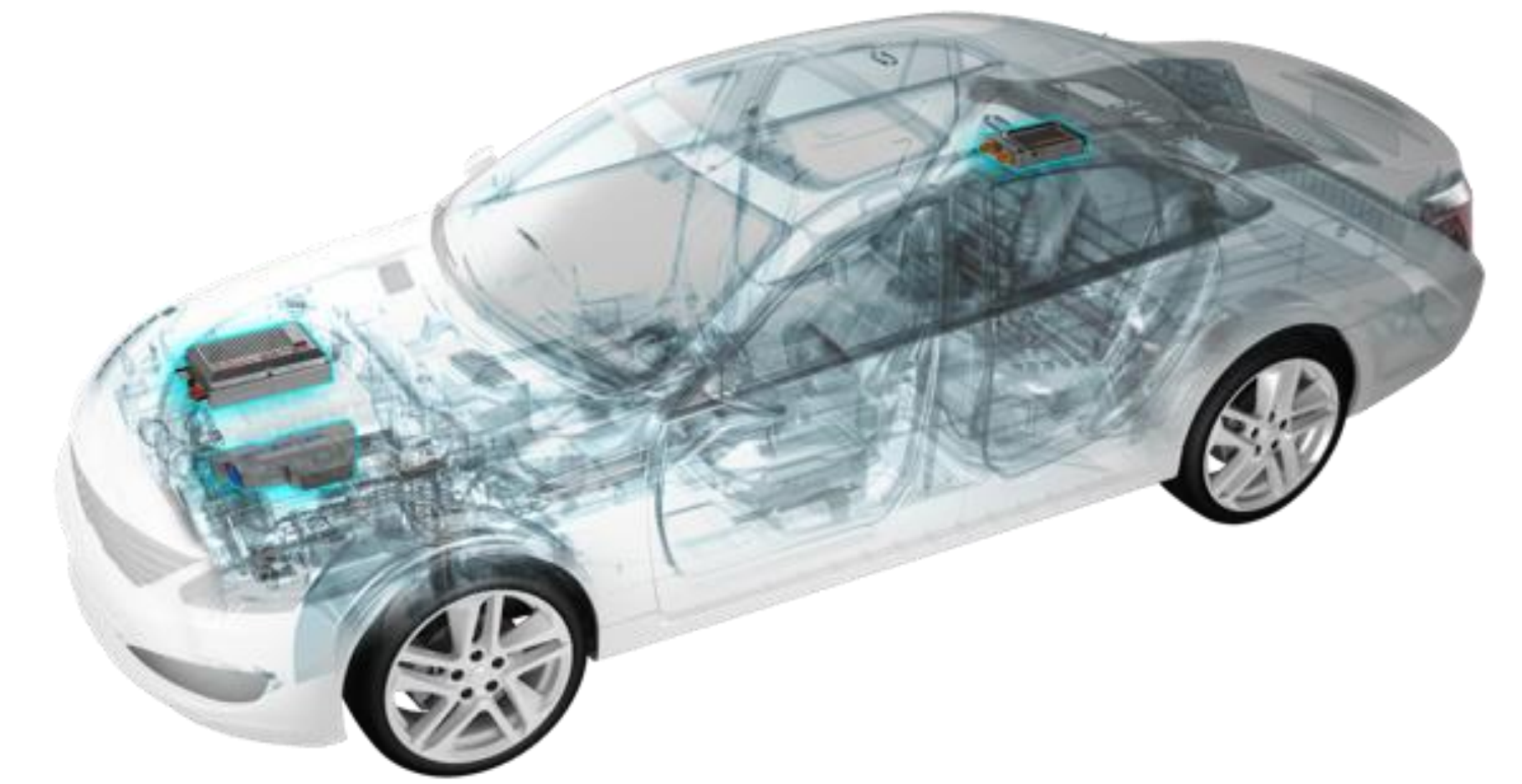




 **Pulse***LARSEN*
Antennas

Electric Vehicles

Pulse and EV Market per Application



SAFETY CONTROL

- Advance Driver Assistance (ADAS)
- Anti-lock Breaking System (ABS)
- Adaptive Cruise Control (ACC)
- Tire Pressure Monitoring System (TPMS)
- Blind Spot Detection
- Door Lock
- Seat Belt Pretention
- Car Alarm
- Trunk Lock
- 77GHz Lens array radar etc.

POWERTRAIN (POWER CONTROL)

- Battery Management System –BMS
- On Board Charger
- DC/DC Converter
- Inverter
- Electric Control Module – ECU:
 - Central Timing Module – CTM
 - Electronic Control Module – ECM
 - General Electronic Module – GEM
 - Powertrain Control Module – PCM
 - Central Control Module – CCM
 - Body Control Module – BCM
 - Transmission Control Module TCM
 - Suspension Control Module – SCM
 - Brake Control Module - BCM

INFOTAINMENT SYSTEM

- GPS and Navigation System
- Telematics
- CAN Bus
- Hotspot and Dual Sim
- Cellular connectivity (covert, Mirrors, roof top)
- Wireless Chargers
- V2X – V2V - DSRC

BODY ELECTRONICS

- DC/DC converters
- LV and HV Heating Systems
- Seat Positioning
- Wipers
- Mirrors Adjustment
- Key Fob
- Mirrors

Infotainment / Connectivity

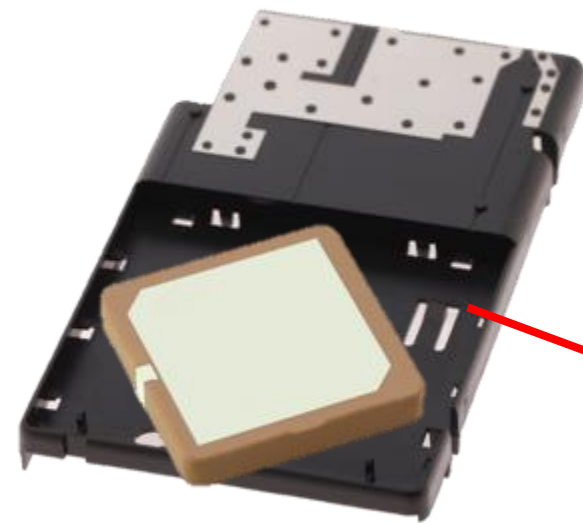


 **Pulse**LARSEN
Antennas

Infrastructure – On Vehicle

Individual Systems

OBD /Safety– Embedded 3G/4G/GPS/WiFi



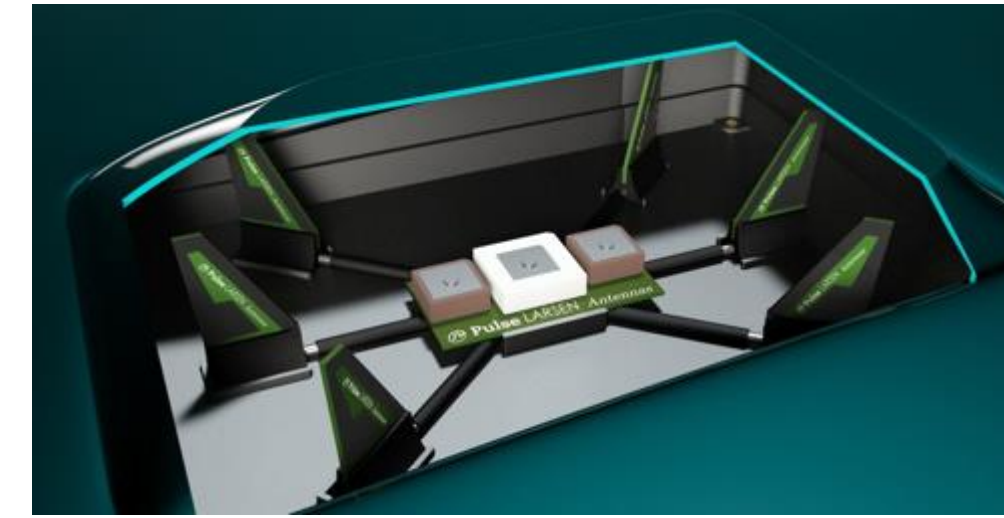
5.9GHz DSRC / V2V / V2X



NFC and Lock Sensor in door handle



Embedded Roof Flush 10-in-1 – Low Profile 3G/4G/WiFi/DSRC/GNSS – Dual SIM



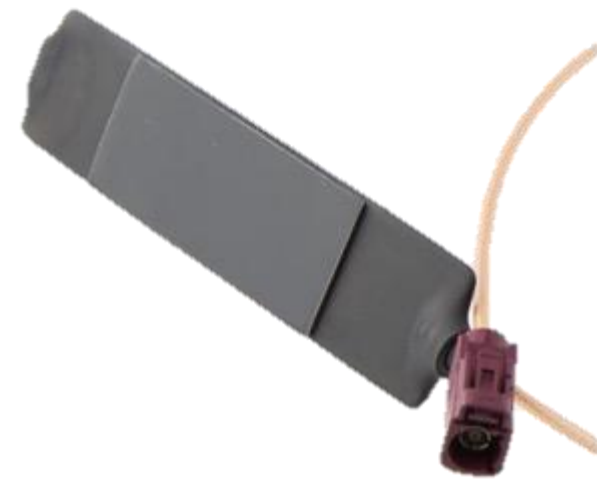
Roof Top 6-in-1 – Low Profile Cellular/WiFi, Satcom connectivity (metallic roof)



Fiber Glass Mount - Low Profile 4G/WiFi/GPS



In-Mirrors Cellular 4G



Wireless Heating Engine



Infotainment, Navigation, Dashboard, Telematics, Hotspot
Embedded GPS/WiFi/wide band 4G



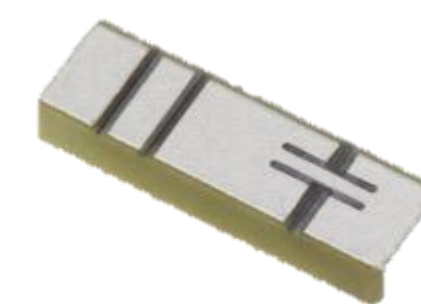
Anti-Theft GPS/3G/4G embedded in pillars / Covert



TPMS – Low frequency

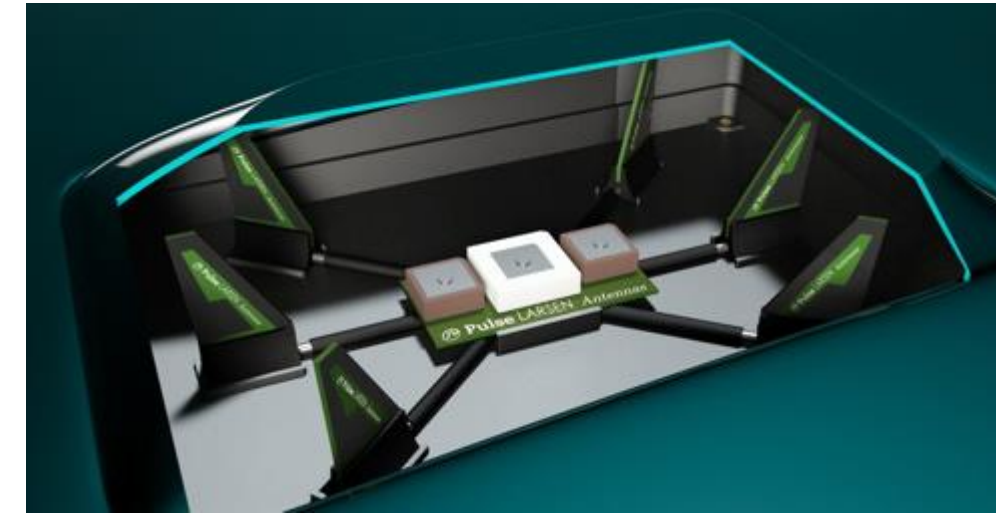


Embedded Wireless BMS



Infrastructure – On Vehicle

Embedded Roof Flush 10-in-1 – Low Profile 3G/4G/WiFi/DSRC/GNSS – Dual SIM



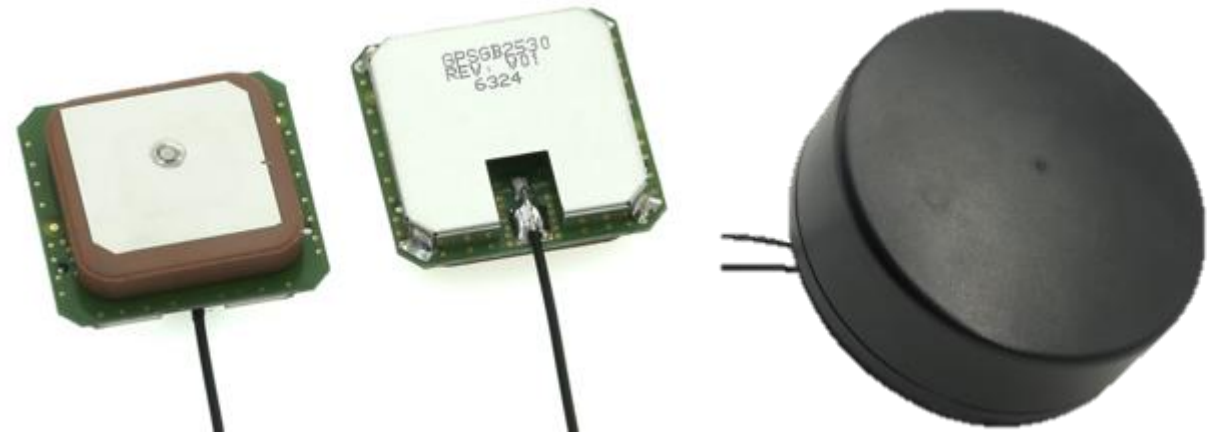
Roof Top 6-in-1 – Low Profile Cellular/WiFi, Satcom connectivity (metallic roof)



Mirror Mount Dipoles.
Glass Mount Dipoles.



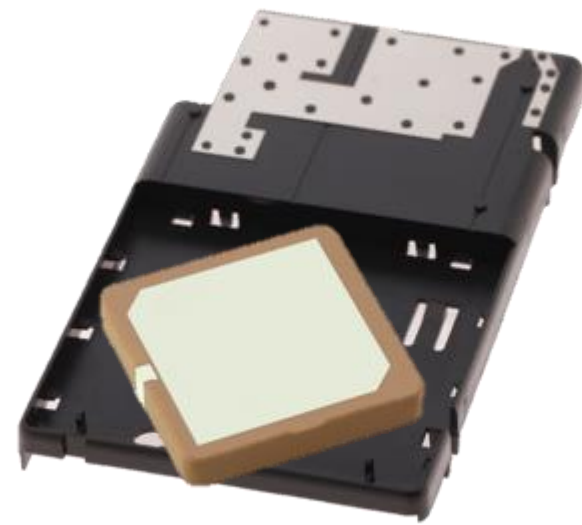
5.9GHz DSRC / V2V / V2X



Fiber Glass Mount - Low Profile 4G/WiFi/GPS



OBD /Safety– Embedded 3G/4G/GPS/WiFi



Anti-Theft GPS/3G/4G embedded in pillars / Covert



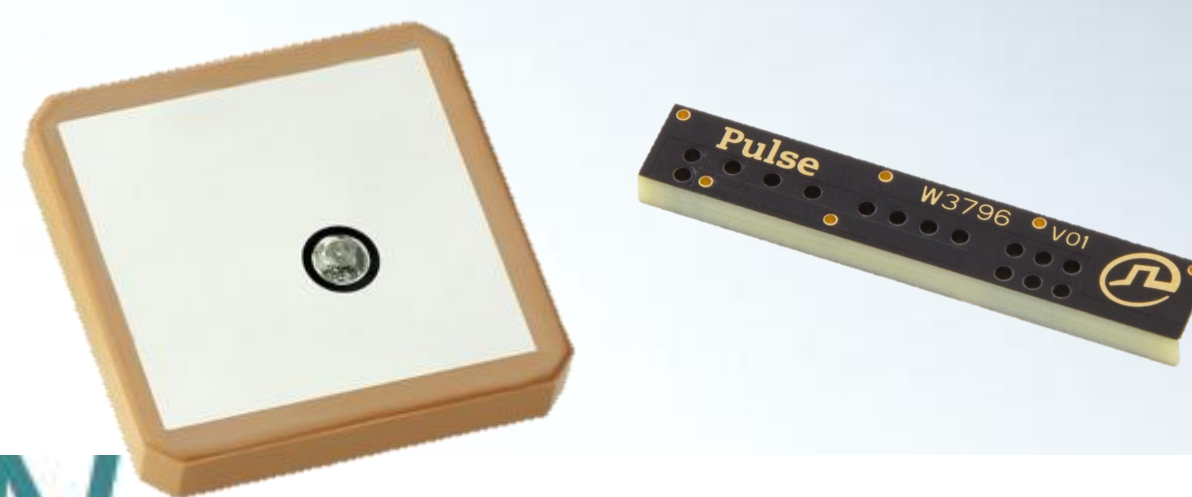
TPMS – Low frequency



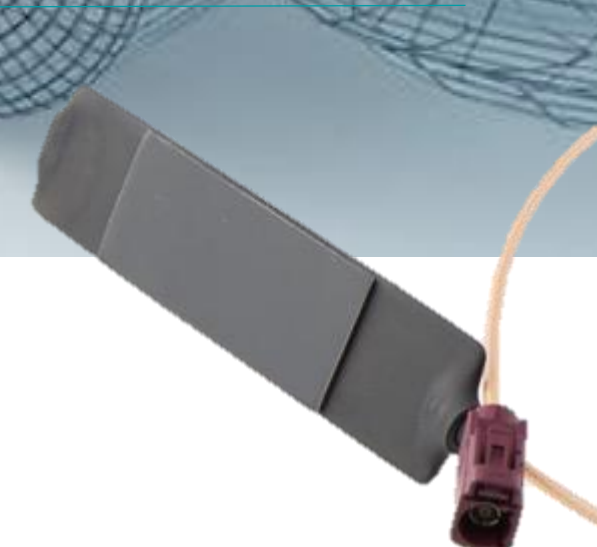
Wireless Heating Engine



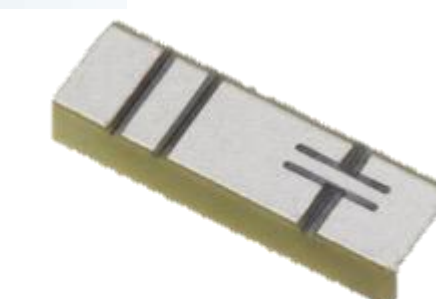
Infotainment, Navigation, Dashboard, Telematics, Hotspot
Embedded GPS/WiFi/wide band 4G



In-Mirrors Cellular 4G



Embedded Wireless BMS



Infotainment / Connectivity

Data Control Module

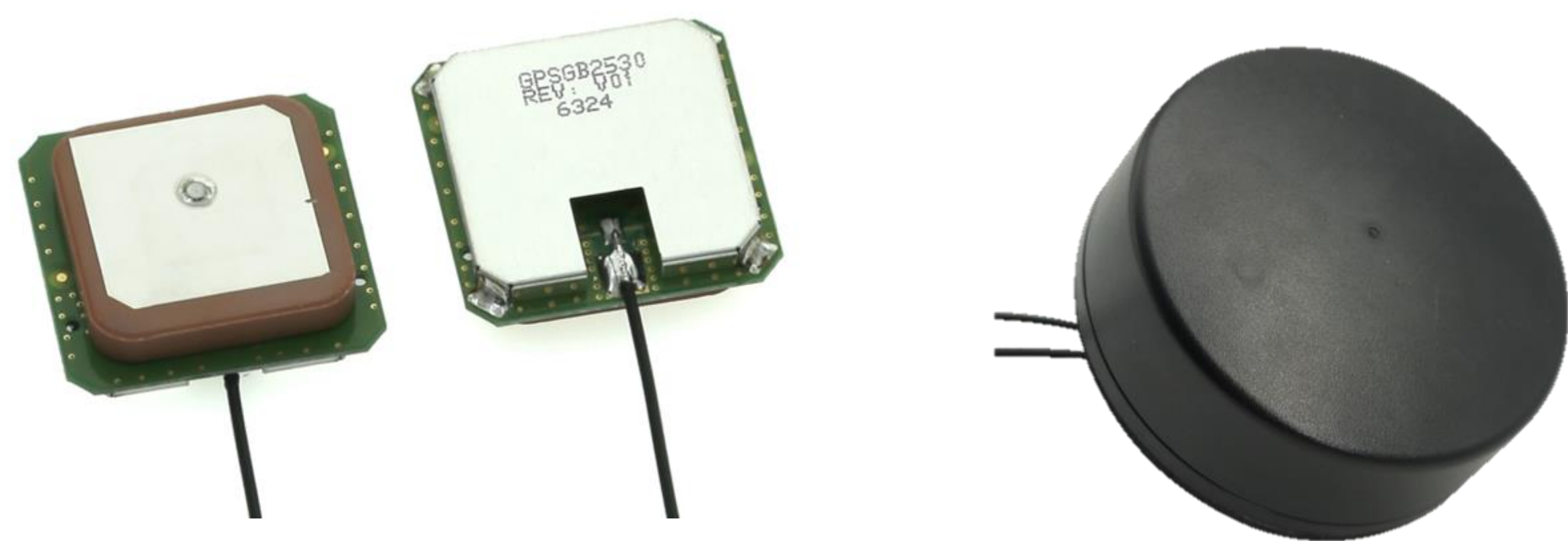
Embedded Solutions for OBD, Trackers

- Active & Passive GPS/GNSS systems
- SMD or Pin mount GPS/GNSS patches
- Ability to combine Metallic and Composite 3G/4G antennas with GPS/GNSS patches
- Low frequency antenna tuning taking into account DC Cables



Features & Benefits

- Embedded in OEM device
- High isolation between antennas
- Optimized Radiation patterns based on device location in vehicle
- Optimized performances based on Operator spec



DSRC / V2X / V2V

- Use of Ceramic, composite, metallic or FPC technology
- 5.9GHz
- Good Isolation between DSRC antennas and WiFi systems.

Features & Benefits

- Singular or combo of antennas (linear or circularly polarized for omnidirectional or directive radiation patterns)
- Antennas can SMD, soldered or cabled
- Can be embedded in radio unit, on roof top combo or deported in the vehicle (front / rear based on radiation patterns)

Infotainment / Connectivity

Safety

Anti-Theft

Embedded omnidirectional In-pillar GPS/3G/4G combos

- Combines GPS & 3G and/or 4G with 2 cables
- Thin design for under carpet installation (in seat)
- Ideal backup solution for anti-theft systems



Features & Benefits

- Easy to install/hide in vehicle under garment
- Customized Cable types, losses, lengths and connectors
- Various frequency options
- Various thickness options
- Can use Adhesive



W7000



W7013

NFC / Lock Combo for Door Handles

- 13.56MHZ antenna combining NFC and lock sensor technology
- W/ or W/O Ferrite mat based on application surface for reading distance optimization

Features & Benefits

- Extra thin solutions (0.2mm)
- Customizable location of the two signal antenna pads based on overall module design, customizable connection methods (clips, pogopins, hotbar)

Infotainment / Connectivity

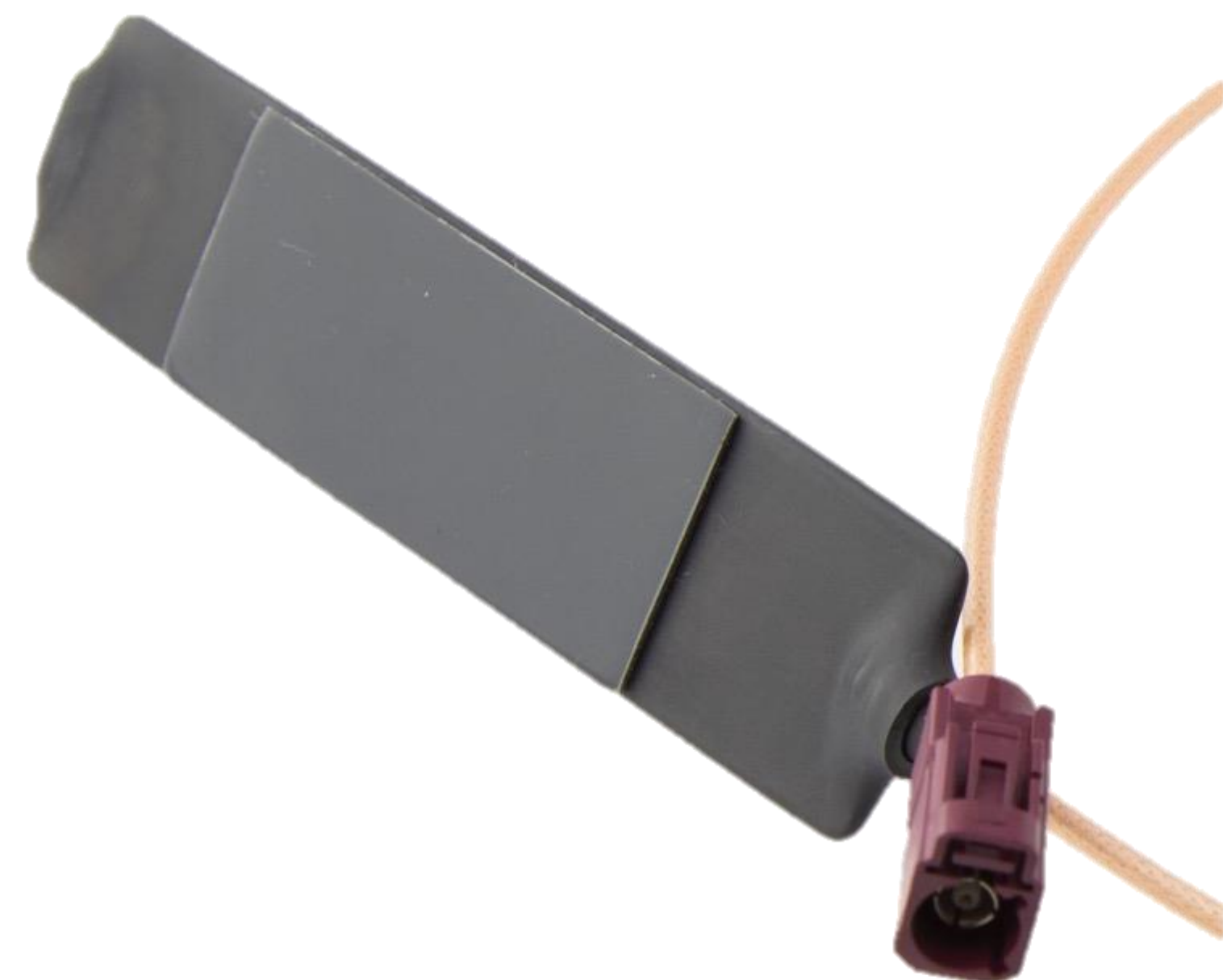
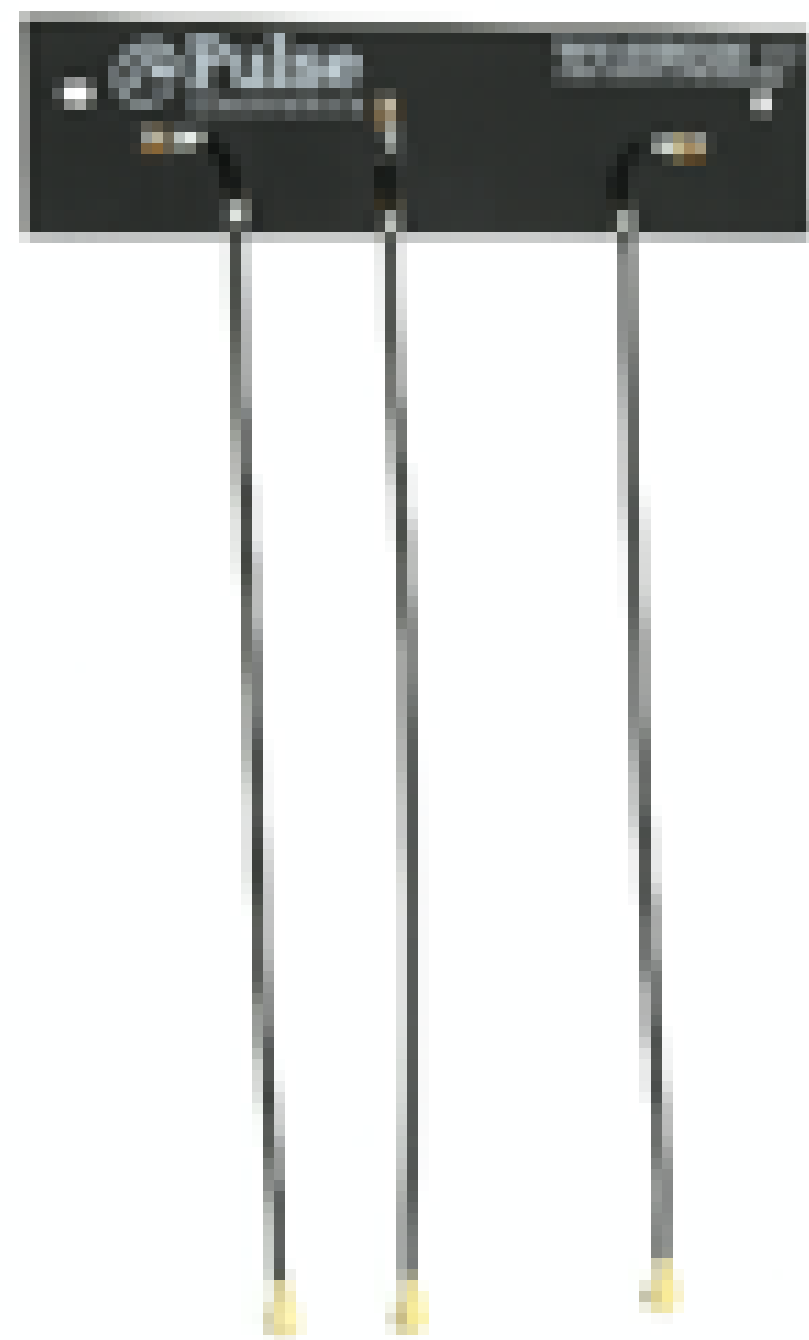
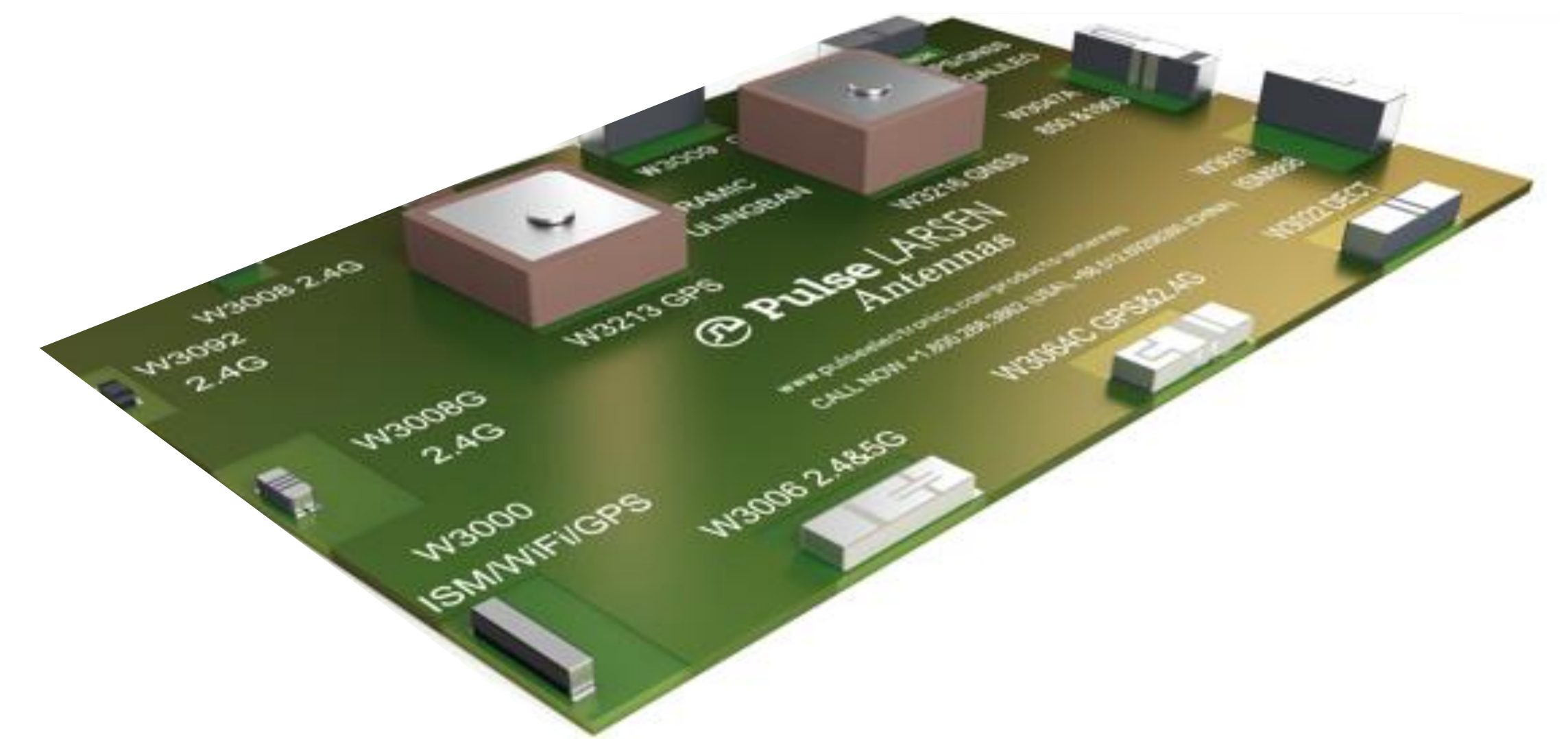
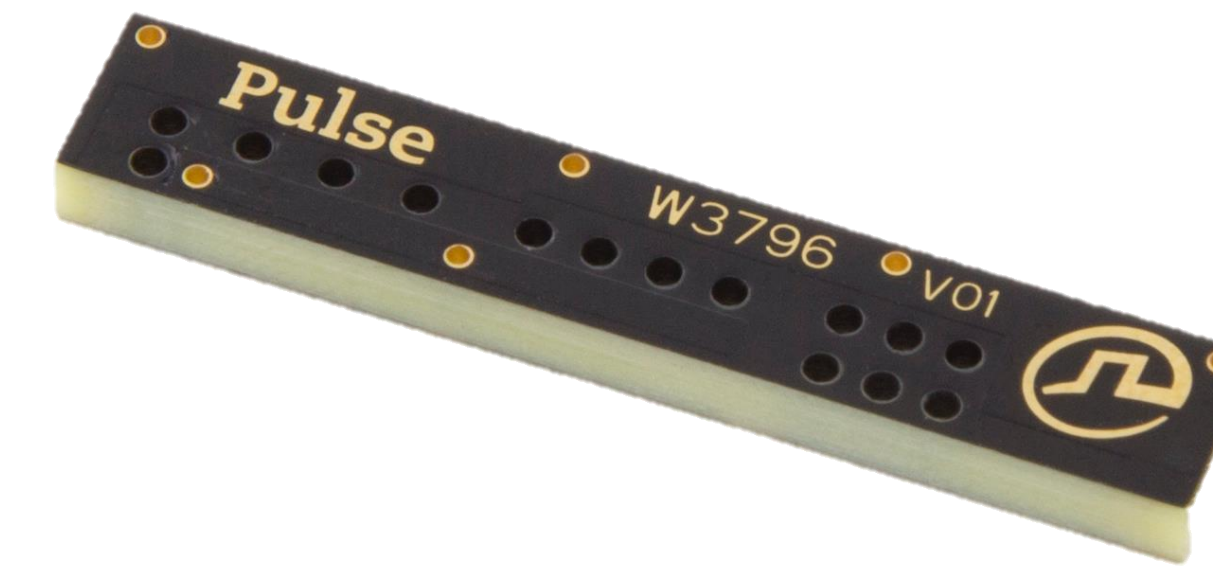
Infotainment / Navigation System

Embedded antenna solutions

- 2G/3G/4G/GPS/GNSS/ WIFI/DSRC/BLE/Bluetooth/ISM
- Ceramic and composite antennas for various frequency bands for on board solutions
- LDS solutions embedded in plastic carrier of the device for space limited applications

Features & Benefits

- All antennas are tunable based on frequency bands
- All antennas require limited PCB footprint based on RF spec
- Cost efficient solution (no cable and connectors)
- Ideal for low profile customer designs



Deported antenna solutions

- Ideal for optimizing RF performance far away from metallic surface, wire harnesses in the dashboard
- 2G/3G/4G/GPS/GNSS/ WIFI/DSRC/BLE/Bluetooth/ISM
- Can have single or multiple cables
- IP67

Features & Benefits

- Easy to install in mirrors, in dashboard for better RF performance
- Customized Cable types, losses, lengths and connectors
- Can cover wideband systems like 3G/4G/GPS with omnidirectional pattern

Infotainment / Connectivity

Telemetrics



Wireless Heating Engine

- Antenna length varies based on frequency band
- Customized Cable types, losses, lengths and connectors

Features & Benefits

- Protected by heatshrink tube
- Very thin design (2-3mm)
- IP67



TPMS

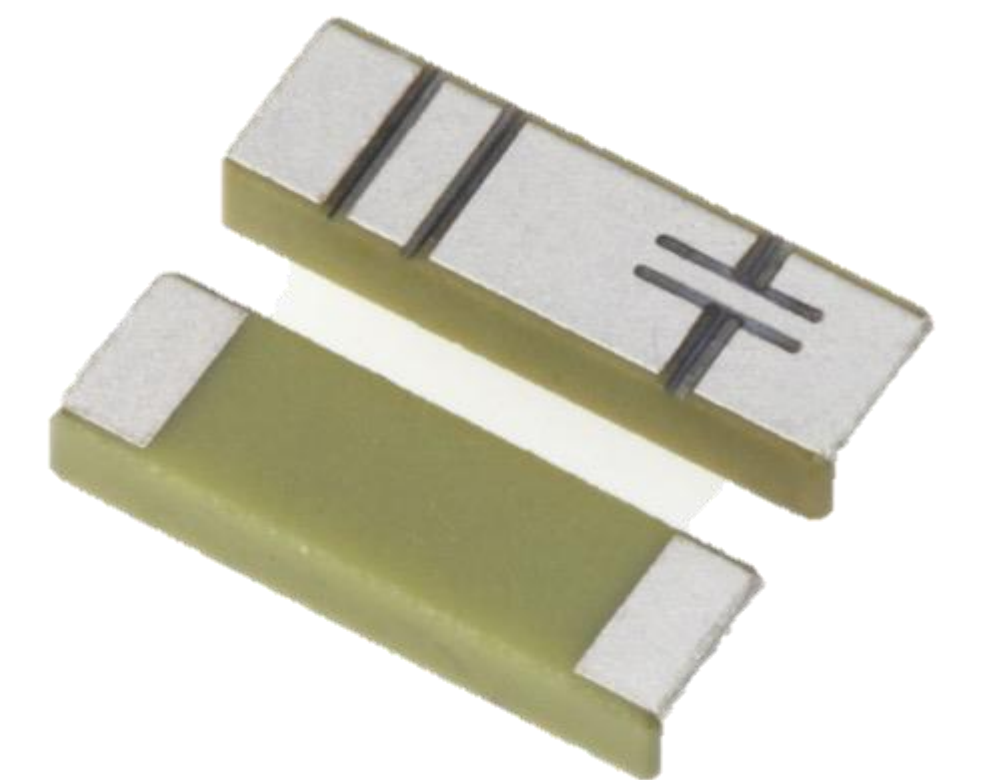
- Low frequency ruggedized or non ruggedized antenna reader
- Customized Cable types, losses, lengths and connectors
- Various shapes and dimensions

Features & Benefits

- Ideal for heavy duty vehicles
- Insert molded metallic parts for better attachment to vehicle
- IP67

Wireless BMS

- On board ceramic antennas
- Available for various frequency bands
- Low profile embedded antenna



Features & Benefits

- Small footprint and easy to integrate on board
- Withstand vibrations, heat and SMD
- Different sizes based on antenna performance and antenna location on the circuit board

External to Vehicle

Cellular or WiFi Gateways

Low Profile 10-in-1, metallic roof top mount

- Customized Cable types, losses, lengths and connectors
- 2xLTE, 3xWiFi, 2xDSRC, 2xGPS, 1xGNSS.
- Could accommodate 3xLTE or 4xLTE,

Features & Benefits

- Low Profile design 15mm above roof top
- Optimized Isolation, ECC and cable routing for best RF performance
- Ideal for sky-roof types
- Passive antenna solution
- Encapsulated in roof top recess
- Cable on the side or towards the bottom
- IP67



Armado Series



Razorback Series



Shark Fin Series



Panther Series



ARMADILLO, RAZORBACK, PANTHER, SHARKFIN series

Low Profile up to 6-in-1

Metallic roof top mount

- Customized Cable types, losses, lengths and connectors
- Black or White
- 2xLTE, 2xWiFi or 3xWiFi or DSRC, 1xGPS/GNSS antenna

Features & Benefits

- Highly integrated, High performance antenna combo
- Narrow profile, low profile, high performance, good performance, aesthetically pleasing
- Optimized Isolation, ECC and cable routing for best in class RF performance
- Screw mount, Direct mount , Mag mount options
- Passive antenna solution
- Cable on the side or towards the bottom of the antenna module
- IP67

External to Vehicle

Cellular or WiFi Gateways (2)

Adhesive Mount



Direct Mount



JAGUAR series, Low Profile up to 6-in-1

Non Metallic roof top mount

- Customized Cable types, losses, lengths and connectors
- Black or White
- 2xLTE, 2xWiFi or 3xWiFi or DSRC, 1xGPS/GNSS antenna

Features & Benefits

- Highly integrated, High performance antenna combo
- Optimized Isolation, ECC and cable routing for best in class RF performance
- Screw mount, Direct mount , Mag mount options
- Passive antenna solution
- IP67
- Cable on the side or towards the bottom of the antenna module

Mag Mount



External to Vehicle

KeyFOBs

Highly embedded antenna systems (narrow band)

- Customized shapes and dimensions
- ISM 169, 315, 433, 868, 915MHz, Zigbee, Proprietary systems
- Using FPC, LDS, molded coil technologies

Features & Benefits

- Highly integrated
- Off the shelf and customized solutions
- Optimized footprint for maximum RF performance
- Mostly SMD antenna solutions
- Passive antenna solution



Highly embedded antenna systems (narrow band)

- Customized shapes and dimensions
- UWB 6GHz-10GHz
- Using ceramic technology

Features & Benefits

- Highly integrated
- Off the shelf bloc and associated customized tuning solutions
- Optimized footprint for maximum RF performance
- SMD antenna solutions
- Passive antenna solution

Infrastructure

External to Vehicle



Infrastructure – External to Vehicle

Power Walls / Off Vehicle Chargers / Charging Stations

Stick / Blade Antennas – SPDA family, W5084 Family

- Multi frequency bands
- Slim Profile
- IP65



Features & Benefits

- Can be rotated based on coverage
- Linearly polarized and Omnidirectional
- Various connectors available

Low Profile Wideband Fin Antennas – SLPT Family and LPT Family

- Dual Band 2.4GHz/5GHz or wideband 3G/4G
- Can be adapted on ground plane or not
- Ruggedized and IP67

Features & Benefits

- Available in Black, White & Clear
- Any connector available

Baton Style Antennas

- Dual Band 2.4GHz/5GHz or Cellular bands or ISM bands
- Ruggedized and IP67
- Can be provided with Brackets

Features & Benefits

- Available in White
- Many connectors available
- Various antenna gains based on antenna length



Infrastructure – External to Vehicle

Power Walls / Off Vehicle Chargers / Charging Stations

Low Profile Wideband Fin Antennas with Cable

- Dual Band 2.4GHz/5GHz or wideband 3G/4G
- Can be adapted on ground plane or not
- Ruggedized and IP67

Features & Benefits

- Available in Black, White & Clear
- Customized Cable types, losses, lengths and connectors
- Ideal for reaching electronic board inside a metallic box



Infrastructure – External to Vehicle

Power Walls / Off Vehicle Chargers / Charging Stations



Armadillo Series



Razorback Series



Shark Fin Series



Panther Series

JAGUAR series, Low Profile up to 6-in-1

Non Metallic roof top mount

- Customized Cable types, losses, lengths and connectors
- Black or White
- 2xLTE, 2xWiFi or 3xWiFi or DSRC, 1xGPS/GNSS antenna

Features & Benefits

- Highly integrated, High performance antenna combo
- Optimized Isolation, ECC and cable routing for best RF performance
- Screw mount, Direct mount , Mag mount options
- Passive antenna solution, IP67
- Cable on the side or towards the bottom of the antenna module

PANTHER, ARMADILLO, SHARKFIN, RAZORBACK Metallic Ground Surfaces

- Customized Cable types, losses, lengths and connectors
- Black or White
- 2xLTE, 2xWiFi or 3xWiFi or DSRC, 1xGPS/GNSS antenna

Features & Benefits

- Highly integrated, High performance antenna combo
- Narrow profile, low profile, high performance, good performance, aesthetically pleasing
- Optimized Isolation, ECC and cable routing for best in class RF performance
- Screw mount, Direct mount , Mag mount options
- Passive antenna solution
- IP67
- Cable on the side or towards the bottom of the antenna module



Infrastructure

Manufacturing



In Production

RKE, GPS

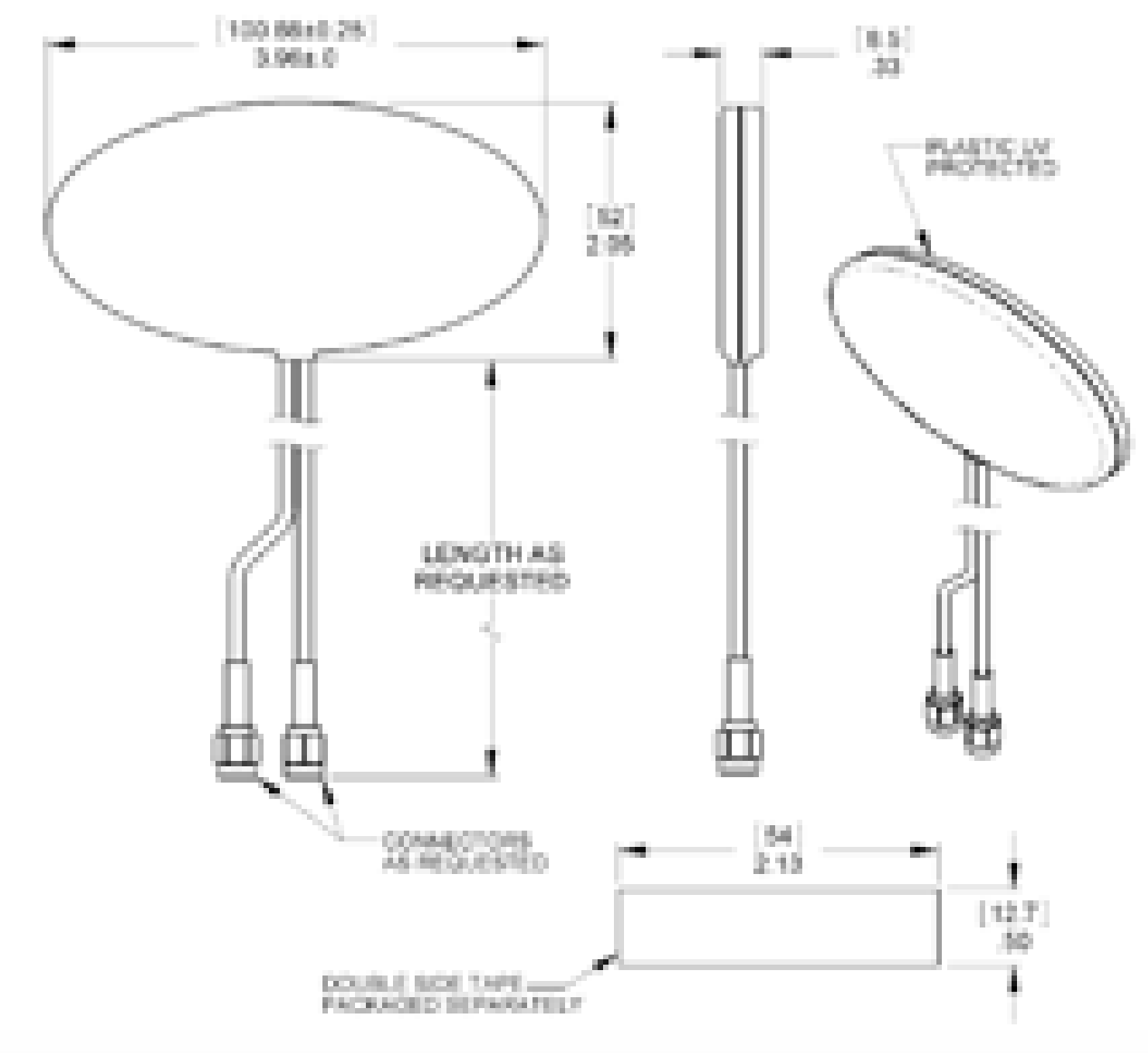
- 313-317MHZ
 - Stealth blade
 - Fakra conn
- **OFF THE SHELF SMALLEST 2.4GHz antenna: W3092**
 - 2x1x0.5mm
- **OFF THE SHELF GPS, GLONASS PATCH: W3223**
 - 25x25x4mm, Pin feed
- **OFF THE SHELF GPS PATCH: W3224**
 - 18x18x4mm, SMT
- **OFF THE SHELF GPS PATCH: W3225**
 - 25x25x4mm, SMT



In Production

3G Combos, After Market

- GPSSGM800/2170 - GPS/3G external antenna
 - GPS
 - 3G
- GPSSB800/2170FS – GPS/3G (.6in thick)
 - 806-960, 1710-2170, GPS
- GPSSB800/2170FS – GPS/3G copy & (THIN) – Stealth blade
 - to be designed
- W3915 (3G/GPS on FPC)
 - 3G
 - GPS



In Production

OBD, Telematics - CUSTOMIZED

- Features & Benefits
 - 3G Antenna for data transfer and Analytics
 - PIFA style for high efficiency in tight environment
 - Omni-directional Radiation Pattern
 - Optimized for max performance in the product (TRP/TIS)



In Production

SAM Car, ARROW ELECTRONICS



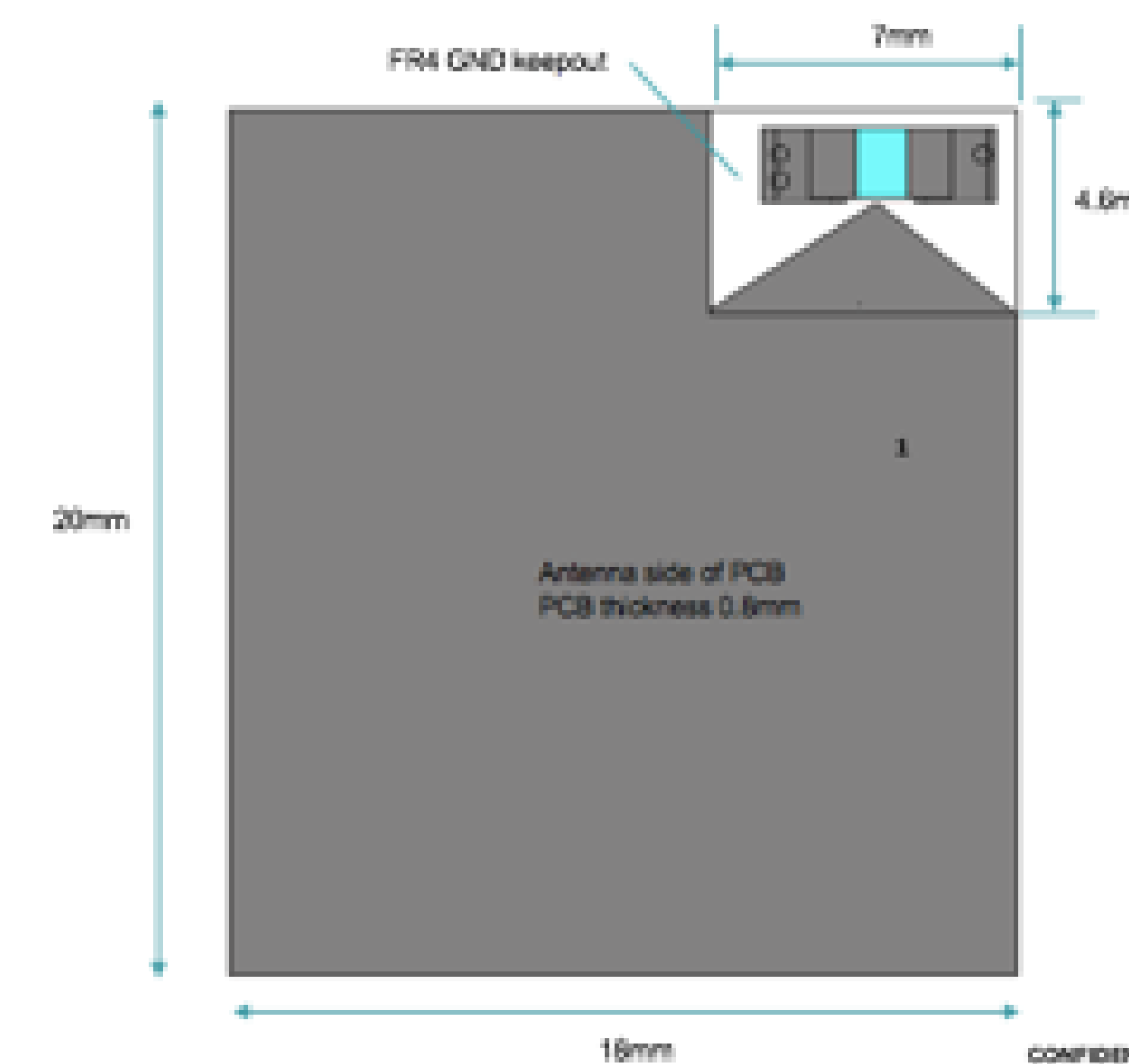
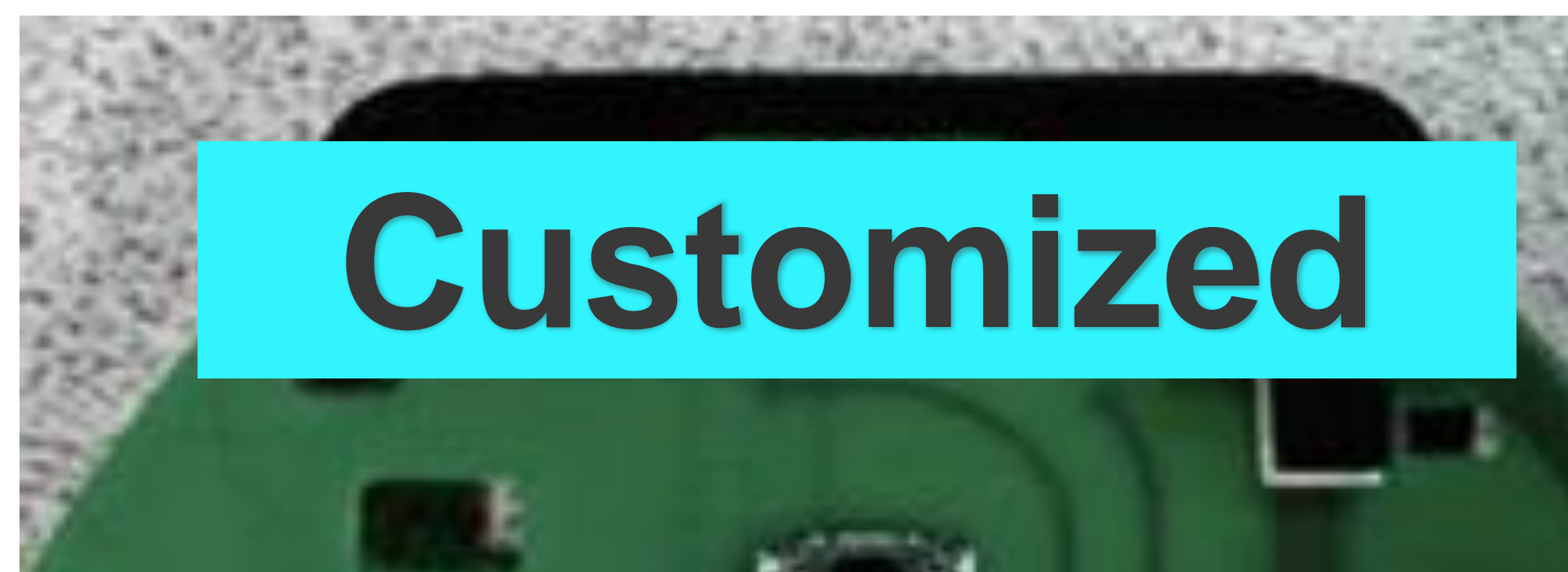
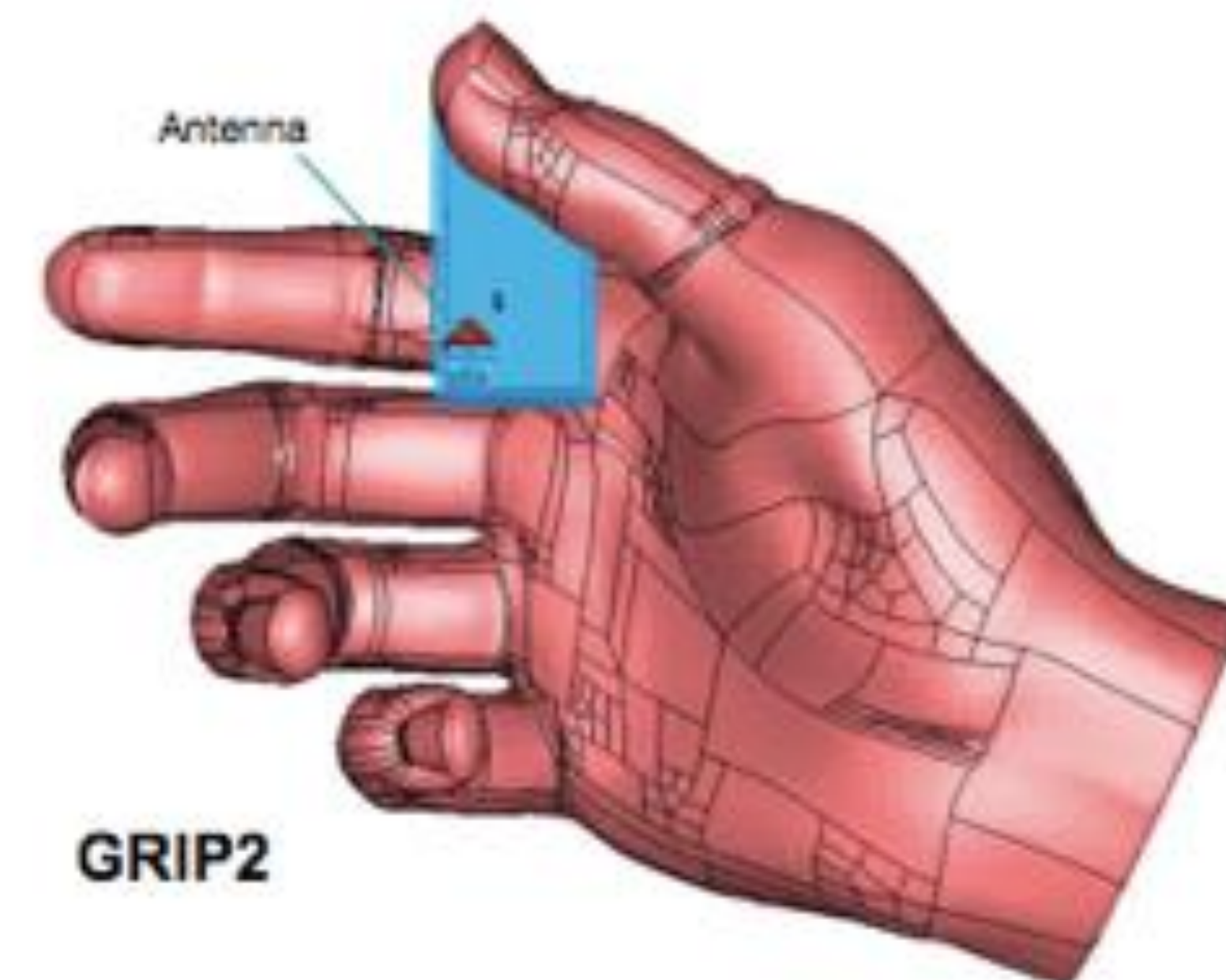
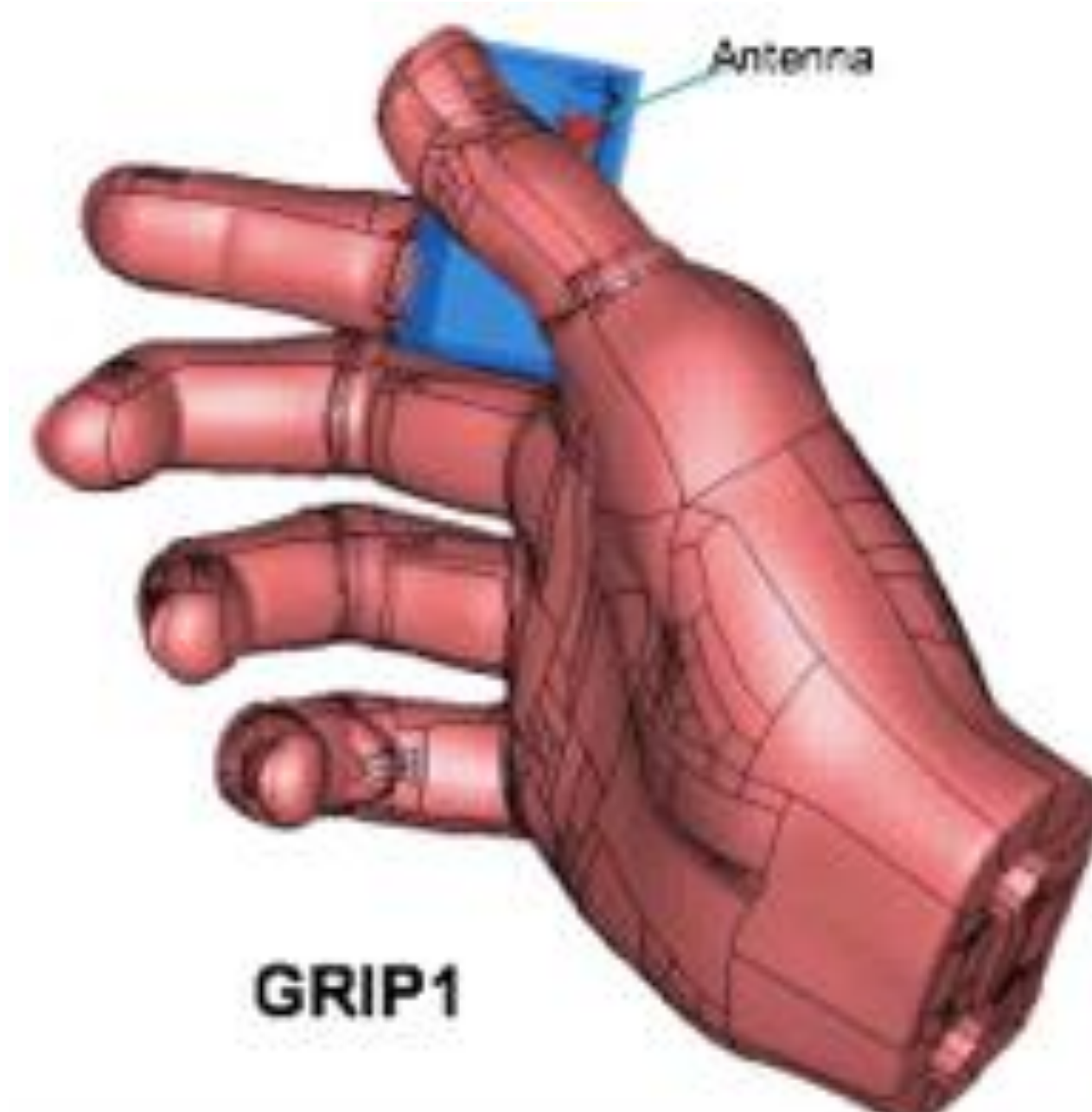
- Features & Benefits

- MIMO LTE Antenna for data transfer and Analytics
- Specially tuned for fiber glass roof top
- Design with direct mount or adhesive mount
- Cables through or on side
- Possibility to add GPS, WIFI



In Production Coils for RKE

Pulse can assist to design magnetic or electric embedded solutions and study body loading, matching impact !



315MHz Coil
W3126

433MHz
Coil W3127 vs Embedded
(FPC+Carrier)

UWB Solution based on
ceramic antenna 3.2 x
1.6 x 1.1mm³, Er 37.

In Production

Mirror Antennas / LTE 4G

W6100

Cable RG316 550mm
Fakra Conn: SMBA Code D
Antenna Size: 105x25x0.2mm



W6101

Cable RG316 550mm
Fakra Conn: SMBA Code D
Antenna Size: 105x25x0.2mm



In Production

V2X / V2V, DSRC

- Chips: W3006, W3078, W3095
- PCB antenna: W3315B0100, W3593B0100
- WIFI: W1043, W1028B, SPDA17RP2400/5900
- Public Safety: EF4905NMO, NMO4E5350B,
- Antenna Combo: GPSMB501
- Shark fin: GPSDM700/2500FFS

- Outdoor Vehicle: SLPT4900NMOHF, SLPT2400/5900NMOHF, SLPT4900DMN

- Outdoor Mount: RO4910NF, RO4910NM, RO5805NF, RO5805NM, RO5806NF, RO5810NF, W5030, RO5810NM

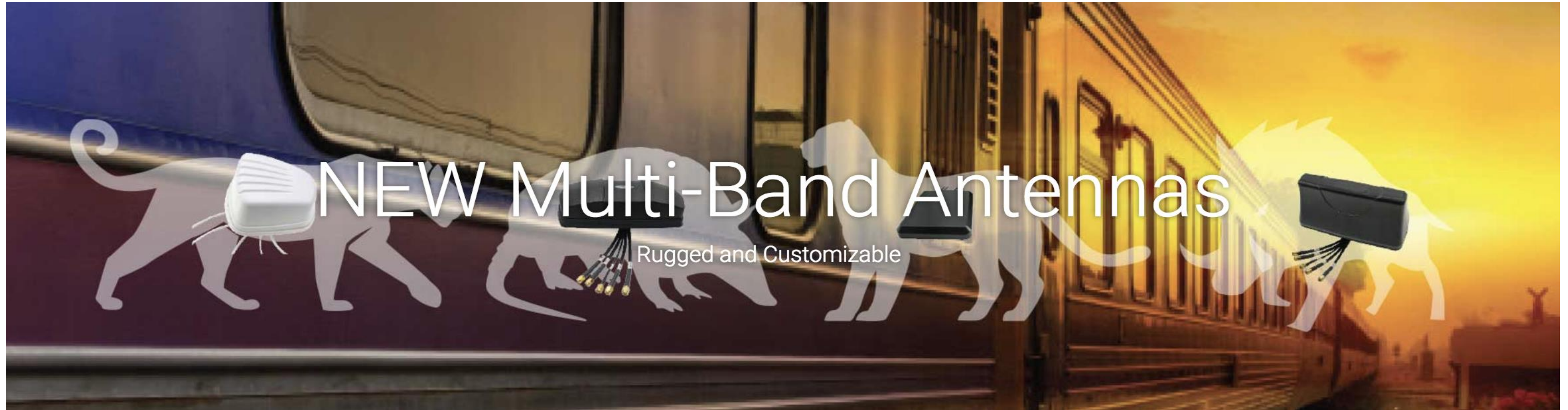
In Production


V2X / V2V, DSRC

- ROADSIDE
 - W5030, Radome omnis, NMO4E4900B, EF4905NMO
- VEHICLE MOUNT
 - SLPT4900DMN, GPSMB501, GPSDM700, EF4900NMO, W3593B0100, W3315B0100, GPS/DSRC combo
- WINDOW MOUNT
 - GPS/DSRC
 - DSRC
- EMBEDDED CHIPS
 - W3006, W3078, W3095

Multiband Antennas

Great Selection of Products



	Panther	Jaguar	Armadillo (Now Sampling)	Razorback	FIN	DISC
	<ul style="list-style-type: none"> • Best Performance • Low Cost • Best Gain, Efficiency, VSWR, and Port-to-Port Isolation 	<ul style="list-style-type: none"> • Low profile • Good Performance • Various Install Methods 	<ul style="list-style-type: none"> • Low Profile • Good Performance • Tamper-proof steel stud 'Narrowest Package' 	<ul style="list-style-type: none"> • Best Performance • Narrow Profile, • Tamper-proof steel stud 	<ul style="list-style-type: none"> • Best Performance • Aesthetically pleasing 	<ul style="list-style-type: none"> • Good Performance, ISM Options

Multiband Antennas

Great Selection of Products

**MULTI-BAND
ANTENNA
SUMMARY**

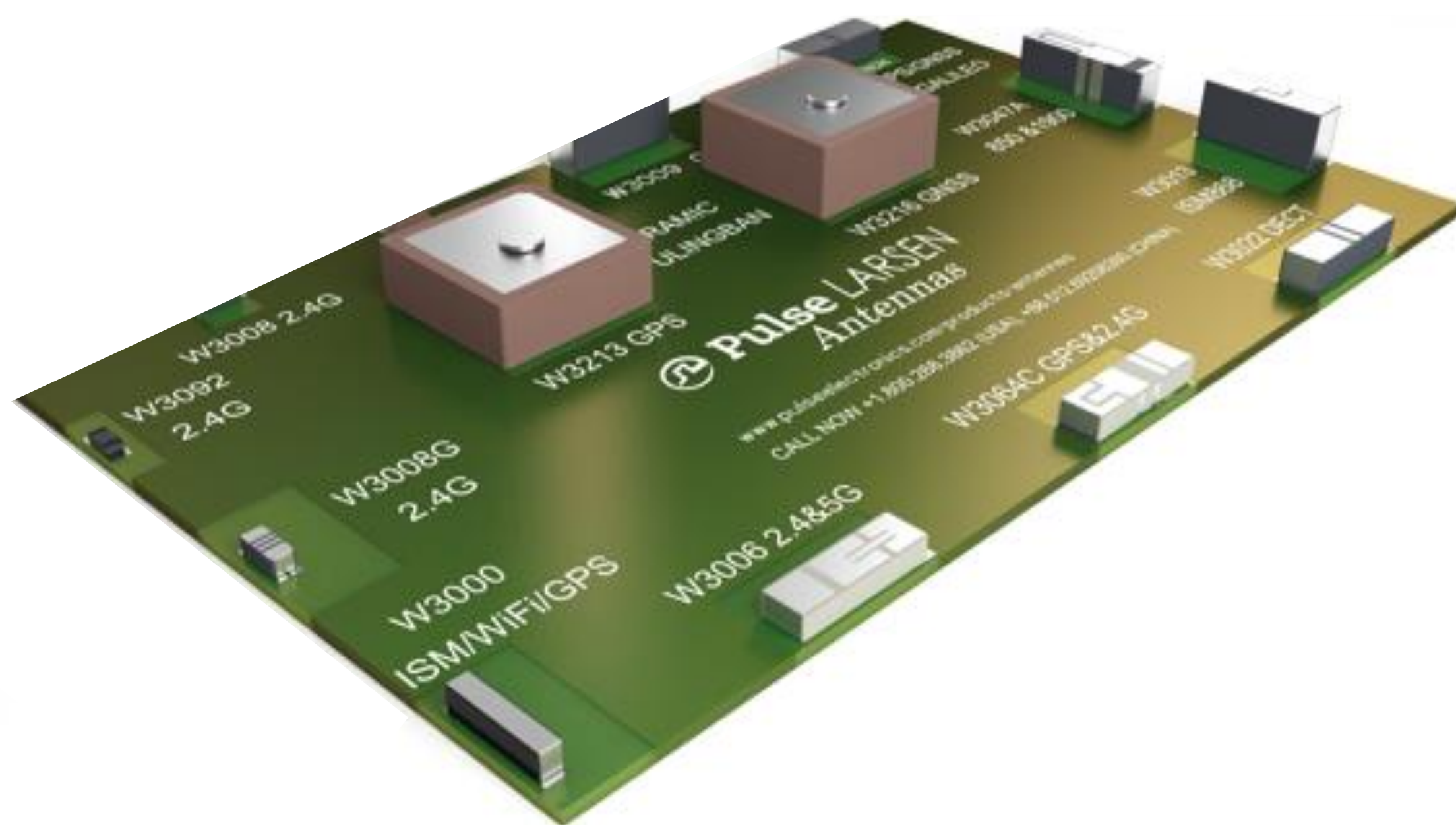
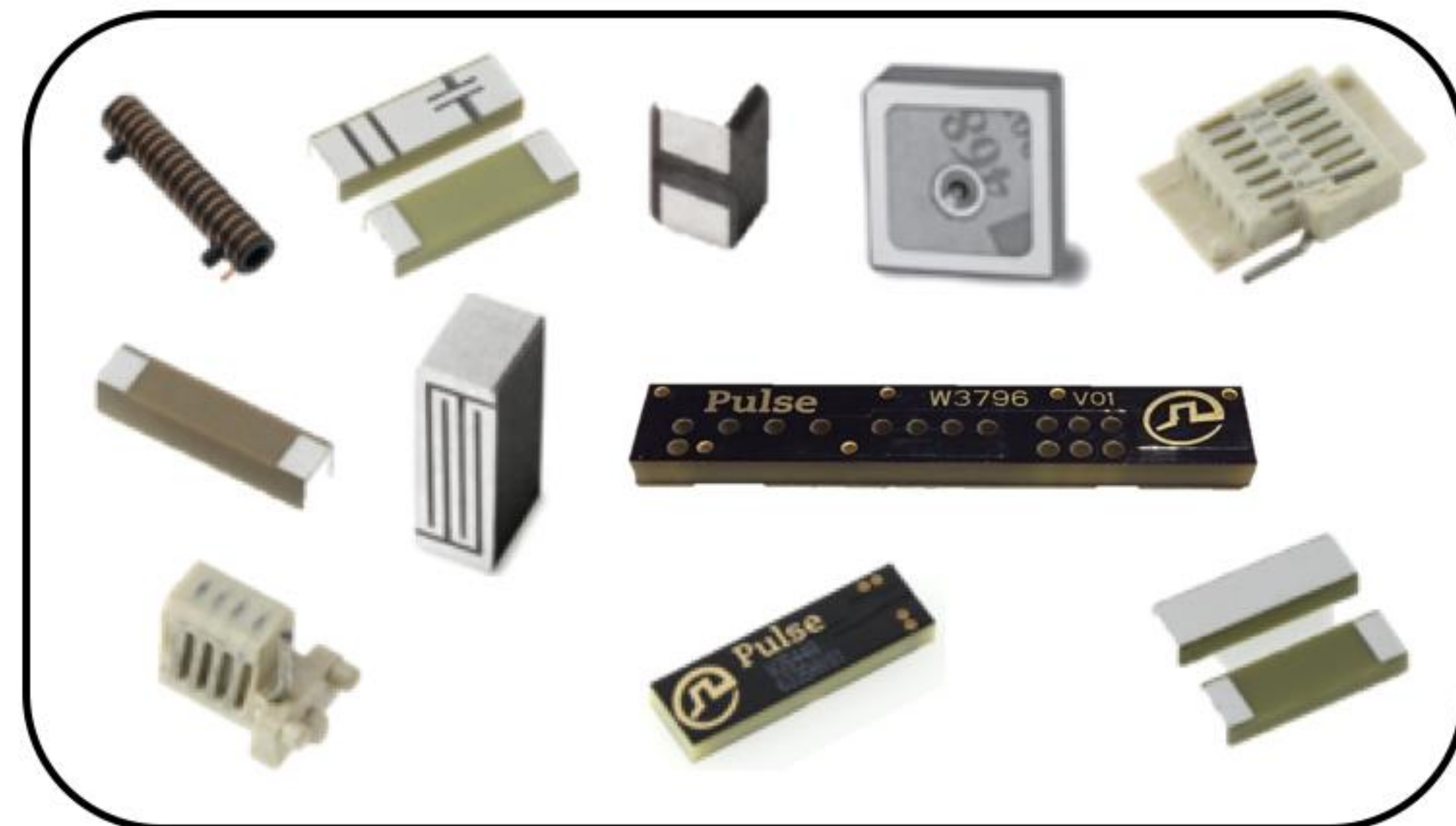


		Panther	Jaguar	Armadillo (Now Sampling)	Razorback	FIN	DISC
		<ul style="list-style-type: none"> • Best Performance • Low Cost • Best Gain, Efficiency, VSWR, and Port-to-Port Isolation 	<ul style="list-style-type: none"> • Low profile • Good Performance • Various Install Methods 	<ul style="list-style-type: none"> • Low Profile • Good Performance • Tamper-proof steel stud 'Narrowest Package' 	<ul style="list-style-type: none"> • Best Performance • Narrow Profile, • Tamper-proof steel stud 	<ul style="list-style-type: none"> • Best Performance • Aesthetically pleasing 	<ul style="list-style-type: none"> • Good Performance, ISM Options
		No. of Ports	Baseline Configuration				
6	LTE - (2x) WiFi -Dual Band (3x) GPS -full GNSS (1x)	✓	✓	✓	✓		
5	LTE - (2x) WiFi -Dual Band (2x) GPS -full GNSS (1x)	✓	✓	✓	✓		
4	LTE - (2x) WiFi -Dual Band (1x) GPS -full GNSS (1x)	✓	✓	✓	✓		
3	LTE - (2x) GPS -full GNSS (1x) or LTE (1x) WiFi-Dual Band (1x) GPS-full GNSS (1x)	✓	✓	✓	✓	✓	✓
2	3G - or ISM - (1x) GPS -Full GNSS (1x) or LTE (1x) GPS-full GNSS (1x) or LTE (2x)		✓	✓	✓	✓	✓
Color Options		Black, White	Black	Black, White	White	Black, White	Black
Ideal Placement		Either: On Ground Plane; or On Non-Metal Surface	Either: On Non-Metal Surface; or On Ground Plane if base used.	On Ground Plane	Either: On Ground Plane ; or On Non-Metal Surface	On Ground Plane	Either: On Ground Plane ; or On Non-Metal Surface
Package Available Mounting		Direct Mount Stud (Magnetic Mount available)	Adhesive Mount (Magnetic Mount and Fixed Mount Adapters available)	Direct Mount Stud (Magnetic Mount versions available)	Direct Mount Stud (Magnetic Mount versions available)	Direct Mount Stud	Direct Mount Stud (Magnetic Mount Versions Available)

On Board Solutions

Various types

- Most suitable components for on-board RF solutions
- Applications:
 - Navigation, Detachable device, Remote control, Ecall, OBD, T-box
- Available manufacturing technologies
 - Ceramic, Molded Helix, Coils, Composite Antennas
 - All are Surface Mountable



• Features & Benefits

- Use of catalog parts,
- Low profile and small required footprint,
- Easy to mount and Reasonable MOQ,
- Requires PCB fine tuning,

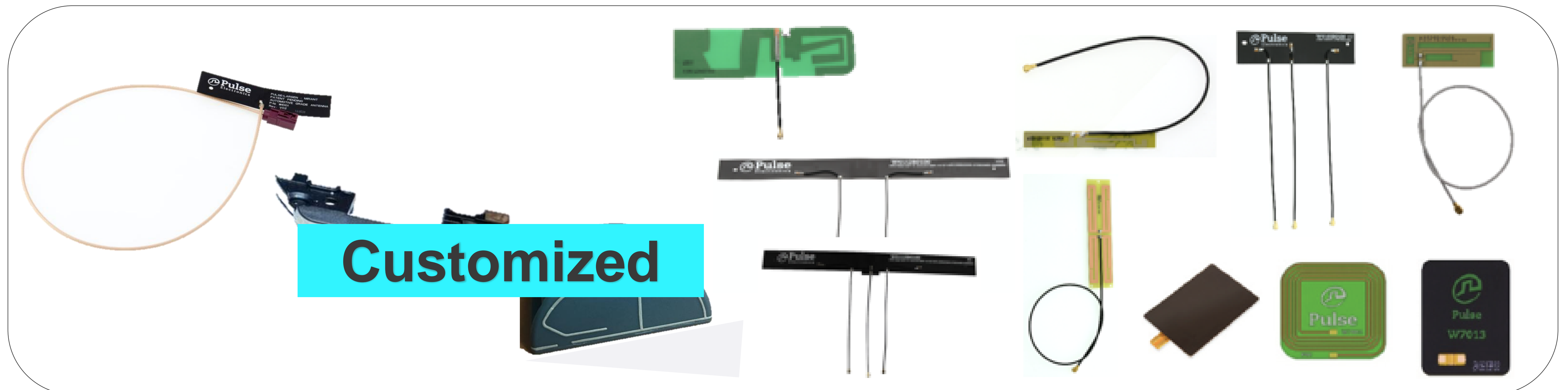
Internal Solutions

Various types

- Any solutions embedded in the Anything deported from the main PCB
 - Mirrors, Bumpers, Engine heater, Seats, Light bar, along Pillars.
 - Dashboard, T-box, Door locking, Camera modules, BMS, TPMS.
- Available 2D, 2.5D & 3D manufacturing technologies
 - Stamping, LDS,
 - FR4 and FPC w/ & w/o cables

• Features & Benefits

- Use of catalog and custom parts,
- Deported solutions,
- Any cables and connectors available,
- Antenna further from board electronic noise,
- Assistance to Integrate Stamping, LDS and FPC inside enclosure and its cable routing for maximum RF performance,
- Antenna further from metallic comp.



External Solutions

Whips



ON-GND Roof Top Combo



Hybrid Roof Top Combo (More than 10-in-1)



OFF-GND Combo



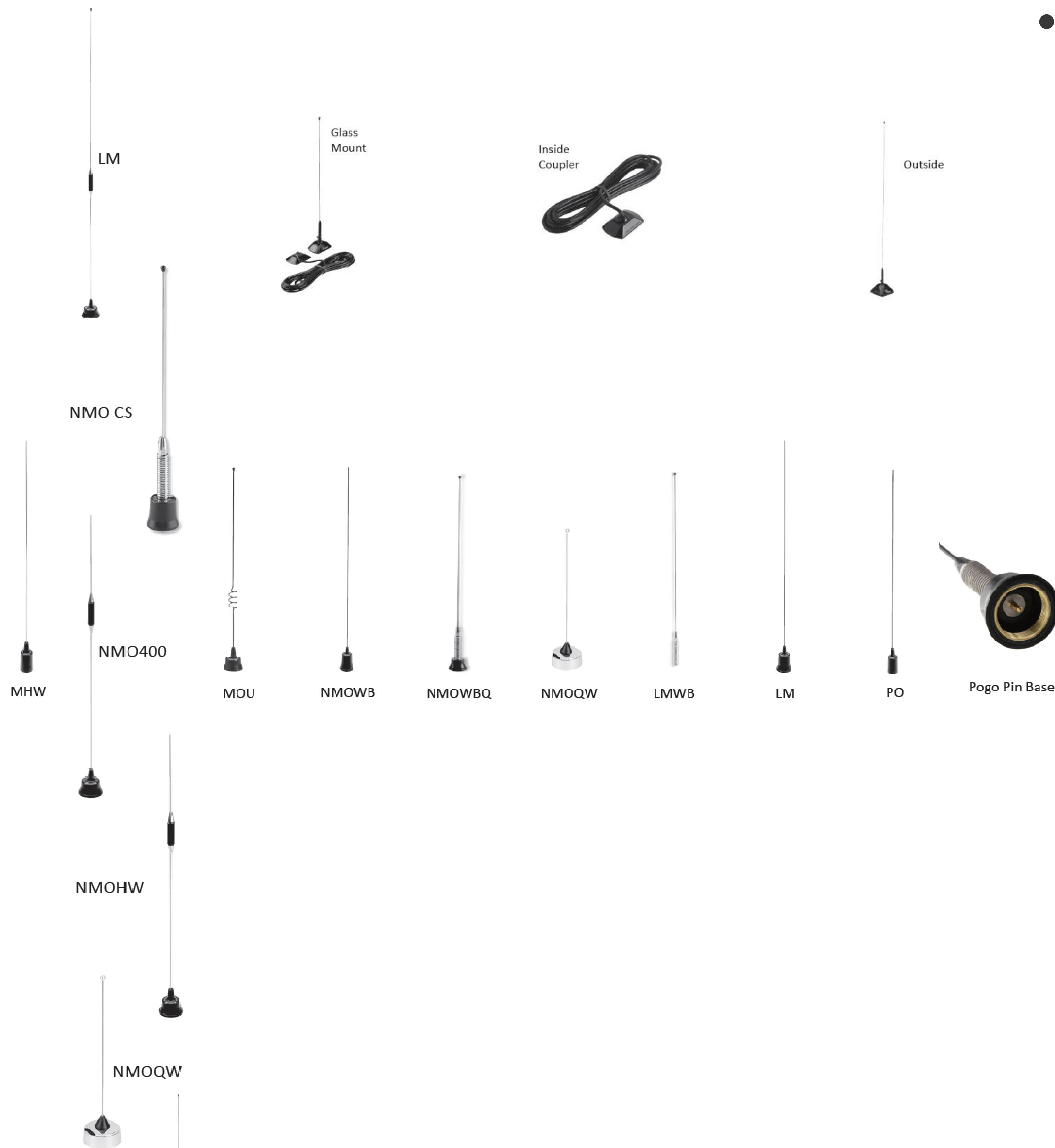
Compact Cellular



Covert Solutions



External Solutions Whips



- Features & Benefits

- Narrow band
- Available from 27MHz to 6GHz
- Mated for all industry standards connectors (NMO, direct mounts...)
- Can be mounted on all Pulse Brackets and NMO mounts
- Ideal for very low frequency
- Light weight solutions and flexible
- Traditional solution for UHF/VHF and below
- Glass Mount types
- $\lambda/4$, $\lambda/2$, $3 \lambda/8$, $5 \lambda/8$ loaded or not
- IP67 solutions

External Solutions On Ground Roof Top

- Features & Benefits
 - Avoids Antenna forest on roof top
 - Very wide range of frequency to be covered (LTE_x2, WiFi_x3, GPS)
 - New family of products
 - Razorback (Best RF performance)
 - Panther (Great RF performance)
 - Armadillo (low profile)
 - Sharkfin
 - Disc (Low profile of the Shark Fin)
 - Ideal combo solutions up to 6-in-1 solutions
 - Available in white and black
 - Direct Mount, Adhesive Mount or Mag Mount (cable on side or not)
 - Available with any connectors types
 - Works best on top of metallic ground plane
 - Ideal to control interferences between embedded antennas
 - Easy to mount on roof top (one hole)
 - IP67 solutions



External Solutions

Compact Cellular Solutions

- Features & Benefits
 - Low profile family of products
 - ICEFIN
 - LPT & SLPT
 - Salt Shaker
 - Whip Combos
 - Robust solutions
 - Adaptable to all PulseLarsen NMO mounts and brackets
 - Available in white, black or clear radome
 - Direct Mount, Adhesive Mount or Mag Mount (cable on side or not)
 - Available with many connectors types
 - Works best on top of metallic ground plane
 - Easy to mount on roof top (one hole)
 - IP67 solutions



External Solutions

Off Ground Solutions

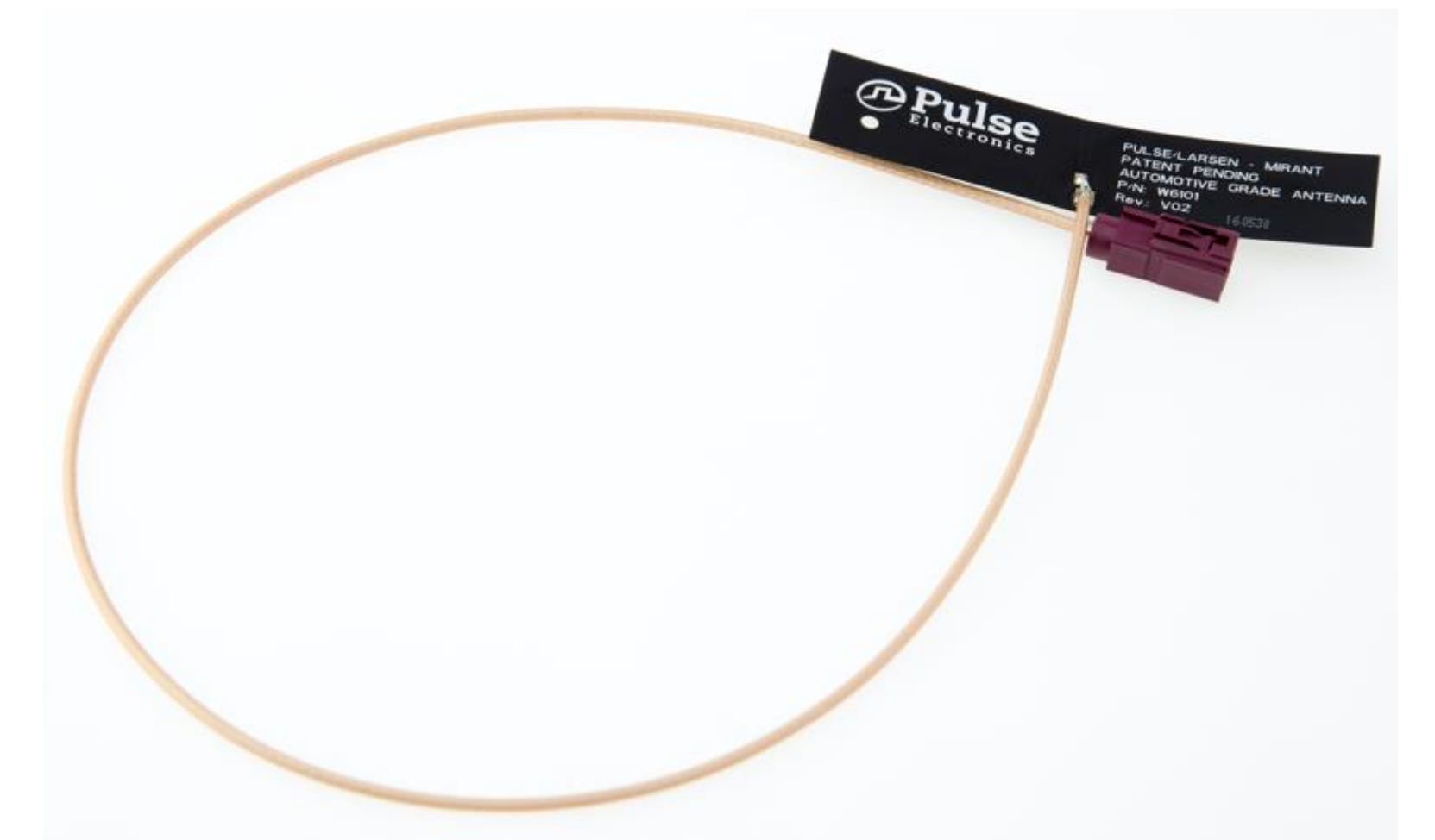
- Features & Benefits
 - Avoids Antenna forest on roof top
 - Very Low Profile, Very low Height
 - Works best on top of Composite roof (Non Metallic)
 - New family of products
 - Jaguar
 - Ideal combo solutions up to 6-in-1 solutions
 - Available in white and black
 - Direct Mount, Adhesive Mount or Mag Mount (cable on side or not)
 - Available with any connectors types
 - Ideal to control interferences between embedded antennas
 - IP67 solutions



External Solutions

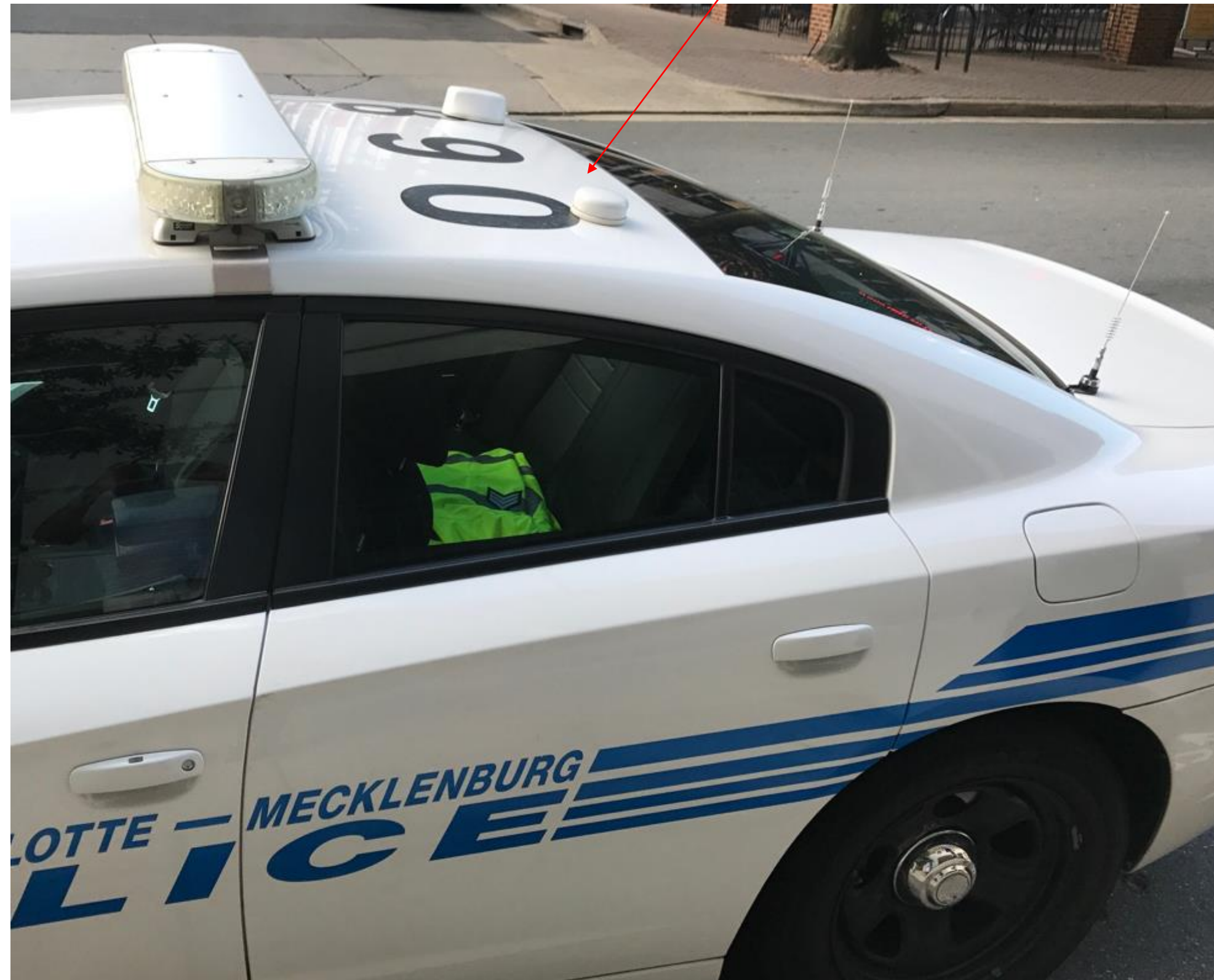
Covert Solutions

- Features & Benefits
 - Embedded and hidden solutions in the vehicle
 - Very Low Profile, Very thin
 - Works best along non metallic surfaces
 - IP67 Solutions
 - Various Dimensions based on Frequency
 - Cable mount with any connector type
 - 2 types
 - Very flexible solution with adhesive
 - More rigid solution
 - Single Band Solutions
 - 315MHz, 450MHz, 868MHz, 915MHz,
 - Multi-Band Solutions
 - LTE 698MHz-2.7GHz
 - WiFi
 - GPS + Cellular



Applications

Combo



Whips



GM Shark fin



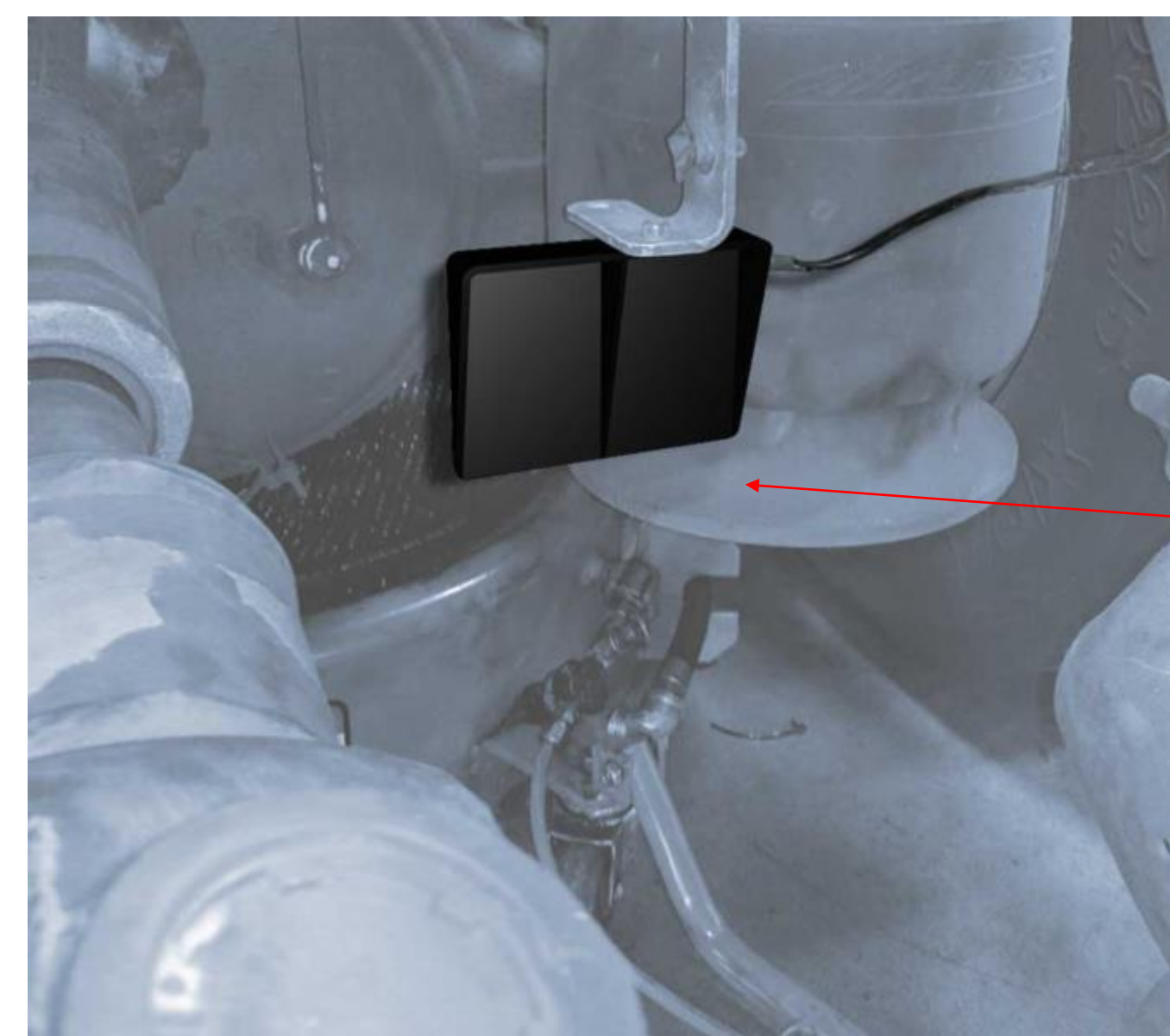
Embedded



SAM Car Roof Top



TPMS



Full EMC Test Capabilities



EMC test laboratory
Accreditation to DIN EN ISO/IEC 17025
granted by DAkkS
Notified Body (EMC Directive)
by Bundesnetzagentur / BNetzA
EMC testcenter Railway
by EBA / Eisenbahnbundesamt
Technical service (Automotive EMC Directive)
by KBA / Kraftfahrtbundesamt and RDW (NL)

