Amphenol

Communication Of Things

5G-FR1 | 4G/LTE | LoRa | Wi-Fi | BT/BLE | UWB

**Antennas
IoT Modules**

**Amphenol
Communication of
Things**

Amphenol Overview

Amphenol is one of the world's largest providers of high-technology interconnect, sensor and antenna solutions.

Our products Enable the Electronics Revolution across virtually every end market, including Automotive, Broadband Communications, Commercial Aerospace, Industrial, Information Technology and Data Communications, Military, Mobile Devices, Mobile Network and IoT Devices.

Founded in 1932, Amphenol trades on the New York Stock Exchange under the ticker APH and is headquartered in Wallingford, Connecticut, USA.

Amphenol Mobile Consumer Products (MCP) is the world's largest antenna maker with an annual shipment of +700M antennas.

CANADA

USA

MEXICO

ARGENTINA

$10.9B
2021 Revenue

130+
Operations

Amphenol
Communication of
Things

GERMANY
FRANCE
SWEDEN
HUNGARY
IRELAND
UK
BELGIUM
NETHERLANDS

KOREA
CHINA
JAPAN
TAIWAN
HONG KONG
INDIA
MALAYSIA
SINGAPORE

BRAZIL

GROUPS

● Commercial

● High Speed

● Mobile Consumer

● RF, Optics & Broadband

● Halo

90,000+
Employees Worldwide

Internet of Things

OVERVIEW

The Internet of Things – or IoT – can be loosely defined as a network of physical objects – "things" – that are embedded with sensors, software, and other technologies for the purpose of connecting and exchanging data with other devices and systems over the internet. These devices range from ordinary household objects to sophisticated industrial machinery.

Even though machine communications has been around for a while, the latest iteration of Internet of things has quickly become one of the most important emerging technologies of the 21st century.

Examples include objects of all shapes and sizes – from self-driving cars to wearable fitness devices to manufacturing machinery. Using IoT enables companies to achieve one of three critical outcomes:

Reduce Costs

Drive Revenue

Remain compliant with Rules & Regulations governing their business

IoT has also become one of the key tech trends in recent years enabling and accelerating digital transformation around the globe. With more than 7 billion connected IoT devices today, experts are expecting this number to grow to 30 billion by 2030 when it's predicted that 75% of all devices will be IoT enabled.

As IoT becomes more widespread in the marketplace, companies are capitalizing on the tremendous business value it can offer. These benefits include:

Deriving data-driven insights from IoT data to help better manage the business

Increasing productivity and efficiency of business operations

Creating new business models and revenue streams

Easily and seamlessly connecting the physical business world to the digital world to drive quick time to value

Leading the way in IoT

Amphenol, originally named American Phenolic Corporation, was founded in 1932 by entrepreneur Arthur J. Schmitt in Chicago, Illinois. The company's first invention was a molded radio socket. Since that, Amphenol became a public company with an expansive line of RF Connectors, Cable and Antenna.

Now, Amphenol will be offering IoT modules as part of their portfolio.

Smart Cities

Amphenol IoT modules and solutions are committed to promoting the deep integration of new generation information technology and urban modernization while building a new type of Smart Cities
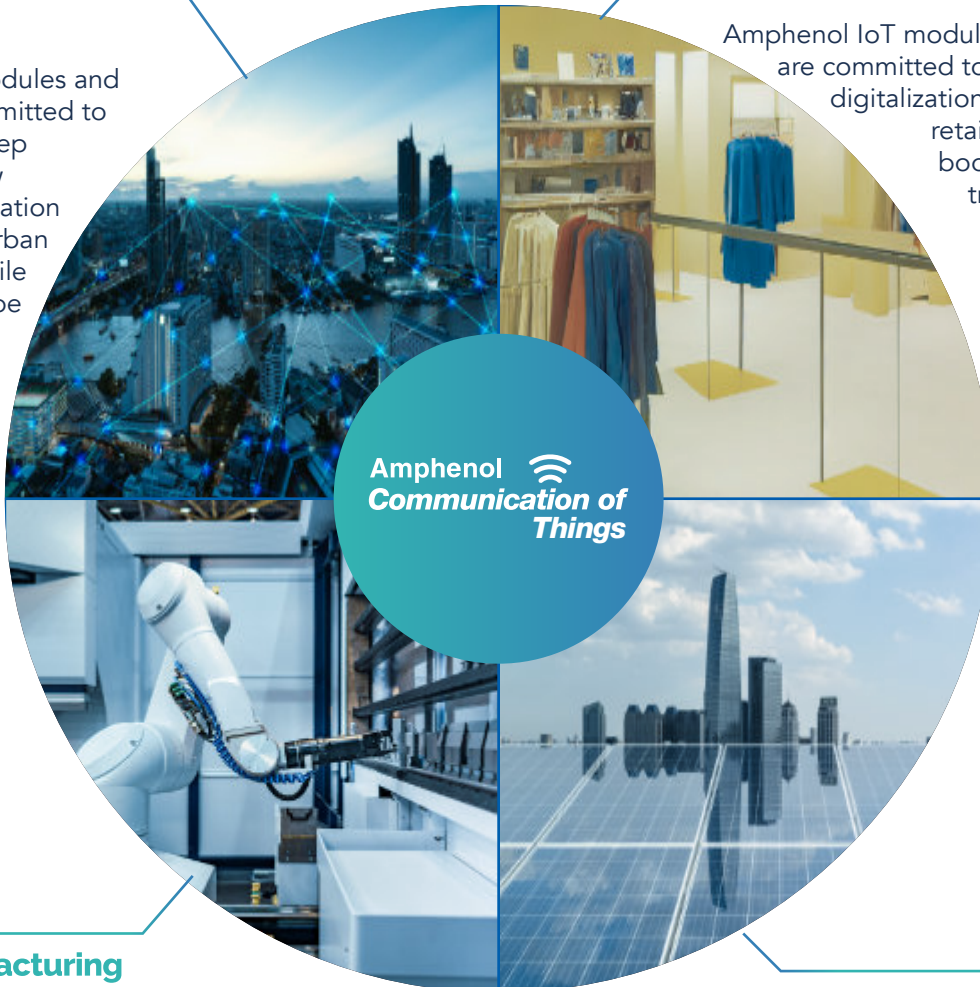
Smart Retails

Amphenol IoT modules and solutions are committed to industrial chain digitalization, creating Smart retail solutions while boosting the digital transformation of retailers

Amphenol
Communication of Things

Smart Manufacturing

Amphenol IoT modules and solutions help Intelligent Manufacturing develop toward lean production, digitalization and flexible workflow and production

Smart Energy

Amphenol IoT modules and solutions focus on building green, low-carbon, safe, efficient, modern energy systems and promotes the deep integration of energy and information for Smart Energy

IoT Modules
INTRODUCTION

It's important to understand the requirements for each IoT application and choose the best module and network technology that best fits. All wireless technologies have advantages and disadvantages in terms of cost, power, and battery size—the key differentiating features of any IoT module.

Amphenol's newest embedded modules and their matched antennas offer a portfolio of wireless IoT technologies that support customer requirements. Customers using Amphenol modules and antennas will be able to lower development cycles.

Amphenol is focused on providing module and antennas solutions for three general types of IoT networks:
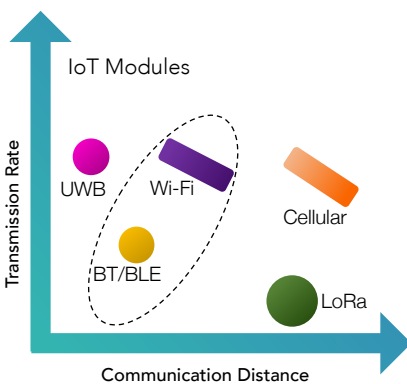
Cellular

Cellular 4GLTE networks are currently deployed all over the world offering a range of bandwidths and speeds at appropriate cost and current consumption levels. For widely distributed applications needing a range of wireless connectivity options – usually the best option is to use the established global cellular networks. Depending on application requirements, cellular offers a range of solutions from cost-efficient LPWAN connectivity up to 5G high speed communication.

LoRa (Long Range Wireless)

LoRa is an LPWAN (Low Power Wide Area Network) technology that enables sending of small packets of information infrequently and over long distances. Advantages of LoRa technology (and LoRaWAN networks) are low power requirement (for long battery life) and relatively low-cost hardware.

Wi-Fi/Bluetooth/UWB

Wi-Fi and Bluetooth provide standard short-range connectivity for IoT applications. Also known as WLAN and based on IEEE 802.11 standards, Wi-Fi is designed as wireless replacement for ethernet local area networks and allows easy networking with multiple devices. Although Wi-Fi is mainly known for its use in computer networking, industrial applications also use this technology to connect embedded devices.

Bluetooth was designed as a short-range wireless cable replacement for mobile phones. It quickly was adopted as a common solution for industrial applications as well. Bluetooth Low Energy (BLE) was added with version 4.0 of the standard. It is especially designed for low power consumption. This enables new markets such as wearables and health devices.

UWB (Ultra-Wideband) is known for it's wide channel coverage (at least 500Mhz) and the operating range 3-10Ghz. The driver for UWB is accurate positioning in the 3D sphere, in real-time, also named as RTLS (Real Time Location Systems).
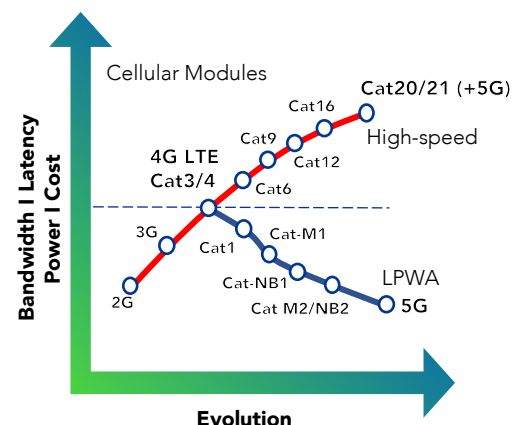
IoT Applications

The application use for IoT devices is very wide and new product categories are entering the segment frequently.

Some of the applications shown here:

Smart City

Smart Metering / Smart Grid

Smart Vending / Smart Retails / POS

Security / Smart Access

Smart Agriculture

Smart Fan / Lawn Mower

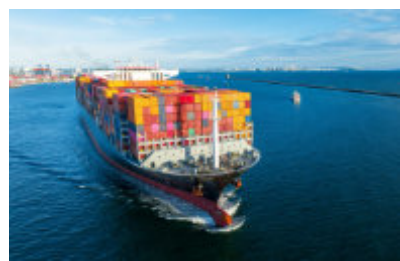AR / VR

Smart Medical Devices

Wearables

Smart Speakers

Asset Tracking / Smart Logistics

Fleet Management

EV Charging stations

M2M / V2X

Public Safety

And much more to come

Cellular Modules

Part Number	A1310EA-XX	A5210EA-XX	A6110
Cellular	LTE Cat1 bis	LTE Cat 4	5G-FR1
Product Family* With GNSS	A1310EA-0V02AX *A1310EA-GV02AX	A5210EA-GVD2A1	A6110-X
Chipset I Platform	Unisoc I 8910DM	ASR I ASR1803	Qualcomm
Band Information	LTE-FDD: B1/B3/B5/B7/B8/ B20/B28 LTE-TDD: B38/B40/B41 GSM: B3/B8	LTE-FDD: B1/B3/B5/B7/B8/ B20/B28 LTE-TDD: 38/B40/B41 UMTS/HSPA: B1/B8, GSM: B3/B8	5G-Sub6/4G/3G NSA/SA
Antenna	External (see pages 10-13)		
Form Factor	LCC+LGA		
Dimensions [mm]	30 x 29 x 2.6	29 x 32 x 2.5	43.6 x 41 x 2.6
Operating Temp. [°C]	-40°C I 85°C		
Approvals	RoHS Compliant I REACH I CE		
Regions	EMEA I APAC		

Wi-Fi BLE Modules

Part Number	B102C	W105C	W106C
Functions	BLE	Wi-Fi	Wi-Fi + BLE
Chipset I Platform	Realtek I RTL8762CMF	Realtek I RTL8710B	Realtek I RTL8720CF
CPU/Memory	4MB Flash, 160KB RAM	4MB Flash, 256KB RAM	2MB Flash, 256KB RAM
Band Information	BLE Version 5.0	IEEE 802.11b/g/n	IEEE 802.11b/g/n, BLE Ver 4.2
Form Factor	LCC		
Antenna	Embedded		
Dimensions [mm]	13.5 x 21 x 2.3	18 x 20 x 2.7	18 x 20 x 2.7
Operating Temp. [°C]	0°C I +70°C	-20°C I +85°C	-20°C I +85°C
Approvals	RoHS Compliant I REACH I CE		
Regions	Global		

LoRa Module

RoHS Part Number	L202C
	LoRa
Chipset I Platform	ASR I ASR6601CB
CPU/Memory	128KB Flash,16KB RAM
Band Information	868 MHz, 915 MHz
Antenna	External
Form Factor	LCC
Dimensions [mm]	20 x 14 x 2.9
Operating Temp. [°C]	-40°C I 85°C
Approvals	*RoHS Compliant REACH
Regions	EMEA, NA
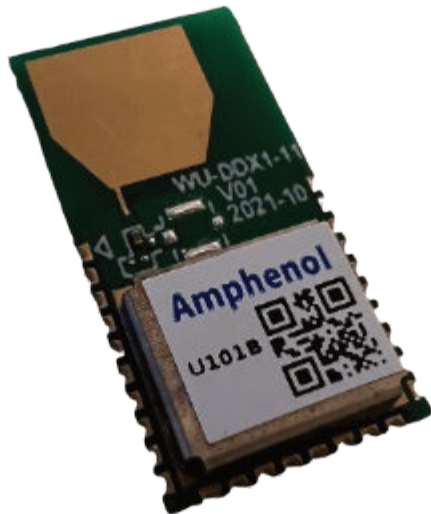
UWB Module

RoHS Part Number	U101B
	Tag
Chipset I Platform	Qorvo I DW3120
CPU/Memory	N/A
Band Information	Bands: 5 & 9
Antenna	Embedded
Form Factor	LCC
Dimensions [mm]	10 x 19.8 x 2.4
Operating Temp. [°C]	-40°C I 85°C
Approvals	*RoHS Compliant REACH I CE
Regions	Global

*Certification ongoing

IoT Antennas
INTRODUCTION

One of the targets for an IoT device is to enable wireless connectivity – wherein it often has a small form factor, compact design and low power entry – yet it requires one or several antennas (depending on the applications) to cover various frequency bands – causing a significant challenge for the antenna engineers to fulfil the requirements.

Amphenol's Off-The Shelf (OTS) antenna portfolio provides a wide range of embedded, internal and external antennas - including Cellular, Wi-Fi, GNSS, BT/BLE, LoRa, UWB, WLC and NFC antennas.

These antennas are especially designed for IoT devices, giving high efficiency and performance, easy to implement and having short production lead-times.

Embedded Antennas

Any type of antenna that is surface mounted on the PCB.

Most common antenna types are ceramic chip antennas, composite material chip antennas and sheet metal antennas. The antenna design is often monopole, loop, IFA or PIFA antennas.

Internal Antennas

Antennas that are assembled inside the device, but not surface mounted on the PCB.

Here, Flex and PCB antennas with cable and connector is very common. Antenna design is usually a dipole.

External Antennas

Antenna that is mounted on the device with connector or a cable assembly with connector. It could be for indoor or outdoor use.

Monopole and dipole antennas.

WLC | NFC | PAN (Personal Area Network) | LAN (Local Area Network) | WAN (Wide Area Network)

2G/3G/4G/5G :
- 617MHz – 960MHz
- 1710MHz – 2690MHz
- 3300MHz – 5000MHz
- 5150MHz – 7200MHz
- 24GHz – 71GHz

GNSS :
- GPS/Glonass/BeiDou/Galileo

LoRa:
- 169 / 433 / 868 / 915 MHz

BT / BLE :
- 2.4G~2.5GHz

WLAN :
- 2.4GHz
- 5.15GHz~7.125GHz

UWB:
- 3.1GHz – 10.6GHz

NFC :
- 13.56 MHz

WLC:
- 80 – 300KHz

External Wi-Fi Antennas

RoHS Part Number	ST0226-30-002-A ST0226-30-502-A	ST0228-30-002-A ST0228-30-502-A	ST0228-30-001-A ST0228-30-501-A	ST1226-30-001-A ST1226-30-501-A
Frequency (GHz)	2.4 – 2.5 I 5.15 – 5.85			2.4 – 2.5 I 5.15 – 5.85 5.925 – 7.125
Return Loss (dB)	< -10	< -10	< -10	< -10
Max input Power (W)	1	2	2	5
Gain, Peak / Average (dB)	3.0 / -0.6 I 3.4 / -1.3	2.7 / -0.5 I 4.0 / -0.6	2.0 / 1.6 I 3.0 / -1.1	1.7 / -2.4 I 3.5 / -1.2 I 4.4 / -1.1
Efficiency, Average (%)		89 I 87	75 I 78	57 I 79 I 77
Length (mm)		109 I 88 (bend)	196 I 166 (bend)	136 I 114 (bend)
Diameter (mm)		10	10	10
Temperature Range (°C)				
Humidity	Non-condensing 65°C 95% RH			
RoHs	RoHS Compliant			

*More antennas available

External 5G FR-1 I LTE/4G Antennas

RoHS Part Number	ST0326-30-004-A ST0326-30-504-A	ST0457-20-001-A ST0457-20-501-A	ST0428-31-001-A ST0428-31-501-A	ST1326-30-001-A ST1326-30-501-A
Frequency (GHz)	0.69 – 0.96 I 1.7 – 2.2 I 2.3 – 2.7	0.69 – 0.96 I 1.7 – 2.2 I 2.3 – 2.7 I 3.3-3.8	0.69 – 0.96 I 1.7 – 2.2 I 2.3 – 2.7 I 3.3-3.8 I 5.15-5.95	
Return Loss (dB)	< –5 I < –10 I < –10	*GP needed, <-5	< –7 I < –10 I < –7 I < –10 I < –7	< -10
Max input Power (W)	2	10	1	2
Gain, Peak / Average (dB)	0.6/ -2.8 I 0.2/ -5.4 I 1.6/-5.8	*0.8 /-2.6 I 3.7 / -1.3 I 3.2/-1.7 I 2.0/-2.9	2.9 /-4.0 I 2.3 / -2.2 I 2.3/-2.3 I 2.0/-1.7 I 4.7/-2.1	5.0 /-4.6 I 4.0 / -2.1 I 4.0/-2.4 I 3.2/-2.0 I 3.2/-2.0
Efficiency, Average (%)	55 I 29 I 27	*60 I 75 I 68 I 54	41 I 61 I 60 I 60 I 61	35 I 63 I 57 I 58 I 58
Length (mm)	115 I 1000 (Cable)	72 I 40 (bend)	134 I 115 (bend)	151 I 128 (bend)
Diameter (mm)	10	10	10	10
Temperature Range (°C)	-40 to 85			
Humidity	Non-condensing 65°C 95% RH			
RoHs	RoHS Compliant			

*More antennas available

Embedded Antennas

Part Number	ST0147-00-012-A	ST0347-10-001-A	ST0347-10-002-B	ST1247-00-001-F
Frequency (GHz)	2.4 – 2.5	0.69-0.96 I 1.7-2.7		6.0 - 8.5
Return Loss (dB)	< -10	< –5 I < –7 I < –8	< –5 I < –8 I < –5	< -10
Max input Power (W)	2	2	1	5
Gain, Peak / Average (dB)	2.0 I -2.5	1.8/ -3.1 I 2.8/ -1.6 I 3.3/-0.9	3.0/ -1.9 I 3.4/ -1.7 I 2.5/-2.4	2.5 I -2.0
Efficiency, Average (%)	56	49 I 61 I 81	64 I 67 I 58	57 I 79 I 77
Dimensions (mm)	2 x 1.25 x 0.9	40 x 8 x 3.2	40 x 5 x 6	3.2 X 1.6 X 1.1mm
Temperature Range (°C)	-40 to 85			
Humidity	Non-condensing 65°C 95% RH			
MSL	3			
RoHs	RoHS Compliant			

*More antennas available

Internal Antennas

Part Number	ST1224-10-401-A	ST0412-20-001-A	ST1225-10-401-A	ST0425-20-401
Frequency (GHz)	FPC I PI I Adhesive 3M 467		PCB I FR-4 I Adhesive 3M 467	
Return Loss (dB)	< -10	< –5 I < –7 I < –8	< –5 I < –8 I < –5	< -10
Max input Power (W)	2	2	1	5
Gain, Peak / Average (dB)	2.0 I -2.5	1.8/ -3.1 I 2.8/ -1.6 I 3.3/-0.9	3.0/ -1.9 I 3.4/ -1.7 I 2.5/-2.4	2.5 I -2.0
Efficiency, Average (%)	56	49 I 61 I 81	64 I 67 I 58	57 I 79 I 77
Dimensions (mm)	2 x 1.25 x 0.9	40 x 8 x 3.2	40 x 5 x 6	3.2 X 1.6 X 1.1mm
Cable length	100mm standard – Custom cable length can be made			
Temperature Range (°C)	-40 to 85			
Humidity	Non-condensing 65°C 95% RH			
RoHs	RoHS Compliant			

*More antennas available

NFC Antennas

Part Number * With matching network. ** No matching	ST0812-00-N01-A	ST0812-11-N01-A	ST0812-11-N02-A NFC Forum	ST0815-00-N01-A	ST0815-11-N01-A	ST0815-11-N02-A NFC Forum
Frequency (MHz)	13.56					
Material	FPC I Ferrite I Adhesive 3M 467			PCB I Ferrite I Adhesive 3M 467		
Impedance (Ω)*	20 / 30	20 / 30	20 / 30	20 / 30	20 / 30	20 / 30
Inductance (µH)**	1.55	1.43	2.24	1.46	1.82	1.61
Resistance (Ω)**	1.82	1.19	1.72	1.12	1.47	1.50
Self Res. Frequency (MHz)**	18.66	93.53	21.30	26.34	23.33	24.47
Q-Factor**	30.5	39.1	35.4	51.9	43.6	42.4
Dimensions (mm)	15 x 19 x 0.35	30 x 34 x 0.35	45 x 34 x 0.35	15 x 19 x 1	30 x 34 x 0.6	45 x 34 x 0.6
Temperature Range (°C)	-40 to 85					
Humidity	Non-condensing 65°C 95% RH					
RoHs	RoHS Compliant					

*More antennas available

Custom Antennas with LDS

ID, Industrial Design, is very important for many customers, where the IoT device could have a very complex design or shape, allowing very limited space for the antenna(s) and therefore a good off-the shelf antenna might not be available or not possible to use.

Amphenol has extensive expertise, +25 years, designing custom antennas. Our experience with consumer products perfectly supports antenna design for IoT devices as well. One of the commonly used technologies for custom antennas is LDS.

LDS, Laser Direct Structuring, enables conductive traces on 3D dimensional surface - opening for new design possibilities and applications.

The motivation for using LDS technology in antenna applications is to allow full 3D design freedom and by that obtain optimum antenna performance.
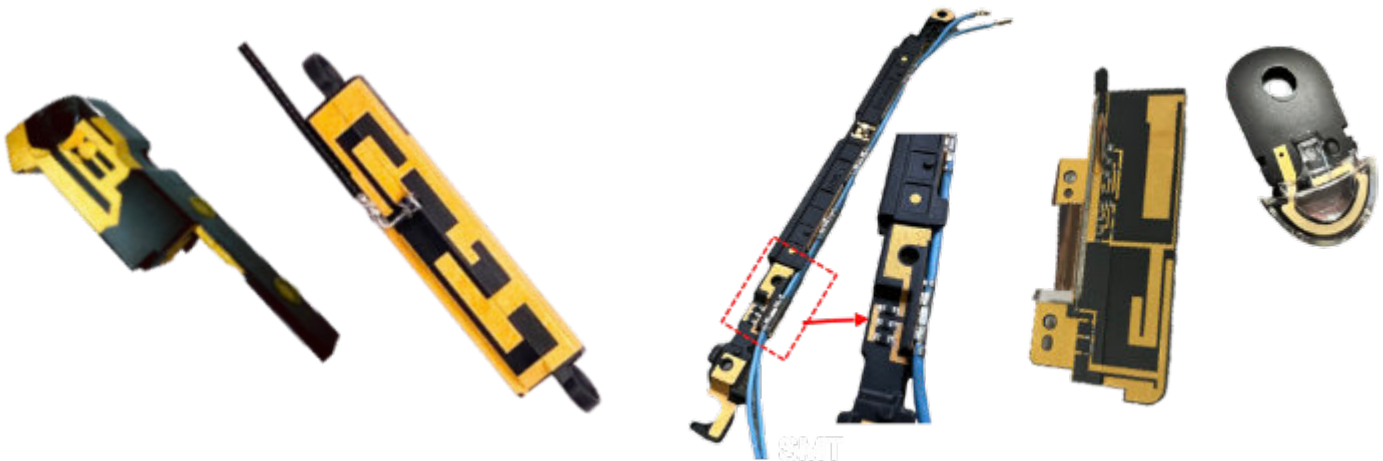
Advantages of LDS Technology

Antenna volume can be maximized (every 'corner' can be used)

Less parts, fewer assembly steps and reduced weight - cost efficient!
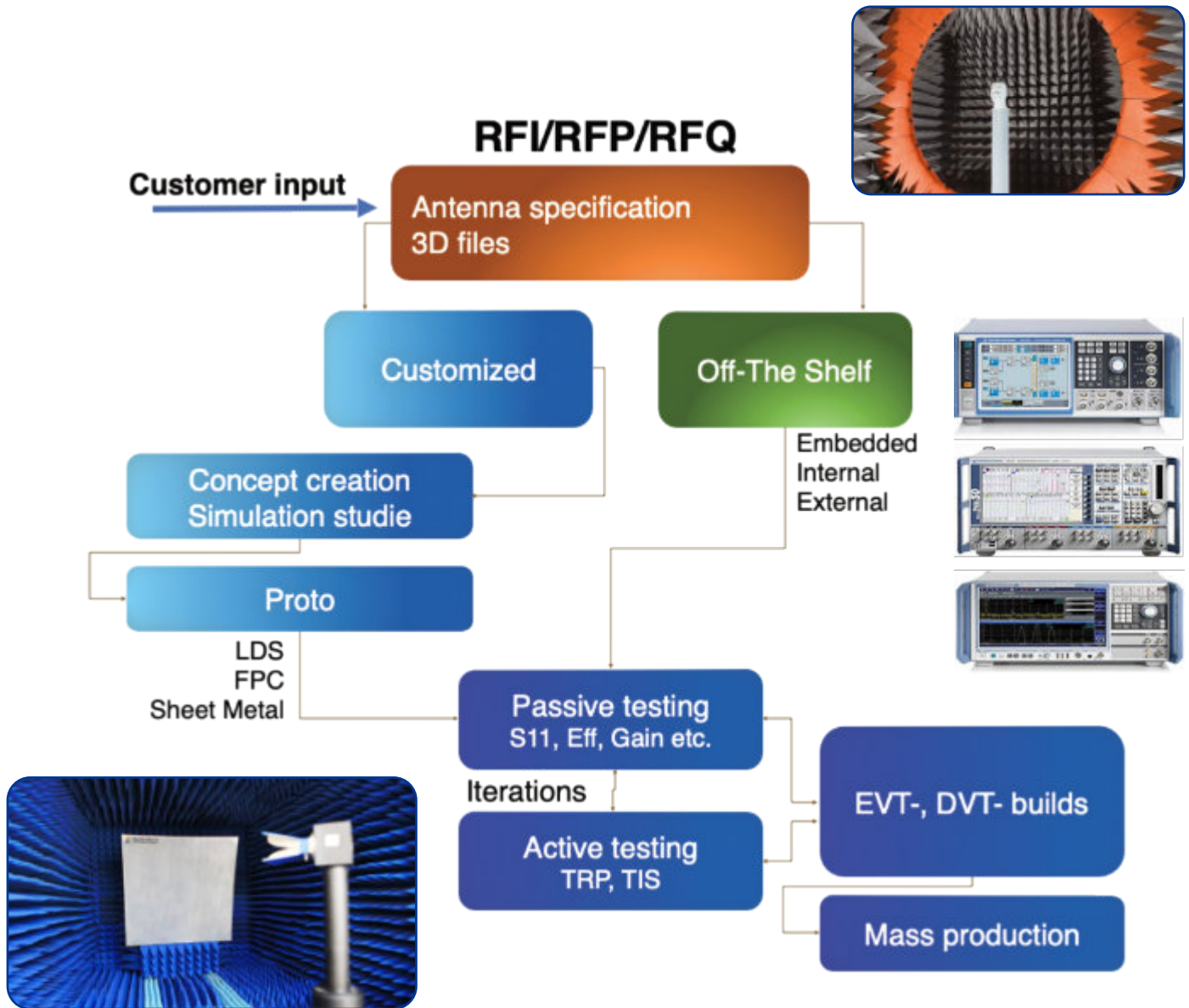
Trace width/gap design down to 150µm with excellent tolerances

Integration of conductive trace into structural and visual mechanics

SMT applicable technology; components to mount directly on LDS trace

Working Model - Antennas

RFI/RFP/RFQ

Customer input → Antenna specification 3D files

Customized

Off-The Shelf → Embedded / Internal / External

Concept creation / Simulation studie

Proto

LDS
FPC
Sheet Metal

Passive testing
S11, Eff, Gain etc.

Iterations

Active testing
TRP, TIS

EVT-, DVT- builds

Mass production

- RFI – Request For Information
- RFP – Request For Proposal
- RFQ – Request For Quotation

Win-Win Solution!

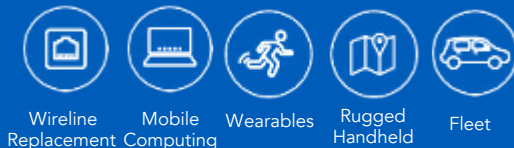| TECHNOLOGY	USE CASES	SOLUTIONS
CELLULAR LTE 4G 50 Kbps-50 Mbps	Smart Meters · Fleet · Security · Vending · Cloud	+
Wi-Fi/BLE 54Mbps-2.4 Gbps / 1-2 Mbps	Wireline Replacement · Mobile Computing · Wearables · Rugged Handheld · Fleet	+ Included
LoRa Up to 250 Kbps	Tank Monitor · Machine Monitoring · Industrial · Smart Ag · Medical Equipment	+
UWB Up to 1.2 Gbps	Mapping · People Monitoring · Location · Logistics · Asset Tracking	+ Included

IoT Modules

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APAC – Asia Pacific
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