# WL1835MODCOM8A WLAN MIMO and BT Module Evaluation Board for TI Sitara™ Platform

# User's Guide

DRAFT ONLY

Literature Number: SWRU359A
September 2013–Revised October 2013

# Contents



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# Read This First

## About This Manual

This user's guide describes how to use the TI WL1835MODCOM8A board to evaluate the performance of the TI WL1835MODGA module.

## Related Documentation From Texas Instruments

- TI WiLink8 Single-Band Combo Module – Wi-Fi, BT, and BLE (SWRS152)
- WiLink 8 Wiki: http://www.ti.com/wilink8wiki

## If You Need Assistance

The primary sources of WL1835MODGA information are the device-specific data sheets and user's guides. For the most up-to-date version of the user's guide and data sheets, go to http://www.ti.com/product/wl1835mod.

## Warning

The WL1835MODCOM8A board is tested to comply with ETSI/R&TTE over temperatures from 0 to +70°C. The WL1835MODCOM8A board is FCC and IC certified.

This board should not be modified to operate in other frequency bands other than what they are designed for.

FCC/IC Regulatory compliance (WL1835MODCOM8A board only)

FCC Part 15 Class A Compliant

IC ICES-003 Class A Compliant

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# WL1835MODCOM8A WLAN MIMO and BT Module Evaluation Board for TI Sitara™ Platform

## 1 Introduction

The WL1835MODCOM8A device is a WiFi® MIMO, *Bluetooth*®, and *Bluetooth* Low Energy (BLE) module board with the TI WL1835MODGA module. WL1835MODGA is built-in TI WL1835 IEEE 802.11 b/g/n and *Bluetooth* 4.0 solutions to provide the best WiFi and *Bluetooth* coexistence interoperability and power-saving technologies from TI.

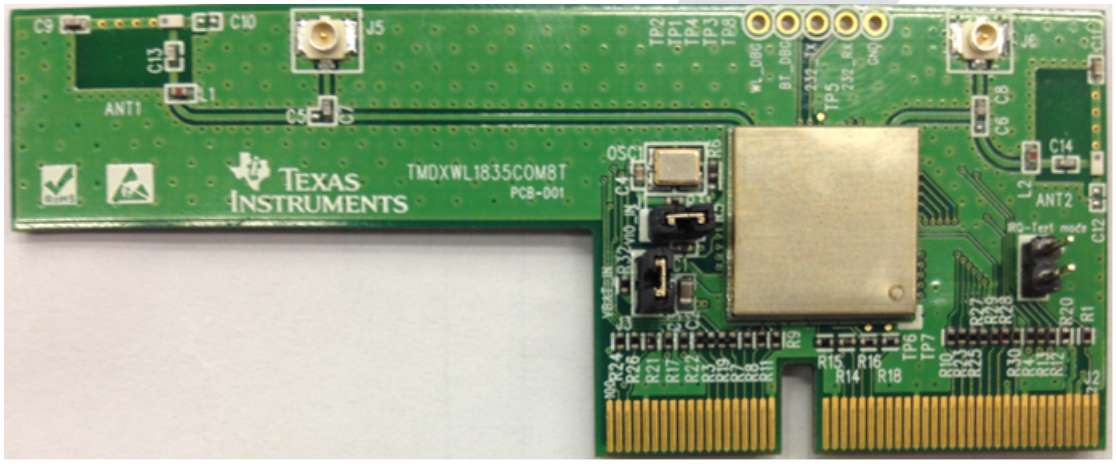


**Figure 1. WL1835MODCOM8A Top View**

### 1.1 Features

- WLAN, *Bluetooth*, BLE on a module board
- 100-pin board card
- Dimension 76.0 mm(L) x 31.0 mm(W)
- WLAN 2.4 GHz SISO (20- and 40-MHz channels), 2.4-GHz MIMO (20-MHz channels)
- Support for BLE dual mode
- Seamless integration with TI Sitara and other application processors
- Design for TI AM335X general-purpose EVM
- WLAN and *Bluetooth*, BLE cores are software and hardware compatible with prior WL127x, WL128x and CC256x offerings, for smooth migration to device.
- Shared HCI transport for *Bluetooth* and BLE over UART and SDIO for WLAN.
- WiFi / *Bluetooth* single antenna co-existence
- Built-in chip antenna
- Optional U.FL RF connector for external 2.4-GHz band antenna
- Direct connection to battery using external switching mode power supply supporting 4.8-V to 2.9-V operation
- VIO in the 1.8-V domain


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## 1.2 Applications

- Internet of Things Multimedia
- Home Electronics
- Home Appliances and White Goods
- Industrial and Home Automation
- Smart Gateway and Metering
- Video Conferencing
- Video Camera and Security

## 1.3 TI Module Key Benefits

- Reduces Design Overhead: Single WiLink8™ Module Scales Across Wi-Fi and *Bluetooth*.
- WLAN High Throughput: 80 Mbps (TCP), 100 Mbps (UDP)
- *Bluetooth* 4.0 + BLE (Smart Ready)
- WiFi-*Bluetooth* Single Antenna Coexistence
- Low Power (30–50% Less than Previous Generation)
- Available as Easy-to-Use FCC, ETSI, and Telec Certified Module
- Lower Manufacturing Costs, Saving Board Space and Minimizing RF Expertise
- AM335x Linux® and Android™ Reference Platform Accelerates Customer Development and Time to Market

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## 2 Board Pin Assignment

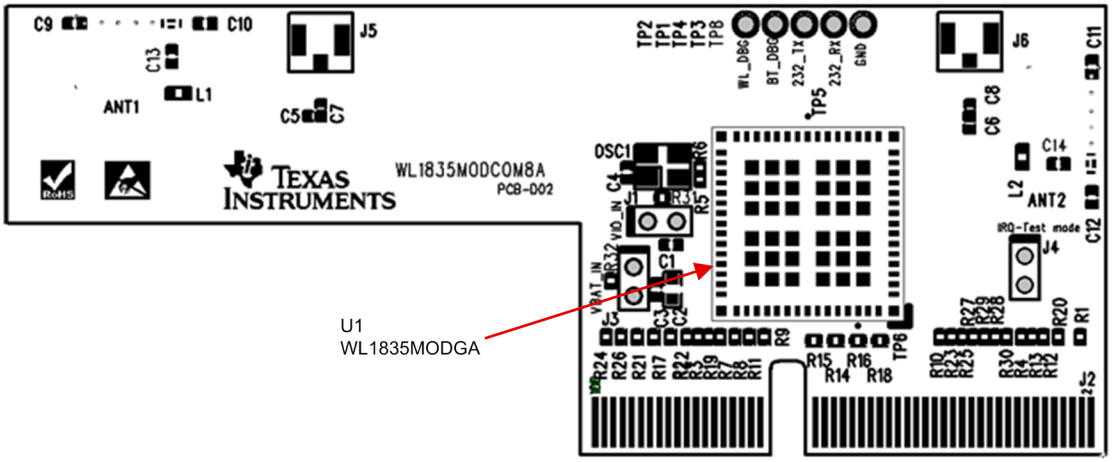


**Figure 2. Board Top View**

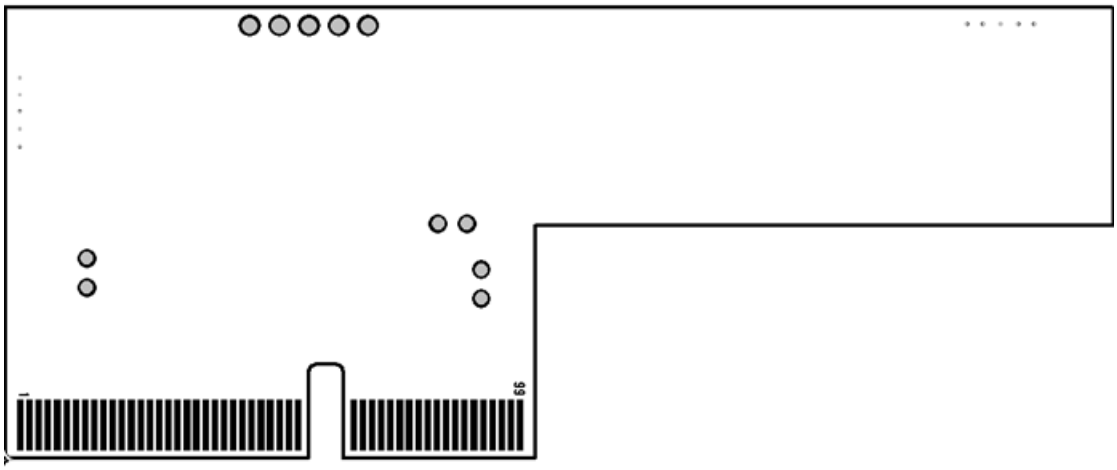

**Figure 3. Board Bottom View**

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## 2.1 Pin Descriptions

| No. | Name | Type | Description |
|---|---|---|---|
| 1 | SLOW_CLK | I | Slow clock input |
| 2 | GND | G | Ground |
| 3 | GND | G | Ground |
| 4 | WL_EN | I | WLAN Enable |
| 5 | VBAT | P | Power supply input |
| 6 | GND | G | Ground |
| 7 | VBAT | P | Power supply input |
| 8 | VIO | P | Power supply input for I/O pin |
| 9 | GND | G | Ground |
| 10 | N.C. | | No connection |
| 11 | WL_RS232_TX | O | WLAN tool RS232 output |
| 12 | N.C. | | No connection |
| 13 | WL_RS232_RX | I | WLAN tool RS232 input |
| 14 | N.C. | | No connection |
| 15 | WL_UART_DBG | O | WLAN Logger output |
| 16 | N.C. | | No connection |
| 17 | N.C. | | No connection |
| 18 | GND | G | Ground |
| 19 | GND | G | Ground |
| 20 | SDIO_CLK | I | WLAN SDIO clock |
| 21 | N.C. | | No connection |
| 22 | GND | G | Ground |
| 23 | N.C. | | No connection |
| 24 | SDIO_CMD | I/O | WLAN SDIO command |
| 25 | N.C. | | No connection |
| 26 | SDIO_D0 | I/O | WLAN SDIO data bit 0 |
| 27 | N.C. | | No connection |
| 28 | SDIO_D1 | I/O | WLAN SDIO data bit 1 |
| 29 | N.C. | | No connection |
| 30 | SDIO_D2 | I/O | WLAN SDIO data bit 2 |
| 31 | N.C. | | No connection |
| 32 | SDIO_D3 | I/O | WLAN SDIO data bit 3 |
| 33 | N.C. | | No connection |
| 34 | WLAN_IRQ | O | WLAN SDIO interrupt out |
| 35 | N.C. | | No connection |
| 36 | N.C. | | No connection |
| 37 | GND | G | Ground |
| 38 | N.C. | | No connection |
| 39 | N.C. | | No connection |
| 40 | N.C. | | No connection |
| 41 | N.C. | | No connection |
| 42 | GND | G | Ground |
| 43 | N.C. | | No connection |
| 44 | N.C. | | No connection |
| 45 | N.C. | | No connection |
| 46 | N.C. | | No connection |
| 47 | GND | G | Ground |

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| No. | Name | Type | Description |
|---|---|---|---|
| 48 | N.C. | | No connection |
| 49 | N.C. | | No connection |
| 50 | N.C. | | No connection |
| 51 | N.C. | | No connection |
| 52 | PCM_IF_CLK | I/O | *Bluetooth* PCM clock input or output |
| 53 | N.C. | | No connection |
| 54 | PCM_IF_FSYNC | I/O | *Bluetooth* PCM frame sync input or output |
| 55 | N.C. | | No connection |
| 56 | PCM_IF_DIN | I | *Bluetooth* PCM data input |
| 57 | N.C. | | No connection |
| 58 | PCM_IF_DOUT | O | *Bluetooth* PCM data output |
| 59 | N.C. | | No connection |
| 60 | GND | G | Ground |
| 61 | N.C. | | No connection |
| 62 | N.C. | | No connection |
| 63 | GND | G | Ground |
| 64 | GND | G | Ground |
| 65 | N.C. | | No connection |
| 66 | BT_UART_IF_TX | O | *Bluetooth* HCI UART transmit output |
| 67 | N.C. | | No connection |
| 68 | BT_UART_IF_RX | I | *Bluetooth* HCI UART receive input |
| 69 | N.C. | | No connection |
| 70 | BT_UART_IF_CTS | I | *Bluetooth* HCI UART Clear to Send input |
| 71 | N.C. | | No connection |
| 72 | BT_UART_IF_RTS | O | *Bluetooth* HCI UART Request to Send output |
| 73 | N.C. | | No connection |
| 74 | BT_FUNC1 | O | BT_HOST_WAKE_UP Signal to wake up the host from *Bluetooth* |
| 75 | N.C. | | No connection |
| 76 | BT_UART_DEBUG | O | *Bluetooth* Logger UART output |
| 77 | GND | G | Ground |
| 78 | GPIO9 | I/O | General-purpose I/O |
| 79 | N.C. | | No connection |
| 80 | N.C. | | No connection |
| 81 | N.C. | | No connection |
| 82 | N.C. | | No connection |
| 83 | GND | G | Ground |
| 84 | N.C. | | No connection |
| 85 | N.C. | | No connection |
| 86 | N.C. | | No connection |
| 87 | GND | G | Ground |
| 88 | N.C. | | No connection |
| 89 | BT_EN | I | *Bluetooth* Enable |
| 90 | N.C. | | No connection |
| 91 | N.C. | | No connection |
| 92 | GND | G | Ground |
| 93 | BT_FUNC2 | I | BT_WAKE_UP *Bluetooth* wakeup from host |
| 94 | N.C. | | No connection |
| 95 | GND | G | Ground |
| 96 | GPIO11 | I/O | General-purpose I/O |

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| No. | Name | Type | Description |
|---|---|---|---|
| 97 | GND | G | Ground |
| 98 | GPIO12 | I/O | General-purpose I/O |
| 99 | N.C. | | General-purpose I/O |
| 100 | GPIO10 | I/O | General-purpose I/O |

# 3 Electrical Characteristics

Refer to the detailed data in the WL1835MODGA data sheet for electrical characteristics.

# 4 Antenna Characteristics

## *4.1 VSWR*

Figure 4 shows the antenna VSWR.

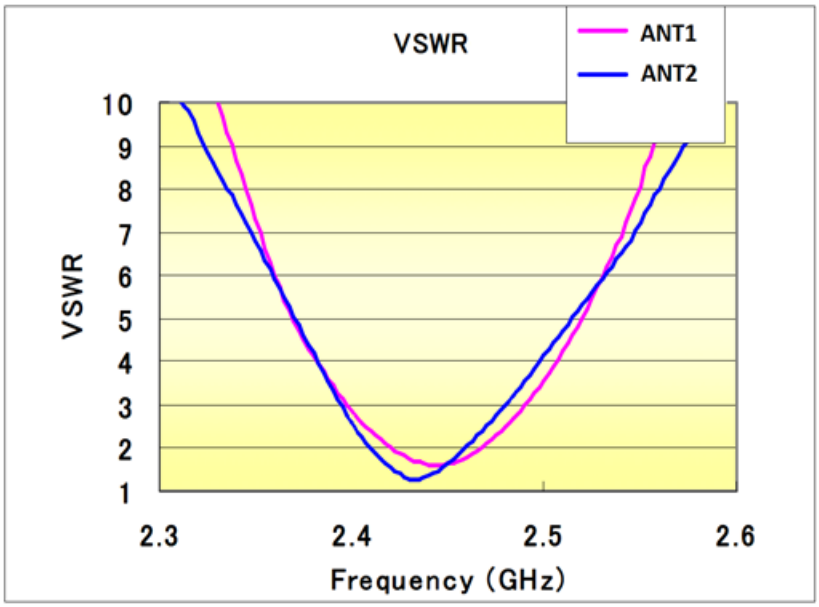


**Figure 4. Antenna VSWR**

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### 4.2 Efficiency

Figure 5 shows the antenna efficiency.

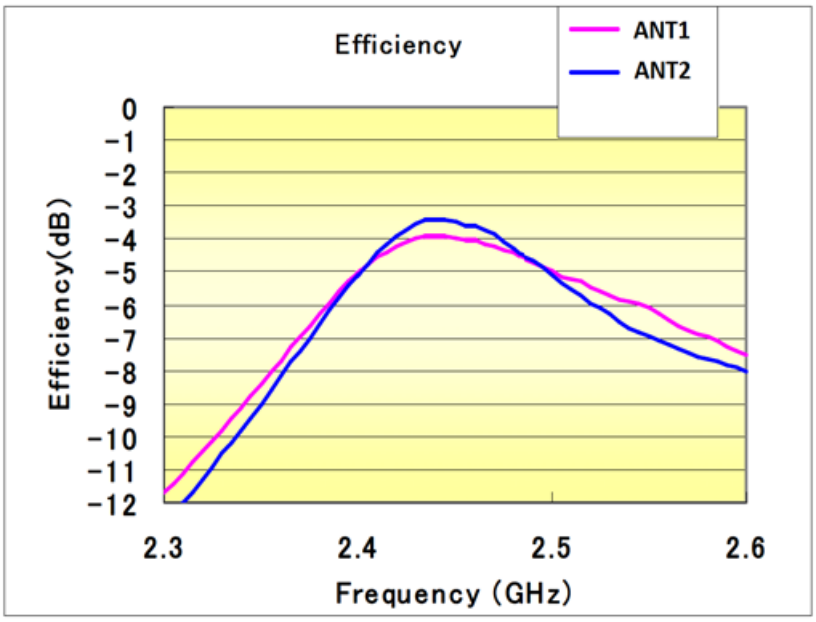


**Figure 5. Antenna Efficiency**

## 5 Antenna Characteristics

### 5.1 Radio Pattern

Figure 6 shows the radio pattern of the WL1835MODCOM8A device.

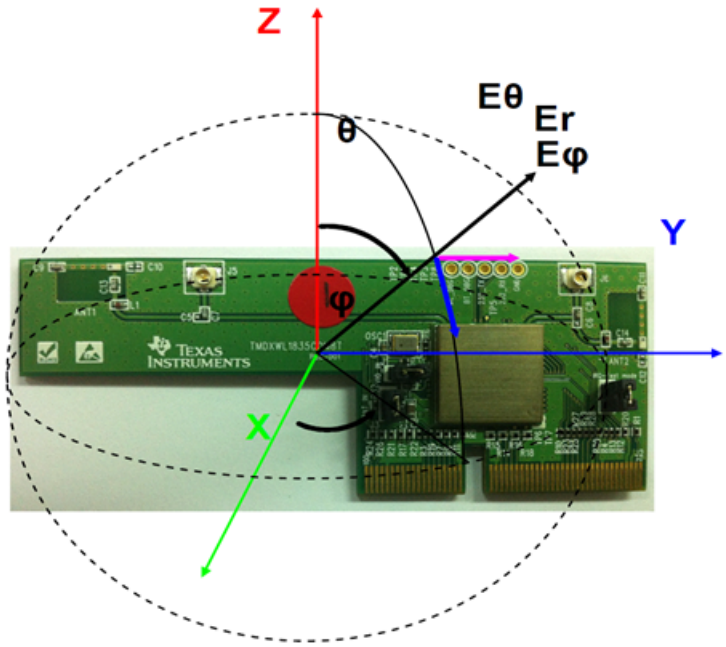


**Figure 6.**


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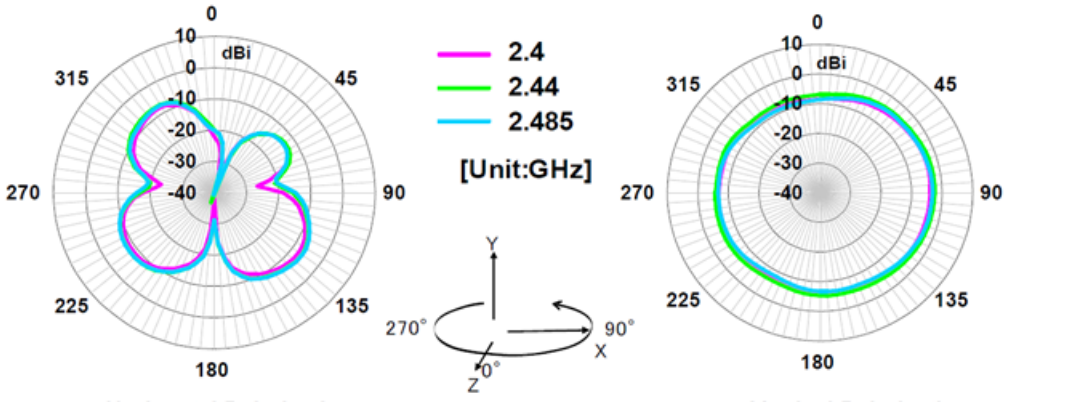
### 5.1.1 ANT1

Figure 7 shows the ANT1 polarization of the WL1835MODCOM8A device.



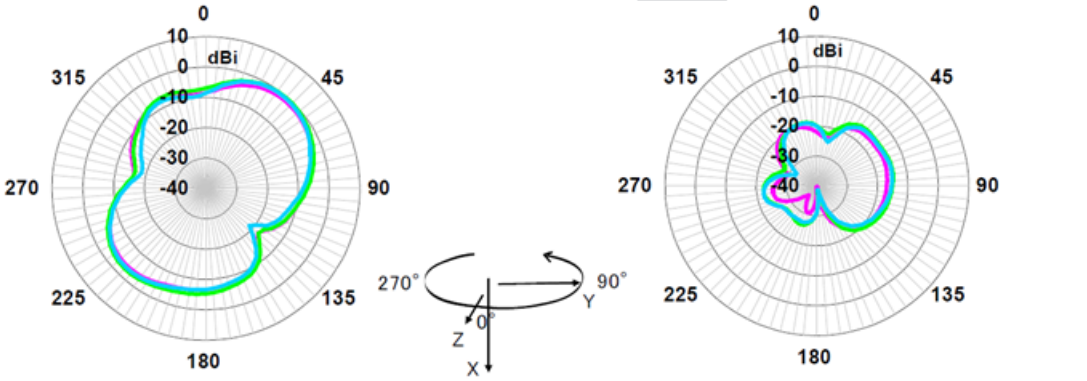

Horizontal Polarization

| Frequency[GHz] | 2.4 | 2.44 | 2.485 |
|---|---|---|---|
| Average[dBi] | -11.96 | -10.83 | -10.88 |
| Maximum[dBi] | -7.52 | -6.36 | -6.12 |
| Minimum[dBi] | -37.91 | -43.28 | -40.60 |

Vertical Polarization

| Frequency[GHz] | 2.4 | 2.44 | 2.485 |
|---|---|---|---|
| Average[dBi] | -6.03 | -4.86 | -5.99 |
| Maximum[dBi] | -3.69 | -2.42 | -3.18 |
| Minimum[dBi] | -8.53 | -7.22 | -9.02 |

**Figure 7.**




Horizontal Polarization

| Frequency[GHz] | 2.4 | 2.44 | 2.485 |
|---|---|---|---|
| Average[dBi] | -6.27 | -5.33 | -6.13 |
| Maximum[dBi] | -1.37 | -0.36 | -0.64 |
| Minimum[dBi] | -17.69 | -17.50 | -21.28 |

Vertical Polarization

| Frequency[GHz] | 2.4 | 2.44 | 2.485 |
|---|---|---|---|
| Average[dBi] | -20.77 | -19.31 | -19.97 |
| Maximum[dBi] | -16.30 | -14.53 | -14.87 |
| Minimum[dBi] | -39.62 | -38.39 | -38.65 |

**Figure 8.**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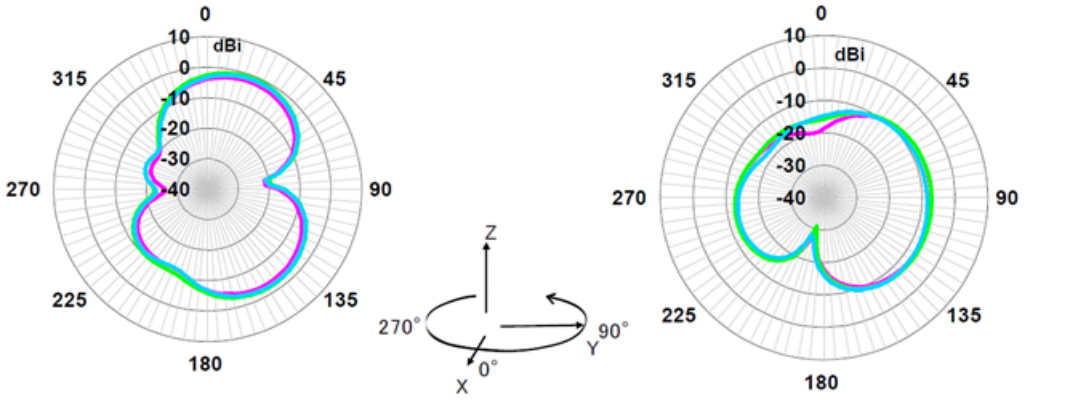



**Horizontal Polarization**

| Frequency[GHz] | 2.4 | 2.44 | 2.485 |
|---|---|---|---|
| Average[dBi] | -7.11 | -5.76 | -6.25 |
| Maximum[dBi] | -2.26 | -0.82 | -1.29 |
| Minimum[dBi] | -26.14 | -22.71 | -23.28 |

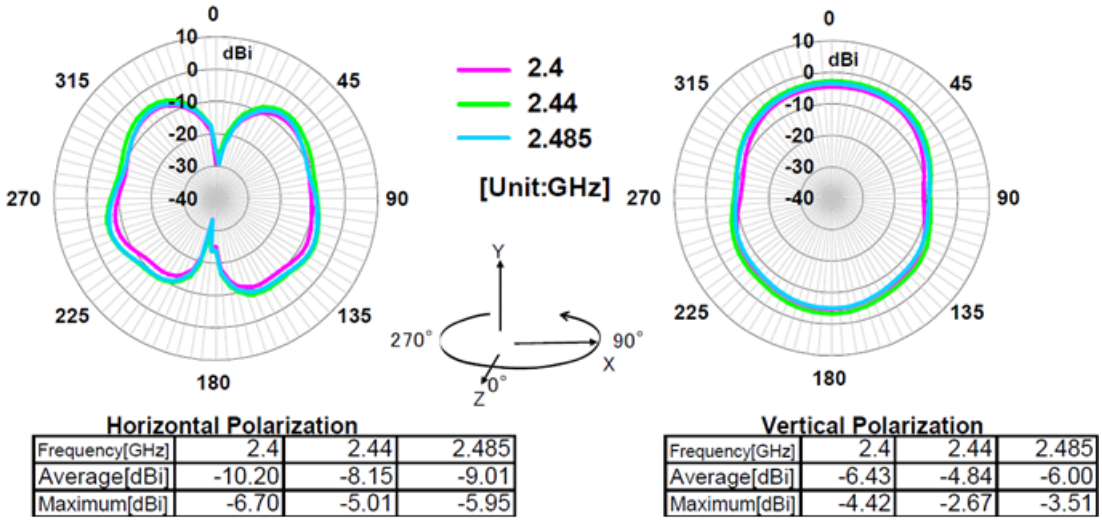
**Vertical Polarization**

| Frequency[GHz] | 2.4 | 2.44 | 2.485 |
|---|---|---|---|
| Average[dBi] | -11.25 | -10.75 | -11.44 |
| Maximum[dBi] | -7.28 | -6.87 | -7.43 |
| Minimum[dBi] | -29.03 | -30.92 | -27.95 |

**Figure 9.**

### 5.1.2 ANT2

Figure 10 shows the ANT2 polarization of the WL1835MODCOM8A device.




**Horizontal Polarization**

| Frequency[GHz] | 2.4 | 2.44 | 2.485 |
|---|---|---|---|
| Average[dBi] | -10.20 | -8.15 | -9.01 |
| Maximum[dBi] | -6.70 | -5.01 | -5.95 |

**Vertical Polarization**

| Frequency[GHz] | 2.4 | 2.44 | 2.485 |
|---|---|---|---|
| Average[dBi] | -6.43 | -4.84 | -6.00 |
| Maximum[dBi] | -4.42 | -2.67 | -3.51 |

**Figure 10.**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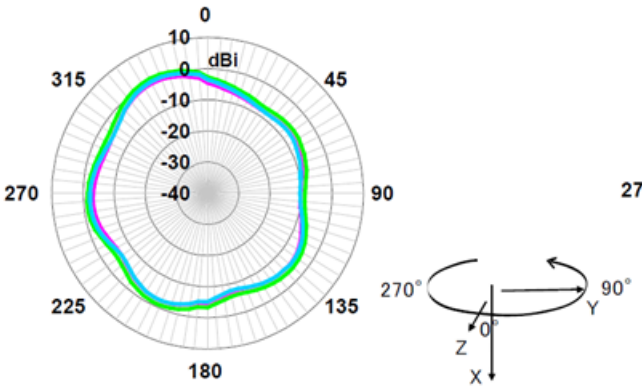
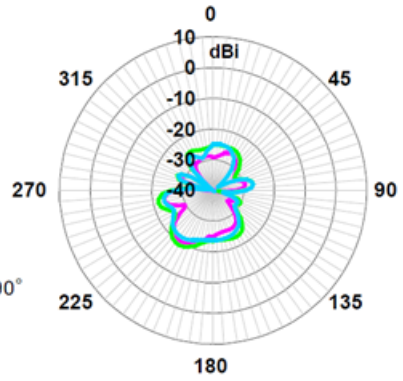


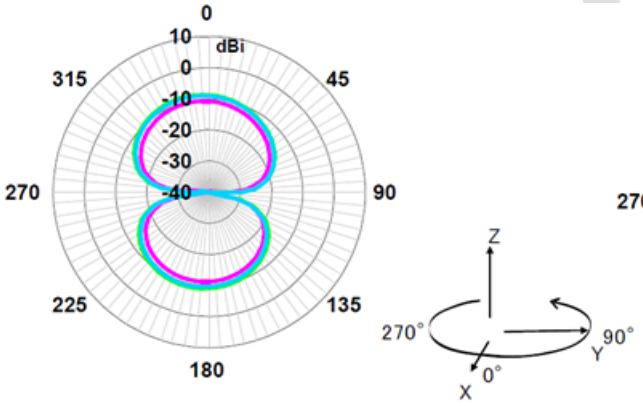

**Horizontal Polarization**

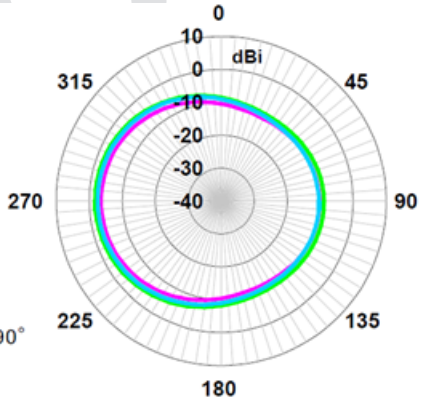
| Frequency[GHz] | 2.4 | 2.44 | 2.485 |
|---|---|---|---|
| Average[dBi] | -4.62 | -3.07 | -4.33 |
| Maximum[dBi] | -0.44 | 1.22 | 0.13 |
| Minimum[dBi] | -10.03 | -8.88 | -10.37 |

**Vertical Polarization**

| Frequency[GHz] | 2.4 | 2.44 | 2.485 |
|---|---|---|---|
| Average[dBi] | -26.83 | -24.88 | -26.19 |
| Maximum[dBi] | -20.29 | -19.04 | -21.59 |
| Minimum[dBi] | -44.93 | -40.26 | -40.51 |

**Figure 11.**




**Horizontal Polarization**

| Frequency[GHz] | 2.4 | 2.44 | 2.485 |
|---|---|---|---|
| Average[dBi] | -13.99 | -11.83 | -12.31 |
| Maximum[dBi] | -10.61 | -8.45 | -8.86 |
| Minimum[dBi] | -46.82 | -39.15 | -42.85 |

**Vertical Polarization**

| Frequency[GHz] | 2.4 | 2.44 | 2.485 |
|---|---|---|---|
| Average[dBi] | -7.55 | -5.77 | -6.58 |
| Maximum[dBi] | -3.58 | -1.78 | -2.60 |
| Minimum[dBi] | -11.89 | -10.50 | -11.43 |

**Figure 12.**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# 6 Circuit Design

## 6.1 Schematic

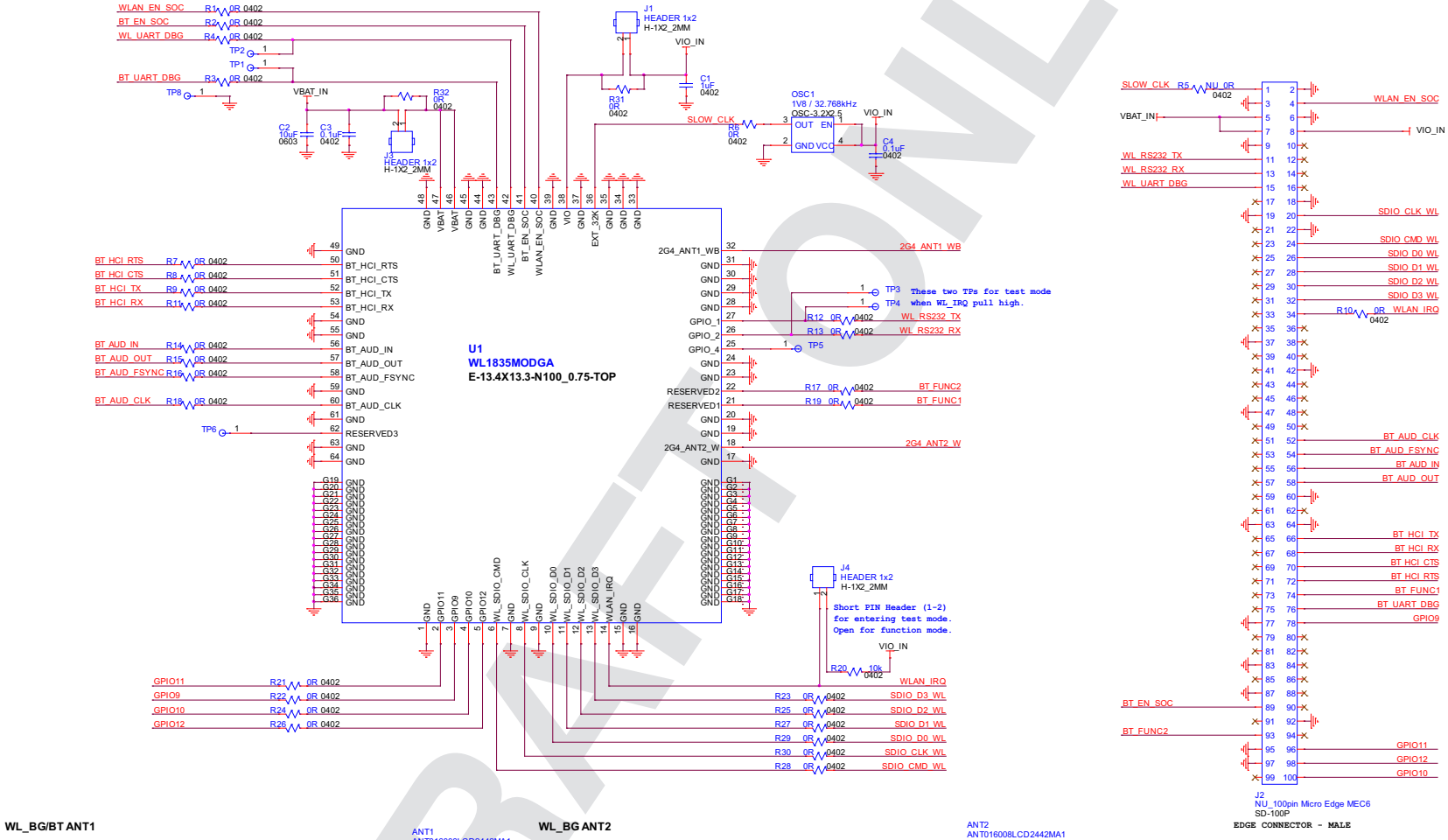


**Figure 13. Schematic**

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## 6.2 Bill of Materials (BOM)

Table 1 lists the bill of materials.

**Table 1. BOM**

| | | | |
|---|---|---|---|
| 1 | TI WL1835 WiFi/*Bluetooth* Module | WL1835MODGA | U1 |
| 2 | XOSC 3225 / 32.768 kHz / 1.8 V / ±50 ppm | 7XZ3200005 | OSC1 |
| 3 | ANT / Chip / 2.4 GHz, 5 GHz / Peak Gain >5 dBi | ANT016008LCD2442MA1 | ANT1, ANT2 |
| 4 | CON Male 1x2 / Pitch | P301-SGP-040/028-02 | J1, J3, J4 |
| 5 | DC JUMPER / PITCH 2.0 mm | CMJ-20BB | J1, J3 |
| 6 | Mini RF Header Receptacle | U.FL-R-SMT-1(10) | J5, J6 |
| 7 | IND 0402 / 1.1 nH / ±0.05 nH / SMD | LQP15MN1N1W02 | L1 |
| 8 | IND 0402 / 1.5 nH / ±0.05 nH / SMD | LQP15MN1N5W02 | L2 |
| 9 | CAP 0402 / 1.2 pF / 50 V / C0G / ±0.1 pF | GJM1555C1H1R2BB01 | C11 |
| 10 | CAP 0402 / 2.2 pF / 50 V / C0G / ±0.1 pF | GJM1555C1H2R2BB01 | C9 |
| 11 | CAP 0402 / 4 pF / 50 V / C0G / ±0.1 pF | GJM1555C1H4R0BB01 | C14 |
| 12 | CAP 0402 / 8 pF / 50 V / C0G / ±0.1 pF | GJM1555C1H8R0BB01 | C13 |
| 13 | CAP 0402 / 10 pF / 50 V / NPO / ±5% | 0402N100J500LT | C7, C8 |
| 14 | CAP 0402 / 0.1 µF / 6.3 V / X7R / ±10% | 0402B104K100CT | C3, C4 |
| 15 | CAP 0402 / 1 µF / 6.3 V / X5R / ±10% / HF | GRM155R60J105KE19D | C1 |
| 16 | CAP 0603 / 10 µF / 6.3 V / X5R / ±20% | C1608X5R0J106M | C2 |
| 17 | RES 0402 / 0R / ±5% | WR04X000 PTL | R1, R2, R3, R4, R5, R6, R7, R8, R9, R10, R11, R12, R13, R14, R15, R16, R17, R18, R19, R21, R22, R23, R24, R25, R26, R27, R28, R29, R30, R31, R32 |
| 18 | RES 0402 / 10K / ±5% | WR04X103 JTL | R20 |

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# 7 Layout Guidelines

## 7.1 Board Layout

Figure 14 shows the WL1835MODCOM8A 4-layer board. Table 2, Figure 15, Figure 16, Figure 17, Figure 18, and Figure 19 show instances of good layout practices.

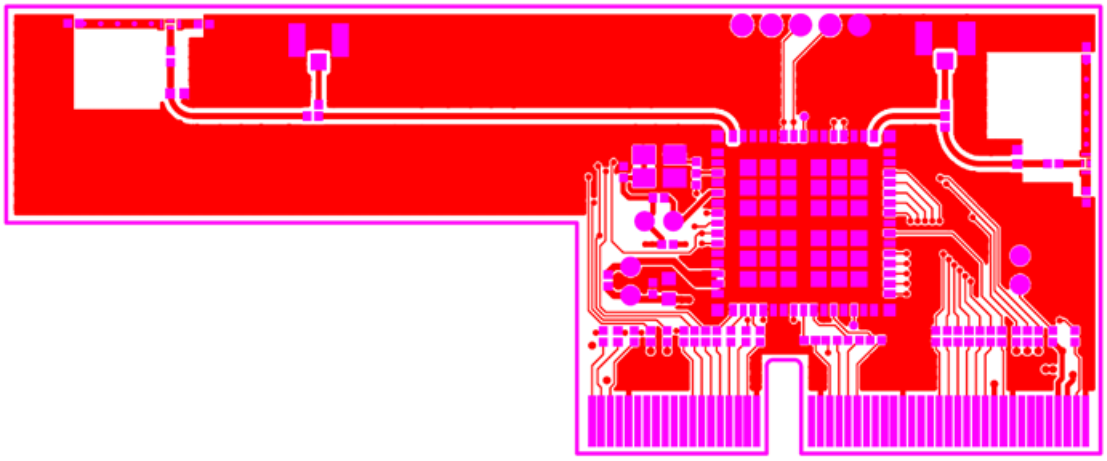

**Figure 14. Layer 1**

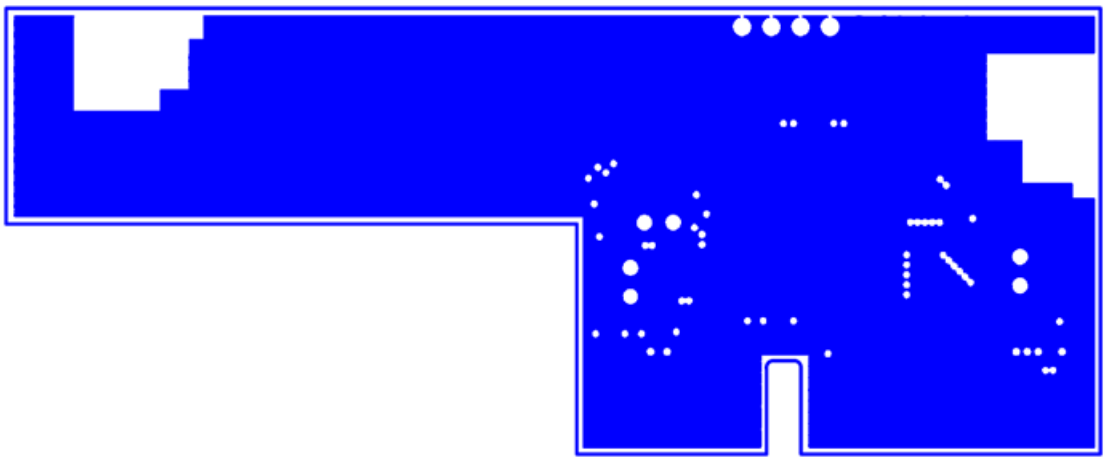

**Figure 15. Layer 2**

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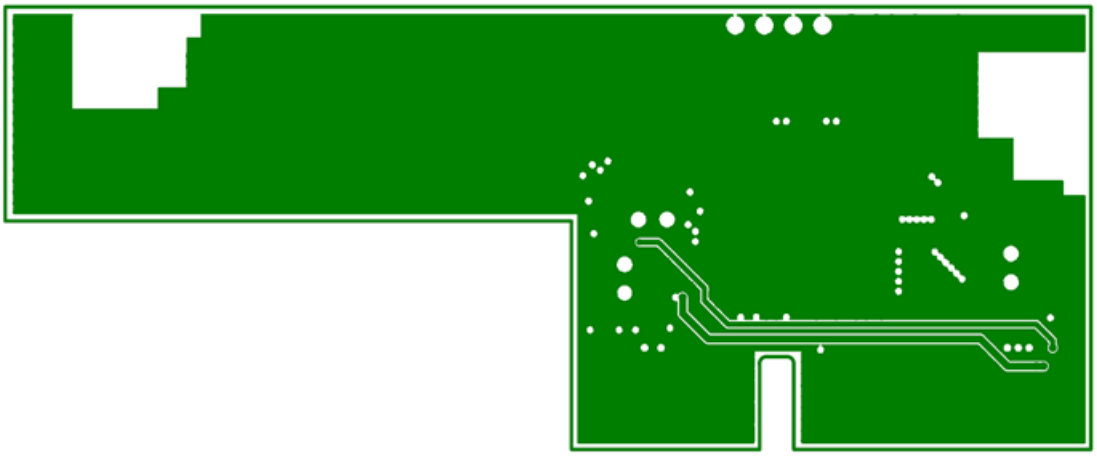

**Figure 16. Layer 3**

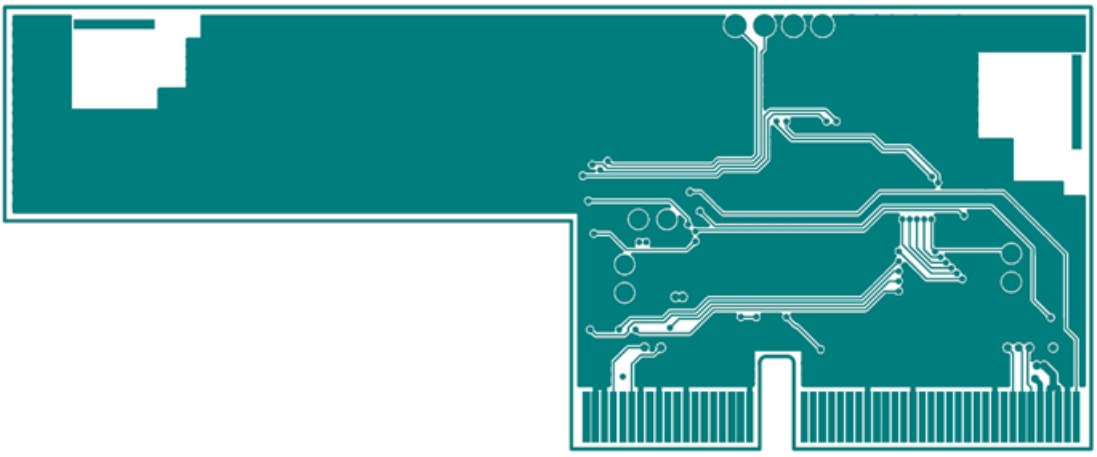

**Figure 17. Layer 4**

**Table 2. Module Layout Guidelines**

| Reference | Guideline Description |
|---|---|
| 1 | The proximity of ground vias must be close to the pad. |
| 2 | Signal traces must not be run underneath the module on the layer where the module is mounted. |
| 3 | Have a complete ground pour in layer 2 for thermal dissipation. |
| 4 | Have a solid ground plane and ground vias under the module for stable system and thermal dissipation. |
| 5 | Increase the ground pour in the first layer and have all of the traces from the first layer on the inner layers, if possible. |
| 6 | Signal traces can be run on a third layer under the solid ground layer, which is below the module mounting layer. |


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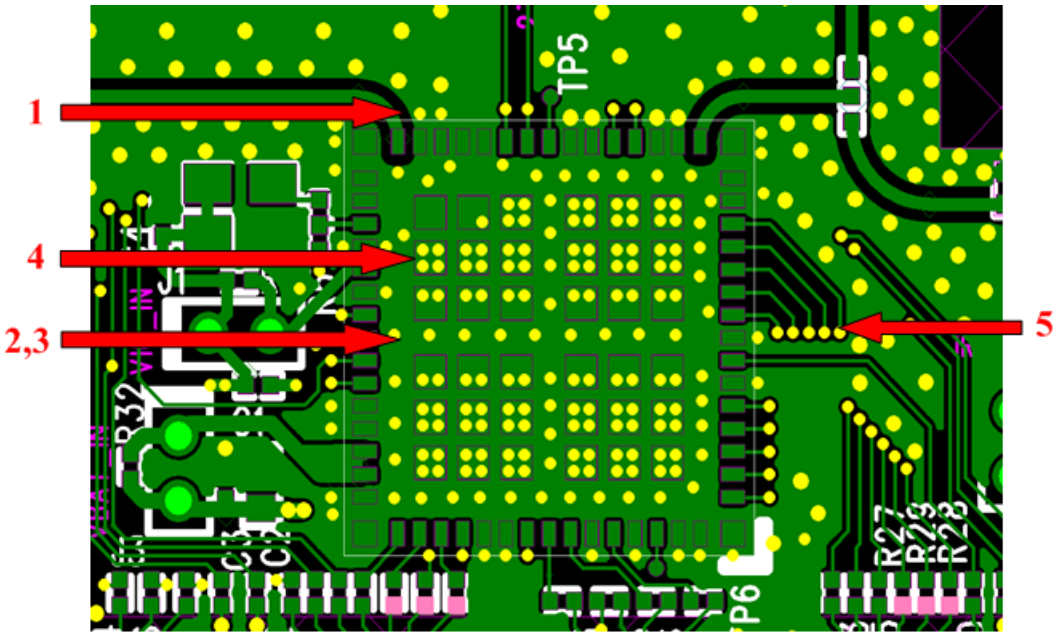


**Figure 18. Module Layout Guidelines (Top Layer)**

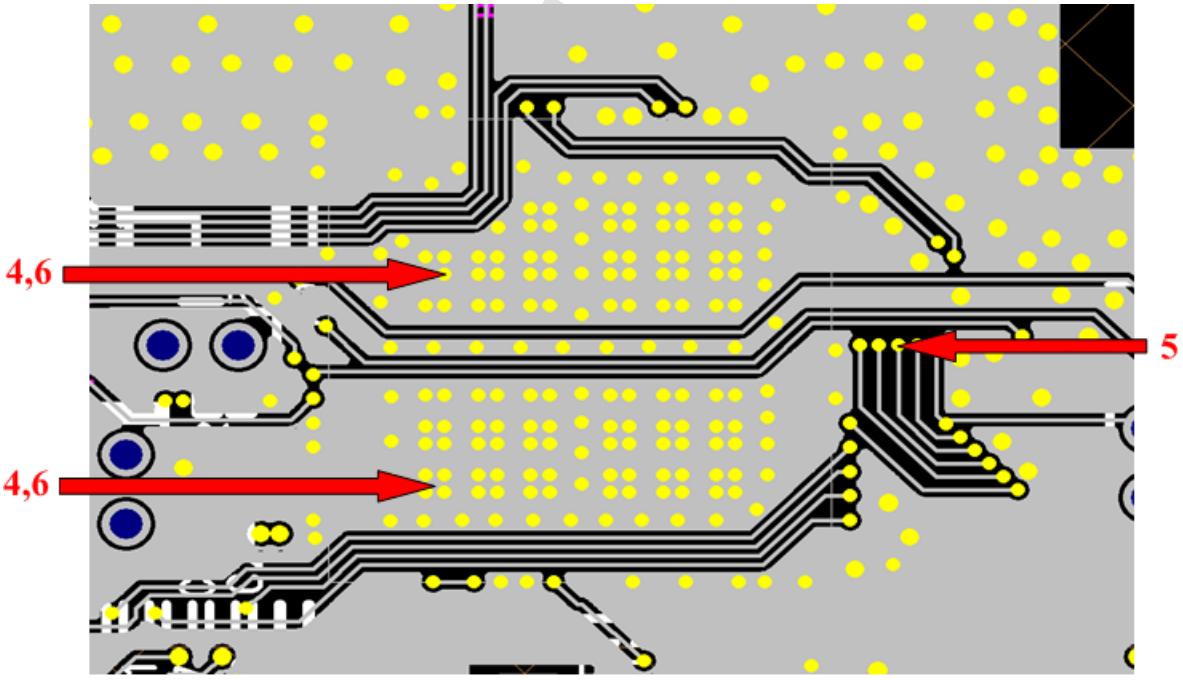


**Figure 19. Module Layout Guidelines (Bottom Layer)**

Figure 20 shows the trace design for the PCB. A 50-Ω impedance match on the trace to the antenna should be used. Also, 50-Ω traces are recommended for the PCB layout.


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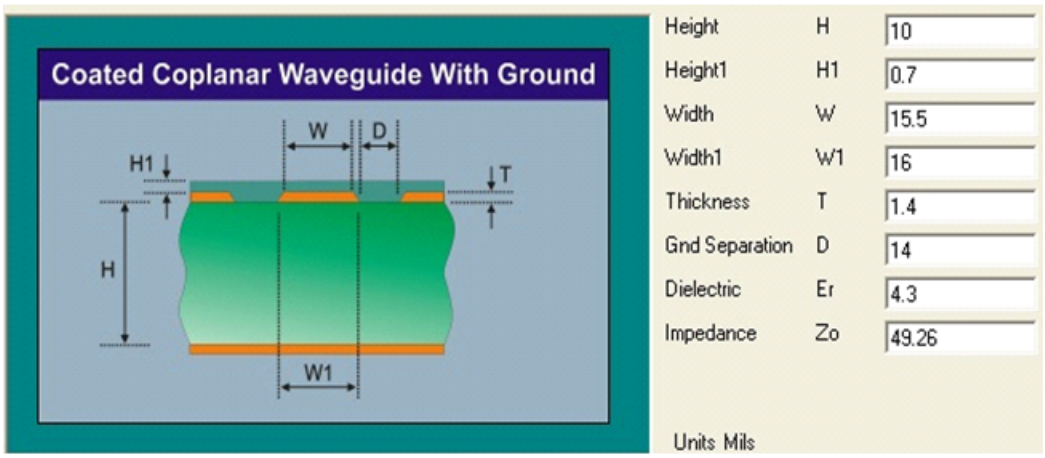


**Figure 20. Trace Design for the PCB Layout**

Figure 21 shows layer 1 with the trace to the antenna over ground layer 2.

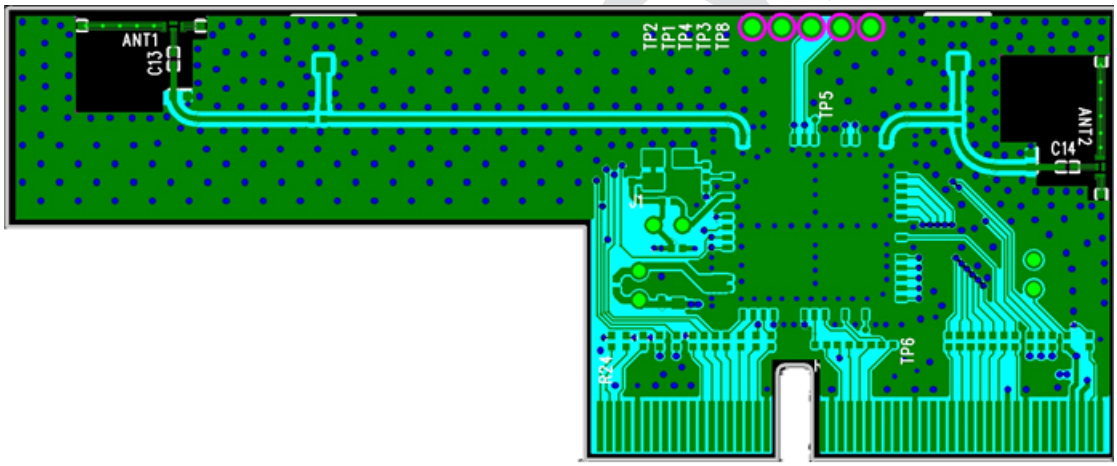


**Figure 21. Layer 1 Combined With Layer 2**

Table 3, Figure 22, and Figure 23 describe instances of good layout practices for the antenna and RF trace routing.

**Table 3. Antenna and RF Trace Routing Layout Guidelines**

| Reference | Guideline Description |
|---|---|
| 1 | The RF trace antenna feed must be as short as possible beyond the ground reference. At this point, the trace starts to radiate. |
| 2 | The RF trace bends must be gradual with an approximate maximum bend of 45 degrees with trace mitered. RF traces must not have sharp corners. |
| 3 | RF traces must have via stitching on the ground plane beside the RF trace on both sides |
| 4 | RF traces must have constant impedance (microstrip transmission line). |
| 5 | For best results, the RF trace ground layer must be the ground layer immediately below the RF trace. The ground layer must be solid. |
| 6 | There must be no traces or ground under the antenna section. |
| 7 | RF traces must be as short as possible. The antenna, RF traces, and modules must be on the edge of the PCB product. The proximity of the antenna to the enclosure and the enclosure material must also be considered. |


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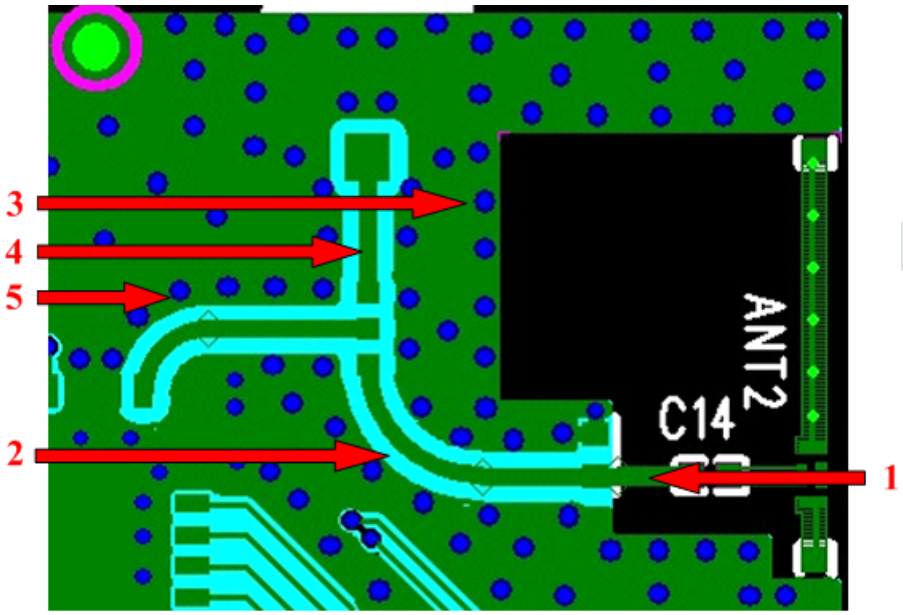


**Figure 22. Top Layer – Antenna and RF Trace Routing Layout Guidelines**

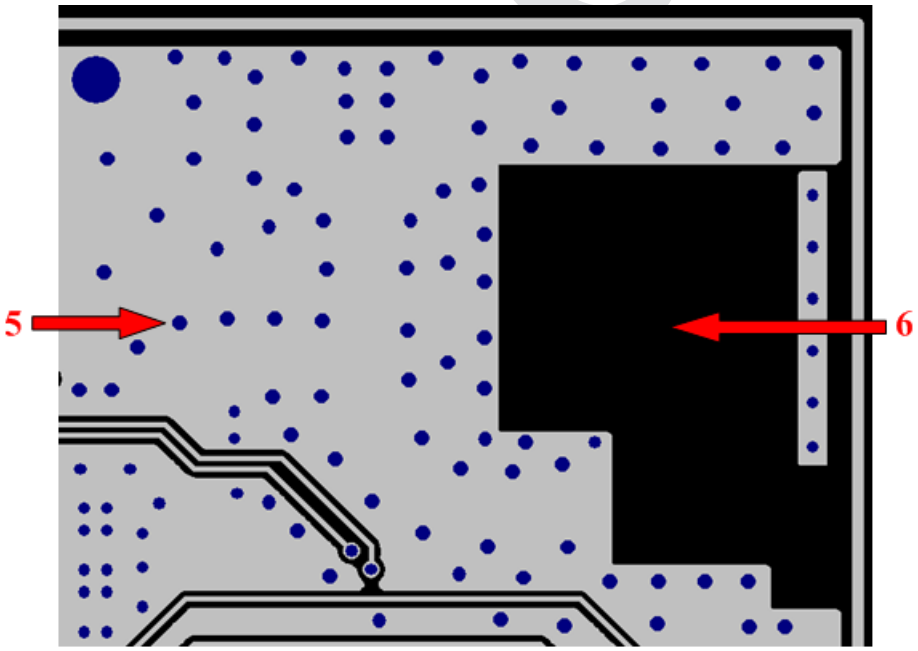


**Figure 23. Bottom Layer – Antenna and RF Trace Routing Layout Guidelines**


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Figure 24 describes the MIMO antenna spacing. The distance of ANT1 and ANT2 must be greater than half of wavelength (62.5 mm @ 2.4 GHz).

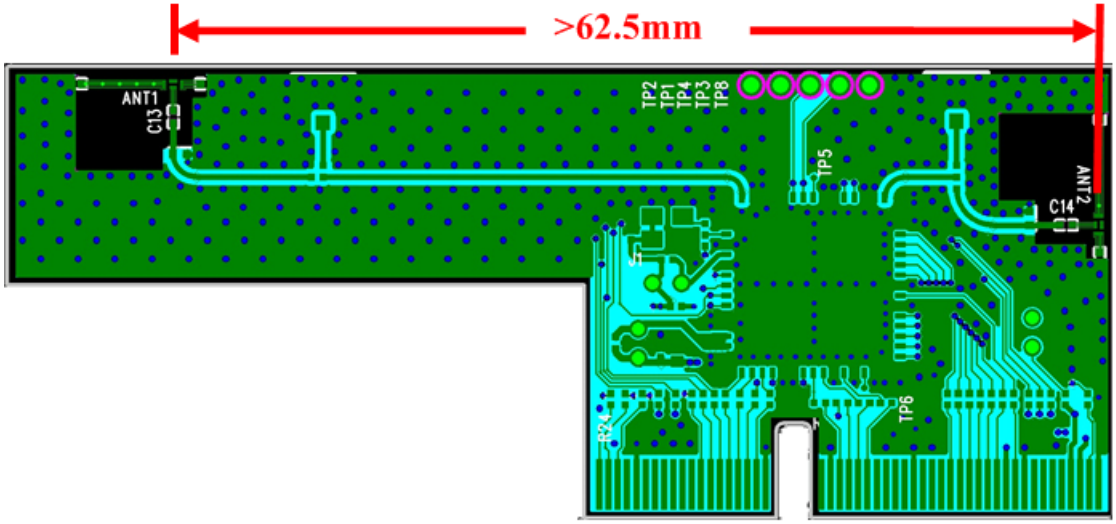


**Figure 24. MIMO Antenna Spacing**

The supply routing guidelines are as follows:

- For power supply routing, the power trace for $V_{BAT}$ must be at least 40 mil wide.
- The 1.8-V trace must be at least 18 mil wide.
- Make $V_{BAT}$ traces as wide as possible to ensure reduced inductance and trace resistance.
- If possible, shield $V_{BAT}$ traces with ground above, below, and beside the traces.

The digital signals routing guidelines are as follows:

- SDIO signals traces (CLK, CMD, D0, D1, D2, and D3) should be routed in parallel to each other and as short as possible (less than 12 cm). In addition, every trace length must be the same as the others. There should be enough space between traces – greater than 1.5 times the trace width or ground – to ensure signal quality, especially for the SDIO_CLK trace. Remember to keep them away from the other digital or analog signal traces. TI recommends adding ground shielding around these buses.
- SDIO Clock, PCM clock… These digital clock signals are a source of noise. Keep the traces of these signals as short as possible. Whenever possible, maintain a clearance around them.

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This user's guide revision history highlights the technical changes made to the SWRU359 device-specific user's guide.

**Revision History**

| Revision | Date | Description / Changes |
|---|---|---|
| SWRS359A | October 2013 | Changed all references of the device name from WL1835MODCOM8 to WL1835MODCOM8A. |

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

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