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 #007

UWB RF Front-End Solution Using BHWA350 and BHWM552

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Background: UWB for High-Precision RTLS

Background & Challenges:

- **Based on IEEE 802.15.4z Standard, Ultra Wideband (UWB) Technology Provides Decimeter-Level Precision Positioning Capabilities, both Indoor and Outdoor, Enabling Key Applications such as Real Time Location Services (RTLS)**
- **UWB Operates in Several 500MHz/1GHz Channels in the 3~7GHz Frequencies Bands, Providing Four Data Rates from 110 kbps to 27 Mbps**
- **Both Antennas and RF Front-Ends (PA/LNA/Switch) Capable of Wideband Operation over 500MHz~1GHz Bandwidth are Critical for Successful Deployment of UWB Systems**

UWB Frequency Channels

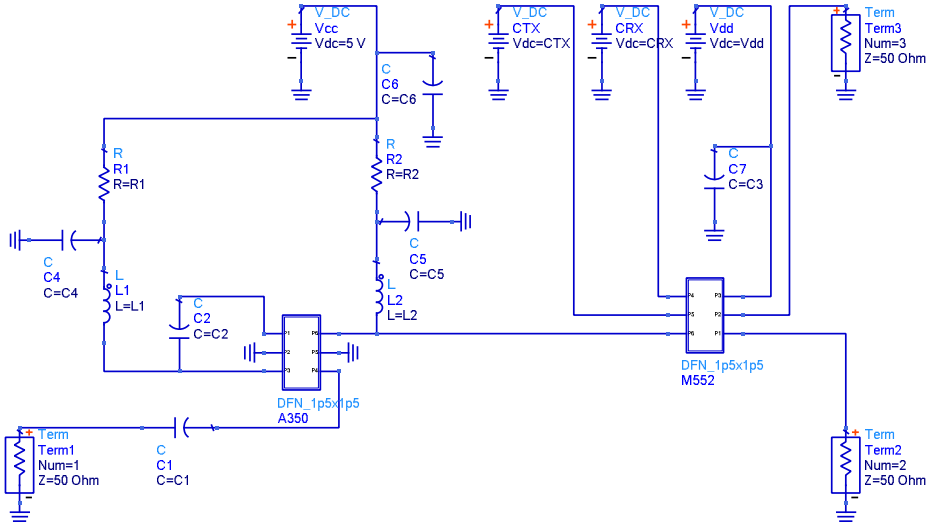
UWB Channel Number	Centre Frequency (MHz)	Band (MHz)	Bandwidth (MHz)
1	3494.4	3244.8 – 3744	499.2
2	3993.6	3744 – 4243.2	499.2
3	4492.8	4243.2 – 4742.4	499.2
4	3993.6	3328 – 4659.2	1331.2*
5	6489.6	6240 – 6739.2	499.2
7	6489.6	5980.3 – 6998.9	1081.6*

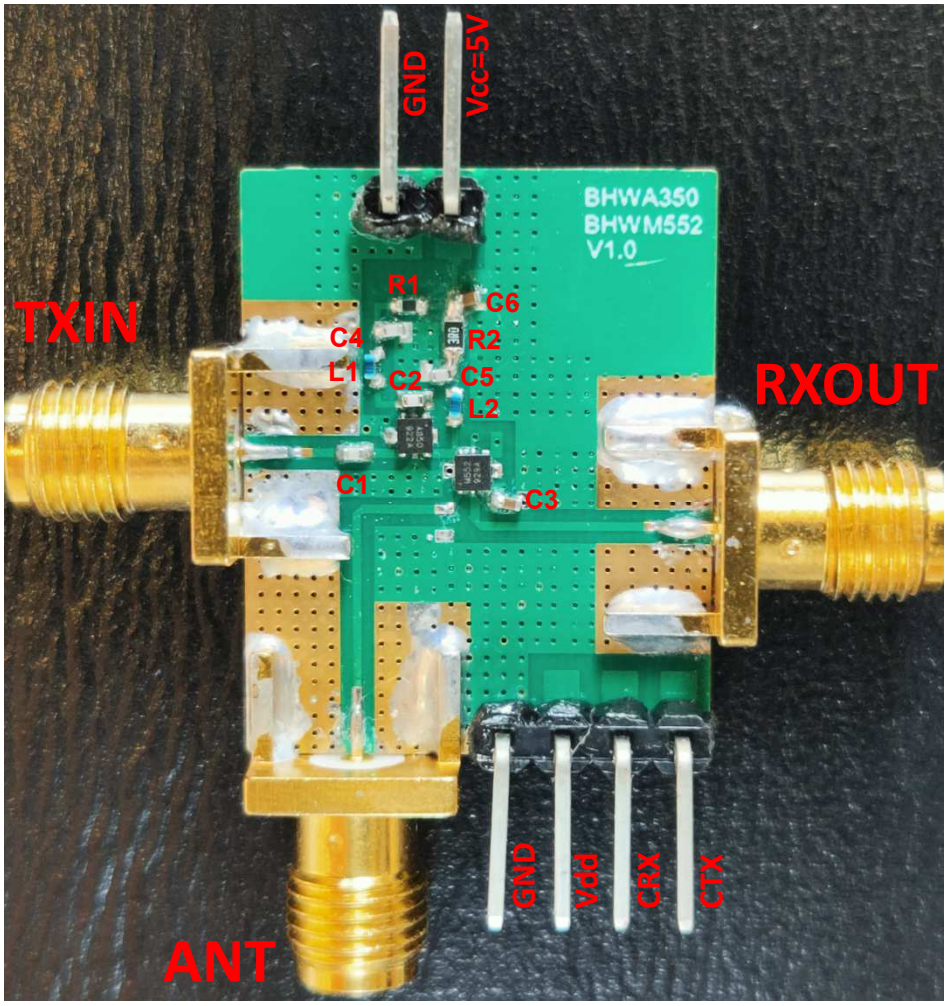
Source: Decawave DW1000.

This AppNote Introduces a Complete UWB RF Front-End Solution Based on BHWA350 PA and BHWM552 Rx Front-End IC, which Delivers up to ~17dBm Tx Power and 1.6dB NF in the UWB B2 Band. Support to Other UWB Bands is Available Upon Request.

BHWA350 & M552 Combo Breadboard

Application Schematic



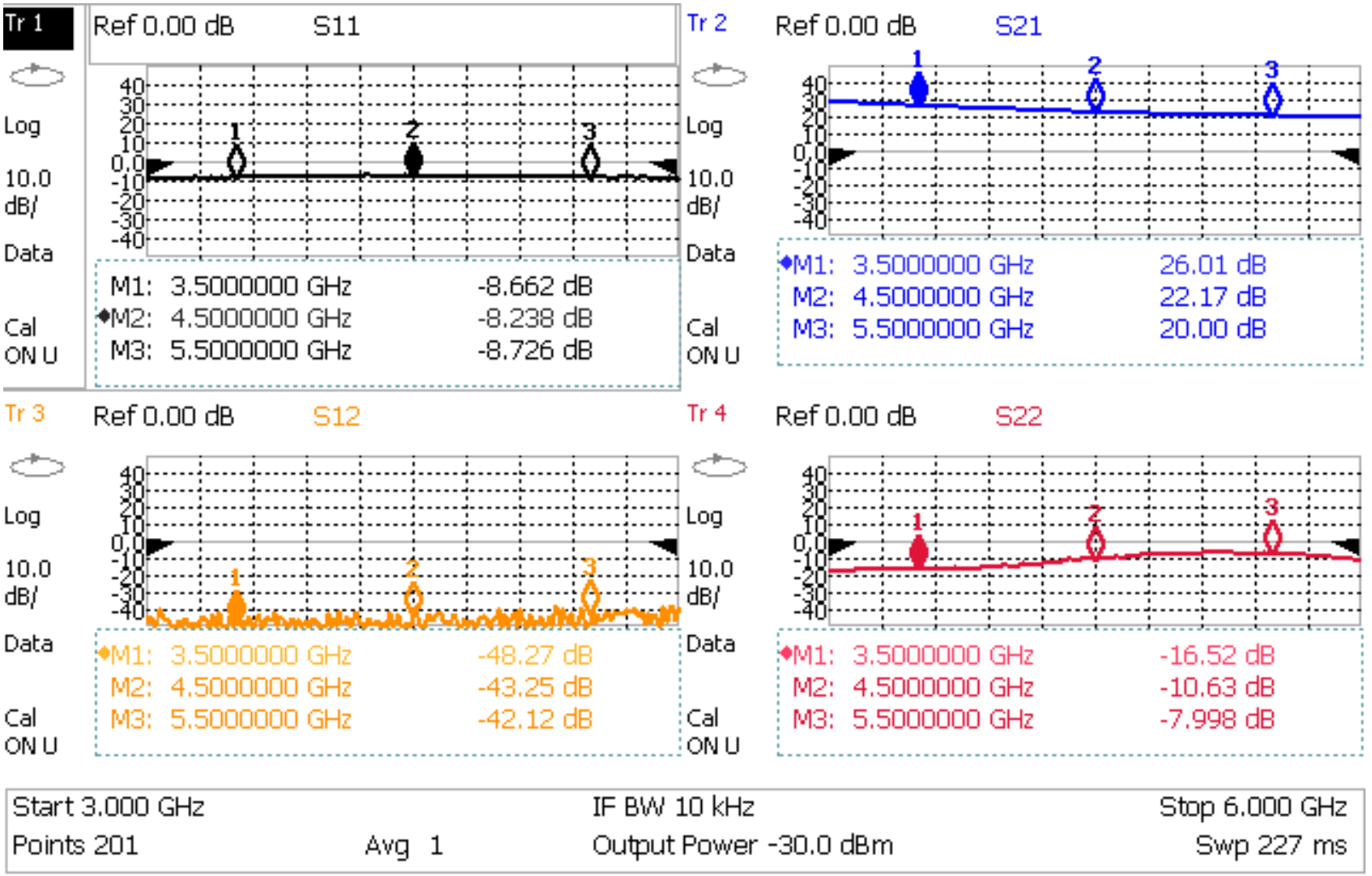


Recommended BOM for UWB B2 (3744-4243.2MHz):

- C1=C2=10pF, C3=1uF, C4=C5=100pF, C5=1uF
- L1=L2=8.2nH
- R1=68 Ohm, R2=3 Ohm

- BHWA350 cascade provides ~18dBm maximum power and ~20dB gain at 5.8GHz at Vcc=5V
- BHWM552 provides ~0.8dB insert loss in Tx mode, resulting in ~17dBm Tx power at antenna
- BHWM552 provides ~1.6dB noise figure at antenna, with ~10dB Rx gain in the 5-6GHz band

BHWA350 & M552 Combo: Tx S-Parameters



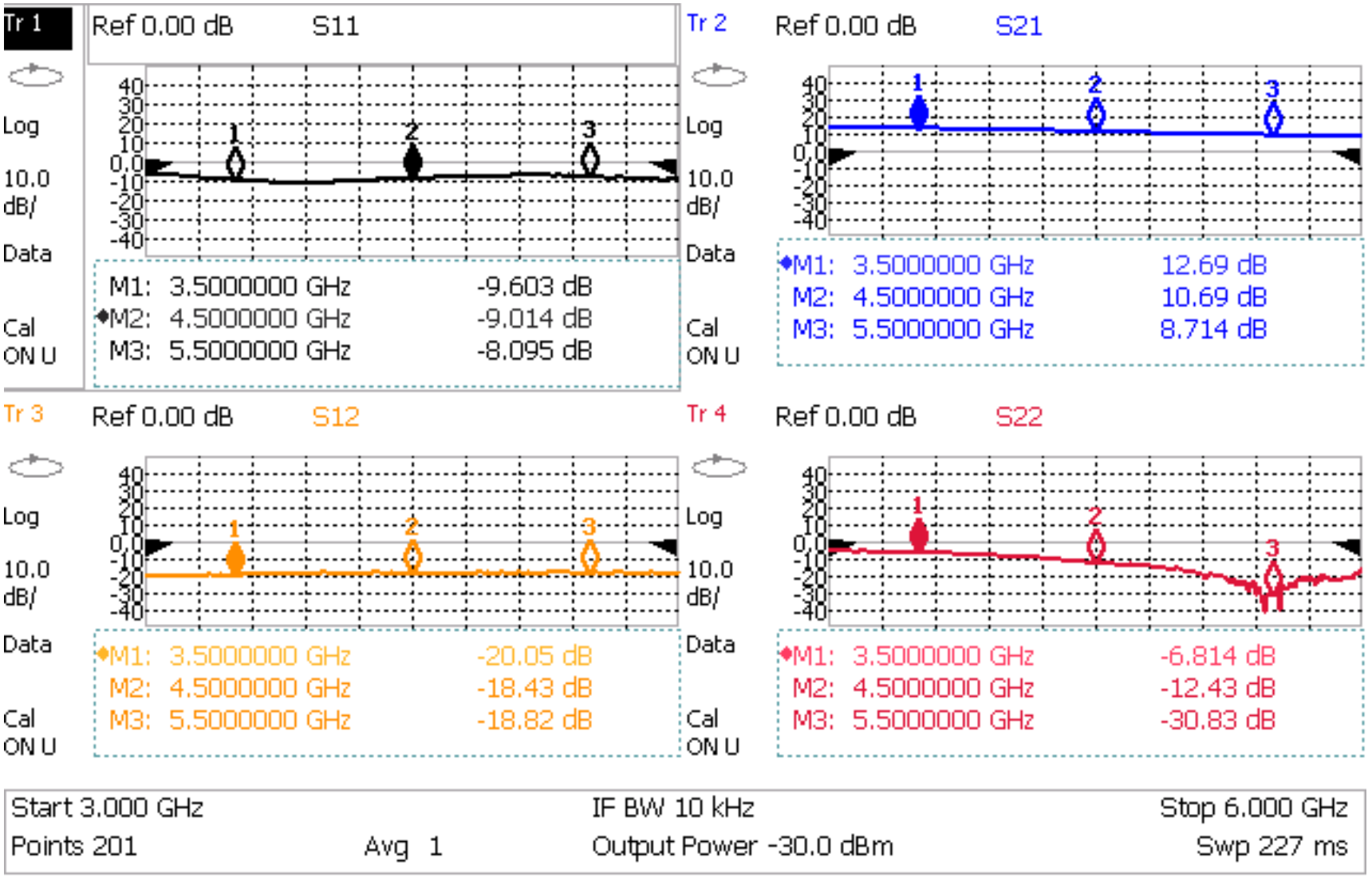
Notes:

-BHWA350 DC Bias: Vcc=5V, Icq~76mA

-BHWM552 DC Bias: Vdd=CTX=3.3V, CRX=0

-Measured data includes SMA connector/adapter and PCB feedline losses (estimated total ~0.4dB at 5.8GHz)

BHWA350 & M552 Combo: Rx S-Parameters

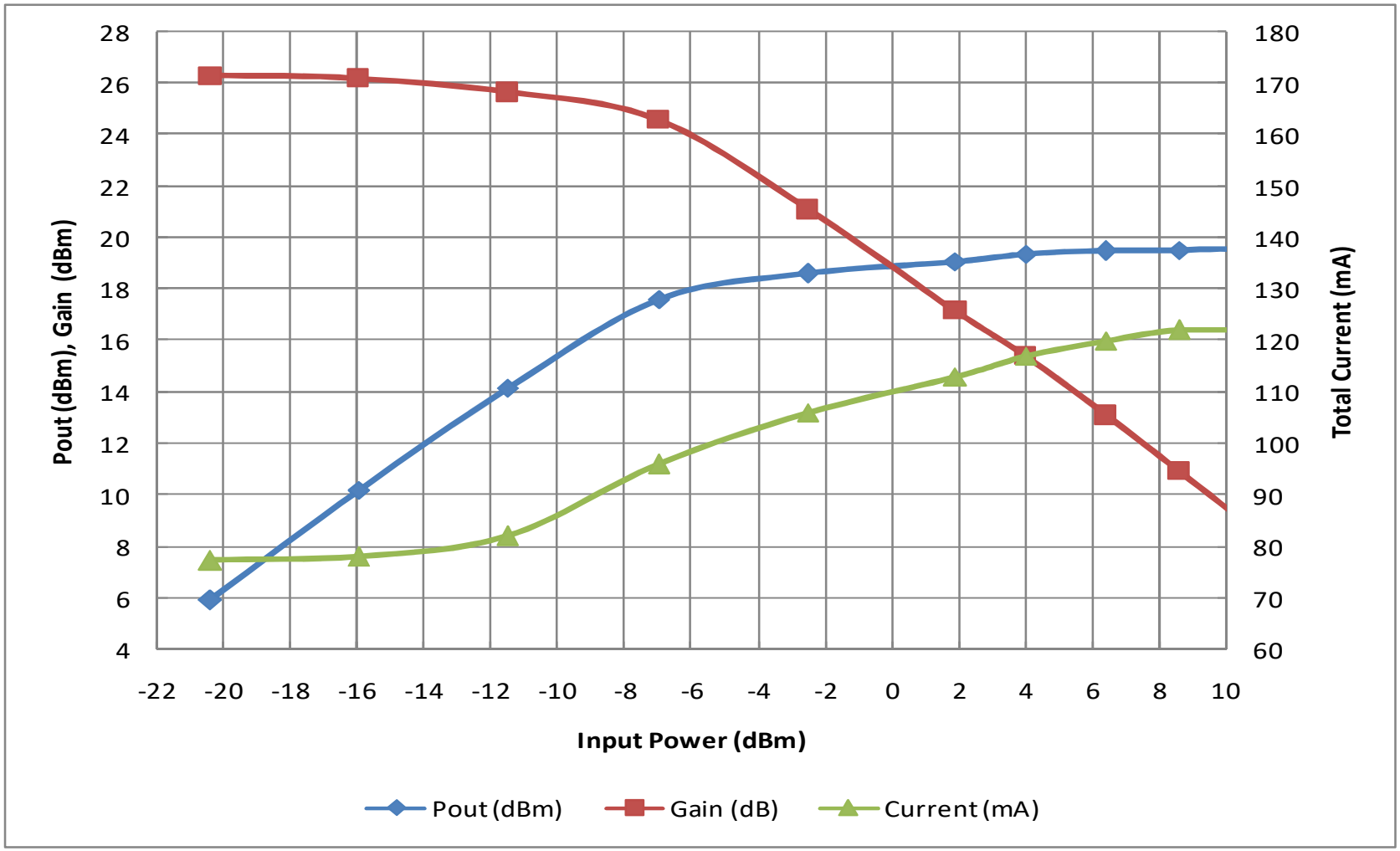


Notes:

-BHWM552 DC Bias: Vdd=CRX=3.3V, CTX=0, Idq~14mA

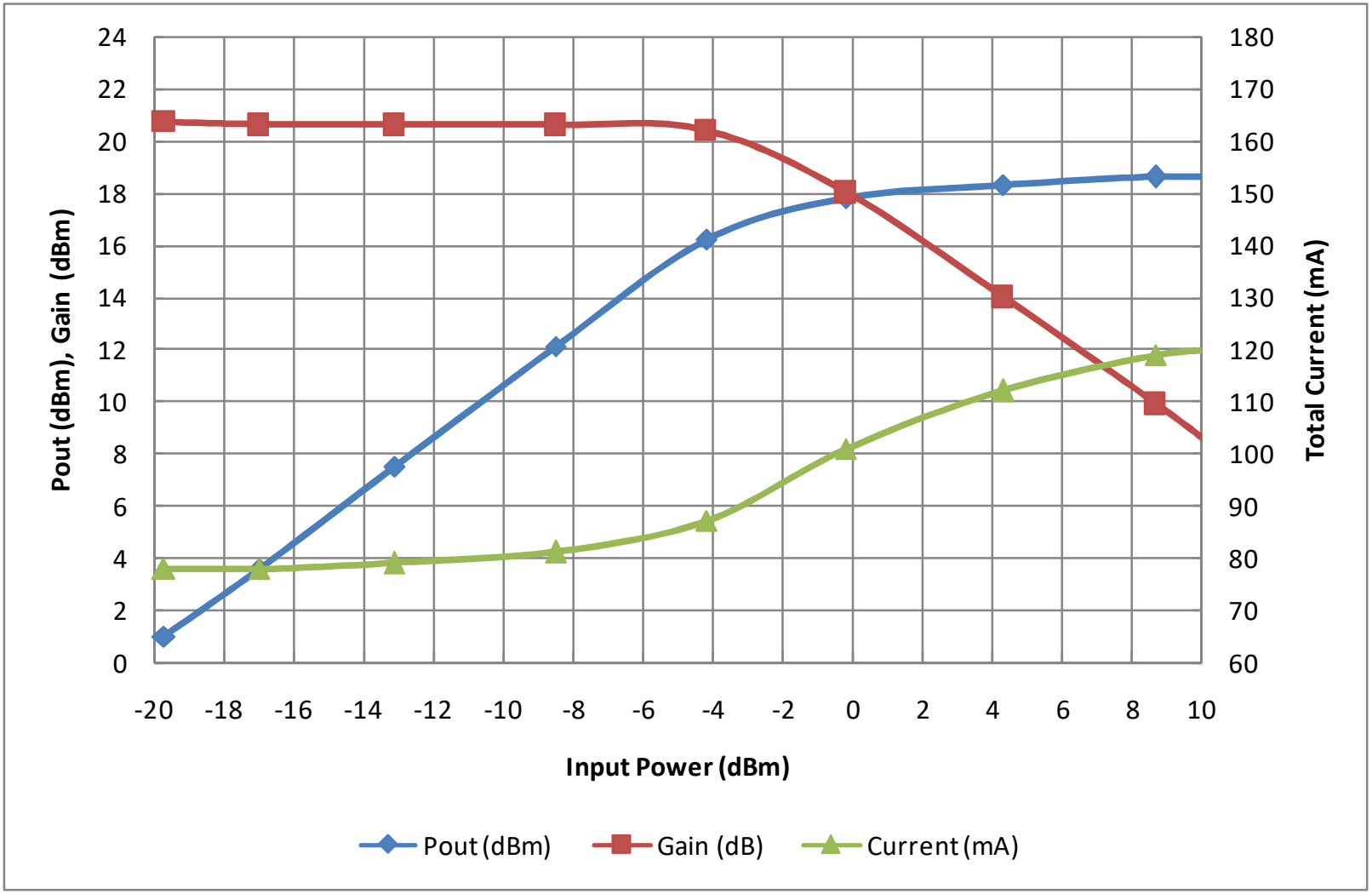
-Measured data includes SMA connector and PCB feedline losses (estimated total ~0.4dB at 5.8GHz)

BHWA350 & M552 Tx Power Sweep at 3.5GHz



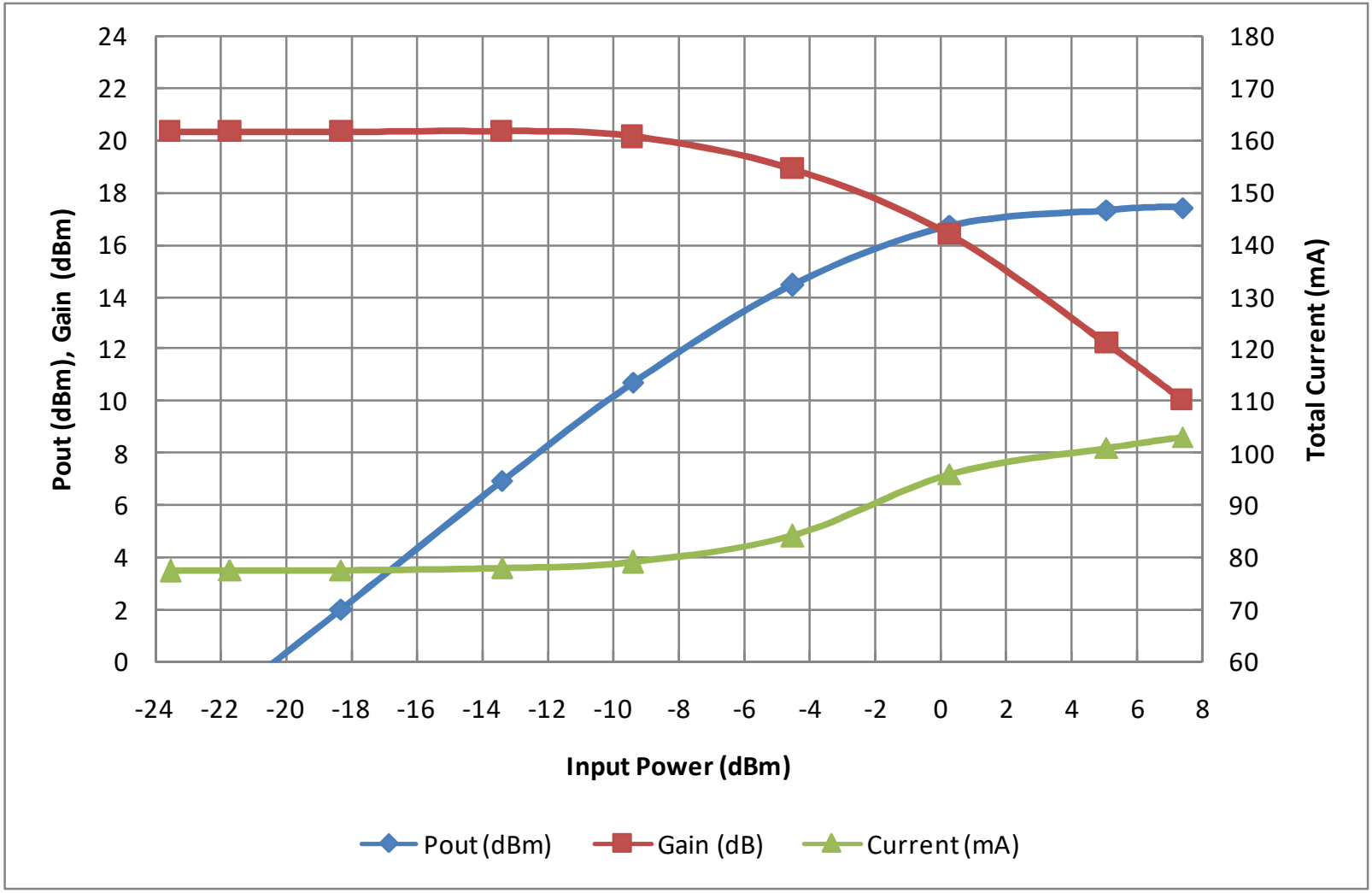
Notes:
-BHWA350 DC Bias: Vcc=5V, Icq~77mA
-BHWM552 DC Bias: Vdd=CTX=3.3V, CRX=0
-Maximal Output Power at Antenna Port is ~19dBm at 3500MHz, including Insertion Loss of the Switch inside BHWM552

BHWA350 & M552 Tx Power Sweep at 4.5GHz



Notes:
-BHWA350 DC Bias: Vcc=5V, Icq~77mA
-BHWM552 DC Bias: Vdd=CTX=3.3V, CRX=0
-Maximal Output Power at Antenna Port is ~18dBm at 4500MHz, including Insertion Loss of the Switch inside BHWM552

BHWA350 & M552 Tx Power Sweep at 5.5GHz

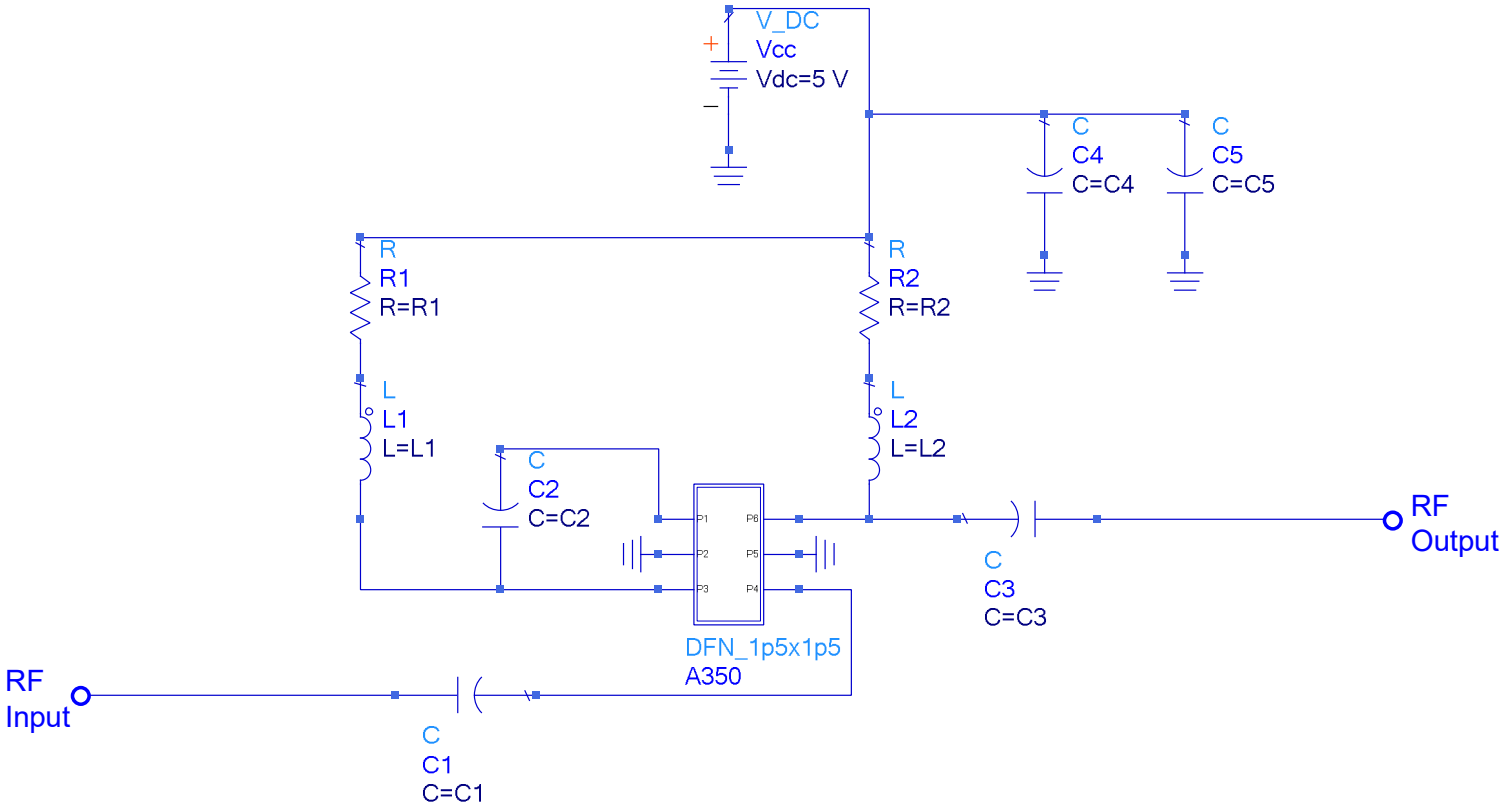


Notes:
-BHWA350 DC Bias: Vcc=5V, Icq~77mA
-BHWM552 DC Bias: Vdd=CTX=3.3V, CRX=0
-Maximal Output Power at Antenna Port is ~17.5dBm at 5500MHz, including Insertion Loss of the Switch inside BHWM552

Appendix 1:

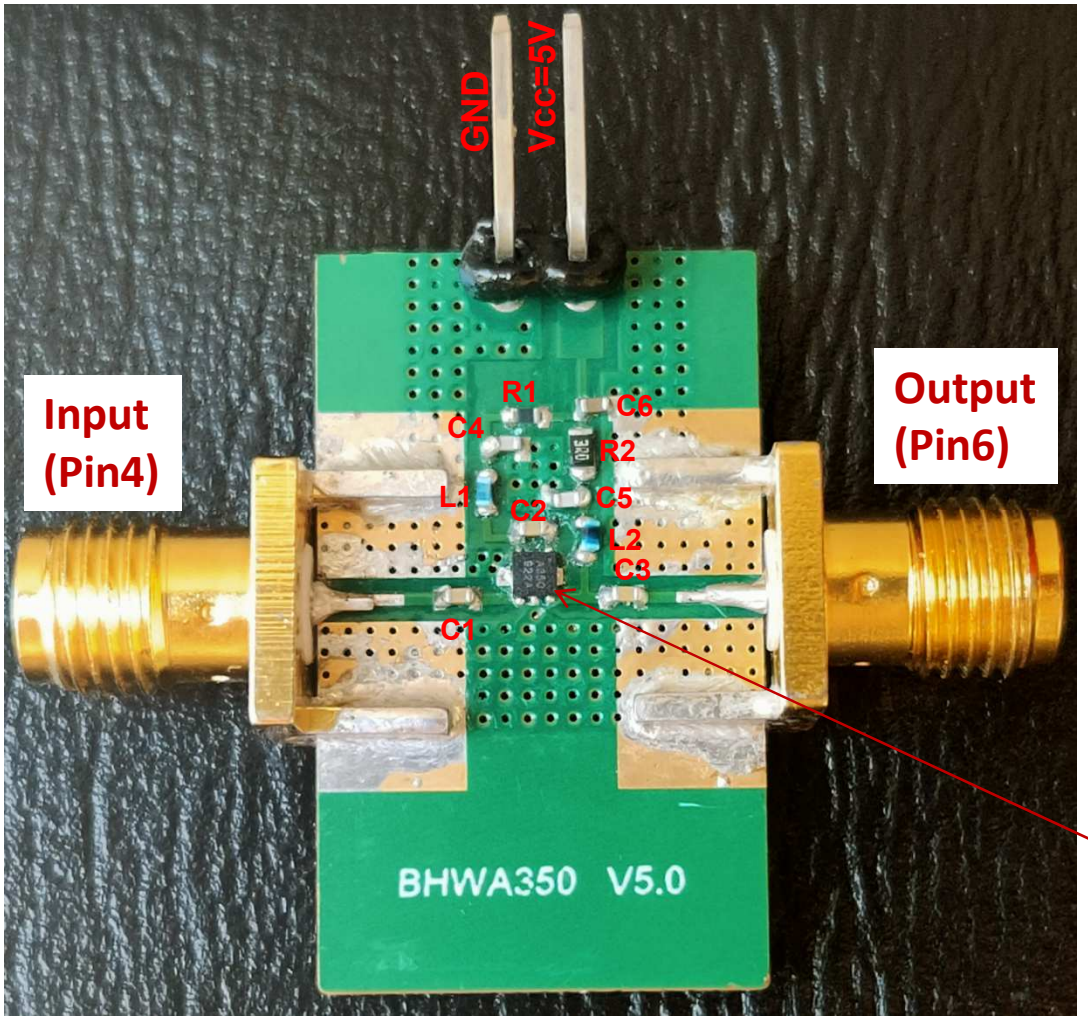
BHWA350 Standalone EVB Test Data
5V Cascade for 1-6GHz

Application Schematic for 5V Cascade Implementation



Recommended BOM for Vcc=5V Single Supply Application:
DC Block: C1=C2=C3=10pF
DC Feed: L1=L2=8.2nH
Vcc Bypass: C4=100pF, C5=1uF
R1=68 Ohm, R2=3 Ohm: R1/R2 can be increased to lower current, if Gain & Pout meet target specs

BHWA350 EVB for 5V Cascade Implementation

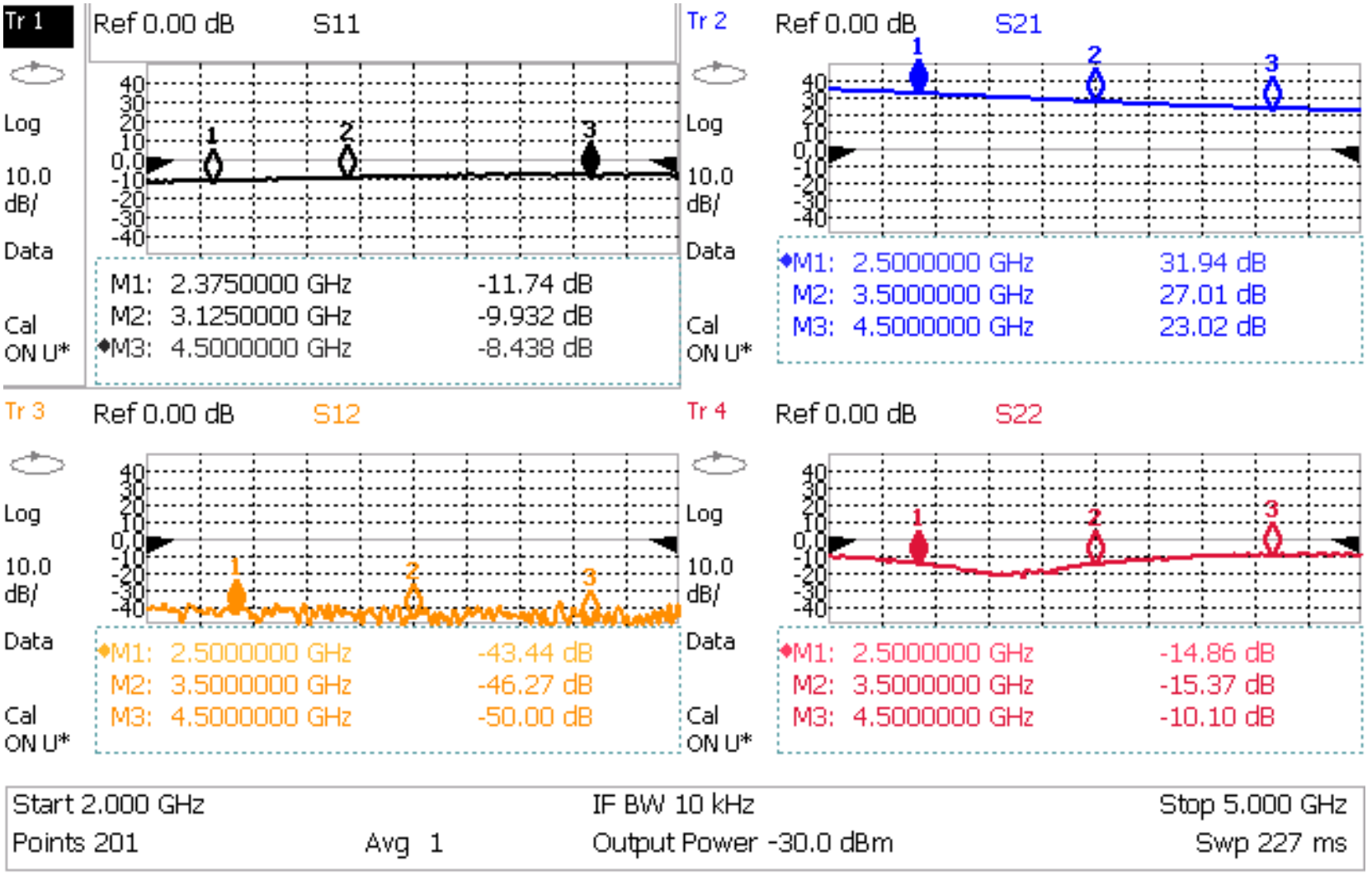


A350
Orientation

DC Block: C1=C2=C3=10pF
DC Feed: L1=L2=8.2nH
Vcc Bypass: C4=C5=100pF, C6=1uF
R1=68 Ohm, R2=3 Ohm: R1/R2 can be increased to lower current, if Gain & Pout meet target specs

BHWA350 5V Cascade EVB: S-Parameters

Typical Small-Signal S-Parameters: 2-5GHz

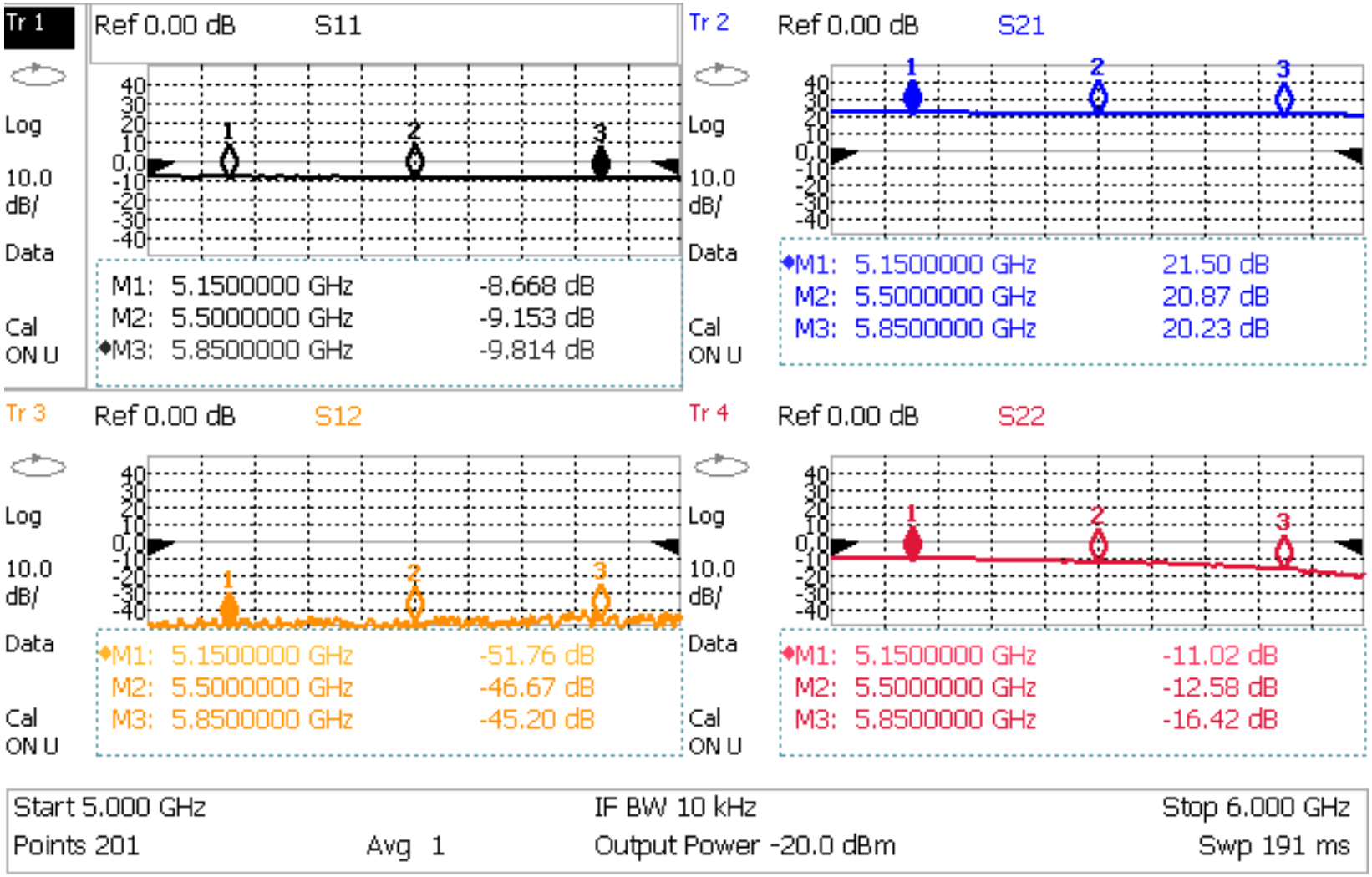


-Bias Setting: Vcc=5V, Icq~77mA

-Measured data includes EVB and SMA connector losses; Actual S21 is 0.2~0.4dB higher

BHWA350 5V Cascade EVB: S-Parameters

Typical Small-Signal S-Parameters: 5-6GHz

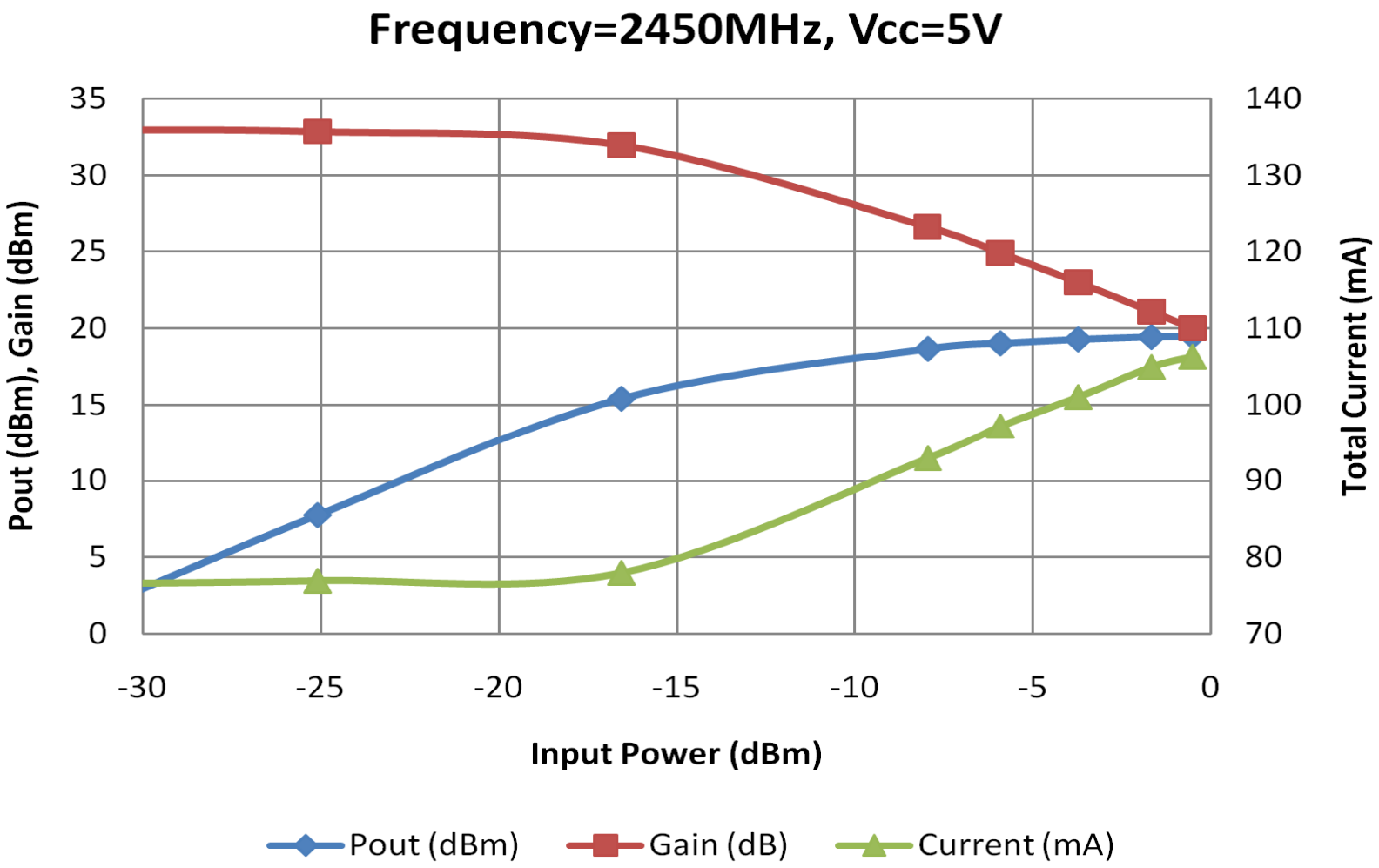


-Bias Setting: Vcc=5V, Icq~77mA

-Measured data includes EVB and SMA connector losses; Actual S21 is 0.4~0.5dB higher

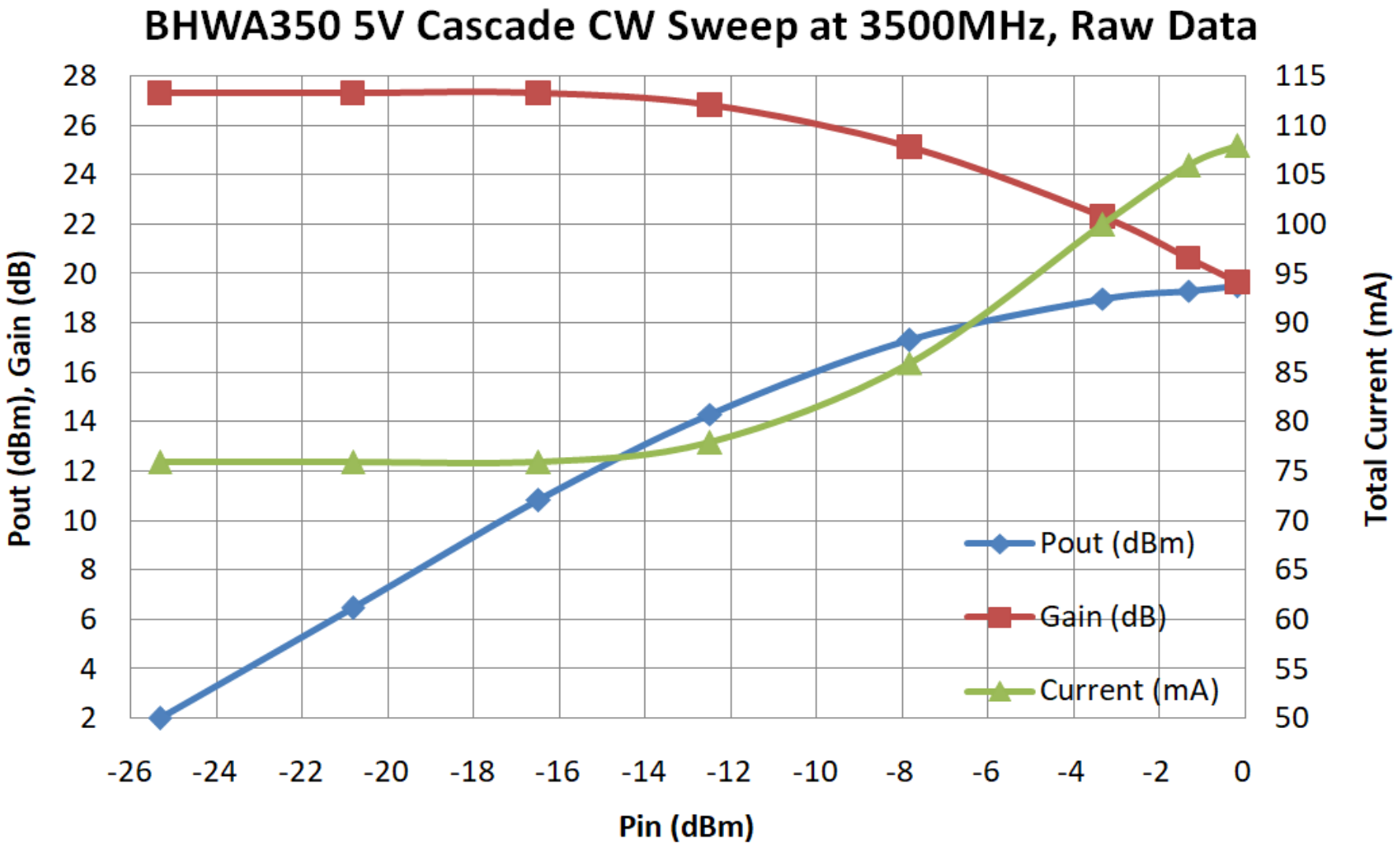
BHWA350 Cascade 5V CW Power Sweep Data

BHWA350 5V Cascade CW Power Sweep at 2.45GHz



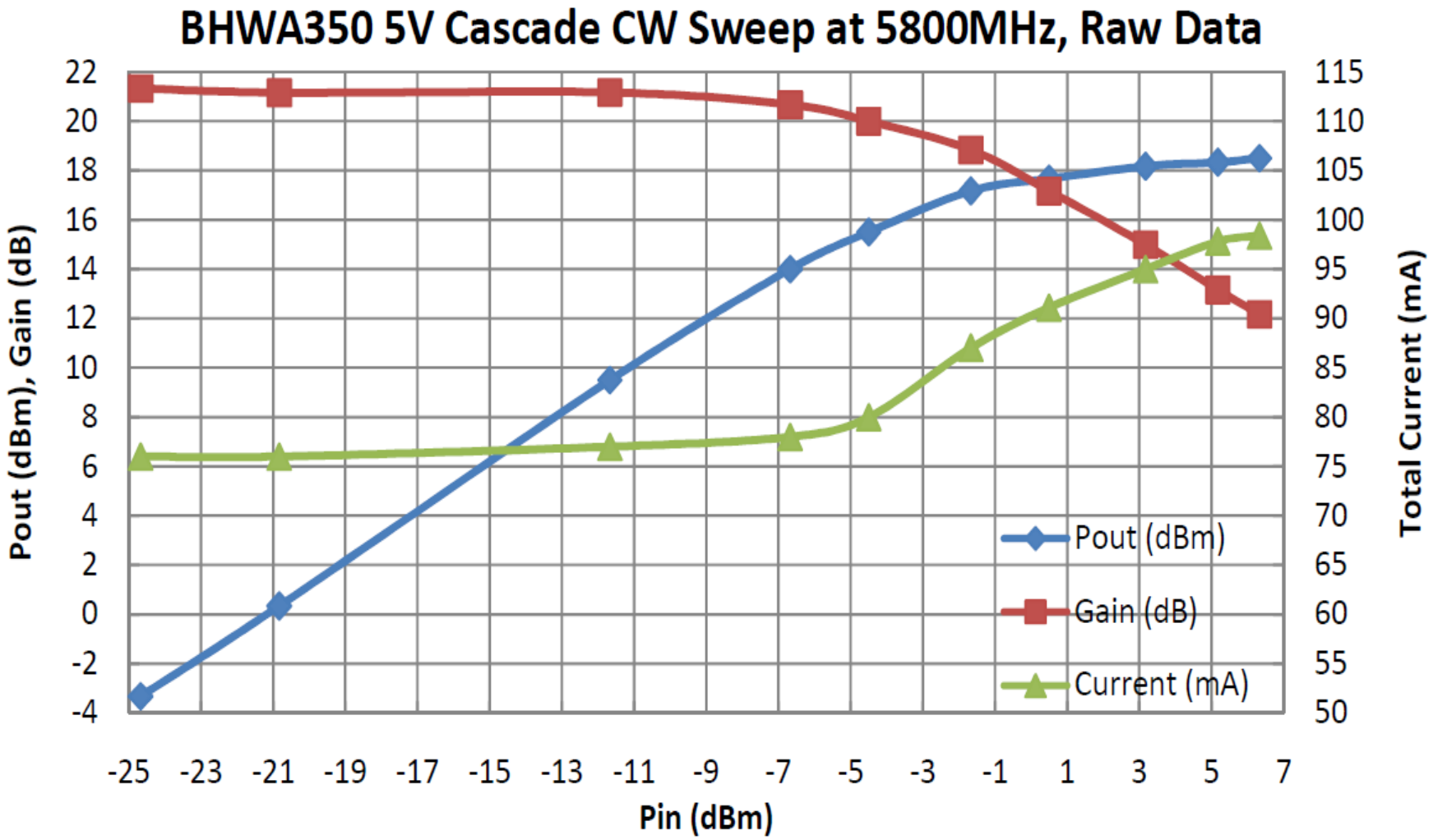
Notes:
-Bias Setting: Vcc=5V, Icq~77mA
-PCB trace and SMA connector losses not de-embedded.

BHWA350 Cascade 5V CW Power Sweep Data



Notes:
-Bias Setting: Vcc=5V, Icq~76mA
-PCB trace and SMA connector losses not de-embedded.

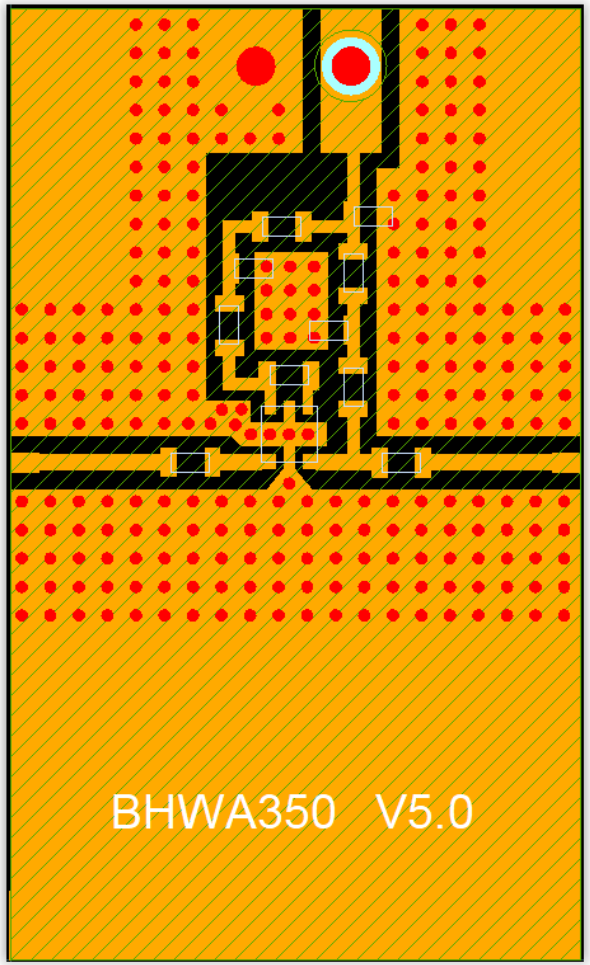
BHWA350 Cascade 5V CW Power Sweep Data



Notes:
-Bias Setting: Vcc=5V, Icq~76mA
-PCB trace and SMA connector losses not de-embedded.

BHWA350 PCB Layout Recommendations

Example of BHWA350 EVB Layout (5V Cascade)



Notes:

-To achieve best RF performance please use 4-layer PCB stack, with 8~10mil RF layer thickness (Top Trace & Layer2 GND)

-To minimize loss please select FR4 substrate with low DF(0.01 or lower), e.g, 生益S1000， 台燿TU-872

-Pay attention to 50 Ohm line impedance control for the PCB materials used for your project

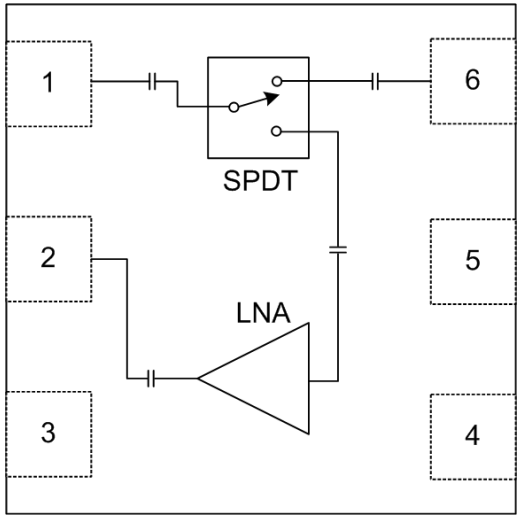
-Use sufficient (3~6) vias underneath & neat the device GND pad, as shown. Via diameter ~ 12mil, Via pitch ~ 20mil

Appendix 2

BHWM552 Standalone EVB Test Data

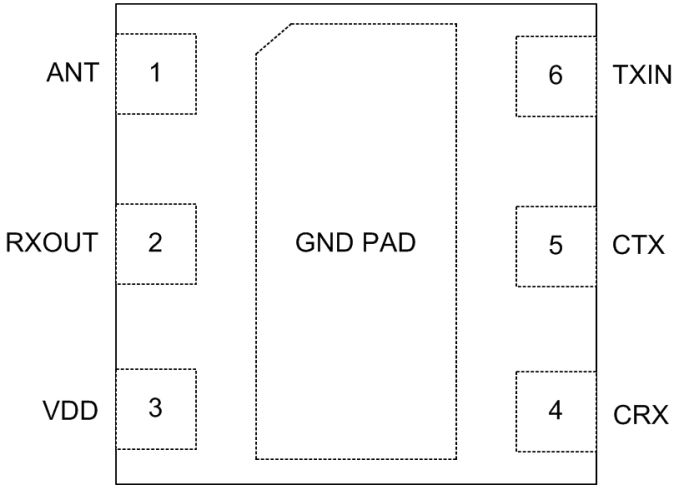
BHWM552 5GHz LNA+SW Rx FE IC

Functional Block Diagram



Package Pin-Out

(Top "See-Through" View)



DFN-6L 1.5x1.5x0.55mm

Product Overview:

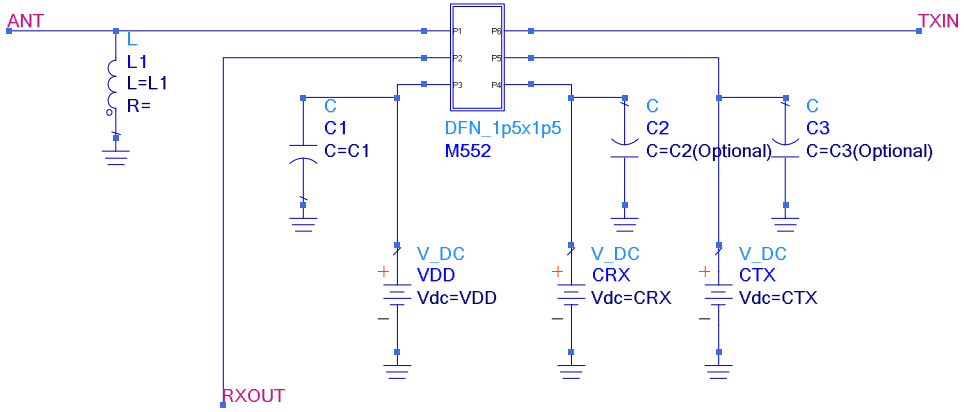
- Advanced GaAs E/D-pHMET Process
- 4-6GHz Operation
- Low Tx Insertion Loss: ~0.8dB
- Low Rx Noise Figure: ~1.6dB
- Low LNA Current: ~14mA
- Rx Gain: ~10dB at 5GHz
- Input P1dB: ~+3dBm at 5.5GHz
- Fully Matched Input & Output Ports (for 5GHz)
- Integrated DC Block Capacitors on all RF Ports
- Minimal External Components
- ESD Protection on All I/O Pins: 500V HBM
- Ultra-Small 1.5x1.5mm DFN Package

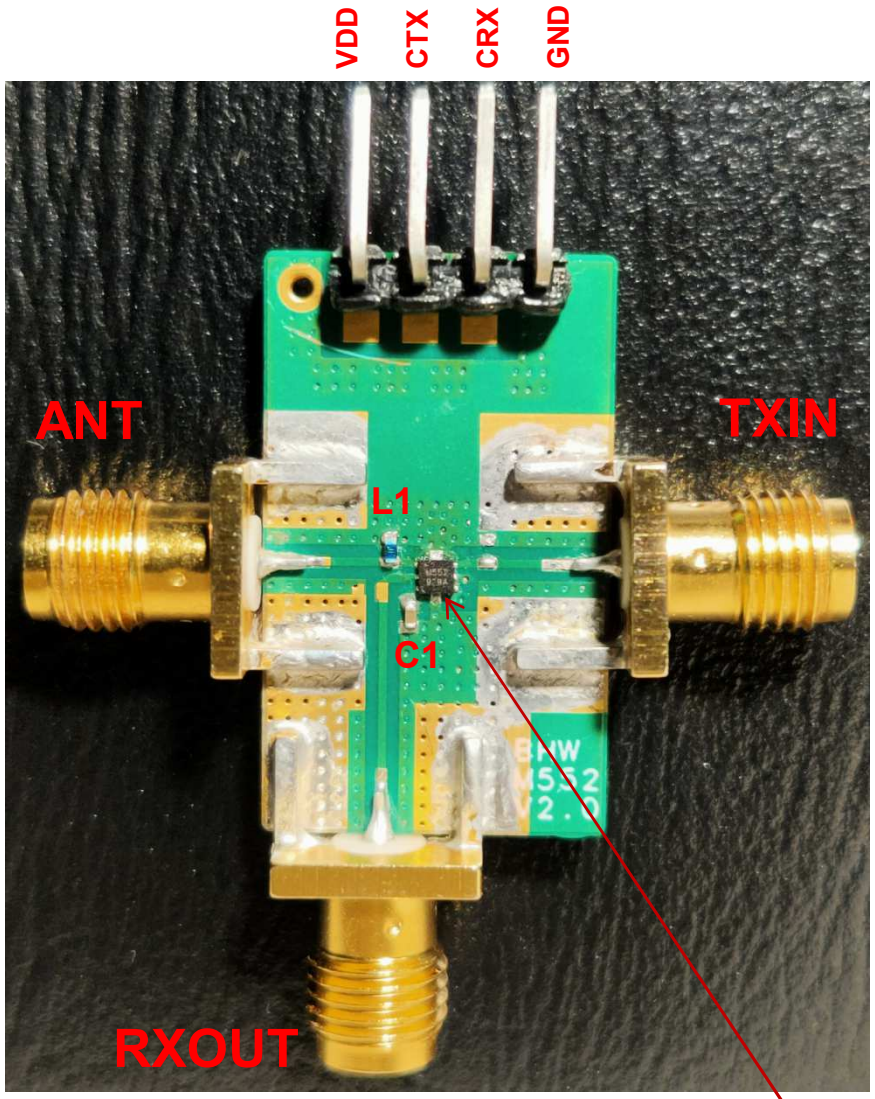
Applications:

- Wi-Fi IEEE 802.11 5.15-5.85GHz Products
- UWB B2/B3/B5/B7 Products
- 5G Band N79 4.4-5GHz Driver
- Remote Control for Drones/UAVs/Toys
- Wireless Audio/Video in 5-6GHz
- Generic Amplifier for 4-6GHz Radios

BHWM552 EVB with Prelim BOM

Application Schematic

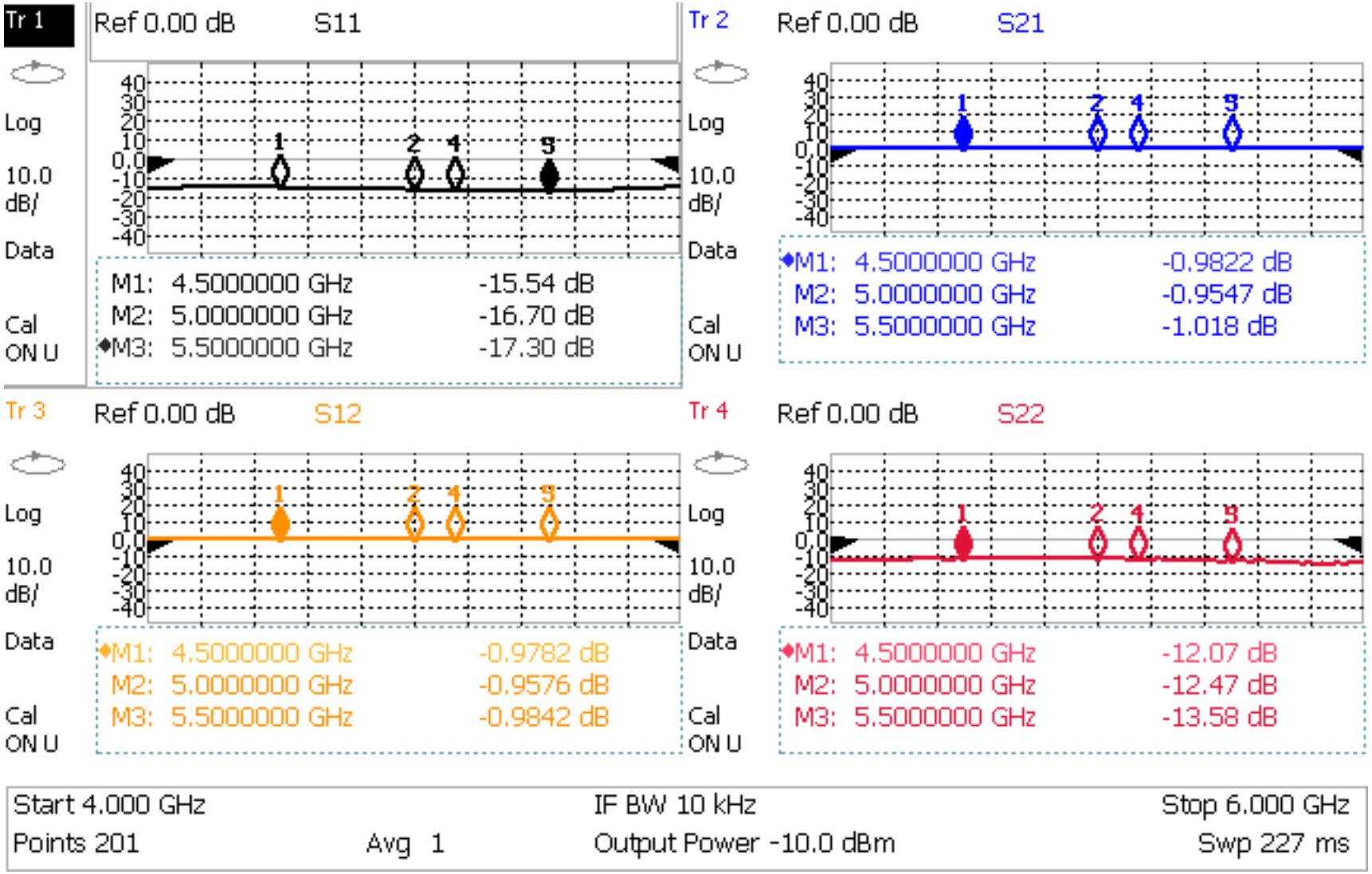




Notes:
-L1=5.6nH (Murata LQW15A Recommended; Optional for slight improvement in Return Loss), C1=1uF
-Place C1 close to Pin3 for best decoupling
-Decoupling cap for CRX/CTX can be omitted for small-size PCB design with short control lines. Otherwise use 1nF each pin.

BHWM552 EVB: Tx Path S-Parameters

RAW Data at VDD=3.3V, CTX=3.3V, CRX=0V

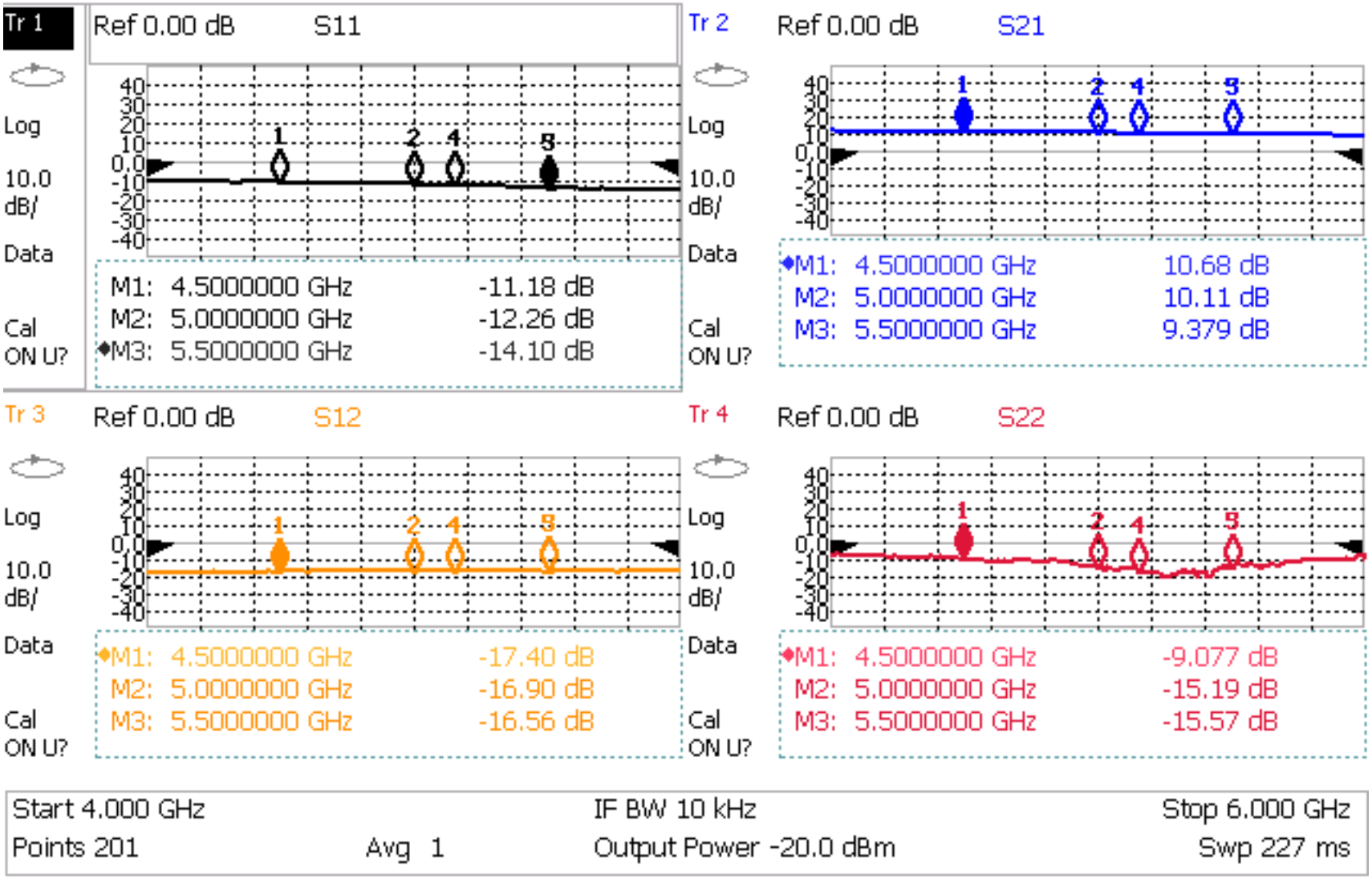


Notes:

-Measured data includes SMA connector and EVB feedline losses. See page 8 for EVB THRU insertion loss at various frequencies.

BHWM552 EVB: Rx Path S-Parameters

Raw Data AT VDD=3.3V, CRX=3.3V, CTX=0V, Idq~14mA



Notes:

-Measured data includes SMA connector and EVB feedline losses. See page 8 for EVB THRU insertion loss at various frequencies.

BHWM552 EVB: Rx NF

Raw Data Including Input SMA Connector and PCB Trace Loss

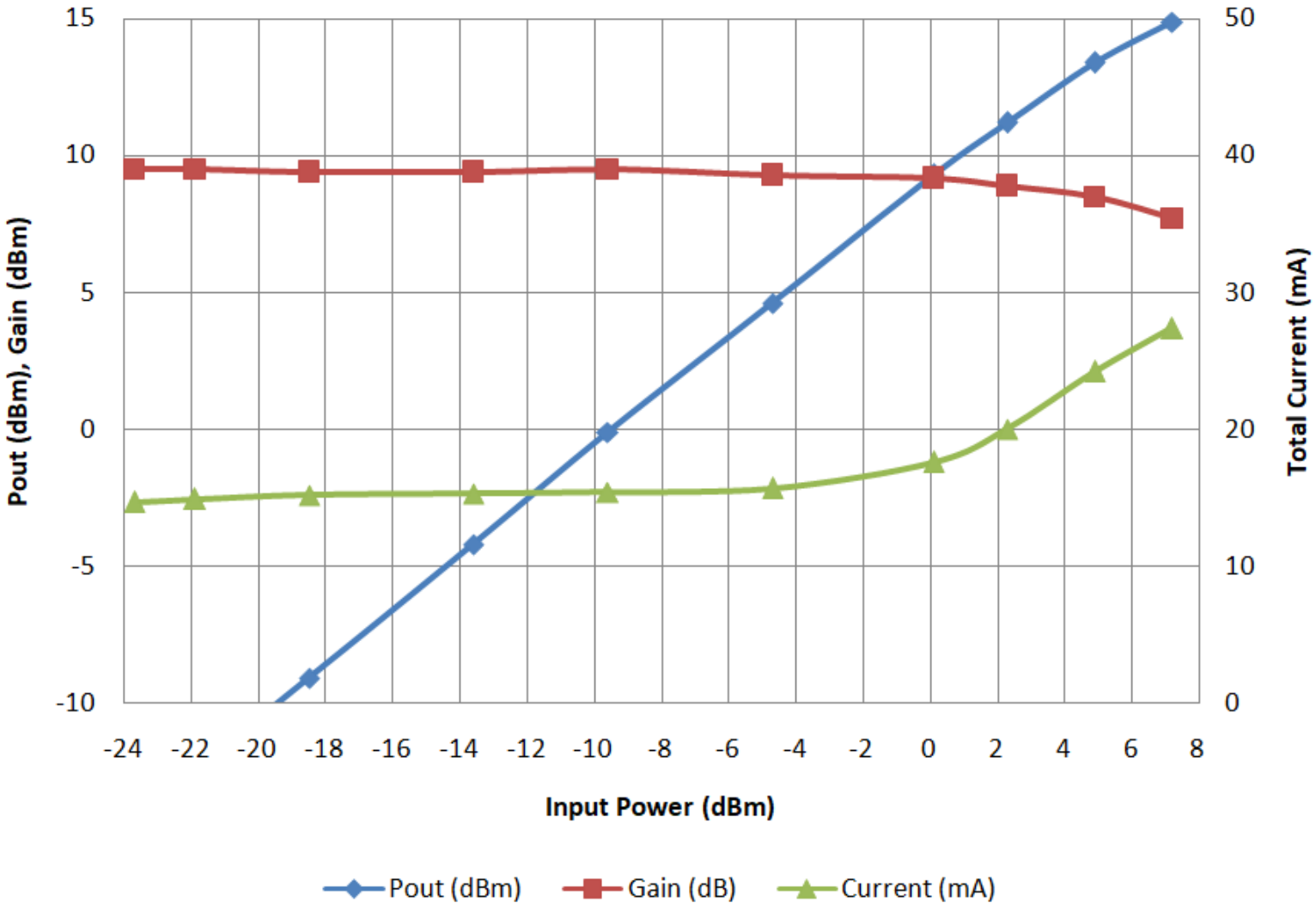
Notes:

-DC Bias: Vdd=CRX=3.3V, CTX=0

-Test data included half of the SMA+PCB loss.

-De-embedded NF~1.6dB. See page 8 for details.

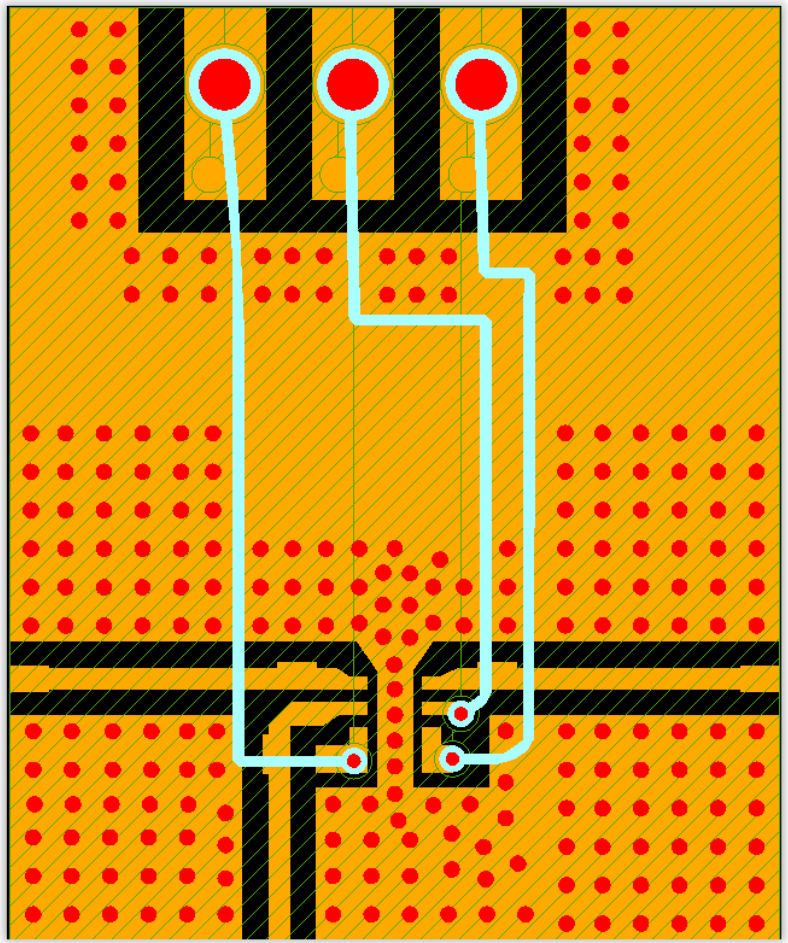
BHWM552 EVB: CW Power Sweep Data



Notes:
-Vdd=CRX=3.3V, Idq~14mA, Frequency=5.5GHz

BHWM552 PCB Layout Recommendations

Example of BHWM552 EVB Layout



Notes:

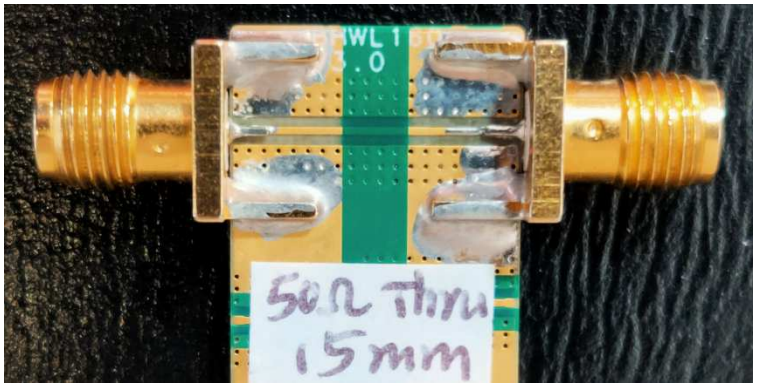
-To achieve best RF performance please use 4-layer PCB stack, with 8~10mil RF layer thickness (Top Trace & Layer2 GND)

-To minimize loss please select FR4 substrate with low DF(0.01 or lower), e.g, 生益S1000， 台燿TU-872

-Pay attention to 50 Ohm line impedance control for the PCB materials used for your project

-Use sufficient (4~6) vias underneath the device GND pad, as shown. Via diameter ~ 12mil, Via pitch ~ 20mil

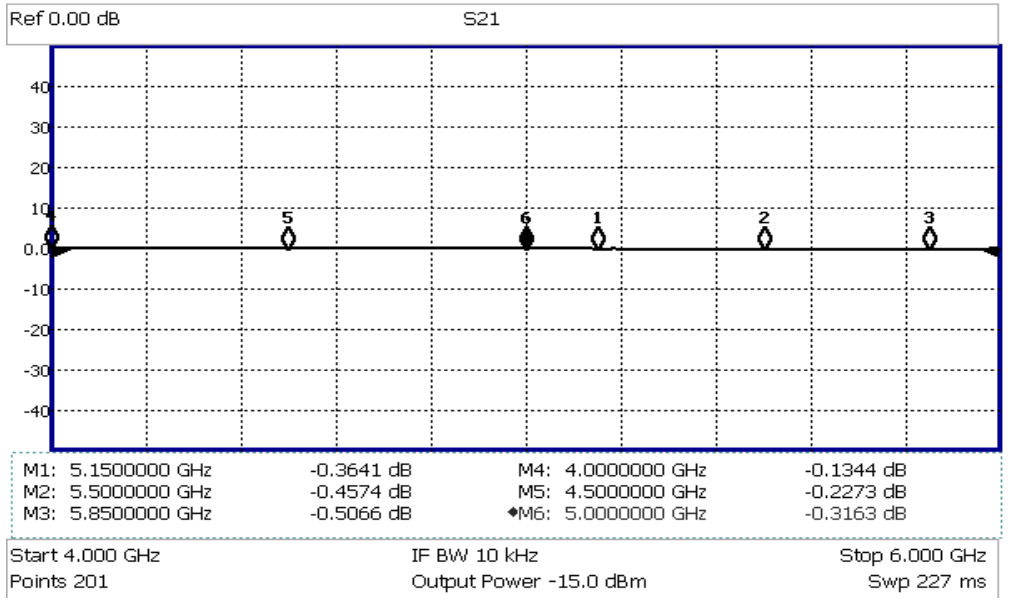
Appendix: Insertion Loss of EVB THRU

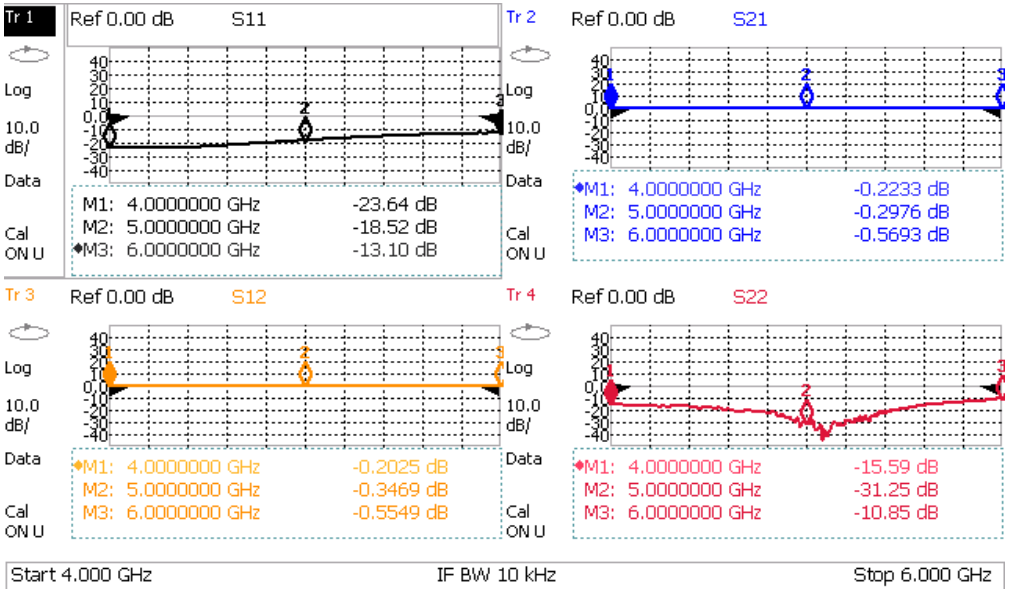


Estimated Offset for De-Embedding
(After Considering Return Loss)

Frequency (GHz)	EVB Insertion Loss (dB)
4	0.15
5	0.25
5.15	0.3
5.5	0.35
5.85	0.4

Notes:
-For S21, offset the above loss
-For NF, offset half the above loss





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 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)

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