



# BL28NA-RD2

---

OEM Manual and User Guide v 2

(to be used for certification)

FCC ID: LHJ-BL28NARD2

IC ID: 2807E-BL28NARD2

## Terms and Acronyms

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

# BL28NA-RD2 Module

The BL28NA-RD2 NAD is a proprietary modem module designed by Continental Automotive Systems, Inc. The modem will be integrated into Data Connectivity Modules (DCMs) or Head Units (HUs) designed and produced by Continental or by a 3<sup>rd</sup> party for use by automotive OEMs. DCMs 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

### 1.1 LTE CAT4 NAD Module

#### Air Interface Support

- LTE FDD/TDD: 3GPP Rel 10
- LTE FDD CAT4 (up to 150-Mbps UL/50-Mbps DL)
- LTE TDD CAT4 (up to 90-Mbps UL/27-Mbps DL) for TDD Configuration 1
- UMTS: HSUPA CAT 6 (up to 5.76-Mbps), HSPA CAT24 (up to 21-Mbps)

## 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-BL28NARD2. 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.

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

The device must not be co-located or operating in conjunction with any other antenna or transmitter. This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions : (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

### **Industry of Canada:**

This device contains license-exempt transmitter(s)/receiver(s) that comply with Innovation, Science and Economic Development Canada's license-exempt RSS(s). Operation is subject to the following two conditions: (1) This device may not cause interference. (2) This device must accept any interference, including interference that may cause undesired operation of the device.

L'émetteur/récepteur exempt de licence contenu dans le présent appareil est conforme aux CNR d'Innovation, Sciences et Développement économique 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; (2) L'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

### **Radiation Exposure Statement:**

This equipment complies with IC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20cm between the radiator & your body. Additional testing and certification for SAR will be required if the distance limitation cannot be met.

### **Déclaration d'exposition aux radiations:**

Cet équipement est conforme aux limites d'exposition aux rayonnements IC établies pour un environnement non contrôlé. Cet équipement doit être installé et utilisé avec un minimum de 20 cm de distance entre la source de rayonnement et votre corps. Des tests et une certification supplémentaires pour le SAR seront requis si la limitation de distance ne peut pas être respectée.

## **3 Device Installation and User Manual**

The BL28NA-RD2 module is a proprietary product designed and manufactured by Continental Automotive Systems, Inc. for integration into telematics control units manufactured by Continental Automotive Systems, Inc. for automotive OEMs.

- 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 BL28NA-RD2 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 must be installed to provide a separation distance of at least 20 cm from all persons and must not be co-located or operate in conjunction with any other antenna or transmitter; except in accordance with FCC multi-transmitter product procedures. If device is collocated with other transmitters, compliance with regulatory requirements must be done. Additional testing and certification for SAR will be required if the distance limitation cannot be met.
- ix. The integrator is responsible for fulfilling FCC and IC requirements for the integrated device.

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-BL28NARD2 and IC: 2807E-BL28NARD2".

#### 4 Antenna requirements for use with BL28NA-RD2 module:

- The module must be installed to provide a separation distance of at least 20 cm from all persons and must not be co-located or operate in conjunction with any other antenna or transmitter; except in accordance with FCC multi-transmitter product procedures. If device is collocated with other transmitters, compliance with regulatory requirements must be done. Additional testing and certification for SAR will be required if the distance limitation cannot be met.
- The BL28NA-RD2 module is for use with external antennas ONLY.
- For all LTE/WCDMA/GSM operating bands the maximum antenna gain including cable loss shall not exceed the following values:
  - GSM 850: 4.5 dBi
  - GSM 1900: 2.5 dBi
  - WCDMA Band 2: 2.5 dBi
  - WCDMA Band 4: 5.5 dBi
  - WCDMA Band 5: 4.5 dBi
  - LTE Band 2: 2.5 dBi
  - LTE Band 4: 5.5 dBi
  - LTE Band 5: 4.5 dBi
  - LTE Band 7: 9.0 dBi
  - LTE Band 12: 6.5 dBi
- This radio transmitter (FCC ID: LHJ-BL28NARD2; IC: 2807E-BL28NARD2) 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 (FCC ID: LHJ-BL28NARD2; IC: 2807E-BL28NARD2) 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 (i.e. for the DCM):

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 provide a separation distance of at least 20cm from all persons, and must not be co-located or operating in conjunction with any other antenna or transmitter, except in accordance with FCC multi-transmitter product procedures. If device is collocated with other transmitters, compliance with regulatory requirements must be done. Additional testing and certification for SAR will be required if the distance limitation cannot be met.
  5. The Maximum ERP/EIRP and maximum antenna gain required for compliance with Parts 15, 22H, 24E, and 27.
  6. Clear instructions describing the other party’s responsibility to obtain station licensing.
- 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 must be installed to provide a separation distance of at least 20 cm from all persons and must not be co-located or operate in conjunction with any other antenna or transmitter.
- ix. The integrator is responsible for fulfilling FCC and IC requirements for the integrated device.

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-BL28NARD2 and IC: 2807E-BL28NARD2”.

## 6 Layout and Routing Recommendations

### 6.1 Module Specific

The pad spacing of 1mm should allow the placement of a 600 $\mu$ m finished VIA between pads, while maintaining a 200 $\mu$ m Via- to-trace or Via-pad spacing, to facilitate the breakout of inner row signals. The 1mm spacing is also large enough to route two 200 $\mu$ m (8 mil) traces between pads.

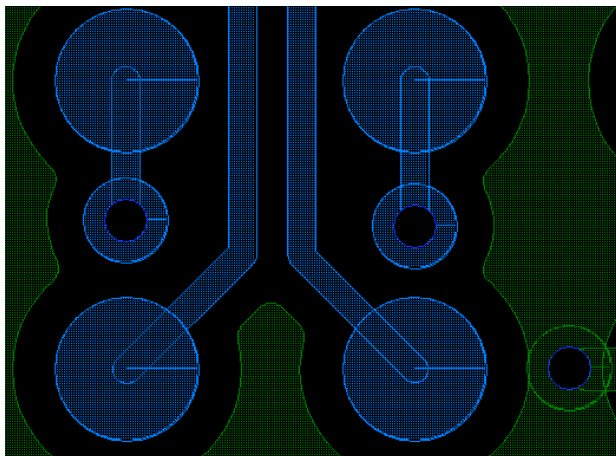


Figure 6-1 Vias placed between Pads

## 6.2 RF Traces for antennas

The NAD has three antenna pins.

- PRIMARY\_ANT
- SECOND\_ANT
- GNSS\_ANT

The figure below shows the general breakout of the module:

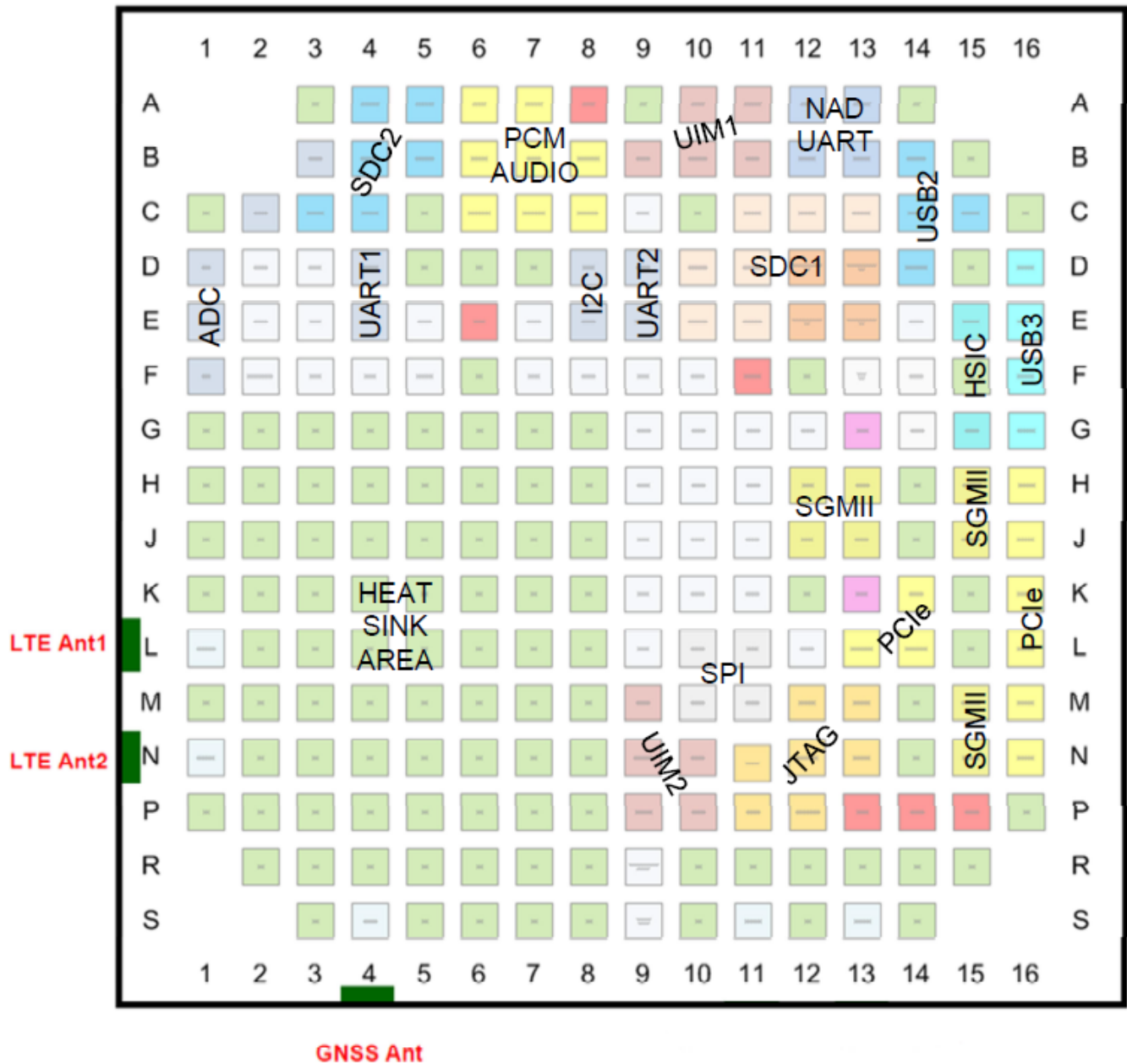
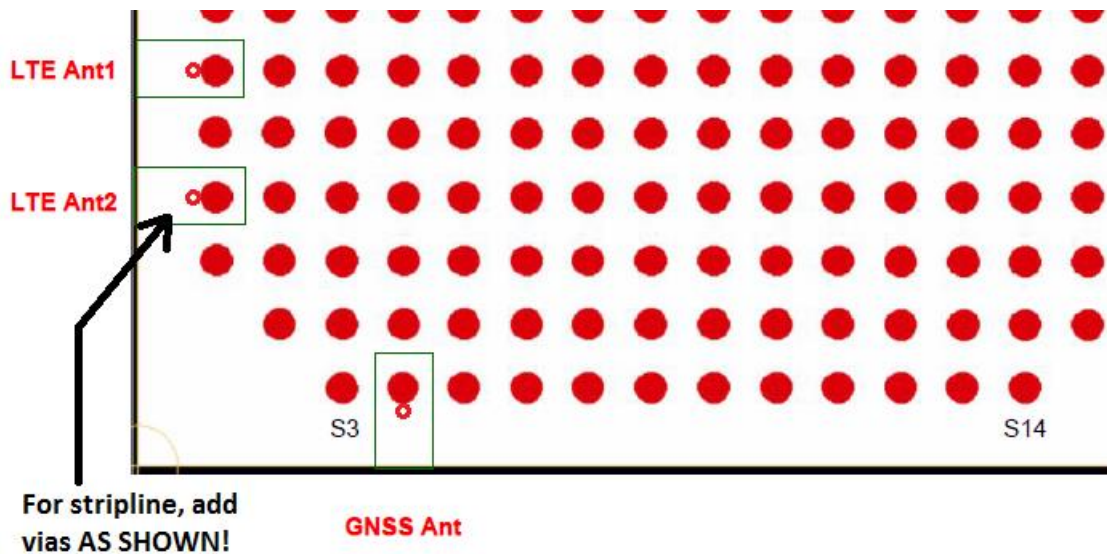


Figure 6-2: NAD Pin Breakout

The LTE CAT4 NAD should be oriented on the main board to minimize the length of the PRIMARY\_LTE antenna pin (LTE Ant1). 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 the stripline approach, vias should be placed to the NAD EDGE SIDE of the pins as close as possible to the NAD antenna pads to minimize any impedance discontinuity (see figure 38). For the microstrip approach, the PCB insertion loss will be less but the short route under the NAD MUST BE TREATED AS STRIPLINE SO IT WILL BE NARROWER UNDER THE NAD THAN THE MICROSTRIP LINE.

The NAD has ground cleared out under the RF antenna routes as shown below:



**Figure 6-2: Antenna Pad Ground Cutout (Top View)**

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 6-3

Assume the main PCB above with a 6 layer stackup 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 16.9mils (433micron) 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) =	16.9
t (trace thickness) =	1.91
h (smaller dielectric thickness) =	21.21
h1 (larger dielectric thickness) =	21.6
er (relative dielectric constant) =	4.2

Zo (Impedance, Ohms) =	49.988
Propagation Delay, Tpd (ps/inch) =	173.50
Inductance, L (nH/in) =	8.673
Capacitance, C (pF/in) =	3.47078

Note: 1oz = 1.4mils = 0.03556mm

$$Z_0 = \frac{80}{\sqrt{\epsilon_r}} \ln \left( \frac{1.9(2h+t)}{(0.8w+t)} \left( 1 - \frac{h}{4h_1} \right) \right) \quad T_{pd} = 3.333 \sqrt{\epsilon_r} \left( \frac{ns}{meter} \right)$$

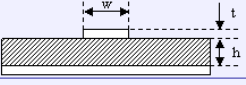
Figure 6-4

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



Calculate

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

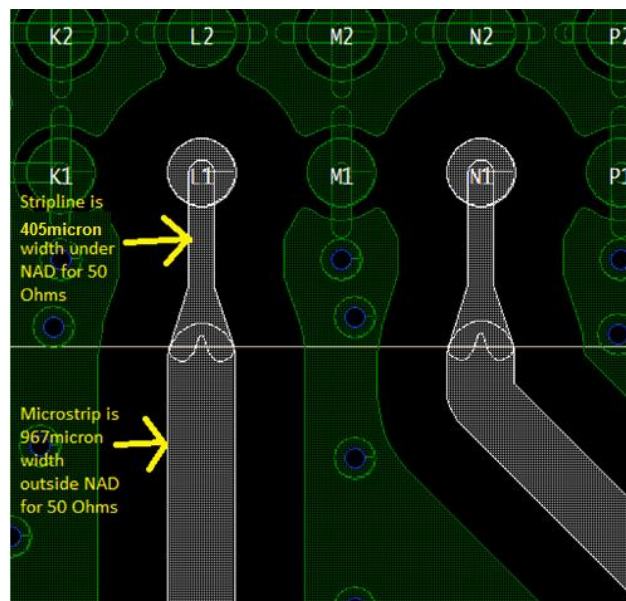
$$Z_0 = \frac{87}{\sqrt{\epsilon_r + 1.41}} \ln \left( \frac{5.98h}{(0.8w + t)} \right) \quad T_{pd} = 3.333 \sqrt{0.475 \epsilon_r + 0.67} \left( \frac{ns}{meter} \right)$$

**Figure 6-5**

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 39 WITH MICROSTRIP ROUTING AND GND CUTS ON LAYER 2 WITH GND REFERENCE ON LAYER 3. THERE SHOULD BE NO ROUTING ON L2 AND SOLID GND ON L3 UNDERNEATH THESE ANTENNA LINE MICROSTRIP TRACES.**

The antenna traces need to be routed **STRAIGHT OUT OF THE NAD TO THE NEAREST NAD EDGE**. The lines need to be tapered from 433micron to the 967micron width gradually but quickly.



**Figure 6-6**

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

## 6.3 RF Antenna Layout Parameters

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

- Signals should be routed along similar route path, but separated by ground trace.
- Trace impedances should match the table, either as microstrip or stripline.
- Total length for both signals should match the table.
- Spacing to ground or other signals on outside of bundled signals should match the table.