



BHW Technologies (博泓微科技有限公司)



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

BHW AppNote #017

High-Efficiency, Low-NF 2.4GHz Front-End Solution for BLE
& IoT Using BHWA251 and BHWM252

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Background: Improving Link Budget of 2.4GHz Systems



Background & Challenges:

- The 2.4GHz ISM Band is the Most Widely Used Spectrum Today, from Wi-Fi, Bluetooth, ZigBee and Other IoT Protocols, to Remote Controls, Game Consoles, Cordless Phones, Baby Monitors, as well as Microwave Ovens
- To Achieve Reasonably Long Range and Maintain Reliable Wireless Connection, RF Front-End with Sufficient Link Budget should be Considered at the Design Stage
- Most State-of-the-Art BLE SoCs Have Transmit Power below 8dBm due Partly to Low-Power Design Constraints
- Most State-of-the-Art BLE SoCs Have Receive Sensitivity that are Limited to the -90~-96dBm Range
- For Certain Applications Especially those in Challenging RF Environments with Less-than-Perfect Antennas, this 98~104dB Link Budget might be Insufficient to Deliver Product Performances with Satisfactory User Experience

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 +25dBm 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
- BHWL161 is a GaAs PHEMT LNA with Ultra-Low NF of 1dB at Very Low-Voltage/Low-Current, in a Tiny 1x1mm DFN
- Combination of BHWA251/M252 Enables up to 125dB Total Link Budget, Over 20dB Higher than that of a Standalone BLE SoC on the Market Today

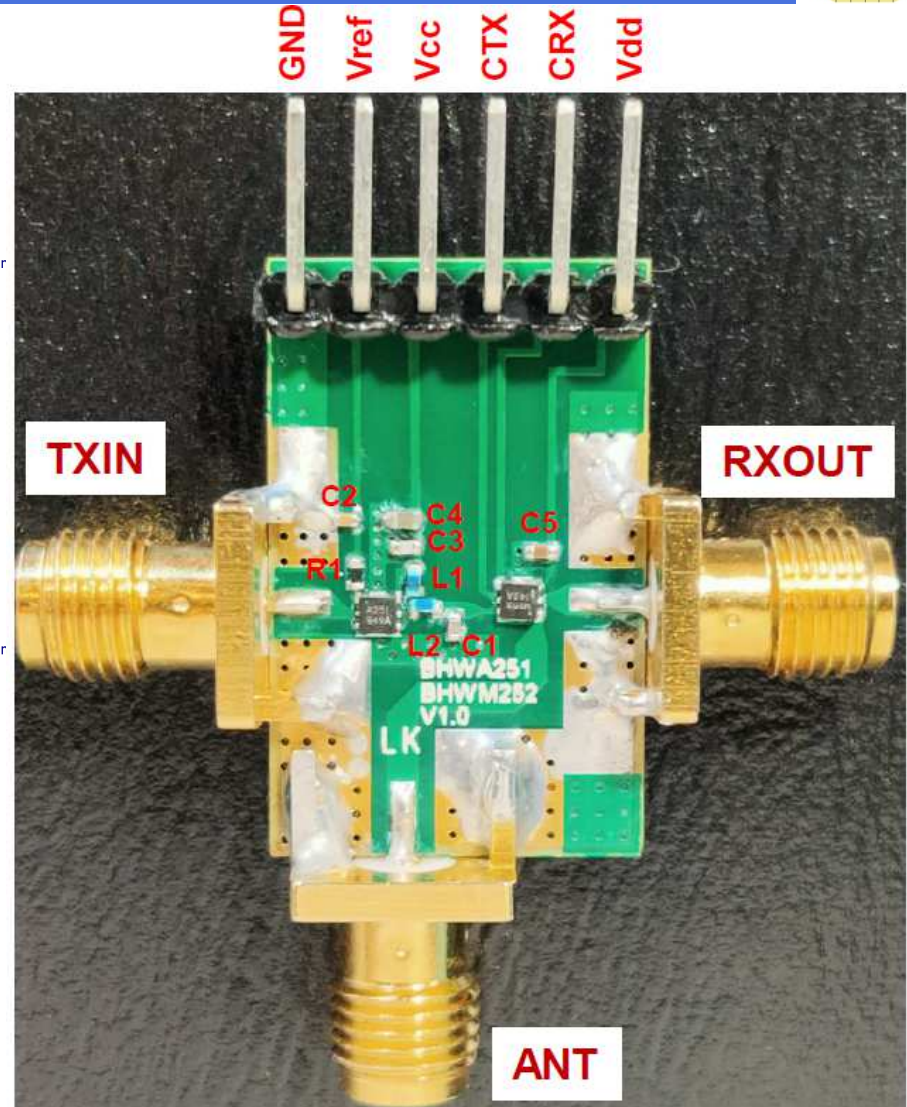
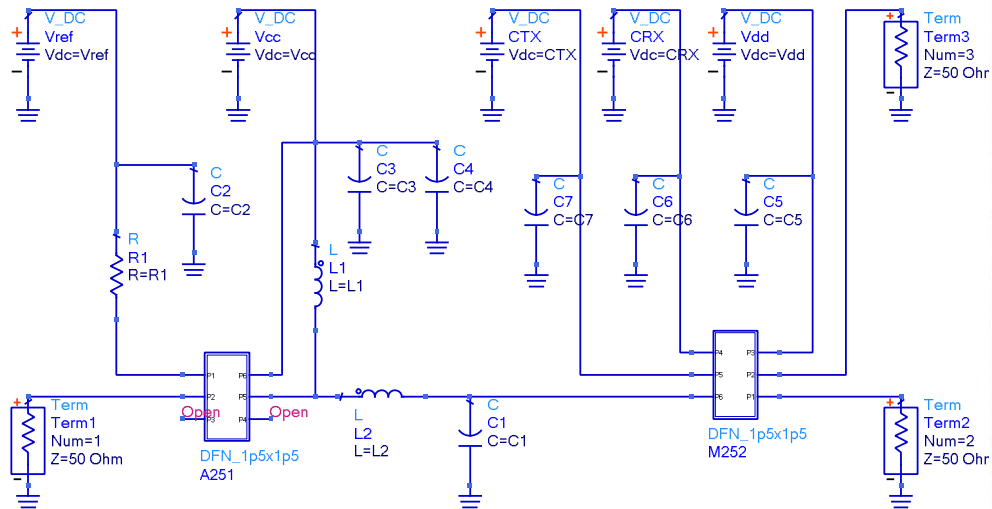
This AppNote Describes the Implementation and Test Results of a Complete 2.4GHz RF Front-End Using the BHWA251/M252 Combo, which Offers Several Advantages such as High Performance, Best-Class Power Efficiency, and Disruptive Cost Structure



BHWA251/M252 Combo EVB: 0402 Components



Application Schematic



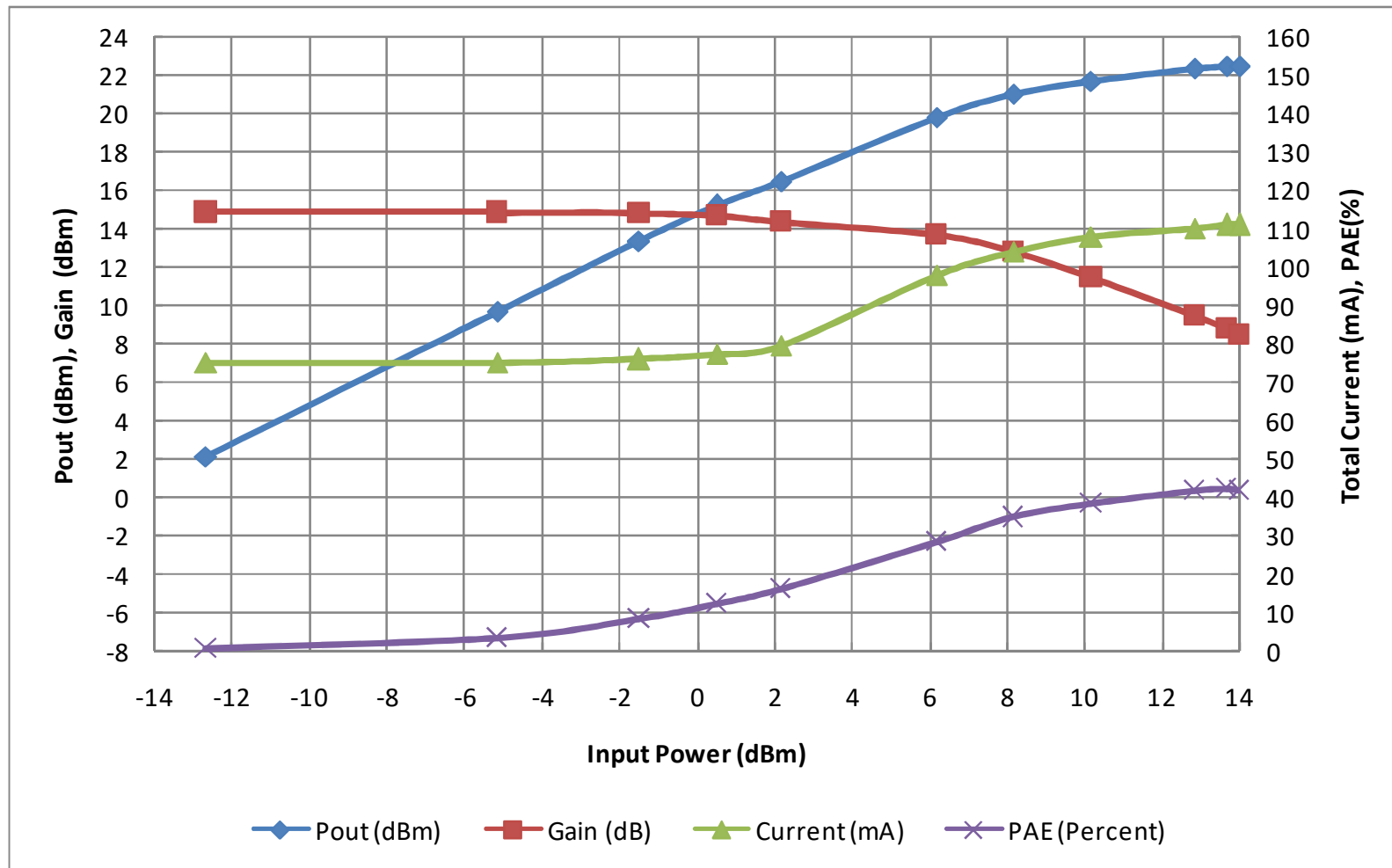
Nominal BOM for 2.4GHz High-Efficiency Operation:

- Capacitors: C1=1.2pF(0402), C2=470pF, C3=330pF, C4=10uF, C5=1uF, C6=C7=1nF
- Inductors: L1=10nH(0402), L2=1.5nH(0402, Murata LQW15A Series Recommended)
- Resistor: R1=200 Ohm for $I_{cq} \sim 75\text{mA}$ at $V_{cc}=V_{ref}=3.3\text{V}$. Other bias settings available upon request

BHWA251/M252 Combo CW Power Sweep



Output Power, Gain, Current & PAE vs Input Power at 2450MHz Using 0402 Components for BHWA251 Output Matching



Notes:

- Bias Setting: $V_{cc}=V_{ref}=V_{dd}=CTX=3.3V$, $I_{cq}\sim 75mA$; $CRX=0$
- Measured data include feedline and SMA connector losses of $\sim 0.2dB$

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 BHW250L Active Integrated Antenna (AIA)