Modifying a USB MSI dongle for an external antenna

MS-6967. USB 2.0 / Bluetooth v1.1 / Class 1

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Introduction

This is a short article detailing how to retrofit a standard Bluetooth dongle with a connector for an external antenna. There are several reasons to perform such a procedure, however, the most useful are the ability to attach the dongle to an RF power amp, a higher gain external antenna or both. While it is possible to do this, it should be noted that using certain antennas and amplifiers with a modifed dongle can be illegal with respect to the UK's radio licensing authority, Ofcom. The primary motivation for this project was to explore how far the Personal Area Networking (PAN) services offered by a Bluetooth device could be contacted from. Current Bluetooth dongles offer connectivity at a range of up to 100 metres.

Required Parts

The two tables below list the required parts and the optional parts. It is recommended that items in the required parts table be used. Items in the optional parts table are optional, however they may aid construction.

Table 1. Required Parts

Supplier	Part Number	Description	Price (ex VAT)
Scan	LN4162	MSI Bluetooth dongle	£15.95
RS	446-6454	MMCX PCB mount socket	£2.49
RS	248-8272	0.8mm Carbide drill bit	£5.05

Table 2. Optional Parts

Supplier	Part Number	Description	Price (ex VAT)
RS	469-4356	Rotary drill kit	£22.00
Wireless Pro	CAB-MMCX-NJ	MMCX to N-Type Female pigtail	£11.95

Tools

Before you start, several tools will be required, these are mentioned in required tools list below.

Required tools

- Small tipped Soldering iron
- Needle nose pliers or tweezers
- Solder
- Solder sucker/de-solder flux
- Magnifying glass (optional)
- Compass point or Tipex/bright nail varnish
- A 4mm drill bit
- A Small flat blade screwdriver

Dongle modification

Warning

Before starting any modification, ensure that the relevant anti-static precautions have been taken. Whilst the Bluetooth module itself is shielded from contact, numerous connections emanate from the case.

Opening the dongle

The first step was to open the dongle itself. This can be achieved by inserting a small flat bladed screwdriver into the side of the case between the two halves of the plastic shell. By sliding the screwdriver down one side of the case, the shell popped open easily. The opened case and the four latches can be seen in Figure 1, "Open Dongle".

Figure 1. Open Dongle

Remove the SMT antenna

Once the casing was removed, the circuit board can lifted out of the casing. At the end opposite to the USB connector is a small SMT antenna. The antenna is approximately 3mm x 5mm and has six soldered mount points. The three connectors nearest the Bluetooth modules are the signal points, two ground and one RF contacts. The three contacts on the opposite side are to provide a mounting only. Using a soldering iron and solder sucker, remove as much solder from the joints as possible. Once most of the solder has been removed, use the pliers to lift the SMT antenna whilst applying heat to the contacts using the soldering iron. Having removed the antenna, clean any excess flux from the PCB. The removed antenna and PCB can bee seen in Figure 2, "Removed Antenna".

Figure 2. Removed Antenna

Mounting the MMCX connector

The three contacts left by the SMT antenna are almost the exact size for the MMCX connector and mounting is therefore relatively simple. The MMCX connector will be mounted on the underside of the board, allowing the connections to be soldered and also providing support for when the plug is removed. Mark out the points for the holes with a compass point, the two ground holes should be placed just above and on the inside edge of the two ground tracks on the PCB. The other three holes can be determined from these points. As there is little room to mark out the holes, one trick is to use Tipex on the legs of the MMCX connector and place it on the PCB. This leaves a series of five white dots in the required positions. Using the 0.8mm drill bit, drill through the PCB on the five marked points. If a drill press is unavailable, it is recommended that the drill be placed on a flat horizontal surface and the PCB is placed against a flat vertical surface. The drill should then be moved forward along the horizontal surface towards the PCB. This will allow easy alignment of the PCB and avoid bending or breaking the drill bit.

Caution! When drilling, always wear face protection, especially when using fine Carbide bits. Carbide drill bits are very brittle and when broken can cause serious injury.

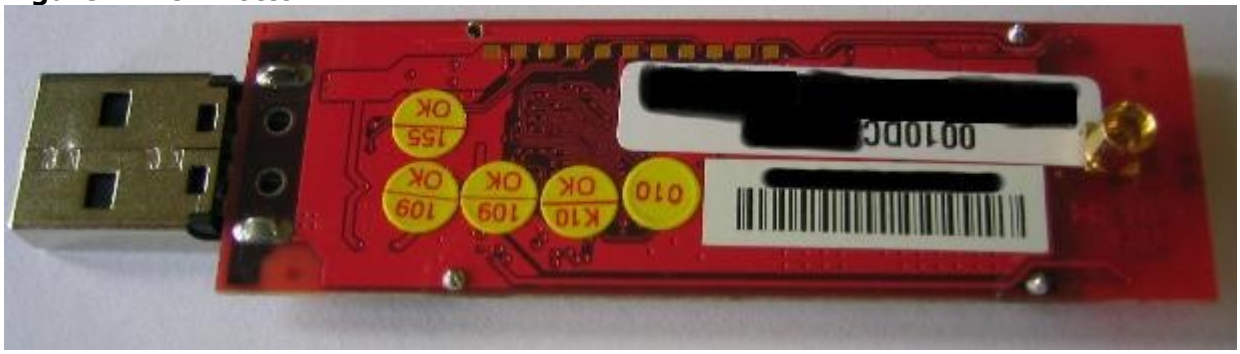
Having drilled the five holes in the PCB, place the PCB back in the lower half of the plastic case. Insert a pin through the centre hole and mark the casing. This will provide the location of the hole in the case for the MMCX connector.

Soldering the MMCX connector

Before inserting the MMCX connector into the PCB, remove any Tipex from the connector pins. Insert the MMCX connector into the PCB from the underside. The MMCX shell pins should emerge very close to the ground contacts. Bend the two pins nearest the ground point over in the direction of the PCB contacts and solder them. Bend the two remaining shell pins out in the opposite direction. Although the pins have nothing to solder onto, place solder on the legs to provide a plug against the PCB, this will provide support when removing the plug from the socket. The final centre pin cannot be bent, as it will distort the connector. Tin a small length of thin copper wire, preferably single core, and cut it to the required length. The length should be just enough to reach from the PCB signal contact to the centre pin of the MMCX connector. Place the wire on the PCB and solder each end, if necessary, use tweezers to hold the wire in place. The finished board can be seen in Figure 3, "PCB Top" and Figure 4, "PCB Bottom".

Figure 3. PCB Top

Figure 4. PCB Bottom



Re-assembling the case

Having soldered the connector to the PCB, a hole must be made in the casing. Using the 4mm drill bit and a suitable drill, create a hole in the bottom half of the shell at the point marked out in the section called "Mounting the MMCX connector". Place the PCB in the lower half of the shell and close the case. The completed dongle is shown in Figure 5, "Modified Dongle"

Figure 5. Modified Dongle

Testing

To test the dongle, external antennas were connected via a pigtail. In total three tests were conducted, with varying antennas. Each test was conducted between the MSI dongle and a Nokia 6310i mobile phone. The test specification was to determine the greatest line of sight distance that connections could be established and maintained at. During each test, the antenna was mounted 1.5 metres above the ground, which may not be enough for some of the tests.

1. No external antenna (baseline)

This test was conducted before the dongle was modified, and therefore using the internal SMT antenna. The greatest range achieved was approximately 20 metres, which is typical of a connection between a class 1 and a class 2/3 device. This device typically has a scanning area or 1256m^2.

2. External 12 dBi omni directional

This test was conducted with a 1.2 metre 12dBi omni directional antenna (Wireless Pro part number 2400012OM). The maximum distance achieved during this test was 85 metres, therefore, the total scanning area was approximately 22698m^2.

3. External 24 dBi parabolic dish

This test was conducted with a 24dBi parabolic dish (Wireless Pro part number 2400024PAR). The maximum distance achieved during this test was 245 metres. This is, however, not the maximum distance that could have been achieved as the limit of the available test area was reached. Further testing in larger areas should increase this distance.

4. External modified Sky digital minidish

This test was conducted using a home made dish. The dish was constructed from a Sky digital minidish and a bi-quad feed. Detailed instructions on how to construct this device will be made available shortly. This antenna should theoretically have a high gain, however the dish is hard to aim and very susceptible to wind. This test was postponed due to rain and high winds.