



Continental FE4NA0210 Proprietary Embedded Module User Guide

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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 the use of special tools. Primary use-cases are data-centric with data and voice connections to Telematics Service Providers (TSP).

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 42Mbps) 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

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 RSS. 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."

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.

Device Installation and User Manual

The FE4NA0210 and FE4NA0110 modules are proprietary products 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 the 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 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 the 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 the text "Contains device with FCC ID: LHJ-FE4NA0210 and IC: 2807E-FE4NA0210".

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 CFR §2.1091, for all standalone LTE/WCDMA operations the maximum antenna gain including cable loss shall not exceed the following values:
 - o UMTS Band 2: 9.0 dBi
 - o UMTS Band 4: 6.0 dBi
 - o UMTS Band 5: 10.0 dBi
 - o LTE Band 2: 9.0 dBi
 - o LTE Band 4: 6.0 dBi
 - o LTE Band 5: 10.0 dBi
 - o LTE Band 12: 9.0 dBi
 - o LTE Band 13: 9.0 dBi
 - o LTE Band 14: 9.0 dBi
 - o 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:
 - o UMTS Band 2: 9.0 dBi
 - o UMTS Band 4: 6.0 dBi
 - o UMTS Band 5: 7.0 dBi
 - o LTE Band 2: 9.0 dBi
 - o LTE Band 4: 6.0 dBi
 - o LTE Band 5: 7.0 dBi
 - o LTE Band 12: 6.50 dBi
 - o LTE Band 13: 6.50 dBi
 - o LTE Band 14: 6.50 dBi
 - o LTE Band 66: 6.00 dBi
- Based on FCC OET Bulletin 65 Supplement C and 47 CFR §2.1091, for all collocated LTE/WCDMA operations the maximum antenna gain including cable loss shall not exceed the following values:
 - o UMTS Band 2: 9.0 dBi
 - o UMTS Band 4: 6.0 dBi
 - o UMTS Band 5: 8.0 dBi
 - o LTE Band 2: 9.0 dBi
 - o LTE Band 4: 6.0 dBi
 - o LTE Band 5: 8.0 dBi
 - o LTE Band 12: 8.0 dBi
 - o LTE Band 13: 8.0 dBi
 - o LTE Band 14: 8.0 dBi
 - o 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:

- o UMTS Band 2: 6.0 dBi
- o UMTS Band 4: 5.50 dBi
- o UMTS Band 5: 3.50 dBi
- o LTE Band 2: 6.0 dBi
- o LTE Band 4: 5.50 dBi
- o LTE Band 5: 3.50 dBi
- o LTE Band 12: 3.50 dBi
- o LTE Band 13: 3.50 dBi
- o LTE Band 14: 3.50 dBi
- o 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.

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 the 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.

Layout and Routing Recommendations

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.

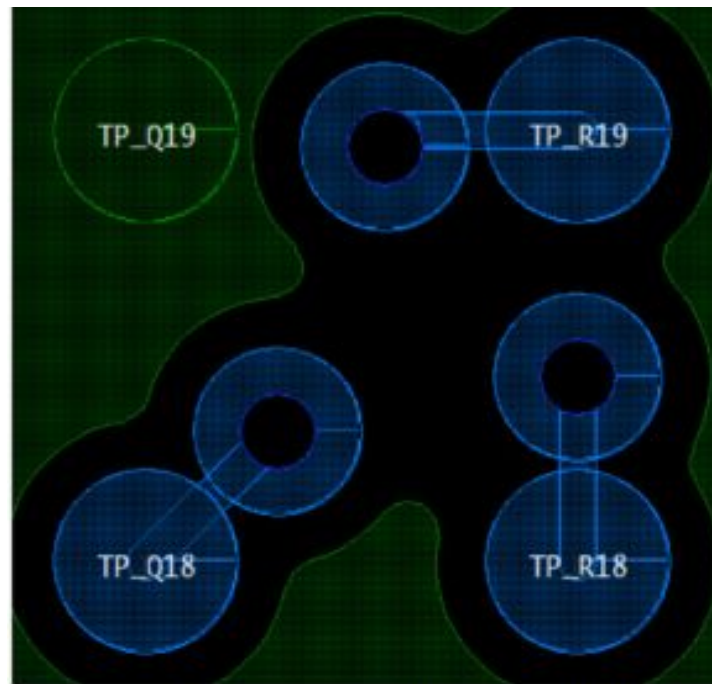


Figure 1: Vias placed between Pads

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:

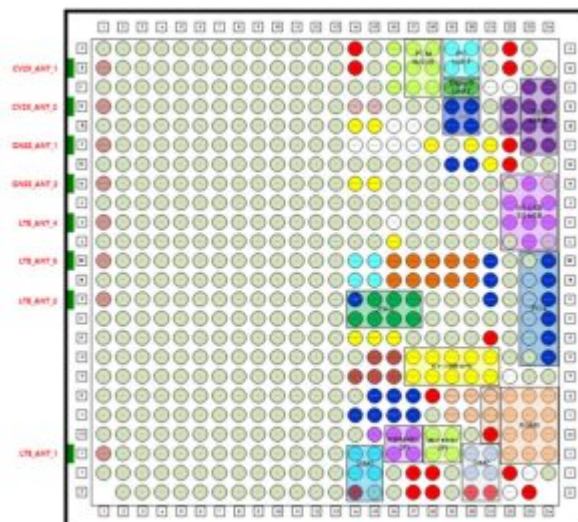


Figure 2: NAD Pin Breakout

The FE4NA0210 and FE4NA0110 NADs should be oriented on the mainboard 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 mainboard 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 stack up for the main PCB:

		Thickness in mils	Tolerance in mils	Thickness in mils
Plated 0.5oz Cu	1.8 mils	10 mils	+0.1 mils	1.7 mil
7628 ± 0.0005 ± 1 Prepreg	18.1 mils	49 mils	+0.10 mils	1.8 mil
Isot Cu	1.8 mils	10 mils	+0.10 mils	1.7 mil
2118 ± 0.0005 ± 2 Core	18.1 mils	274 mils	+0.10 mils	1.8 mil
Isot Cu	1.8 mils	10 mils	+0.10 mils	1.7 mil
2165 ± 0.0005 ± 1 Prepreg	18.1 mils	271 mils	+0.10 mils	1.8 mil
Isot Cu	1.8 mils	10 mils	+0.10 mils	1.7 mil
2118 ± 0.0005 ± 2 Core	18.1 mils	274 mils	+0.10 mils	1.8 mil
Isot Cu	1.8 mils	10 mils	+0.10 mils	1.7 mil
7628 ± 0.0005 ± 1 Prepreg	18.1 mils	273 mils	+0.10 mils	1.8 mil
Plated 0.5oz Cu	1.8 mils	49 mils	+0.10 mils	1.7 mil
		10 mils	+0.10 mils	1.7 mil
Total board thickness:	199.3 mils	+0.10 mils	-0.10 mils	199.3 mil

Figure 3: Recommended PCB Stack-up

Assume the main PCB above with a 6 layer stack up with ground cutaway 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:

Asymmetric Stripline Impedance Calculator

Note: valid for (w/h) from 0.1 to 2.0 and (t/h) less than 0.25
Dimensional units: ☐ mm ☒ mils

w (trace width) =	15.9
t (trace thickness) =	1.91
h (smaller dielectric thickness) =	19.3
h1 (larger dielectric thickness) =	21.2
er (relative dielectric constant) =	4.2

Zo (Impedance, Ohms) =	50.062
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Figure 4: Stripline Impedance Calculations


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

Microstrip Impedance Calculator

Note: valid for (w/h) from 0.1 to 3.0

Dimensional units: ☐ mm ☒ mils

w (trace width) =	37.7
t (trace thickness) =	1.91
h (dielectric thickness) =	21.21
er (relative dielectric constant) =	4.3



Z ₀ (Single Ended Impedance, Ohms) =	50.060
Propagation Delay, T _{pd} (ps/inch) =	139.43
Inductance, L (nH/in) =	6.980
Capacitance, C (pF/in) =	2.78522
DC Resistance, R _{dc} (mOhm/in) =	9.404

Note: 1oz = 1.4mils = 0.03556mm

$$Z_0 = \frac{87}{\sqrt{\epsilon_r + 1.41}} \ln \left(\frac{5.98h}{(0.8w + t)} \right) \quad T_{pd} = 3.333 \sqrt{0.475 \epsilon_r + 0.67} \left(\frac{ns}{meter} \right)$$

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.

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

Antenna Routing Recommendations:

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

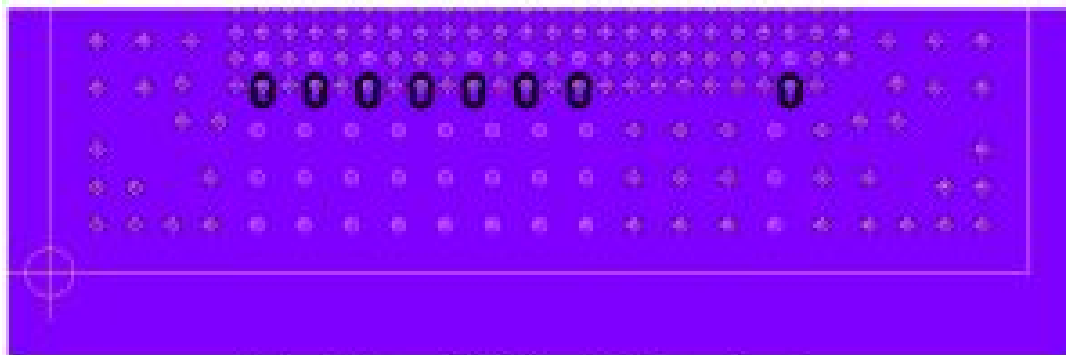


Figure 6: Antenna Line Microstrip Routes on Layer1

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

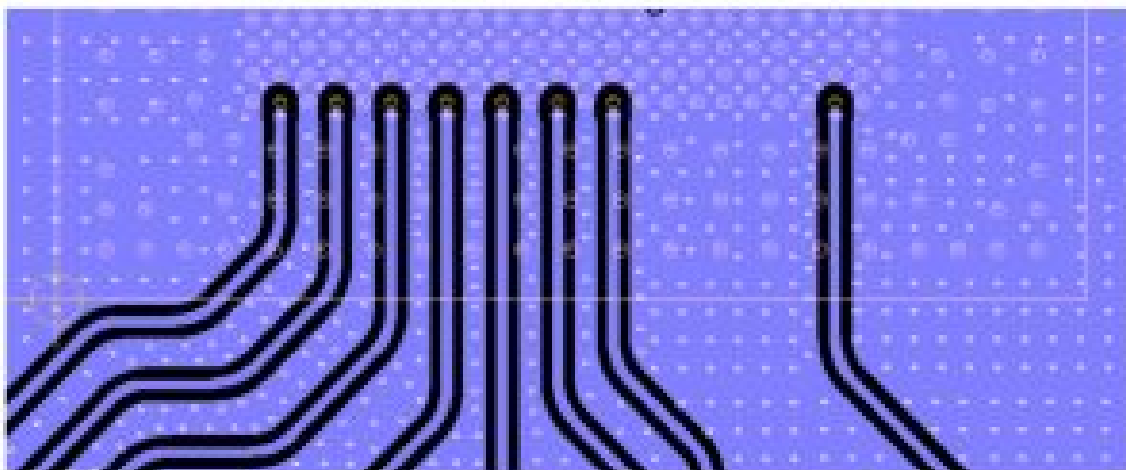


Figure 7: Antenna Line Stripline Routes On Inner Layer


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

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 a similar route pat but separated by ground trace.
- Trace impedances should match the table, either as microstrip or stripline.
- The total length for both signals should be kept to a minimum always optimizing the PRIMARY_ANT (LTE_ANT_1) path.
- Spacing to the ground or other signals outside of bundled signals should match the table.

Documents / Resources

<div>  </div> <div> FE4NA0210 FE4NA0110 QEM Manual and User Guide v 4.0 Not for sale FCC ID: L8J-FE4NA0210 IC: 2812-FE4NA0210 </div>	<div> Continental FE4NA0210 Proprietary Embedded Module [pdf] User Guide FE4NA0210, LHJ-FE4NA0210, LHJFE4NA0210, FE4NA0210, FE4NA0110, FE4NA0210 Proprietary Embedded Module, Proprietary Embedded Module, Embedded Module, Module </div>
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