**Manuals+** — User Manuals Simplified.



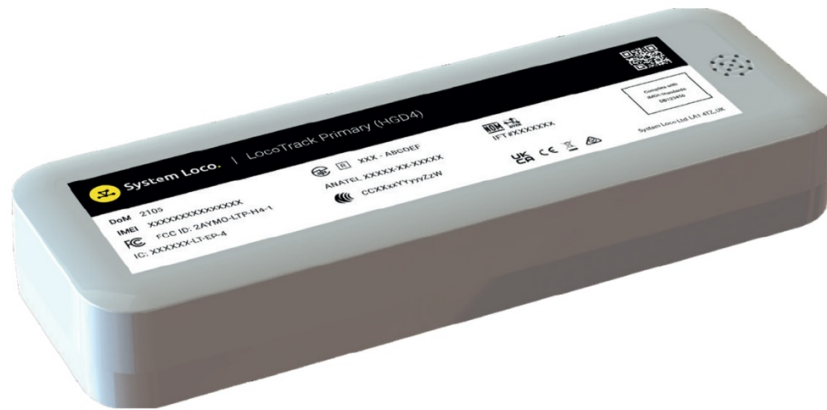# Continental FE4RW0110 NAD Proprietary Embedded Module User Guide

**Contents**

**System-Loco-LTP-H4-1-Primary-LocoTrack-Featured-Image**

**FCC ID:** LHJ-FE4RW0110

## 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

**FE4RW0110**

The FE4RW0110 NAD is a proprietary embedded module 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).

## 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

### Regulatory Compliance Notes

**Europe:**

Hereby, Continental Automotive Systems, Inc, declares that the radio equipment type FE4RW0110 is in compliance with Directive 2014/53/EU. The full test of the EU Declaration of Conformity is available at the following internet address:

**https://www.continental-homologation.com/en-gl/General-Motors**

**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-FE4RW0110. 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.

**Material Statement:**

The End of Life Vehicle Directive (EVL) must be applied to the FE4RW0110 module. This means that the component is included into the overall vehicle (since it is permanently installed) and if the explanation of the materials used and, if applicable, disposal descriptions from the vehicle manufacturer.

## Device Installation and User Manual

The FE4RW0110 modules are proprietary product designed and manufactured by Continental Automotive Systems, Inc. for integration into telematics control units manufactured by Continental Automotive Systems, Inc.

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

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

3. The integrated device must provide RF connectors to external antennas or RF traces to connect the FE4RW0110 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.

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

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

6. No other operation configurations are allowed.

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

8. The module does not have a pre-defined antenna. The module must be installed to provide a separation distance of at least 20 cm from all persons and 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.

9. The module must be installed to provide a separation distance of at least 20 cm from all persons and antenna and must not be co-located or operate in conjunction with any other antenna or transmitter, except in accordance with FCC multi-transmitter evaluation procedures as documented in this filing. Additional testing and certification for SAR will be required if the distance limitation cannot be met.

10. The integrator is responsible for fulfilling FCC and IC requirements for the integrated device. The module must be installed to provide a separation distance of at least 20 cm from all persons and antenna. 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-FE4RW0110".

## Antenna requirements for use with FE4RW0110 modules

- The FE4RW0110 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/GSM operations the maximum antenna gain including cable loss shall not exceed the following values:
  o GSM850: 4.5 dBi
  o GSM1900: 2.5 dBi
  o UMTS Band II: 2.5 dBi
  o UMTS Band IV: 5.5 dBi
  o UMTS Band V: 4.5 dBi
  o LTE Band 2: 2.5 dBi
  o LTE Band 4: 5.5 dBi
  o LTE Band 5: 4.5 dBi
  o LTE Band 7: 9.0 dBi
  o LTE Band 38: 9.0 dBi
  o LTE Band 41: 9.0 dBi
- This radio transmitter (FCC ID: LHJ-FE4RW0110) has been approved by FCC 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.
- Based on EN 62311;2020 and EN 50665:2017, for all standalone LTE/WCDMA/GSM operations the maximum antenna gain including cable loss shall not exceed the following values:
  o GSM900: 6.5 dBi
  o GSM1800: 11.5 dBi
  o UMTS Band 1: 12.0 dBi
  o UMTS Band 3: 11.5 dBi
  o UMTS Band 8: 6.5 dBi
  o LTE Band 1: 12.0 dBi
  o LTE Band 3: 11.5 dBi
  o LTE Band 7: 13.0 dBi
  o LTE Band 8: 6.5 dBi
  o LTE Band 20: 9.0 dBi
  o LTE Band 28: 8.0 dBi
  o LTE Band 38: 13.0 dBi
  o LTE Band 40: 13.0 dBi

## 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.

## 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.
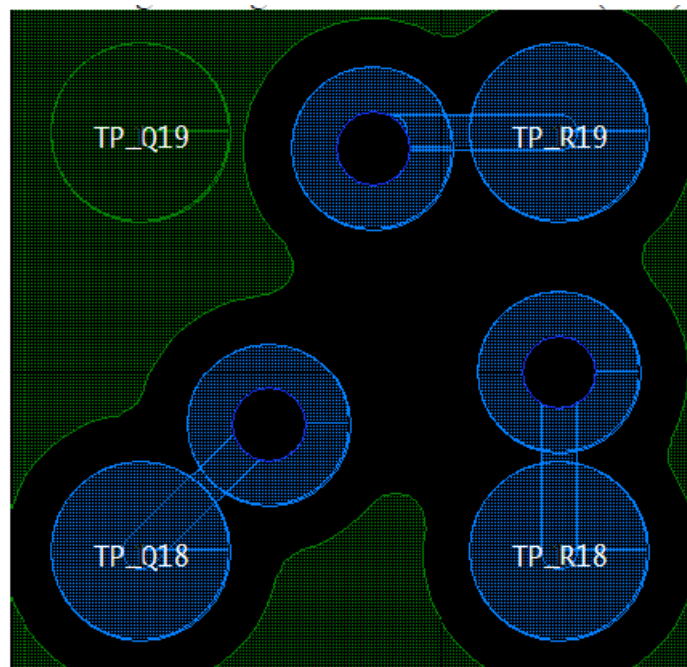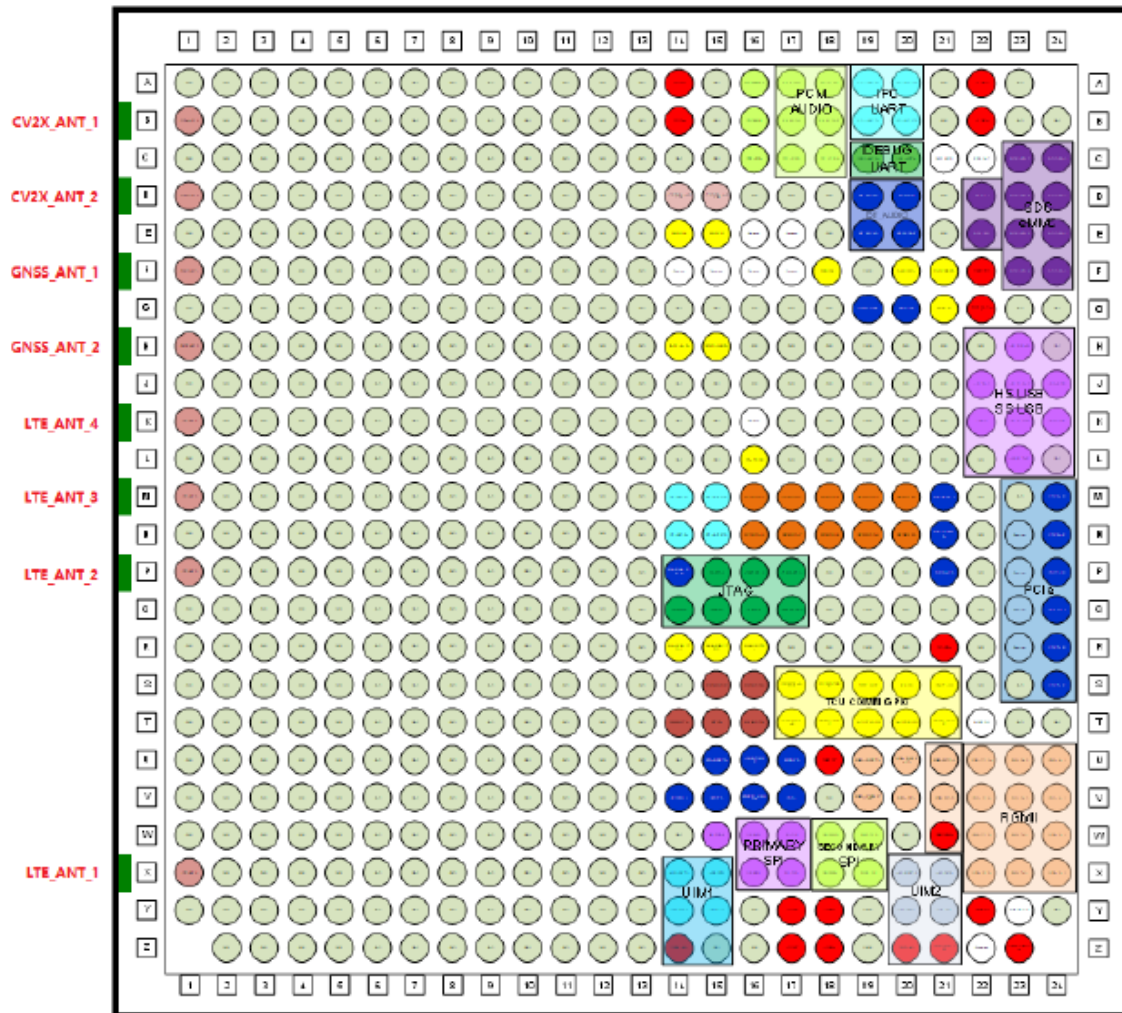


Figure 1: Vias placed between Pads

### 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 FE4RW0110NADs 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**

| | | 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 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
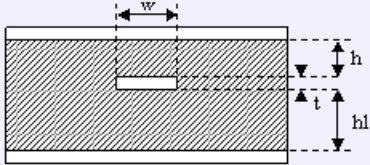Dimensional units: ○mm ●mils

| | |
|---|---|
| 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 |

Calculate

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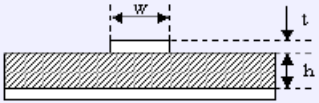
**Figure 4: Stripline Impedance Calculations**

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 |



| | |
|---|---|
| Zo (Single Ended Impedance, Ohms) = | 50.060 |
| Propagation Delay, Tpd (ps/inch) = | 139.43 |
| Inductance, L (nH/in) = | 6.980 |
| Capacitance, C (pF/in) = | 2.78522 |
| DC Resistance, Rdc (mOhm/in) = | 9.404 |

Note: 1oz = 1.4mils = 0.03556mm

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

## 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.
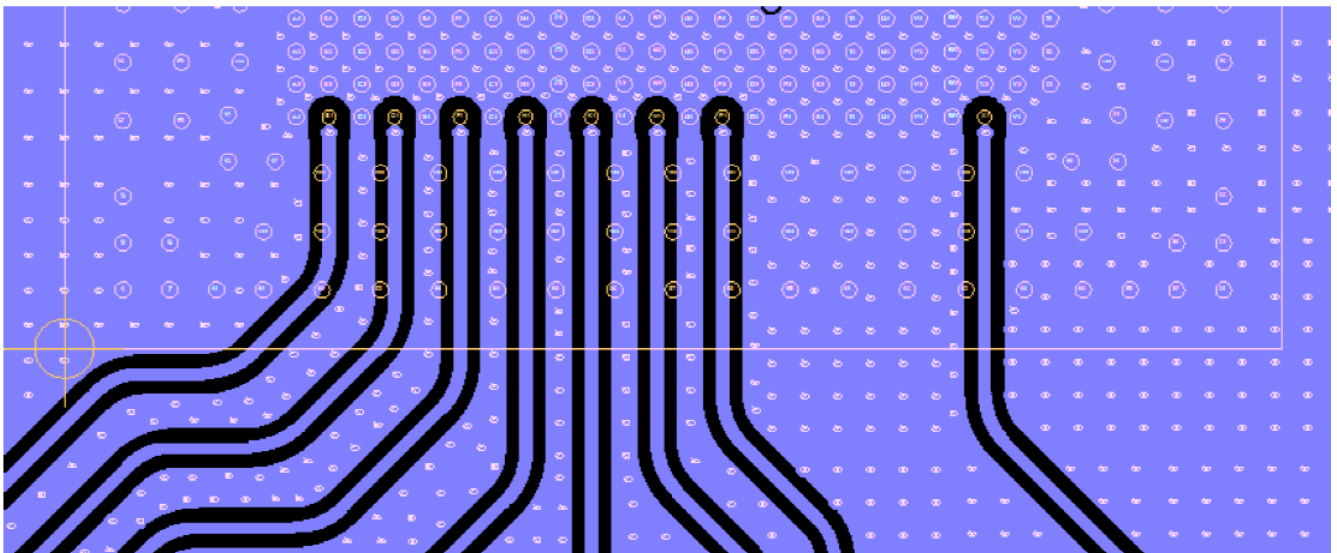
**Antenna Routing Recommendations:**

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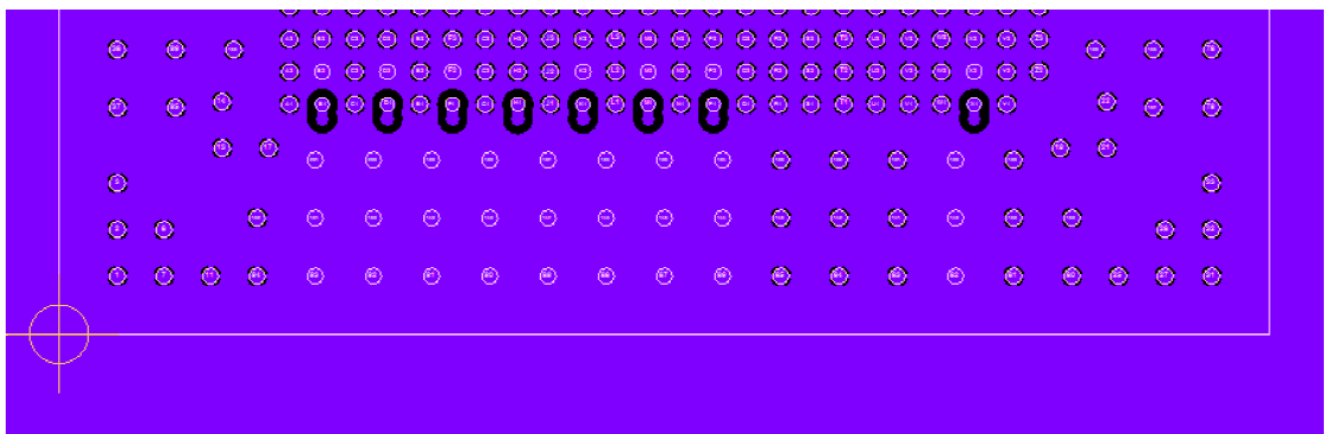


## Figure 6: Antenna Line Microstrip Routes on Layer1

2. Then routes to 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 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.

## Documents / Resources

| | |
|---|---|
| Ⓒntinental<br><br>FE4RW0110<br>OEM Manual and User Guide v 4.2<br>*to be used for certifications*<br>FCC ID: LHJ-FE4RW0110 | **Continental FE4RW0110 NAD Proprietary Embedded Module** [pdf] User Guide<br>FE4RW0110, LHJ-FE4RW0110, LHJFE4RW0110, FE4RW0110 NAD Proprietary Embedded Module, FE4RW0110, NAD Proprietary Embedded Module |