm providing strategic guidance on the most compelling transformative technologies. The report finds that the bulk of this growth will come from the adoption in the smartphone market with consumers hungry for better location accuracy.

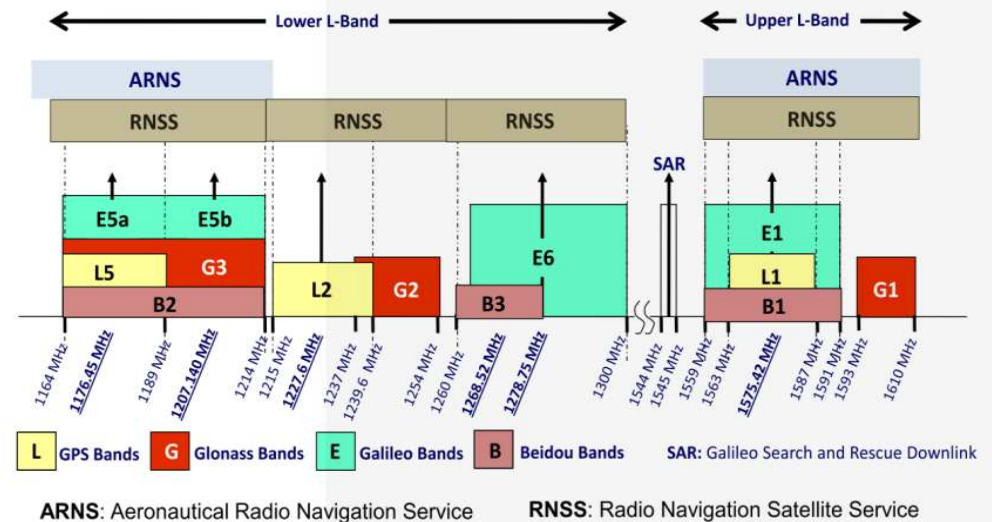
Dual-band GNSS can mitigate the so-called multipath interference effects which are especially present in areas with a high density of buildings, like urban canyons, and deliver significantly higher accuracy than single-frequency devices. However, there have been several obstacles preventing widespread adoption of dual-band GNSS until now, including insufficient satellite coverage of a second band, which could be L2 or L5/E5, high chipset prices, and challenges in fitting these integrated circuits and related antennas into small devices such as smartphones.

- 全球导航卫星系统正在经历从传统单频(L1/B1/E1/G1)到双频/三频 (L1/2/5, B1/2/3, E1/5/6) 的技术升级
- 定位精度由目前的3-6米大幅提升到30厘米-1米, 实现车道级别的精准定位导航
- 2018年后发射的大多数卫星具有多频功能, 下一代高精度卫星导航技术市场蓄势待发
- 多频GNSS将在5年内从微不足道发展到十亿级规模

### Technical Challenges for Dual/Multi-Band GNSS:

- Multi/Wideband Antenna
- Wideband LNA
- Anti-Jamming and Desensitization
- System Implementation and Optimization
- Low Cost for Best-Class Performance

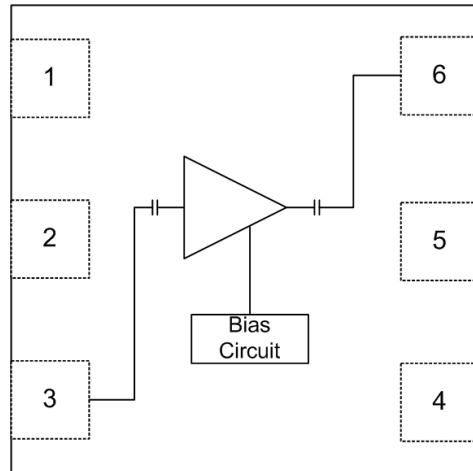
This AppNote provides a brief introduction of BHWL160 wideband GNSS LNA, and describes a reliable and accurate method to compare C/N0 of various GNSS systems



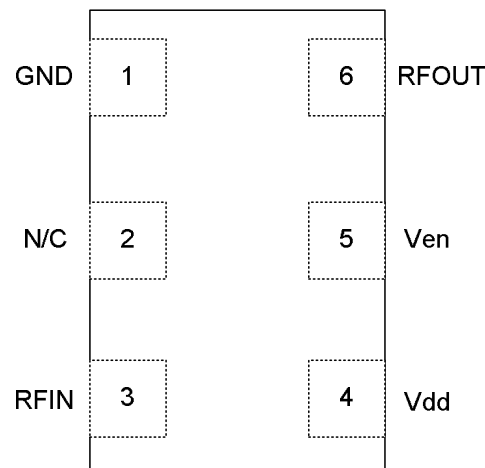
# BHWL160 Wideband GaAs Low Noise Amplifier



## Functional Block Diagram



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



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

## Product Overview:

- Advanced GaAs E/D-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

## Applications:

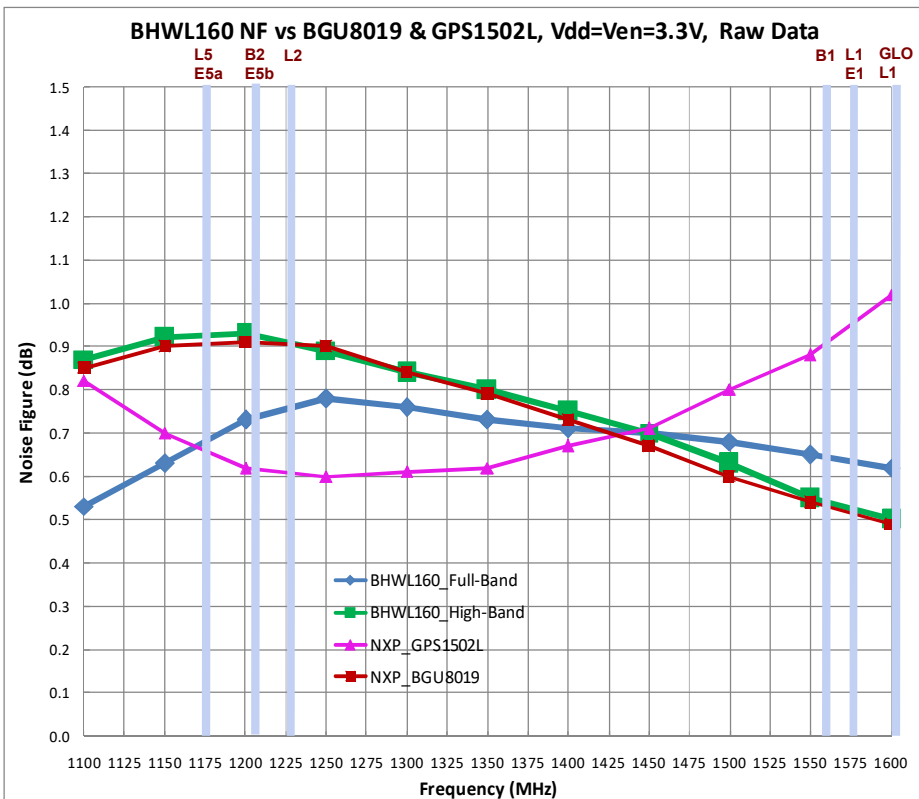
- GNSS for Smartphones, Smart Watches, Wearables
- GNSS for PNDs, UAVs and Drones
- GNSS for Vehicles, ADS Systems
- GNSS for Shared Rides, Asset Tracking
- Active GNSS Antennas & Modules
- UHF 600/700/868/915MHz Products
- 2.4GHz Angle-of-Arrival Systems
- 2.4GHz Remote Controls
- Other Generic Radios from Sub-GHz to 2.5GHz

# BHWL160 All-Band All-Constellation GNSS LNA

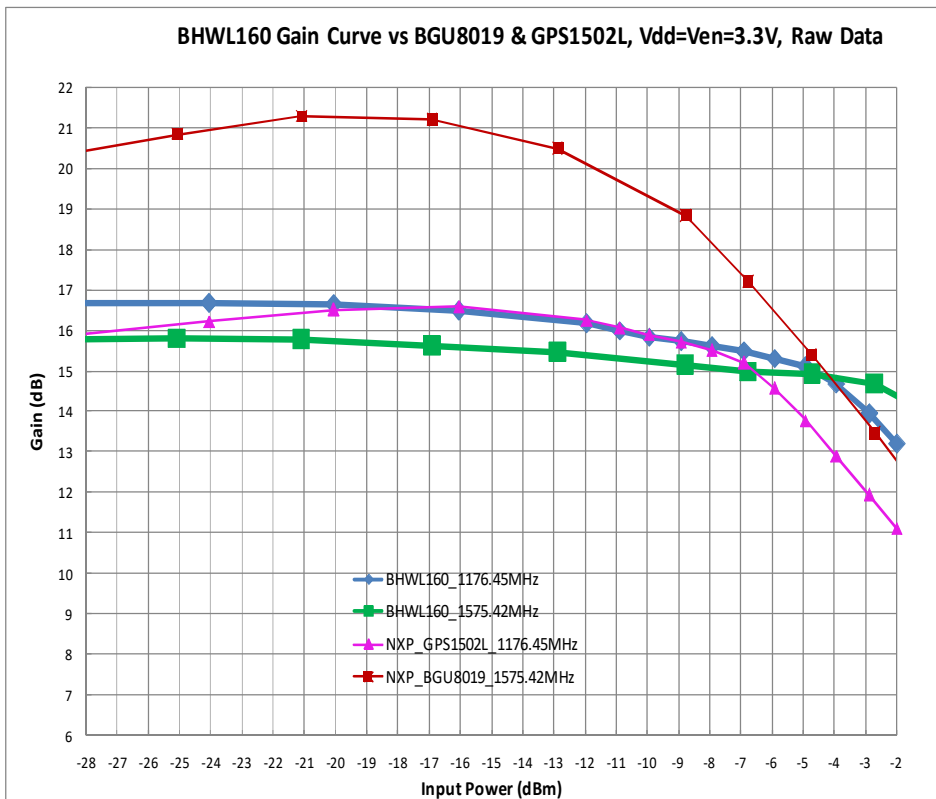


## Benchmark of Key RF Performance Matrix

### Noise Figure (Un-Deembedded )



### Linearity (Gain Flatness & Input P1dB)



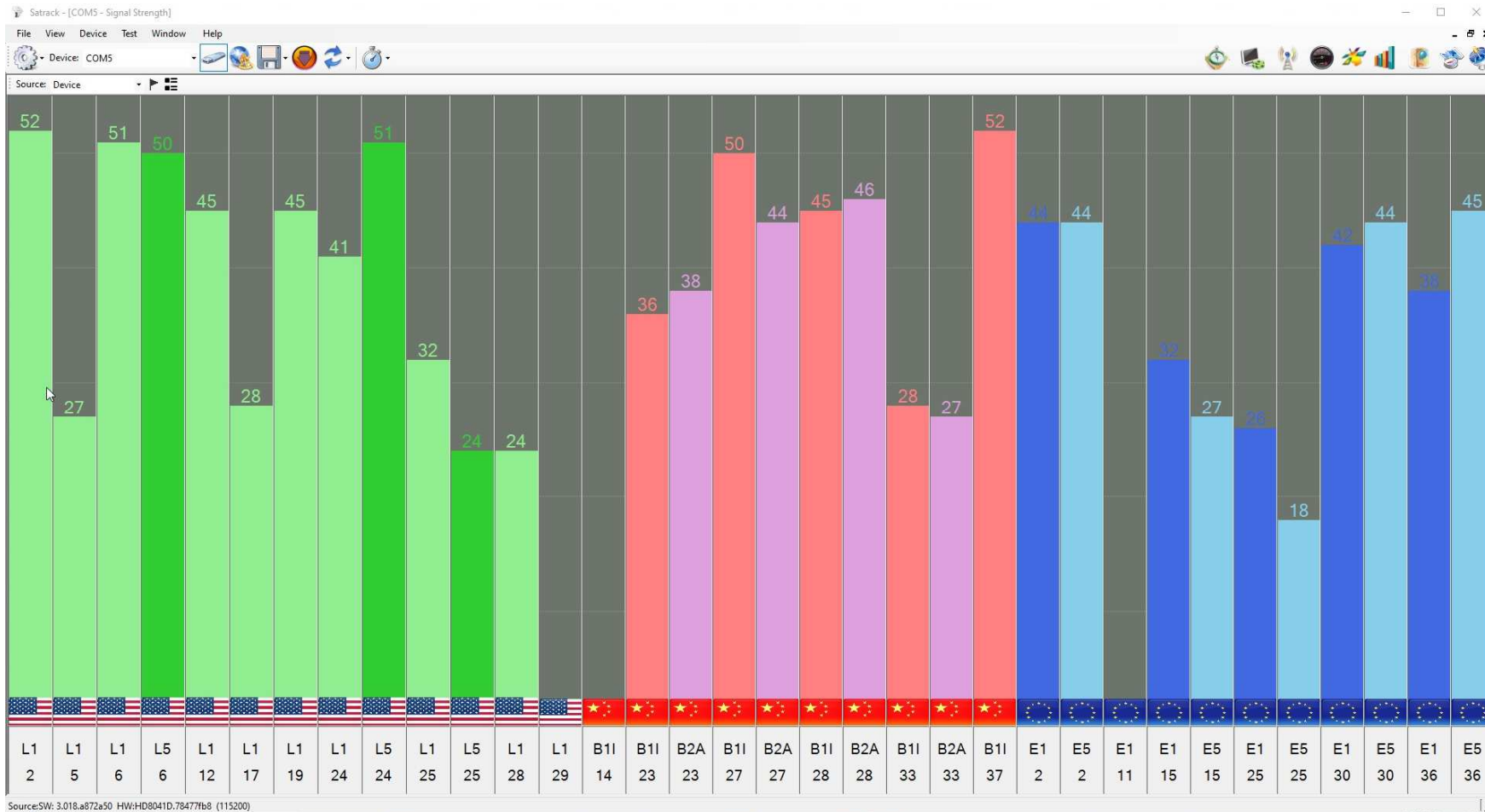
### Notes:

- All LNA samples were mounted on EVBs with same PCB material, 50-Ohm line length and SMA connectors.
- All impedance matching used the same Murata LQW15A series inductors for apple-to-apple comparison.
- All results are raw data including SMA and PCB trace losses. Intrinsic NF of LNA is ~0.1dB lower.
- Expect further improvement in performance (lower NF) if higher-Q inductors can be used.
- All tests were done with same calibration in the same lab setting at room temperature.
- HP/Agilent 8970A/346B with external pre-amp was used for NF measurement .

# BHWL160 All-Band All-Constellation GNSS LNA



## Example of >50dB C/N0 at L1/L5 Band with BHWL160 Full-Band Matching



### Comments:

- C/N0 test results depend on sky clearance and constellation status during measurement.
- Antenna performance plays a critical role in C/N0 test results.
- The most accurate way to compare C/N0 of different systems is the Power-Splitter Method. See below.

# BHW RF Front-End AppNote Library



*This is an abridged version of BHW AppNote #002. 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 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 RC and IoT
- BHW AppNote #012 - Enabling Cost-Effective High-Precision GNSS Using BHWL161 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 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 2.4GHz Music Streaming with BHWR250L Active Integrated Antenna (AIA)

Contact [support@bhwtechnologies.com](mailto:support@bhwtechnologies.com) or **BHW distributor/representative** for your copy of the above and new up-coming documents.