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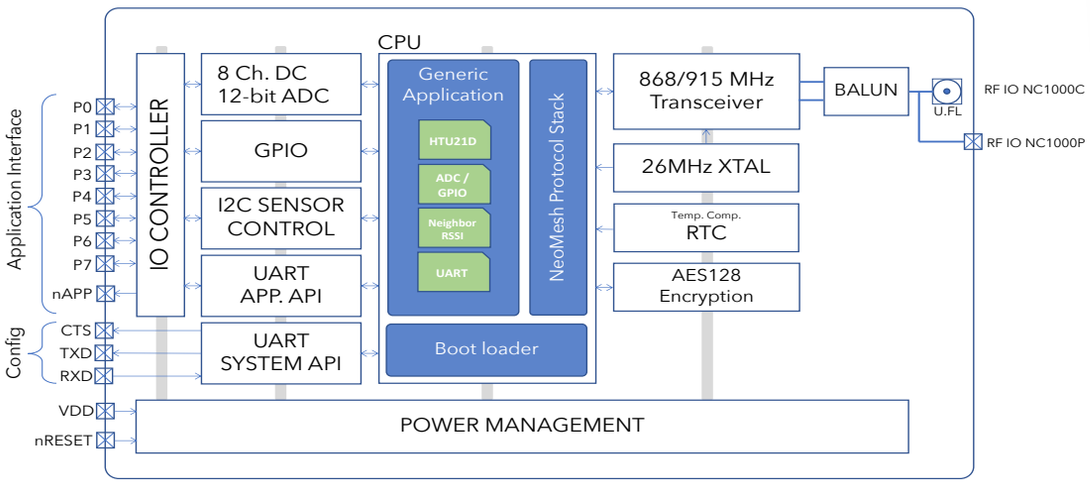
NeoCortec-NC1000
Wireless Mesh Network Module Series
Datasheet version 1.5



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/µs		
Input RF level		10 dBm		
Storage temperature range	−50	150	°C	
Solder reflow temperature		260	°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°C	85°C	
Supply voltage, VDD	2V	3.6V	

Table 2: Conditions for normal use.

3. Power consumption

TA = 25°C, VDD = 3.0 V if nothing else stated. Measured on NC1000 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		19.1	20.4	mA	Standard protocol
Transmit, Tx, current			36.2	mA	Standard protocol @ +10dBm output
CPU activity,		5.0		mA	Standard protocol, without radio activity
Sleep mode		0.5	2	µA	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		-94 -93		dBm	868MHz 1% packet loss 915MHz 1% packet loss
Saturation		-16		dBm	
Transmitter					
Output power, highest setting		+10		dBm	Delivered to a 50 Ω single-ended load via U.FL connector / pad output
Output power, lowest setting		-30		dBm	Delivered to a 50 Ω single-ended load via U.FL connector / pad output

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

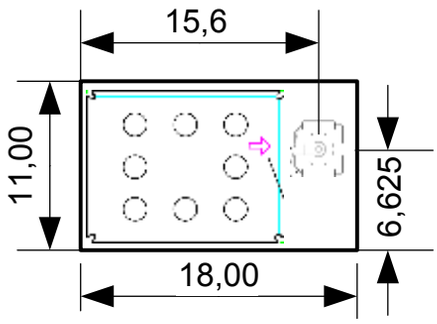
Pin number	Pin name	Pull at Reset	IO-type	Description of function
1	GND			Module ground
2	nRESET	PU-res	I	Module reset
3	SAPI_RX	PU	I	UART Rx, Transmit data, System API
4	SAPI_ CTS		O	CTS, Module ready to accept commands, System data
5	SAPI_TX		O	UART Tx, Received data, System API
6	GND			Module ground
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	AAPI_RX / P2	PU/	I/IO	UART Rx, Transmit data, Application data / P2 Function
17	AAPI_TX / P3		O/IO	UART Tx, Received data, Application data / P3 Function
18	P4		IO	P4 Function
19	AAPI_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 20kΩ
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 no 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	±0.2mm	
Length	18mm	±0.2mm	
Height	2.6mm	±0.25mm	Without U.FL plug

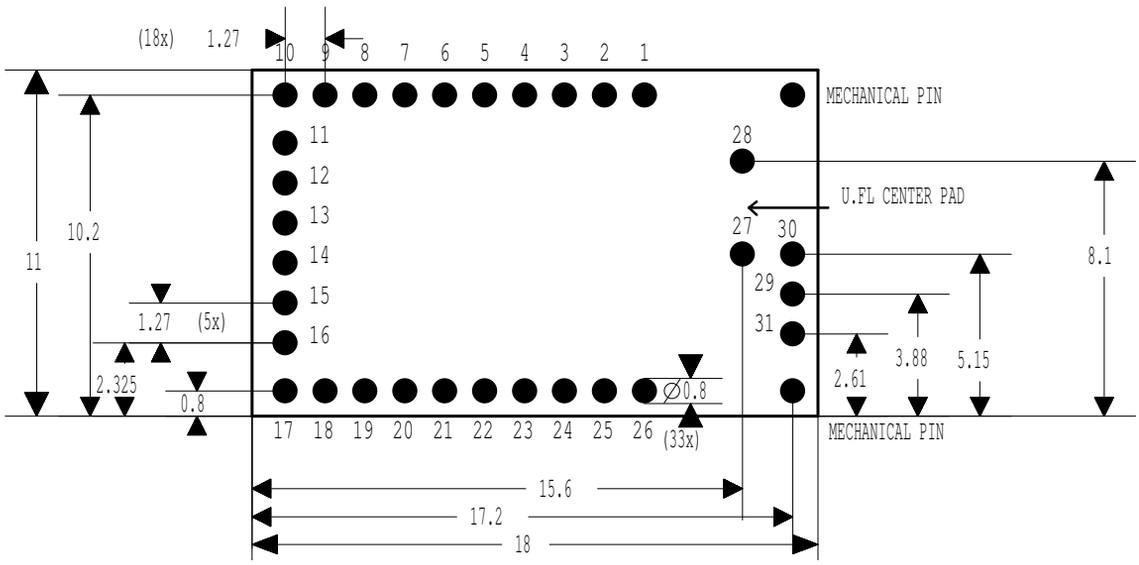


All dimensions are in mm.

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 NC1000 module has been designed to comply with most national requirements for world wide operation. The NC1000 modules comes in two versions: NC1000C-8 or NC1000P-8 which are intended for use in the 868MHz frequency band, and NC1000C-9 or NC1000P-9 which are intended for use in the 915MHz frequency band.

7.1 USA (FCC)

The NC1000C-9 or NC1000P-9 using the below mentioned antenna has been tested to comply with FCC part 15.247 "Intentional Radiators". The devices meet the requirements for modular transmitter approval. The FCC Grant of Equipment Authorization document can be obtained by contacting NeoCortec.

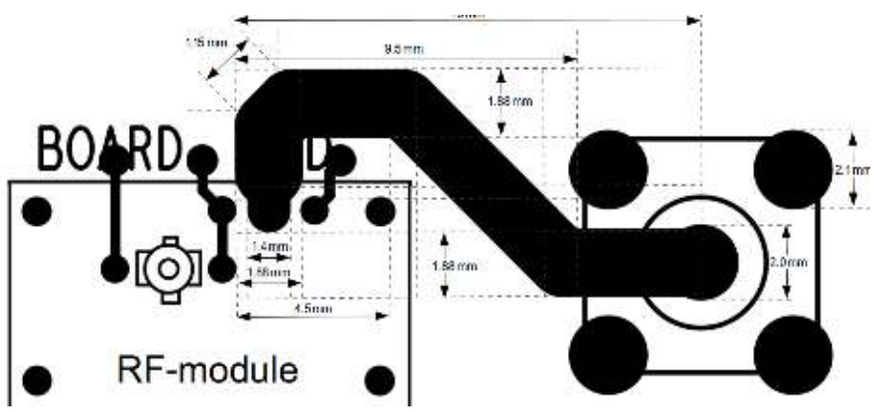
7.1.1 Host Integration

The NC1000C-9 or NC1000P-9 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.

Approved antenna: Pulse Electronics W5017 with a gain of 2dBi.

NC1000P-9 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, 35µ 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 bbatch if the conducted RF outout power to 15.247(b) is 10-11dBm, indicating that all RF energy is fed to the antenna.



7.1.2 FCC Labeling requirements

The NC1000C-9 and NC1000P-9 modules have been labeled with their own FCC ID number. Since the number is located on the bottom side and therefor not visible, it is needed to place a label on the outside of the finished product into which the module is installed referring to the enclosed module.
This exterior label can use wording such as the following:

> Contains Transmitter Module FCC ID: 2AB76NC1000C1
> -or-
> Contains FCC ID: 2AB76NC1000C1
>
> 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.

7.1.3 End user manual

The OEM integrator shall not provide information to the end user regarding how to install or remove this RF module in the user's manual of the finished product containing this module. The manual of the finished product shall include all required regulatory information as shown in the FCC Notice in this manual.

FCC Notice:
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.

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

7.2 ISED CANADA (IC, Canada, EN)

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."

The final end product must be labeled in a visible area with the following:
"Contains IC: 11904A-NC1000C1".

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.

7.2.1 Host Integration

The NC1000C-9 or NC1000P-9 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.

Approved antenna: Pulse Electronics W5017 with a gain of 2dBi.

NC1000P-9 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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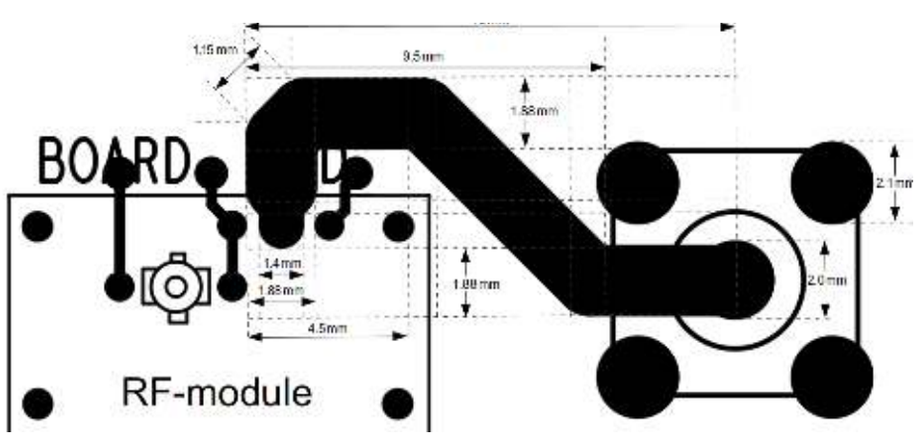


8. European Union - CE

The NC1000C-8 & NC1000P-8 modules has tested to comply with the following standards:

- EN 300 220-1 V3.1.1
- EN 300 220-2 V3.2.1
- EN 301 489-1 V2.2.0
- EN 301 489-3 V2.1.1
- 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.

9. Recommended Solder profile

Contact NEOCORTEC for detailed recommendations.

10. Moisture sensitivity level

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

11. Ordering information

Model	Part number	Remark
NC1000-8	NC1000C-8	Module configured for 868MHz (EU), with the RF IO through U.FL connector
NC1000-8	NC1000P-8	Module configured for 868MHz (EU), with the RF IO on a PAD under the module
NC1000-9	NC1000C-9	Module configured for 915MHz (US), with the RF IO through U.FL connector
NC1000-9	NC1000P-9	Module configured for 915MHz (US), with the RF IO on a PAD under the module

11.1 Part number coding

```
NC XXXX Y  - Z - 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
     |  |    +--------------------- Band variant:
     |  |                                   8 = 868MHz SRD Band EU
     |  |                                   9 = 915MHz ISM Band US/Canada
     |  +-------------------------- RF Connection:
     |                                      C = U.fl. connector
     |                                      P = PAD under module
     +----------------------------- HW Variant:
                                            1000 = Standard version for band 8 & 9
```

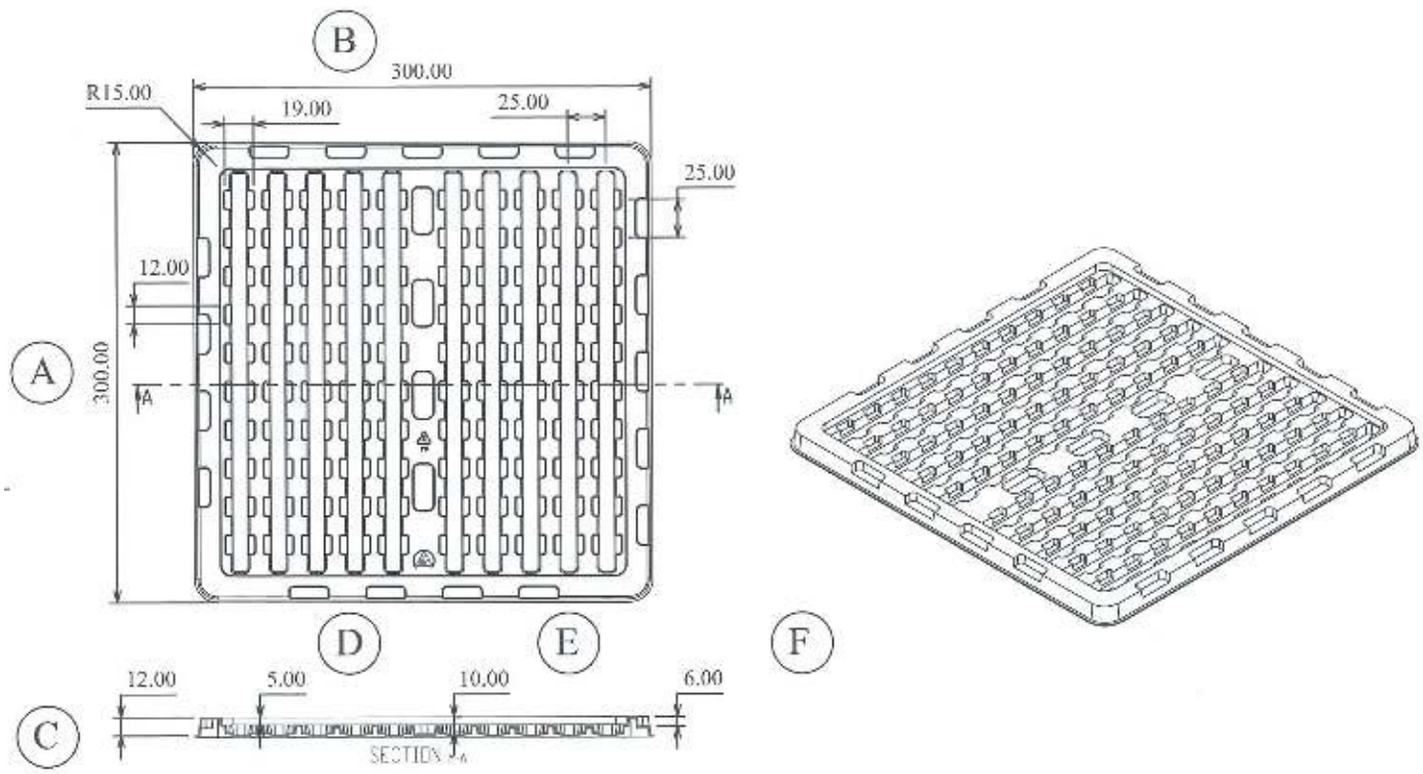
*) Optional values can not be specified for order quantities below 500 pcs. Orders below 500 pcs will be delivered in trays with 100 pcs and will be shipped with the lastest production release of the firmware.

**) 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 adviseable to ensure that the version is checked as part of the end-device production, and potentially updated/downgraded to the version required.

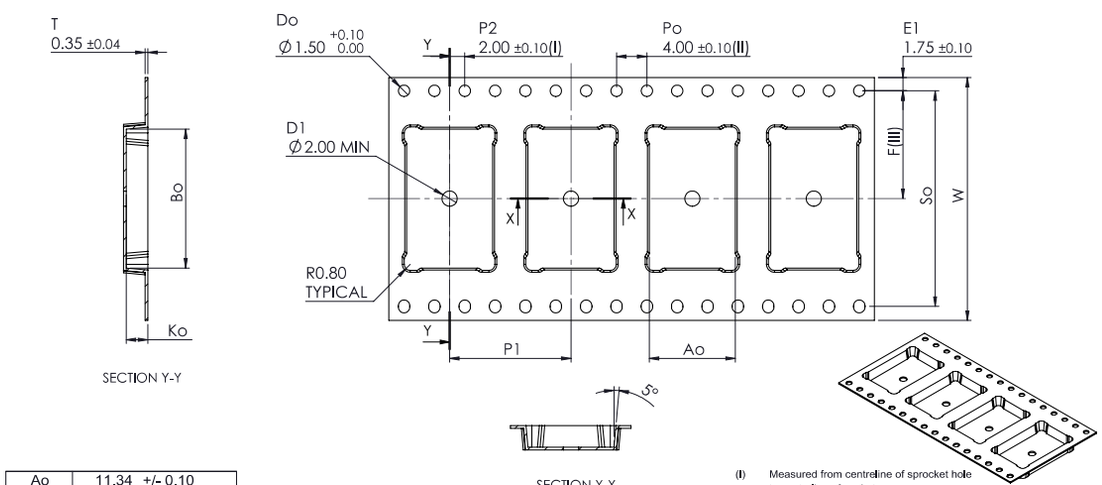
12. Package information

Available in 100 pcs tray or tape and reel.

12.1 Tray dimensions



12.2 Tape & Reel dimensions



Ao	11.34 +/- 0.10
Bo	18.31 +/- 0.10
Ko	2.85 +/- 0.10
F	14.20 +/- 0.10
So	28.40 +/- 0.10
P_1	16.00 +/- 0.10
W	32.00 +/- 0.30

(I) Measured from centreline of sprocket hole to centreline of pocket.
(II) Cumulative tolerance of 10 sprocket holes is ± 0.20 .
(III) Measured from centreline of sprocket hole to centreline of pocket.
(IV) Other material available.

ALL DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE STATED.

13. 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 NC1000 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 NC1000 module in a gateway device

14. Related products

The NC1000 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:

FWNC1000 Breakout boards:
- Available with all "C" module variants
- Compatible with Adafruit Feather series of controller boards
- Stand alone breakout board for easy sensor integration

PCNC1000 miniPCIexpress boards:
- Available with all "C" module variants
- Fits with most industrial PC's and similar
- Utilises the USB interface of the miniPCIe

Evaluation platform

NC1000 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

NC1000 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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Wireless connectivity made simple.

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