TAOGLAS

Shift

Product Specification

Providing extended deep coverage in areas of low signal quality for Gateways & IoT Devices

AI Powered Beam Steering Antenna with integrated LTE Modem

TSA1 Series

TAOGLAS

Shift

Contents

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation."

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Ireland ISO 9001 : 2015 Certified

Taiwan ISO 9001 : 2015 Certified

TAOGLAS

Shift

www.taoglas.com

Provides reliable connectivity to your broadband network.

Plug & Play High-Performance Connectivity which Dynamically Adapts to the Environment

Keeps you online, even in basements & rural areas where signal is weak.

Connecting in places where your phone doesn't connect.

Introduction

The **Taoglas Shift** has been designed to provide reliable connectivity for broadband internet in areas of low signal quality.

Taoglas has developed a software-defined, LTE beam steering antenna system that is capable of dynamically adapting its antenna radiation patterns in real-time to extend coverage in areas of low signal quality. The Shift also increases the link quality compared to any standard passive antenna system on the market with can, in turn, lead to substantial throughput increases.

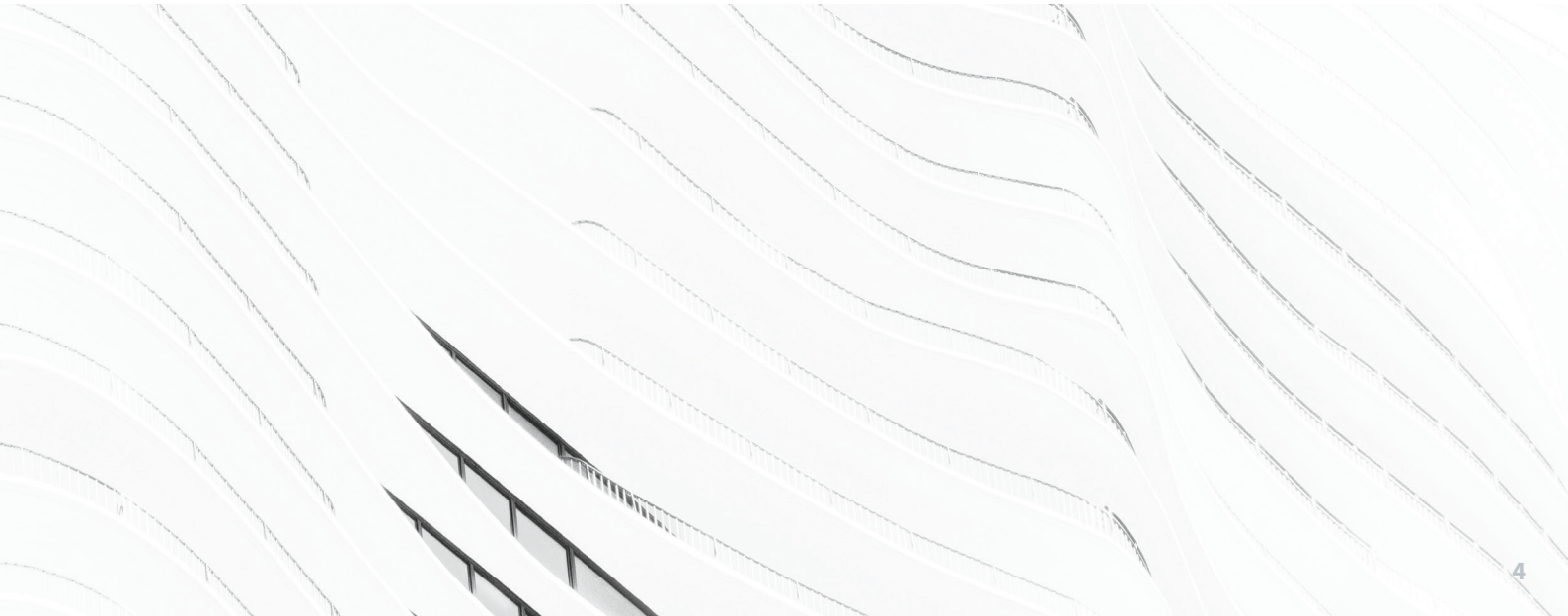
The Shift negates the need for expensive repeater solutions to provide internet broadband connectivity and switches its link to another cell tower if one of the base stations goes down. It provides extended coverage in underground car parks, rural areas and other areas that the cellular signals find hard to reach.

Current LTE modems use a pair of passive antennas to provide MIMO connectivity. The difficulty with passive antennas in mobile or fixed applications where the node location is unknown is that the passive antenna is required to operate in all directions, i.e. omnidirectional. Taoglas' Software-Defined Shift Antenna System uses an intelligent control driver to identify and dynamically select the optimal antenna configuration.

The additional technology layer to beam steering practice brings unprecedented antenna performance, with huge efficiency improvements delivering greater network coverage and dramatically increased data throughput rates within a simple 'Plug and Play' installation. The Shift is not a suitable solution for voice over LTE. Taoglas is developing several variations of products around this smart antenna system and is upgradable to sub 6GHz, 5G NR. and options for Wi-Fi Connectivity.

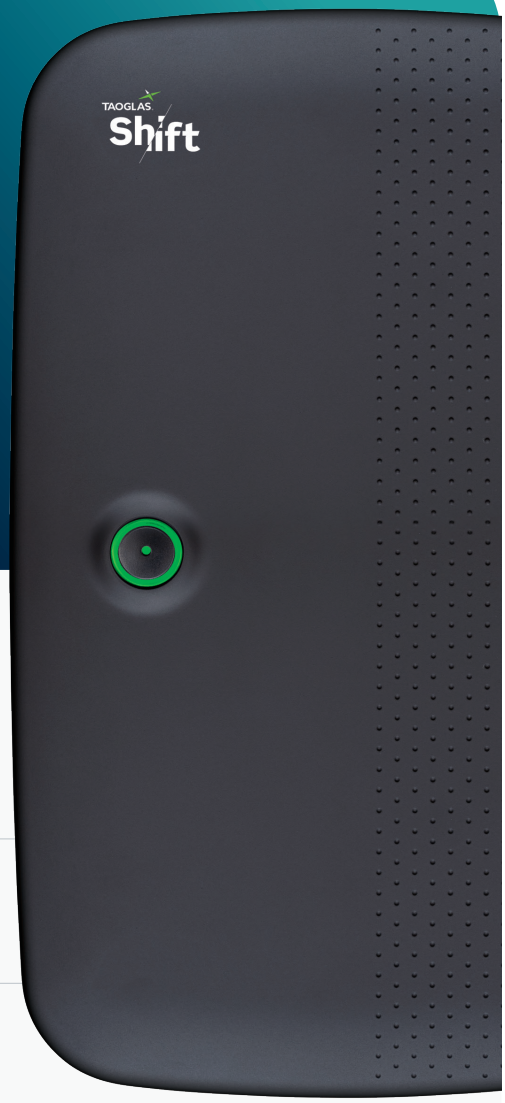
The ABS enclosure is compact at just 242 x 137 x 50mm and with an IP67 rated enclosure ensure it will stand up to most demanding of environments. Multiple mounting brackets are available, including permanent/ screw mount and other for wall or pole mounting options.

For more information, or to discuss customizing the Shift system for your application, contact your local Taoglas Customer Services Team.



Product Features

- Multi-band worldwide LTE coverage
- Combined LTE module & Smart Antenna System
- Plug & play, rapid installation
- Proprietary antenna technology
- AI powered, real-time beam adaptation
- Full-time connection monitoring
- Signal interference mitigation
- Improved data throughput



Product SKU's:

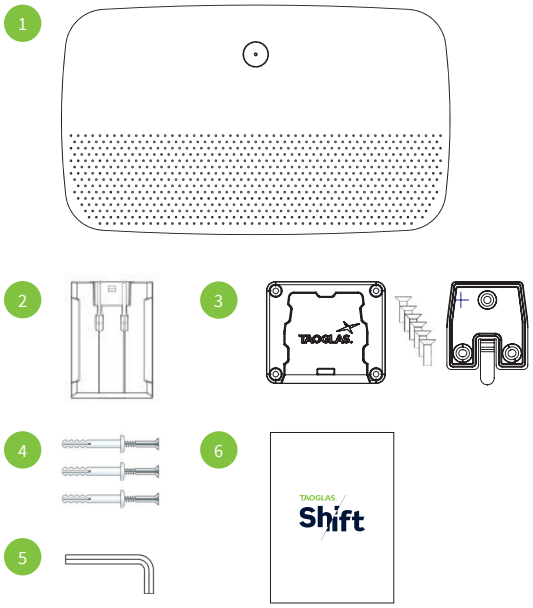
TSA1.A1 Shift 2*LTE MIMO Smart Antenna for US
Level 1 US Version with W7603 Sierra Wireless Modem

TSA1.E1 Shift 2*LTE MIMO Smart Antenn for Europe
Level 1 EU Version with W7607 Sierra Wireless Modem

Each version is available in internal / external mount and pole mount options.
Each variant above is also available in white.

What's in the Box?

1. Shift with Integrated Cables (Inc. Micro SIM seal)
2. Mains Power Adaptor (Region Specific)
3. 6 M3 screws for mounting bracket and Micro SIM cover
4. 3X Wall Screws & Rawl Plugs
5. Allen Key
6. Quick Start Guide



The Technology

The **Taoglas Shift** is a software-defined antenna (SDA) system that provides an antenna that is re-configurable to allow for dynamically optimizing the antenna to compensate for changes in the radio protocol, propagation channel, or other variations in the operating environment when cellular and Wi-Fi systems are used. Compared to the commonly used passive antenna, an SDA can provide a beam steering function which will put more gain directed at the other side of the communication link. Additionally, the directive radiation pattern generated for beam steering provides interference mitigation for interferers that fall outside the main beam of the antenna system.

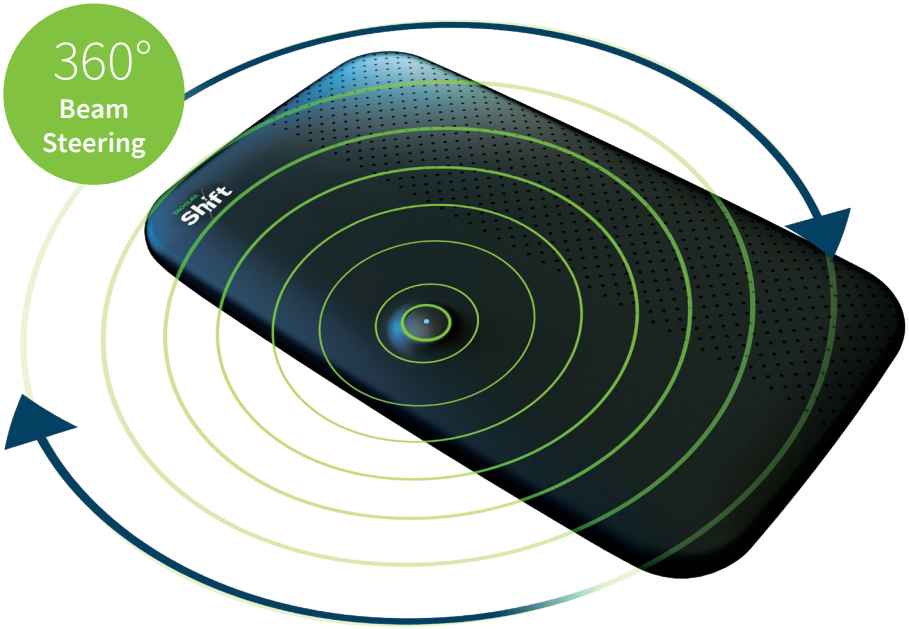
This improved gain at the intended node along with interference suppression allows us to optimize for both signal and interference which substantially improves SINR (Signal to Interference and Noise Ratio). We use the term “system” as we describe the SDA because this is indeed a system approach where an algorithm, radio system metrics, and tunable components all need to come together to implement this optimized technique.

Current LTE modems use a pair of passive antennas to provide MIMO connectivity. The difficulty with passive antennas in mobile or fixed applications where the node location is unknown is that the passive antenna is required to operate in all directions, i.e. omnidirectional. The Shifts potential for improvement is more than from -8dBi average gain. It can improve the average gain in a worst case scenario from a -20dBi null to a +3dBi. These parameters are of keen interest to the end user looking for a faster data download or improved reliability from the communication system.

With more nodes being implemented to accommodate more users, interference is also a concern, and a passive antenna is ill-equipped to provide improvement in this area.

The Technology

Taoglas Shift dynamically adjusts the radiation pattern to optimize the communication link between the user and base station. This dynamic optimization results in an increased antenna gain for each antenna in the MIMO pair which in turn translates into higher throughput – meaning faster downloads.



Availability in Black & White

Quickstart Guide

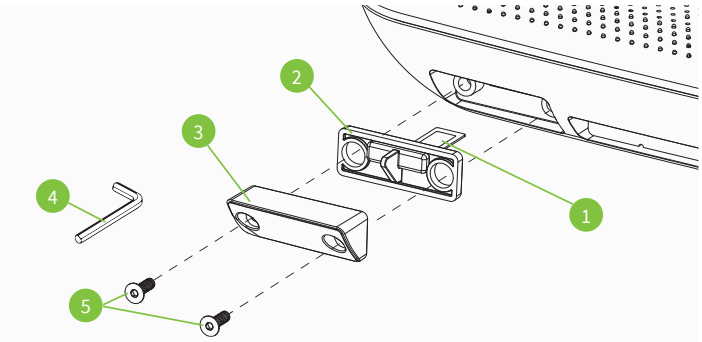
Micro SIM Installation

Insert the Micro SIM with the contacts facing upwards, as shown. The Micro SIM holder is spring loaded, so to remove, push the Micro SIM further into the holder and it will partially spring out.

Once the Micro SIM is in place, push the rubber seal into position, ensuing that it faces the correct way to match the Micro SIM access holder. Push the Micro SIM access holder into place and fix with the two M3 screws screwing tight with the allen key provided, until it sits flush with the enclosure.

Please note that when the Micro SIM is installed and the unit powered up, it may take up to 5 minutes to register the device on the network.

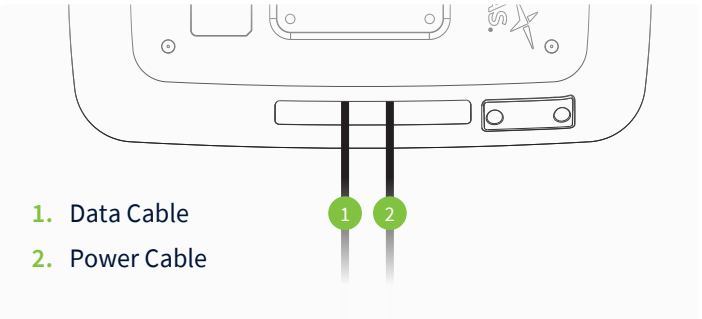
Assembly Note: In order to maintain the devices IP rating, it is essential that the Micro SIM cover is fitted correctly in place when using the device in locations where water ingress may occur.



1. Micro SIM Card
2. Rubber Seal
3. Micro SIM Access Holder
4. Allen Key
5. M3 Hex Head Screws

Connect Power & Data Cables

Connect the cable labelled “5V 2.4A” to the supplied power supply. Connect the other USB cable to your host computer. Avoid connecting the power cable to a host PC USB socket; these sockets are not guaranteed to provide sufficient power. Use the supplied power supply provided or a similar smartphone charger rated at 2.4A or higher.

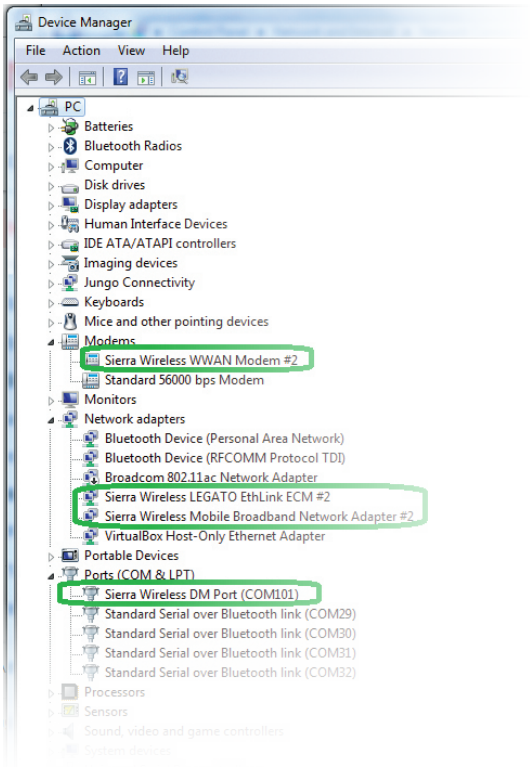


1. Data Cable
2. Power Cable

Download and Install Driver

Depending on your host PC operating system environment, you may be required to download and install the Sierra Wireless modem drivers. These can be found on the **Taoglas Shift Support Page** located at **www.taoglas.com/shift-support**

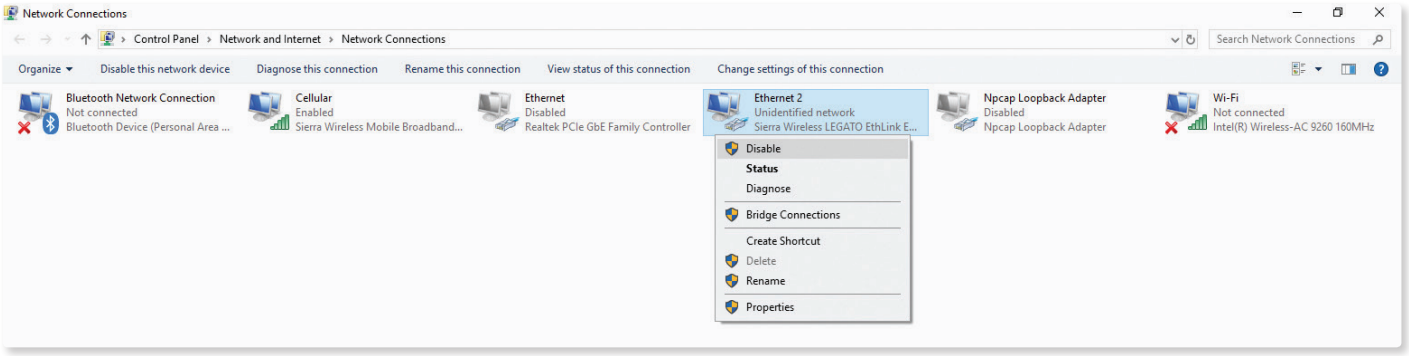
In Windows, after the drivers are installed you can check using Device Manager to ensure the driver has been successfully installed.



Quickstart Guide

Which Network on my PC?

First, connect to the ‘Cellular Network’ in Network Connections . Note that the internet browsing is possible when the virtual ethernet port is disabled, see graphic below, labelled, ‘Ethernet 9’ in this scenario.

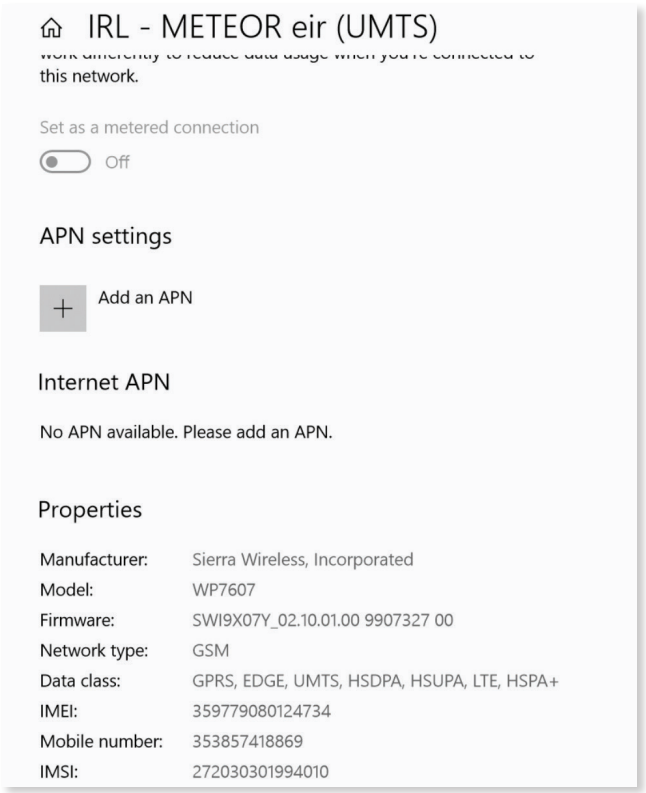


The first time a Micro SIM is installed, it may take up to 30 minutes (if you are in a very poor signal area) to register with the network. Following the first connection, subsequent connections will be very quick. It is possible that initial setup will fail because you are required to enter an APN associated with the Micro SIM card provided by your carrier. In this case, they should provide the name of the APN. To enter the APN details, you first have to power the device up. Once the modem has been detected, click on the network icon in the lower right of the screen, then right-click over “Mobile”, and select “Settings”. In the dialogue that is shown, click on “Advanced Settings”.

Click on “+ Add an APN”

In the dialogue that appears, enter the APN settings supplied by your carrier. Now reboot your modem, and again allow up to 30 minutes for the first connection.

If you continue to have connection problems, contact your carrier to ensure you have the correct connection settings.



Quickstart Guide

LED Indicators

The Shift device contains four LED indicators. The centre LED should remain on while the unit is powered. Four LEDs in the ring surrounding the centre LED illuminate to indicate when the antenna is searching for the best direction to steer the antenna to. This pattern will change whenever the Shift device detects poor signal reception. Pattern changes as Shift optimises the signal reception.

Powered Off

Searching / Switching Modes

Current Beam Direction

Use Cases: Deep Connectivity

Underground Car Park

The Challenges

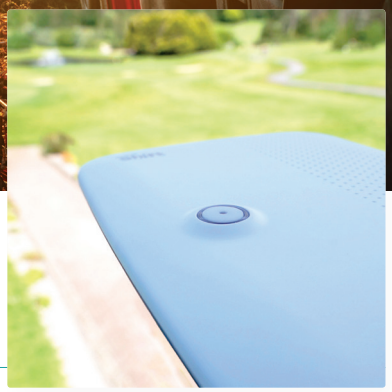
IoT networks can be anywhere in the world, from remote environments to dense urban neighbourhoods. Devices required to perform in weak signal environments, such as deep indoor utility metering or underground car park payment terminals, have difficulty finding and maintaining a connection with the cellular network whilst using a router with passive antenna technology.

The need for connectivity, coverage, high data rates, unobtrusive installation, and reliability requires a product that is critical for implementing robust and secure access to multiple devices in real-time and this is where the power of the Taoglas Shift becomes evident.

The Shift Advantage

The **Taoglas Shift** has been tested and proven to extend the range of the LTE network in subterranean environments and in the middle of buildings (away from outer walls and windows) where signals can be weak, providing coverage where often typical antenna systems simply cannot work.

The Shift multi-band beam-steered antenna system is capable of dynamically adapting the antenna radiation pattern in real-time to improve the link quality, to in turn provide coverage. Results vary from location to location but the benefit here is also the throughput is significantly increased.



Use Cases: Edge of Cell

Rural Remote Monitoring

The Challenges

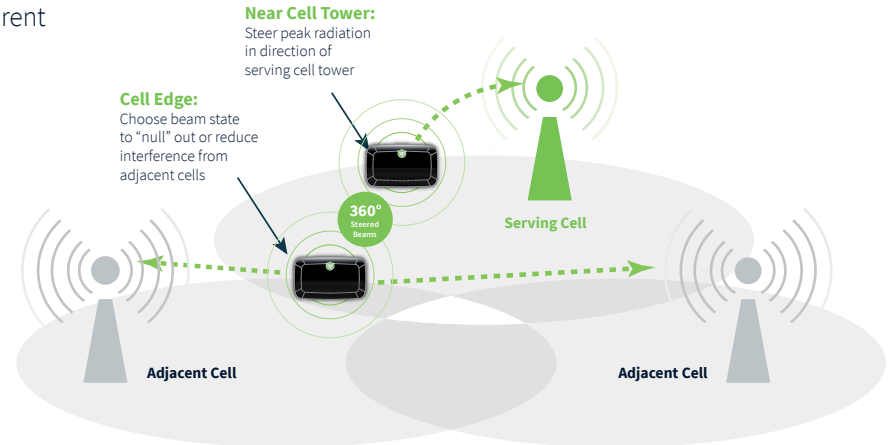
Similar to the challenges seen in subterranean environments where signal quality is poor, rural areas on the edge of cellular networks also suffer from connection problems. Many smart agricultural IoT systems require around the clock monitoring, for example, irrigation systems, and with the help of sensors and the right device to ensure connectivity farmers can monitor the field conditions from any location. Other common remote applications include connected cameras on construction sites, where to monitor high-value plant and machinery, a robust cellular connection is required.

The Shift Advantage

The Taoglas Shift has shown fantastic results when tested at the edge of cellular networks, working reliably where other devices cannot. The Shifts multi-band beam-steered antenna system dynamically adapts the antenna radiation pattern in real-time to improve the link quality, to in turn provide coverage. The Shift is designed with a robust ABS IP69K rated enclosure that can stand up to the most demanding of environments making it ideal to be installed and left to work with little or no maintenance in remote locations. Multiple mounting brackets are available, including permanent / screw mount and other for wall or pole mounting options.

Dynamic Optimization for Different Parts of the Cell

Dynamic optimization of the antenna beam allows for improved performance that can be adjusted for different regions in the cellular network



Technical Specifications

Bands & Frequencies	
Supported Operation Bands TSA1 Series:	LTE700 (698-803 MHz): **Bands 12, 13, 14, 17** GSM850 (824-894 MHz): **Bands 5, 20** | GSM900 (880-960 MHz): **Band 8** | DCS (1710-1880 MHz): **Band 3** | PCS (1850-1990 MHz): **Band 2** | UMTS1 (1920-2170 MHz): **Band 1** | LTE2600 (2490-2690 MHz): **Band 7** | +4G 2300 + LTE3500MHz: **Bands 30, 22, 48, 49, 43**
Supported Frequency Bands	**North America Version - TSA1.A1** LTE Bands: 2, 4, 5, 12 | UMTS Bands: 2, 4, 5
Supported Frequency Bands	**EMEA Version - TSA.E1** LTE Bands: 1, 3, 7, 8, 20, 28 | UMTS Bands: 1, 8 | GSM/GPRS/EDGE Bands: 900, 1800
ECC	<0.25
Polarization	Vertical
Impedance	50 Ohms

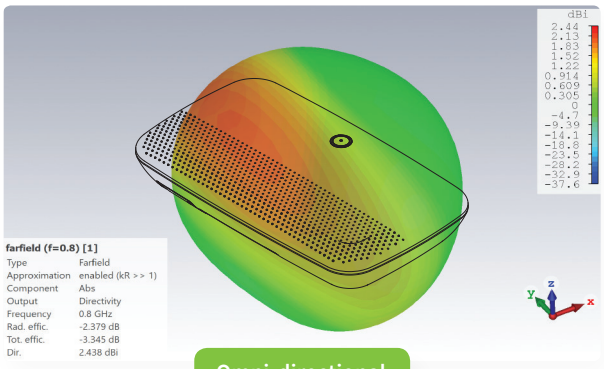
Characteristic	Value
System Dimensions:	243 x 141 x 45mm
System Weight:	T.B.D.
Omnidirectional Mode:	Yes
Number of directional beams:	4 per antenna; the antennas are independently controlled
Input Voltage Range	4.5 - 5.5V
Input Current Draw	TSA1: < 500mA : Up to 2.4A
Interface	TSA1: USB2.0 Full Speed up to 480Mbps | CAN, GPIO
Indicators	Beam Direction Indicators (Green, LED - Can be disabled) Status Indicator (RGB LED - Can be disabled after power-up
Micro SIMs	Choice of 3FF (removable)
Standard Cable Type	TSA1 Series: Multi-conductor, 24~26AWG USB2.0, 1m
Mounting Type	Multiple mounting brackets available, including indoor and exterior wall-mount and pole-mount

Environmental	
Operating Ambient Temperature Range	-40°C ~ +60°C
Storage Temperature	-40°C ~ +60°C
Humidity	95% RH
Ingress Protection	IP69K
UV	ASTM G154
Salt Spray	IEC 60068-2
Shock, Vibration, Drop	ISO 16750-3
ESD	IEC 61000-4-2, 8kV contact / 15kV air

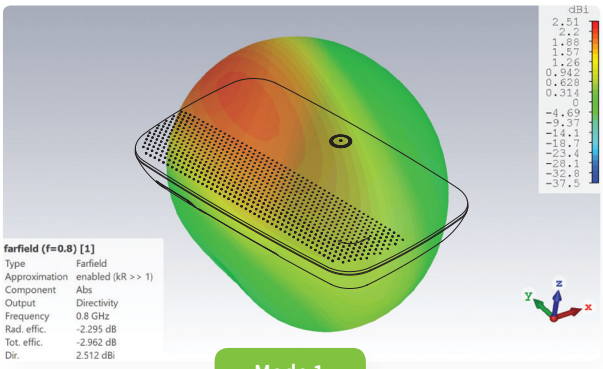
Compliance	
Regulatory	FCC, CE
RoHS & REACH Compliant	Yes

Technical Specifications

3D Radiation Plots – 800MHz



Omni-directional



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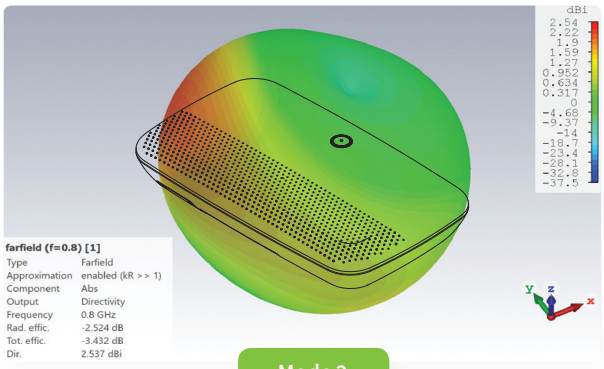

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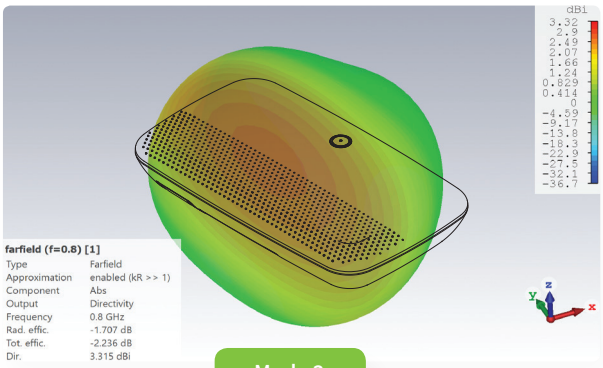

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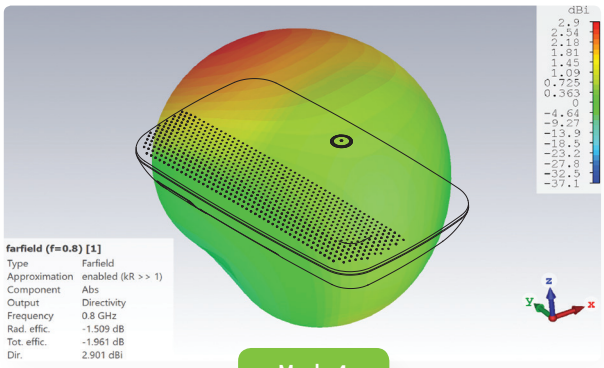
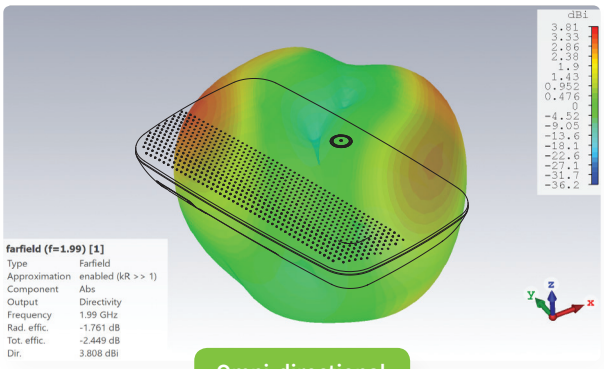


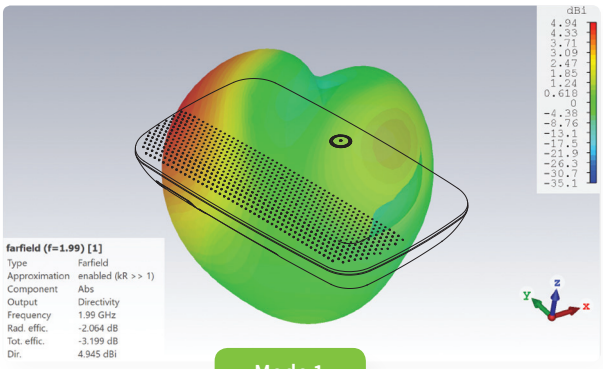
Mode 4

Technical Specifications

3D Radiation Plots – 1990MHz



Omni-directional



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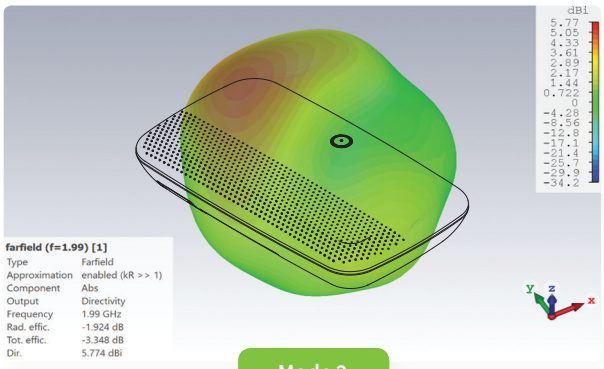

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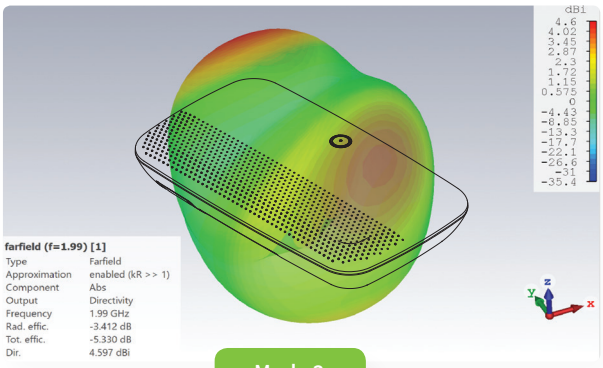

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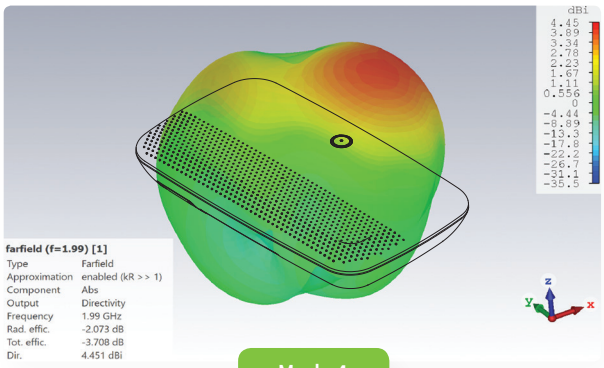
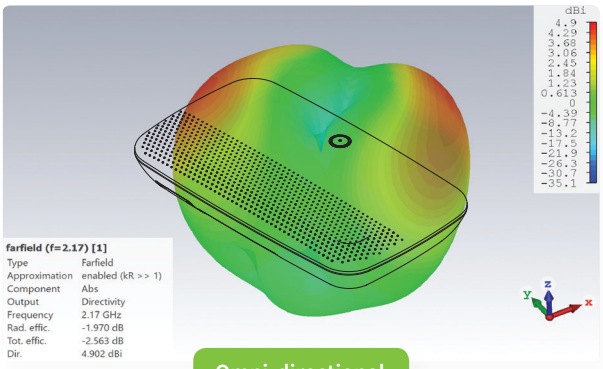


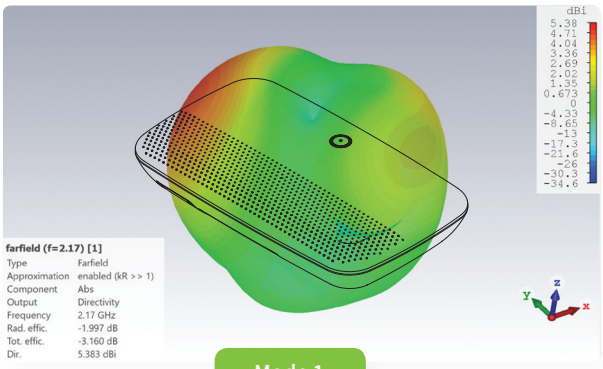
Mode 4

Technical Specifications

3D Radiation Plots – 2170MHz



Omni-directional



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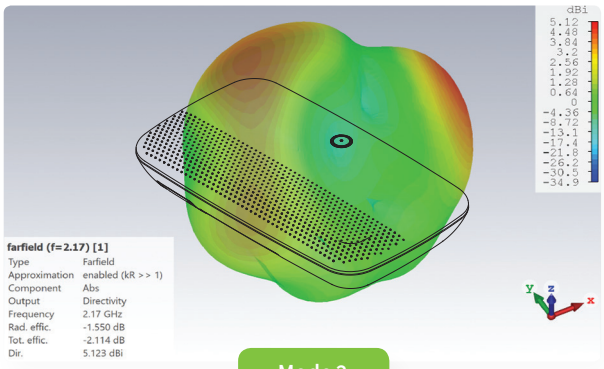

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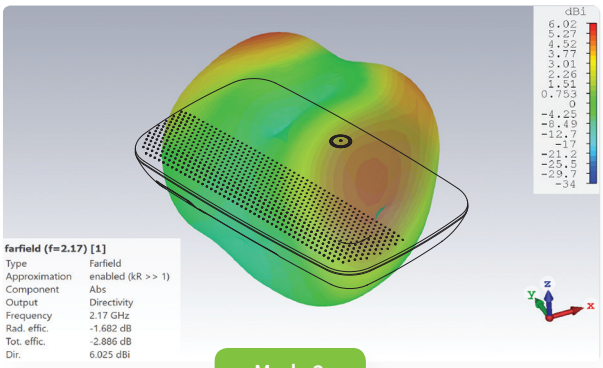

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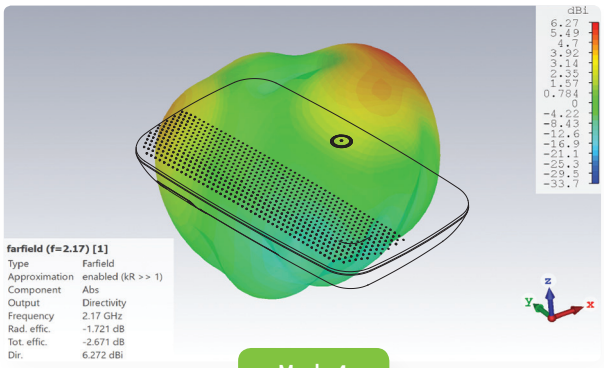
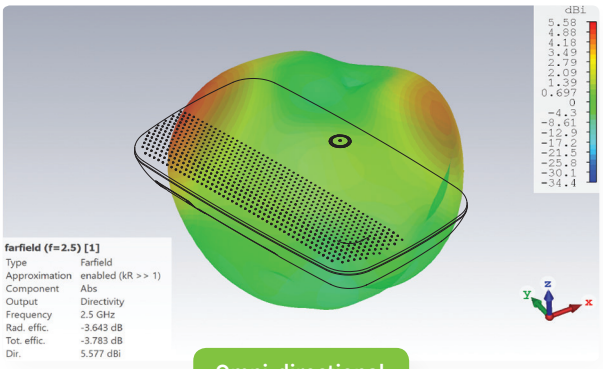


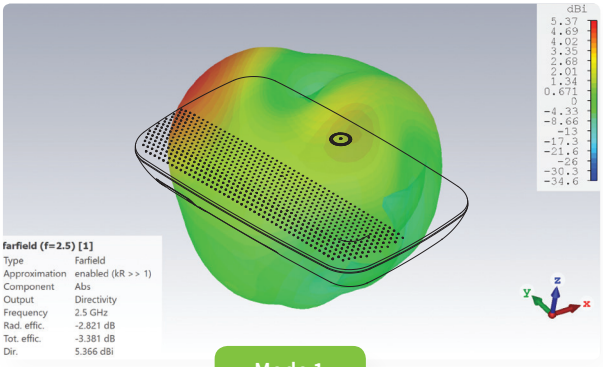
Mode 4

Technical Specifications

3D Radiation Plots – 2500MHz



Omni-directional



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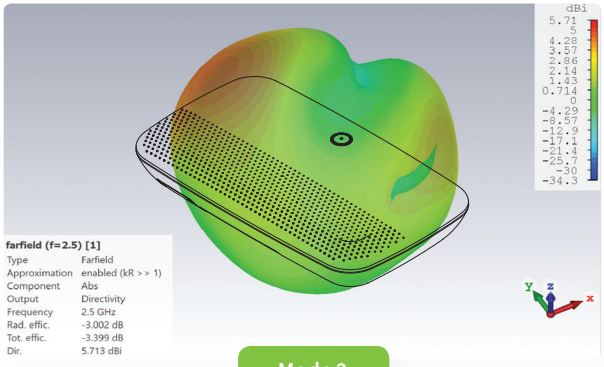

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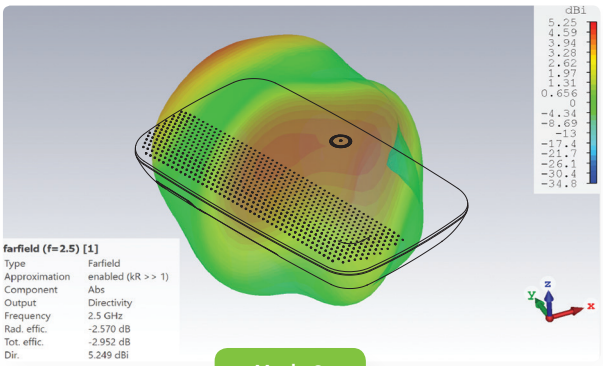

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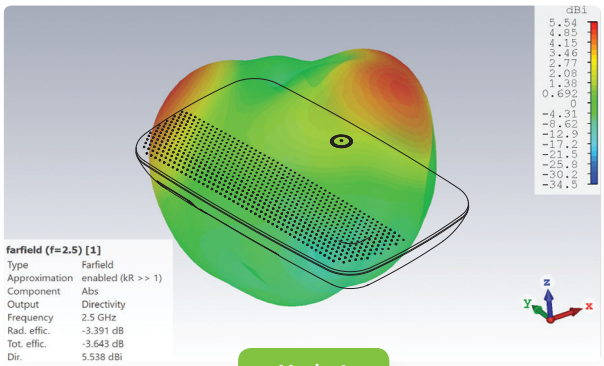
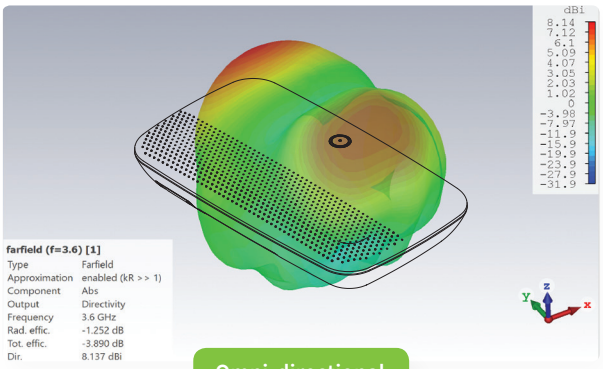


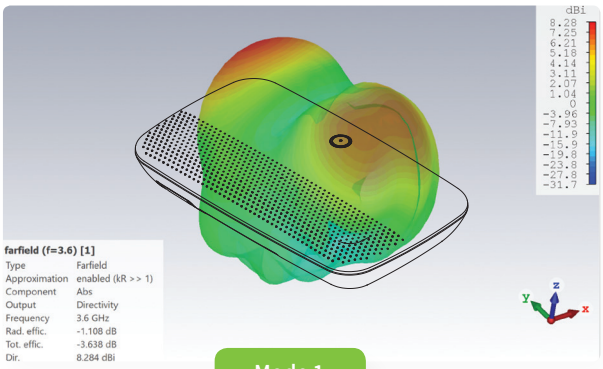
Mode 4

Technical Specifications

3D Radiation Plots – 3600MHz



Omni-directional



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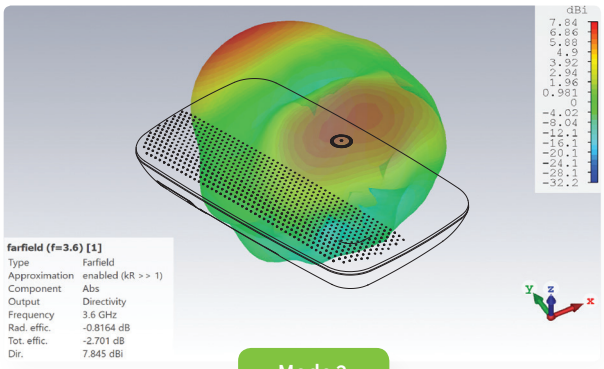

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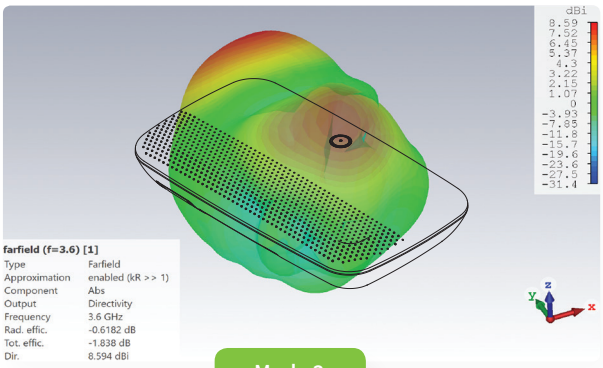
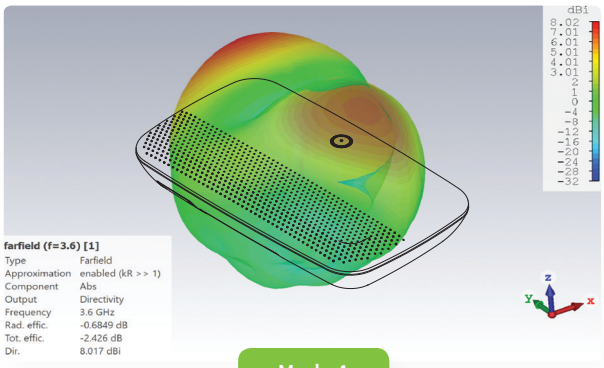


Mode 3



Mode 4

Mounting Options

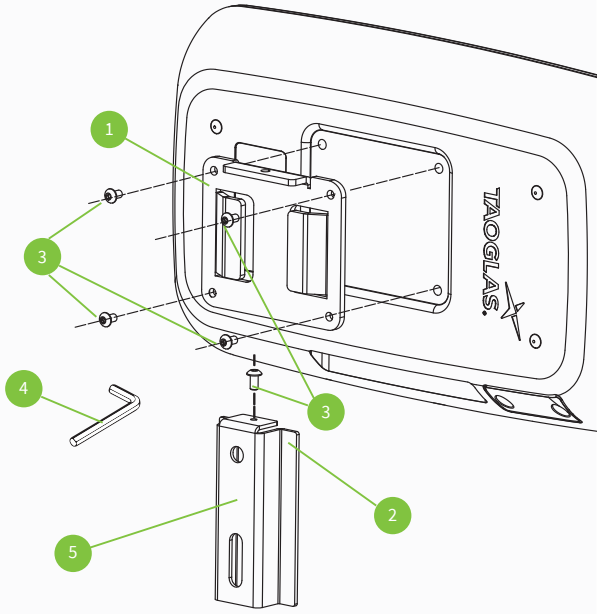
External Wall Mount

Supplied:

1x Shift TSA1 Unit, 1x Rear Mounting Plate,
1x Wall Mount, 5x M3 Hex Head Screws, 1x Allen Key,
2x Rawl Plugs, 2x Wall Screws.

Instructions

1. Attach the metal mounting bracket to the back of the Shift device using the 4 screws provided.
2. Using a level, place the wall bracket on a flat even wall surface and make a mark on the wall where the two holes need to be drilled into the wall.
3. Drill holes and insert the two rawl plugs into holes. Screw the Wall Mount firmly into place with the three screws included, ensuring that it is level.
4. Slide the Shift with the mounting plate attached down over the wall mount bracket until it sits in the locked position. Secure firmly in place using the last M3 screw.



1. Mounting Bracket
2. Wall Bracket
3. M3 Hex Head Screws
4. Allen Key
5. Surface to mount flush with wall

Indoor Wall Mount

Supplied:

1x Shift TSA1 Unit, 1x Rear Mounting Plate, 1x Wall Mount, 4x Bracket Screws, 3x Rawl Plugs, 3x Wall Screws.

Instructions

1. Attach the plastic mounting plate to the back of the Shift device using the 4 screws provided.
2. Using a level, place the wall bracket on a flat even wall surface and make a mark on the wall where the three holes need to be drilled.
3. Drill holes and insert the three rawl plugs into holes. Screw the Wall Mount firmly into place with the three screws included, ensuring it is level.
4. Slide the Shift with the mounting plate attached down over the wall mount bracket until it clicks locked into position.

Mounting Options

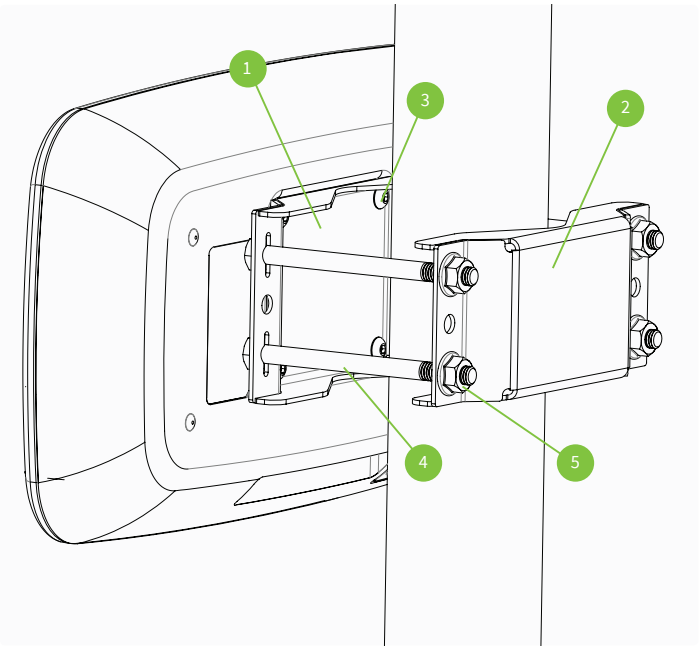
External Pole Mount

Supplied:

1x Shift TSA1 Unit, 1x Rear Mounting Plate, 1x Pole Mount, 4x M3 Hex Head Screws, 4x M6 60mm Bolts, 4x Washers, 4x M6 Flange Bolts.

Instructions

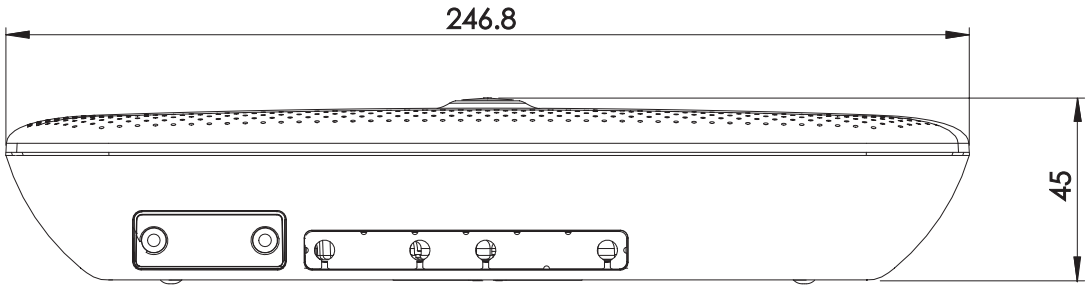
1. Place the four M6 60mm bolts through the rear mounting bracket before screwing the bracket itself tight to the Shift unit with the four M3 screws provided.
2. Place the Shift on the mounting pole and feed the 4 M6 60mm Bolts through the Pole Bracket.
3. Position the Shift as desired and tightly fasted the 4 M6 Flange nuts on the M6 Bolts.



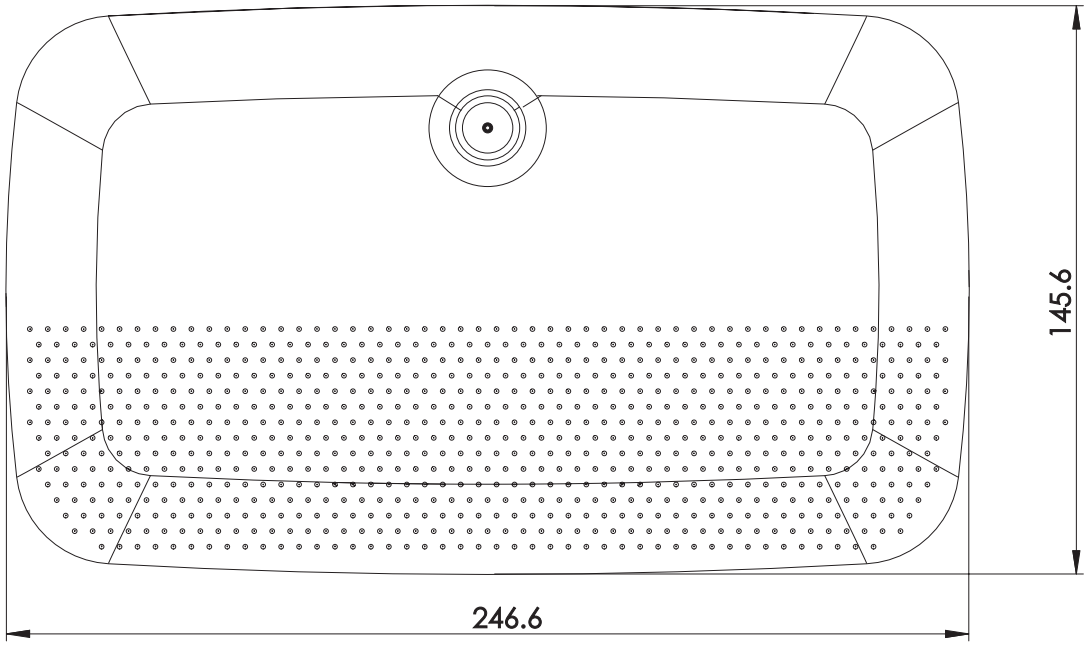
1. Mounting Bracket
2. Pole Bracket
3. M3 Hex Head Screws
4. M6 60mm Bolts
5. M6 Flange Nuts

Mechanical Drawing

Side View:



Top View:

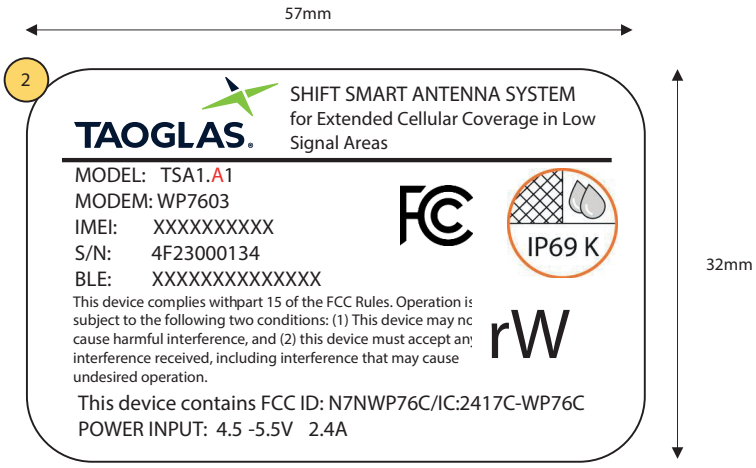


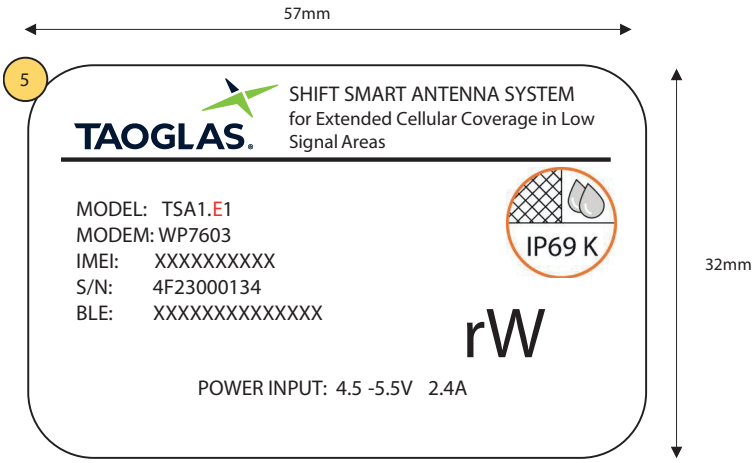
Packaging & Labelling Information

Shipping Packaging:

Total Weight: TBD

Devices Labelling:





FAQs & Troubleshooting

For troubleshooting tips, more support and up to date FAQ's,

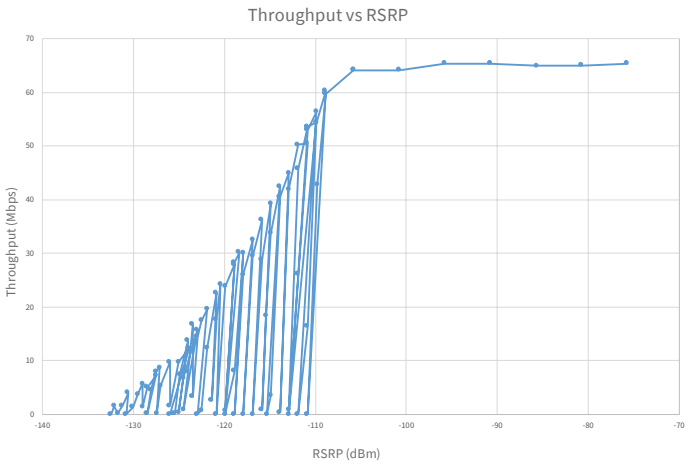
visit **www.taoglas.com/shift-support**

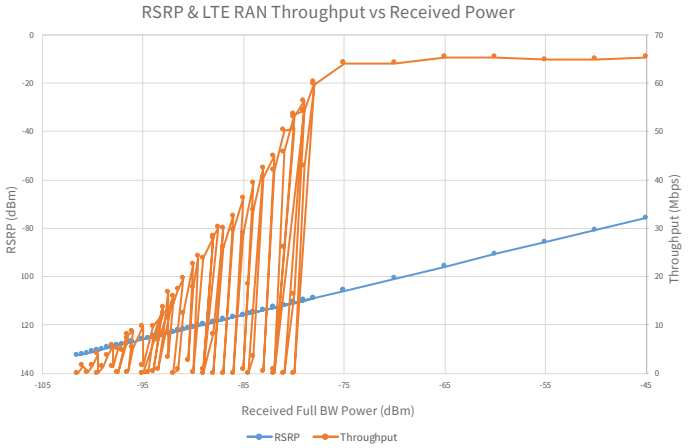
or contact your local Taoglas customer support team

Appendix

1. Shift Controlled Test to Map RSRP vs Throughput

The Shift Antenna System provides performance improvements in areas of poor signal strength where reported RSRP in a device is typically less than -100dBm. The 2 graphs below illustrate throughput improvements from a Sierra Wireless CAT 4 radio modem used in the Shift device when tested in a controlled environment where conducted power received in the module was lowered till there was a change in throughput. The 2 graphs below show that the Shift system begins to improve throughput when RSRP is below -100dBm.





2. Signal Strength Metric Definitions

2.1 RSSI- Received Signal Strength Indicator

The carrier RSSI measures the average total received power over the entire channel bandwidth of the UE for the available (N) Resource Blocks (RBs). RSSI includes power from the co-channel serving cell & neighboring cells, adjacent channel interference and thermal noise. RSSI is not reported to the eNode B but rather calculated to be used for the calculation of RSRP in LTE systems.

RSSI (dBm) = Serving Cell Power + Interference Power + Thermal Noise

2.2 RSRP- Reference Signal Receive Power

RSRP is the linear average of cell specific Reference Signal power (RS) measured over a specified bandwidth in number of Resource Elements. RSRP can also be described as the Average receive power of a single Resource Element (RE). There are 84 resource elements in a single Resource Block (RB) in LTE. This is the main parameter used by a UE for cell selection, reselection and handover, but it does not give us any information about signal quality. When RSRP is not enough, another parameter known as RSRQ has to be used to determine cell selection, reselection and handover. The reference point of the RSRP measurement is the connector/s of the UE.

RSRP (dBm) =RSSI – 10*log(12*N)

Where:

N is the number of Resource Blocks per channel
The definition of RSRP depends on the specified number of Resource Block (N)

Narrowband (N) = 62 sub carriers (6 RBs)
Wideband (N) = Full LTE bandwidth (up to 100 RBs/ 20 MHz)

2.3 RSRQ- Reference Signal Receive Quality

The RSRQ measurement provides additional information when RSRP is not sufficient to make a reliable handover or cell re-selection decision, it is given by the following

RSRQ = (N*RSRP)/ RSSI

RSRQ = 10log*(N) + RSRP (dBm) -RSSI (dBm)

The reference point of the RSRQ measurement is the connector/s of the UE.

NB: All the above quantities are measured over the same bandwidth and typically both RSRP and RSRQ are used for cell selection, re-selection and handover.

2.4 SNIR- Signal to Interference Plus Noise Ratio

As the name implies, SNIR is the ratio of the signal strength divided by the strength of any interference

SNIR = Signal Power / (Thermal Noise + Interference Power)

SNIR = Signal Power (dBm) – Thermal Noise (dBm) - Interference Power (dBm)

NB: All the above quantities are measured over the same bandwidth.

2.5 CQI – Channel Quality Indicator

The CQI is the reported quality of the received signal as perceived by the UE indicating how good or bad the communication channel is. Generally, SNIR is used to calculate CQI and allocate the correct Modulation Coding Scheme to the UE for a given Block Error Rate (BLER). CQI ranges from 0 to 15 going from worst to best.

Appendix (Cont'd)

3. Definitions and Abbreviations

User Equipment -(UE) is an end user communications device.

N-Number of Resource Blocks

Resource Element- (RE) is the smallest resource unit made up of one 15 kHz subcarrier x 1 symbol. Resource Elements aggregate into Resource Blocks.

Resource Block - A resource block (RB) is the smallest block of resources that can be allocated to a user. The RB consists of 12 consecutive subcarriers in the frequency domain and six or seven symbols in the time domain.

Reference Signal - Reference Signals (RS) carry cell specific information used for purposes such as cell identification (cell ID), channel quality measurements and initial cell acquisition.

4. Signal Strength Metric Chart

3GPP TS 36.133 V8.9.0 (2010-03) RSRP mapping describes the reported range for RSRP from -140dBm to -44dBm with 1dB resolution. RSRP levels of usable signal typically range from about -75dBm close to an LTE cell site to -120dBm at the edge of LTE coverage. The table below illustrates the signal strength metric chart.

		RSSI (dB)	SNIR (dB)	CQI	RSRQ (dB)	RSRP (dB)	Ec/No (dB)
	Technology	LTE and 3G	LTE Only	LTE Only	LTE Only	LTE Only	HSPA+ &EVDO
Signal Quality	Excellent	>-65	>12.5	12 to 15	>-5	>-80	>-2
	Good	-65 to -75	10 to 12.5	10 to 11	-6 to -10	-80 to -90	-2 to -5
	Fair (Mid Cell)	-75 to -85	7 to 10	7 to 9	-6 to -10	-90 to -100	-5 to -10
	Poor (Cell Edge)	<-85	<7	1 to 6	<-11	<-100	<-10

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For further details or to arrange a demonstration of **Taoglas Shift Antenna System** please contact your local Taoglas Sales Representative or visit us at: **www.taoglas.com**