

## **Long-Range Bluetooth: Going Beyond the Personal Area Network for Industrial Applications**

Since its debut in 1998, Bluetooth has matured into one of the world's most influential technologies as the standard for wireless communications in portable devices. Primarily concerned with establishing "Personal Area Networks" of nearby devices, Bluetooth is familiar to consumers and provides great performance, reliability, convenience, and device interoperability. Its widespread, global implementation has led to reduced costs for manufacturers. Additionally, with its groundbreaking innovations in power-efficiency and speed, Bluetooth is positioned to be the key technology for a wide range of applications and industries such as automotive, medical, industrial, and retail.

Bluetooth's low-power technology, which will continue to improve in coming years, will help Bluetooth's implementation in areas that it currently does not serve. This will culminate in what ABI Research predicts will surge from 3.5 billion Bluetooth-enabled devices shipped in 2012 to over 10 billion by 2018. And while low-energy, personal area networks are the primary application and growth area for Bluetooth technology, it is capable of producing reliable and robust connections well beyond the personal area network.

The concept of long range Bluetooth is not new; Laird's modules have been able to achieve long-range connections for some time. However, many of the same benefits associated with short-range connections are also available when using the technology in long-range applications. In this test, we took Bluetooth beyond the headset and stretched the limits of long-range Bluetooth, and the results are exceptional.

### **Test Setup**

The BT730 modules were specifically designed for long-range applications, but a Laird engineer wanted to quantify just how much range the module was capable of outside the lab environment. The test was conducted in Brean Sands North Somerset, UK. The weather conditions were nearly ideal: dry, warm, and sunny with a light breeze, which allowed up to 7 km line of sight – overall highly unusual for most British Summers!

Two Laird BT730 modules were used in the test, which include a complete Bluetooth v2.0 protocol stack with support for and numerous Bluetooth profiles including SPP, DUN, FTP, partial HSP, and HFP. In this test, the Serial Port Profile (SPP) was used and the BT730-SA variant of this module series, as it includes an integrated ceramic antenna.

Module A, the static module, was mounted on a Laird DVK-BT730-SA development board and attached to a tripod. It was positioned approximately 2.3 meters above the ground and powered via USB from a laptop. The laptop was connected to the module's UART via a RS232 cable attachment on the development board. It was set to 4800 baud to match the GPS output of Module B.

Module B, the mobile module, was mounted on a Laird DVK-BT730-SA development board and placed in the top pocket of a rucksack facing back towards the static module. It was positioned approximately 1.6

meters above the ground. The top antenna surfaces were roughly facing each other during the test and powered by a USB battery pack via the development board USB connector. Module B was set to 4800 baud to match GPS NMEA settings.

A Garmin Geko 201 GPS was set to output GPS NMEA data and connected to the Module B via the DVK-BT730-SA board's RS232 connector. The GPS used space based augmentation (SBAS) to provide differential correction data; the reported accuracy was between three and seven meters during the test.

The modules used no more than the maximum of 18dBm transmit power for the duration of the test.



**Figure 1 and 2: Module A (static) on left and Module B (mobile) on right**

### **Test Procedure**

First, a Bluetooth wireless connection was established between the two Bluetooth modules. In order to establish a Bluetooth connection between the modules, the engineer programmed Module A as a Bluetooth 'Master' device and Module B as a Bluetooth 'Slave' device. This effectively means that the 'Master' device is programmed to implement a focused Bluetooth discovery and then subsequent connection to a nominated 'Slave' device – in this case Module B. The 'Slave' configuration is minimal and simply sets the module to be connectable and discoverable to other Bluetooth devices and to wait to be connected to. The configurations for each device are outlined below and are based on using the simple AT style command interface embedded into the virtual machine in each BT730 module. The AT commands are downloaded into the modules via the RS232 port on each DVK-BT730-SA utilizing any terminal emulator program.

#### **Module A – Bluetooth 'Master' – AT Configuration**

ATS512=1	Idle Mode
ATS507=1	Allows DSR input to be used to inhibit autoconnect cycle
ATS530=2000	Wait period in milliseconds

AT&W	between connection attempts Store settings to non-volatile memory
ATZ	Reboot module
AT+BTR<MAC address of Slave>	Autoconnect to Slave module

#### Module B – Bluetooth ‘Slave’ – AT Configuration

ATS512=4	Make connectable and discoverable
ATS0=-1	Auto answer and suppress connection messages
AT&W	Store settings to non-volatile memory
ATZ	Reboot module

As NMEA data was received by the static module from the GPS via the mobile module, the data was captured to a log (.txt) file using Tera Term (an open-source, free, software implemented, terminal emulator program). The mobile module was walked away from the static module until NMEA data was no longer received by the static module. The log file (with raw NMEA sentences) was saved and converted into a KML file using the following website: <http://www.gpsvisualizer.com/>. The KML file was loaded into Google Earth for evaluation.

#### Test Results

The following results emerged from the range test:

- The KML file showed that NMEA data sent from the mobile module was received by the static module up to almost 970 meters.
- Data arrived at the static module at regular intervals up until 964 meters (beyond that, the data became irregular).

**Figure 3** shows the starting location. The red line shows the path taken and the red dots display the individual GPS position reports.



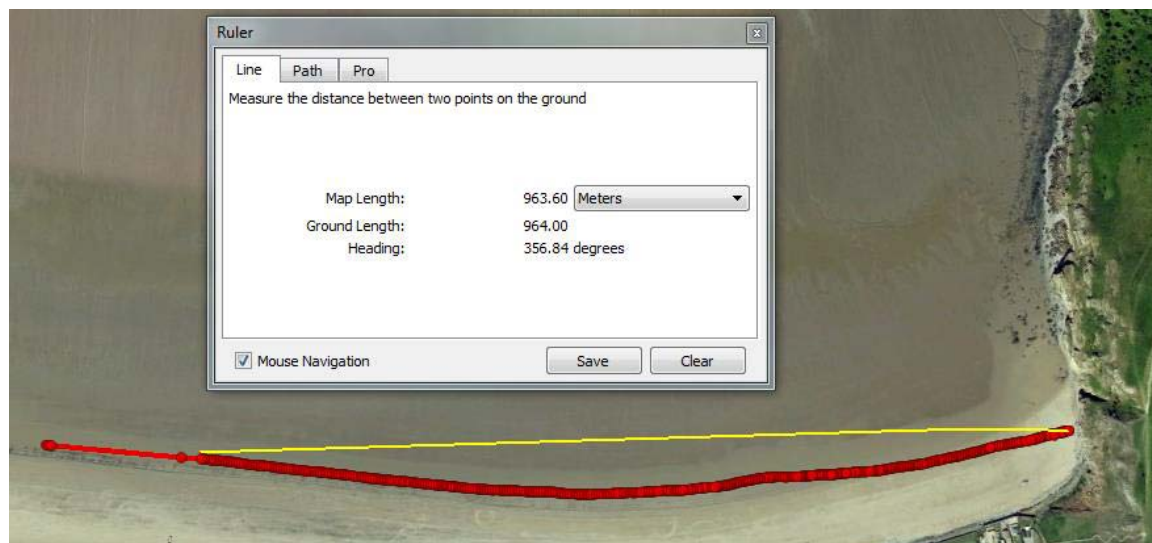
**Figure 3: Start location and initial path**

Figure 4 shows the limit of reliable data at 964 meters.



**Figure 4: End location**

**Figure 5** displays the entire path. The red line shows the path taken and is made up of a series of red dots indicating each position report. The yellow line indicates Google Earth's measuring tool. The dialogue window indicates the point-to-point distance of 964 meters.



**Figure 5: Entire path**

## Summary

The range test was conducted in close to ideal conditions, including good line of sight, minimal Wi-Fi interference, and no physical obstructions. Additionally, the test was performed at a very low data rate. Although range is greatly reduced when modules are used indoors or in urban environments, these test results indicate that Bluetooth can reliably send data at close to 1000 meters.

Bluetooth technology is used in a variety of industries and markets. Long-range applications currently include medical devices, ePOS terminals, automotive diagnostic equipment, barcode scanners, and industrial cable replacement. This is only the start. The strong performance of long-range Bluetooth opens the door to new potential industries, markets, and countless opportunities.

The Laird BT730 Class I Bluetooth module is a strong contender for these applications, solving many problems that occur in some of the world's harshest environments. For example, the BT730 is particularly helpful with ePOS/ credit card terminals. Real world operating environments are unpredictable, but the BT730 gives OEM devices maximum stability and caters to most eventualities. Industrial environments that suffer from RF-interfering metals, heavy machinery, and other potential obstacles can rely on the BT730's reliable performance. Outdoor applications that rely on reliability at long ranges such as truck weighing scales, pipeline leak detection devices, or anything over water (which rapidly attenuates RF signal) benefit from the superior performance of the BT730. And all of these

applications benefit from the easy-to-use, low cost BT730 development kits, exceptionally low power consumption, familiar AT command set, Laird-provided modular approvals, and world class support and documentation that decrease manufacturers' costs and time to market.

Overall, the BT730's ability to support long-range connections solves many problems manufacturers are faced with and opens the door to new possibilities and markets. Developers looking to embed Bluetooth into their products are leveraging Laird's robust Bluetooth Product lines in order to take full advantage of the rapidly expanding market.

For more information, view the BT730 product page or watch the BT700 Series video on Laird's YouTube channel.