Aerospace **& Defense**

WEBINAR: Multi-band GNSS Antenna Integration within **Aerospace and Defense**

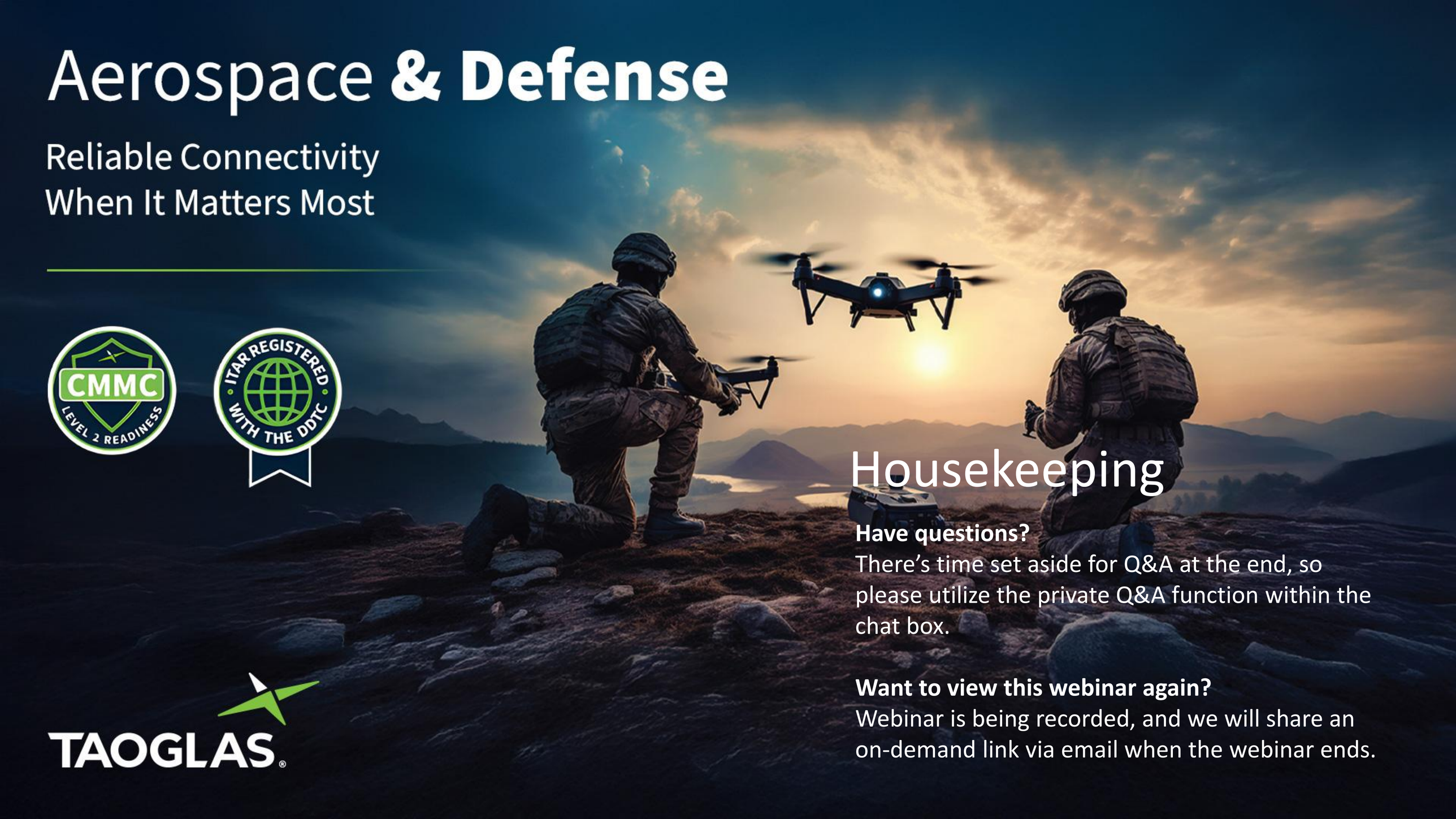
Today's Speakers

Kevin Blakeley
Head of Aerospace and Defense - Marine Corp Veteran

Patrick Frank
Principal RF Engineer

Aerospace **& Defense**

Reliable Connectivity When It Matters Most



Housekeeping

Have questions?
There's time set aside for Q&A at the end, so please utilize the private Q&A function within the chat box.

Want to view this webinar again?
Webinar is being recorded, and we will share an on-demand link via email when the webinar ends.

TAOGLAS®

Why Taoglas?

Industry-leading Antenna Supplier for **A&D Applications**

Long History with Aerospace & Defense

Shipped 100,000’s of devices to A&D and government agencies

U.S. Military Veteran Team

Experience Handling Tough Requirements

Highly reliable, robust antennas for use in harsh environments

Cybersecurity and quality standards compliance and certifications

In-house Engineering & Manufacturing

Full capabilities in North America for security and compliance

100% U.S. Owned with Taoglas USA headquarters in San Diego, CA

Quality & Certifications

ITAR Registered with DDTC

Directorate of Defense Trade Controls (DDTC)

IPC-A-610 and IPC-A-620S

Certified technicians for IPC-A-610 and IPC-A-620S for Military and Space cable assembly applications in our San Diego facility

Customs Trade Partnership Against Terrorism (CTPAT)

Started in 2022, in progress for application in 2023

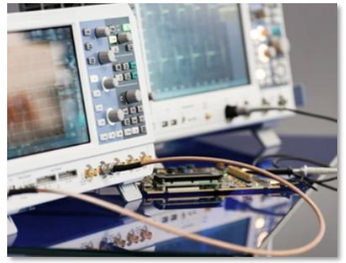
Cybersecurity Maturity Model Certification (CMMC) – Level 2 Ready

ISO 27001 certified

Global Engineering Resources & Capabilities

State-of-the-art RF Test Chambers & Analyzers

- 25+ VNAs WW
- 10 anechoic chambers WW
  - x4 in US from 400MHz to 40GHz
  - Active & Passive Tests
  - Call boxes
- Active Roof Top GNSS test setups in EMEA & Asia
- Customized Production Test Setup



Engineering Test & Development Lab

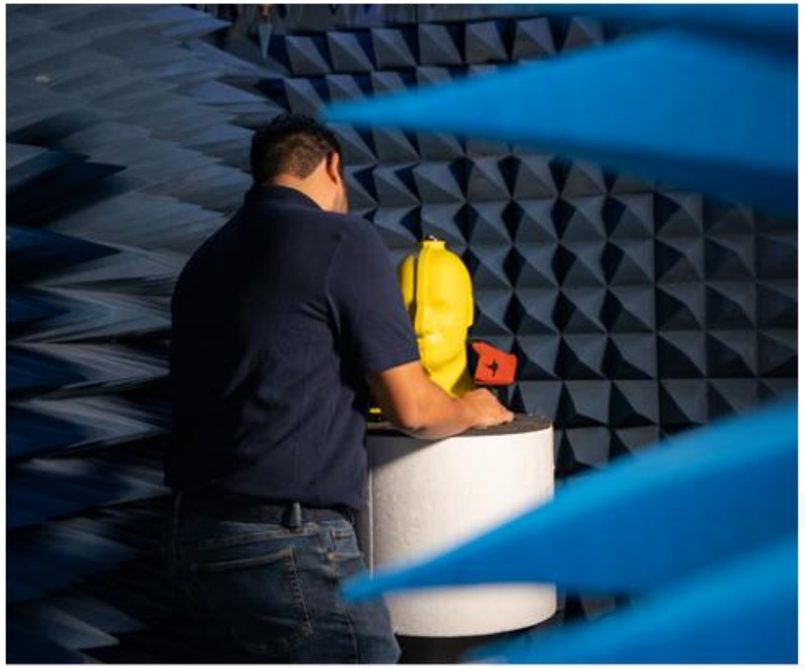
- Designed for Manufacturing
- Electronics Design: Gerber, Circuitry
- Software Design: Python
- Mechanical Design: Solidworks
- RF Simulations CST & HFSS
- 3D Printing
- Concept Hardware Prototyping
- Validating & Testing
- Online Catalog of Test & Services for customer project completion by phases

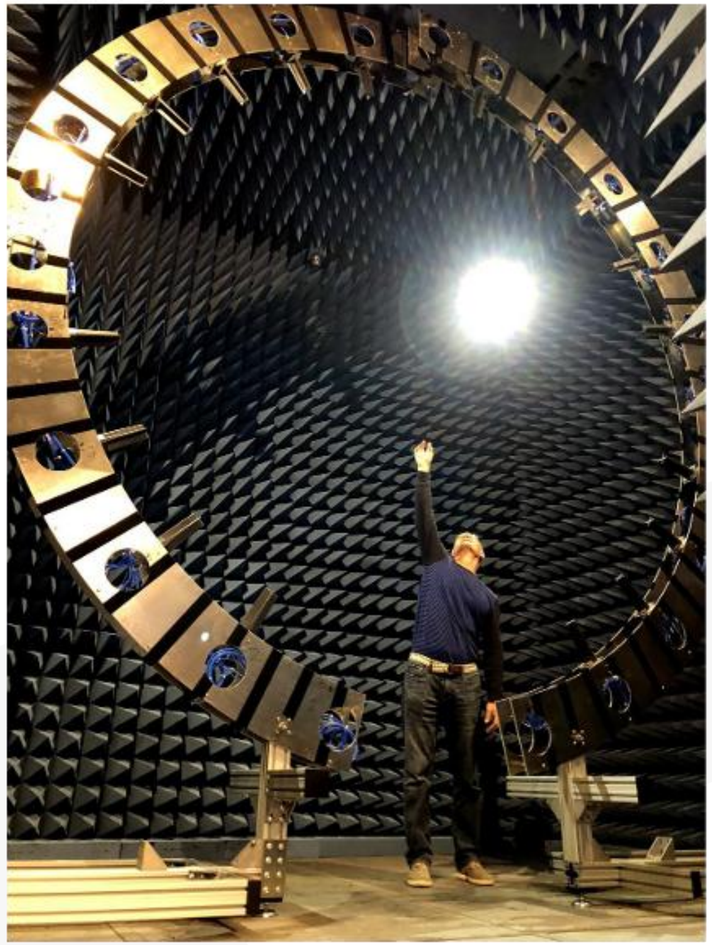
Environmental Testing & Statistical Analysis

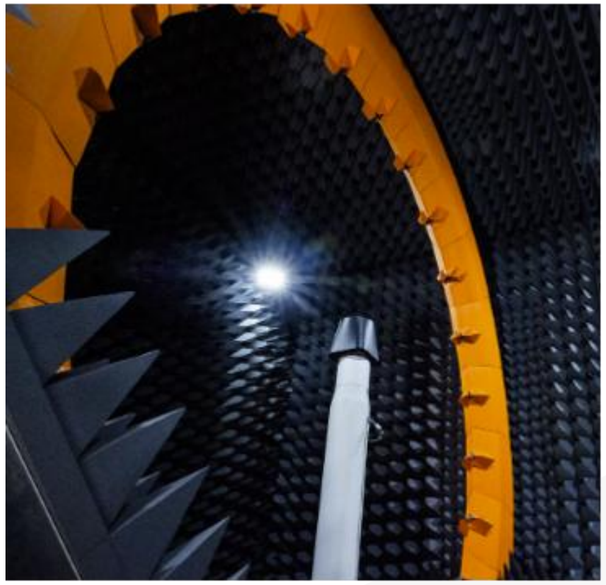
- Validating and Releasing to Mass Production for Uncompromised Quality
- Torque, Pull, Free fall
- Temperature Cycles with Humidity
- Vibration, ESD, Salt spray
- UV, Magnetic force, 50G ME shock
- IP ratings IPx5, IPx7, IPx8
- Common SW to capture S-parameters during production for all Taoglas Partners

Mechanical Lab in San Diego, CA

- LDS machine
- LPKF routers
- CO2 laser cutting machines
- Sheet metal laser cutting machines
- Pad printing for logo
- Ultrasonic welding machines
- Komax trimmer & stripper
- Schleuninger cutters
- IPEX connector crimping machine
- Homemade manufacturing test Jigs



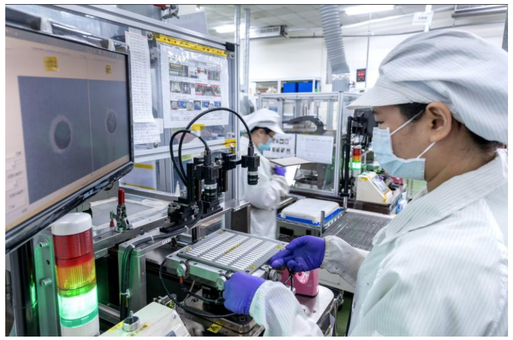




State-of-the-Art Manufacturing Capabilities

Global Manufacturing

- Taoglas Factory
  - Taiwan (100%)
  - India (W/H + IQC/OQC)
  - Vietnam by 2025
- Contract Manufacturers
  - Taiwan
  - Vietnam
  - India



In-house Manufacturing Capabilities

- Cable and Connector management
- Silver Paste Silk Screening on Ceramic Blocs & Terrablast
- Ultra Sonic Welding for External antennas
- Kiln Oven for ceramic baking
- Automatic welding stations
- Potting & Foaming Machines for outdoor antennas
- Water leakage machines (air pressure) for external antennas
- CNC machine
- Own Test Jig department
- Common SW to capture S-parameters during production for all Taoglas Partners

AMTIVO
ISO 9001 Certified
Quality Management

CERTIFIED ISO14001

CERTIFIED IATF 16949:2016 COMPANY

Quality Standards

- ROHS, REACH compliance
- IATF-16949 (Factory & CM)
- ISO9001, ISO14001
- Experience with PPAP submission
- No functional field failures
  - No antenna recalls

Delivering Long-term Quality & Trust to Rugged Transportation

Synergy - MA1509 9-in-1
Combination Antenna – GNSS,
5*5G/4G Cellular & 3*Wi-Fi

Pantheon – MA750 5-in-1
Permanent Mount GNSS
5G/4G 2xMIMO Wi-Fi
2xMIMO Antenna

Meteor FW.90
4G/3G/2G Cellular
Flexible Whip,
SMA(M)

APEX TG.46
Wideband 5G/4G Dipole
Terminal Antenna

MagmaX2 – AA.200
Active Multiband GNSS
Magnetic Mount Antenna

SPKR.10.4.A
10 Inch Round Subwoofer
Speaker 80W

Monsoon MA170
2*5G/4G MIMO Permanent
Mount Antenna

Lightweight, Low-profile Antennas Mobilize the Smart Battlefield

Drone Antennas

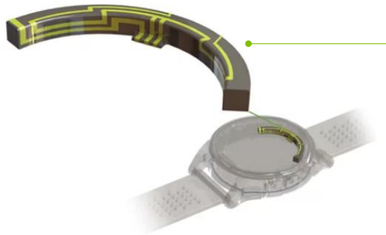
ADFGP.60A
Light weight Active Multi-band GNSS High Precision Patch Antenna

AJA Series for UAV
2.4GHz Flexible Cable Dipole Antenna with Integrated Anti-Jamming Out-of-Band Filter

Inception HP5354.A
Low Profile L1/L5 GNSS Patch-in-a-patch Antenna

GP.15A
L1 GPS/GALILEO Patch Antenna

Wearables



LDS technology and all other embedded products

CBD Series for UAV
Lighweight, Thin 5.8GHz Cable Dipole Antenna

ASGGB.184
Active GNSS Surface Mount Patch

EAHP.125 for UAV
All-band GNSS Embedded Quad Helix Antenna

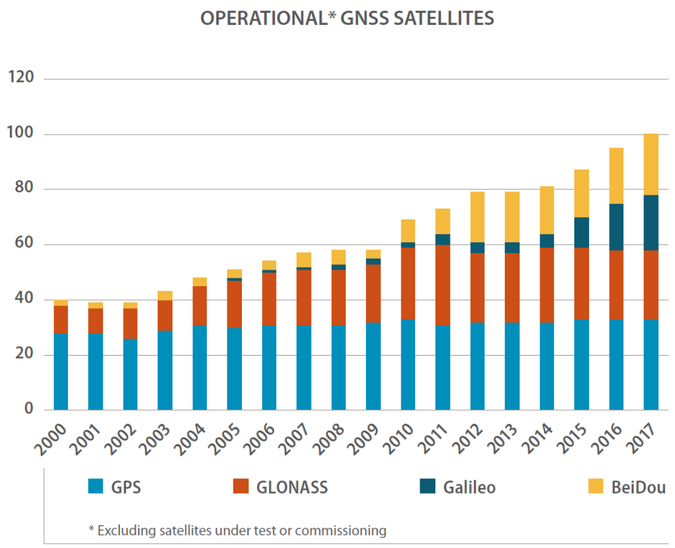
Introduction to Multi-Band GNSS

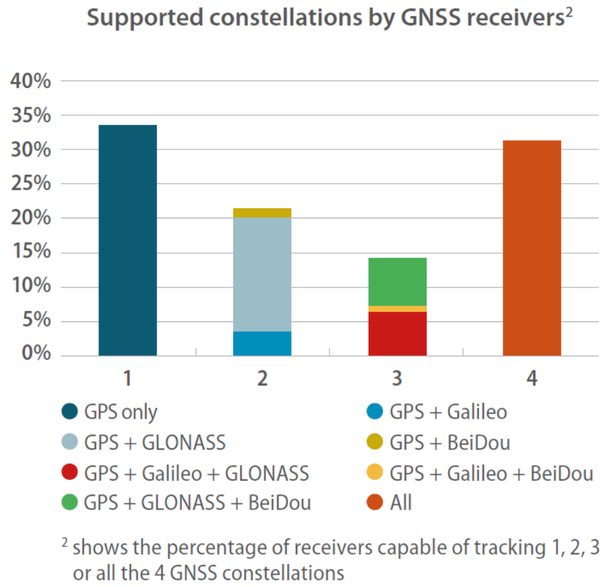
Multi-Constellations GNSS Systems

Use of multiple constellations results in more satellites in the field of view, which has the following benefits:

Multi-Constellations GNSS Systems

The benefits of multi-constellation have been recognized by consumer chipset manufacturers. Currently, more than 30% of all chipsets support four constellations.





(Study European Global Navigation System Agency: https://www.gsa.europa.eu/system/files/reports/market_report_issue_6_v2.pdf)

https://www.gsa.europa.eu/system/files/reports/gnss_user_tech_report_2018.pdf

GNSS Technology 101 – US Global Positioning System (GPS) Example

GPS Bands	L1	L1 + L2	L1 + L5	L1 + L2 + L5	L1 + L2 + L5 + L-band
Basic Info	Legacy configuration	Common configuration	Long-term configuration	Future-proof global solution	Supports correction service
Accuracy	3m	1.5m	1.5m	1.5m	0.2m
Power			Improved gain	Improved gain + more resilience, dynamic movement, signal more often	

RTK
All-in-one solution
cm-level

L1
1575.42 MHz

- Legacy configuration in ALL satellites
- Civilian signals

L2
1227.60 MHz

- Legacy configuration in ALL satellites
- Signal not as good → lower power and narrower signal
- Military signals

L5
1176.45 MHz

- Provided in NEWER satellites
- Higher gain signal → more power from L5 than L1
- L1/L5 is more resilient, better stability/accuracy
- Civilian signals

L-band
1542 MHz

- Subscription-based corrections (PPP) from satellite
- Provides higher level of accuracy

E6
1278.75 MHz

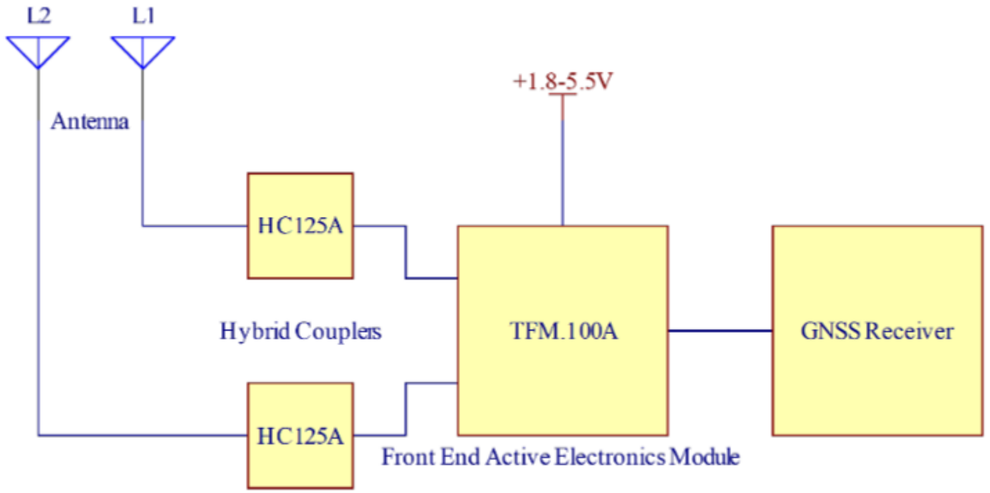
- Free correction service in GALILEO E6 satellites *not yet turned on*
- Provides higher level of accuracy

Multi-band Solutions are Bigger…

Single band, quad constellation
25*25*4mm

Triple-band, quad constellation
50*50*12mm

…and more complex



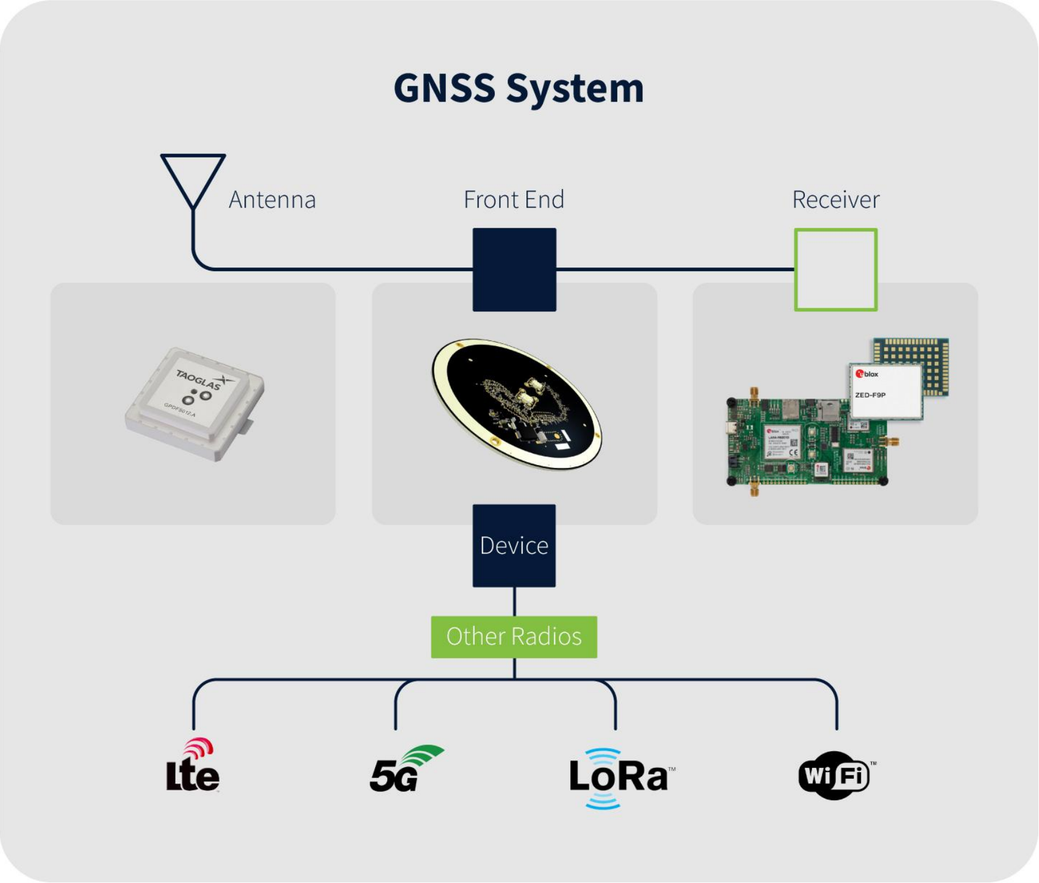
Block Diagram of integration of the TFM.100A

Future-proof your GNSS design with Taoglas Antenna solutions

- For years designs have been using single band GNSS → same antennas, same filters & amplifiers.
  - Typical design has a 25x25x4mm patch antenna, or an active antenna for off board, or an external antenna

- Today - new bands and technology (L2, L5, L6, L-band) - means you can enjoy cleaner signal and better accuracy

- Prices are coming down for technology around the new bands, e.g. Edge Locate



GNSS Antenna Types

Chip

Loop
Antenna

Characteristics:
- Linear Polarized Antennas (catch half of the signal)
- Small Antennas
- Passive or Active Antennas

GGBLA.125A

FPC

Flexible
PCB

Characteristics:
- Linear Polarized Antennas
- Variety of sizes
- Omnidirectional
- Passive or Active Antennas

FXP612

Patch

Passive
or Active

Characteristics:
- RHCP Polarized Antennas
- Large variety of sizes
- High Gain
- Passive or Active Antennas

ADFGP.50

Dipole

Cross-Dipole

Characteristics:
- RHCP Polarized Antennas
- Low Cross-Pol
- Wide bandwidth
- Passive or Active Antennas

XAHP.50

Helical

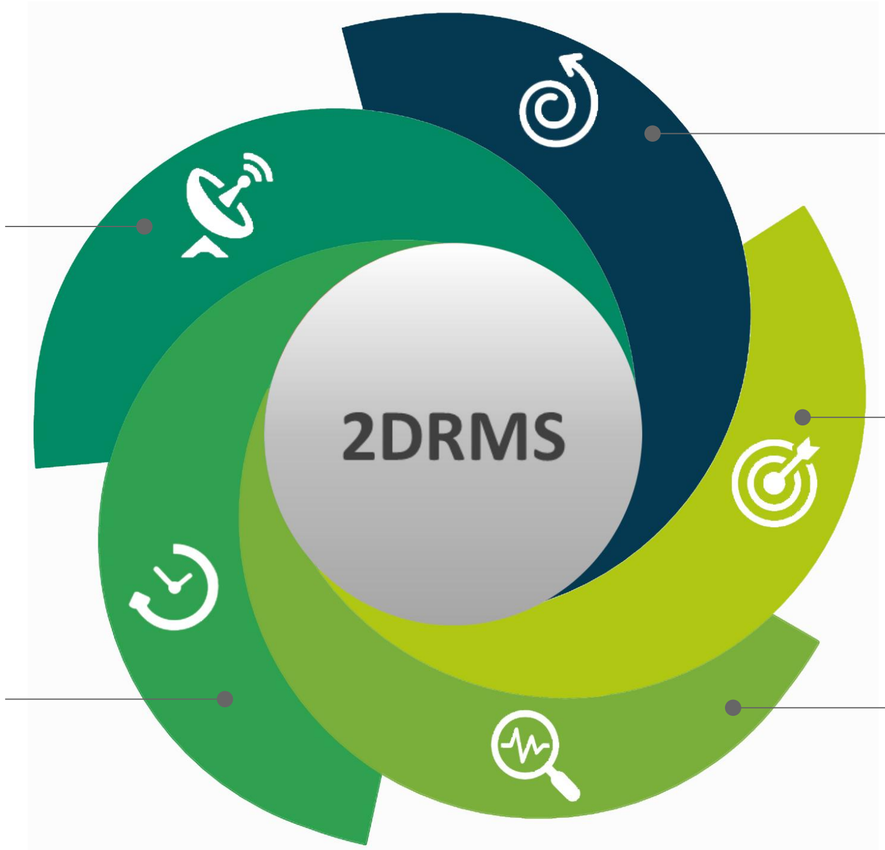
Quad
Helical

Characteristics:
- RHCP Polarized Antennas
- Large variety of sizes
- Omnidirectional
- Passive or Active Antennas

AQHA.11

Size / Cost / Performance

GNSS Antenna Characteristics



Axial Ratio

Antenna Gain

Phase Center Offset (PCO)

Group Delay Variation

Phase Center Variation (PCV)

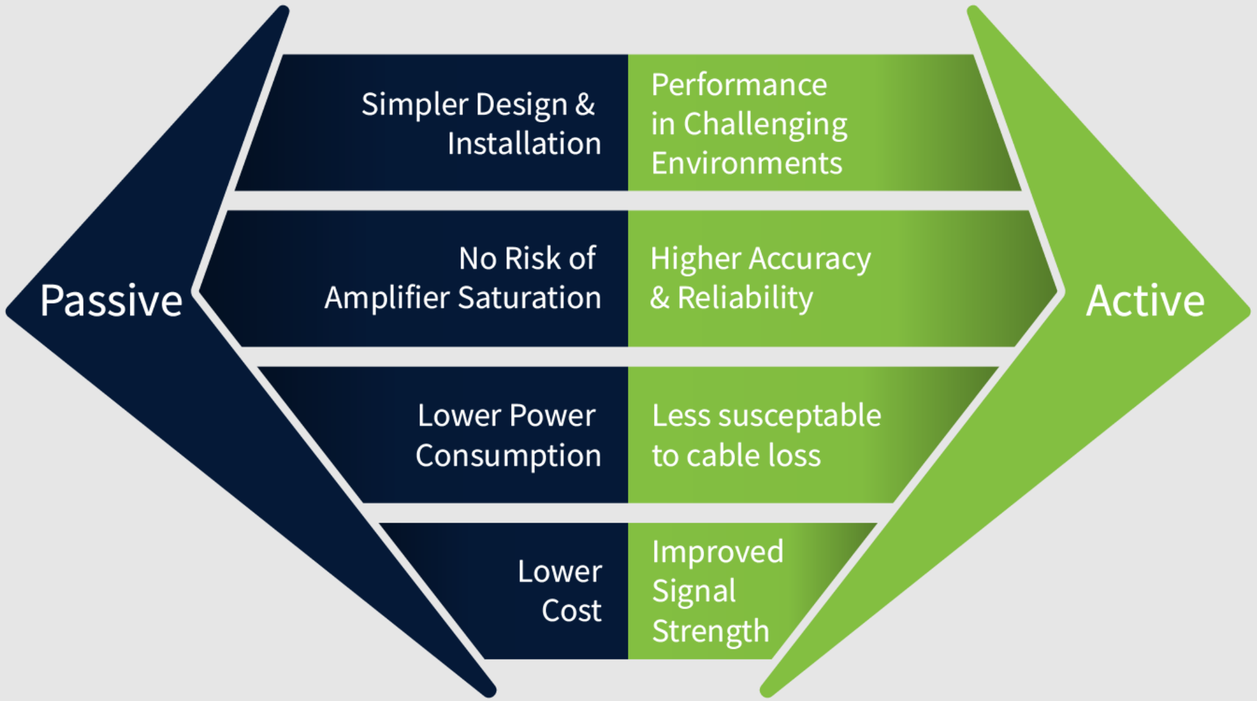
Twice of the Distance Root Mean Squared (2DRMS) is a single number that illustrates two-dimensional accuracy. It is the probability of being within a circle, with a radius equals to 2DRMS, 95% of the time.

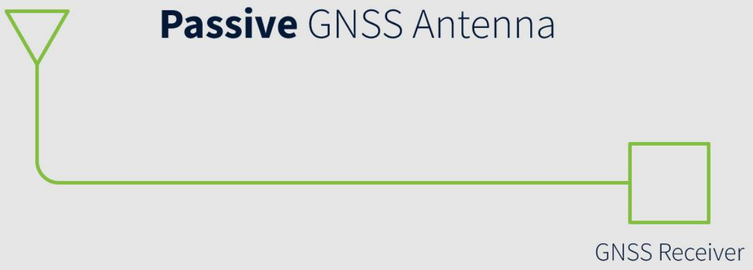
Types of GNSS Antennas

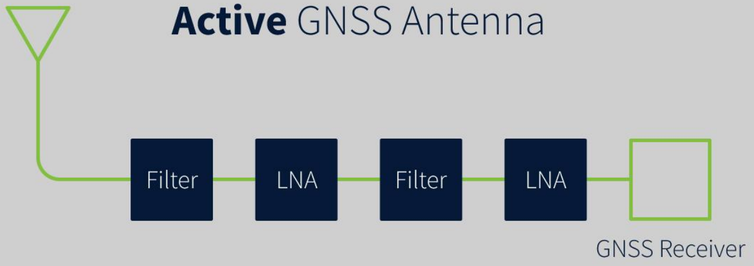
GNSS Antennas

Passive or **Active**?

Application Design Priorities as an Indicator







Taoglas Product Portfolio

Longstanding History of Taoglas **External Antenna** Designs

SYNERGY Combo up to 11-in-1

OLYMPIAN II Combo up to 3-in-1

GUARDIAN Combo up to 9-in-1

GUARDIAN X Combo up to 17-in-1

HERCULES GNSS 2-in-1

ULTIMA low profile permanent mount

STINGRAY GNSS, Cellular 2-in-1

STREAM Combo up to 3-in-1

PANTHEON Combo up to 5-in-1

STORM Combo up to 5-in-1

SAUCER Magnet Mount 2-in-1

SENTINEL Combo up to 3-in-1

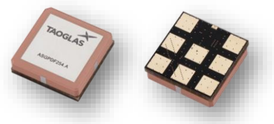
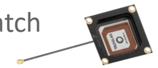
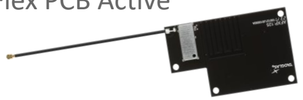
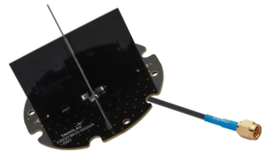
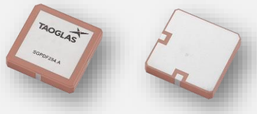
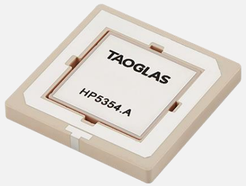
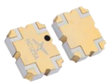
COLOSSEUM Combo up to 5-in-1

RAPTOR III Combo up to 7-in-1

TAOGLAS®

20+ Years Trusted Quality and Innovation

High Precision **Embedded GNSS** Antenna & Components Portfolio – Featured Products

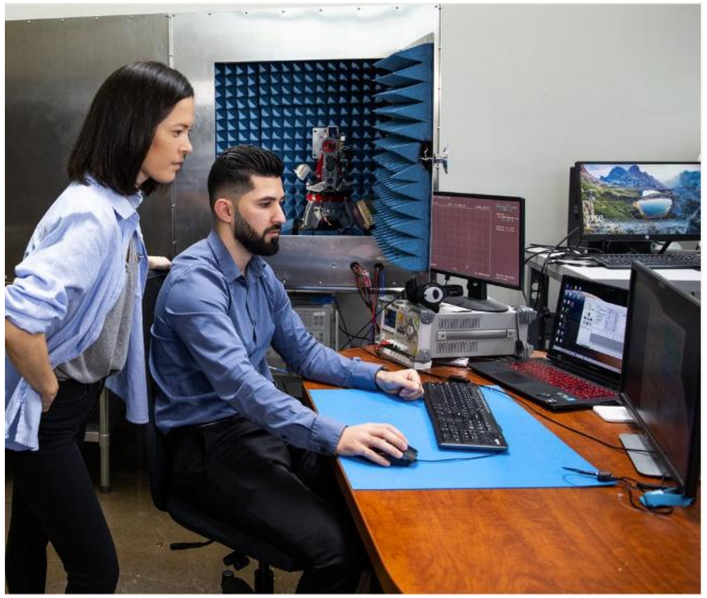
GPS Bands	L1	L1 + L2	L1 + L5	L1 + L2 + L5	L1 + L2 + L5 + L-band
Embedded Antennas - Active	**ASGPDF254** Dual Feed SMD Active Patch 	**AGPSF.36C** GPS L1/L2 Low Profile Stacked Patch 	**AGVLB.25B** Stacked Patch  **AFXP125** Flex PCB Active  **AGGBLA.125** Active SMD 	**EAHP.50 –** L1/L2/L5/L6 Cross Dipole  **ADFGP.50A** – L1/L2/L5 Dual-feed Stacked Patch 	**AHP24510** L1/L2/L-Band  **ALPDF254** L-Band Patch  **ADFGP.60A** – L1/L2/L5/L-band Patch 
Embedded Antennas – Passive	**SGPDF254** Dual Feed SMD Patch 	**HP2258.A** Stacked Patch 	**HP5354.A** Patch-in-a-patch 		**HP24510A** Dual-feed L1/L2/ L-band Stacked Patch  **HP54510A** Dual-feed L1/L5/ L-band Stacked Patch 
Active Circuitry – Front End Modules		**TFM.100A** FEM 	**TFM.100B** FEM 	**TFM.110A** FEM 	**TFM.120A** FEM 
Hybrid Couplers	**HC125A** – Low Profile 				

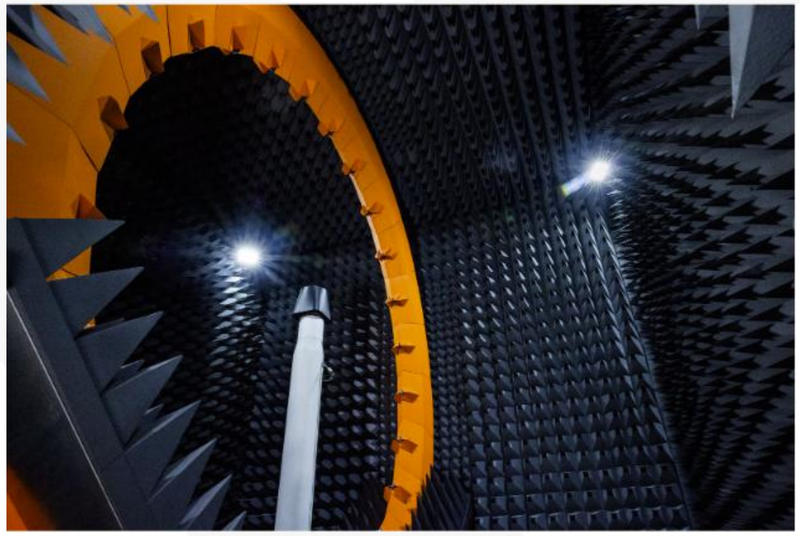
What's your biggest challenge and how can we help?

Cutting-edge Applications

Innovative Antenna Designs for:

- Military and Public Safety Vehicles (Rooftop, Window and Covert mount antenna options)
- Smart Battlefield (Tablets, Handheld Radios, Positioning)
- Wearables for ground troops and soldiers (Laser Direct Structuring – LDS)
- Aerospace / Satcom
- UAVs /Drones (Terrablast and Flex antenna options)





Aerospace **& Defense**

Reliable Connectivity When It Matters Most

CMMC LEVEL 2 READINESS

ITAR REGISTERED WITH THE DDTC

TAOGLAS®

Questions?

KEVIN H BLAKELEY

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Marine Corp Veteran

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DEL MAR TECHNICAL SEMINAR

Reliable Connectivity
When It Matters Most

Presented By:

KEVIN BLAKELEY
Head of Aerospace and Defense

CARLOS MONTOYA
Senior RF and Lead Engineer

NEXT EVENT

Del Mar Electronic & Manufacturing Show

Del Mar Fairgrounds, San Diego, CA

Free Parking | Free Attendance | Free Reception

APR 23

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10:30 TO 11:30 AM PST

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