Nielsen - Global Cellular Modem (GCM)
ELLA-W1 Antenna Trace Design

Topic :	**Global Cellular Modem Antenna Trace Design**		
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1 Scope

This document defines the essential specifications necessary to implement the Global Cellular Modem antenna trace designs. The information contained herein and its references should be sufficient to guide a skilled person in an attempt to implement the design on a host carrier. It will provide the designer with PCB layout details and expected performance specifications.

The document supports the GCM PCB design and 4 possible external Wi-Fi antenna combinations. GCM two connector-based designs (both sharing same antenna pin ANT1 of the ELLA module) are:

- Nielsen Global Cellular Modem – GCM - NA device variant

2 FCC/IC ID reference

Model	FCC ID	IC ID
ELLA-W131	PV7-WIBEAR11N-SF1	7738A-WB11NSF1

Table 1: FCC and IC IDs of ELLA-W131 used in the Global Cellular Modem

3 General description

When using the ELLA-W1 together with this antenna trace design, the circuit trace layout must be made in strict compliance with the instructions below.

All the components placed on each RF trace must be kept as indicated in the reference design, even if not used. The PCB areas of unused reference designs must be flooded with ground.

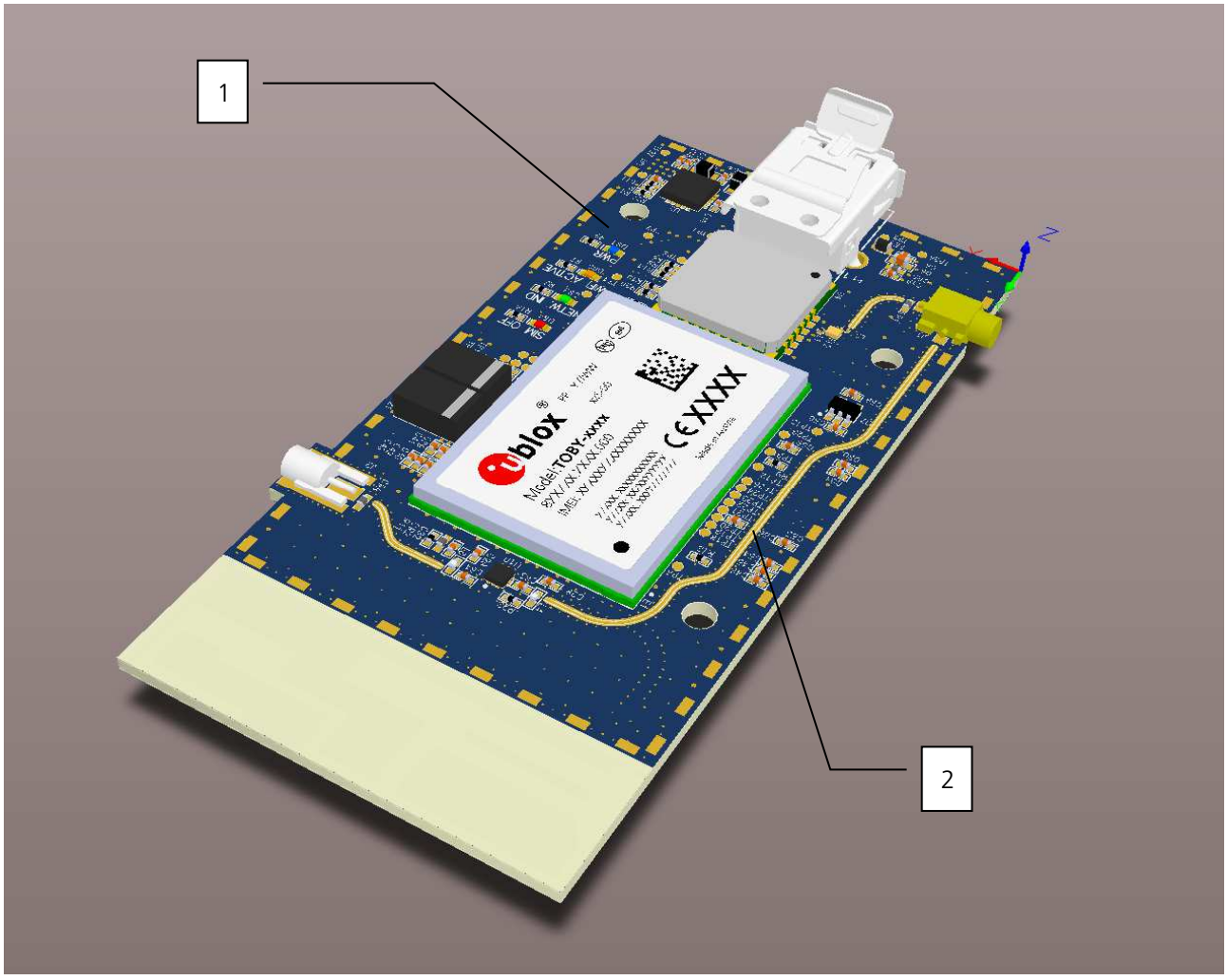

Figure 1: Antenna Trace design embedded in Global Cellular Modem

Reference	Description
1	GCM - Host carrier PCB (blue)
2	Antenna trace design (orange)
…	

3.1 Floor plan and PCB stack-up

This section describes where the critical components are positioned on the antenna trace design. It also presents the stack-up of the PCB.

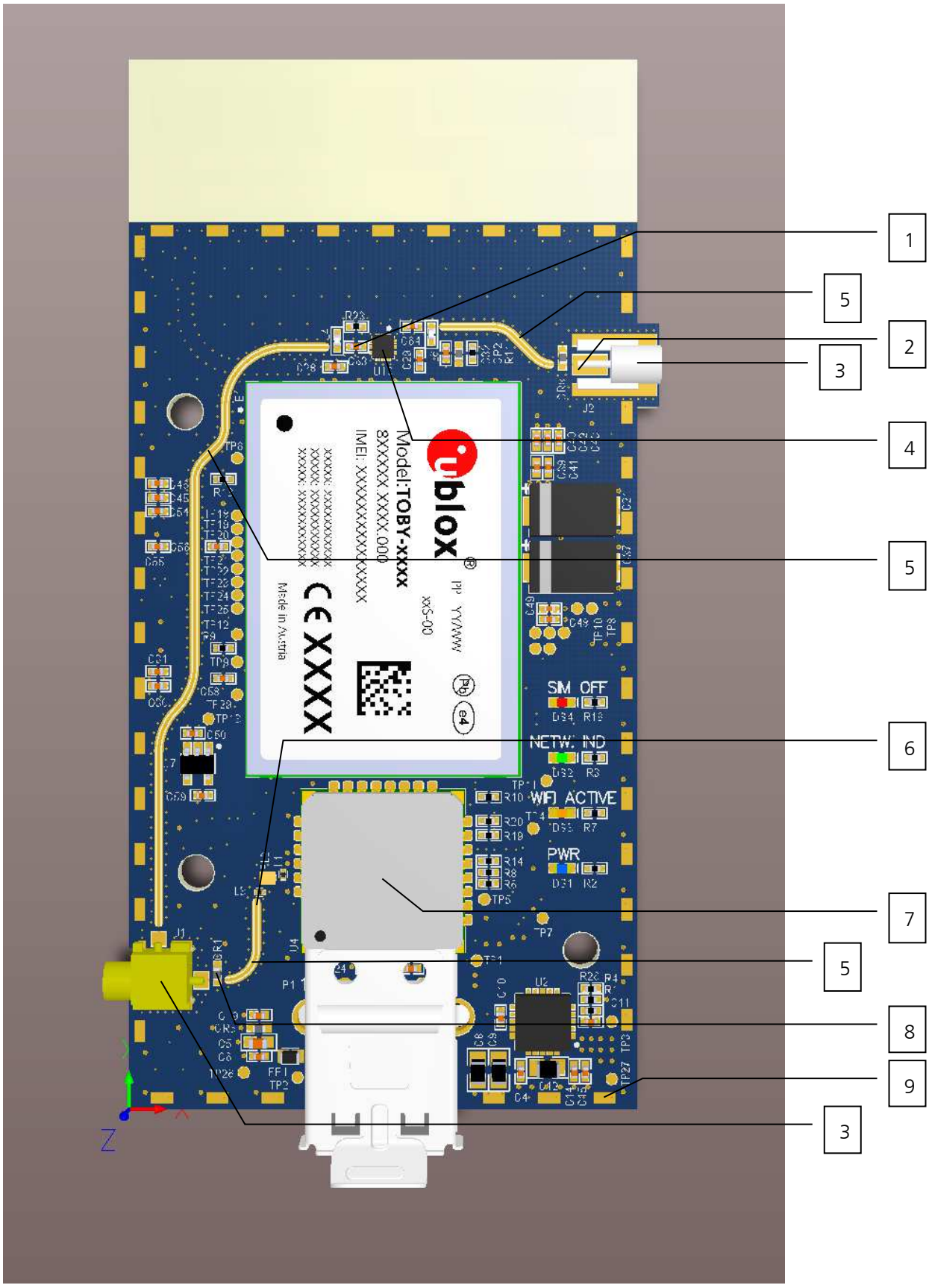

Figure 2: ELLA-W1 module antenna trace design

Reference	Description
1	AC/DC Decoupling (C63, C64)
2	ESD Protection (CR8)
3	Connectors for external antennas (J1, J2)
4	RF Switch SP2T (U10)
5	Antenna coplanar micro-strip, matched to 50 □
6	WLAN/BT LTE Coexistence Filter (L1, FL2, L3)
7	ELLA-W1 module (U4)
8	ESD Protection (CR1)
9	Top layer GND-plane

3.2 PCB stack-up

The stack-up used in the GCM design is specified in Table 2.

Layer	Name	Material	Thickness	Constant	Board Layer Stack
1	Top Overlay				
2	Top Solder	Solder Resist	0.010mm	3.5	
3	Component Side	Copper	0.035mm		
4	Dielectric 2 x 1080	FR-4	0.154mm	4.2	
5	Ground Plane	Copper	0.035mm		
6	Dielectric 6 x 7628	FR-4	1.200mm	4.2	
7	Signal Layer 1	Copper	0.035mm		
8	Dielectric 2 x 1080	FR-4	0.154mm	4.2	
9	Solder Side	Copper	0.035mm		
10	Bottom Solder	Solder Resist	0.010mm	3.5	
11	Bottom Overlay				

Table 2: Stack-up of GCM

3.2.1 RF trace specification

The 50 Ω coplanar micro-strip dimensions used in GCM designs are stated in Figure 2 and Table 3.

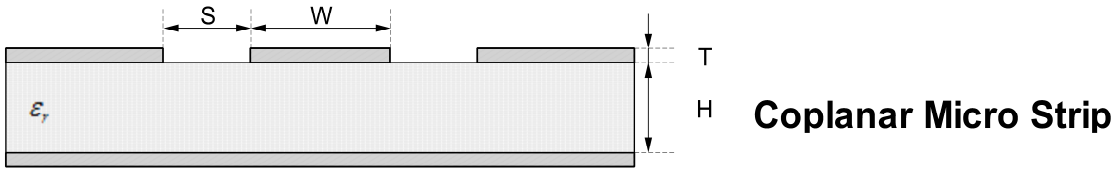

Figure 3: Coplanar micro-strip dimension specification

Item	Value
S	150 um
W	265 um
T	35 um
H	154 um

Table 3: Coplanar micro-strip specification

3.3 Mechanical dimensions

The mechanical dimensions and position of the components are specified in Figure 4.

The layer beneath the 'top layer' is ground plane (4 layers PCB design). No RF traces are routed in this layer.

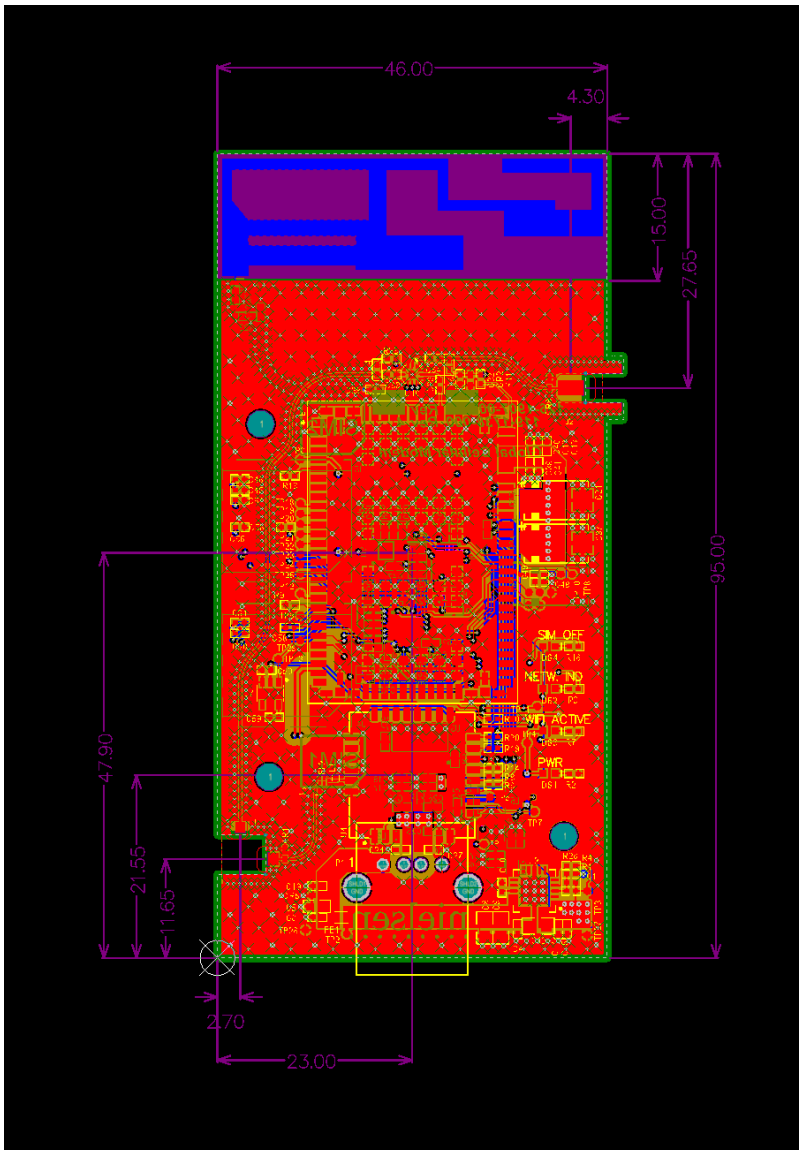

Figure 4: Mechanical dimensions of GCM top layer

4 Reference design for antenna pin 1

This section describes the GCM designs variants for the antenna pin 1 of the ELLA-W1 module.

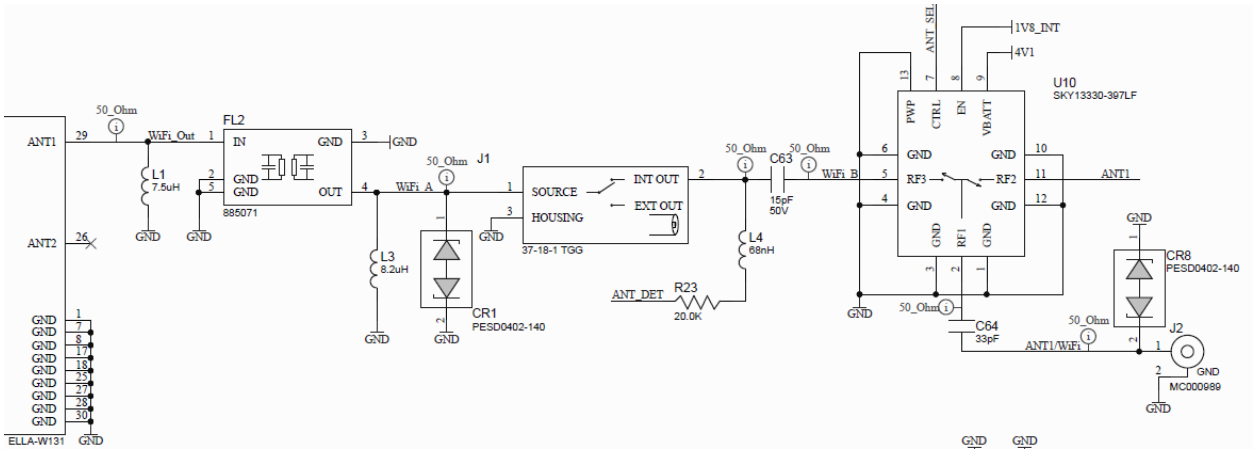

Figure 5: Schematic for ELLA-W1 antenna pin 1

4.1 Internal antenna

GCM design don't include internal Wi-Fi antenna.

4.2 External antenna

The GCM design implement external Wi-Fi antenna usage. External Wi-Fi antenna can be connected to one of MMCX coaxial connectors found on GCM device. If antennas are present on both connectors ELLA-W1 module will use antenna connected to J1 connector. If only one antenna connected to connector J2 it will be shared in functionality between ELLA-W1 and TOBY module (mutually exclusive). Antenna sharing is regulated via RF IC switch U10 driven from TOBY module. In this antenna configuration ELLA-W1 and TOBY modules are not supposed to operate antenna simultaneously.

External antenna p/n:

- Taoglas WiFi Antenna FXP73.09.0016A (connects only to J1 connector)
- Taoglas LTE Antenna GSA.8827r.a.201911 (connects only to J2 connector)
- Evercom LTE Antenna WG-UMB-TC883 (connects only to J2 connector)

4.2.1 Wi-Fi RF trace bill of materials

Reference designator	Description	Manufacturer	P/N
U10	IC, SMT, Switch RF, SP2T, 0.1 -6GHz, SKY13330-397LF, QFN12	Skyworks Solutions, Inc.	SKY13330-397LF
CR1-CR8	Discrete, SMT, Diode, TVS, 14 V, Bidirectional, PESD0402-140, 0402	TE Connectivity	PESD0402-140
J1	Connector, SMT, Female, MMCX, Straight edge mount, Switching	Multicomp	37-18-1 TGG
J2	Connector, SMT, Female, MMCX, Straight edge mount	Multicomp	MC000989
FL2	Filter, SMT, BAW Bluetooth/WLAN with LTE, 885071	TriQuint Semiconductor	885071
L1	Inductor, SMT, High Frequency, 7.5nH, 3%, 0201	Murata	LQP03TN7N5H02
L3	Inductor, SMT, High Frequency, 8.2nH, 3%, 0201	Murata	LQP03TN8N2H02

Reference designator	Description	Manufacturer	P/N
C63	Capacitor, SMT, 15pF @ 50V,+-0.5pF, NPO, Ceramic, Self-Resonant Frequency in 1800/1900 MHz range, 0402	Murata	GRM1555C1E150J
C64	Capacitor, SMT, 33pF @ 50V,5%, NPO, Ceramic, 0402	Murata	GRM1555C1H330J*

5 Approved external antenna list

For ELLA-W1 Bluetooth and Wi-Fi operations in the 2.4 GHz band, the module has been tested and approved for use with antennas listed in Table 4.

Model name	Connector	Manufacturer and description	Antenna Type	Gain [dBi] (peak)
FXP73.09.0016A	J1	Taoglas WiFi Antenna	Dipole	3
GSA.8827r.a.201911	J2	Taoglas LTE Antenna	Dipole	2
WG-UMB-TC883	J2	Evercom LTE Antenna	Dipole	3.8

Table 4: Approved antennas list, single-band operation