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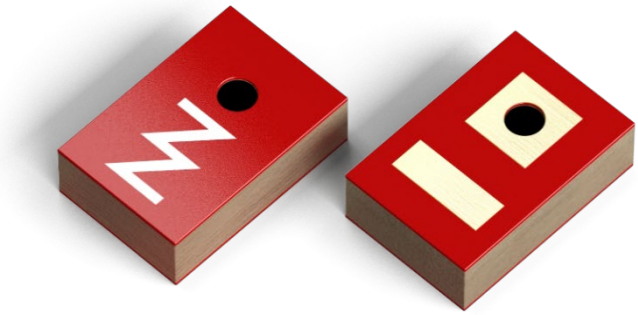
NANO mXTEND™: MINIATURE AND HIGH EFFICIENCY BLUETOOTH/WI-FI ANTENNA

USER MANUAL
NANO mXTEND™ (NN02-101)

NANO mXTEND™

MINIATURE AND HIGH-EFFICIENCY BLUETOOTH/WI-FI ANTENNA



NN02-101

NANO mXTEND™ | Bluetooth & Wi-Fi

Operating range: 2400 – 10600 MHz

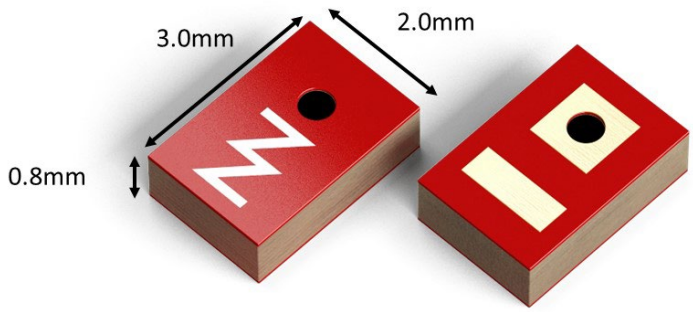
Best for: 2400 – 2500 MHz

Dimensions : 3.0 mm x 2.0 mm x 0.8 mm

What is the NANO mXTEND™?

The **NANO mXTEND™** is the smallest Virtual Antenna® chip to date. Featuring a size of only 3 mm x 2 mm x 0.8 mm, this off-the-shelf chip antenna has been designed to fit almost every **IoT device** from entry-level to high-end products. The **NANO mXTEND™** is enabled by Virtual Antenna® technology, thus featuring the unique properties of this class of products: easy to use; versatile, and broadly tunable. The **NANO mXTEND™** is available for Bluetooth, Wi-Fi, Wi-SUN, and any wireless connectivity protocol operating in the 2.4 - 2.5 GHz band. Due to Ignion's proprietary Virtual Antenna® technology, this chip antenna is non-resonant and therefore broadly tunable, enabling additional frequency bands to be supported by the same antenna part and released in the future.

As with every other Virtual Antenna® chip, the **NANO mXTEND™** is available through Ignion's **Antenna Intelligence Cloud** tool, enabling predictable design and performance throughout the entire product development cycle. Moreover, the **NANO mXTEND™** is built on a glass epoxy substrate, making its manufacturing broadly available and therefore resilient against shortage.



Material: The NANO mXTEND™ antenna booster is built on a glass epoxy substrate.

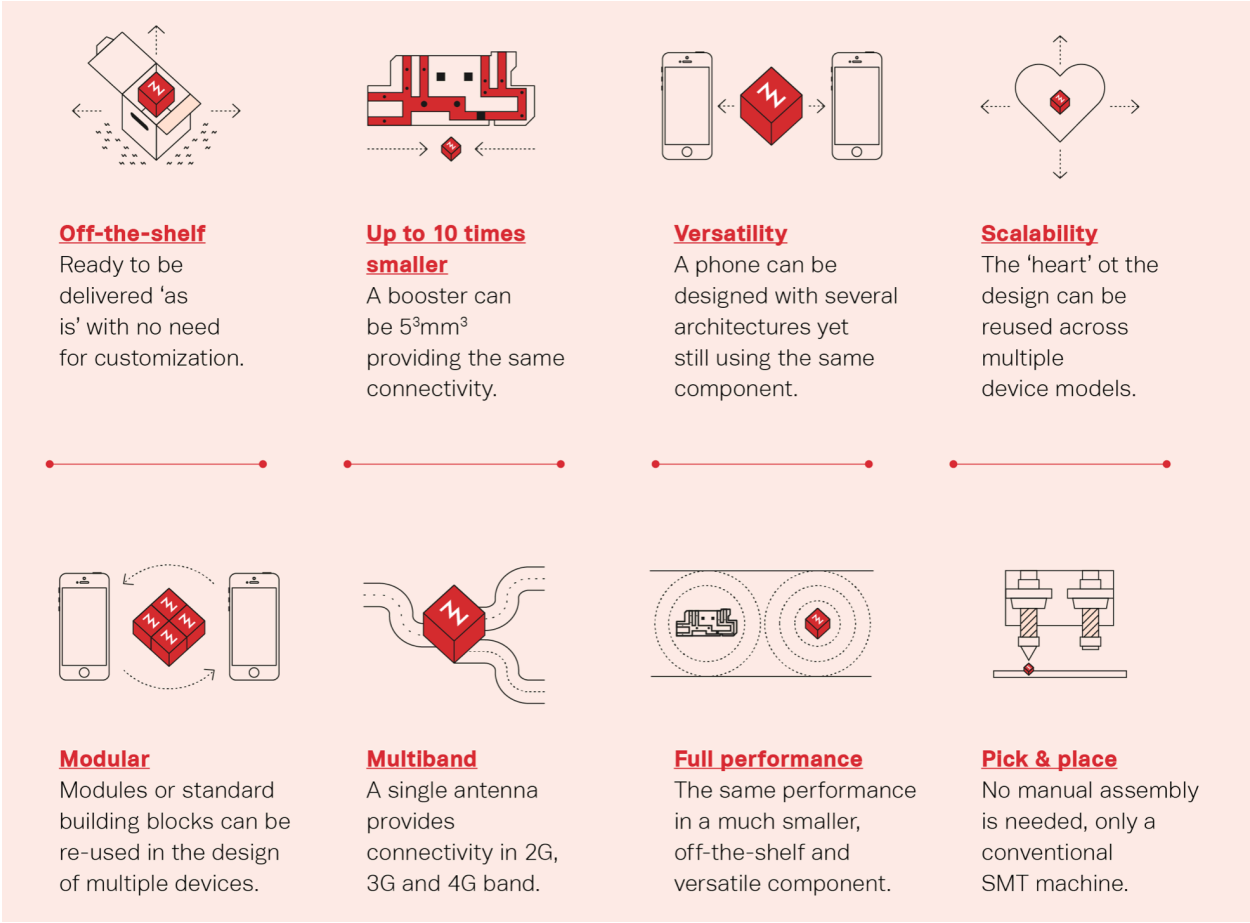
What is the NANO mXTEND™ used for?

The **NANO mXTEND™** is suitable for embedding an antenna into any wireless device requiring optimum performance in a small, cost-effective package for operating in the Bluetooth/Wi-Fi/Wi-SUN ISM 2.4 GHz frequency bands, including:

- Asset Trackers
- Smart Tags
- Earphones and Headsets
- Wearables
- Logistic Trackers
- Health sensors
- Animal Trackers
- Security Sensors
- Service Buttons
- Environmental Sensors
- IoT Developer Kits
- Wireless Sniffing Sensors

What differentiates the NANO mXTEND™ from other chip antennas?

Like every other Virtual Antenna® product, the NANO mXTEND™ is frequency neutral, meaning that its frequency response is not determined by the antenna component but designed by the electronics engineer. Virtual Antenna® technology provides the broadest range of connectivity options with desired antenna performance in the smallest ever form factor. This unique technology enables the whole mXTEND™ range of components to become tiny, off-the-shelf, surface-mount (SMD) electronic chips while still providing connectivity with multiple frequency bands and meeting the requirements of most wireless devices' architectures and form factors. Being non-resonant, the whole antenna performance can be customized through a shorter and easier design cycle by means of a matching circuit, while benefiting at the same time from a robust, reliable, and cost-effective manufacturing process because of the chip, SMD form factor. Also, the NANO mXTEND™'s architecture is not using ceramic materials to achieve miniaturization, which ensures a pervasive availability of raw materials thus making the supply chain resilient to shortage and price fluctuations.



Click to view other useful NANO mXTEND™ guidelines:

HOW TO EMBED A VIRTUAL ANTENNA®

MECHANICAL SPECIFICATIONS

ASSEMBLY AND MANUFACTURING

PACKAGING

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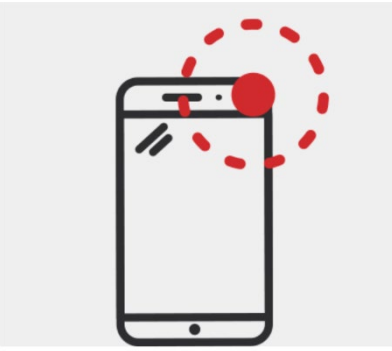
How to embed Virtual Antenna®

Design with Virtual Antenna® in 1-2-3



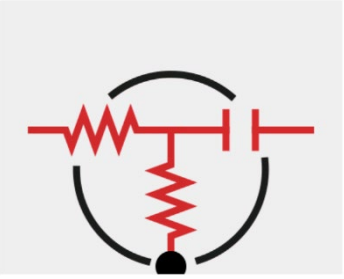
STEP 1: Place the antenna component

1. Select one corner of your PCB
2. Ensure your ground plane meets the NANO mXTEND™ clearance area restrictions
3. Respect a keep out space around the booster. Keep at least 5mm distance from metallic objects

Look here for an example of antenna placement

STEP 2: Design your matching network

1. Through a combination of inductors & capacitors obtain 50 Ohms of antenna impedance to optimize the transfer of energy to your antenna
2. It is critical to fine-tune your MN throughout the entirety the design process to achieve your desired frequency response



Look here for an example of a matching network for a Virtual Antenna® product application via simulation

STEP 3: Test your device

1. Perform a field test in which your antenna is placed in its final housing. Fine-tune the MN if needed.
2. Use a network analyzer to adjust mismatch
3. Test the antenna's efficiency with an anechoic chamber

Look here for a short video tutorial on how to test your antenna.

https://ignion.io/design-center/tutorials-webinars/

Scan this QR code to see our videos highlighting these three easy steps

Need further help? Easy start with Antenna Intelligence Cloud

Do you need more help with your antenna for your device?

Use our **Antenna Intelligence Cloud service** and get your ready-to-test, proof-of-concept antenna design especially simulated for your platform **free of charge**[1], and in **24 hours**.

https://www.ignion.io/antenna-intelligence/

[1] *Subject to terms and conditions here.*

Scan QR code to be taken to our Antenna Intelligence Cloud page

The NANO mXTEND™ for Bluetooth/Wi-Fi

The NANO mXTEND™ has been designed for **Bluetooth/Wi-Fi** connectivity at 2.4 GHz**.** An optimum tuning of this chip at the 2.4 GHz band is achieved through a matching network. Due to its versatility, the chip antenna component can be mounted both on the corner or on the center of an edge of the printed circuit board (PCB) of your wireless device just by changing the matching network. The table below includes a quick reference guide for the antenna specifications on a reference design of 80 x 40 mm, as well as the set-up matching network and performance for both a corner and an edge mounting configuration.

QUICK REFERENCE GUIDE

Technical Specs for the NANO mXTEND™ in the corner configuration:

Technical features	2400 – 2500 MHz
Average Efficiency	>55 %
Peak Gain	2.4 dBi
VSWR	< 2.5:1
Radiation Pattern	Omnidirectional
Polarization	Linear
Weight (approx.)	0.01 g.
Temperature	-40 to +125 ºC
Impedance	50 Ω
Dimensions (L x W x H)	3.0 mm x 2.0 mm x 0.8 mm

Table 1 – Technical Features. Measurements from the evaluation board (Figure 1)

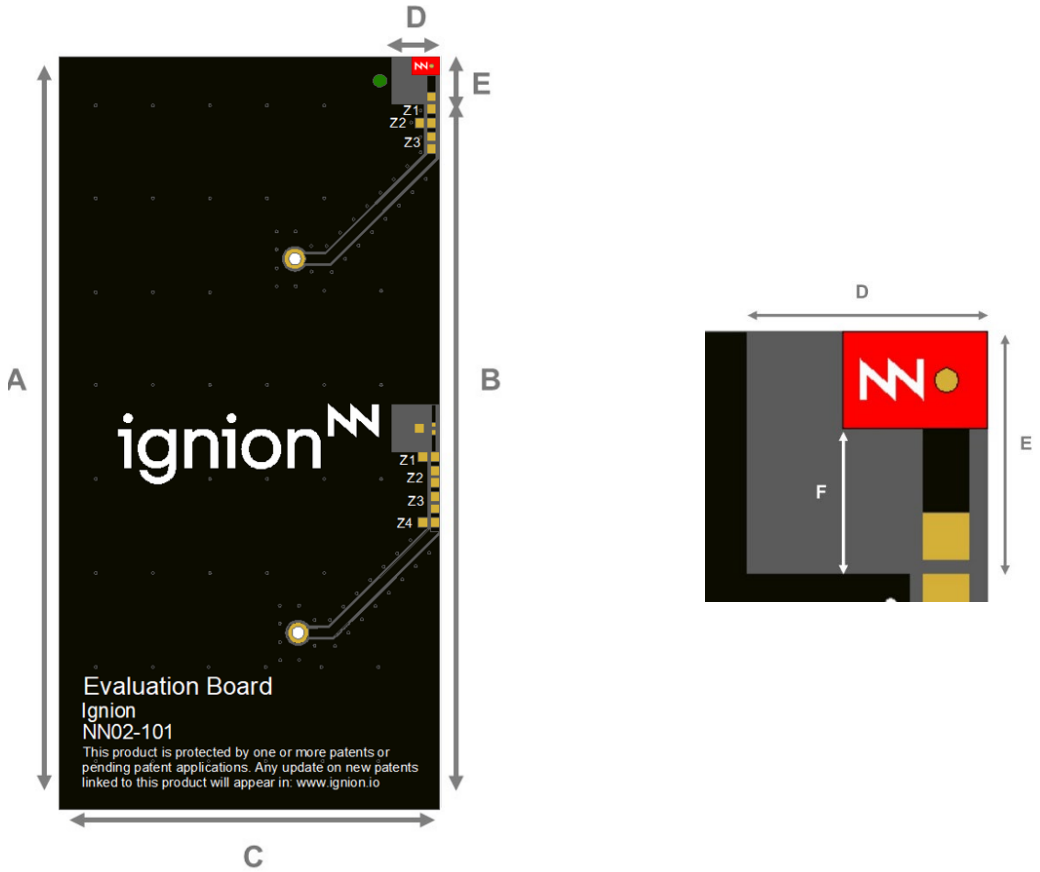
Technical Specs for the NANO mXTEND™ in the edge configuration:

Technical features	2400 – 2500 MHz
Average Efficiency	>65 %
Peak Gain	2.4 dBi
VSWR	< 3.0:1
Radiation Pattern	Omnidirectional
Polarization	Linear
Weight (approx.)	0.01 g.
Temperature	-40 to +125 ºC
Impedance	50 Ω
Dimensions (L x W x H)	3.0 mm x 2.0 mm x 0.8 mm

Table 2 – Technical Features. Measurements from the evaluation board (Figure 4)

CORNER MOUNTING CONFIGURATION

The NANO mXTEND™ is ready and recommended for corner mounting in those devices where this region is available for antenna placement. This section details a corner mounting design on a reference ground plane of 80 mm x 40 mm including a clearance area of 5 mm x 5 mm (Figure 1). Other ground plane sizes and clearances can be implemented by adapting the matching network.



Measure	mm
A	80
B	75
C	40
D	5
E	5
F	3

Tolerance: ±0.2 mm

D: Length of clearance area.

Figure 1 - EB_NN02-101_c_BT. Evaluation board configured to provide operation at Bluetooth (2400 – 2500MHz).

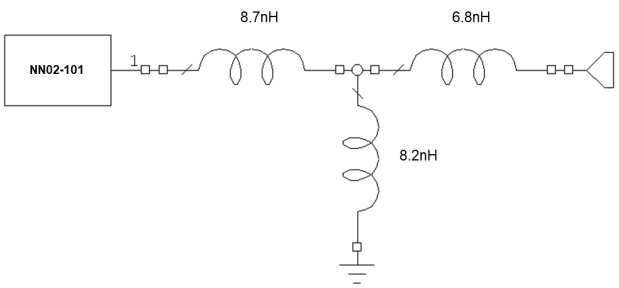
This product and its use are protected by at least one or more of the following patents and patent applications PAT. US 62/529032; and other domestic and international patents pending.

MATCHING NETWORK

The NANO mXTEND™ antenna booster needs a matching network to ensure optimal performance in the 2.4 GHz – 2.5 GHz frequency range. This section presents a suitable matching network for the corner mounting configuration (Figure 7). Please note that different form factors, RF ground planes, and nearby components may require a different matching network.

If you need assistance to design your matching network beyond this application note, please contact support@ignion.io, or if you are designing a **different device size** or a **different frequency band**, **we can assist you** in less than 24 hours. Please, try our free-of-charge[1] Antenna Intelligence Cloud, which will get you a complete design report including a custom matching network for your device in 24h[1]. Additional information related to Ignion's range of R&D services is available at: https://ignion.io/rdservices/

2.4 GHz – 2.5 GHz



Value	Part Number
8.7 nH	LQW18AN8N7G80
8.2 nH	LQW18AN8N2C80
5.8 nH	LQW15AN5N8B80

Figure 2 – Matching network implemented on the Evaluation Board (Figure 1) for covering Bluetooth from 2.4GHz to 2.5GHz.

For an optimal result, the use of high-quality factor (Q) and tight tolerance components is highly recommended (e.g., Murata components with part numbers as shown in **Figure 2**). The antenna performance is always conditioned by its operating environment meaning that differences in the device, including differences in printed circuit board sizes, components near the antenna, displays, batteries, covers, connectors, etc. affect the antenna performance. Accordingly, placing pads compatible with 0402 and 0603 SMD components for a matching network as close as possible to the feeding point of the antenna element is highly recommendable. It is also recommendable to do this in the ground plane area, not in the clearance area. By tuning the matching network in your final design after your final surrounding components are in place (batteries, displays, covers, etc.) you will be able to optimize the antenna performance without changing the antenna part or the design.

[1] See terms and conditions for a free Antenna Intelligence Cloud service in 24h at: https://www.ignion.io/antenna-intelligence/

VSWR AND TOTAL EFFICIENCY

VSWR (Voltage Standing Wave Ratio) and Total Efficiency versus Frequency (GHz).

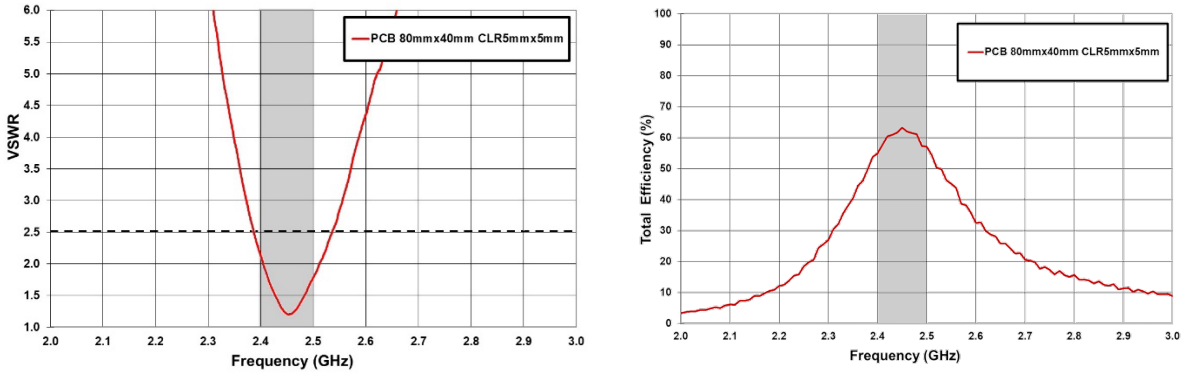


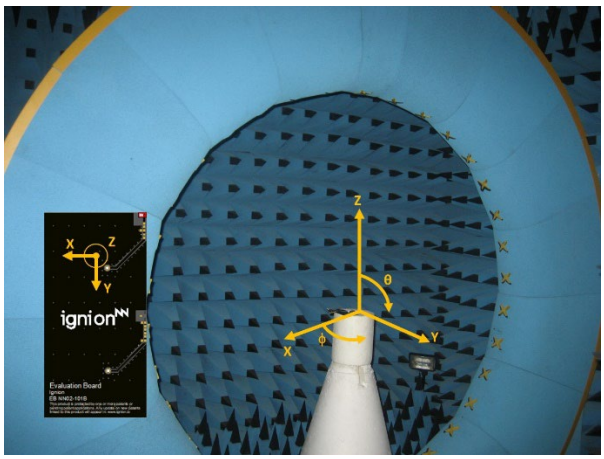
Figure 3 - VSWR and Total Efficiency for the 2.4 – 2.5 GHz frequency range as observed on the evaluation board EB_NN02-101_c_BT (Figure 1).

	2.4 – 2.5GHz				
NANO mXTEND™	**$\eta_{a\ 2400MHz}$**	**$\eta_{a\ 2500MHz}$**	**Min**	**Max**	**Av. η_a**
On the corner	54.9	57.1	54.9	63.2	60.1

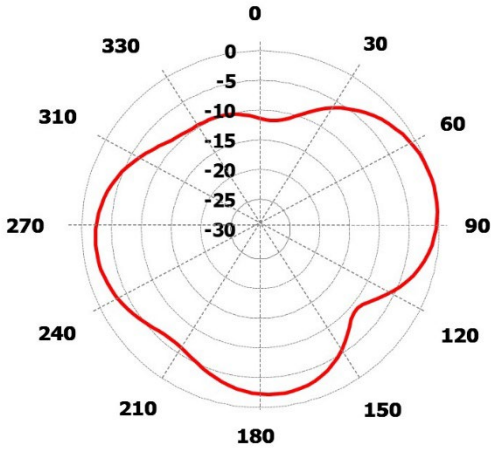
Table 3 - Antenna efficiency comparison considering the evaluation board EB_NN02-101_c_BT (Figure 1).

The NANO mXTEND™ operates at the required Bluetooth/Wi-Fi frequency spectrum with high-efficiency values. Please note that its high performance can be sustained even with a reduced clearance area.

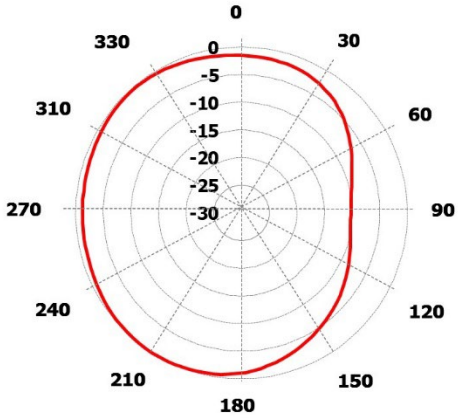
RADIATION PATTERNS, GAIN, AND EFFICIENCY



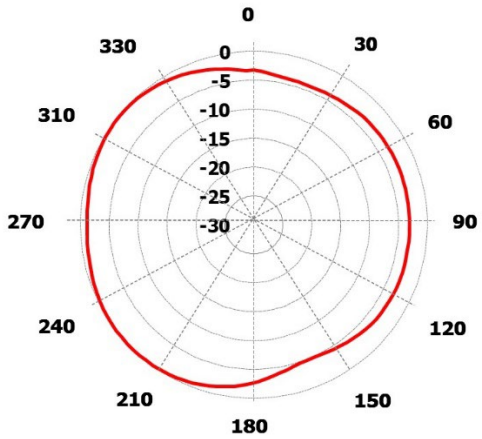
Measurement System Set-Up Evaluation Board in Plane XY



θ = 90º Plane XY at 2450 MHz



ϕ = 0º Plane XZ at 2450 MHz



ϕ = 90º Plane YZ at 2450 MHz

Gain	**Peak Gain**	2.4 dBi
	Average Gain across the band	2.2 dBi
	Gain Range across the band (min, max)	1.9 dBi <–> 2.4 dBi
Efficiency	**Peak Efficiency**	75.4 %
	Average Efficiency across the band	71.9 %
	Efficiency Range across the band (min, max)	66.3 – 75.4 %

Table 4 – Antenna Gain and total efficiency from the evaluation board (Figure 1) Bluetooth band. Measurements made in the STARLAB 18 anechoic chamber.

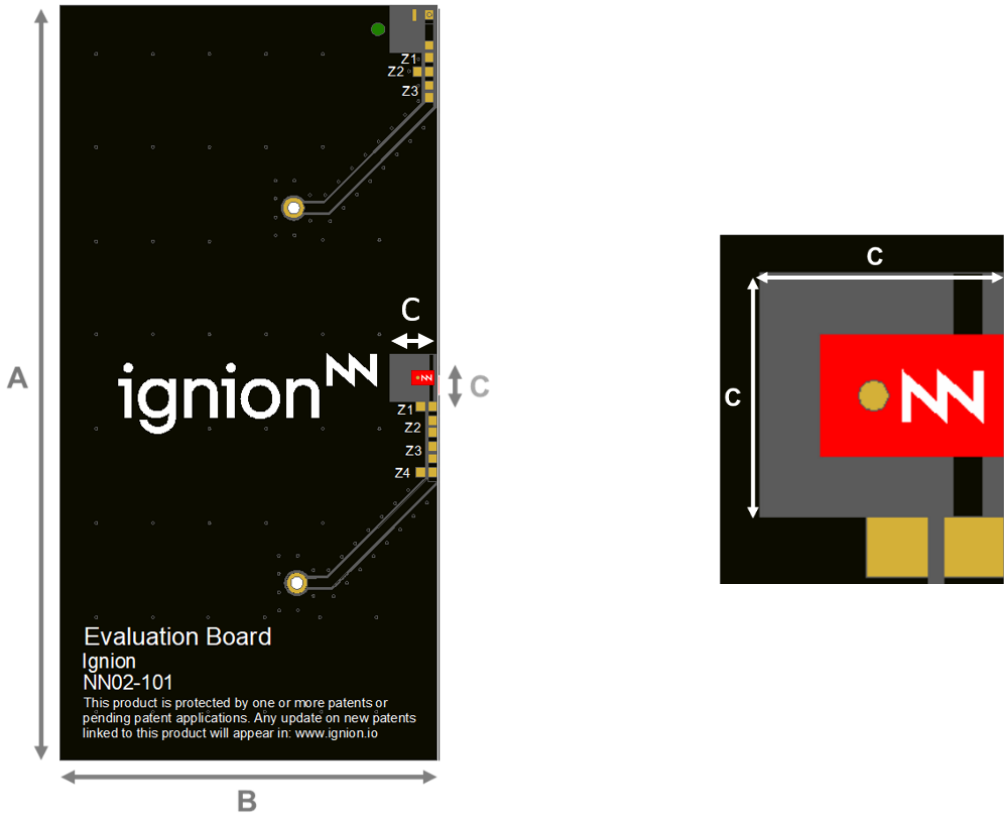
2450MHz																
Phi=0º	Angle Theta [rad]	Angle Theta [º]	Gain [dBi]	Gain [0dB]	Phi=90º	Angle Theta [rad]	Angle Theta [º]	Gain [dBi]	Gain [0dB]	Theta=90º	Angle Phi [rad]	Angle Phi [º]	Gain [dBi]	Gain [0dB]	Gain (Phi Corrected) [0dB]
	-3.14159265	-180	-0.79059523	-1.48		−3. 1415927	-180	-0.79059523	-3.23		0	0.00	-9.52105135	-11.14	-11.39
	-3.0917261	-177	-0.85873335	-1.54		−3. 0917261	-177	-1.00344627	-3.45		0. 04908739	2.81	-9.24309677	-10.86	-11.57
	-3.04185955	-174	-0.91987623	-1.61		−3. 0418596	-174	-1.19506703	-3.64		0. 09817477	5.62	-8.96678344	-10.59	-11.63
	-2.991993	-171	-0.97785104	-1.66		−2. 991993	-171	-1.35946289	-3.80		0. 14726216	8.44	-8.71447141	-10.34	-11.52
	-2.94212645	-169	-1.03790738	-1.72		−2. 9421265	-169	-1.49359172	-3.94		0. 19634954	11.25	-8.49906396	-10.12	-11.23
	-2.8922599	-166	-1.10799272	-1.79		−2. 8922599	-166	-1.59330021	-4.04		0. 24543693	14.06	-8.32997472	-9.95	-10.75
	-2.84239335	-163	-1.19404169	-1.88		−2. 8423934	-163	-1.65860916	-4.10		0. 29452431	16.87	-8.20214127	-9.82	-10.13
	-2.7925268	-160	-1.30258956	-1.99		−2. 7925268	-160	-1.68799716	-4.13		0. 3436117	19.69	-8.11301755	-9.73	-9.41
	-2.74266025	-157	-1.43842693	-2.12		−2. 7426603	-157	-1.68242528	-4.13		0. 39269908	22.50	-8.05606277	-9.68	-8.63
	-2.6927937	-154	-1.60853385	-2.29		−2. 6927937	-154	-1.64617778	-4.09		0. 44178647	25.31	-8.01918986	-9.64	-7.83
	-2.64292715	-151	-1.81421908	-2.50		−2. 6429272	-151	-1.58332923	-4.03		0. 49087385	28.12	-7.98494296	-9.61	-7.03
	-2.5930606	-149	-2.05974239	-2.75		−2. 5930606	-149	-1.499926	-3.94		0. 53996124	30.94	-7.93550637	-9.56	-6.26
	-2.54319405	-146	-2.34572074	-3.03		−2. 5431941	-146	-1.40210003	-3.85		0. 58904862	33.75	-7.84756892	-9.47	-5.53
	-2.4933275	-143	-2.67173196	-3.36		−2. 4933275	-143	-1.29761928	-3.74		0. 63813601	36.56	-7.7046789	-9.33	-4.84
	-2.44346095	-140	-3.03748458	-3.72		−2. 443461	-140	-1.19349465	-3.64		0. 68722339	39.38	-7.48861637	-9.11	-4.19
	-2.3935944	-137	-3.43997655	-4.13		−2. 3935944	-137	-1.09227159	-3.54		0. 73631078	42.19	-7.19443056	-8.82	-3.59
	-2.34372785	-134	-3.87808747	-4.56		−2. 3437279	-134	-0.99881526	-3.44		0. 78539816	45.00	-6.8190411	-8.44	-3.04
	-2.2938613	-131	-4.34262413	-5.03		−2. 2938613	-131	-0.9163256	-3.36		0. 83448555	47.81	-6.37377693	-8.00	-2.53
	-2.24399475	-129	-4.83092862	-5.52		−2. 2439948	-129	-0.84525471	-3.29		0. 88357293	50.62	-5.87593764	-7.50	-2.08
	-2.1941282	-126	-5.33405814	-6.02		−2. 1941282	-126	-0.78595103	-3.23		0. 93266032	53.44	-5.34467768	-6.97	-1.66
	-2.14426165	-123	-5.84486227	-6.53		−2. 1442617	-123	-0.7379998	-3.18		0. 9817477	56.25	-4.79807304	-6.42	-1.30
	-2.0943951	-120	-6.3543594	-7.04		−2. 0943951	-120	-0.70037685	-3.14		1. 03083509	59.06	-4.25394309	-5.88	-0.98
	-2.04452855	-117	-6.85042449	-7.54		−2. 0445286	-117	-0.67310294	-3.12		1. 07992247	61.88	-3.72552647	-5.35	-0.70
	-1.994662	-114	-7.32845963	-8.01		−1. 994662	-114	-0.65311822	-3.10		1. 12900986	64.69	-3.22462084	-4.85	-0.47
	-1.94479545	-111	-7.77516517	-8.46		−1. 9447955	-111	-0.64019378	-3.08		1. 17809725	67.50	-2.75616716	-4.38	-0.28
	-1.8949289	-109	-8.18281527	-8.87		−1. 8949289	-109	-0.63204806	-3.08		1. 22718463	70.31	-2.32848156	-3.95	-0.14
	-1.84506235	-106	-8.54562123	-9.23		−1. 8450624	-106	-0.62873558	-3.07		1. 27627202	73.12	-1.9448129	-3.57	-0.05
	-1.7951958	-103	-8.85610225	-9.54		−1. 7951958	-103	-0.62958462	-3.07		1. 3253594	75.94	-1.60570354	-3.23	0.00
	-1.74532925	-100	-9.11020085	-9.80		−1. 7453293	-100	-0.63152846	-3.08		1. 37444679	78.75	-1.31563668	-2.94	0.00
	-1.6954627	-97	-9.30493985	-9.99		−1. 6954627	-97	-0.63566261	-3.08		1. 42353417	81.56	-1.07285339	-2.69	-0.05
	-1.64559615	-94	-9.44232675	-10.13		−1. 6455962	-94	-0.63951581	-3.08		1. 47262156	84.38	-0.88011583	-2.50	-0.16
	-1.5957296	-91	-9.52105135	-10.21		−1. 5957296	-91	-0.6420386	-3.09		1. 52170894	87.19	-0.73633726	-2.36	-0.31
	-1.54586305	-89	-9.54459889	-10.23		−1. 5458631	-89	-0.64359227	-3.09		1. 57079633	90.00	-0.6420386	-2.26	-0.53
	-1.4959965	-86	-9.51732231	-10.20		−1. 4959965	-86	-0.64191654	-3.09		1. 61988371	92.81	-0.5978243	-2.22	-0.80
	-1.44612995	-83	-9.43973053	-10.13		−1. 44613	-83	-0.63782578	-3.08		1. 6689711	95.62	-0.60235957	-2.22	-1.13
	-1.3962634	-80	-9.31311257	-10.00		−1. 3962634	-80	-0.6321466	-3.08		1. 71805848	98.44	-0.65608342	-2.28	-1.53
	-1.34639685	-77	-9.14391385	-9.83		−1. 3463969	-77	-0.6250374	-3.07		1. 76714587	101.25	-0.75921064	-2.38	-2.00
	-1.2965303	-74	-8.93590841	-9.62		−1. 2965303	-74	-0.6170862	-3.06		1. 81623325	104.06	-0.90981532	-2.53	-2.54
	-1.24666375	-71	-8.6878478	-9.37		−1. 2466638	-71	-0.61205639	-3.06		1. 86532064	106.88	-1.10874811	-2.73	-3.16
	-1.1967972	-69	-8.40879154	-9.09		−1. 1967972	-69	-0.61121888	-3.06		1. 91440802	109.69	-1.35357075	-2.98	-3.86
	-1.14693065	-66	-8.10168358	-8.79		−1. 1469307	-66	-0.61680252	-3.06		1. 96349541	112.50	-1.64184719	-3.26	-4.63
	-1.0970641	-63	-7.77393886	-8.46		−1. 0970641	-63	-0.63308792	-3.08		2. 01258279	115.31	-1.96939659	-3.59	-5.47
	-1.04719755	-60	-7.43215177	-8.12		−1. 0471976	-60	-0.66205777	-3.11		2. 06167018	118.12	-2.33145451	-3.95	-6.36
	-0.997331	-57	-7.0846318	-7.77		−0. 997331	-57	-0.7073518	-3.15		2. 11075756	120.94	-2.71810845	-4.34	-7.25
	-0.94746445	-54	-6.73183328	-7.42		−0. 9474645	-54	-0.77178582	-3.22		2. 15984495	123.75	-3.11614762	-4.74	-8.06
	-0.8975979	-51	-6.37857977	-7.06		−0. 8975979	-51	-0.85738063	-3.30		2. 20893233	126.56	-3.51093552	-5.13	-8.68
	-0.84773135	-49	-6.030392	-6.72		−0. 8477314	-49	-0.96600819	-3.41		2. 25801972	129.38	-3.87683475	-5.50	-8.98
	-0.7978648	-46	-5.68591115	-6.37		−0. 7978648	-46	-1.09852142	-3.54		2. 30710711	132.19	-4.1892998	-5.81	-8.89
	-0.74799825	-43	-5.34521503	-6.03		−0. 7479983	-43	-1.25510173	-3.70		2. 35619449	135.00	-4.41916259	-6.04	-8.46
	-0.6981317	-40	-5.00700798	-5.69		−0. 6981317	-40	-1.43183891	-3.88		2. 40528188	137.81	-4.54224197	-6.16	-7.80
	-0.64826515	-37	-4.66930597	-5.36		−0. 6482652	-37	-1.62390798	-4.07		2. 45436926	140.62	-4.54098298	-6.16	-7.03
	-0.5983986	-34	-4.32956072	-5.02		−0. 5983986	-34	-1.82272613	-4.27		2. 50345665	143.44	-4.41868581	-6.04	-6.25
	-0.54853205	-31	-3.98730289	-4.67		−0. 5485321	-31	-2.01483656	-4.46		2. 55254403	146.25	-4.18469098	-5.81	-5.50
	-0.4986655	-29	-3.64062995	-4.33		−0. 4986655	-29	-2.1853258	-4.63		2. 60163142	149.06	-3.86367496	-5.49	-4.82
	-0.44879895	-26	-3.28985864	-3.98		−0. 448799	-26	-2.31494164	-4.76		2. 6507188	151.88	-3.4858458	-5.11	-4.22
	-0.3989324	-23	-2.93856502	-3.62		−0. 3989324	-23	-2.38487688	-4.83		2. 69980619	154.69	-3.07607082	-4.70	-3.70
	-0.34906585	-20	-2.5861663	-3.27		−0. 3490659	-20	-2.37919942	-4.82		2. 74889357	157.50	-2.65992625	-4.28	-3.26
	-0.2991993	-17	-2.23859262	-2.92		−0. 2991993	-17	-2.29021135	-4.73		2. 79798096	160.31	-2.25566788	-3.88	-2.89
	-0.24933275	-14	-1.89905784	-2.59		−0. 2493328	-14	-2.11544066	-4.56		2. 84706834	163.12	-1.87706636	-3.50	-2.60
	-0.1994662	-11	-1.57220319	-2.26		−0. 1994662	-11	-1.86658288	-4.31		2. 89615573	165.94	-1.53308227	-3.15	-2.38
	-0.14959965	-9	-1.26254535	-1.95		−0. 1495997	-9	-1.557785	-4.00		2. 94524311	168.75	-1.2330908	-2.85	-2.23
	-0.0997331	-6	-0.97291909	-1.66		−0. 0997331	-6	-1.20887235	-3.65		2. 9943305	171.56	-0.9796342	-2.60	-2.15
	-0.04986655	-3	-0.70622347	-1.39		−0. 0498666	-3	-0.83971064	-3.28		3. 04341788	174.38	-0.7764673	-2.40	-2.12
	0	0	-0.46580857	-1.15		0	0	-0.46580857	-2.91		3. 09250527	177.19	-0.62796734	-2.25	-2.16
	0.04986655	3	-0.25118057	-0.94		0. 04986655	3	-0.1004224	-2.54		3. 14159265	180.00	-0.53479664	-2.16	-2.25
	0.0997331	6	-0.0643276	-0.75		0. 0997331	6	0.24663667	-2.20		3. 19068004	182.81	-0.49933477	-2.12	-2.40
	0.14959965	9	0.09652826	-0.59		0. 14959965	9	0.57018631	-1.87		3. 23976742	185.62	-0.52389487	-2.15	-2.60
	0.1994662	11	0.23216808	-0.45		0. 1994662	11	0.8655187	-1.58		3. 28885481	188.44	-0.61163108	-2.23	-2.85
	0.24933275	14	0.34474415	-0.34		0. 24933275	14	1.13180585	-1.31		3. 33794219	191.25	-0.76313168	-2.38	-3.15
	0.2991993	17	0.43748327	-0.25		0. 2991993	17	1.37070868	-1.07		3. 38702958	194.06	-0.98233637	-2.60	-3.50
	0.34906585	20	0.51243329	-0.17		0. 34906585	20	1.57722811	-0.87		3. 43611696	196.88	-1.27203298	-2.89	-3.88
	0.3989324	23	0.57095378	-0.12		0. 3989324	23	1.76311793	-0.68		3. 48520435	199.69	-1.63540338	-3.26	-4.28
	0.44879895	26	0.61681474	-0.07		0. 44879895	26	1.91658959	-0.53		3. 53429174	202.50	-2.07676567	-3.70	-4.70
	0.4986655	29	0.65120787	-0.03		0. 4986655	29	2.05543252	-0.39		3. 58337912	205.31	-2.59735106	-4.22	-5.11
	0.54853205	31	0.67368492	-0.01		0. 54853205	31	2.16222006	-0.28		3. 63246651	208.12	-3.19931392	-4.82	-5.49
	0.5983986	34	0.68607164	0.00		0. 5983986	34	2.25433218	-0.19		3. 68155389	210.94	-3.87816647	-5.50	-5.81
	0.64826515	37	0.68604568	0.00		0. 64826515	37	2.32501429	-0.12		3. 73064128	213.75	-4.62416234	-6.25	-6.04
	0.6981317	40	0.67353728	-0.01		0. 6981317	40	2.37912731	-0.06		3. 77972866	216.56	-5.40893261	-7.03	-6.16
	0.74799825	43	0.64762323	-0.04		0. 74799825	43	2.4181257	-0.03		3. 82881605	219.38	-6.17694096	-7.80	-6.16
	0.7978648	46	0.60593002	-0.08		0. 7978648	46	2.43934284	0.00		3. 87790343	222.19	-6.8401972	-8.46	-6.04
	0.84773135	49	0.5487265	-0.14		0. 84773135	49	2.44395227	0.00		3. 92699082	225.00	-7.27247357	-8.89	-5.81
	0.8975979	51	0.47594353	-0.21		0. 8975979	51	2.4332803	-0.01		3. 9760782	227.81	-7.35903854	-8.98	-5.50
	0.94746445	54	0.38886688	-0.30		0. 94746445	54	2.40897929	-0.03		4. 02516559	230.62	-7.05931307	-8.68	-5.13
	0.997331	57	0.28854444	-0.40		0. 997331	57	2.36592253	-0.08		4. 07425297	233.44	-6.44176405	-8.06	-4.74
	1.04719755	60	0.1802302	-0.51		1. 04719755	60	2.30885603	-0.14		4. 12334036	236.25	-5.62930046	-7.25	-4.34
	1.0970641	63	0.06684518	-0.62		1. 0970641	63	2.23527602	-0.21		4. 17242774	239.06	-4.73789842	-6.36	-3.95
	1.14693065	66	-0.04677384	-0.73		1. 14693065	66	2.14753376	-0.30		4. 22151513	241.88	-3.84949469	-5.47	-3.59
	1.1967972	69	-0.15484938	-0.84		1. 1967972	69	2.04144646	-0.40		4. 27060251	244.69	-3.00728586	-4.63	-3.26
	1.24666375	71	-0.25292497	-0.94		1. 24666375	71	1.93140502	-0.51		4. 3196899	247.50	-2.23362426	-3.86	-2.98
	1.2965303	74	-0.33810507	-1.02		1. 2965303	74	1.81111769	-0.63		4. 36877728	250.31	-1.53693044	-3.16	-2.73
	1.34639685	77	-0.4072884	-1.09		1. 34639685	77	1.69395717	-0.75		4. 41786467	253.12	-0.91892353	-2.54	-2.53
	1.3962634	80	-0.46002351	-1.15		1. 3962634	80	1.57193797	-0.87		4. 46695205	255.94	-0.37730038	-2.00	-2.38
	1.44612995	83	-0.49736995	-1.18		1. 44612995	83	1.47015611	-0.97		4. 51603944	258.75	0.09188375	-1.53	-2.28
	1.4959965	86	-0.52118645	-1.21		1. 4959965	86	1.38897853	-1.05		4. 56512682	261.56	0.49063458	-1.13	-2.22
	1.54586305	89	-0.53244547	-1.22		1. 54586305	89	1.33322074	-1.11		4. 61421421	264.38	0.8242857	-0.80	-2.22
	1.5957296	91	-0.53479664	-1.22		1. 5957296	91	1.30869464	-1.14		4. 6633016	267.19	1.09614497	-0.53	-2.26

	1.64559615	94	-0.5288283	-1.21		1.64559615	94	1.32011422	-1.12		4.71238898	270.00	1.30869464	-0.31	-2.36
	1.6954627	97	-0.51624524	-1.20		1.6954627	97	1.36434321	-1.08		4.76147637	272.81	1.46589857	-0.16	-2.50
	1.74532925	100	-0.49507406	-1.18		1.74532925	100	1.43761738	-1.01		4.81056375	275.62	1.56886792	-0.05	-2.69
	1.7951958	103	-0.46669282	-1.15		1.7951958	103	1.53923303	-0.90		4.85965114	278.44	1.6204683	0.00	-2.94
	1.84506235	106	-0.42855519	-1.11		1.84506235	106	1.65170015	-0.79		4.90873852	281.25	1.62167309	0.00	-3.23
	1.8949289	109	-0.37906527	-1.07		1.8949289	109	1.76795491	-0.68		4.95782591	284.06	1.57501599	-0.05	-3.57
	1.94479545	111	-0.31805323	-1.00		1.94479545	111	1.88673227	-0.56		5.00691329	286.88	1.48083964	-0.14	-3.95
	1.994662	114	-0.24624649	-0.93		1.994662	114	1.9985871	-0.45		5.05600068	289.69	1.33995822	-0.28	-4.38
	2.04452855	117	-0.16454661	-0.85		2.04452855	117	2.10048939	-0.34		5.10508806	292.50	1.15374397	-0.47	-4.85
	2.0943951	120	-0.07607132	-0.76		2.0943951	120	2.1819802	-0.26		5.15417545	295.31	0.92193597	-0.70	-5.35
	2.14426165	123	0.01584257	-0.67		2.14426165	123	2.24016906	-0.20		5.20326283	298.12	0.64596366	-0.98	-5.88
	2.1941282	126	0.1061818	-0.58		2.1941282	126	2.28372033	-0.16		5.25235022	300.94	0.32389508	-1.30	-6.42
	2.24399475	129	0.19041259	-0.50		2.24399475	129	2.29692273	-0.15		5.3014376	303.75	-0.04252632	-1.66	-6.97
	2.2938613	131	0.26353995	-0.42		2.2938613	131	2.28863632	-0.16		5.35052499	306.56	-0.45504723	-2.08	-7.50
	2.34372785	134	0.32299573	-0.36		2.34372785	134	2.25926402	-0.18		5.39961237	309.38	-0.91311925	-2.53	-8.00
	2.3935944	137	0.36438444	-0.32		2.3935944	137	2.20436952	-0.24		5.44869976	312.19	-1.41800989	-3.04	-8.44
	2.44346095	140	0.38485116	-0.30		2.44346095	140	2.12599417	-0.32		5.49778714	315.00	-1.96955967	-3.59	-8.82
	2.4933275	143	0.38458644	-0.30		2.4933275	143	2.02414101	-0.42		5.54687453	317.81	-2.56872428	-4.19	-9.11
	2.54319405	146	0.3614875	-0.32		2.54319405	146	1.89881874	-0.55		5.59596191	320.62	-3.21572384	-4.84	-9.33
	2.5930606	149	0.31640654	-0.37		2.5930606	149	1.75059882	-0.69		5.6450493	323.44	-3.90810479	-5.53	-9.47
	2.64292715	151	0.25001504	-0.44		2.64292715	151	1.57945906	-0.86		5.69413668	326.25	-4.64100596	-6.26	-9.56
	2.6927937	154	0.16621104	-0.52		2.6927937	154	1.38758664	-1.06		5.74322407	329.06	-5.41238538	-7.03	-9.61
	2.74266025	157	0.06671661	-0.62		2.74266025	157	1.1764572	-1.27		5.79231146	331.88	-6.20663996	-7.83	-9.64
	2.7925268	160	-0.04397738	-0.73		2.7925268	160	0.94857578	-1.50		5.84139884	334.69	-7.00879252	-8.63	-9.68
	2.84239335	163	-0.16168471	-0.85		2.84239335	163	0.70688758	-1.74		5.89048623	337.50	-7.78855542	-9.41	-9.73
	2.8922599	166	-0.28348065	-0.97		2.8922599	166	0.45600408	-1.99		5.93957361	340.31	-8.51179103	-10.13	-9.82
	2.94212645	169	-0.40271281	-1.09		2.94212645	169	0.19867889	-2.25		5.988661	343.12	-9.13281458	-10.75	-9.95
	2.991993	171	-0.51539987	-1.20		2.991993	171	-0.05953153	-2.50		6.03774838	345.94	-9.60407856	-11.23	-10.12
	3.04185955	174	-0.61935335	-1.31		3.04185955	174	-0.31294963	-2.76		6.08683577	348.75	-9.89581687	-11.52	-10.34
	3.0917261	177	-0.71049228	-1.40		3.0917261	177	-0.55896036	-3.00		6.13592315	351.56	-10.0038894	-11.63	-10.59
	3.14159265	180	-0.79059523	-1.48		3.14159265	180	-0.79059523	-3.23		6.18501054	354.38	-9.9468743	-11.57	-10.86
											6.23409792	357.19	-9.77061606	-11.39	-11.14

Note: Find attached the radiation patterns phi0, phi90 and theta90 at 2450MHz of NN02-101 when this is placed on the corner and the clearance is of 5mm x 5mm. Notice the gain in those values is expressed respect to the isotropic antenna. Additionally, attach the excel file where these values are normalized respect to the maximum. Apart from this, find the max Gain as well.

EDGE MOUNTING CONFIGURATION

In devices such as dual-hand gaming handhelds and landscape handheld devices, the center of the edge can be the ideal placement area for your chip antenna, This section details a design example and evaluation board (80 mm x 40 mm with 4 mm x 4 mm of ground clearance) in such an edge mounting configuration (Figure 4).



Measure	mm
A	80
B	40
C	5

Tolerance: ±0.2 mm

C: Length of clearance area.

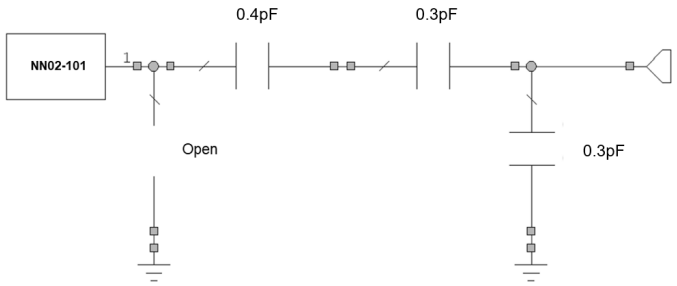
Figure 4 - EB_NN02-101_m_BT. Evaluation board providing operation at Bluetooth (2400 – 2500 MHz).

MATCHING NETWORK

By simply changing the matching network, the NANO mXTEND™ can also deliver optimal performance in an edge mounting configuration. A suitable matching network for edge mounting in the reference board pictured above is shown in Fig.5. Please note that different form factors of your wireless device and its RF ground planes, and the proximity of other elements such as shields, covers, connectors and the like might result in the need for a fine-tuning of the matching network.

If you need assistance to design your matching network beyond this application note, please contact support@ignion.io, or if you are designing a **different device size** or a **different frequency band**, **we can assist you** in less than 24 hours. Please, try our free-of-charge[1] Antenna Intelligence Cloud, which will get you a complete design report including a custom matching network for your device in 24h[2]. Additional information related to Ignion's range of R&D services is available at: https://ignion.io/rdservices/

2.4 GHz – 2.5 GHz



Value	Part Number
-	-
0.4pF	GJM1555C1HR40WB01
0.3pF	GJM1555C1HR30WB01
0.3pF	GJM1555C1HR30WB01

Figure 5 – Matching network implemented in the Evaluation Board (Figure 4) for covering Bluetooth from 2.4GHz to 2.5GHz.

To ensure optimal results, the use of high-quality factor (Q) and tight tolerance components is highly recommended (e.g. Murata components with part numbers as shown in **Figure 5**). The antenna performance is always conditioned by its operating environment meaning that differences in the device, including differences in printed circuit board sizes, components near the antenna, displays, batteries, covers, connectors, etc. affect the antenna performance. Accordingly, placing pads compatible with 0402 and 0603 SMD components for a matching network as close as possible to the feeding point of the antenna element is highly recommendable. It is recommended to do this in the ground plane area, not in the clearance area. By tuning the matching network in your final design after your final surrounding components are in place (batteries, displays, covers, etc.) you will be able to optimize the antenna performance without changing the antenna part, or the design.

[2] See terms and conditions for a free Antenna Intelligence Cloud service in 24h at: https://www.ignion.io/antenna-intelligence/

VSWR AND TOTAL EFFICIENCY

VSWR (Voltage Standing Wave Ratio) and Total Efficiency versus Frequency (GHz).

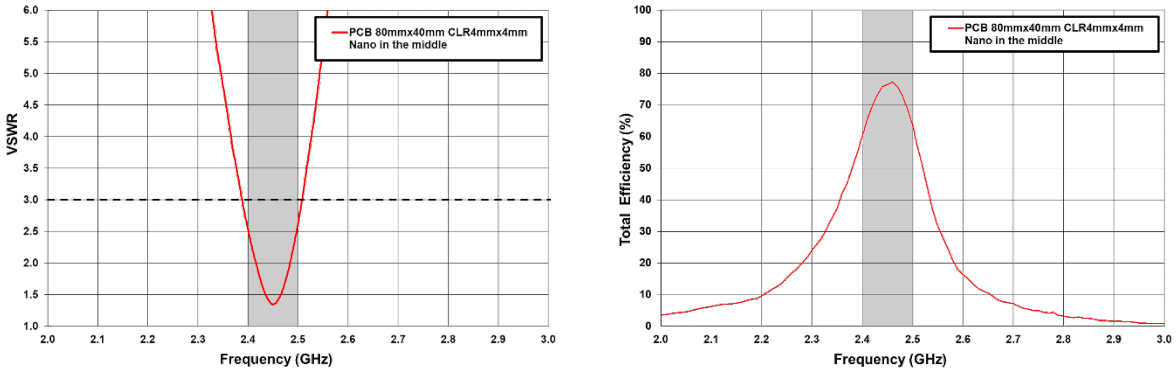


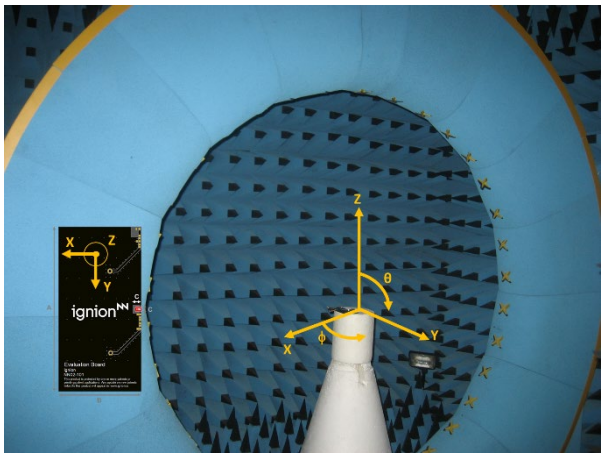
Figure 6 - VSWR and Total Efficiency for the 2.4 – 2.5 GHz frequency range configured to provide operation the evaluation board EB_NN02-101_m_BT (Figure 4).

	2400 – 2500 MHz				
NANO mXTEND™	**$\eta_{a\ 2400MHz}$**	**$\eta_{a\ 2500MHz}$**	**Min**	**Max**	**Av. η_a**
On the middle	60.1	63.6	60.1	77.3	71.7

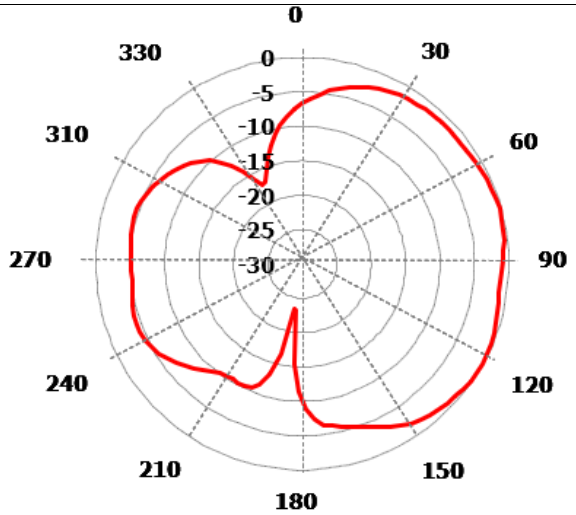
Table 5 - Antenna efficiency comparison configured to provide operation the evaluation board EB_NN02-101_m_BT (Figure 4).

The NANO mXTEND™ operates at the required Bluetooth/Wi-Fi frequency spectrum with high efficiency values. Please note that its high performance can be sustained even with the small 5x5 mm clearance area.

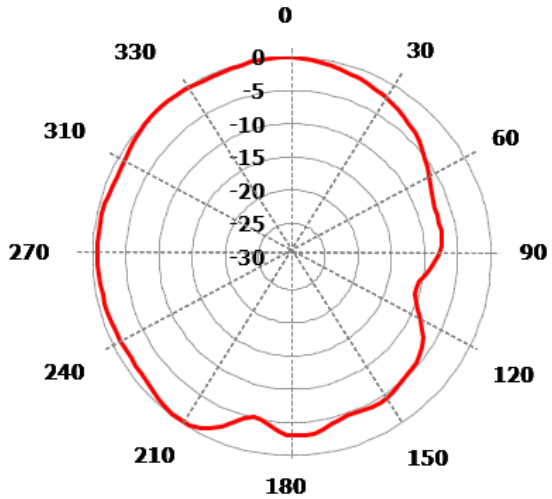
RADIATION PATTERNS, GAIN, AND EFFICIENCY



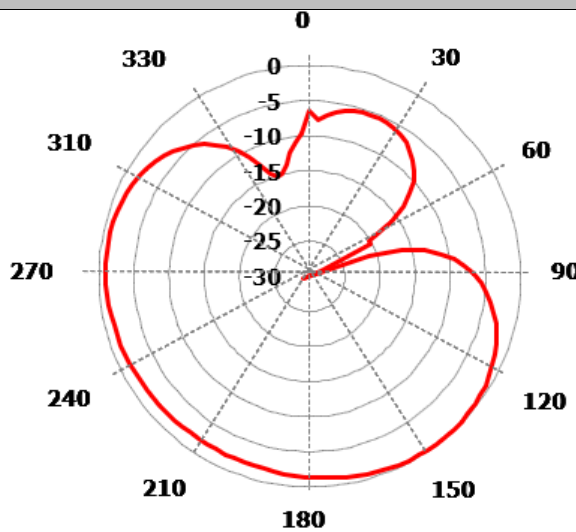
Measurement System Set-Up Evaluation Board in Plane XY



θ = 90º Plane XY at 2450 MHz



ϕ = 0º Plane XZ at 2450 MHz



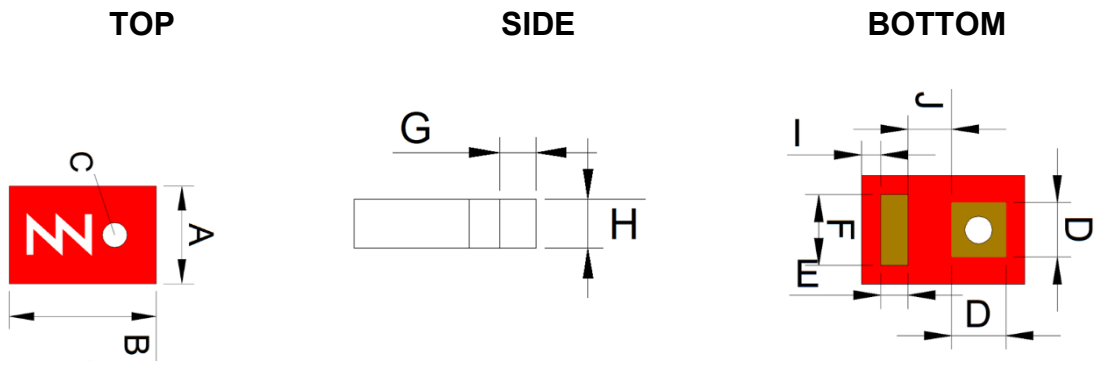
ϕ = 90º Plane YZ at 2450 MHz

Gain	**Peak Gain**	1.1 dBi
	Average Gain across the band	0.85 dBi
	Gain Range across the band (min, max)	0.3 dBi <–> 1.1 dBi
Efficiency	**Peak Efficiency**	73.7 %
	Average Efficiency across the band	69.6 %
	Efficiency Range across the band (min, max)	70.0 – 73.7 %

Table 6 – Antenna Gain and total efficiency from the evaluation board (Figure 4) Bluetooth band. Measurements made in the STARLAB 18 anechoic chamber.

MECHANICAL SPECIFICATIONS

DIMENSIONS, TOLERANCES, AND RoHS



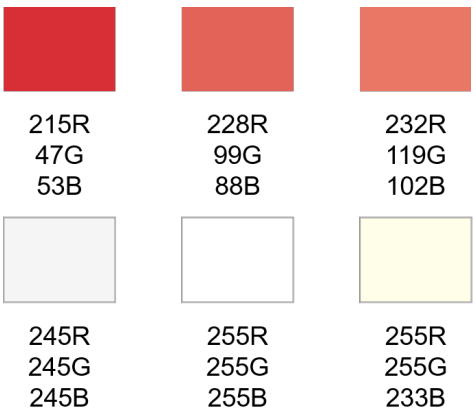
Dimension	mm	Dimension	mm
A	2.0	**B**	3.0
C	0.25	**D**	1.0
E	0.5	**F**	1.3
G	0.6	**H**	0.8
I	0.35	**J**	0.8

Figure 7 - NANO mXTEND™ antenna booster dimensions and tolerances.

The NANO mXTEND™ (NN02-101) antenna booster is compliant with the restriction of the use of hazardous substances (**RoHS**). For more information, please contact info@ignion.io.

INK COLOR RANGE

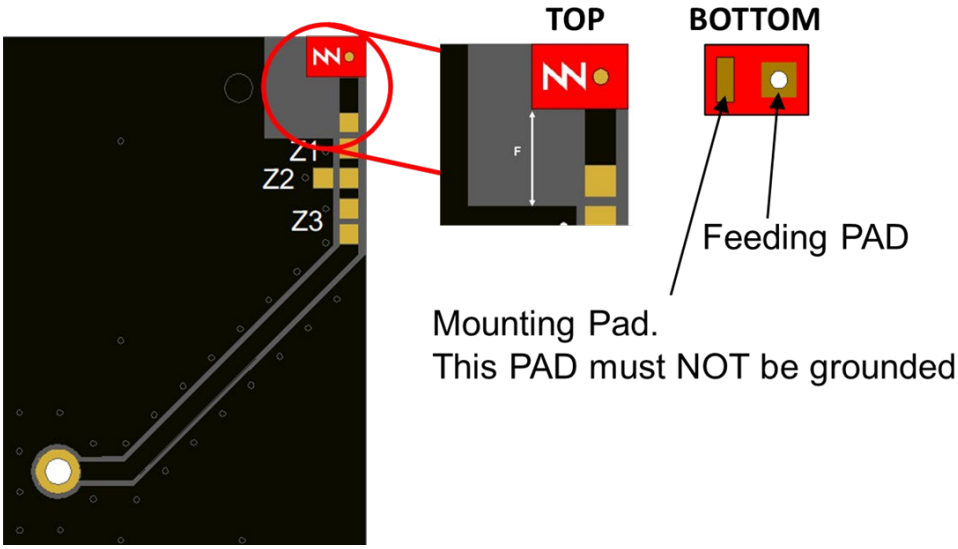
The next figure shows the range of colors in the NANO mXTEND™ antenna booster:

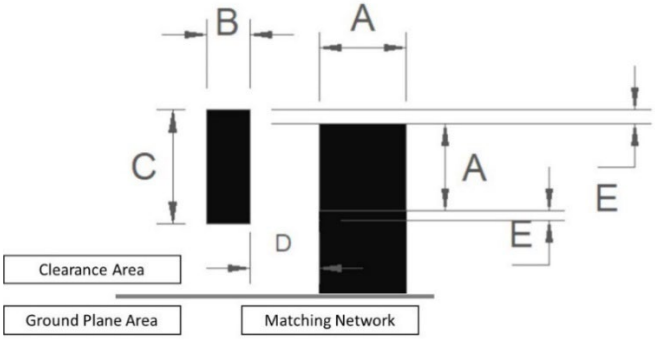


Acceptable color range

RECOMMENDED FOOTPRINT FOR THE NN02-101

See below the recommended footprint dimensions for the **NANO mXTEND™** (NN02-101) antenna booster on the **corner**.



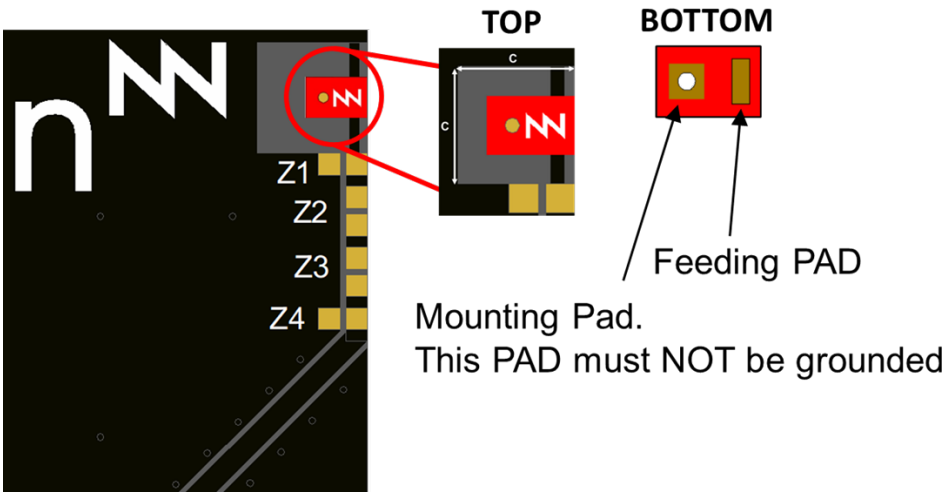


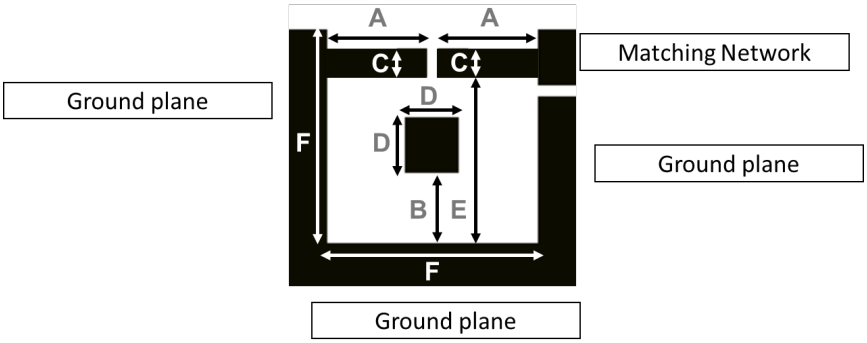
Measure	mm
A	1.0
B	0.5
C	1.3
D	0.8
E	0.15

Tolerance: ±0.05mm

Figure 8 - Footprint dimensions for the NANO mXTEND™ (NN02-101) antenna booster (on the corner).

See below the recommended footprint dimensions for the **NANO mXTEND™** (NN02-101) antenna booster in the **middle**.





Measure	mm
A	1.875
B	1.35
C	0.5
D	1.0
E	3.15
F	4.0

Tolerance: ±0.05mm

Figure 9 - Footprint dimensions for the NANO mXTEND™ (NN02-101) antenna booster (on the middle).

For additional support in the integration process, please contact support@ignion.io.

ASSEMBLY AND MANUFACTURING

Figure 10 shows the back and front views of the NANO mXTEND™ (NN02-101) antenna booster.

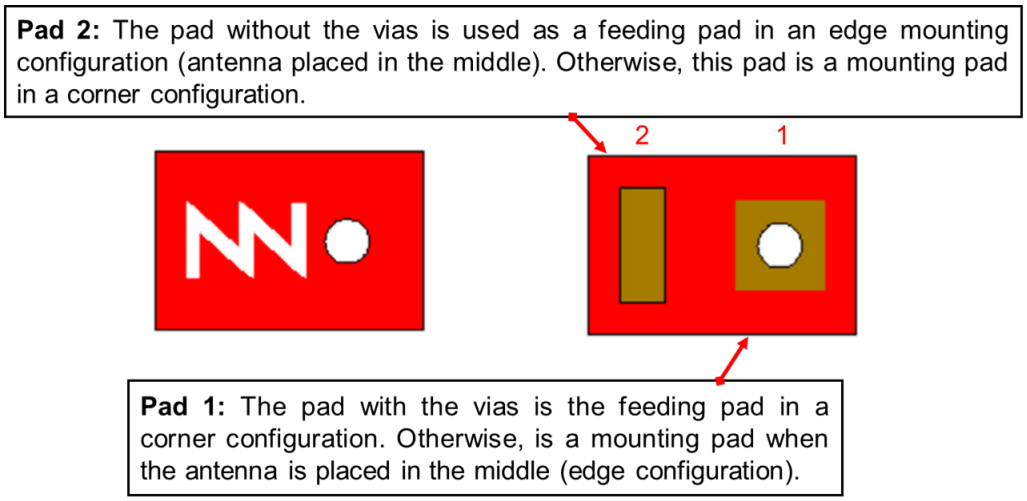


Figure 10 – Pads of the NANO mXTEND™ (NN02-101) antenna booster.

As a surface mount device (SMD), the NANO mXTEND™ antenna booster is compatible with industry standard soldering processes. The basic assembly procedure for the NANO mXTEND™ antenna booster is as follows:

1. Apply a solder paste on the pads of the PCB. Place the NANO mXTEND™ antenna booster on the board.
2. Perform a reflow process according to the temperature profile detailed in Figure 11.
3. After soldering the NANO mXTEND™ antenna booster to the circuit board, perform a cleaning process to remove any residual flux. Ignion recommends conducting a visual inspection after the cleaning process to verify that all reflux has been removed.

The figure below shows the soldering details obtained after a correct assembly process:

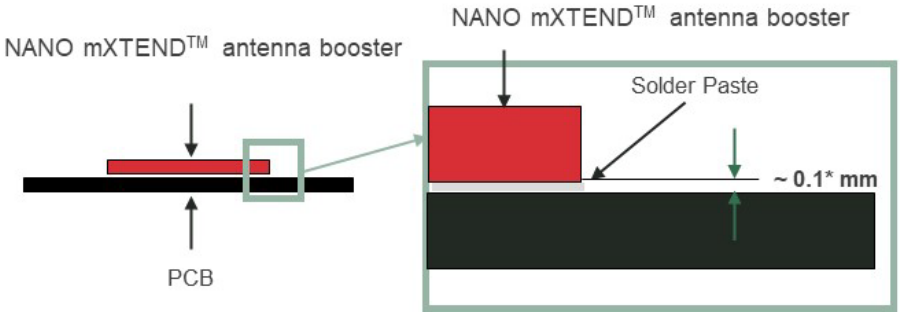


Figure 11 - Soldering details

NOTE (*): Solder paste thickness after the assembly process will depend on the thickness of the soldering stencil mask. A stencil thickness equal to or larger than 127 microns (5 mils) is required.

The NANO mXTEND™ (NN02-101) antenna booster can be assembled following the Pb-free assembly process. According to the **IPC/JEDEC J-STD-020C** Standard, the suggested temperature profile is as follows:

Phase	Profile features	Pb-Free assembly (Sn Ag Cu)
RAMP-UP	Avg. Ramp-up Rate (Tsmax to Tp)	3 ºC / second (max.)
PREHEAT	- Temperature Min (Tsmin) - Temperature Max (Tsmax) - Time (tsmin to tsmax)	150 ºC 200 ºC 60-180 seconds
REFLOW	- Temperature (TL) - Total Time above TL (tL)	217 ºC 60-150 seconds
PEAK	- Temperature (Tp) - Time (tp)	260 ºC 20-40 seconds
RAMP-DOWN	Rate	6 ºC/second max
Time from 25 ºC to Peak Temperature		8 minutes max

Table 7 – Recommended soldering temperatures.

The next graphic shows the temperature profile (grey zone) for the NANO mXTEND™ antenna booster assembly process reflow ovens.

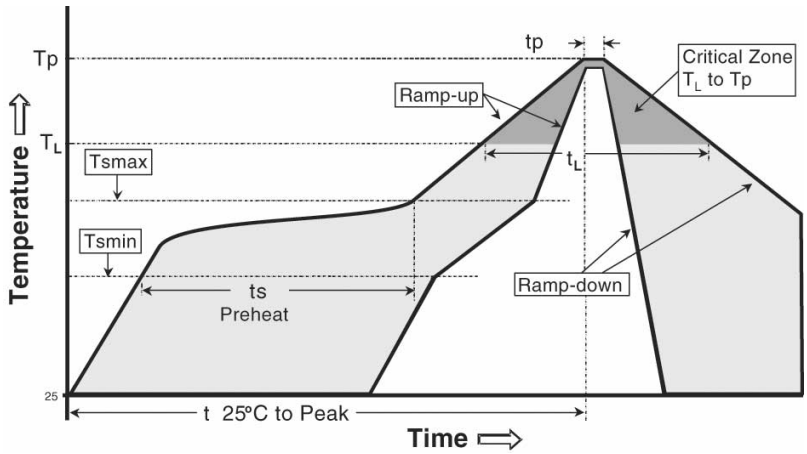
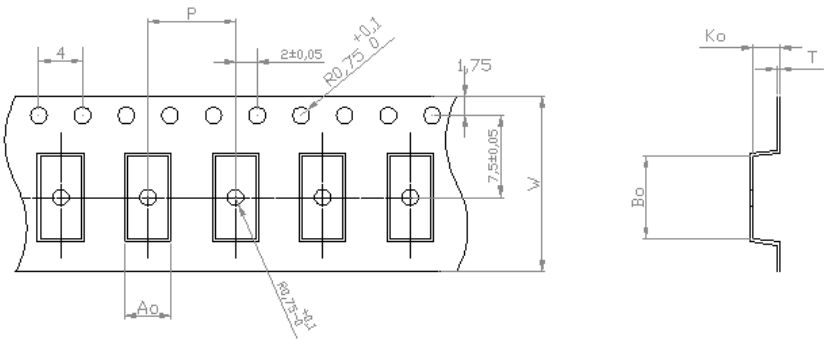


Figure 12 – Temperature profile

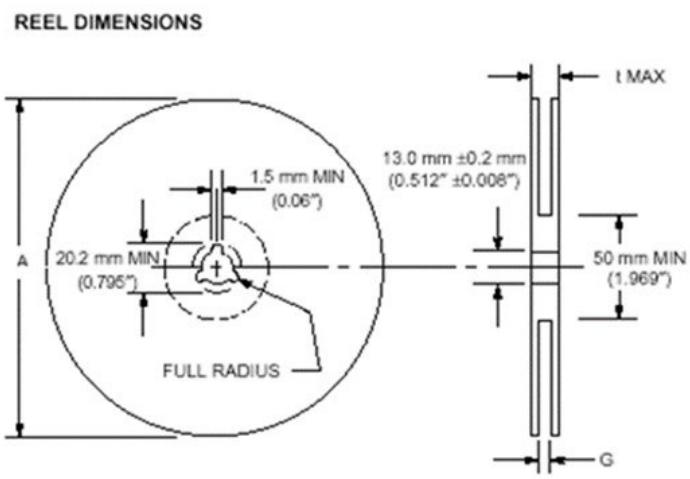
PACKAGING

The NANO mXTEND™ (NN02-101) antenna booster is delivered in tape and reel packaging.



Measure	mm
A0	3.6 ± 0.1
B0	7.5 ± 0.1
K0	2.5 ± 0.1
W	16.0 ± 0.3
P	8.0 ± 0.1
T	0.3 ± 0.05

Figure 13 - Tape dimensions and tolerances.



Measure	Mm
A	330 ± 1.0
G	16.4 ± 0.1
t max	20.4 ± 0.1

Reel Capacity: 2500 pcs

Figure 14 - Reel dimensions and capacity.

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Ignion is an ISO 9001:2015 certified company. All our antennas are lead-free and RoHS compliant.

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ignion

Your innovation.
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Contact:
support@ignion.io
+34 935 660 710

Barcelona

Av. Alcalde Barnils, 64-68 Modul C, 3a pl.
Sant Cugat del Vallés
08174 Barcelona
Spain

Shenzhen

Topway Information Building, 2303 Room
No.3369, Binhai Avenue, Nanshan District
Shenzhen, Guangdong 518000
China

+86 138 2653 8470

Tampa

8875 Hidden River Parkway
Suite 300
Tampa, FL 33637
USA