

FEATURES

- 2.5% EVM @ $P_{OUT} = +19$ dBm with IEEE 802.11g 64 QAM OFDM at 54 Mbps
- -34 dBr 1st Sidelobe / -56 dBr 2nd Sidelobe ACPR at +21 dBm with IEEE 802.11b at 1, 2, 5.5, 11 Mbps, Gaussian baseband filtering
- SP3T RF Switch to Enable Bluetooth Path
- Single +3.8 V Supply
- Transmit Path Linear Power of Gain 24 dB
- Receive Path In-Band Gain of 13 dB
- Receive Path Noise Figure of 1.9 dB
- 3 x 3 x 0.55 mm ULPCC Package
- Leadfree and RoHS Compliant

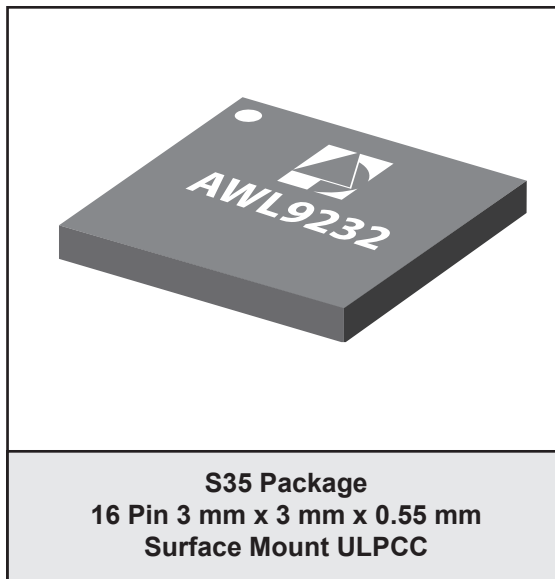
APPLICATIONS

- 802.11b/g WLAN in Consumer Electronics Products (e.g., cell phones, MP3 players, cameras, etc.)
- 2.4 GHz Cordless Phone Handsets/Basestations

PRODUCT DESCRIPTION

The ANADIGICS AWL9232 is a high performance InGaP HBT power amplifier, low-noise amplifier and RF switch integrated on a single IC. It is particularly applicable in consumer electronics products (e.g., cell phones, MP3 players, cameras, etc.) that integrate 802.11b/g WLAN in the 2.4 - 2.5 GHz band. Matched to 50Ω on all RF ports, the part requires only one choke inductor and one power supply decoupling cap off-chip.

The antenna port is switched between WLAN transmit, WLAN receive and Bluetooth paths with a low-loss single-pole triple-throw RF switch. The transmit path PA exhibits unparalleled linearity for both IEEE 802.11g and 802.11b WLAN systems under the toughest signal configurations within these standards. The WLAN receive path from the antenna port to receiver output port provides a low noise, high-gain path to the system receiver chain. The AWL9232 is biased by a single +3.8 V supply and consumes ultra-low current in the OFF mode.



The AWL9232 is manufactured using advanced InGaP HBT technology that offers state-of-the-art reliability, temperature stability and ruggedness. It is provided in a 3 x 3 x 0.55 mm ULPCC package optimized for a 50Ω system.

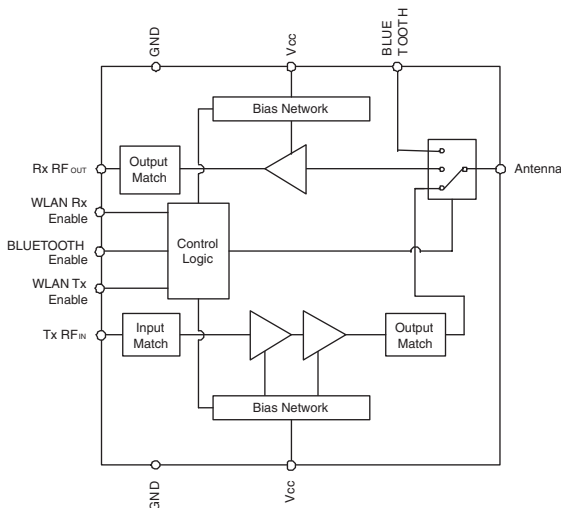

Figure 1: Block Diagram and Pinout

Table 1: Pin Description

| PIN | NAME | DESCRIPTION |
|-----|------------------|--|
| 1 | BLUETOOTH | Bluetooth RF Port |
| 2 | GND | Ground |
| 3 | RX_RF | Receive RF Port |
| 4 | GND | Ground |
| 5 | LNA_EN | LNA Enable. On/Off control for the Rx Path low noise amplifier |
| 6 | BT_EN | Bluetooth Enable. On/Off control for the Bluetooth path |
| 7 | PA_EN | Power Amplifier Enable. On/Off control for the the Tx path power amplifier |
| 8 | GND | Ground |
| 9 | PA_IN | Power Amplifier Input |
| 10 | GND | Ground |
| 11 | V _{CC1} | Power Supply. Bias for the 1st and 2nd stage transistors. |
| 12 | V _{CC2} | Power Supply. Bias for the 3rd stage transistors. |
| 13 | N/C | No connect. |
| 14 | GND | Ground |
| 15 | ANT | Antenna Port. Common connection for the PA, LNA and Bluetooth paths. |
| 16 | GND | Ground |

Table 2: Absolute Minimum and Maximum Ratings

| PARAMETER | MIN | MAX | UNIT | COMMENTS |
|--|-----|-------|----------|--|
| DC Power Supply Voltage (V_{CC}) | - | +5.0 | V | No RF signal applied |
| DC Power Control Voltage (V_{PA_EN}) | - | +5.0 | V | No RF signal applied |
| DC Power Control Voltage (V_{LNA_EN}) | - | +5.0 | V | No RF signal applied |
| DC Power Control Voltage (V_{BT_EN}) | - | +5.0 | V | No RF signal applied |
| DC Current Consumption | - | 350 | mA | |
| Tx RF Input Level (RF_{IN}) | - | 5 | dBm | |
| Ant RF Input Level (RF_{IN}) | - | -3 | dBm | |
| Bluetooth RF Input Level (RF_{IN}) | - | 30 | dBm | |
| Storage Case Temperature | -55 | +150 | °C | |
| Operating Case Temperature | -40 | +85 | °C | |
| ESD Tolerance | 300 | - | V_{DC} | All pins, forward and reverse voltage. Human Body Model (HBM) |
| MSL Rating | - | MSL-2 | | |
| Reflow Temperature | - | 260 | °C | |

Stresses in excess of the absolute ratings may cause permanent damage. Functional operation is not implied under these conditions. Exposure to absolute ratings for extended periods of time may adversely affect reliability.

Table 3: Operating Ranges

| PARAMETER | MIN | TYP | MAX | UNIT | COMMENTS |
|--|----------|--------|-------------------------|----------|----------------------------|
| Operating Frequency (f) | 2400 | - | 2500 | MHz | |
| DC Power Supply Voltage (V _{CC}) | +3.0 | +3.8 | +4.2 | V | |
| Control Voltage (V _{PA_EN}) | 2.0 0 | - - | V _{CC} +0.4 | V | PA "ON" PA "SHUTDOWN" |
| Control Voltage (V _{BT_EN}) | 2.0 0 | - - | V _{CC} +0.4 | V | BT "ON" BT "SHUTDOWN" |
| Control Voltage (V _{LNA_EN}) | 2.0 0 | - - | V _{CC} +0.4 | V | LNA "ON" LNA "SHUTDOWN" |
| Control Current (V _{PA_EN}) | - - | 3 - | 25 1 | μA | PA "ON" PA "SHUTDOWN" |
| Control Current (V _{BT_EN}) | - - | 3 - | 25 1 | μA | BT "ON" BT "SHUTDOWN" |
| Control Current (V _{LNA_EN}) | - - | 1 - | 5 1 | mA μA | LNA "ON" LNA "SHUTDOWN" |
| Case Temperature (T _c) | -40 | - | +85 | °C | |

The device may be operated safely over these conditions; however, parametric performance is guaranteed only over the conditions defined in the electrical specifications.

ELECTRICAL CHARACTERISTICS

Table 4: Electrical Specifications - Tx Path Continuous Wave and DC Electrical Specification
 (T_C = +25 °C, V_{CC} = +3.8 V, V_{PA_EN} = +3.1 V, V_{LNA_EN} = 0 V, V_{BT_EN} = 0 V)

| PARAMETER | MIN | TYP | MAX | UNIT | COMMENTS |
|--|-----|-----|-----|------|--|
| Shutdown Current | - | 20 | 90 | μA | Tx Mode (V _{CC} = +3.8 V, V _{BT_EN} = V _{PA_EN} = V _{LNA_EN} = 0 V) |
| Quiescent Current | 20 | 50 | 80 | mA | V _{CC} = +3.8 V, V _{LNA_EN} = 0 V, V _{BT_EN} = 0 V, V _{PA_EN} = 3.1 V, RF = off |
| 2 nd Harmonic (2fo) | - | -30 | -15 | dBm | P _{OUT} = +21 dBm ⁽¹⁾ |
| 3 rd Harmonic (3fo) | - | -20 | -10 | dBm | P _{OUT} = +21 dBm ⁽¹⁾ |
| Input Return Loss, TX RF In | - | -10 | -4 | dB | |
| Output Return Loss, Antenna Port, Switch in Transit Mode | - | -6 | -4 | dB | Switch in TX position |
| Reverse Isolation (Antenna port to TX Input Port) | 20 | 45 | - | dB | Switch in TX position, signal injected into Antenna Port and measured at TX input Port, PA = "ON" |
| Stability | - | -65 | - | dBc | 6:1 VSWR, P _{OUT} = +21 dBm ⁽¹⁾ , -40 °C |
| T _{ON} Rise Time | - | - | 2 | μs | 10% to 90% of maximum RF power. P _{OUT} = +19 dBm ⁽¹⁾ |

Notes:

(1) Power as measured at antenna port of AWL9232.

Table 5: Electrical Specifications - Tx Path 802.11g(T_C = +25 °C, V_{CC} = +3.8 V, V_{PA_EN} = +3.1 V, V_{LNA_EN} = 0 V, V_{BT_EN} = 0 V, 64 QAM OFDM 54 Mbps)

| PARAMETER | MIN | TYP | MAX | UNIT | COMMENTS |
|---|------|-------|-------|------|---|
| Operating Frequency | 2400 | - | 2500 | MHz | |
| Power Gain | 21 | 25 | 29 | dB | |
| Gain Ripple | - | ± 1.0 | ± 2.5 | dB | Across 100 MHz band |
| Error Vector Magnitude (EVM) ⁽²⁾ | - | 2.5 | 4.0 | % | P _{OUT} = +19 dBm ⁽¹⁾ |
| | - | -32.0 | -28.0 | dB | |
| Current Consumption | 110 | 145 | 180 | mA | P _{OUT} = +19 dBm ⁽¹⁾ |
| TX Spectrum Mask | Pass | - | - | N/A | P _{OUT} = +19 dBm ⁽¹⁾ |

Notes:

(1) Power as measured at antenna port of AWL9232.

(2) EVM does not include system noise floor of 1% (-40 dB).

Table 6: Electrical Specifications - Tx Path 802.11b(T_C = +25 °C, V_{CC} = +3.8 V, V_{PA_EN} = +3.1 V, V_{LNA_EN} = 0 V, V_{BT_EN} = 0 V, 1 Mbps CCK/DSSS, Gaussian Baseband Filtering, bT = 0.50)

| PARAMETER | MIN | TYP | MAX | UNIT | COMMENTS |
|--|------|-------|-------|------|---|
| Operating Frequency | 2400 | - | 2500 | MHz | |
| Power Gain | 21 | 25 | 29 | dB | |
| Gain Ripple | - | ± 1.0 | ± 2.5 | dB | Across any 100 MHz band |
| Adjacent Channel Power (ACPR) 1 st Sidelobe (11-22 MHz Offset) | - | -34 | -30 | dBr | P _{OUT} = +21 dBm ⁽¹⁾ |
| Adjacent Channel Power (ACPR) 2 nd Sidelobe (>22 MHz Offset) | - | -56 | -50 | dBr | P _{OUT} = +21 dBm ⁽¹⁾ |
| Tx Spectrum Mask | Pass | - | - | N/A | P _{OUT} = +21 dBm ⁽¹⁾ |
| Current Consumption | 130 | 175 | 220 | mA | P _{OUT} = +21 dBm ⁽¹⁾ |

Notes:

(1) Power as measured at antenna port of AWL9232.

Table 7: Electrical Specifications - Rx Path Continuous Wave
 (T_C = +25 °C, V_{CC} = +3.8 V, V_{PA_EN} = 0 V, V_{LNA_EN} = +3.1 V, V_{BT_EN} = 0 V)

| PARAMETER | MIN | TYP | MAX | UNIT | COMMENTS |
|---|-----|------|------|------|---|
| Gain | 10 | 13 | 16 | dB | |
| Gain Ripple | - | ±0.5 | ±2.0 | dB | Across any 100 MHz band |
| IP1dB | -12 | -7 | - | dBm | |
| Current at IP1dB | 9 | 14 | 19 | mA | |
| Quiescent Current | 9 | 14 | 19 | mA | |
| Noise Figure | - | 1.9 | 4.0 | dB | Includes RF switch and LNA |
| Return Loss, RX RF Port | - | -15 | -6 | dB | Switch in Rx position, Antenna port terminated in 50 Ω Load |
| Return Loss, Antenna Port, Switch in Receive Mode | - | -5 | -3 | dB | Switch in RX position, with 50Ω Rx path load |
| Isolation (Antenna port to RX port) | 20 | 50 | - | dB | Switch in TX position, signal injected into Antenna Port and measured at Rx Port, PA = "ON" |
| Stability | - | -65 | - | dBc | 6:1 VSWR, P _{IN} = -7 dBm ⁽¹⁾ , -40°C |

Note:

(1) Power as measured at antenna port of AWL9232.

Table 8: Electrical Specifications - BT Path Continuous Wave
 (T_C = +25 °C, V_{CC} = +3.8 V, V_{PA_EN} = 0 V, V_{LNA_EN} = 0 V, V_{BT_EN} = +3.1 V)

| PARAMETER | MIN | TYP | MAX | UNIT | COMMENTS |
|---|-----|-----|-----|------|---|
| Insertion Loss | - | 0.7 | 2.0 | dB | 2.4 GHz to 2.5 GHz |
| Quiescent Current | - | 20 | 100 | μA | |
| OP1dB | 21 | 27 | - | dBm | Measured at Ant port |
| Return Loss, Bluetooth RF Port | - | -12 | -6 | dB | Switch in Bluetooth position, Antenna port terminated in 50 Ω load |
| Return Loss, Antenna Port, Switch in Bluetooth Mode | - | -11 | -6 | dB | Switch in Bluetooth position, Bluetooth port terminated in 50 Ω load |
| Isolation (Antenna port to RX port) | 15 | 33 | - | dB | Switch in Bluetooth position, signal injected into Antenna Port and measured at Rx Port |

Table 9: Control Logic Truth Table

| FEIC Mode | V _{CC} | PA Enable | Bluetooth Enable | LNA Enable | PA Status | LNA Status | Switch Status |
|-----------|-----------------|-----------|------------------|------------|-----------|------------|---------------|
| Shutdown | On | 0 | 0 | 0 | Off | Off | Not connected |
| WLAN Rx | On | 0 | 0 | 1 | Off | On | WLAN Rx |
| Bluetooth | On | 0 | 1 | 0 | Off | Off | Bluetooth |
| WLAN Tx | On | 1 | 0 | 0 | On | Off | WLAN Tx |

Table 10: Control Voltages and Timing

| Parameter | Min | Typ | Max | Unit | Comments |
|--------------------------------------|----------|--------|-------------------------|------|--------------------------------|
| LNA Enable Pin Control Voltage | 2.0 - | - - | V _{CC} +0.4 | V | LNA = 1 LNA = 0 |
| Bluetooth Enable Pin Control Voltage | 2.0 - | - - | V _{CC} +0.4 | V | Bluetooth = 1 Bluetooth = 0 |
| PA Enable Pin Control Voltage | 2.0 - | - - | V _{CC} +0.4 | V | PA = 1 PA = 0 |

PERFORMANCE DATA - TRANSMIT PATH

Figure 2: Tx Path Gain and Icc vs. Output Power Across Freq (V_{CC} = +3.8 V, T_A = +25°C) 802.11g 54 Mbps OFDM

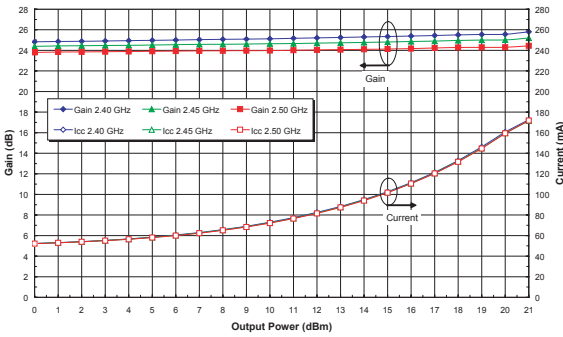


Figure 3: Tx Path Gain and Icc vs. Output Power Across Temp (Freq = 2.45 GHz, V_{CC} = +3.8 V) 802.11g 54 Mbps OFDM

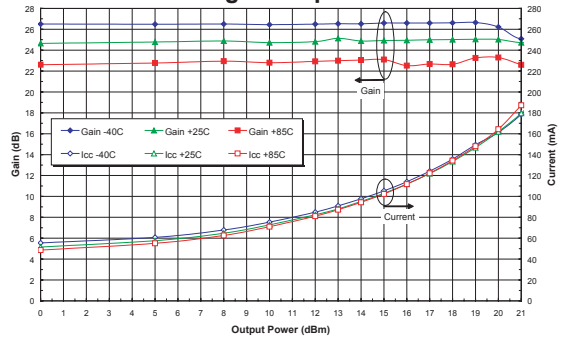


Figure 4: Tx Path Gain and Icc vs. Output Power Across Supply Voltage (Freq = 2.45 GHz, T_A = +25°C) 802.11g 54 Mbps OFDM

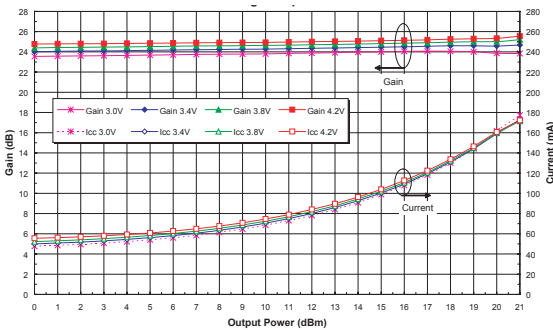


Figure 5: Tx Path EVM vs. Output Power Across Frequency (V_{CC} = +3.8 V, T_A = +25°C) 802.11g 54 Mbps OFDM

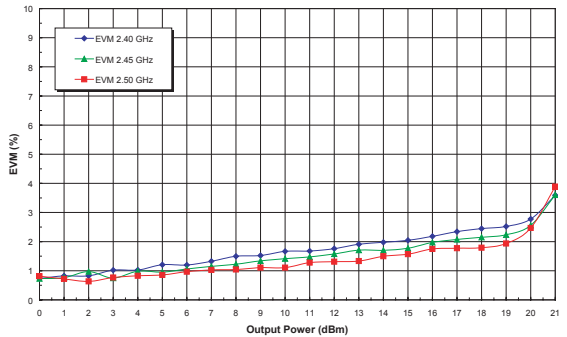


Figure 6: Tx Path EVM vs. Output Power Across Temp (Freq = 2.45 GHz, V_{CC} = +3.8 V) 802.11g 54 Mbps OFDM

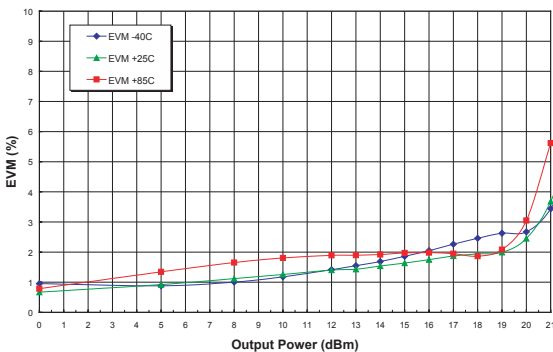


Figure 7: Tx Path EVM vs. Output Power Across Power Supply Voltage (Freq = 2.45 GHz, T_A = +25°C) 802.11g 54 Mbps OFDM

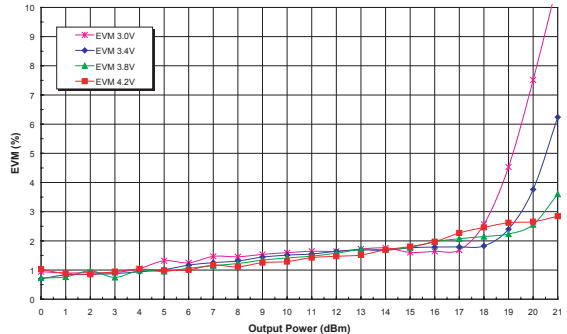


Figure 8: Tx Path Gain and Icc vs. Output Power Across Freq ($V_{CC} = +3.8\text{ V}$, $T_A = +25^\circ\text{C}$) 802.11b Gaussian Filtering ($bT = 0.5$), 1 Mbps

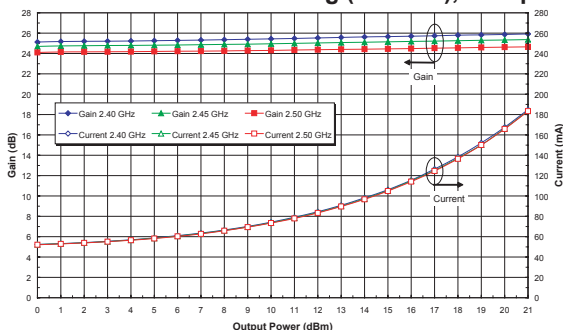


Figure 9: Tx Path Gain and Icc vs. Output Power Across Temp (Freq = 2.45 GHz, $V_{CC} = +3.8\text{ V}$) 802.11b Gaussian Filtering ($bT = 0.5$), 1 Mbps

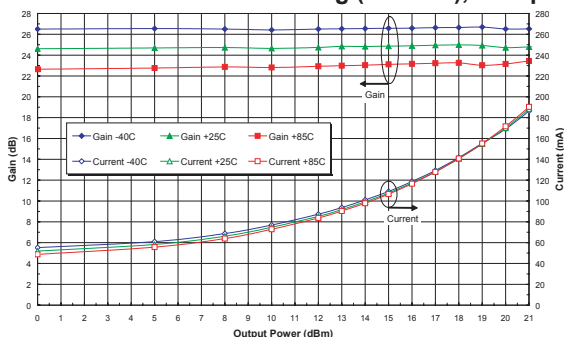


Figure 10: Tx Path Gain and Icc vs. Output Power Across Supply Voltage (Freq = 2.45 GHz, $T_A = +25^\circ\text{C}$) 802.11b Gaussian Filtering ($bT = 0.5$), 1 Mbps

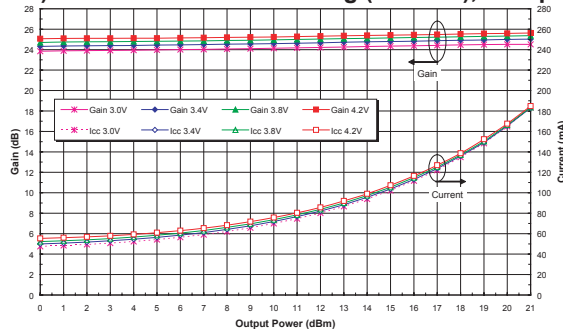


Figure 11: Tx Path ACPR Sidelobes 1&2 vs. Output Power Across Freq ($V_{CC} = +3.8\text{ V}$, $T_A = +25^\circ\text{C}$) 802.11b Gaussian Filtering ($bT = 0.5$), 1 Mbps

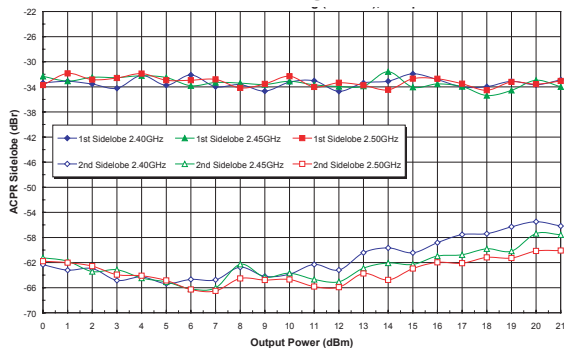


Figure 12: Tx Path ACPR Sidelobes 1&2 vs. Output Power Across Temp (Freq = 2.45 GHz, $V_{CC} = +3.8\text{ V}$) 802.11b Root Cosine Filtering ($bT = 0.5$), 1 Mbps

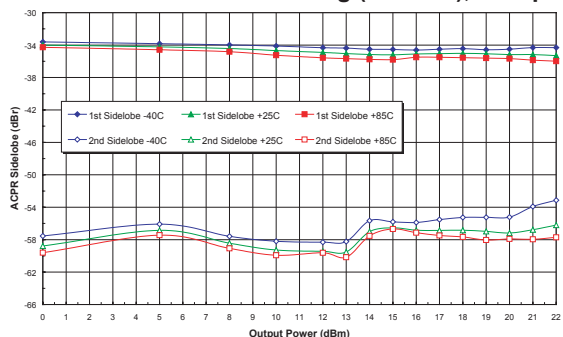
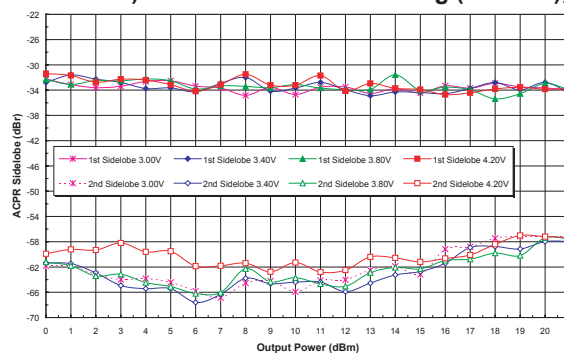
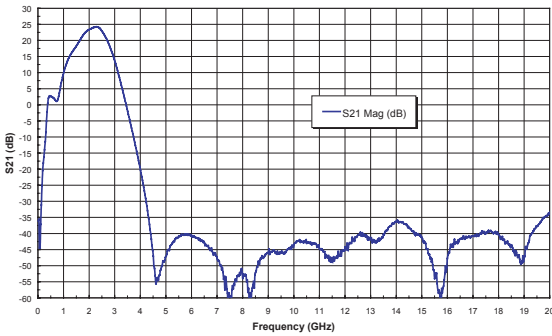


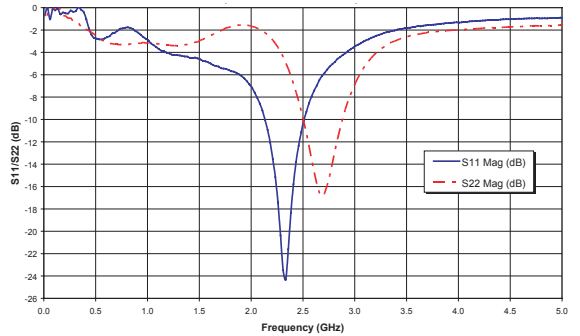
Figure 13: Tx Path ACPR Sidelobes 1&2 vs. Output Power Across Power Supply Voltage (Freq = 2.45 GHz, $T_A = +25^\circ\text{C}$) 802.11b Gaussian Filtering ($bT = 0.5$), 1 Mbps



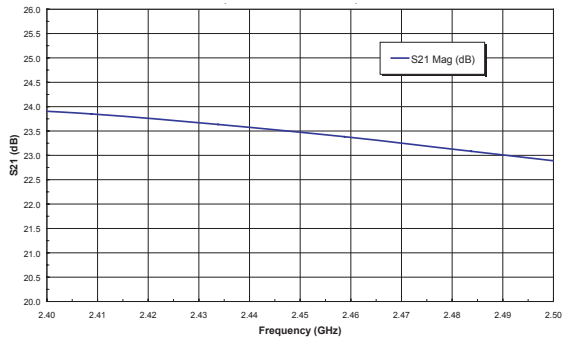
**Figure 14: 2.4 GHz Tx Path S-Parameters
S21 Response
(V_{CC} = +3.8 V, T_C = +25°C)**



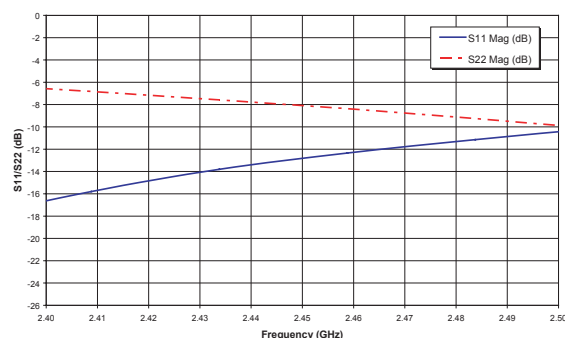
**Figure 15: 2.4 GHz Tx Path S-Parameters
S11 & S22 Response
(V_{CC} = +3.8 V, T_A = +25°C)**



**Figure 16: 2.4 GHz Tx Path S-Parameters
S21 Response (Narrow band)
(V_{CC} = +3.8 V, T_A = +25°C)**

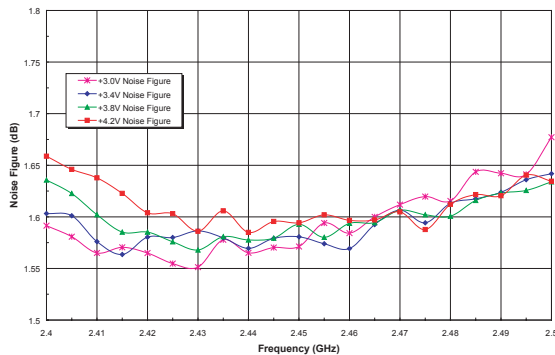


**Figure 17: 2.4 GHz Tx Path S-Parameters
S11 & S22 Response (Narrow band)
(V_{CC} = +3.8 V, T_A = +25°C)**

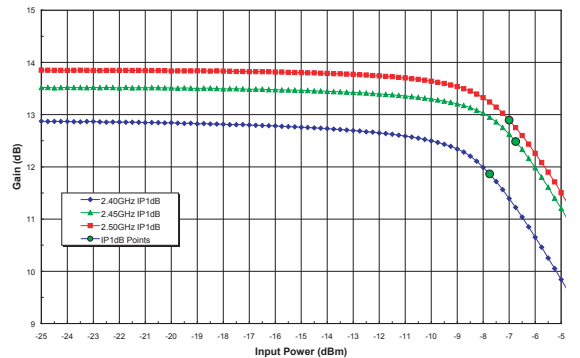


PERFORMANCE DATA - RECEIVE PATH

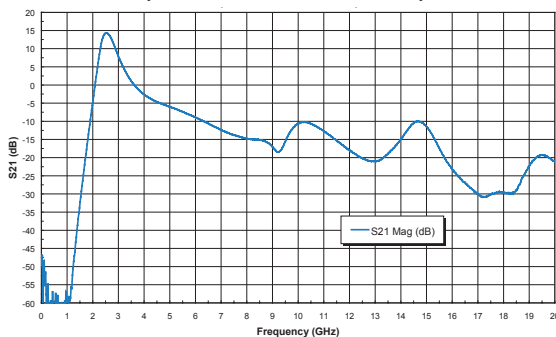
**Figure 18: Receive Path Noise Figure Across
Supply Voltage (V_{LNA_EN} = +3.1 V, T_A = +25°C)**



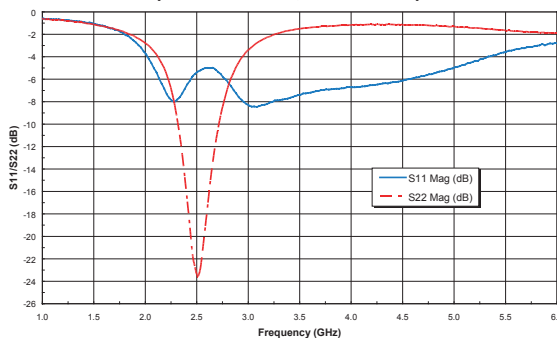
**Figure 19: Receive Path Input P1dB Across Freq
(V_{CC} = +3.8, V_{LNA_EN} = +3.1 V, T = +25°C)**



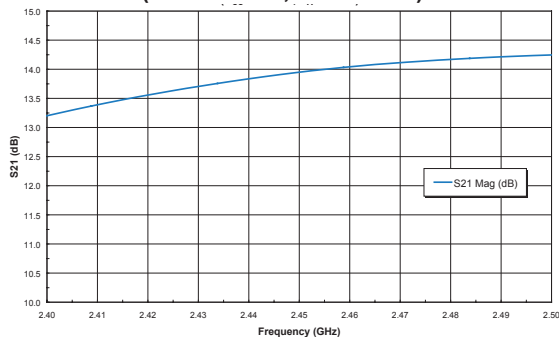
**Figure 20: Rx Path S-Parameters
S21 Response
(V_{CC} = +3.8 V, T_A = +25°C)**



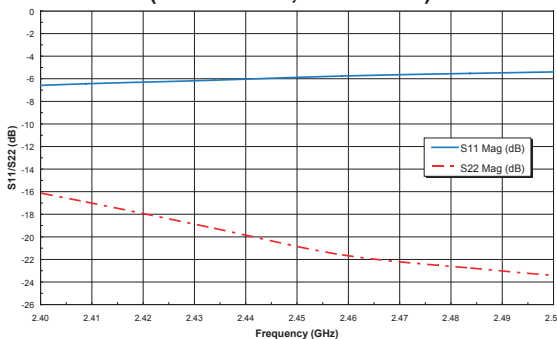
**Figure 21: Rx Path S-Parameters
S11 & S22 Response
(V_{CC} = +3.8 V, T_c = 25°C)**



**Figure 22: Rx Path S-Parameters
S21 Response (Narrow band)
(V_{CC} = +3.8 V, T_A = +25°C)**

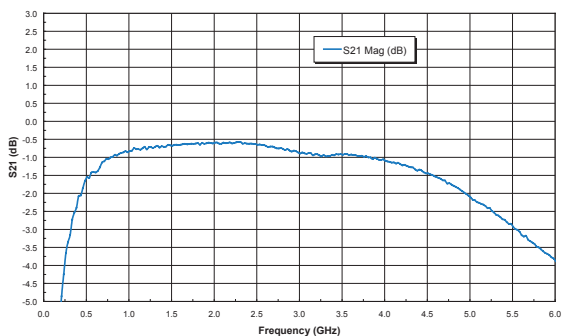


**Figure 23: Rx Path S-Parameters
S11 & S22 Response (Narrow band)
(V_{CC} = +3.8 V, T_A = +25°C)**

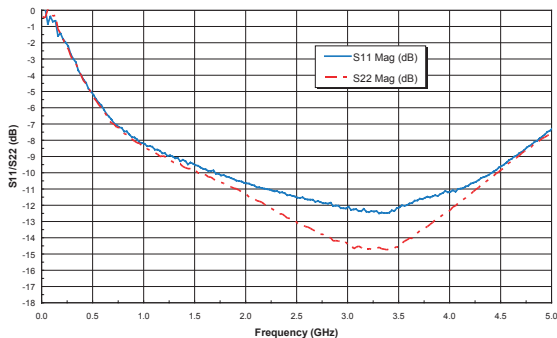


PERFORMANCE DATA - BLUETOOTH PATH

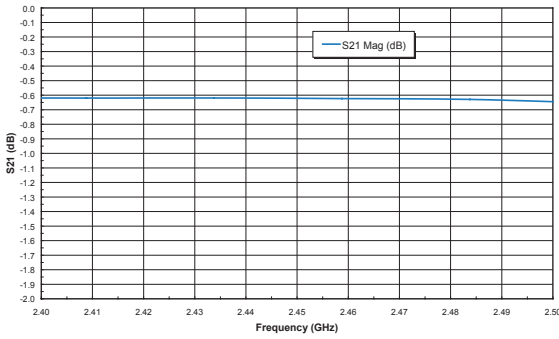
**Figure 24: Bluetooth S-Parameters
S21 Response
(V_{CC} = +3.8 V, T_A = +25°C)**



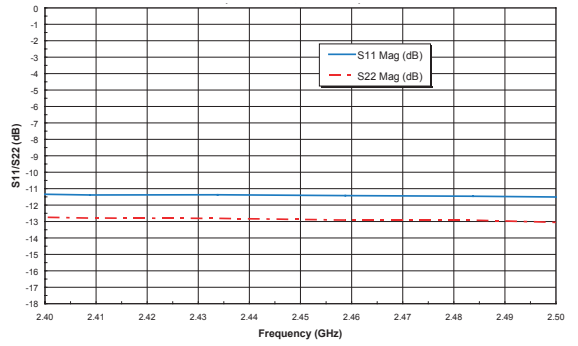
**Figure 25: Bluetooth S-Parameters
S11 & S22 Response
(V_{CC} = +3.8 V, T_A = +25°C)**



**Figure 26: Bluetooth S-Parameters
S21 Response (Narrow band)
(V_{CC} = +3.8 V, T_A = +25°C)**



**Figure 27: Bluetooth S-Parameters
S11 & S22 Response (Narrow band)
(V_{CC} = +3.8 V, T_A = +25°C)**



APPLICATION INFORMATION

Following is an application schematic for the AWL9232. A 10uF decoupling capacitor should be connected to the system voltage supply line for low frequency bypassing.

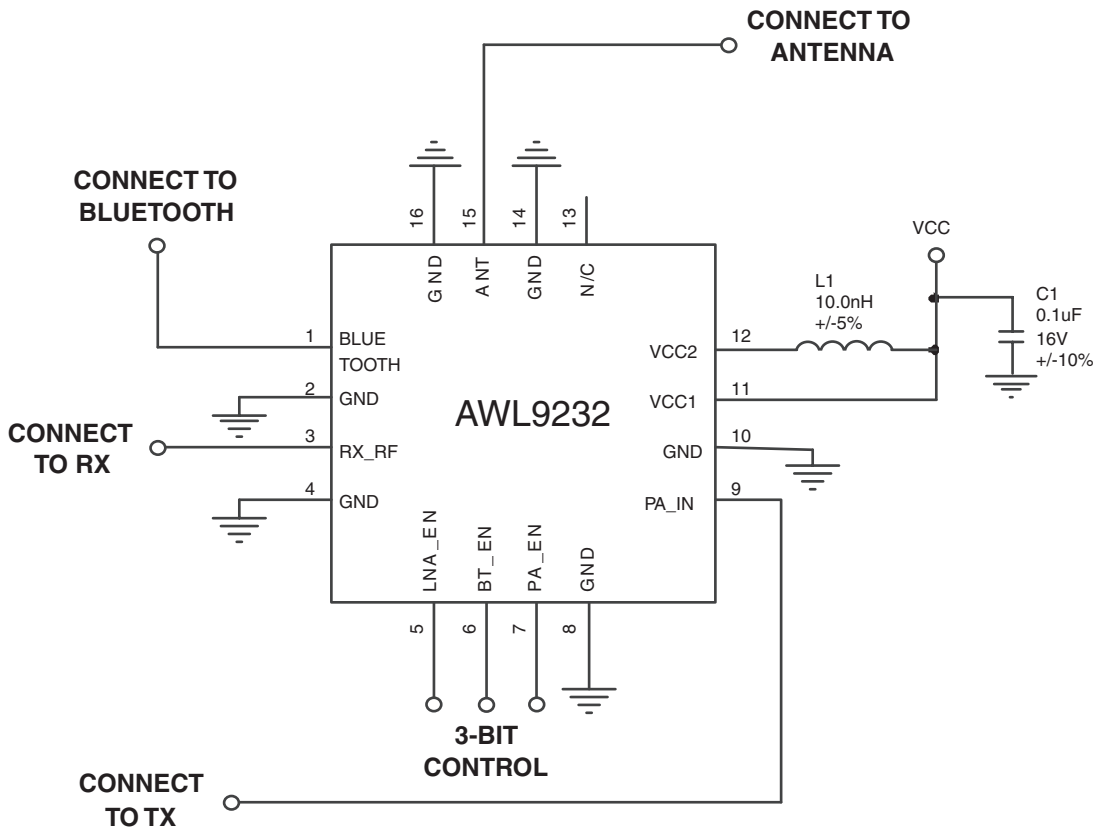
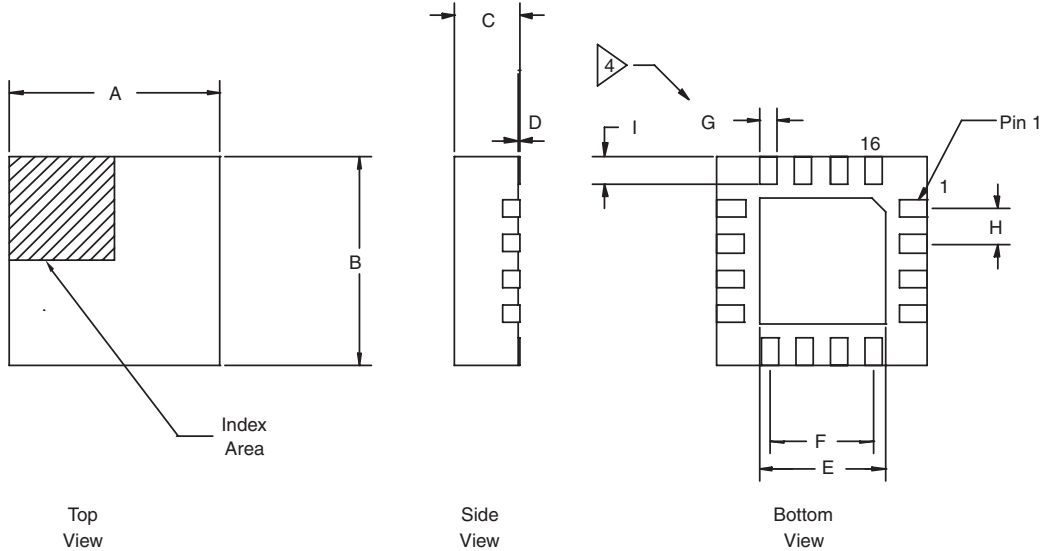


Figure 26: Application Circuit

PACKAGE OUTLINE

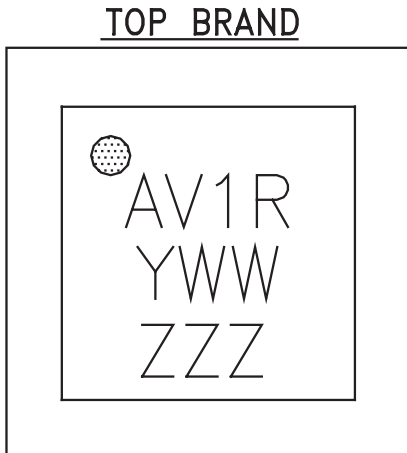
The AWL9232 is offered in a 3 mm x 3 mm x 0.55 mm surface mount ULPC package:



| DIMENSION | MILLIMETERS | | |
|-----------|-------------|------|------|
| | MIN | TYP | MAX |
| A | 2.90 | 3.00 | 3.10 |
| B | 2.90 | 3.00 | 3.10 |
| C | 0.50 | 0.55 | 0.60 |
| D | 0.00 | 0.02 | 0.05 |
| E | 1.55 | 1.70 | 1.85 |
| F | 1.50 BSC. | | |
| G | 0.18 | 0.25 | 0.30 |
| H | 0.50 BSC. | | |
| I | 0.20 | 0.30 | 0.40 |

1. All dimensions are in millimeters, angles in degrees.
2. The terminal #1 identifier and pad numbering convention shall conform to JESD 95-1 SPP-012
3. Lead coplanarity: 0.05 max.
4. Dimension applies to metalized pad and is measured between 0.25 and 0.30 MM from pad tip.

Figure 27: S35 Package Outline - 16 Pin 3 mm x 3 mm x 0.55 mm Surface Mount Module



NOTES:

1. ANADIGICS LOGO SIZE: N/A
2. PART NUMBER: AV = 2 DIGIT PART NUMBER
1 = CURRENT ISSUE NUMBER OF BOM.
R = ROHS COMPLIANCE.
3. YEAR AND WORK WEEK: YWW = LAST DIGIT OF YEAR, TWO DIGIT WORK WEEK.
4. LOT NUMBER: ZZZ = LAST THREE NUMBERS OF WAFER LOT NUMBER
5. PIN 1 INDICATOR: MOLD NOTCH -or- INK DOT
6. COUNTRY CODE: N/A
7. TYPE : ELITE
SIZE : 1.5-POINT
COLOR : LASER

Figure 28: Branding Specification

ORDERING INFORMATION

| ORDER NUMBER | TEMPERATURE RANGE | PACKAGE DESCRIPTION | COMPONENT PACKAGING |
|---------------|-------------------|--|---|
| AWL9232RS35P8 | -40 °C to +85°C | 16 Pin 3 mm x 3 mm x 0.55 mm Surface Mount ULPCC | 2,500 piece Tape and Reel 13 inch Reel |
| AWL9232RS35Q7 | -40 °C to +85°C | 16 Pin 3 mm x 3 mm x 0.55 mm Surface Mount ULPCC | 2,500 piece Tape and Reel 7 inch Reel |
| AWL9232RS35Q1 | -40 °C to +85°C | 16 Pin 3 mm x 3 mm x 0.55 mm Surface Mount ULPCC | 1000 piece Tape and Reel |
| EVA9232RS35 | -40 °C to +85°C | 16 Pin 3 mm x 3 mm x 0.55 mm Surface Mount ULPCC | 1 piece Evaluation Board |

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