Taoglas Boost Technology

SEPT 2018 / WP-18-8-06

Taoglas Boost Technology increases Antenna Performance for Compact Wireless IoT Devices

The patent pending Taoglas Boost is a new innovation in antenna technology that improves performance by 1.5dB to 2dB in critical lower band efficiency for embedded on board cellular antenna applications. This equates to efficiency boosts of 20%+. It can be used for any antenna to improve efficiency particularly in the 600-1000MHz regions.

Introduction

The common ISM bands 868MHz and 915MHz used in LPWAN applications such as LoRa and Sigfox will also see these improvements when utilizing Taoglas Boost technology. This phenomenon of performance loss at the lower bands is commonly experienced in IoT device designs when an internal antenna is coupled to a short host circuit board in compact and smaller devices such as telematics, tracking, medical and metering devices. Taoglas' new invention helps compensate for that loss by making the ground plane look electrically longer to the antenna, while not physically lengthening it.

The Problem

This reduction in antenna efficiency for internal antennas coupled to small circuit boards is a well-known effect. It occurs when single or multi-resonance antennas are coupled to ground planes formed by the ground layer of the host PCB of the device that the antenna is being integrated in. For frequencies in the 600 to 1000MHz range the efficiency of the internal antenna is reduced when the ground plane length that the antenna is driven against is less than 100mm. This decrease can be seen in figure 1, which shows a plot of measured antenna efficiency for the Taoglas PA.710 cellular antenna on an evaluation board as the ground plane length is reduced. As can be seen the antenna efficiency at the 700 to 960 MHz range is substantially reduced when we compared the "Ground 106mm" trace to the "Ground 80mm" and "Ground 60mm" traces.

It is important to note that this reduction in efficiency occurs for all antenna types coupled or driven against a small ground plane, i.e. circuit board. This lower efficiency results in poor reception and transmission for these compact devices at the lower bands in particular and can sometimes lead to certification failures at an operator and failed IOT solution rollouts, a typical example would be an OBDII device for an insurance backed driver safety program that doesn't get certification or that doesn't work reliably in the field, which can lead to large commercial losses for the IOT solution provider as it tries to redesign the product.

The Solution: Taoglas Boost

Taoglas Boost alters the electrical delay in the ground plane and hence improves efficiency. This is particularly effective at the lower frequencies typically used for cellular applications, 600 to 1000 MHz. The technology is implemented in the “keep-out” or footprint area of the antenna, the area on the host circuit board reserved for antenna placement. By grouping this modification in the antenna keep-out area there is minimal impact to the size and shape of the device design. Like any onboard antenna a tuning feature is also implemented between the antenna and the radio. The end-result is an antenna implementation with 1.5 to 2 dB of antenna efficiency improvement, resulting in corresponding system gain improvement (often measured as TRP and TIS). These gains not only improve performance but can also be key to meeting carrier and type approval over-theair (OTA) requirements for IoT devices.

We can get a better understanding of the improvement Taoglas Boost technology provides by studying the PA710a antenna board cut-down test results (shown in figure 1). This shows the total efficiency of the antenna as the ground plane is reduced in length, along with the efficiency we can achieve if we account for mismatch loss, i.e. we provide a perfect impedance match using loss-less components. Though real matching components have losses, this assumption of loss-less matching components allows us to set a theoretical upper limit to efficiency when attempting to impedance match.

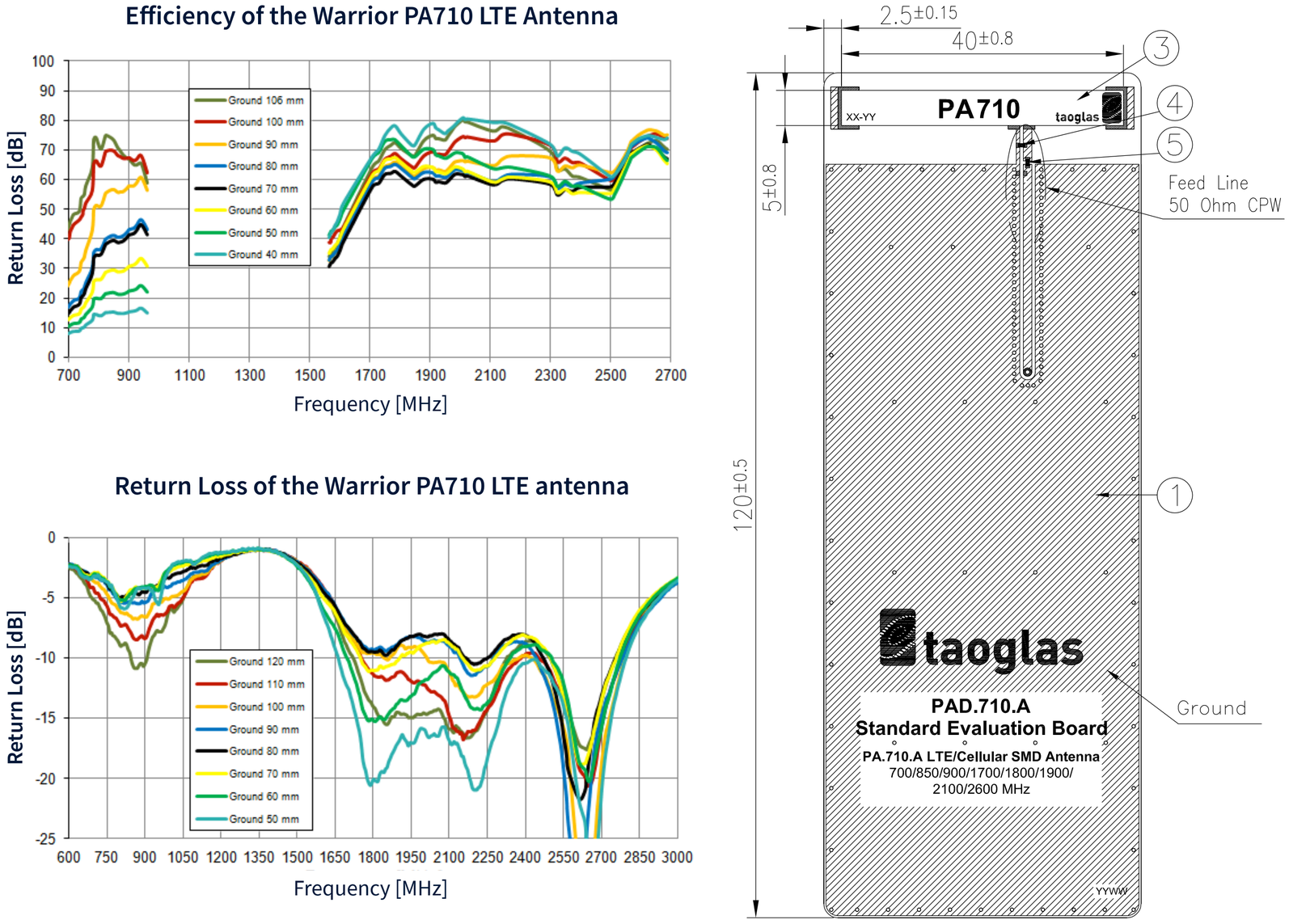

Fig 1. Cut-down test for PA.710, where the ground plane dimension is reduced and performance is tracked

Figure 2 shows a plot of total efficiency at 825MHz for various ground plane lengths. A plot of efficiency is also shown where mis-match loss has been accounted for. As can be seen for ground plane lengths below 90mm the efficiency that can be achieved when the antenna is matched (a good return loss) is decreasing with ground plane length. This indicates that the decreased efficiency is due to the length of the ground plane that the antenna is coupled to, and to recoup this efficiency we need to address the electrical length of the ground plane. The Taoglas Boost technology is designed to improve antenna efficiency in the regions highlighted by the red oval in the plot in figure 2.

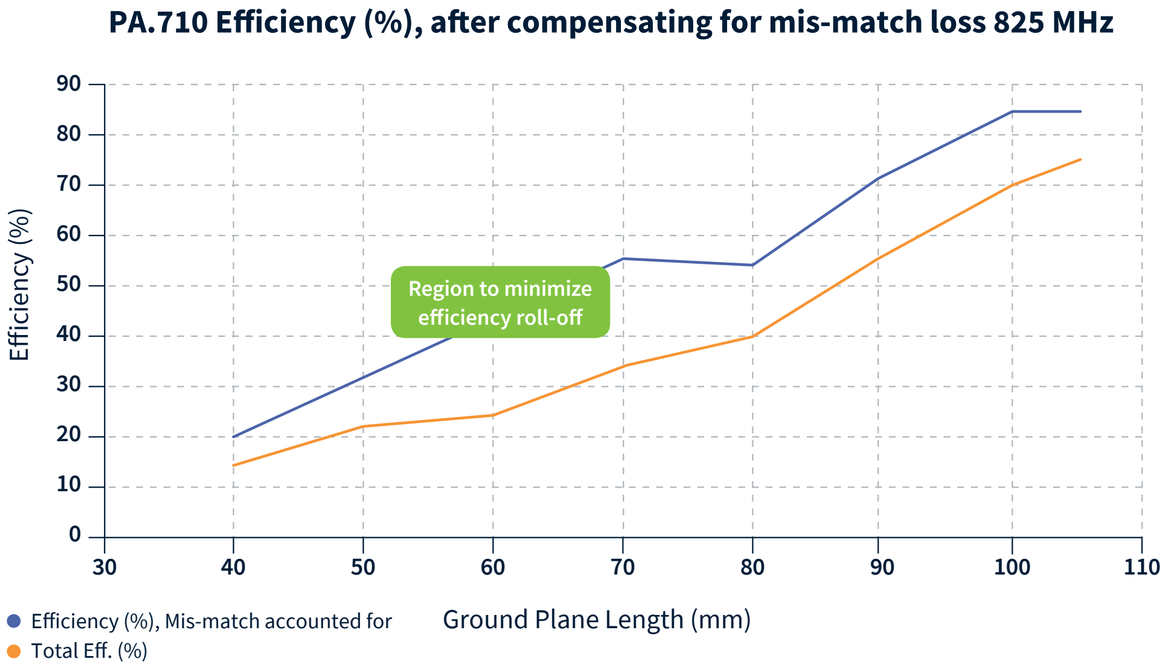

Fig 2. PA.710 Total efficiency and potential efficiency improvement when accounting for mis-match loss

To highlight the efficiency improvements that Taoglas Boost technology can provide a set of measurements were conducted to compare internal cellular antenna performance before and after implementing the technology.

Figure 3 shows a plot of measured data on the Taoglas PA.710 evaluation board where the ground plane region of the evaluation board has been reduced in length from 106.5mm to 85mm. The solid green trace is the efficiency of the PA.710 without implementing Taoglas Boost technology while the solid blue trace is the efficiency with Taoglas Boost implemented.

The green and blue dotted lines show antenna efficiency of the PA.710 on an 85mm ground plane after accounting for mis-match loss for the baseline case (without Taoglas Boost) and with the Taoglas Boost, respectively. What we see from a comparison of the dotted line traces is that at the 700 to 850 MHz range (Bands 12, 13, 17, and 5 for example) the Taoglas Boost technology can provide up to 1.3 dB of improved efficiency, which is shown at 750 MHz where the efficiency increases from 44% to 73% when Taoglas Boost is implemented.

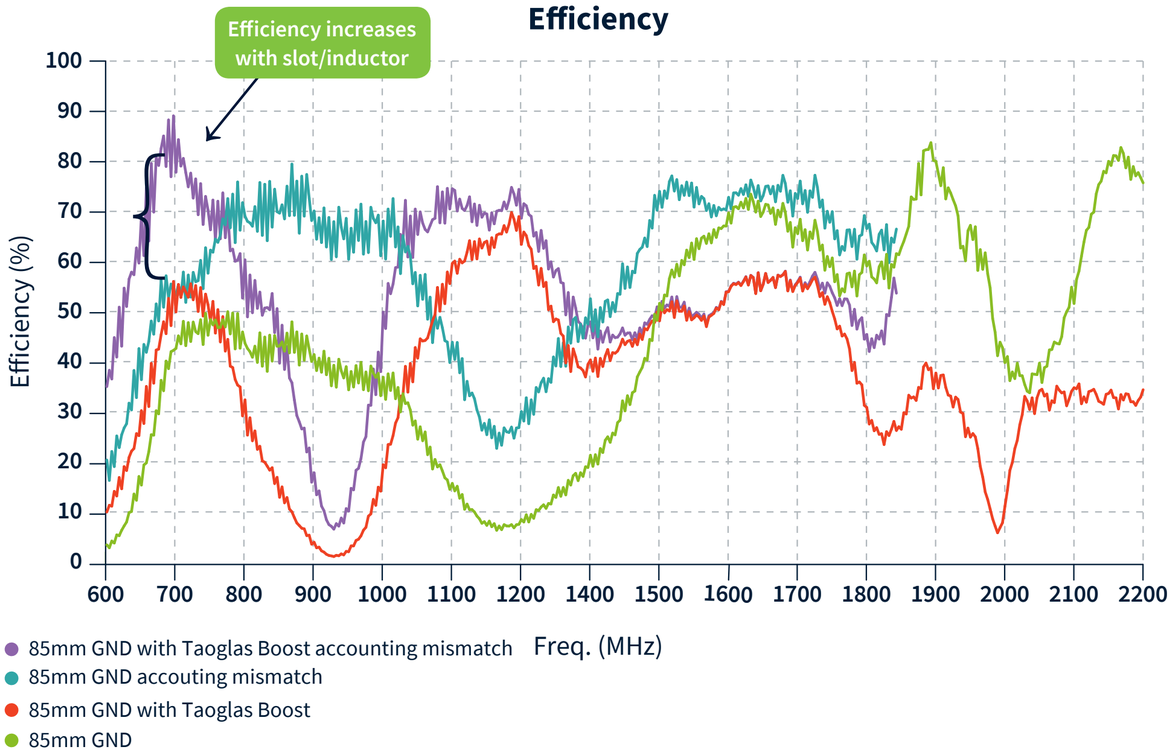

Fig 3. PA.710 with ground plane reduced from 106.5mm to 85mm

Figure 4 shows measured data for this same type of comparison as shown in figure 3 with the ground plane now reduced to 65mm. The efficiency improvement when implementing Taoglas Boost provides up to 1.6 dB of efficiency improvement, which is shown at 750 MHz where the efficiency increases from 40% to 54%.

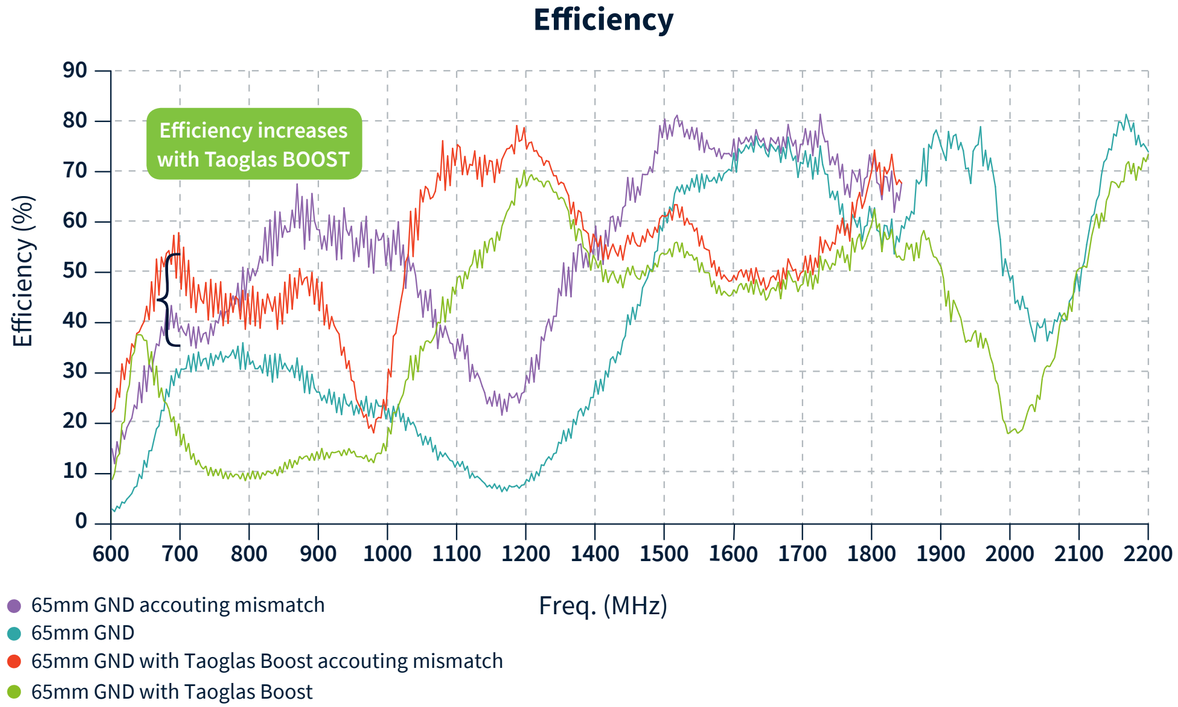

Fig 4. PA.710 with ground plane reduced from 106.5mm to 65mm

A more practical example is shown in figure 5, where the efficiency at Bands 17 and 13 can be improved by applying Taoglas Boost to the ground plane of the evaluation board of a PA.710 antenna. Without increasing the length of the ground plane, the efficiency at these lower LTE Bands can be improved.

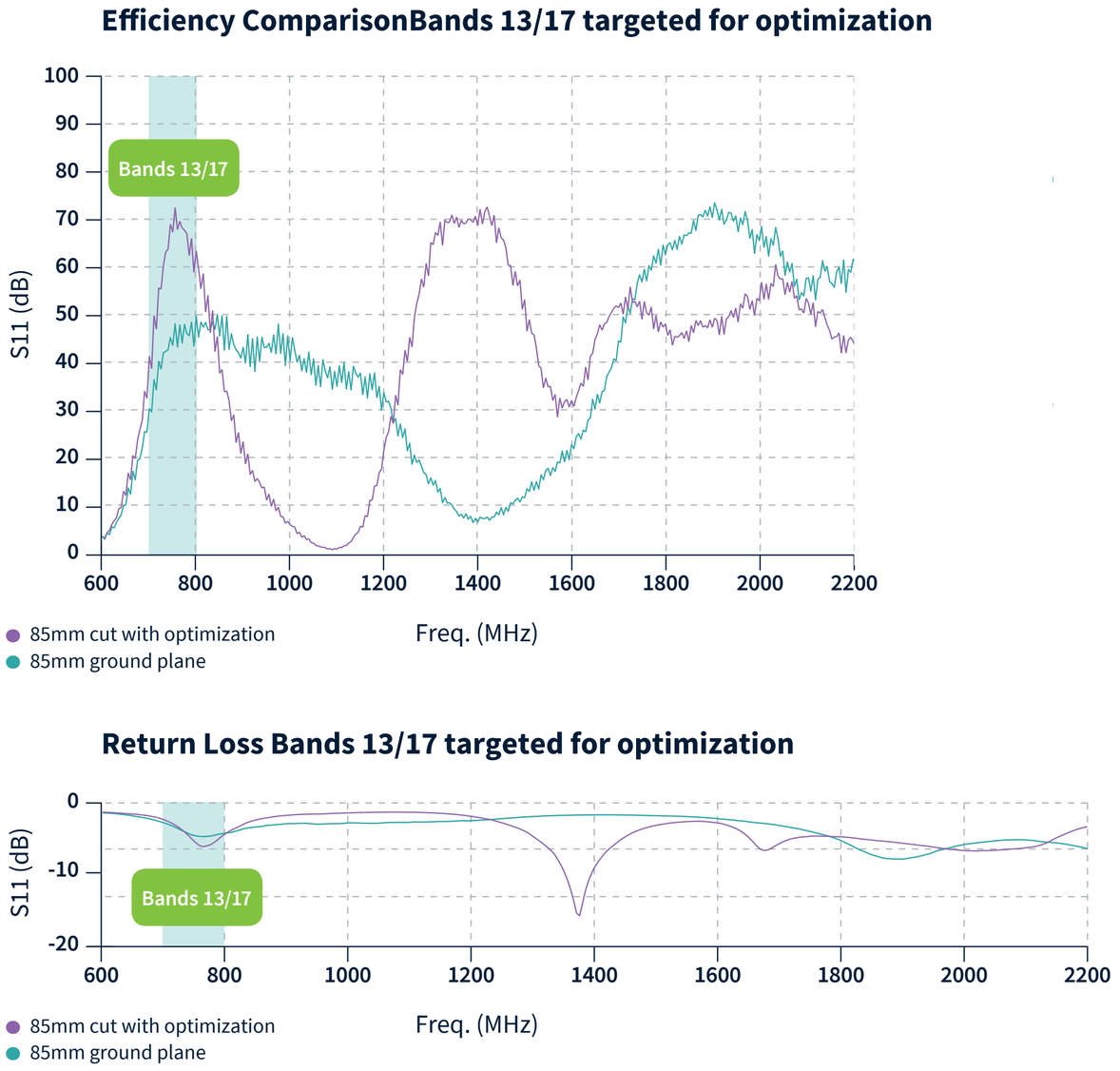

Fig 5. Efficiency and Return Loss with and without optimization applied to PA.710 evaluation board

Figure 6 shows the dimensions of the Taoglas PA.710 evaluation board when reduced to 85mm in length in the ground plane region, with the area where optimization is applied highlighted.

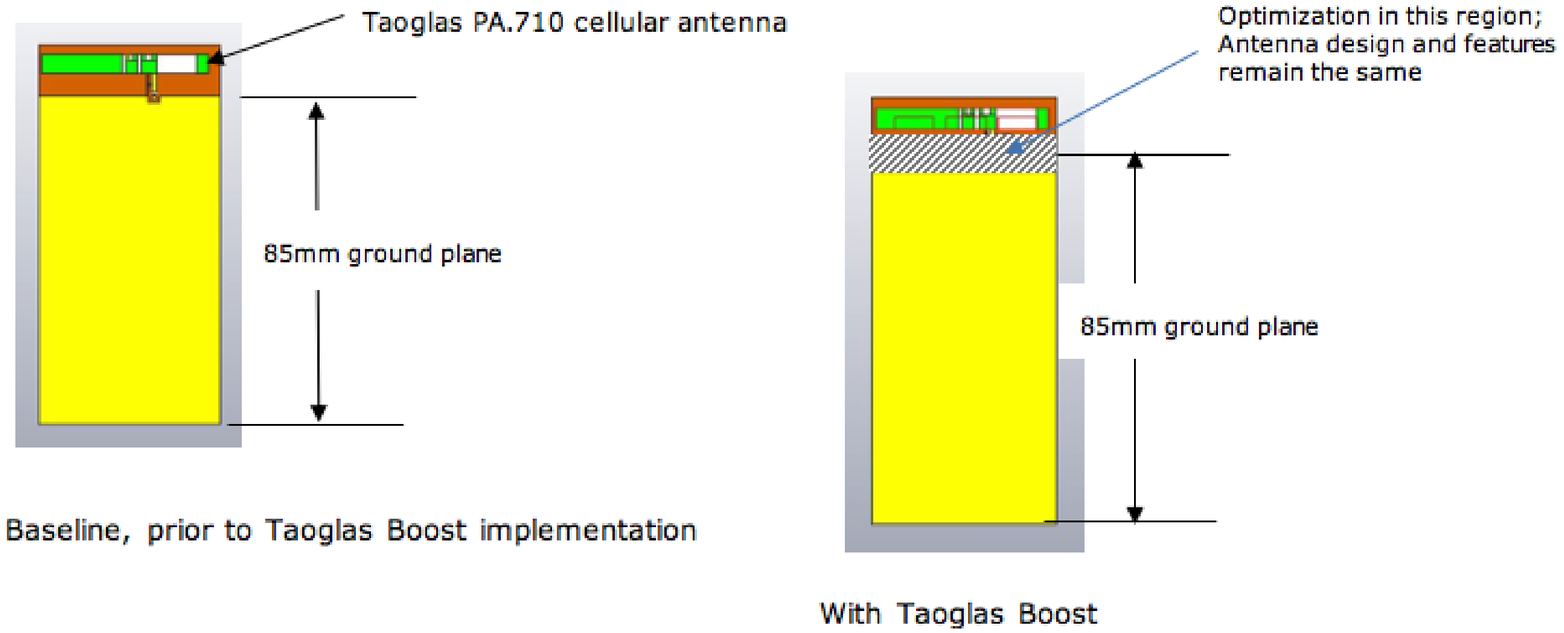

Fig 6. PA.710 antenna and evaluation board reduced in length to 85mm

First Commercial Application of Taoglas Boost

Taoglas Boost technology has been first implemented in the Taoglas onboard NB-IoT antenna offering, but is available to use from today on any onboard embedded antenna design using Taoglas antennas.

Due to the small size of these antennas and their device groundplanes, common for NB-IoT applications, Taoglas conducted exhaustive research and development in antenna design and integration techniques. Due to the narrower bandwidth and sharp roll off in radiation efficiency these applications in particular require a technology such as Taoglas Boost, not only to improve performance, but to achieve cellular network approvals for NB-IoT applications.

One method of improving efficiency roll-off with any onboard antenna is to increase the ground plane length, which results in improved efficiency across the entire frequency range. This technique, is often not feasible for current commercial and consumer devices in the M2M and IoT space.

Instead of increasing the ground plane length Taoglas Boost can be utilized, with the results on the first use case showing that Taoglas' NB-IoT antenna provided the same efficiency with a 115mm length ground plane without Toaglas Boost on the 137mm length ground plane. The benefit of Taoglas Boost technology is the ability to provide the same efficiency on a ground plane that is 22mm shorter in length.

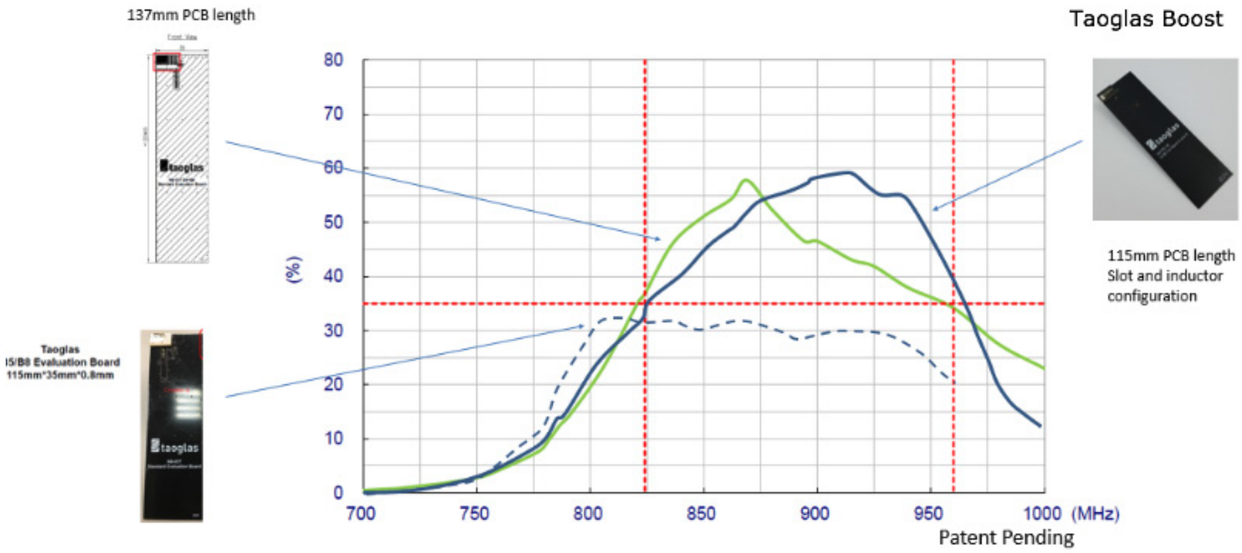

Fig 7. Comparison of efficiency performance for Taoglas Boost enabled ground plane and ground planes without Taoglas Boost modification

To summarize the features of Taoglas Boost

- Improved antenna efficiency on small ground planes
- Minimal modifications required to host device
- A tuning function to allow easy customization during integration
- Works with Taoglas internal cellular, NB-IoT, and ISM antennas
- No modifications needed to the antenna

Enniscorthy, Ireland (HQ)
Unit 5, Kilcannon Business Park, Old Dublin Road
Enniscorthy, Co. Wexford, Y21 XW56, Ireland
+353 53 9169500 | emeasales@taoglas.com

San Diego, USA
8525 Camino Santa Fe, Suite A & B,
San Diego, CA 92121, United States
+1 858 450 0888 | nasales@taoglas.com

Taoyuan, Taiwan
No.2-2 Ln. 66, ZhongShan 1st Rd.,
Bade City, Taoyuan City 33454, Taiwan (R.O.C.)
+886 3 3681223 | asiasales@taoglas.com

Shenzhen, China
Unit 509, Neptune Building, Lanxiang 1st Street,
Nanshan District, Shenzhen 518067, China
+86 755 86538292 | cnsales@taoglas.com

Dublin, Ireland
DCU Alpha, Innovation Campus,
Old Finglas Road, Glasnevin, Dublin 11, Ireland
emeasales@taoglas.com

Minneapolis, USA
15 S. 5th St. Suite 150,
Minneapolis, MN 55402, United States
+1 858 450 0888 | nasales@taoglas.com

Tainan, Taiwan
4F.-2, No.15, Guoji Road, Xinshi District,
Tainan City 744, Taiwan (R.O.C.)
+886 3 3681223 | asiasales@taoglas.com

Munich, Germany
Erika-Mann-Straße 25, Second Floor
80636 München, Germany
+49 89 3803 7426 | emeasales@taoglas.com

www.taoglas.com