



FE3RW0051

LTE 4G CAT4 NAD Module

User Manual V1.3 for certification

Change History

Rev	Date	Change Description	Owner (s)
1	2022.11.18	Initial version	Liu Pujia
1.1	2022.12.05	Add antenna requirements	Liu Pujia
1.2	2023.01.04	Add regulatory compliance notes	Liu Pujia
1.3	2023.01.04	Add general test antenna spec	Liu Pujia

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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

LTE 4G NAD Module

The LTE 4G is a CAT 4 Rel. 14 NAD is a family of 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).

Hardware Version Notes

This document may contain details specific to only certain Hardware revisions of the device. When detailing properties unique to one or more HW revisions, the specific revision will be identified, otherwise it is assumed to be applicable to the latest Hardware.

1 Key Features

1.1 LTE 4G NAD Module (SA415M Entry)

1.1.1 Air Interface Support

LTE FDD/TDD: 3GPP Rel. 14
 LTE FDD CAT4 DL (150Mbps) / CAT4 UL (50Mbps)
 LTE TDD CAT4 DL (150Mbps) / CAT4 UL (50Mbps)
 UMTS Rel.9: HSUPA CAT6 (up to 5.76-Mbps), HSPA CAT14 (up to 21-Mbps) or HSPA CAT24 (up to 42-Mbps) depending on configuration
 GSM: EGPRS Rel-9
 VoLTE – HD Voice
 Embedded Qualcomm GNSS Sub-system
 GNSS L1 Frequency Band: Beidou-B1, Galileo E1, GLONASS-G1, GPS-L1 and SBAS-L1
 GNSS L5 Frequency Band: Galileo-E5A and GPS-L5
 SBAS supported: EGNOS/MSAS/QZSS/WAAS/GAGAN

1.1.2 Processing and Memory Support

Apps Processor	Cortex-A7 – 1.5 GHz ARMv7 Instruction Set 32-bit architecture 32 KB L1 I/D Cache 256 KB L2 Cache
Modem Processor	Hexagon QDSP6 – 1.5 GHz 2MB L2 Cache Low-Power Audio Post-Processing supported in the modem system
AOSS (Always-On Sub-System) RPM	Cortex M3 – 100 MHz MPM is the only master MPM coordinates shutdown/wakeup, clock rates, and VDDs
Internal Memory	176 KB Boot ROM 24 KB IMEM
Module RAM	1x16 LPDDR4x – 1.33 GHz 4Gbit / 512 M Bytes

Module NAND	4Gbit / 512 M Bytes -x8 SLC Micron MT29GZ5A5BPGA-53
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1.1.3 Electrical Interface Support

Antenna Ports	LTE/WCDMA/GSM: LTE_ANT_1, LTE_ANT_2 GNSS: GNSS_ANT_1
PCIe	1x Lane (Gen2) End Point and Root Complex support
Ethernet	RGMII Integrated MAC 4 Rx bits 4 Tx bits 1 Gbps
USB	1 port Supports USB3.0 or USB2.0
QLINK	QLINK 2.0 4 lanes DL0, UDL0, UDL1, UL0
I2S	Up to two ports
UIM	UIM1/UIM2 1.8V/3V support
BLSP Interfaces	4 BLSP Ports (I2C, SPI, UART) 4 bits each; Muxed serial interfaces UART: 4 Mbps I2C: Yes SPI: Yes (Master)
ADC	2 ADC ports

1.2 Package

585-pin LGA module of size 38 x 40 x 2.93 mm

1.3 Band Configurations Supported

1.3.1 SA415M -based Design

Table 1: SA415M Band Configuration Support

Model Name	TRC	LTE Bands	WCDMA Bands	GSM	GNSS	MCP
FE3RW0051	TRC0806040000	B1, B2, B3, B4, B5, B7, B8, B28a, B28b, B26, B9, B18, B19	B1, B2, B4, B5, B8	B2, B3, B5, B8	L1	4G + 4G

1.4 NAD Accessibility Requirement during development and certification

HS-USB and UART: Product teams must make sure to provide access to the NAD communication ports to be used during development and certification testing. The following functionality must be available after the NAD is integrated:

- Access to the NADs HS-USB interface, including AT command, Diagnostics and NMEA ports.
- Ability to conduct basic call processing and data throughout measurements.
- NAD UART for communication using Linux console.

RF Ports: If on-board antennas are used by the product, provisions must be made to support conducted RF measurements on all antenna interfaces: LTE Primary, Diversity and GNSS.

SIM Interface: Electrical performance of the SIM interface is always evaluated during certification testing of the final product. Product teams must insure that the SIM interface can be accessed for testing without degrading its integrity.

2 Regulatory Compliance Notes

2.1 Regulatory compliance notes

2.1.1 CE-RED:

Hereby, Continental Automotive Systems, Inc, declares that the radio equipment type FE3RW0051 is in compliance with Directive 2014/53/EU. The full test of the EU Declaration of Conformity is available at the following internet address:

[Homologation - Daimler \(continental-homologation.com\)](http://continental-homologation.com)

2.1.2 FCC:

This device complies with Part 15, Part 22(H), Part 24(E) Part 27 and Part 90 of the FCC Rules. The FCC ID for this device is LHJ-FE3RW0051.

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.

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.

Caution: Changes or modifications not expressly approved by the party responsible for compliance could void the user 's authority to operate the equipment.

2.1 Device Installation and user manual

The FE3RW0051 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 FE3RW0051 modules to antennas inside the integrated device.
- 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. 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, Part 27, and Part 90.
- ix. 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.
- x. 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-FE3RW0051".

2.2 Instruction of 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 transmit simultaneously with any other transmitter, except in accordance with FCC/ISED multi-transmitter product procedures. 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, 27, and 90.
6. Clear instructions describing the other party's responsibility to obtain station licensing.

2.3 Antenna requirements for user with FE3RW0051 module

The module 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. Additional testing and certification for SAR will be required if the distance limitation cannot be met.

The FE3RW0051 module does not contain internal antennas and external antenna must be provided by the integrator or OEM. Based on EN 62311:2020 and EN 50665:2017 and FCC OET Bulletin 65 Supplement

C and 47 CRF §2.1091, for all LTE/WCDMA/GSM operations the maximum antenna gain including cable loss shall not exceed the following values:

- GSM 850: 7.1 dBi
- GSM 1900: 2.5 dBi
- WCDMA Band 2: 10.4 dBi
- WCDMA Band 4: 6.0 dBi
- WCDMA Band 5: 8.5 dBi
- LTE Band 2: 9.0 dBi
- LTE Band 4: 6.0 dBi
- LTE Band 5: 10.4 dBi
- LTE Band 7: 9.0 dBi
- LTE Band 26: 10.3 dBi

The FE3RW0051 module was tested against general test antenna with below spec and max antenna gain above were calculated according to test results with test antenna:

- GSM 850: 0.82 dBi
- GSM 1900: 1.52 dBi
- WCDMA Band 2: 1.52 dBi
- WCDMA Band 4: 0.68 dBi
- WCDMA Band 5: 0.82 dBi
- LTE Band 2: 1.52 dBi
- LTE Band 4: 0.68 dBi
- LTE Band 5: 0.82 dBi
- LTE Band 7: 3.35 dBi
- LTE Band 26: 0.82 dBi

2.4 Material statement

The End-of-Life Vehicle Directive (EVL) must be applied to the FE3RW0051 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.

3 Specifications

3.1 Recommended Operating Conditions

Over operating temperature range (unless otherwise stated)

Table 2: Recommended Operating Conditions

Parameter		MIN	TYP	MAX	UNIT
4V_PMX_V	Power management input supply voltage (1)	3.8	4.0	4.2	V
4V_QET_V	Average power tracking input supply voltage (1)	3.8	4.0	4.2	V
5V_CV2X	Average power tracking input supply voltage (1)	4.75	5.0	5.25	V
4V_MODULE_IMAX	Total module maximum peak current (1ms), all pins (4)	-	-	4.2	A
4V_PMX_RMS	Power management input supply RMS current (5)	-	-	300	mA
4V_QET_RMS	Average power tracking input supply RMS current (5)	-	-	580	mA
VREG_SDC	Output voltage for SD card signals – 1.8V or 2.95V		1.8 / 2.95		V
VREF_RGMII			1.8		V
Operating Temperature:	Fully Compliant Operation (2)	-30		+75	°C
	Extended Operation (3)	-40		+85	°C
Junction Temperature (Tj) of Key Qualcomm ICs					
SA415M (Tj) (6)					
Ecall temperature				+115	°C
Operating temperature				+105	°C
SDR8179 (Tj) (6)					
Ecall temperature				+115	°C
Operating temperature				+105	°C

- (1) Voltage range includes both DC and AC components, including ripple, overshoot, undershoot or sag.
- (2) Module is functional and meets all required RF performance criteria.
- (3) Module is functional and may not meet all required RF performance criteria.
- (4) Peak module current drain is dominated by 3A GSM pulse, which is on for 0.57-ms and off for 4.03-ms.
- (5) RMS current drain measurement period is 5-ms minimum.
- (6) Emergency calling allowed for Tj (junction temperature) within this range.

3.2 Output Voltage Supplies

Table 3: Output Voltage Supplies

Parameter		MIN	TYP	MAX	UNIT
VREF_1V8	Digital Reference – 1.8V	1.70	1.80	1.95	V
VREF_1V8_IMAX	Digital Reference – 1.8V	-	-	10	mA
VREF_2V7	Analog Reference – 2.7V	2.60	2.70	2.80	V
VREF_2V7_IMAX	Analog Reference – 2.7V	-	-	10	mA
VREF_SDC	Digital Reference voltage for SDC	1.7	1.8/2.95	2.99	V
VREF_SDC_IMAX				5	mA
VREG_CORE_VH	WLAN power supply – 1.8V	1.8	1.8	2	V
VREG_CORE_VH_IMAX				tbd	mA
VREG_CORE_VM	WLAN power supply – 1.2V	1.224	1.224	1.3	V
VREG_CORE_VM_IMAX				tbd	mA

3.3 NAD Module RF Characteristics

3.3.1 NAD Module RF Transmitter Output Power

The Transmitter Power at the NAD antenna terminal at Room Temperature (not the FAKRA of the evaluation board or the Telematics/parent module):

WCDMA: +23.5 dBm +1.0/-2.5 dB
 LTE: +23.0 dBm +1.0/-2.0 dB *
 CV2X: +23.0 dBm +1.0/-2.0 dB

GSM 850 and 900: +32.5 dBm ±1.5 dB
 GSM 1800 and 1900: +29.5 dBm ±1.5 dB

Per 3GPP TS 05.05, the following Maximum Output Power Reduction will be taken during Multi-slot GPRS operation:

- 0 dB back-off for 1TX slot
- 1.5 dB back-off for 2TX slots
- 3.5 dB back-off for 3TX slots
- 4.5 dB back-off for 4TX slots

EDGE 850 and 900: +27 dBm ±1.5 dB
 EDGE 1800 and 1900: +26 dBm ±1.5 dB

Per 3GPP TS 05.05, the following Maximum Output Power Reduction will be taken during Multi-slot EDGE operation:

- 0 dB back-off for 1TX slot
- 2.0 dB back-off for 2TX slots
- 3.0 dB back-off for 3TX slots
- 4.0 dB back-off for 4TX slots

For most bands. Some exceptions exist, based on 3GPP standard

3.3.2 NAD Module RF Receiver Sensitivity

The Receiver Sensitivity at the NAD antenna terminal at Room Temperature (not the FAKRA of the evaluation board or the Telematics/parent module):

- GSM low bands (800/900): 3GPP TS 51.010-1 Section 14.2
- WCDMA bands: 3GPP TS 34.121-1 Section 6.2
- LTE bands: 3GPP TS GPP 36.521 Section 7.3
- GNSS bands: -163 dBm (in Out-Of-Service mode)

4 Mechanical Information

4.1 Module Exploded View

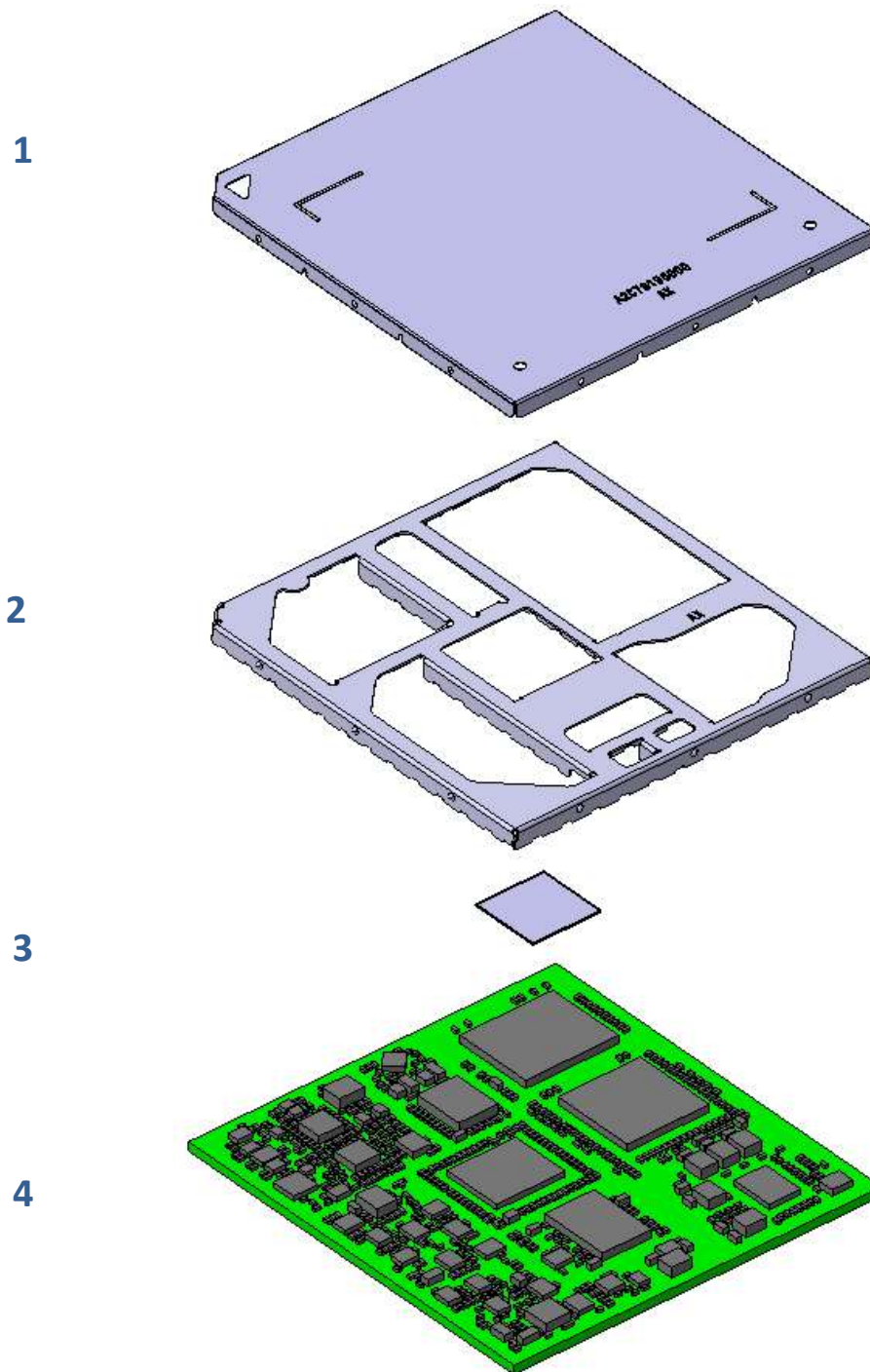


Figure 1: Module Exploded View

- 1: Cover
- 2: Shield
- 3: Label
- 4: PCB Assembly.

4.2 Module Top View

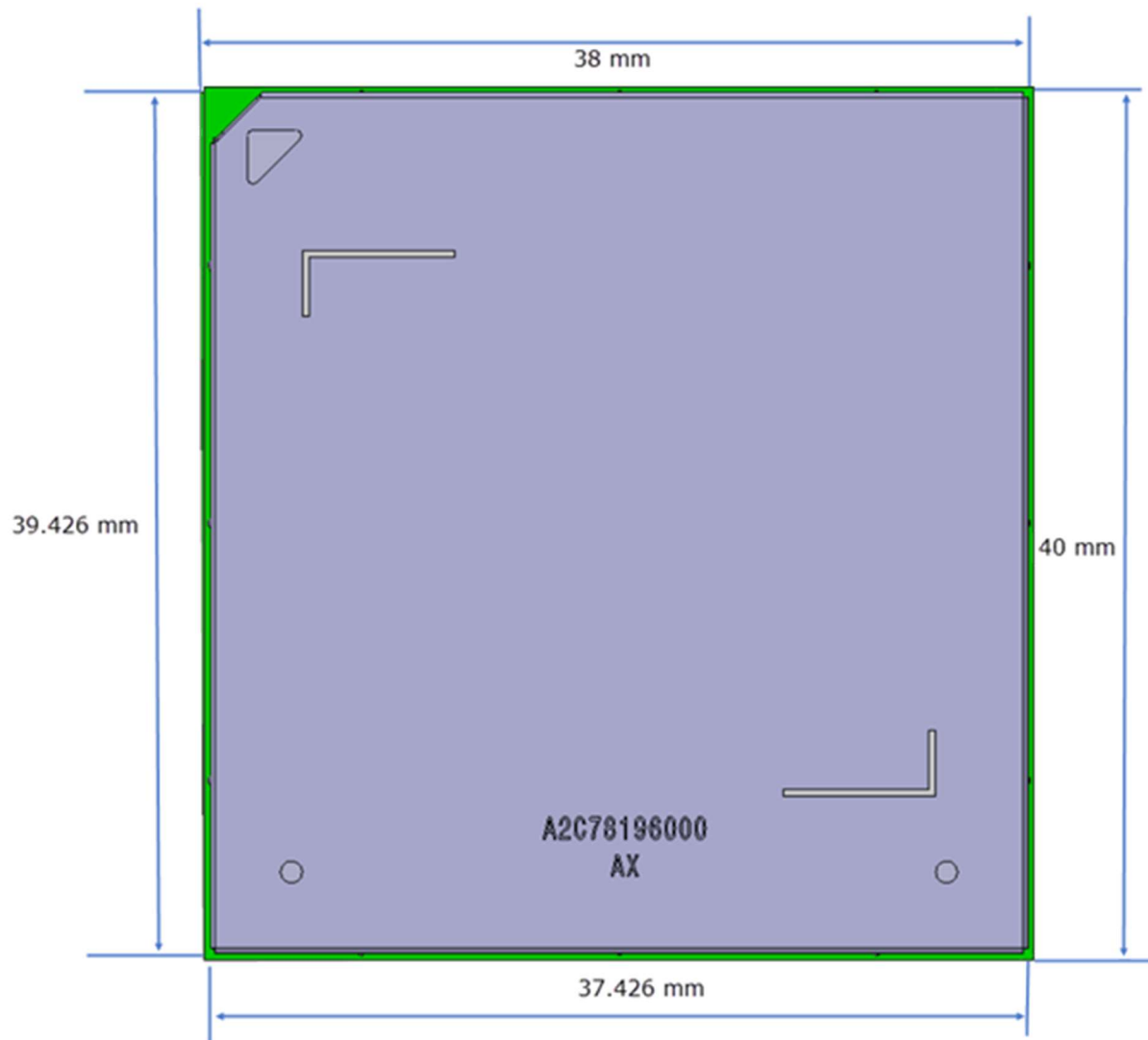


Figure 2: Module Top Side View

All dimensions are in mm.

4.3 Module Side View

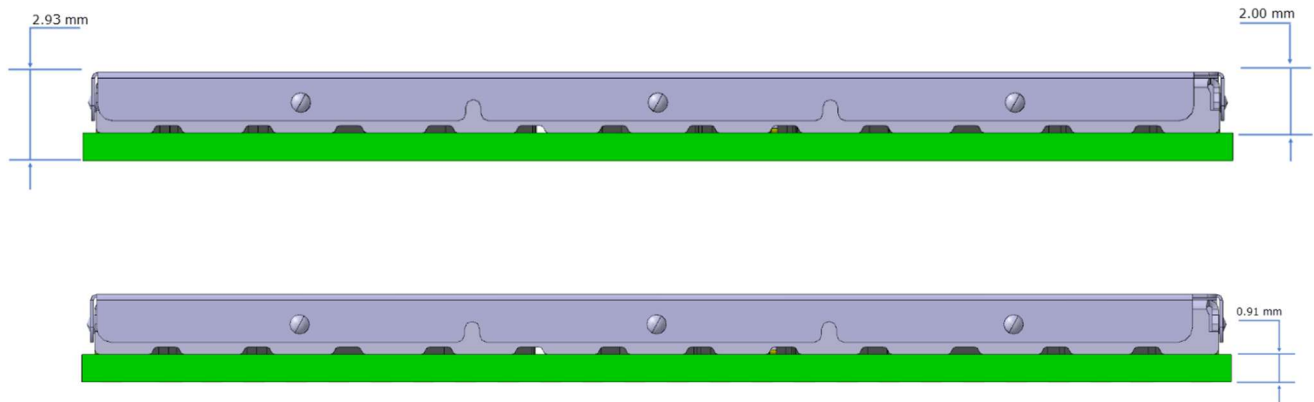


Figure 3: Module Side View

All dimensions are in mm.

5 Storage and Handling

5.1 Moisture Sensitivity Level (MSL)

All NAD modules are moisture sensitive and should be kept in their sealed moisture resistant bags until ready for assembly onto the DCM-TCU via the soldering process. Any parts that are not used immediately should be properly resealed in the same moisture resistant bag using appropriate equipment or placed into a dry box until they are needed again. The moisture sensitivity level (MSL) shown below is the amount of time the NAD modules may be exposed before this action must be taken. If the allowed MSL time elapses, the NAD modules must be baked per standard protocol to remove moisture.

Moisture Sensitivity Level: MSL Level 3 (1 Week)

This remainder of this section will be completed in a future release of this document.

6 Part Reliability

This section will be completed in a future release of this document.