FE4NA0210
FE4NA0110

OEM Manual and User Guide v 4.0

(to be used for certification)

FCC ID: LHJ-FE4NA0210
IC: 2807E-FE4NA0210

Terms and Acronyms

CDMA	Code Division Multiple Access
UMTS	Universal Mobile Telecommunication System
WCDMA	Wideband Code Division Multiple Access
LTE	Long Term Evolution
LTE-A	LTE-Advanced
GLONASS	GLObalnaya NAvigatsionnaya Sputnikovaya Sistema
GNSS	Global Navigation Satellite System
DCM-TCU	Data Connectivity Module
DRX	Discontinuous Reception
ES	Engineering Sample
FDD	Frequency Division Duplex
GPIO	General Purpose Input Output
GSM	Global System for Mobile
HU	USB host
HSIC	High Speed Inter-Chip
PCIe	Peripheral Component Interconnect Express
MP	Mass Production
NAD	Network Access Device
OEM	Original Equipment Manufacturer
PCB	Printed Circuit Board
PHY	Physical Layer
SIM	Subscriber Identity Module
TDD	Time Division Duplex
TSP	Telematics Service Provider

FE4NA0210 and FE4NA0110 Modules

The FE4NA0210 and FE4NA0110 NADs are proprietary embedded modules designed by Continental Automotive Systems, Inc. The modules will be integrated into Data Connectivity Modules (DCM-TCUs) or USB hosts (HUs) designed and produced by Continental or by a 3rd party for use by automotive OEMs. DCM-TCUs will be installed into vehicles during the OEM's factory assembly process and will not be accessible without use of special tools. Primary use-cases are data-centric with data and voice connections to Telematics Service Providers (TSP).

1 Key Features

Air Interface Support

- LTE FDD: 3GPP Rel 14
- LTE FDD: DL Category-9 / UL Category-5
- UMTS: HSUPA CAT6 (up to 5.76-Mbps), HSPA CAT14 (up to 21-Mbps) or HSPA CAT24 (up to 42-Mbps) depending on configuration
- VoLTE – HD Voice
- Embedded Qualcomm GNSS Sub-system, Gen9v2
- GPS, Glonass, Beidou, Galileo Receiver
- SBAS supported: EGNOS/MSAS/QZSS/WAAS/GAGAN
- Able to track ~40 channels simultaneously

2 Regulatory Compliance Notes

FCC:

This device complies with Part 15, Part 22(H), Part 24(E) and Part 27 of the FCC Rules. The FCC ID for this device is LHJ-FE4NA0210. Operation is subject to the following two conditions:

1. This device may not cause harmful interference.

2. This device must accept any interference received, including interference that may cause undesired operation.

Industry of Canada:

This device complies with Industry Canada's license-exempt RSSs. Operation is subject to the following two conditions:

(1) This device may not cause interference; and

(2) This device must accept any interference, including interference that may cause undesired

operation of the device."

« Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes :

(1) l'appareil ne doit pas produire de brouillage, et

(2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le

brouillage est susceptible d'en compromettre le fonctionnement. »

This radio transmitter (2807E-FE4NA0210) has been approved by Industry Canada to operate with the antenna types listed below with the maximum permissible gain indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

« Le présent émetteur radio (2807E-FE4NA0210) a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés ci-dessous et ayant un gain admissible maximal. Les types d'antenne non inclus dans cette liste, et dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur.».

3 Device Installation and User Manual

The FE4NA0210 and FE4NA0110 modules are proprietary product designed and manufactured by Continental Automotive Systems, Inc. for integration into telematics control units manufactured by Continental Automotive Systems, Inc.

i. The module is limited to installation ONLY in an integrated device manufactured by Continental Automotive Systems, Inc.

ii. During manufacturing process of the integrated device, the module is soldered onto the pcb of the integrated device.

iii. The integrated device must provide RF connectors to external antennas or RF traces to connect the FE4NA0210 and FE4NA0110 modules to antennas inside the integrated device. The typical reference design for the RF trace layout, including pcb stack-up and trace length is described in Section 6 of this document.

iv. Automotive OEM is responsible for ensuring that the end-user has no manual instructions to remove or install module.

v. The module is limited to installation in mobile applications, according to Part 2.1091(b).

vi. No other operation configurations are allowed.

vii. Changes or modifications to this system by other than a facility authorized by Continental could void authorization to use this equipment.

viii. The module does not have a pre-defined antenna. Under No conditions may an antenna gain be used that would exceed the ERP and EIRP power limit as specified in Part 22, Part 24 and Part 27.

ix. The integrator is responsible for fulfilling FCC and IC requirements for the integrated device. SAR is related to the final product’s implementation and should be assessed based on its proximity to human body.

If Continental chooses to re-use modular approval, then the TCU shall be clearly labeled with an external label containing the integrated modem’s FCC ID. For example, the label can include text “Contains device with FCC ID: LHJ-FE4NA0210 and IC: 2807E-FE4NA0210”.

4 Antenna requirements for use with FE4NA0210 and FE4NA110 modules:

- The FE4NA0210 and FE4NA0110 modules are for use with external antennas ONLY.

- Based on FCC OET Bulletin 65 Supplement C and 47 CRF §2.1091, for all standalone LTE/WCDMA operations the maximum antenna gain including cable loss shall not exceed the following values:
    - UMTS Band 2: 9.0 dBi
    - UMTS Band 4: 6.0 dBi
    - UMTS Band 5: 10.0 dBi
    - LTE Band 2: 9.0 dBi
    - LTE Band 4: 6.0 dBi
    - LTE Band 5: 10.0 dBi
    - LTE Band 12: 9.0 dBi
    - LTE Band 13: 9.0 dBi
    - LTE Band 14: 9.0 dBi
    - LTE Band 66: 6.0 dBi

- Based on RSS-102 Issue 5, for all standalone LTE/WCDMA operations the maximum antenna gain including cable loss shall not exceed the following values:
    - UMTS Band 2: 9.0 dBi
    - UMTS Band 4: 6.0 dBi
    - UMTS Band 5: 7.0 dBi
    - LTE Band 2: 9.0 dBi
    - LTE Band 4: 6.0 dBi
    - LTE Band 5: 7.0 dBi
    - LTE Band 12: 6.50 dBi
    - LTE Band 13: 6.50 dBi
    - LTE Band 14: 6.50 dBi
    - LTE Band 66: 6.00 dBi

- Based on FCC OET Bulletin 65 Supplement C and 47 CRF §2.1091, for all collocated LTE/WCDMA operations the maximum antenna gain including cable loss shall not exceed the following values:
    - UMTS Band 2: 9.0 dBi
    - UMTS Band 4: 6.0 dBi
    - UMTS Band 5: 8.0 dBi
    - LTE Band 2: 9.0 dBi
    - LTE Band 4: 6.0 dBi
    - LTE Band 5: 8.0 dBi
    - LTE Band 12: 8.0 dBi
    - LTE Band 13: 8.0 dBi
    - LTE Band 14: 8.0 dBi
    - LTE Band 66: 6.0 dBi

- Based on RSS-102 Issue 5, for all collocated LTE/WCDMA operations the maximum antenna gain including cable loss shall not exceed the following values:
    - UMTS Band 2: 6.0 dBi
    - UMTS Band 4: 5.50 dBi
    - UMTS Band 5: 3.50 dBi
    - LTE Band 2: 6.0 dBi
    - LTE Band 4: 5.50 dBi
    - LTE Band 5: 3.50 dBi
    - LTE Band 12: 3.50 dBi
    - LTE Band 13: 3.50 dBi
    - LTE Band 14: 3.50 dBi
    - LTE Band 66: 5.50 dBi

- This radio transmitter (FCC ID: LHJ-FE4NA0210; IC: 2807E- LHJ-FE4NA0210) has been approved by FCC and Industry Canada to operate with the antenna types listed below with the maximum permissible gain indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

- « Le présent émetteur radio (ID: LHJ-FE4NA0210; IC: 2807E-FE4NA0210) a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés ci-dessous et ayant un gain admissible maximal. Les types d'antenne non inclus dans cette liste, et dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur.»

5 Instructions to OEMs:

Continental must instruct the automotive OEM and provide them to include the following information into the car user’s manual:

1. End-users must be provided with transmitter/antenna installation requirements and operating conditions for satisfying RF exposure compliance:
2. A separate section should clearly state “FCC RF Exposure requirements:”
3. Required operating conditions for end users.
4. The antenna used with this device must be installed to satisfy RF exposure compliance. The antenna gain, including cable loss, must not exceed values listed above.
5. Under no conditions may an antenna gain be used that would exceed the ERP and EIRP power limits as specified in Parts 15, 22H, 24E, and 27.
6. Clear instructions describing the other party’s responsibility to obtain station licensing.

6 Layout and Routing Recommendations

6.1 Module Specific

The pad spacing of 0.7mm should allow the placement of a 450um finished VIA between pads, while maintaining a 125um via-to-trace or via-to-pad spacing, to facilitate the breakout of inner row signals. The 0.7mm spacing is also large enough to route two 160um (6mil) traces between pads.

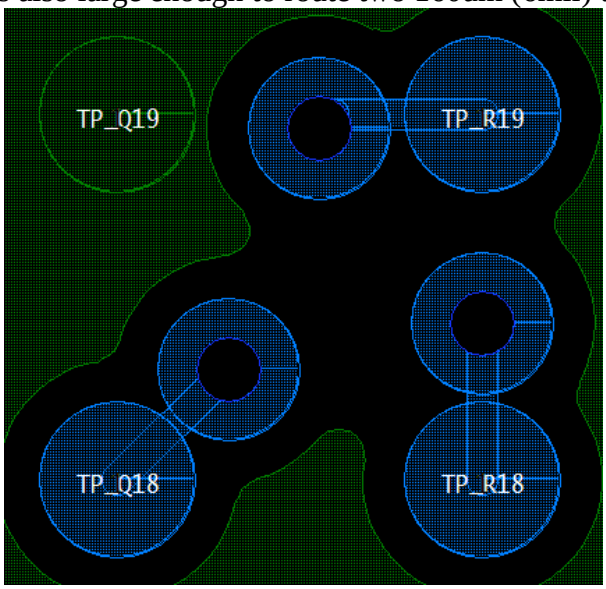

Figure 1: Vias placed between Pads

6.2 RF Traces for antennas

The NAD has eight antenna pins.

- LTE_ANT_1
- LTE_ANT_2
- LTE_ANT_3
- LTE_ANT_4
- GNSS_ANT_1
- GNSS_ANT_2
- CV2X_ANT_1
- CV2X_ANT_2

Multi-transmission is not possible. The figure below shows the general breakout of the module:

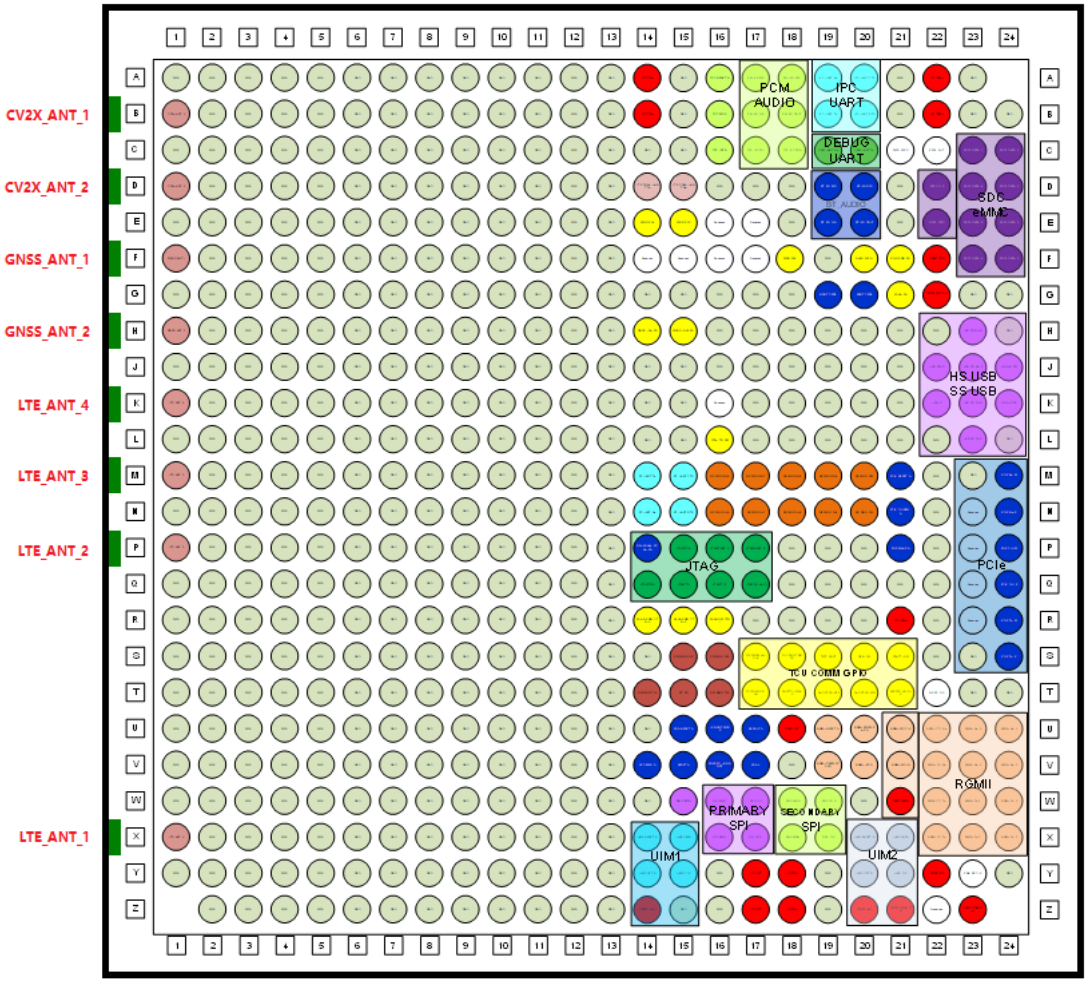

Figure 2: NAD Pin Breakout

The FE4NA0210 and FE4NA0110 NADs should be oriented on the main board to minimize the length of the primary LTE TX/RX antenna (LTE_ANT_1). This 50ohm line should be as short as possible to the external RF connector or internal antenna feed point.
The RF traces from the NAD antenna pins on the main board can be stripline or microstrip.

For routing microstrip lines UNDERNEATH the NAD on layer 1, these ground cutouts internal to the NAD need to be accounted for in the stripline calculation. The internal GND height and dielectric constant of the NAD board are shown below:

H = 19.3 mils (491 micron)
Dielectric Constant = 4.1

For example, consider the following stackup for a main PCB:

		Thickness in microns	Tolerance in microns	Thickness in mils
	Solder Mask	30 micron	+11 micron	1.17 mil
Plated 0.5oz Cu	ML1	49 micron	+/-10 micron	1.91 mil
7628 x 1+1080 x 1 Prepreg	DL1	253 micron	+/-38 micron	9.88 mil
1oz Cu	ML2	36 micron	+/-10 micron	1.41 mil
2116 x 2 Core	DL2	254 micron	+/-38 micron	9.92 mil
1oz Cu	ML3	36 micron	+/-10 micron	1.41 mil
2165 x 2 Prepreg	DL3	277 micron	+/-38 micron	10.82 mil
1oz Cu	ML4	36 micron	+/-10 micron	1.41 mil
2116 x 2 Core	DL4	254 micron	+/-38 micron	9.92 mil
1oz Cu	ML5	36 micron	+/-10 micron	1.41 mil
7628 x 1+1080 x 1 Prepreg	DL5	253 micron	+/-38 micron	9.88 mil
Plated 0.5oz Cu	ML6	49 micron	+/-10 micron	1.91 mil
	Solder Mask	30 micron	+11 micron	1.17 mil
	Total board thickness:	1593 micron	+272 mu -250 mu	62.23 mil

Figure 3: Recommended PCB Stack-up

Assume the main PCB above with a 6 layer stack up with ground cut away on layer 2 so the microstrip lines reference ground on layer 3. The dielectric thickness from L1 to L3 is 21.2 mils.

Using an online impedance calculator, the line width under the NAD for a 50 ohm line is 15.9mils (405micron) shown below:

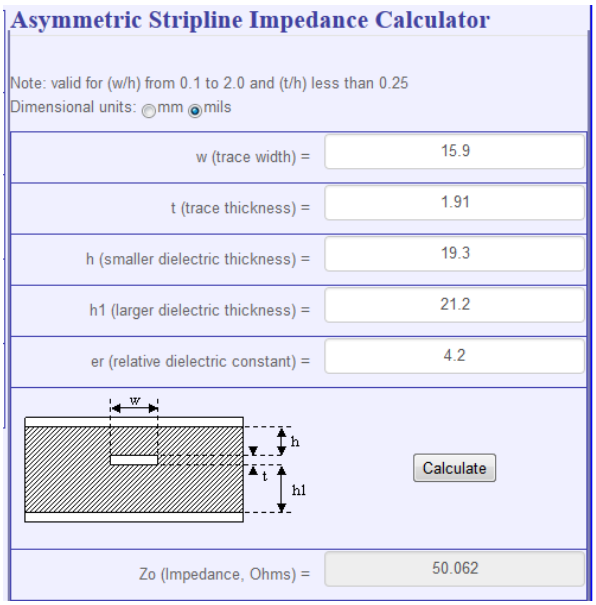

Figure 4: Stripline Impedance Calculations

The calculation for the microstrip line width outside the NAD is 37.7mils (967micron) shown below:

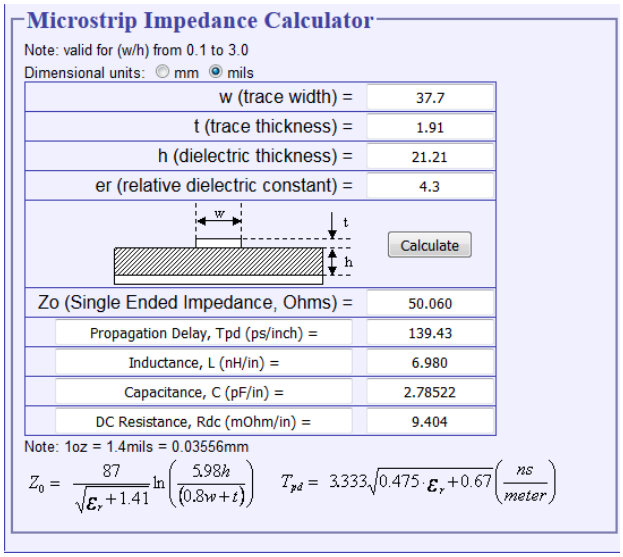

Figure 5: Microstrip Impedance Calculations

Due to the nature of the weave chosen for each PCB, the dielectric constant of the NAD board is 4.1 while the main board is 4.3. A dielectric constant of 4.2 was chosen in the stripline calculation, while 4.3 was used for the microstrip calculation.

Main board stack up may vary so these line widths may need to be recalculated. IT IS HIGHLY RECOMMENDED TO USE A SIMILAR STACKUP AS SHOWN IN FIGURE 3.

Antenna Routing Recommendations:

1. Microstrip routes on layer1 and very short route under the NAD.

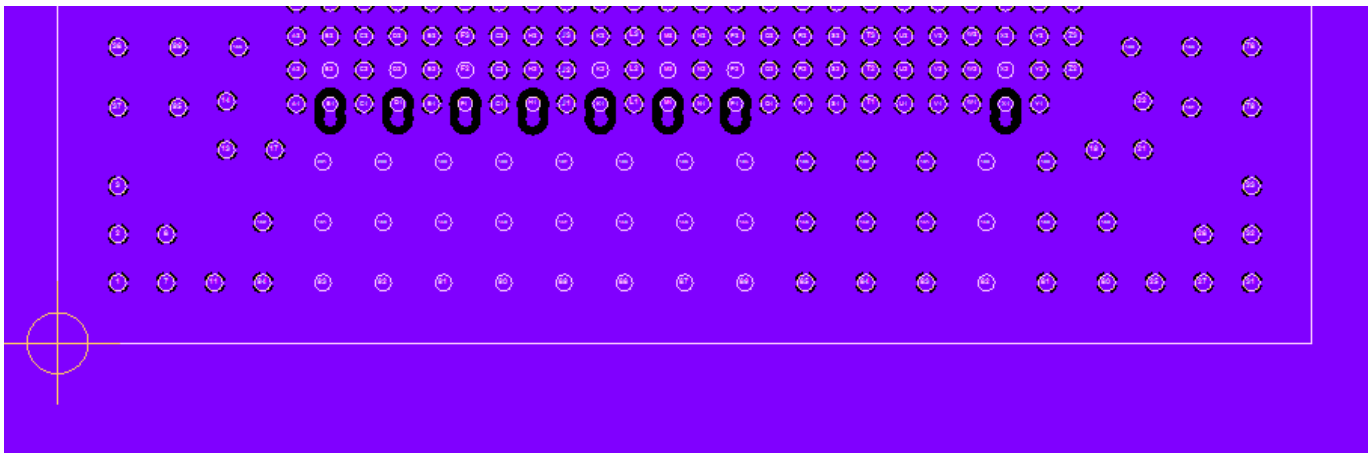

Figure 6: Antenna Line Microstrip Routes on Layer1

2. Then routes to inner layer and continues route as stripline.

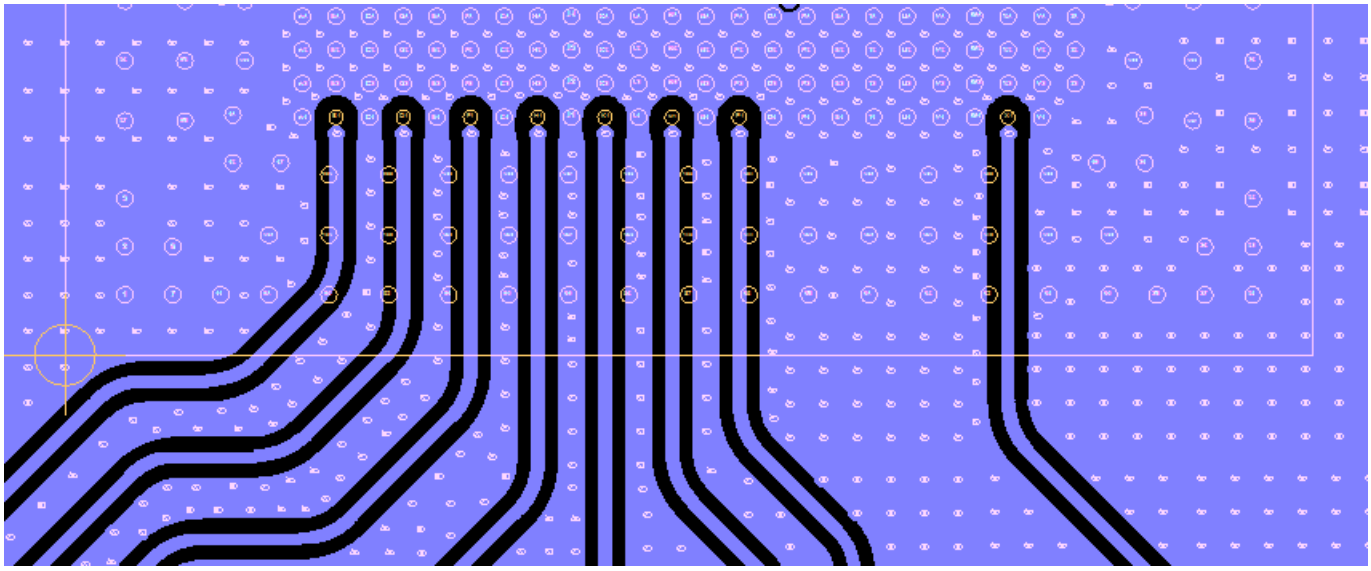

Figure 7: Antenna Line Stripline Routes On Inner Layer

These line widths may vary depending on the stack up selected for the main board.

6.3 RF Antenna Layout Parameters

Type of Guidance	Requirement
Trace impedance	50-Ohms ± 10% single-ended
Total route length	<100-mm
Ground between signals	> 1 x line width of ground trace between, stitched VIA to ground
Ground between signals	> 3 x line width of ground trace between, stitched VIA to ground
Spacing to other signals	< 3:1

- The RF signals should be routed STRAIGHT OUT OF THE NAD TO THE NEAREST EDGE along similar route pat but separated by ground trace.
- Trace impedances should match the table, either as microstrip or stripline.
- Total length for both signals should be kept to a minimum always optimizing the PRIMARY_ANT (LTE_ANT_1) path.
- Spacing to ground or other signals on outside of bundled signals should match the table.