

Antennas matter: Overcoming integration challenges and succeeding in device certification



Presenter:

Maria El Bacha, Product Manager, PhD

Agenda

1

Introduction to
KYOCERA AVX
& Device
Certification



2

Top Reasons
Devices Fail in
Certification



3

Real-world
Case Studies &
Success
Stories



4

Strategies,
Solutions and
KYOCERA AVX
Resources



5

Q&A



01

Introduction to KYOCERA AVX & Device Certification

Company Overview

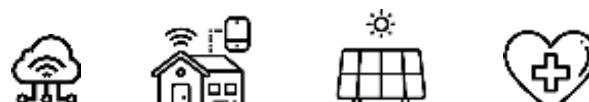
VISION STATEMENT

“ KYOCERA AVX will foster an environment where our employees can reach their full potential. We will achieve superior customer satisfaction and expand our business by developing technologies and products that enhance society while delivering tomorrow's solutions. ”



*“Unifying 2 Great Brands
to Provide Solutions for
a Better Tomorrow”*

Markets Served



Product Offering



CAPACITORS



ANTENNAS



RF / MICROWAVE



SENSORS /
CONTROLS



CONNECTORS /
MECHATRONICS



CIRCUIT
PROTECTION



CRYSTALS / SAW DEVICES

+\$3B
Revenue

20,000+
Employees

43
Factories

23
Sales Offices



Antennas for each Application



Standard Antennas



Industrial Gateways

External Antennas or Embedded Solutions

5G RedCap, 5G/4G, LoRa, Wi-Fi 6E/7



Custom Designs



Validation & Pre-certification



Smart Meters & Lighting

Versatile Standard Antennas or Custom Solutions

169MHz, 433 MHz, LoRa, NB-IoT, 2.4 GHz, DECT NR+, Wi-SUN



Wearables

LDS Technology for Thinner and Smaller Devices

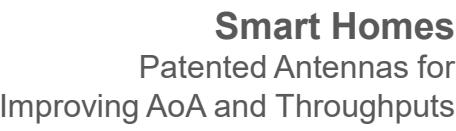
BLE, GNSS, Cellular, Wi-Fi



Satellite Communications

The Smallest Chip Antennas for SatCom

5G NTN, GNSS, RTK, L1/L2/L5/L6, LoRa S-band



Smart Homes

Patented Antennas for Improving AoA and Throughputs

UWB, BLE, Matter, Zigbee, Thread, Wi-Fi 6E/7

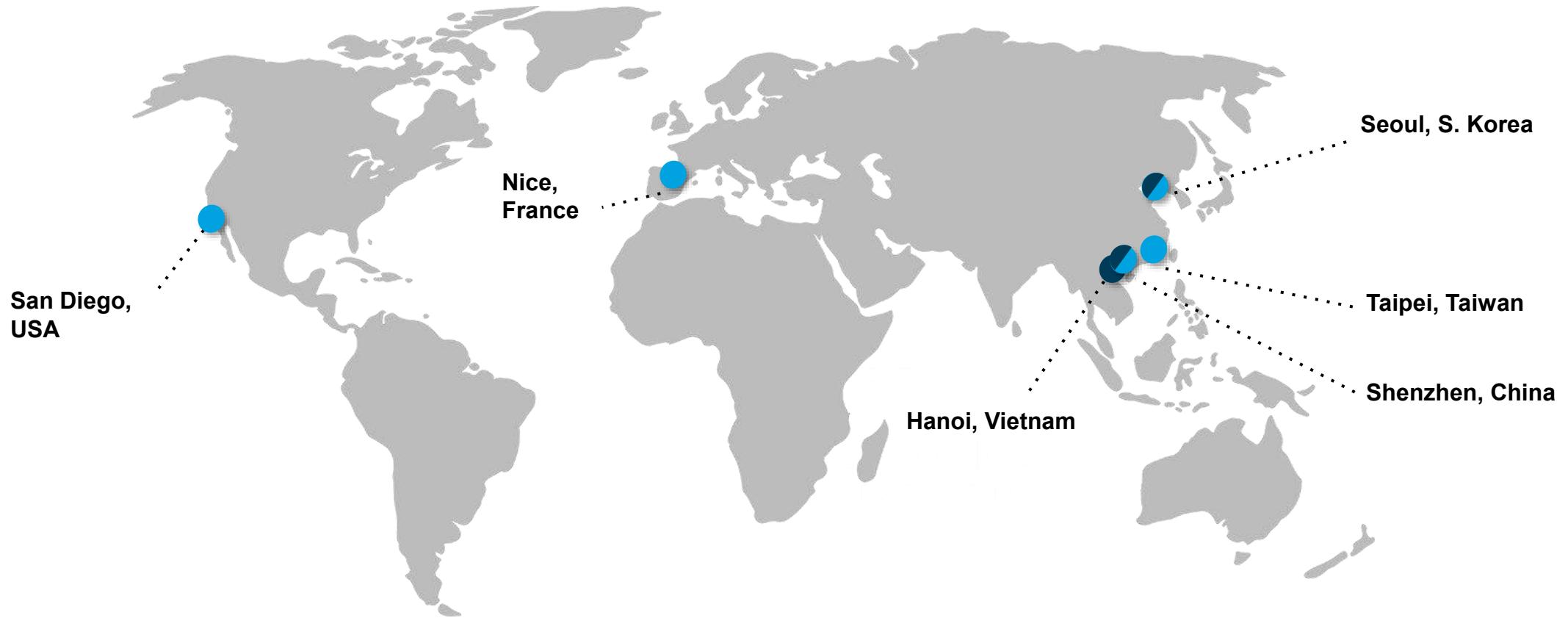


Automotive & Fleet & Asset Tracking

Active Antenna Band Switching for Small Devices and Embedded or External Antennas

5G NTN, 5G/4G, NB-IoT, LTE-M, GNSS, BLE, Wi-Fi

Global Design and Manufacturing Presence



DESIGN CENTERS

- San Diego, USA
- Nice, France
- Seoul, S. Korea
- Taipei, Taiwan
- Shenzhen, China

MANUFACTURING CENTERS

- Seoul, Korea
- Hanoi, Vietnam
- Shenzhen, China

Services we provide



RF Knowledge and Extensive Experience with adequate solutions, antenna integration and test reports



Customized Solutions for any need and for Challenging Mechanics

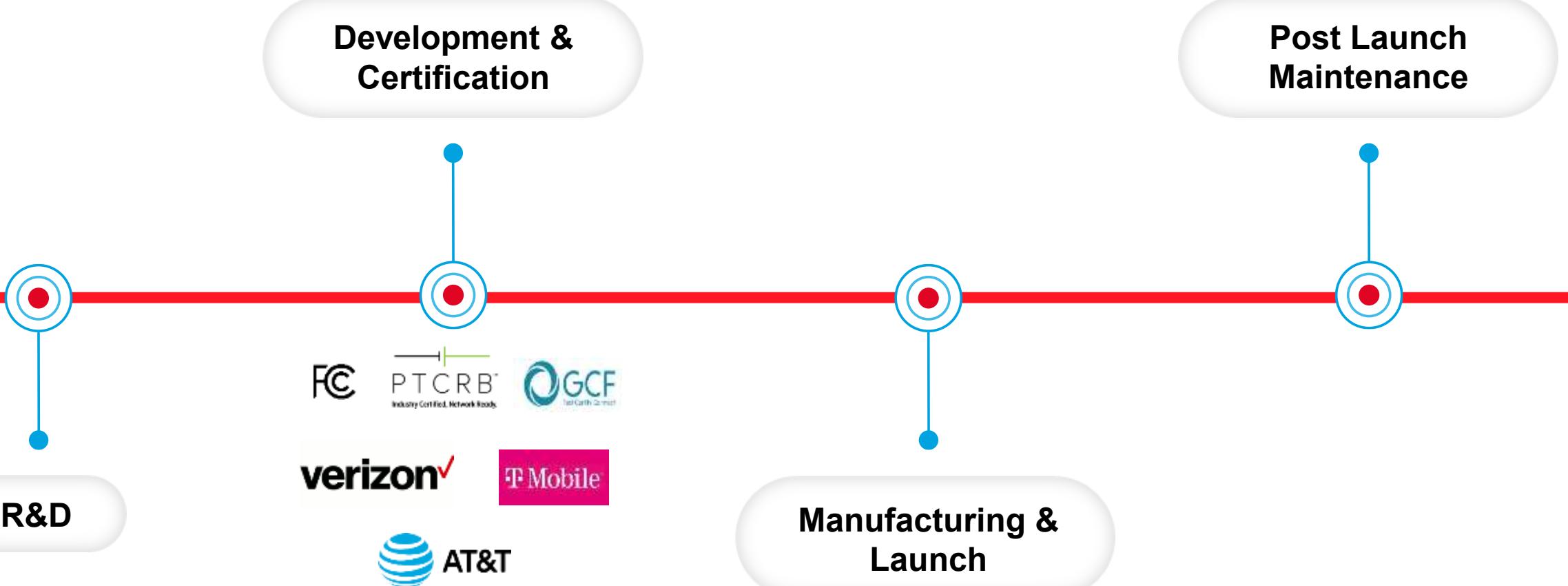


Validation and Pre-certification Testing



Innovative Roadmap with industry partners

Product Development Journey



Certification Types



01

Regulatory: **SAFETY**
FCC/CE

02

Industry: **CONSISTENCY**
PTCRB, GCF

03

Carrier: **PERFORMANCE**

FCC/CE Regulations: Ensuring Device Safety & Compatibility in different countries

Parameters	
Max Output Power	Ensuring the device does not transmit power above a certain level, which might interfere with other devices or services.
Specific Absorption Rate (SAR)	This test ensures that the amount of radiofrequency (RF) energy absorbed by the body is within safe limits. SAR testing is especially relevant for devices held close to the body, like cell phones.
Bandwidth	To ensure whether the device is transmitting within its operating frequency range
Spurious Emission	Ensuring that unwanted signals or "spurs" outside the main transmission band are below defined levels.
Conducted Emissions	These emissions come directly from a device's electronic circuitry and can be conducted down connected cables (e.g., power cords)
Radiated Emissions	These are the RF signals that are radiated directly from the device and its connected cables into free space.

PTCRB / GCF Certification

	PTCRB	GCF
Region	NA, Brazil	Europe, NA
Carrier	AT&T, T-Mobile, Rogers (Canada)	Verizon, EU carriers
Technology	GSM, UMTS, LTE, 5G	CDMA, 1x-EvDo, LTE, 5G
Certification validation	Requires validation for every hardware and software change.	Single validation required, unless there's a hardware change.

Parameters	
Sim Card Compatibility	Ensuring the device can operate on the network
Spurious Emission	Similar to FCC, but stringent limits (test done, in Idle mode and Active Mode)
Radiated	TRP / TIS tested, but not fail/pass criteria
Radiated	RSIC (Relative Sensitivity, Intermediate Channel). Has fail/pass criteria

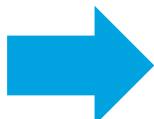
Carrier Certification

Parameters	
Radiated (Free Space)	TRP / TIS tested, with fail/pass criteria
Radiated (Beside Head and Hand)	TRP / TIS tested, with fail/pass criteria
Radiated (Hand)	TRP / TIS tested, with fail/pass criteria



Example of Specification

Mode Band & Ch Num.	Free Space				Talking Position			
	TRP		TIS		TRP		TIS	
850(190)	1900(661)	850(190)	1900(661)	850(190)	1900(661)	850(190)	1900(661)	
3G (WCDMA)	18	20	-99	-103	13	18.5	-96.4	-100.7
4G (LTE)	18		-89 (Main) / -85 (Div)					



Carriers have different specs depending on the form factors, the user case and the antenna itself (primary or secondary)

02

Top Reasons Devices Fail in Certification



Antenna Basics

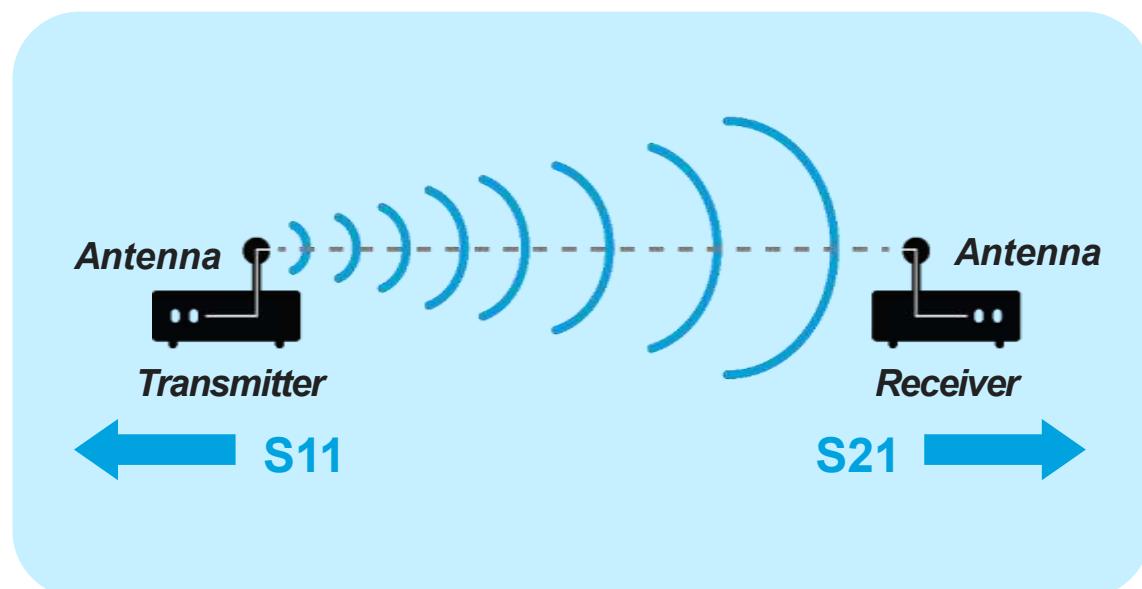
Passive Parameters

Return Loss (S11) / Isolation (S21)

S11: ratio of the input power to the reflected power

Gain: how well antenna directs energy in specific direction

Efficiency: how well an antenna converts delivered power into radiated power.)



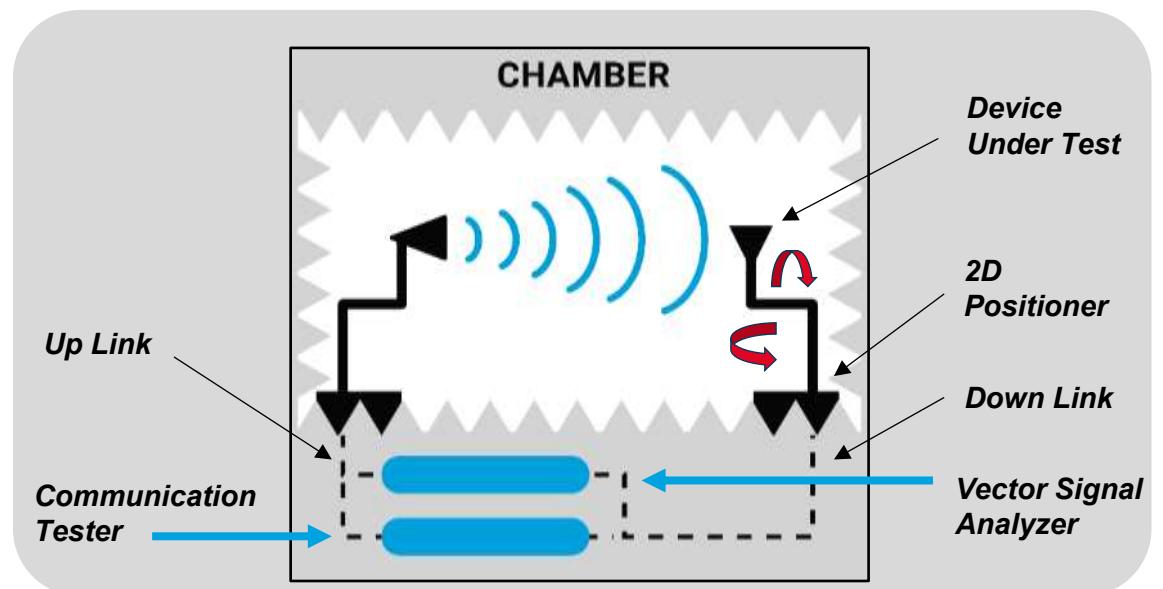
Active Parameters

TRP (Total Radiated Power)

$$\text{TRP}_{\text{dBm}} = \text{Conducted Power}_{\text{dBm}} + \text{Efficiency} (\eta)_{\text{dB}}$$

TIS (Total Isotropic Sensitivity)

$$\text{TIS}_{\text{dBm}} = \text{Conducted Sensitivity}_{\text{dBm}} + \text{Efficiency} (\eta)_{\text{dB}} \text{ (ideally)}$$



Not Considering the Antenna First

Antenna design should be **a key consideration** in the early stages of product development.

The antenna is a **very sensitive** component, and its performance can depend on several factors: placement, application, location, etc.

Neglecting antenna design can lead to issues with its performance => affecting device & certification.

Not Considering the Antenna First

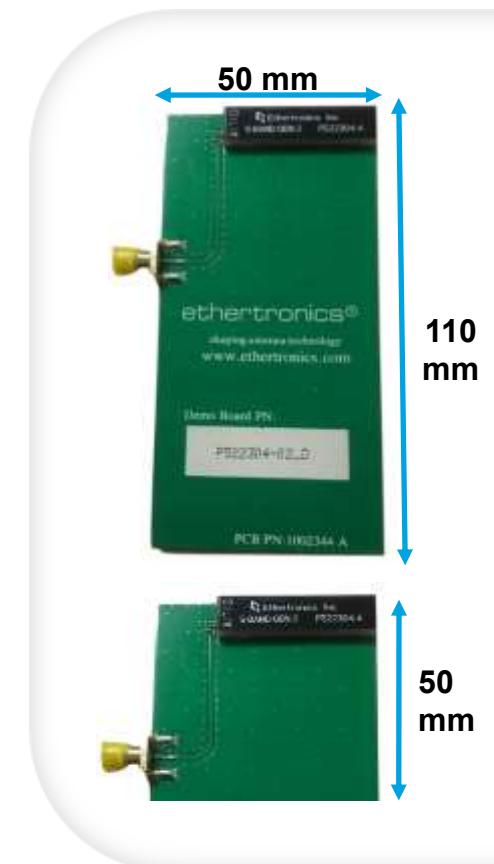
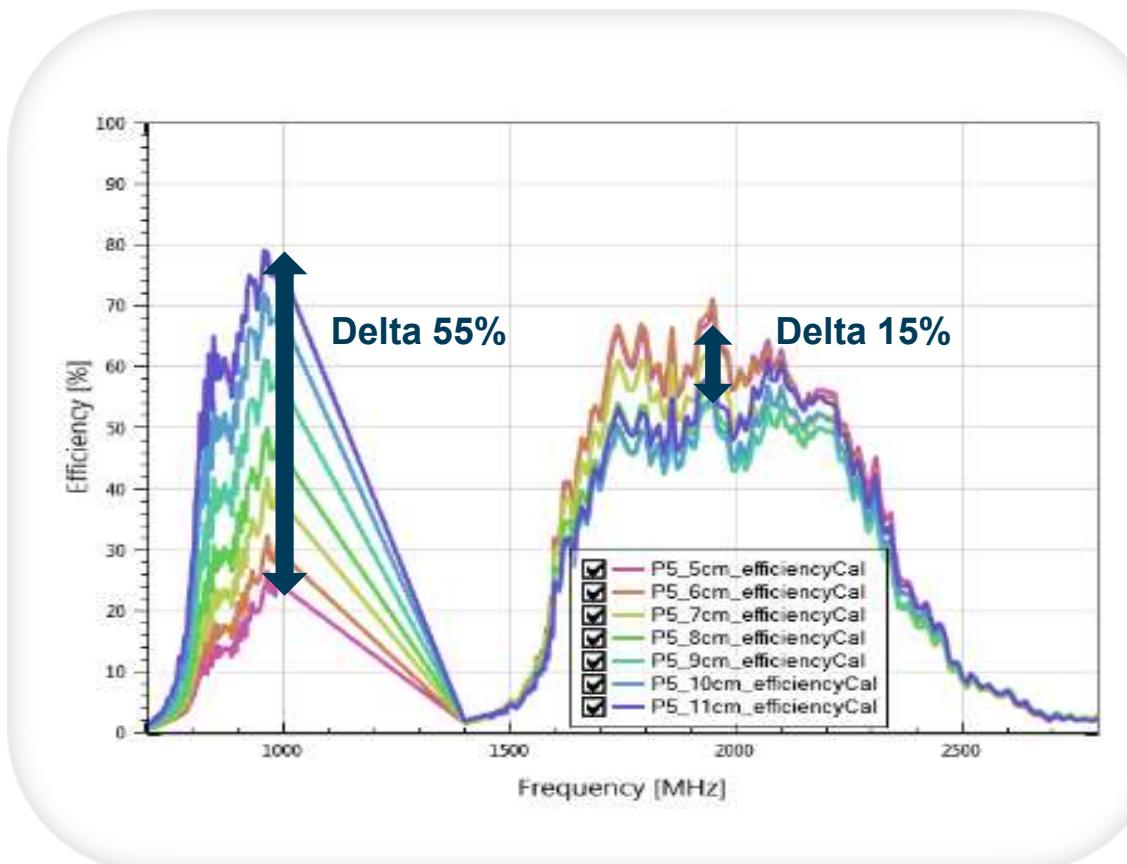
Example 1: PCB size impacts performance

Performance difference when reducing the PCB size:

55% (~5dB)

Efficiency dropped for low bands

Significant drop in TPR/TIS results



Not Considering the Antenna First

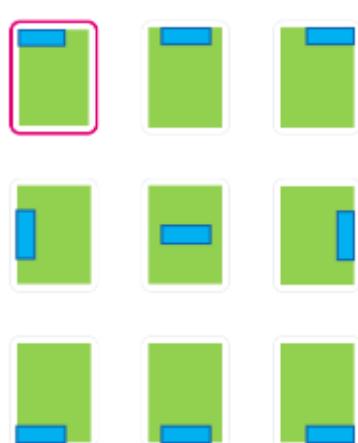
Example 2: Antenna location impact

Position 1 vs Position 2:

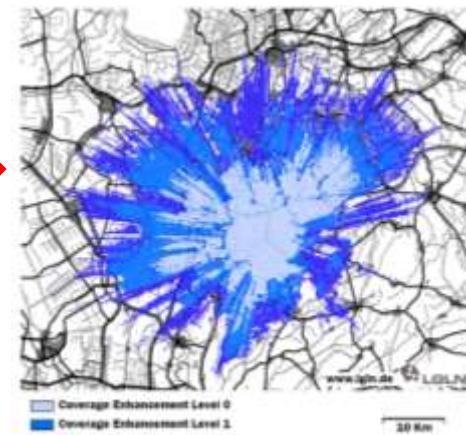
Antenna Coverage _{Position 1} > Antenna Coverage _{Position 2}

The wrong location of the antenna can significantly reduce the performance of the device

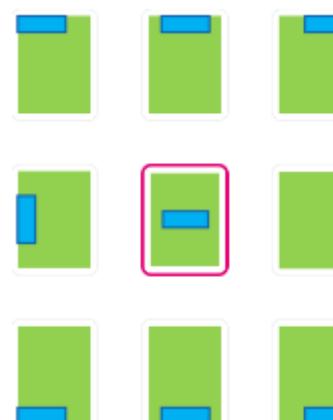
Position 1: Antenna on the top left of the PCB



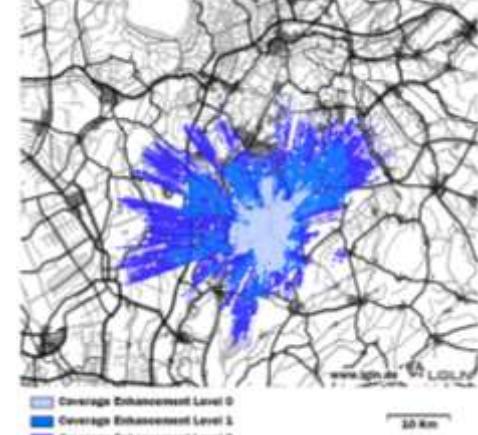
Antenna Coverage Zone:



Position 2: Antenna in the middle of the PCB



Antenna Coverage Zone:



Ignoring the Real User Case

The Environment

Devices are used in different real-life environments where they might not have the same performance.

Real-life environments: proximity to metal or human body, inside the pocket, etc.

Antenna performance might be affected by these different environments, and therefore, they must be considered during design and testing.



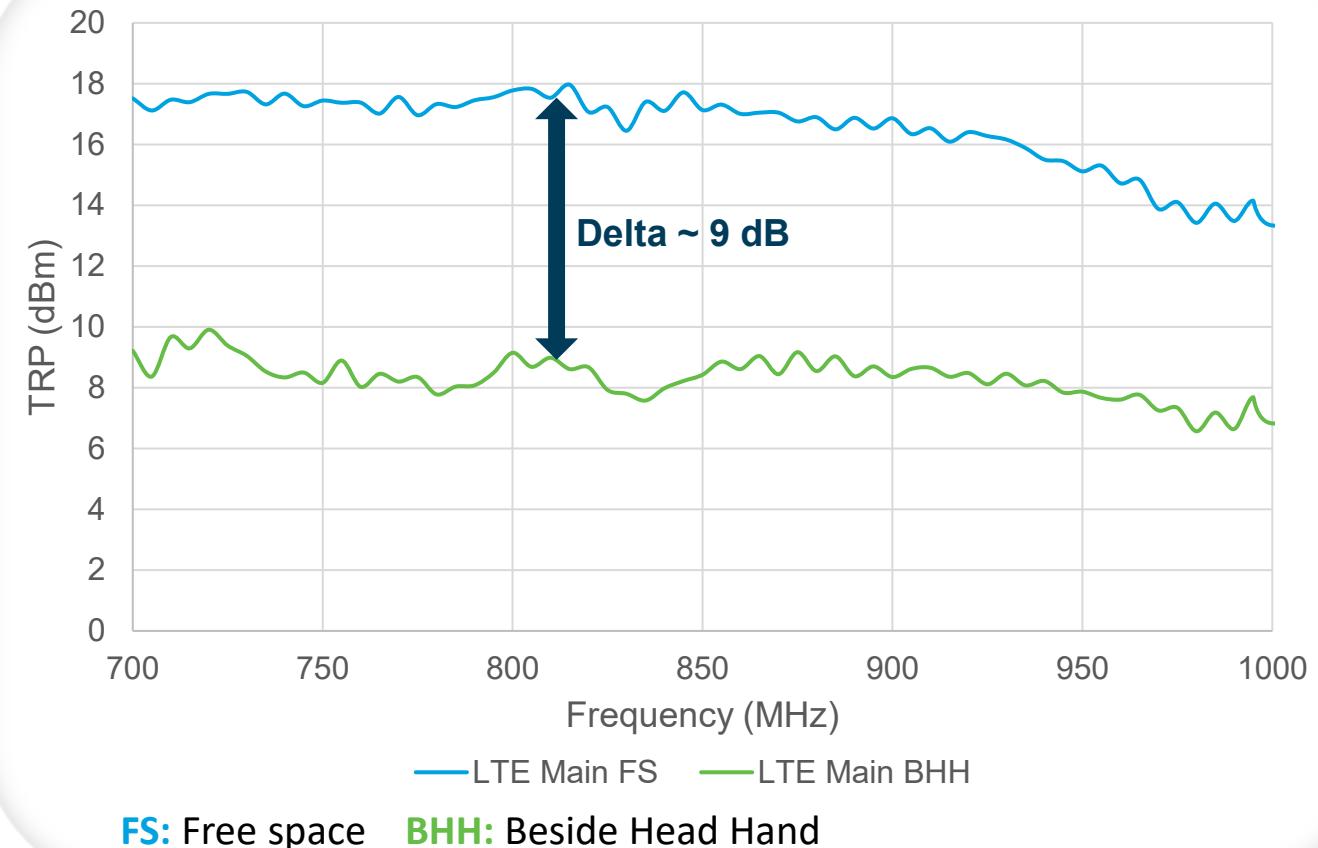
Ignoring the Real User Case

Example 1: body absorption can result in ~9 dB TRP losses

Human Head Phantom



Antenna performance in free space has **9dB of TRP gap** with the antenna placed beside the head of the human body



Ignoring the Real User Case

Example 2: Material Detuning

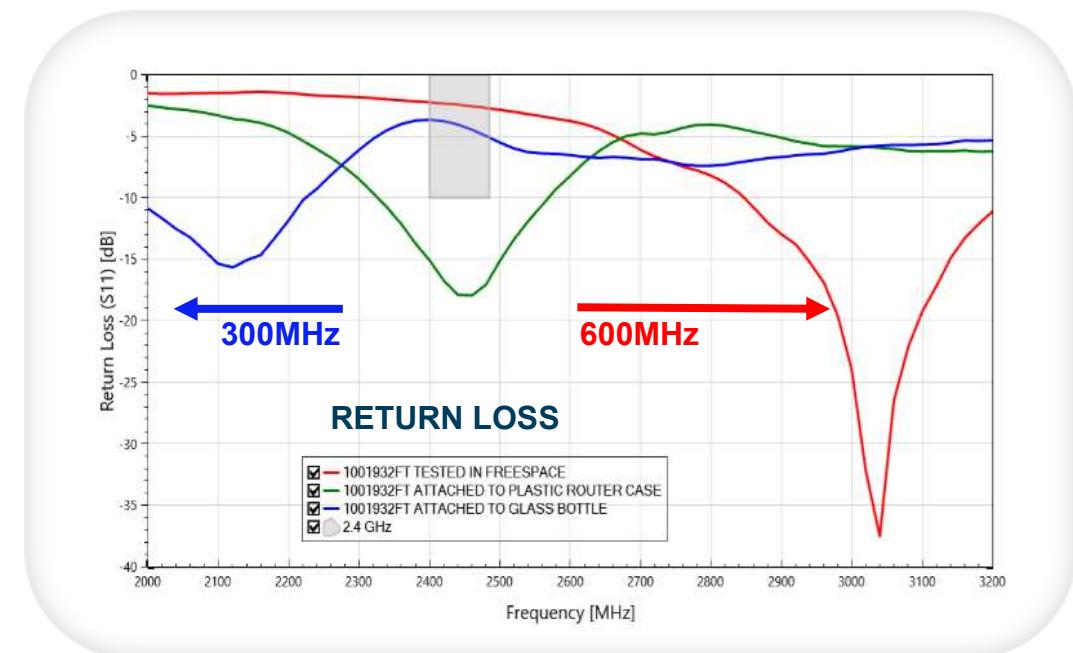
Placing the antenna on 3 different material supports: Glass, Plastic, Free Space (Air)



Antenna performance Evaluation through S11:

- Plastic substrate as **reference**: ($\epsilon \approx 2.6$)
→ coverage at 2320 – 2650 MHz
- Glass substrate ($\epsilon \approx 4$): the return loss curve **shifted 300 MHz to the left**
→ **lower frequency** coverage (2000 – 2200 MHz)
- Air substrate ($\epsilon \approx 1$): the return loss curve **shifted 600 MHz to the right**:
→ **higher frequency** coverage (3000 – 3100 MHz)

Different substrates can cause **Frequency shift**

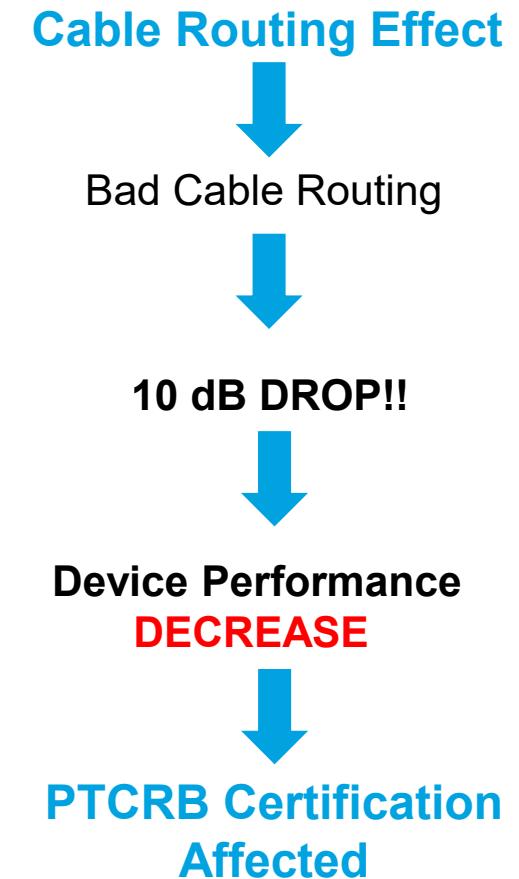
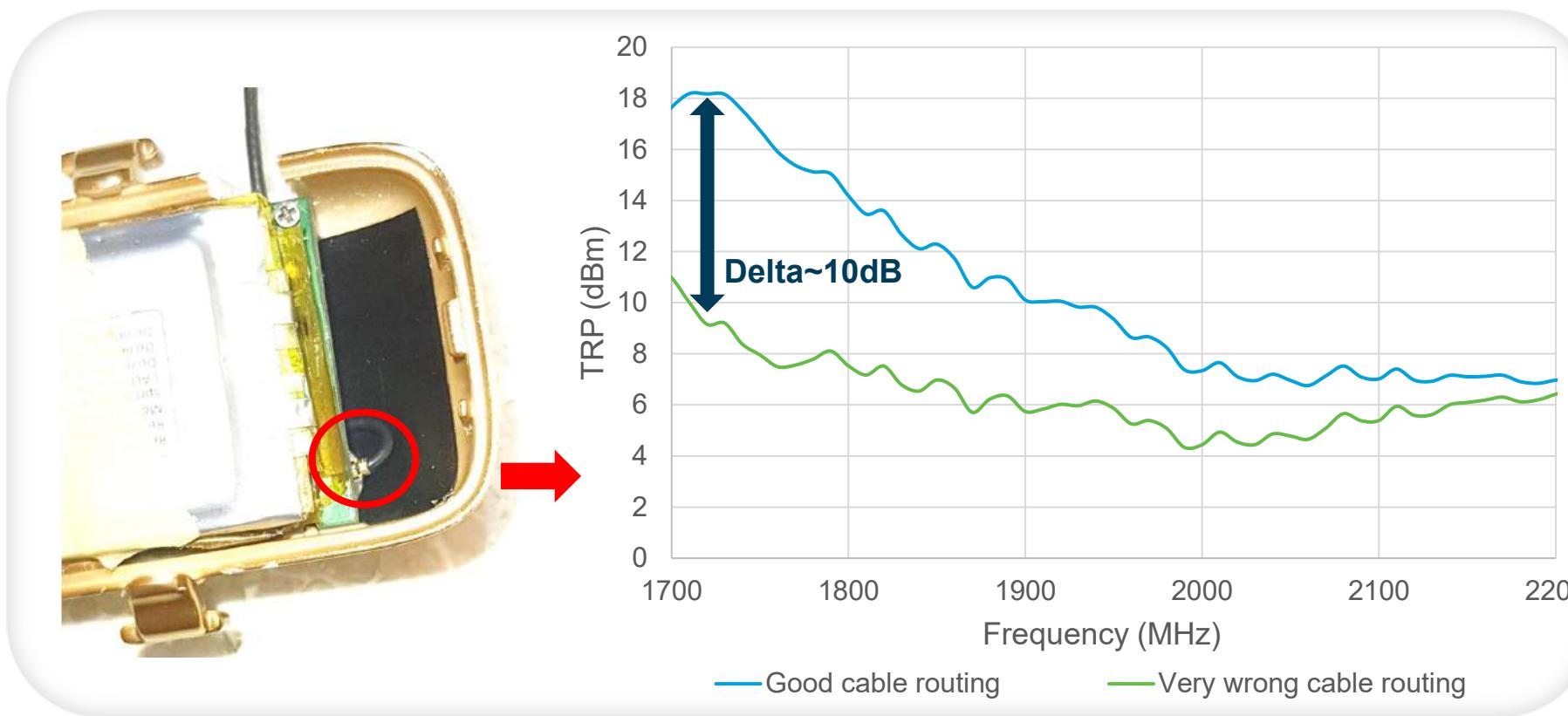


Poor Cable Quality or Routing

The quality of the cable that connects the antenna to the device can significantly impact performance

1. Poor cable quality => Signal loss => certification failure
2. Bad cable routing in the device => Noise issues / Antenna detuning

Example: Cable routing affecting Antenna performance



Insufficient Grounding

Example: Grounding effect on the antenna performance

Proper grounding is critical for optimal antenna performance.

Inadequate grounding => poor signal quality => certification failure.

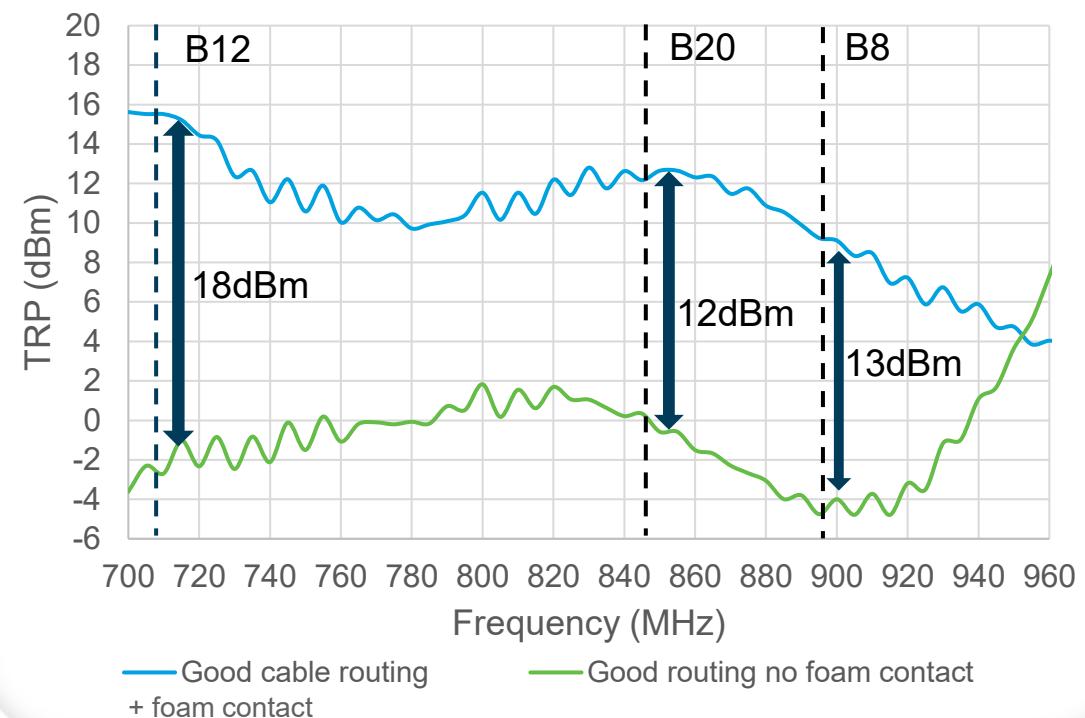
Tape to avoid contact with the conductive foam

Conductive foam to ground antenna to main PCB



**Strong grounding => Strong signal quality =>
Better performance => Certification Success**

3 Scenarios Studies in Terms of TRP:



Inadequate Filtering

Why Filter?

- Essential for crystal-clear communication.
- Reduces noise & interference for optimal performance.

The Risk of Incorrect Filtering?

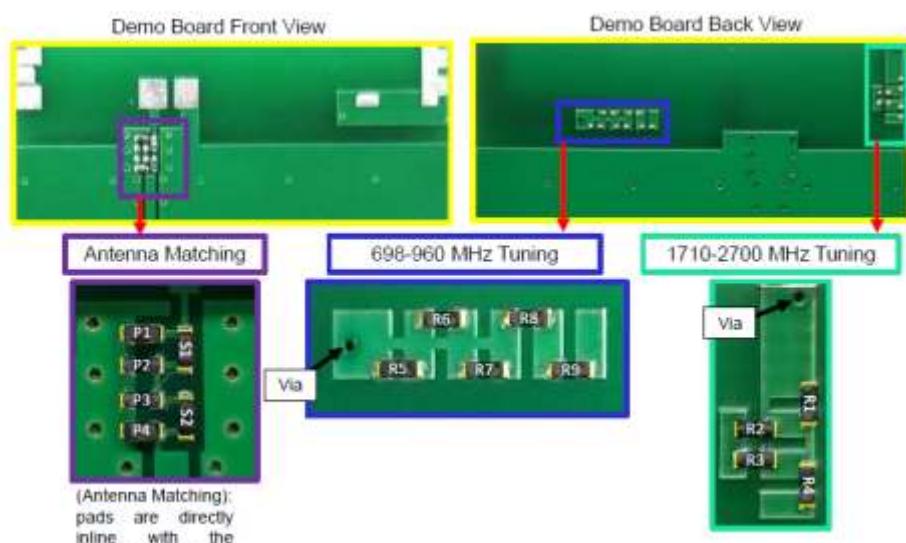
- Harmonics increase → Noise upsurge → Performance dip.
- Result? Risk of certification failure!

More technical:

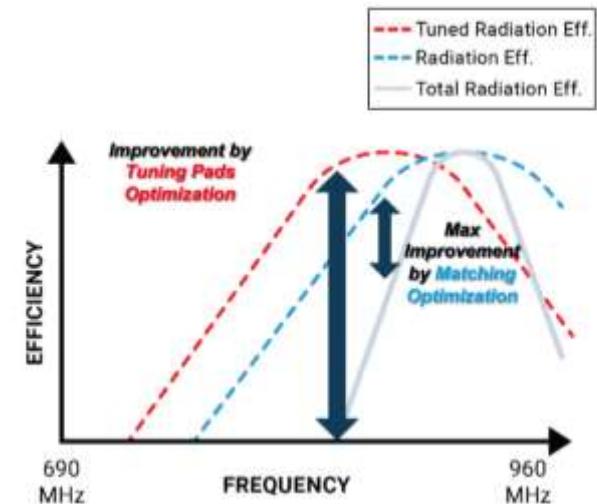
- In Tx, filter reduces power so doesn't pollute surrounding by power overlapping
- In Rx, filter reduce the sensitivity of the device preventing interference

Our Solution

- Leveraging matching circuits to nullify harmonic hitches.
- Unique optimization techniques to ensure peak efficiency.
- Without layout changes or device deterioration



Antenna Fine Tuning



Poor PCB Layout

Poor PCB layout typical issues:

- The proximity of power and high-speed digital to RF traces or antennas => to noise affecting the sensitivity (TIS).
- Poor shielding of the modules or bad 50-ohm lines mismatching the antenna.

Checks on the PCB layout around the antenna

Check the RF line is ok

- Matched at 50ohm
- Avoid stub
- Avoid complex routing (vias)
- Have a point to measure (line not connected from the antenna to the module through inner layer)
- Avoid too thin lines

Have enough vias around the antenna

- Avoid parasitic effect
- Homogenic ground = easy to match

03

Case Study & Success Stories



CASE
STUDY

Case Study on a Tracking Device

Problem



Customer's new updated version of a previously launched device: pre-certification concerns with the same antenna setup:
TGSM900 harmonics exceeding by 10dB

Root Cause



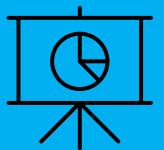
2nd harmonic resulted from antenna from coupling with solar panels.
3rd harmonic from coupling with the Sub-PCB

Solution



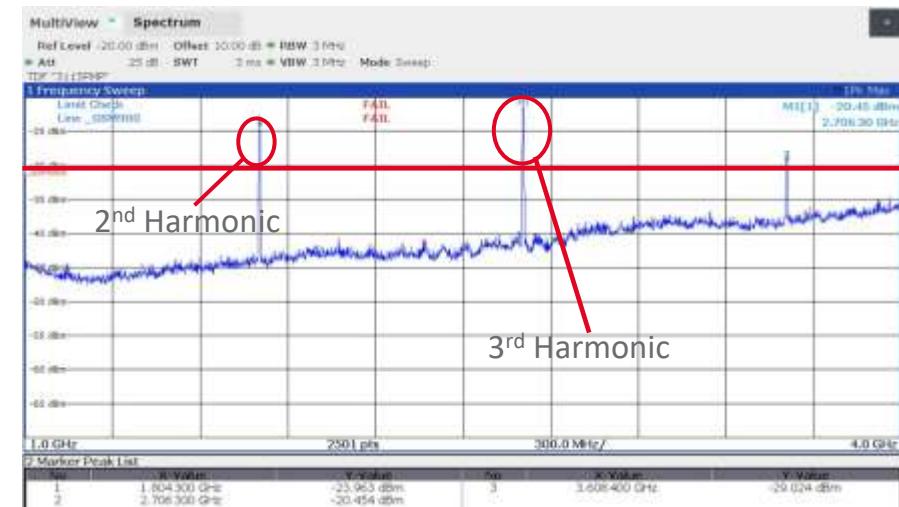
Ferrite beads were added after studies.
No change on the antenna layout nor its matching circuit was needed

Outcome



After the adjustments, harmonics were successfully brought below the specified limits

Certification test: Radiated emissions



Case Study on a Modem



Problem

Customer encountered a pre-certification issue, which was linked to the 2nd harmonic resonance of the antenna



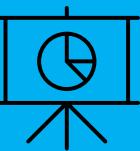
Root Cause

KYOCERA AVX indicated that the antenna's 2nd harmonic resonance can contribute to an FCC 2nd harmonic problem



Solution

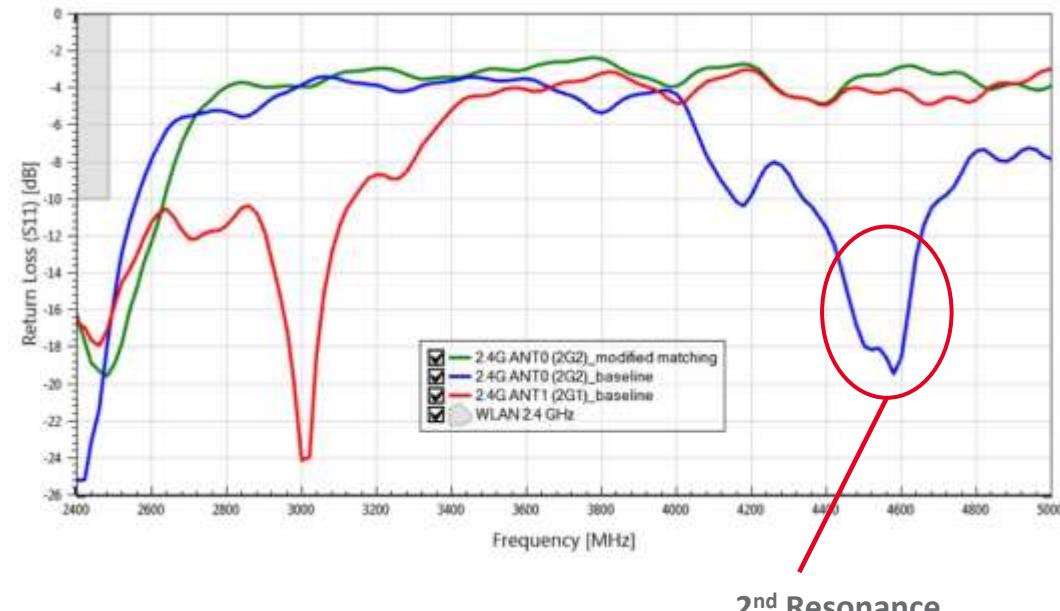
Updates on the antenna matching circuit, to remove the resonance and resolve the harmonic concerns while maintaining the antenna performance



Outcome

2nd harmonic issue was resolved and the certification succeeded

Certification test: Radiated emissions



04

Strategies, Solutions & KYOCERA AVX Resources

How can KYOCERA AVX help you
succeed your certifications?



Correct PCB Layout Around Antenna

Golden Rule: Involve us as soon as possible in early stage of your design

01

Ensure RF Line Integrity:

PCB Layout: Implement a 50-ohm match, circumvent stubs and complex routes, and include distinct measurement points away from inner layer connections. **Not all FR4 from different supplier have the same permittivity**

02

Add as many vias as possible

Optimized Grounding: Incorporate **sufficient vias near the antenna** for a consistent and **strong ground**. This homogeneous ground aids in easier antenna matching and mitigates parasitic effects.

03

Address Typical PCB Layout Issues: Isolate power and high-speed digital paths from RF traces to minimize noise interference. Further, bolster module shielding and guarantee 50-ohm line accuracy to avoid antenna mismatches.

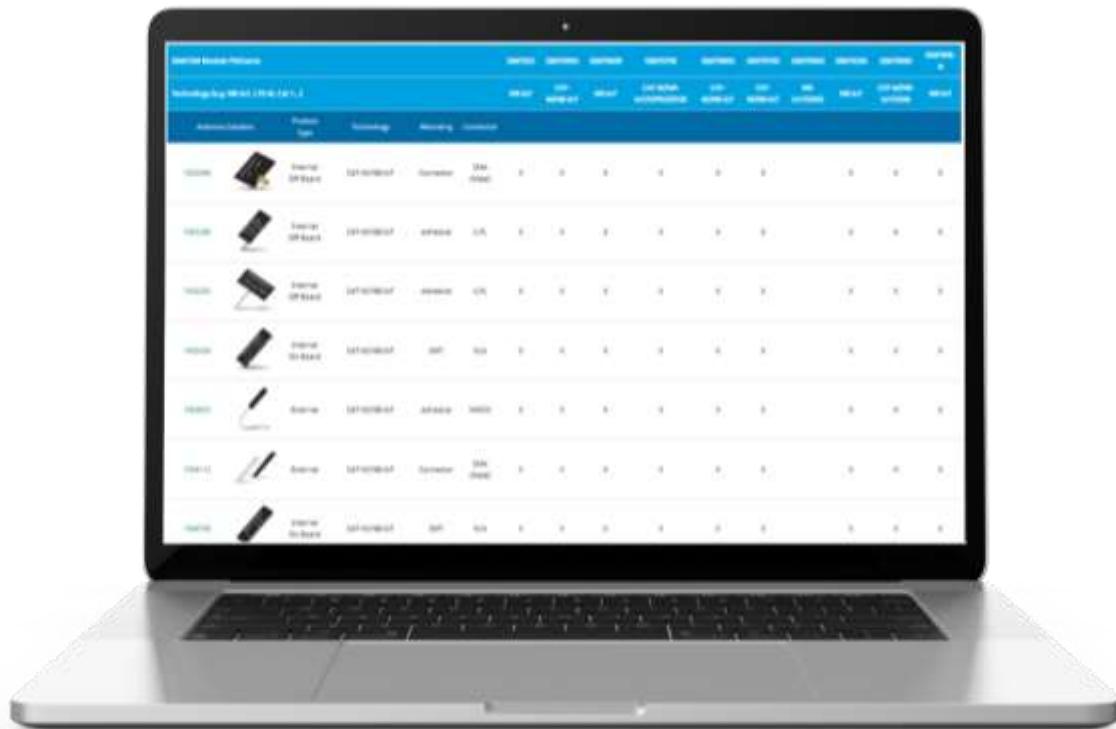


1004795 – Universal Embedded FR4 400 MHz Satellite Communications or RKE 315 – 433MHz Antenna

Antenna Type:	Internal (On Board)
Technology:	SatCom / RKE
Band:	400 MHz / 315-433
Frequency:	315 MHz, 400 MHz, 433 MHz
Peak Gain:	Various Depending on Frequency -- Refer to Datasheet
Efficiency:	Various Depending on Frequency -- Refer to Datasheet
Size (mm):	36.0 x 9.0 x 3.2
Weight (grams):	2.1
Mounting:	SMT
Antenna PN:	1004795
Antenna Evaluation Board:	1004795-01

- ▶ Download Datasheet
- ▶ Download Application Note
- ▶ Download DXF File
- ▶ Download Gerber File
- ▶ Download 3D FIT File
- ▶ Download Ansys HFSS Encrypted Simulation File (23R1)
- ▶ Download Ansys HFSS Encrypted Simulation File (19R3-22R2)

Use our Online Antenna Design Tools



Antenna Design Tools

KYOCERA AVX offers various design tools for Antenna and Module products. These tools are extremely helpful when trying to design an antenna/module into any application and can help save valuable time on the front end of the design cycle.

- ▶ Application Notes
- ▶ DXF Files
- ▶ Antenna Reference VS. RF Modules
- ▶ Best Practices & Advice for Antenna Tuning
- ▶ IoT Solution Optimizer

[View Details](#)



Application notes



DXF/gerber files



Simulation files

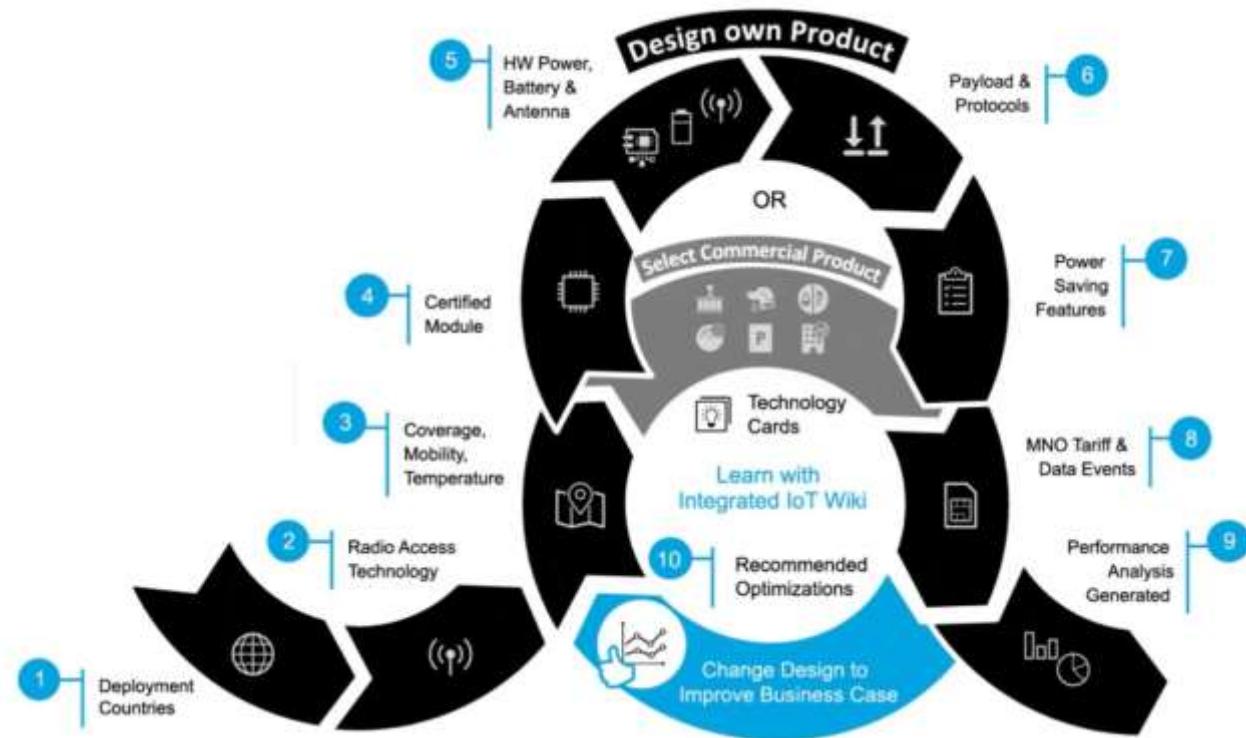
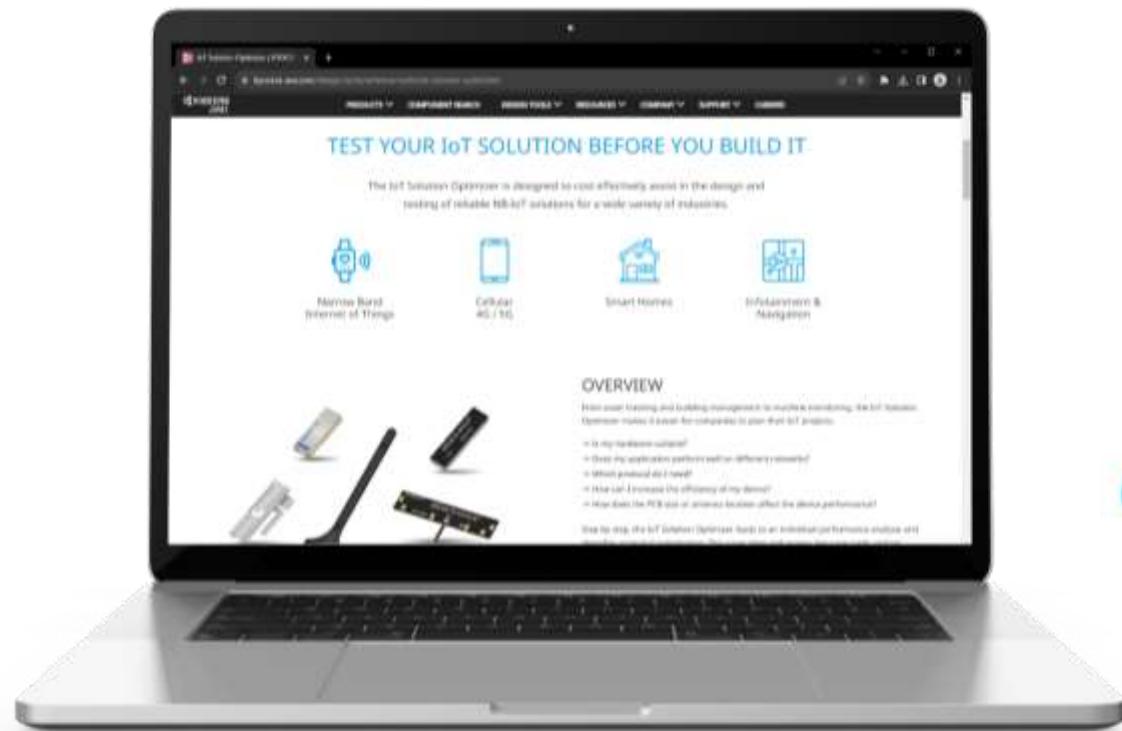


3D FIT files

Design Your Application Journey Using Our IoT Solution Optimizer

KYOCERA AVX IoT Solution Optimizer

Modeling IoT projects in the blink of an eye



SCAN FOR MORE INFO

Check Our Part Number Compatibility With Popular Modules

Nordic Semiconductor Antenna Reference Table

The antennas listed below on the reference table are compatible with the Nordic Semiconductor modules outlined. Please check our reference table below to see which are most suitable for your device.



nRF9160 DK
Development kit for LTE-M/NB-IoT/GNSS/
Bluetooth Low Energy

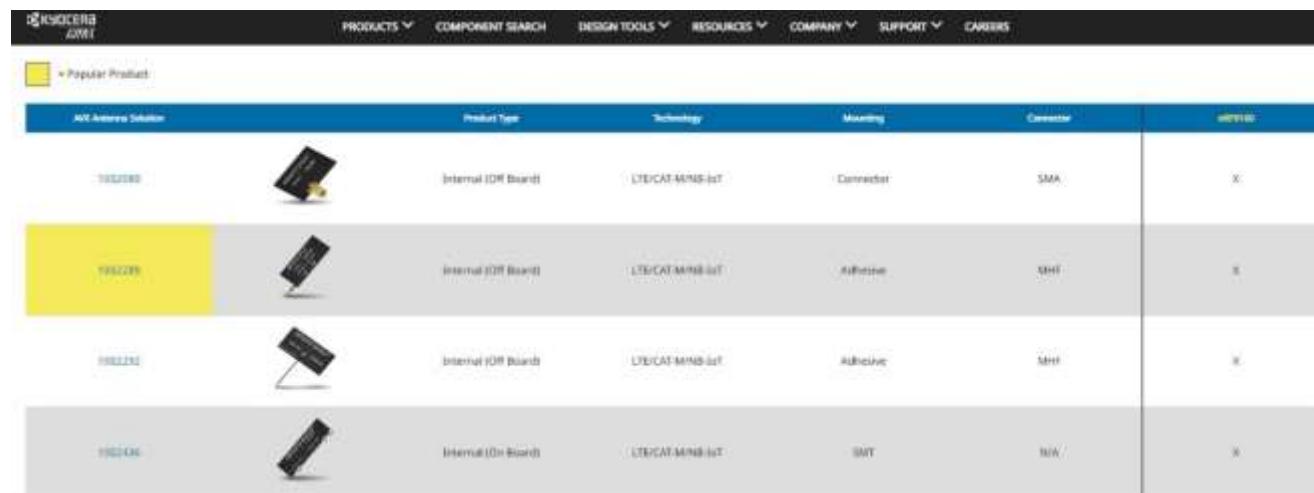
[Datasheet](#)

[Learn More about NRF9160 Development Kit](#)

nRF9160
LTE Antenna Band Switching Solution
& GPS in a 53 x 53mm PCB

[Datasheet](#) [DXF File](#)

[Learn More about nRF9160](#)



Part Number	Product Type	Technology	Mounting	Connector	Notes
1002280	Internal (D/F Board)	LTE/CAT-M/NB-IoT	Connector	SMA	X
1002281	Internal (D/F Board)	LTE/CAT-M/NB-IoT	Adhesive	SMA	X
1002282	Internal (D/F Board)	LTE/CAT-M/NB-IoT	Adhesive	SMA	X
1002286	Internal (D/F Board)	LTE/CAT-M/NB-IoT	GBT	SMA	X



Use our Global Testing Capabilities for Precertification and Performance Measurements



Near-field Measurement Systems

Far-field Measurement Chambers

MIMO Measurement Systems

Automotive Test Chamber

Wi-Fi Throughput Evaluation Systems

mmWave Measurement Chamber

- 5G mmWave
- Radar

Extensive Simulation Capabilities

- 3D EM simulators
- Cellular Field Test Simulator



Sample Kits / Boxes

Sample Boxes

For customers with in-house (will be available at distribution)

PN: **ANT-SAMPLEBOX-IOT**



Sample Kits

For sales and partners (for promotion)



PN: **KIT-AUTOANTENNAS** PN: **KIT-BTANTENNAS** PN: **KIT-UWBANTENNAS** PN: **KIT-IOTANTENNAS**



Newsletter



Do not forget to register for our Newsletter!

As we close out 2024 and look ahead to 2025, we're excited to share the highlights, breakthroughs, and innovations that define the year, and a glimpse of what's coming next.

From award-winning antennas to focused technology content, this month's newsletter packed with everything you need to stay up-to-date in Antennas. Let's dive in!

Top New Product Introductions (NPIs)

KYOCERA AVX Antenna division has released more than 50 new products in 2024. Here are some of the highlights:

Expanded Patch Antenna Portfolio

- SMT versions
- Dual-Feed stacked patches
- Active stacked patches
- RTK data



[Check Out The Full Patch Antenna Portfolio](#)

[Click to See On-Board](#)

New FPC Antenna Configurations

- Small version for ISM/LoRa and Wi-Fi 7
- Lock Connector for continuous shock and vibration applications (e.g. Drones or Robotics)



[Check Out The Full FPC + Cable Antenna Portfolio](#)

[Click to See FPC + Cable](#)

Key Factors for Trackers

Global Coverage



- Convergence: Satellite, 5G, Low-Power Connectivity (NB-IoT, LTE-M...)
- Compliant with Carrier Requirements (WW)

Reliable Connectivity



- Low Power
- Optimal Efficiency
- High Accuracy
- Interference Management

Compact Designs



- Small Form Factors
- Low Profile
- High Integration
- Light Weight

The Tulip Antenna: An Innovative Award-Winning UWB Antenna

The Tulip Antenna, an award-winning innovation in UWB technology, redefines performance and design with its groundbreaking capabilities, setting new standards for modern wireless communication.

Product Characteristics



[Click to Read More](#)

The Electronics Excellence Award Winner



[Click to Read More](#)

Track with Precision:
Advanced Antenna Solutions for Next-Gen Tracking



[Click to See More](#)

Case Study: IoT Satellite Connectivity Enabled by Small Ceramic Chip Antennas



[Click to See More](#)

Tulip Antenna at our Partners



[Click to See More](#)

Podcast about LDS and the Tulip Antenna



[Listen to the Podcast](#)

Upcoming Events

November 27-28, 2025



Antennas matter: Overcoming integration challenges and succeeding in device certification

January 6-9, 2026



March 10-12, 2026



Presentation copy

To receive the presentation:

- please scan the QR code below and enter your email address
- Leave you buisness card at our booth on the right



05

Questions

THANK YOU.



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