TIWI-UB1

ANTENNA DESIGN GUIDE

Last updated
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1 Introduction

2 Purpose & Scope

The purpose of this document is to provide details regarding the design and integration of certified antennas to the TiWi-uB1 module. It covers both a PCB trace antenna as well as an externally mounted dipole antenna. It will inform the designer as to the required PCB layout details, and provide expected performance specifications.

3 Applicable Documents

- *TiWi-uB1 Datasheet (330-0132)*
- *TiWi-uB1 EM Board Users Guide (330-0134)*
- *LS Research 2.4 GHz Dipole Antenna Datasheet (330-0016)*
- *LS Research U.FL to RPSMA Cable Datasheet (330-0018)*

4 Revision History

Date	ECN	Change Description	Revision
8/14/2013	87-2013	Initial Release	1.0
9/10/2013	99-2013	Added Reference boards BOM, Gerber Plots, U.FL RF Trace Dimensions, U.FL Drawing	1.1

Table 1 Revision History

5 PCB Trace Antenna

The PCB trace antenna is Intrinsic to the TiWi-uB1 450-0103 modules. Since the PCB trace antenna is integrated onto the module, the end user does not incur the added cost of adding an external antenna to their end product.

	LSR Part Number	Description
	450-0103C 450-0103R	TiWi-uB1 Module with PCB Trace Antenna

Table 2 PCB Trace Antenna Overview

5.1 PCB Trace Antenna Specifications

Specification	Value
Peak Gain	-4.2 dBi
Type	PCB Trace
Polarization	Linear Vertical
Frequency	2400-2500MHz

Table 3 PCB Trace Antenna Specifications

6 Dipole Antenna

The LSR 001-0001 Dipole Antenna is used in conjunction with the LSR 080-0001 U.FL to Reverse Polarity SMA Cable, and the Hirose PCB mounted U.FL connector, to provide an externally mounted antenna solution for the TiWi-uB1 450-0106 module.

	Part Number	Description
	450-0106C 450-0106R	TiWi-uB1 Module, RF Castellation
	LS Research 001-0001	2.4 GHz Dipole Antenna with Reverse Polarity SMA Connector
	LS Research 080-0001	U.FL to Reverse Polarity SMA Bulkhead Cable 105 mm
	Hirose U.FL-R-SMT(10)	PCB Mounted U.FL Connector

Table 4 Dipole Antenna Overview

6.1 Dipole Antenna Specifications

Specification	Value
Gain	+2 dBi
Impedance	50 ohms, Nominal
Type	Dipole
Polarization	Linear Vertical
VSWR	≤2.5：1, Maximum
Frequency	2400-2500MHz
Weight	13g
Size	105×10 mm
Antenna Color	Black

Table 5 Dipole Antenna Specifications

6.2 Mechanical Dimensions

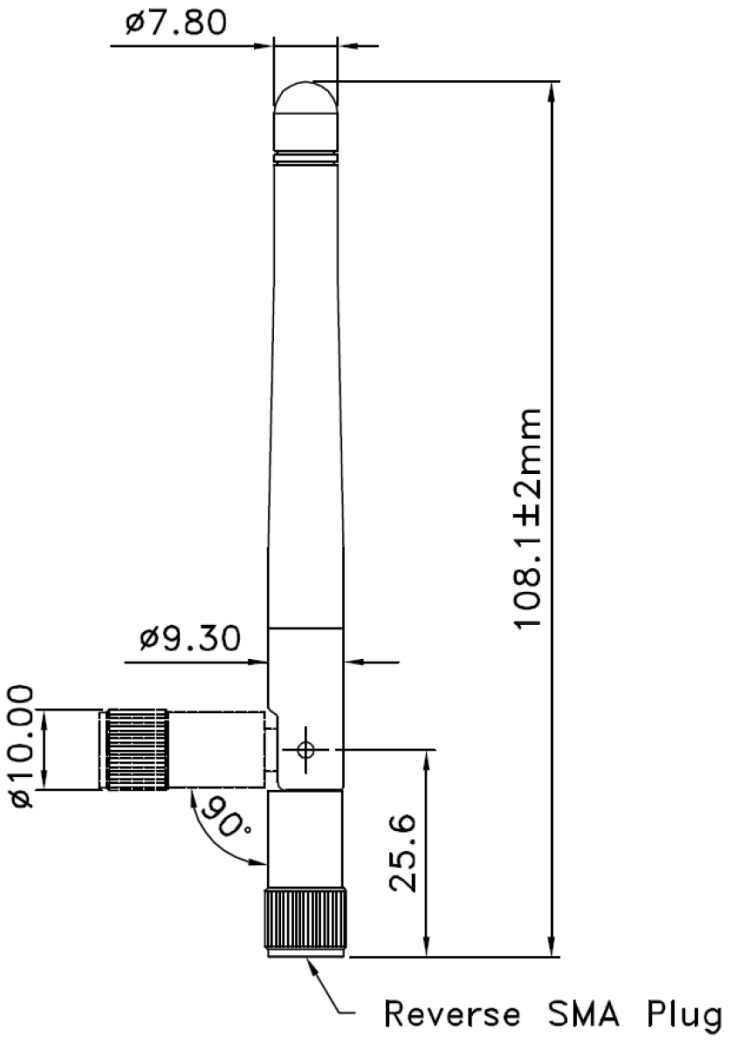


Figure 1 Dipole Antenna Dimensions

7 PCB Layout Requirements

Since this module and its associated set of approved antennas has been certified by the FCC and Industry Canada (IC) as a Modular Radio, the end user is authorized to integrate this module into an end-product, and is solely responsible for the Unintentional Emissions levels produced by the end-product.

In order to preserve the Modular Radio certifications, the integrator of the module must abide by the PCB layout recommendations outlined in the following paragraphs. Any divergence from these recommendations will invalidate the modular radio certifications and require the integrator to re-certify the module and/or end-product.

The module must be used with one of the approved antennas:

1. On module PCB trace antenna.

2. LS Research 001-0001 center-fed 2.4 GHz dipole antenna and 080-0001 U.FL to Reverse Polarity SMA connector cable.

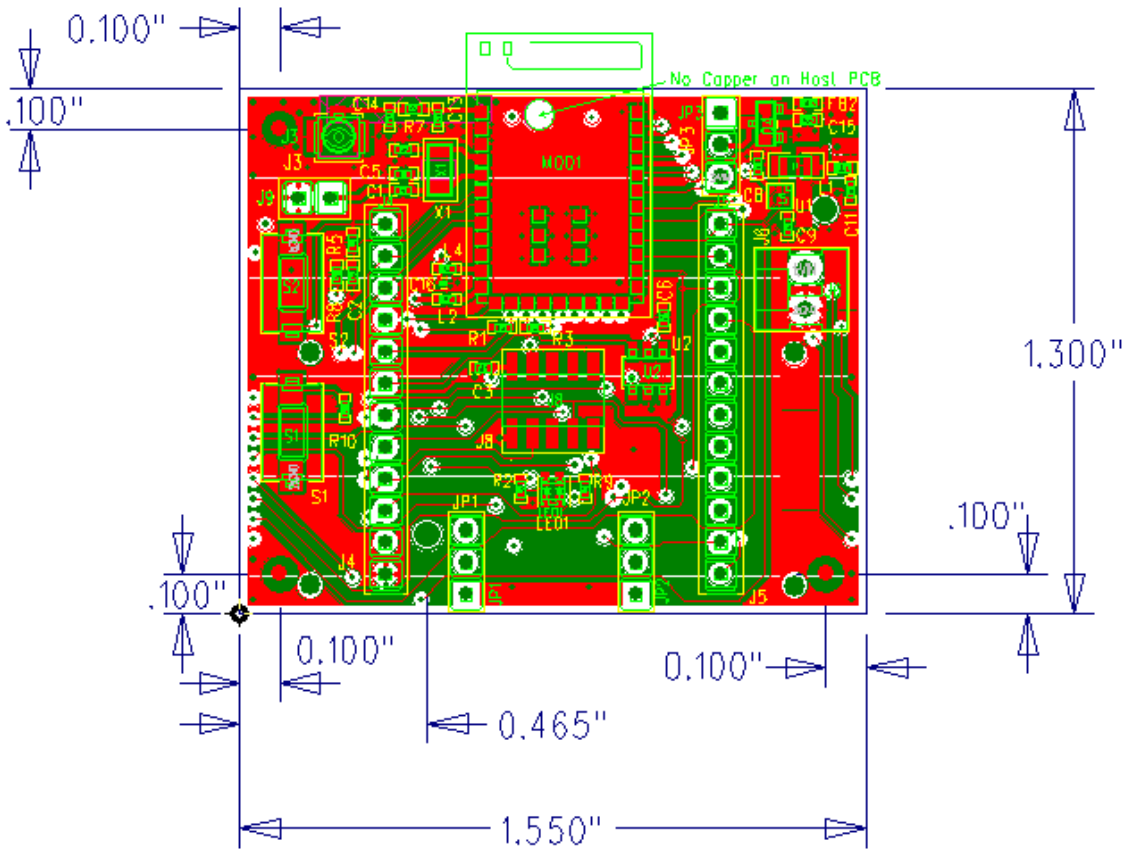
PCB Trace Antenna Implementation

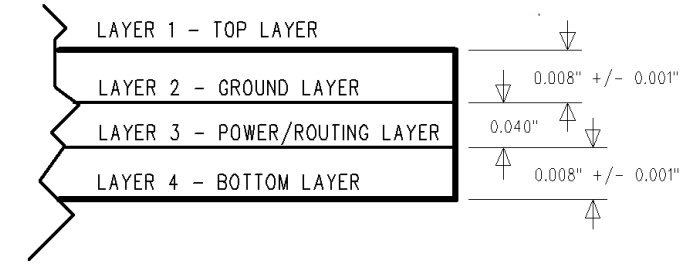
When using the PCB Trace Antenna version of the module (Part Number 450-0103), the PCB layout can be removed entirely, as the RF signal does not come out of the module. It is acceptable to keep the U.FL circuitry, and the components J3, C13, C14, and R7 can either be populated or not.

2.4 GHz Dipole Antenna Implementation

When using the RF castellation version of the module (Part Number 450-0106), and the certified 2.4 GHz Dipole Antenna and U.FL to RPSMA Cable, the PCB layout shown in Section 7.1 should be followed. Components J3 and R7 should be populated as shown in the schematic in Section 7.2.

7.1 Reference Design PCB





*** Material thickness between Layer 2 and Layer 3 may be adjusted to meet Total Thickness requirement.

Figure 2 Reference Design PCB

7.2 Reference Design Schematic

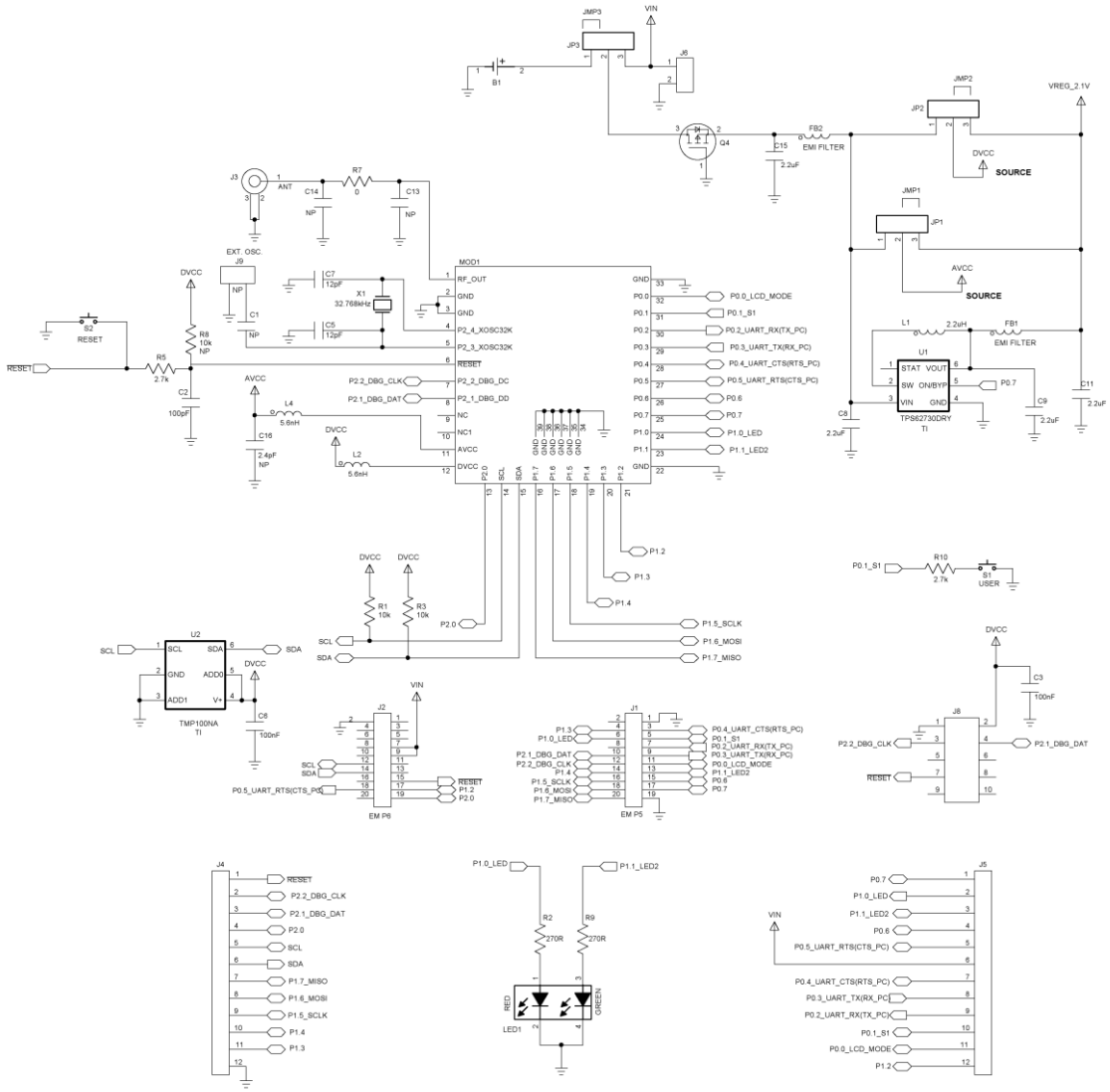


Figure 3 Reference Design Schematic

7.3 Reference Design BOM

Qty	PCB Ref	Pop Option	Value	Tolerance	Manufacturer	Mfg Part Number
1	B1				Memory Protection Devices	BU2032SM-G
1	C1	NP	100nF	+/- 10%	Murata	GRM155R71C104KA88#
2	C13 C14	NP			LSR	000-0000
1	C16	NP	2.4pF	+/- 0.1pF	Johanson Technology	250R05L2R4BV4T
1	C2		100pF	+/- 5%	Murata	GRM1555C1H101JA01#
2	C3 C6		100nF	+/- 10%	Murata	GRM155R71C104KA88#
2	C5 C7		12pF	+/- 5%	Murata	GRM1555C1H120JA01#
4	C8 C9 C11 C15		2.2uF	+/- 20%	Kemet	C0402C225M9PAC#
2	FB1 FB2				Murata	BLM15HG102SN1#
2	J1 J2				Samtec	SFM-110-02-L-D-A
1	J3				Hirose	U.FL-R-SMT-1#
2	J4 J5				Sullins	NRPN121PAEN-RC
1	J6				AMP	640456-2
1	J8				Sullins	GRPB052VWQS-RC
1	J9	NP			Sullins	PRPN021PAEN-RC
3	JMP1 JMP2 JMP3				Sullins	SPN02SXCN-RC
3	JP1 JP2 JP3				Sullins	NRPN031PAEN-RC
1	L1		2.2uH	+/- 30%	Murata	LQM21PN2R2NGC#
2	L2 L4		5.6nH	+/- 0.3nH	Johanson Technology	L-07C5N6SV6T
1	LED1				Kingbright	APTB1612ESGC-F01
1	MOD1				Gigatek	450-0106C
1	PCB1				LSR	750-00490
1	Q4				Fairchild	FDN340P
2	R1 R3		10K	5%	KOA	RK73B1ET#103J
2	R2 R9		270	1%	Vishay	CRCW0402270RFK#
2	R5 R10		2.7K	1%	Vishay	CRCW04022K70FK#
1	R7		0	50m Ohm Max	KOA	RK73Z1ET#
1	R8	NP	10K	5%	KOA	RK73B1ET#103J
2	S1 S2				Panasonic	EVQ-PNF04M
1	U1				Texas Instruments	TPS62730DRY#
1	U2				Texas Instruments	TMP100NA#
1	X1				ECS	ECS-.327-12.5-34B

Notes:

designates mfg material package option.

NP designates a component that is not populated.

Table 6 Reference Design EM Board BOM

7.4 Reference Design Gerber Files

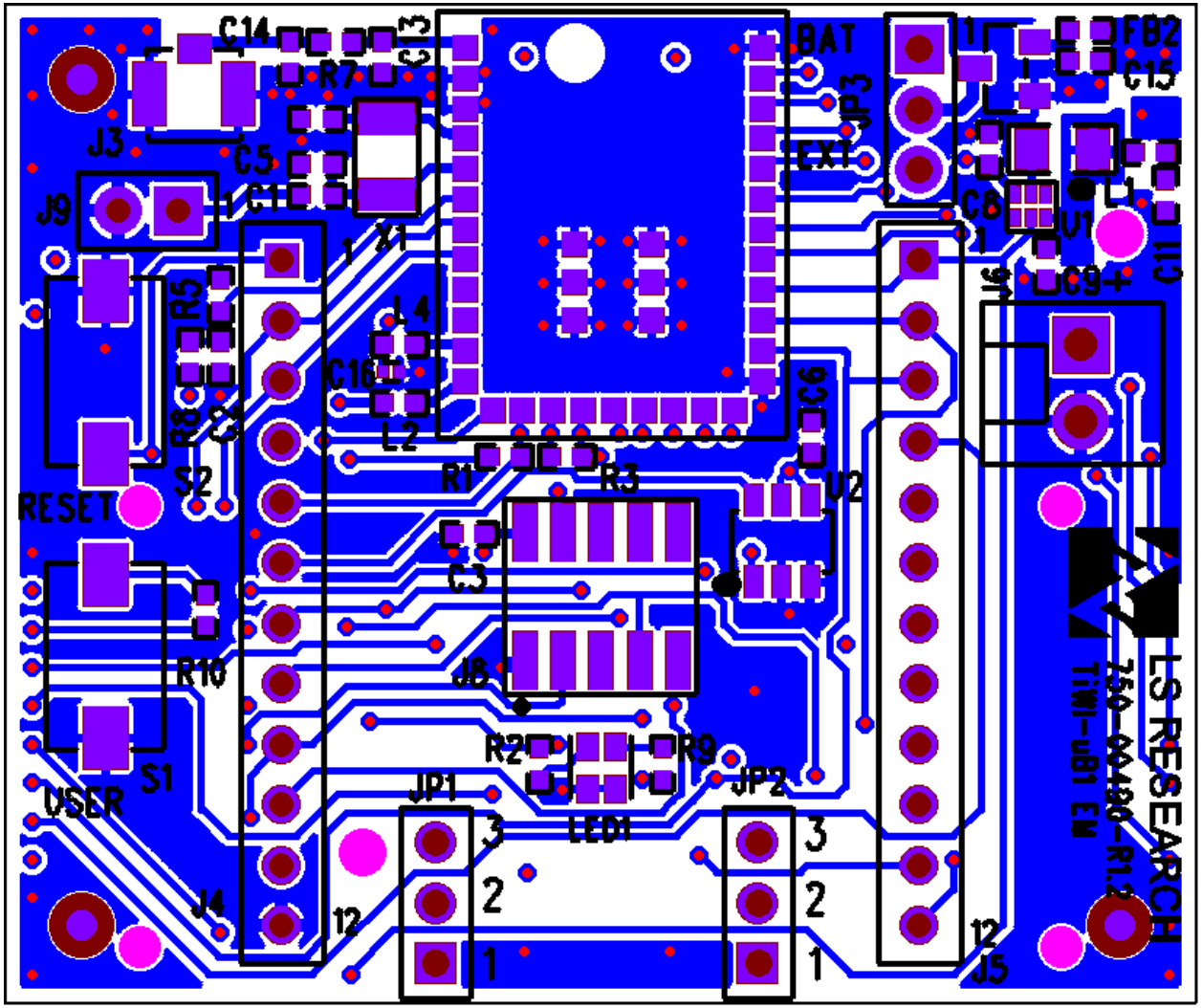


Figure 4 - Top Layer (1) with Silkscreen and Solder Mask Gerber

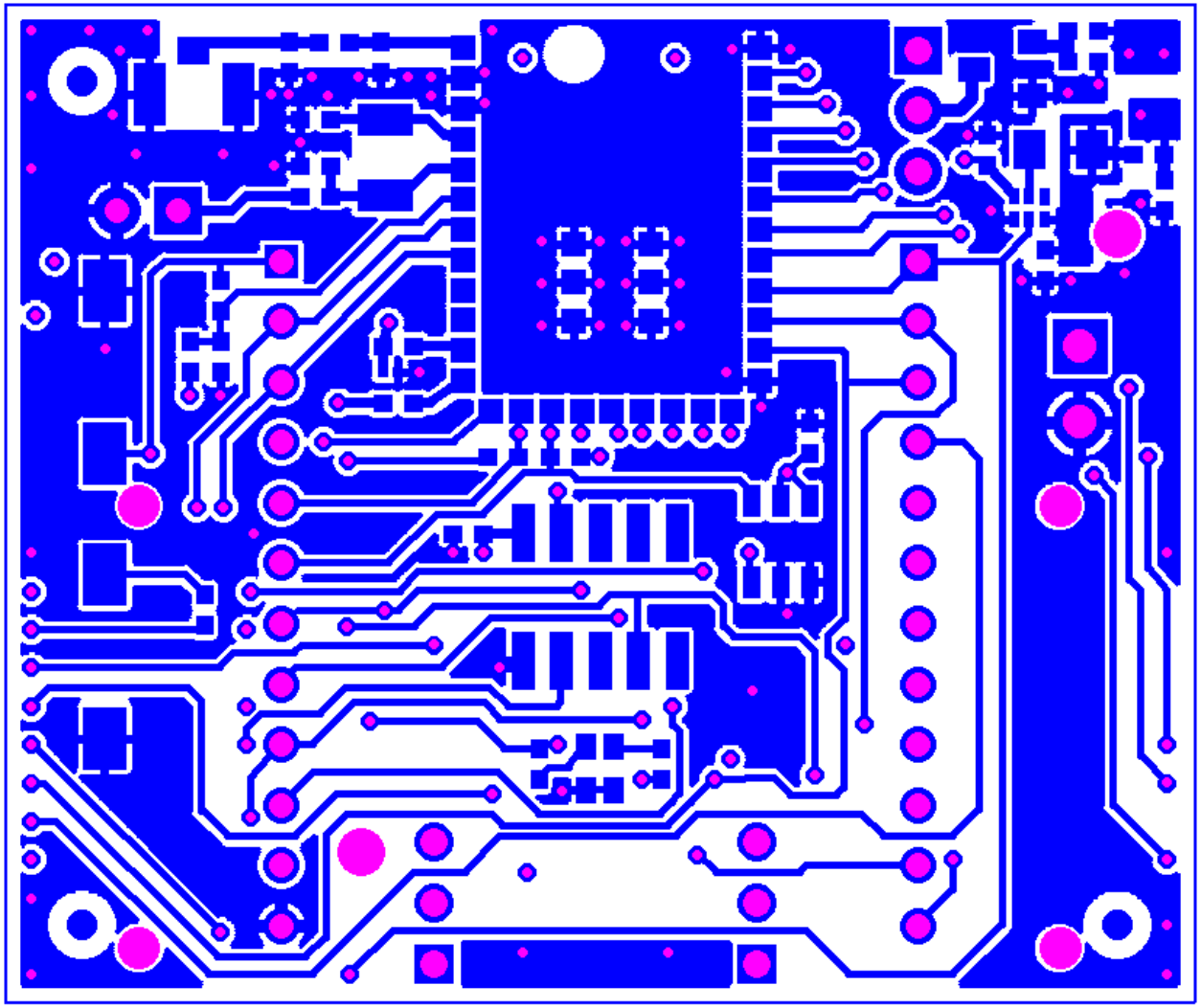


Figure 5 – Top Layer (1) Gerber

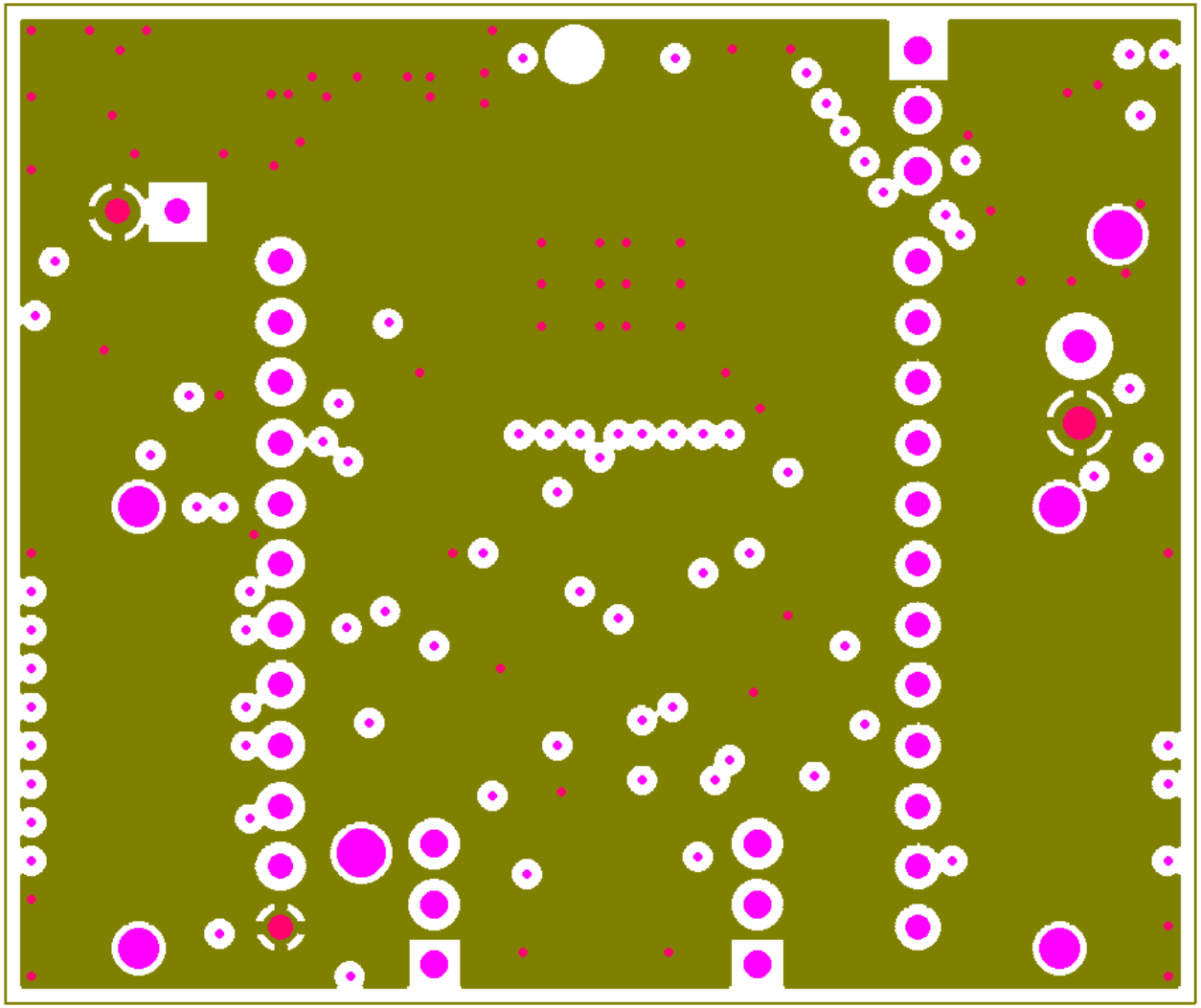


Figure 6 - Layer 2 Gerber

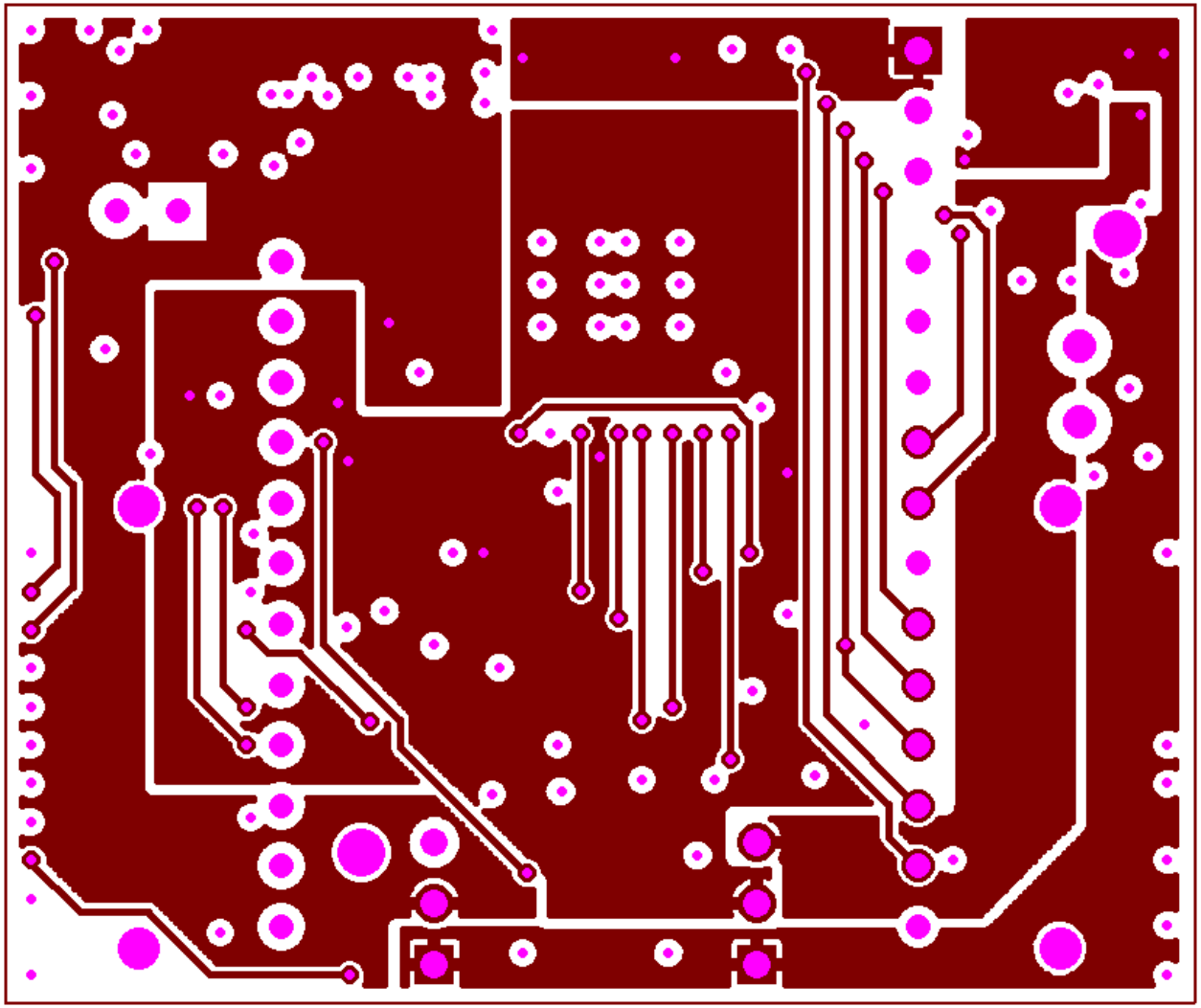


Figure 7 - Layer 3 Gerber

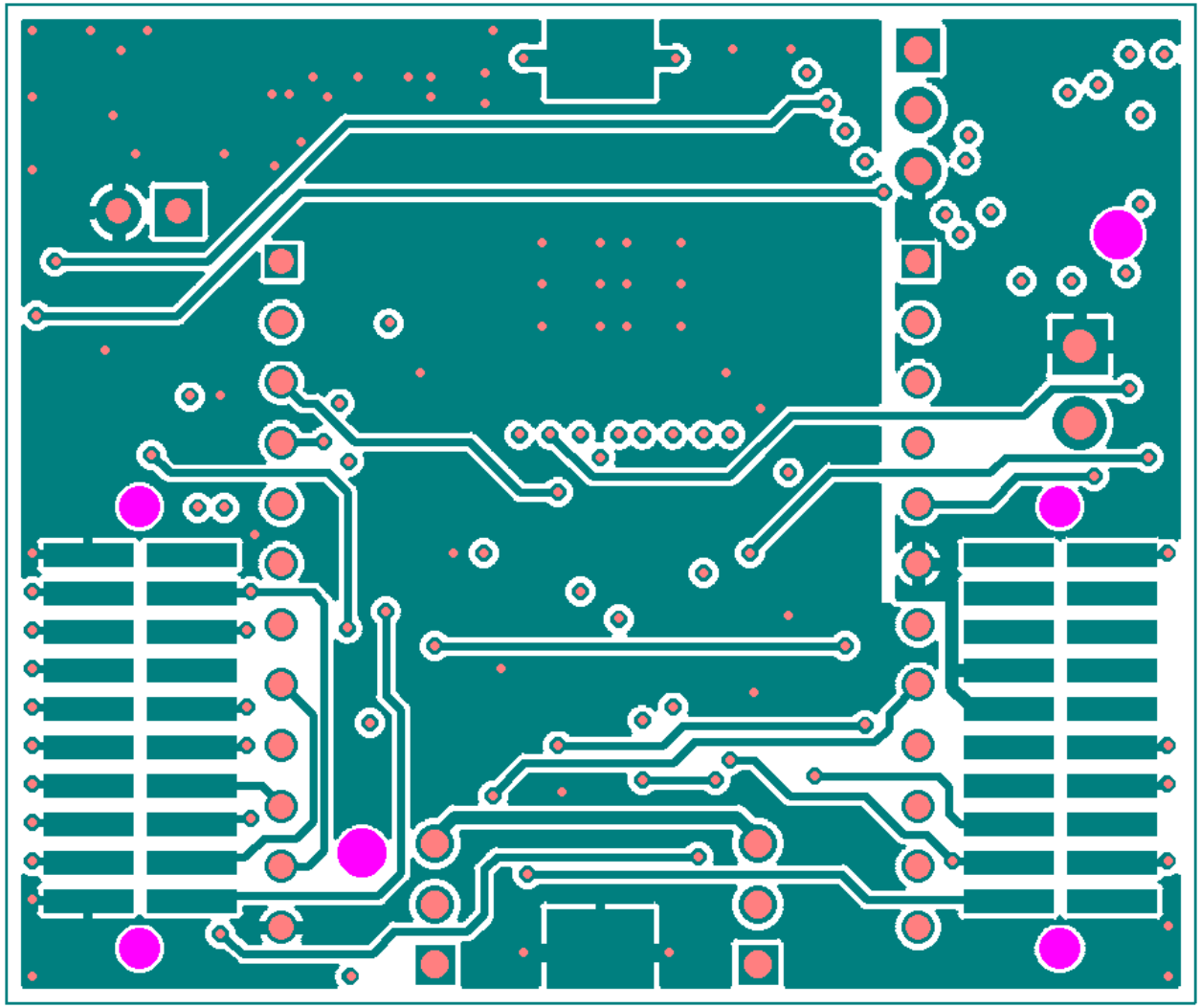


Figure 8 – Bottom Layer (4) Gerber

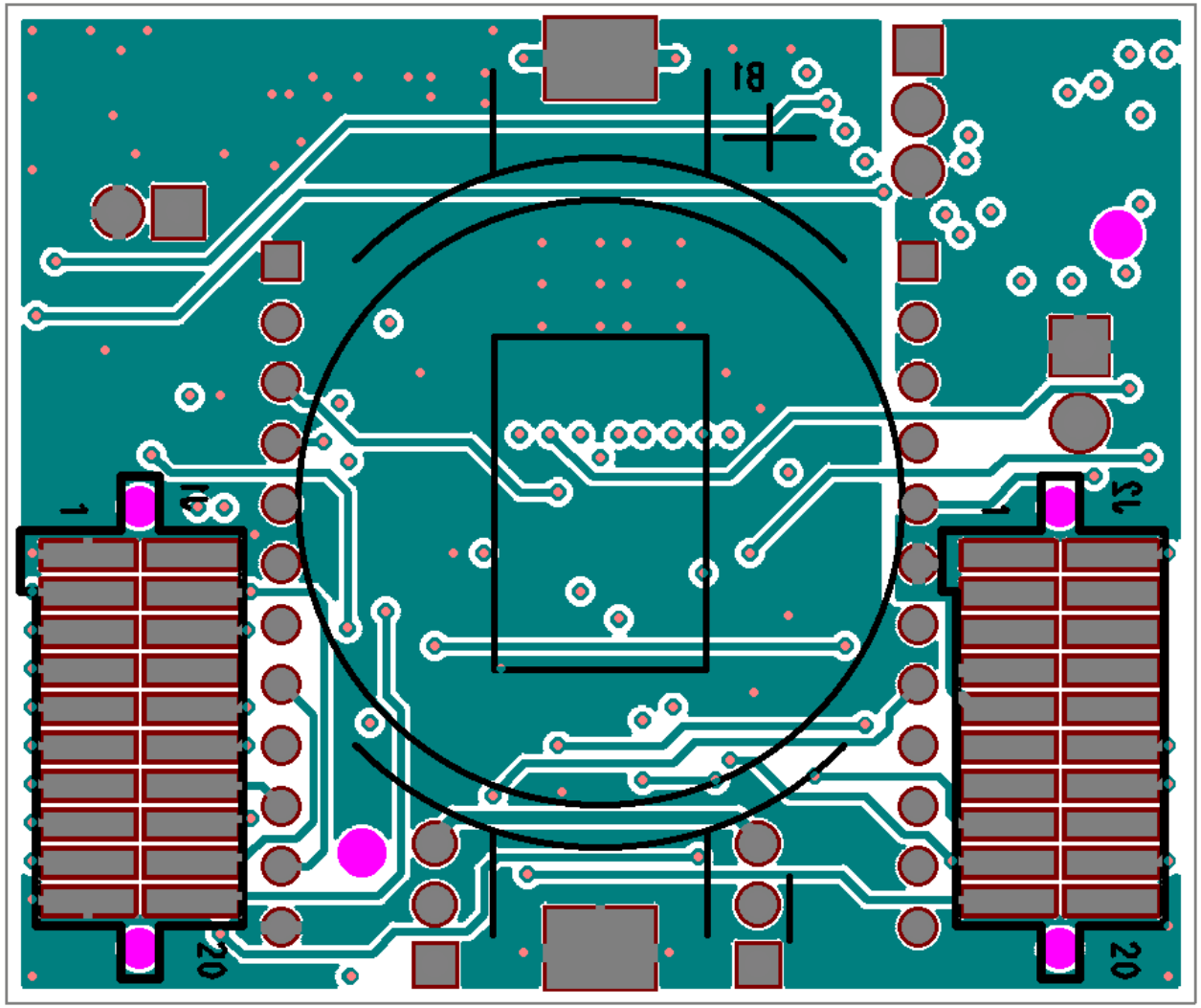


Figure 9 – Bottom Layer (4) with Silkscreen and Solder Mask Gerber

7.5 Reference Design - U.FL RF Trace Dimensions

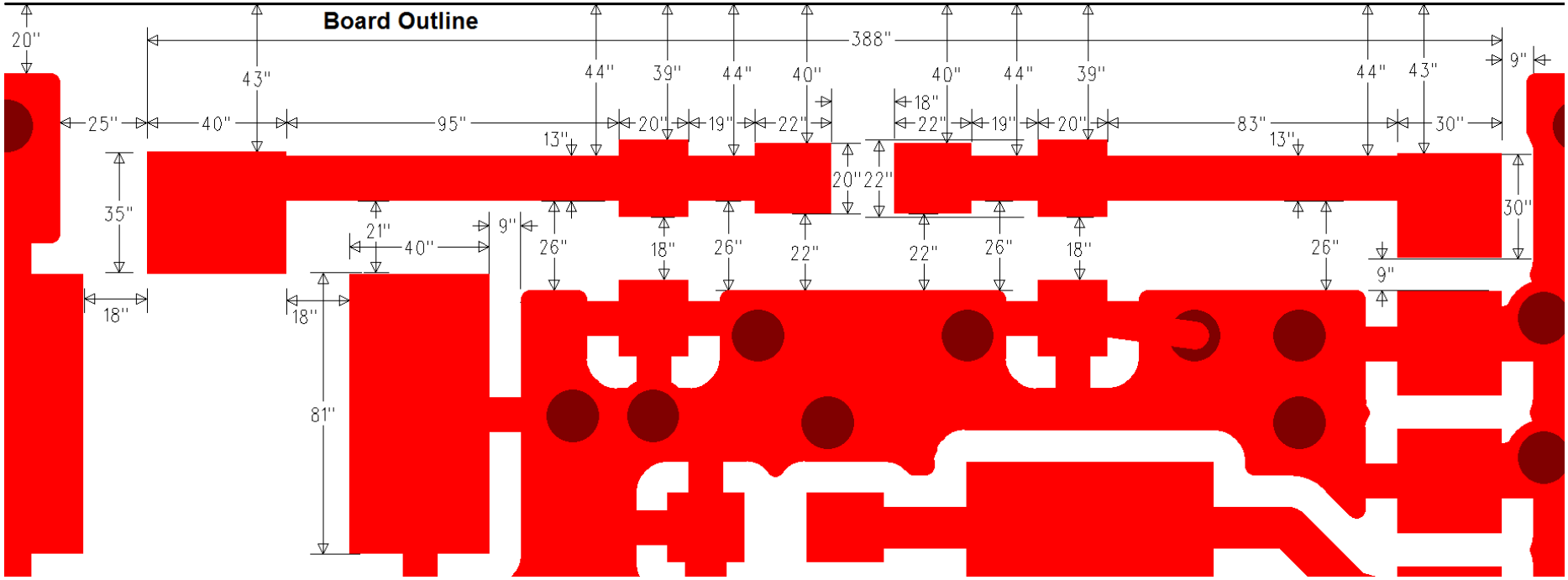


Figure 10 – U.FL RF Trace Details

7.6 U.FL Connector Drawing

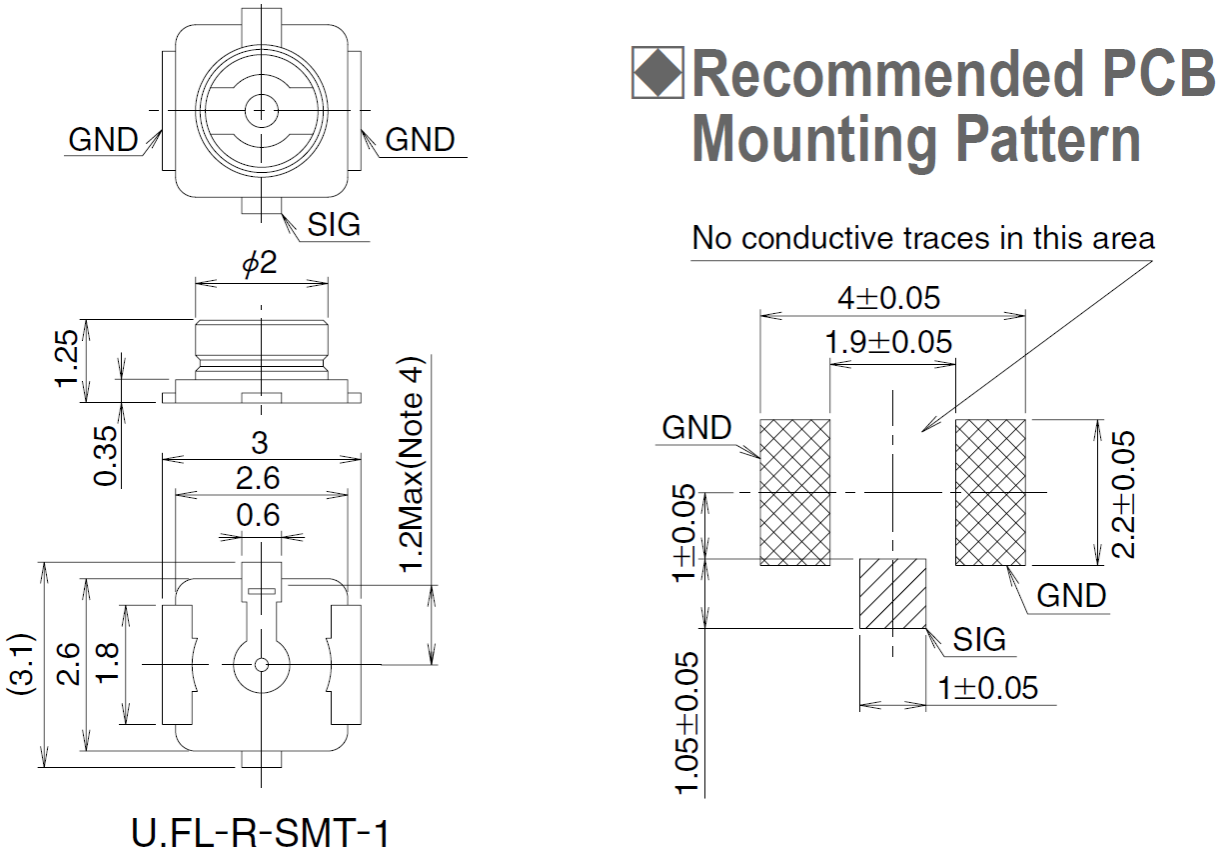


Figure 11 – U.FL Connector Drawing

8 EMC Compliance

8.1 Summary

The TiWi-uB1 module has been tested and approved as a Modular Radio in accordance with the appropriate FCC and IC standards. The supporting test data may be found in the modular test report.

Since this module and its associated set of approved antennas have been certified as a Modular Radio, this allows the end user to integrate this module into an end-product without the requirement of re-certifying the radio module. The module-integrator is responsible for the unintentional conducted and radiated emissions and must ***verify*** that the integrated product is compliant with the rules associated with unintentional radiators. The module integrator is also required to maintain an engineering record of the verification testing and declare on the product through proper labeling and marking that the device is compliant with these particular rules. The module integrator is responsible for using the patch file that corresponds to the antenna configuration and region for EMC compliance.

The installed module's FCC ID and IC numbers need to be clearly marked on the product with the following verbiage "Contains FCC ID: TFB-BT2" and "Contains IC: 5969A-BT2".

The TiWi-uB1 has been certified for use in a portable configuration, which allows a transmitting device to be used with any part of its radiating structure in direct contact with the user's body or within 20 cm of the body of a user or bystanders under normal operating conditions.

8.2 Module Integration Considerations - Antenna Systems

The module must be used with one of the approved antennas:

1. On module PCB trace antenna.

2. LS Research 001-0001 center-fed 2.4 GHz dipole antenna and LS Research 080-0001 U.FL to Reverse Polarity SMA connector cable.

The antenna should be placed such that it is minimally disturbed by the product's packaging material. The incorporation of the largest practical free-space clearance around the antenna is important for maximizing overall performance. Further, the antenna must be placed such that at least a 20 cm separation distance is maintained from the antenna to all other radio transmitters.

8.3 Module Integration Considerations - Substitute Antenna Systems

The module's certification is only valid for the list of approved antennas presented in section 4. However, substitute antennas may be used in place of the approved antenna only if the antennas are of the same type and the peak gain is less than or equal to the peak gain of the similar approved antenna. Also the antennas should have similar in-band and out-of-band characteristics.

8.4 Module Integration Considerations - Circuit Implementation

It is recommended that all connection PCB (printed circuit board) traces to the power supply and digital control terminal be as short as possible. Though not necessarily required in all cases, it is

a best practice to provide an optional shunt capacitor placement at the module pin on all active and routed power supply and digital control lines. Further, a series damping resistor placement should be incorporated between the module pin/shunt capacitor node and the source/sink of the digital control signals. This provides for effective bypassing and decoupling of digital lines from the radio module, in the event that the application circuit has longer power supply and digital routing.

8.5 Module Integration Considerations - Top Assembly

In addition to the recommendations given for the antenna systems and the module placement onto a product PCB, it is recommended that all wiring and interconnect systems within the product be not routed anywhere close the module and its associated circuitry on the PCB, doing so could change the emission characteristics of the module.

8.6 Testing Requirements for End-Product

Once the module is integrated and the product realized in a mobile or portable configuration, the product must be tested and follow the verification process for Unintentional Conducted and Radiated Emissions in accordance to the FCC and IC guidelines. The module needs to be powered and placed in the receive mode for this test. The receiver must be tuned to its lowest frequency channel, mid-frequency channel, and highest frequency channel. The supporting test data does not need to be submitted to the FCC or IC.

8.7 SAR Testing Requirements for End-Product

Since the TiWi-uB1 radio module was certified in a portable configuration, the end-product does not require SAR testing assuming it is not located within 20 cm of another transmitter.

9 Contacting LS Research

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