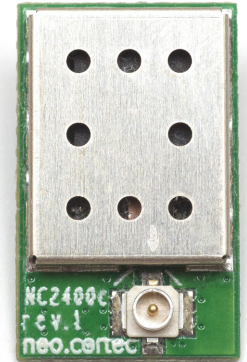
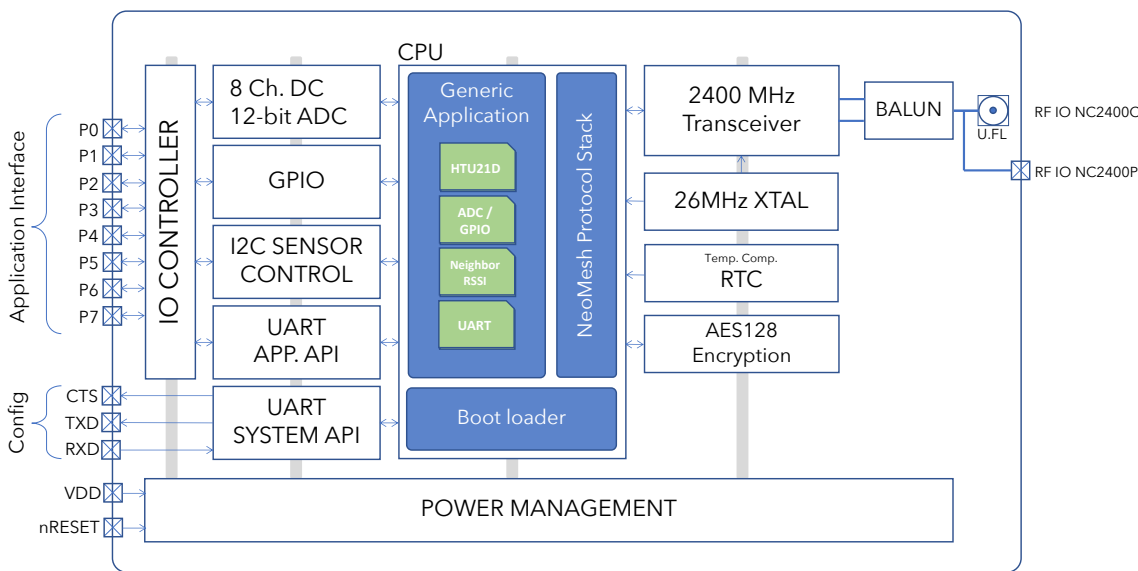


NeoCortec-NC2400

Wireless Mesh Network Module Series

Datasheet version 1.3



FEATURES:

- Full System in a module:
 - Add power and an antenna to create a fully functional Wireless Mesh Network node
 - NeoMesh Protocol Stack optimized for ultra low power and reliability
 - Generic Application layer which can be configured to suit the product needs
- Ultra Small Form factor which allows for easy integration in compact products
- Supply Range 2.0 – 3.6V suitable for direct battery operation
- Pre certified for ETSI, FCC & IC
- RF IO either through U.FL connector or solder pad under module

APPLICATIONS:

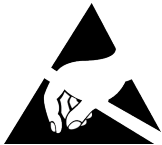
- Wireless Sensor Networks
- Automatic Meter Reading
- Advanced Metering Infrastructure
- Mobile Ad-Hoc Networks
- Home Control & Building Automation
- Industrial Automation
- Alarm and Security Systems
- Asset tracking
- Agricultural and Forest Monitoring
- Extension of NB-IoT/LTE-M networks into hard to reach places

1. Absolute Maximum Ratings

Under no circumstances must the absolute maximum ratings given in Table 1 be violated. Stress exceeding one or more of the limiting values may cause permanent damage to the module.

Parameter	Min	Max	Unit	Condition
Supply voltage (VDD)	-0.3	3.9	V	All supply pins must have the same voltage
Voltage on any digital pin	-0.3	VDD + 0.3, max 3.9	V	
Voltage on U.FL connector	-0.3	2.0	V	
Voltage ramp-up rate		120 kV/ μ s		
Input RF level		10 dBm		
Storage temperature range	-50	150	$^{\circ}$ C	
Solder reflow temperature		260	$^{\circ}$ C	According to IPC/JEDEC J-STD-020D
ESD		750	V	According to JEDEC STD 22, method A114, Human Body Model (HBM)
ESD		500	V	According to JEDEC STD 22, C101C, Charged Device Model (CDM)

Table 1: Absolute maximum ratings



Caution! ESD sensitive device.
Precaution should be used when handling the device in order to prevent permanent damage.

2. Conditions for operational use

Parameter	Min	Max	Condition
Operational temperature	-40 $^{\circ}$ C	85 $^{\circ}$ C	
Supply voltage, VDD	2V	3.6V	

Table 2: Conditions for normal use.

3. Power consumption

TA = 25 $^{\circ}$ C, VDD = 3.0 V if nothing else stated. Measured on NC2400C module. Please note that average current consumption is given by Protocol Settings. The expected average current consumption can be calculated using the Configuration tool provided.

Parameter	Min	Typ	Max	Unit	Condition
Receive, Rx, current		26		mA	Standard protocol
Transmit, Tx, current		27.5		mA	Standard protocol @ 1dBm output
CPU activity,		4.5		mA	Standard protocol, without radio activity
Sleep mode		0.5	2	μ A	Oscillators, except 32768Hz oscillator, are off.

Table 3: Power consumption

3.1 I/O DC characteristics

TA = 25°C, VDD = 3.0 V if nothing else stated.

Digital Inputs/Outputs	Min	Typ	Max	Unit	Condition
Logic "0" input voltage			30	%	Of VDD supply (2.0 - 3.6 V)
Logic "1" input voltage	70			%	Of VDD supply (2.0 - 3.6 V)
Logic "0" input current per pin			12	nA	Input is 0V
Logic "1" input current per pin			12	nA	Input is VDD
Logic "0" input current RESET pin			65	μA	VDD = 3.6V, due to 56k2 pull-up
I/O pin pull-up and pull-down resistor		20		kΩ	

Table 4: DC characteristics

3.2 I/O AC characteristics

TA = 25°C, VDD = 3.0 V if nothing else stated.

Digital Inputs/Outputs	Min	Typ	Max	Unit	Condition
Port output rise time (min. / max. drive strength) ¹		3.15 / 1.34		ns	Load = 10 pF Timing is with respect to 10% VDD and 90% VDD levels.
Port output fall time (min. / max. drive strength) ¹		3.2 / 1.44		ns	Load = 10 pF Timing is with respect to 90% VDD and 10% VDD levels.

¹ Min. drive is for VDD ≥ 2.6V, Max drive is for VDD < 2.6V

3.3 RF parameters

Parameters	Min	Typ	Max	Unit	Condition
Receiver					
Receiver sensitivity		-82		dBm	1% packet loss
Saturation		-15		dBm	
Transmitter					
Output power, highest setting		1		dBm	Delivered to a 50 Ω single-ended load via U.FL connector
Output power, lowest setting		-30		dBm	Delivered to a 50 Ω single-ended load via U.FL connector

Table 5: RF, receive and transmit parameters

The module is certified for compliance with FCC and CE, and as such spurious emissions and harmonic levels are below the acceptable limits given by the applicable standards.

4. Pin description

Pin number	Pin name	Pull at Reset	IO-type	Description of function
1	GND			Module ground
2	nRESET	PU-res	I	Module reset
3	SAPI_RX	PU	I	UART Rx, Transmit data, System API
4	SAPI_CTS		O	CTS, Module ready to accept commands, System data
5	SAPI_TX		O	UART Tx, Received data, System API
6	GND			Module ground
7	nWES	PU	I	Enable WES Client
8	Reserved			Leave unconnected
9	GND			Module ground
10	Reserved			Leave unconnected
11	Reserved			Leave unconnected
12	Reserved			Leave unconnected
13	nWU/P0		O/IO	nWU. Indicates activity state of module. Active low/P0 Function
14	P1		IO	P1 Function
15	GND			Module ground
16	AAPL_RX / P2	PU/	I/IO	UART Rx, Transmit data, Application data / P2 Function
17	AAPL_TX / P3		O/IO	UART Tx, Received data, Application data / P3 Function
18	P4		IO	P4 Function
19	AAPL_CTS / P5		O/IO	CTS, Module ready to accept commands, Application data / P5 Function
20	P6			P6 Function
21	P7			P7 Function
22	Reserved			Leave unconnected
23	nAPP		O	Indicates activity of the embedded generic application. When low, the application is active. This can be used for enabling an external sensor only when the generic application is active.
24	Reserved			Leave unconnected
25	VDD			Module power supply.
26, 27, 28	GND			Module ground
29	RF IO		IO	RF single ended 50Ohm transmit and receive
30, 31	GND			Module ground

Table 6: Pin list for module

PU: Pull-up, typical 20k Ω

PU-res: Pull-up 56k

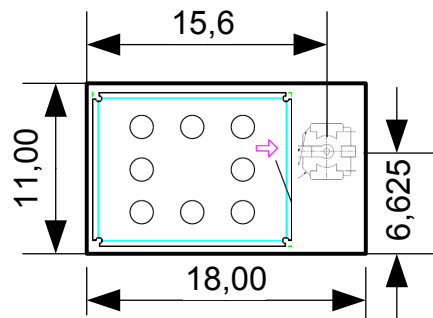
P0-P7: IO's for the Generic Application. Se User Guide for details.

Reserved: Pins allocated for future use. Do not connect these. Solder to non connected pad.

Pins 29,30,31 only connected on NC1000P-x variants of the module, but also present on NC1000C-8 variants.

5. Dimensions and drawing

Item	Dimension	Tolerance	Remark
Width	11mm	$\pm 0.2\text{mm}$	
Length	18mm	$\pm 0.2\text{mm}$	
Height	2.6mm	$\pm 0.25\text{mm}$	Without U.FL plug

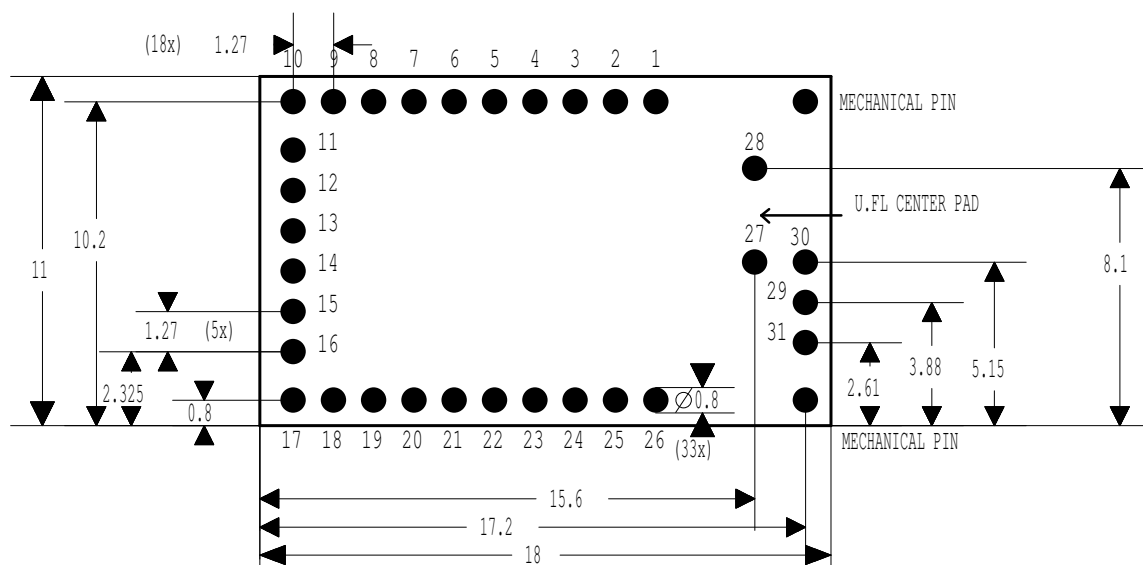


All dimensions are in mm.

Figure 2: Module drawing

6. PCB Footprint & Pin numbers

A recommended footprint is shown here. Please note that no components must be placed under the module.



All dimensions are nominal and in mm.

Figure 3: Module footprint (top-view)

7. Product approvals

The NC2400 module has been designed to comply with most national requirements for world wide operation. The NC2400 module comes in two versions: NC2400C or NC2400P which are both intended for use in the 2.4GHz frequency band world wide. Modular approval has been uptained for EU, US & Canada. In the following more details can be found related to the individual approvals.

7.1 USA (FCC)

Neocortec modules NC2400C and NC2400P have been tested to comply with FCC part 15.247 "Intentional Radiators". The devices meet the requirements for modular transmitter approval.

Federal Communication Commission Statement (FCC, U.S.)

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 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.

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.

FCC Caution:

Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment.

IMPORTANT NOTES

FCC Radiation Exposure Statement:

This equipment complies with FCC 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.

Limited Channels:

The frequencies channels are permanently fixed in the device and cannot be changed by the end user or integrator.

OEM integration instructions:

This device is intended only for OEM integrators under the following conditions:

The antenna must be installed such that 20 cm is maintained between the antenna and users, and the transmitter module may not be co-located with any other transmitter or antenna. The module shall be only used with the external antenna(s) that has been originally tested and certified with this module.

As long as 3 conditions above are met, further transmitter test will not be required. However, the OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this module installed (for example, digital device emissions, PC peripheral requirements, etc.).

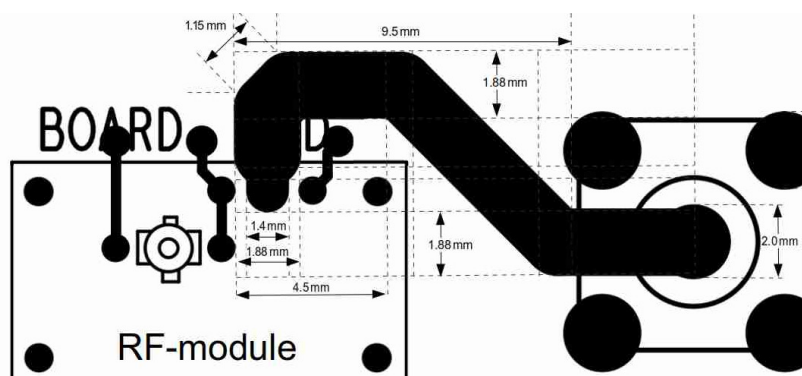
7.1.1 Host Integration

The NC2400C or NC2400P module can be integrated into a finished product without obtaining subsequent FCC approvals for intentional radiators provided that the instructions for integration is followed and that the host device does not contain multiple transmitter modules, however at all times, the integrator must ensure that the module remains compliant to part 15C while installed in the finished product, including compliance with any possible additional requirements, such as digital device emissions, PC peripheral requirements, etc. The approved antenna must be installed as such that 20 cm distance can be maintained between the antenna and user of the finished product.

Approved antenna: Antenova Titanis 2.4 GHz Swivel, with a gain of 2.2 dBi.

NC2400P Antenna trace guidelines:

1. RF-trace must be nominal 50Ω , and be routed directly away from the module. Connect the two ground pins directly to the bottom side ground plane using through hole vias.
2. Track: On top side 1.88mm wide, 35 μ thickness.
3. Isolation, PCB core: 1.0mm Tg=150°C
4. Bottom: Plane, solid copper.
5. Through hole for SMA antenna connector: Molex 0733910060
6. As design verification, quick-scan the radiated emissions to 15.205 / 12.209 for lower and higher channel.
7. In production, verify for 1 sample per batch if the conducted RF outout power to 15.247(b) is 2-3dBm, indicating that all RF energy is fed to the antenna.



7.1.2 Validity of using the module certification

In the event that these conditions cannot be met (for example certain laptop configurations or co-location with another transmitter), then the FCC authorization for this module in combination with the host equipment is no longer considered valid and the FCC ID of the module cannot be used on the final product. In these circumstances, the OEM integrator will be responsible for re-evaluating the end product (including the transmitter) and obtaining a separate FCC authorization.

Custom design antennas may be used, however the OEM installer must follow the FCC 15.21 requirements and verify if new FCC approval will be necessary.

7.1.3 End product labeling

This transmitter module is authorized only for use in device where the antenna may be installed such that 20 cm may be maintained between the antenna and users. The final end product must be labeled in a visible area with the following: "Contains FCC ID: 2AB76NC2400C1".

7.1.4 Information that must be placed in the end user manual

The OEM integrator has to be aware not to provide information to the end user regarding how to install or remove this RF module in the user's manual of the end product which integrates this module. The end user manual shall include all required regulatory information/warning as shown in this manual.

7.2 ISED CANADA (IC, Canada)

This device complies with Industry Canada licence-exempt RSS standard(s). 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."

Limited Channels:

The frequency channels are permanently fixed in the device and cannot be changed by the end user or integrator.

OEM integration instructions:

This device is intended only for OEM integrators under the following conditions:

The antenna must be installed such that 20 cm is maintained between the antenna and users, and the transmitter module may not be co-located with any other transmitter or antenna. The module shall be only used with the external antenna(s) that has been originally tested and certified with this module.

As long as 3 conditions above are met, further transmitter test will not be required. However, the OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this module installed (for example, digital device emissions, PC peripheral requirements, etc.).

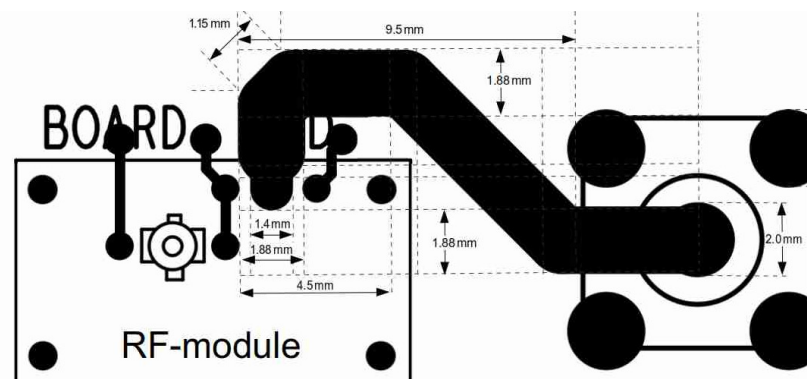
7.2.1 Host Integration

The NC2400C or NC2400P module can be integrated into a finished product without obtaining subsequent ISED Canada approvals for intentional radiators provided that the instructions for integration is followed and that the host device does not contain multiple transmitter modules, however at all times, the integrator must ensure that the module remains compliant with the latest edition of RSS-247 while installed in the finished product, including compliance with any possible additional requirements, such as digital device emissions, PC peripheral requirements, etc. The approved antenna must be installed as such that 20 cm distance can be maintained between the antenna and user of the finished product.

Approved antenna: Antenova Titanis 2.4 GHz Swivel, with a gain of 2.2 dBi.

NC2400P Antenna trace guidelines:

1. RF-trace must be nominal 50Ω , and be routed directly away from the module. Connect the two ground pins directly to the bottom side ground plane using through hole vias.
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4. Bottom: Plane, solid copper.
5. Through hole for SMA antenna connector: Molex 0733910060
6. As design verification, quick-scan the radiated emissions to 15.205 / 12.209 for lower and higher channel.
7. In production, verify for 1 sample per batch if the conducted RF outout power to 15.247(b) is 2-3dBm, indicating that all RF energy is fed to the antenna.



7.2.2 Validity of using the module certification

In the event that these conditions cannot be met (for example certain laptop configurations or co-location with another transmitter), then the ISED Canada certification for this module in combination with the host equipment is no longer considered valid and the Certification Number off the module cannot be used on the final product. In these circumstances, the OEM integrator will be responsible for re-evaluating the end product (including the transmitter) and obtaining a separate ISED Canada certification.

Custom design antennas may be used, however the OEM installer must following the ISED Canada requirements and verify if new ISED Canada certification will be necessary.

7.2.3 End product labeling

This transmitter module is authorized only for use in device where the antenna may be installed such that 20 cm may be maintained between the antenna and users. The final end product must be labeled in a visible area with the following: "Contains IC: 11904A-NC2400C1".

7.2.4 Information that must be placed in the end user manual

The OEM integrator has to be aware not to provide information to the end user regarding how to install or remove this RF module in the user's manual of the end product which integrates this module. The end user manual shall include all required regulatory information/warning as show in this manual.

7.3 European Union - CE

The NC2400C & NC2400P modules has tested to comply with the following standards:

- EN 300 328-1 V2.1.1
- EN 301 489-1 V2.2.0
- EN 301 489-17 V3.2.0
- EN 62479:2010
- EN 62368-1: 2014

Declaration of conformity with European Union Radio Equipment Directive 2014/53/EU (RED) can be released upon request.

8. Recommended Solder profile

Contact NEOCORTEC for detailed recommendations.

9. Moisture sensitivity level

The module is a MSL3 device as defined in IPC/JEDEC J-STD-033B.1.

10. Ordering information

Model	Part number	Remark
NC2400	NC2400C	Module configured for 2.4GHz (World wide), with the RF IO through U.FL connector
NC2400	NC2400P	Module configured for 2.4GHz (World wide), with the RF IO on a PAD under the module

10.1 Part number coding

```

NC  XXXX  Y  -  PPP  -  SSSS  -  OOO
  ----  -  (  ---  ----  ---  ) Optional values in parenthesis
    |    |    |    |    |
    |    |    |    |    +--- Custom option code * (3 characters)
    |    |    |    +----- Firmware build version ** (4 characters)
    |    |    +----- Packaging:
    |    |                    T01 = Tray with 100 modules
    |    |                    R05 = Tape/Reel with 500 modules
    |    |                    R10 = Tape/Reel with 1000 modules
    |    +----- RF Connection:
    |                C = U.fl. connector
    |                P = PAD under module
    +----- HW Variant:
                2400 = Standard version for band 2.4GHz

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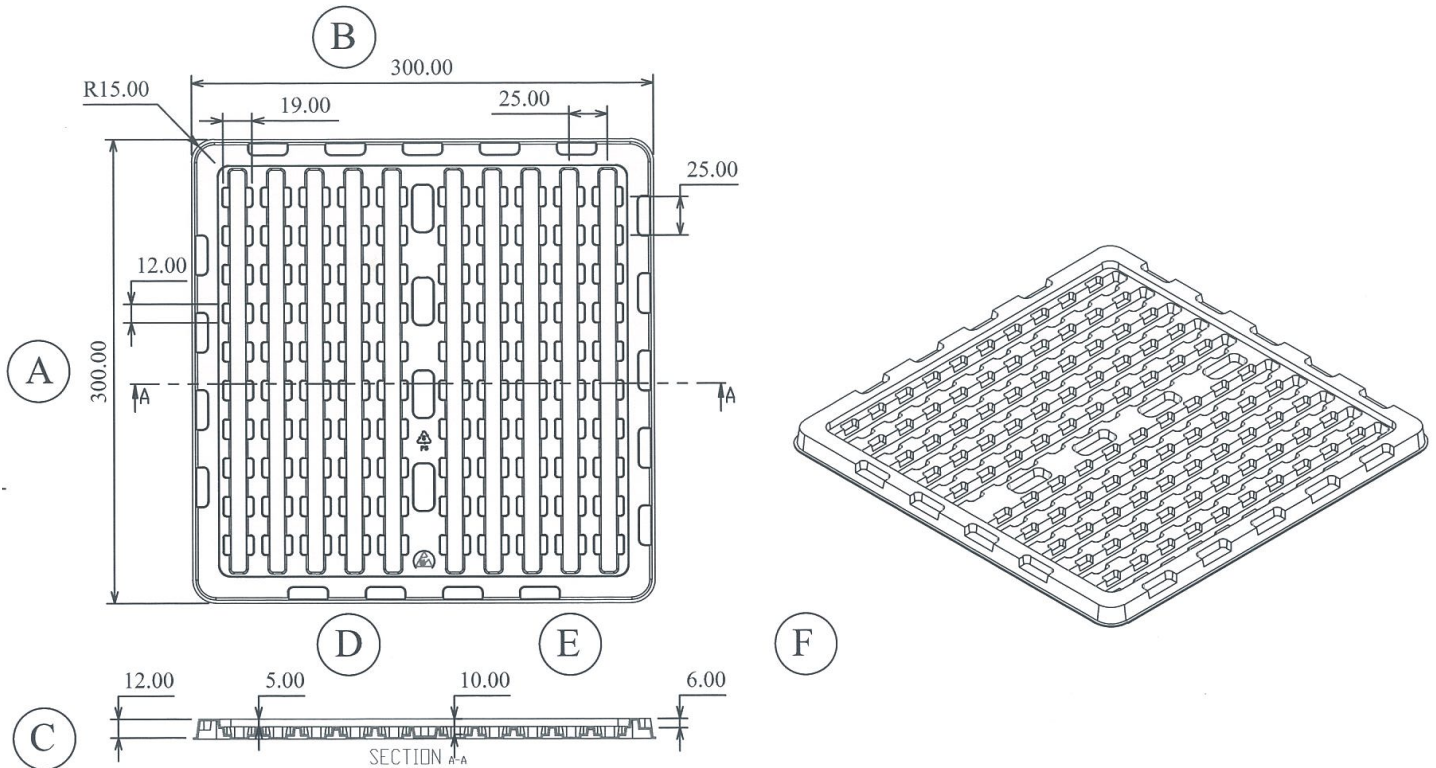
*) Optional values can not be specified for order quantities below 500 pcs. Orders below 500 pcs will be delivered in trays with 100 pcs and will be shipped with the latest production release of the firmware.

**) If the Firmware build version is not specified (SSSS = 0000), the latest production release will be shipped. It is important that all modules in the same NeoMesh network is using the same firmware version. As such it is advisable to ensure that the version is checked as part of the end-device production, and potentially updated/downgraded to the version required.

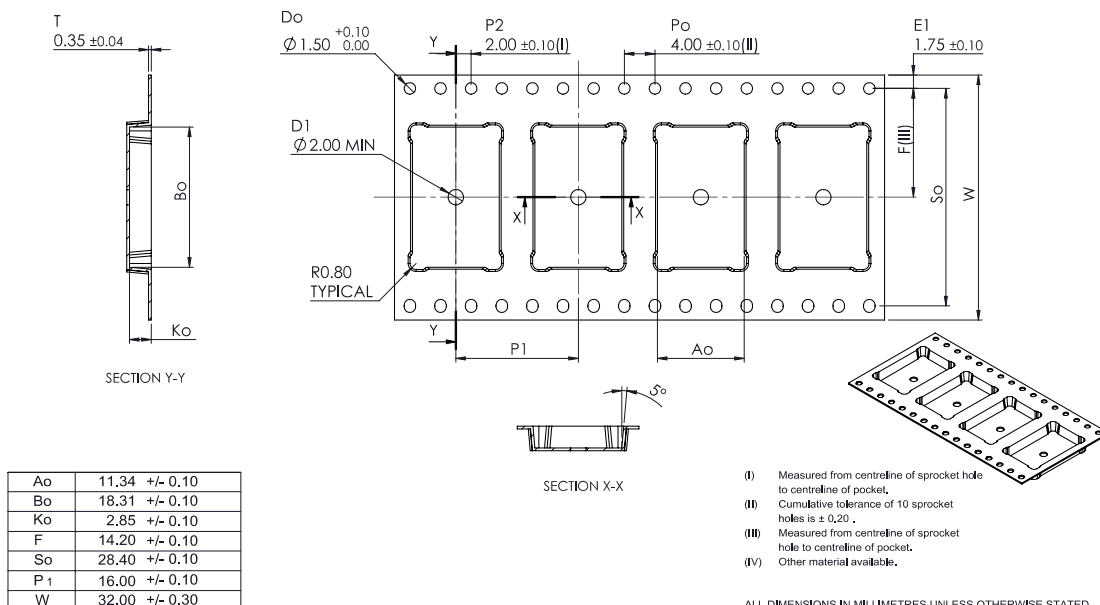
11. Package information

Available in 100 pcs tray or tape and reel.

11.1 Tray dimensions



11.2 Tape & Reel dimensions



12. Other documentation

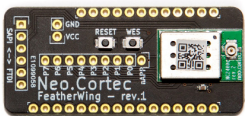
For further details on the usage of the module and the NeoMesh protocol stack, please visit www.neocortec.com to download additional documents. Here is a list of relevant documentation:

Document	Description
NEOCORTEC User Guide	General introduction to the NeoMesh protocol stack as well as detailed documentation of all parameters and settings in the NC2400 modules
Integration Manual for NCxxxx Series Modules	Detailed documentation of how to integrate the module into the application device. Includes hardware as well as software documentation.
NeoGateway User Guide	Documentation of the open source Linux based gateway software which allow the use of a NC2400 module in a gateway device

13. Related products

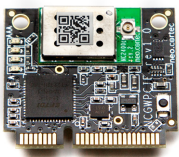
The NC2400 series of modules is also available in other hardware variants which can be well suited for various tasks and applications. Here is a short introduction to the options available:

Assemblies for rapid prototyping and short time to market:



FWNC2400 Breakout boards:

- Available with all "C" module variants
- Compatible with Adafruit Feather series of controller boards
- Stand alone breakout board for easy sensor integration



PCNC2400 miniPCle boards:

- Available with all "C" module variants
- Fits with most industrial PC's and similar
- Utilises the USB interface of the miniPCle

Evaluation platform



NC2400 Evaluation Board

- Available with all "C" module variants
- Eval board contains all relevant circuitry to evaluate the module
- USB interface for the Serial interface & GPIO test circuit



NC2400 Evaluation Kit

- Available with all "C" module variants
- Contains 5 eval boards
- USB stick with PC software for evaluation and configuration

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