# Bluetooth Transmitter Modules

In order for LogiSteps to function, the data from the piezoelectric sensors will have to be transmitted from those sensors to the microcontroller and on to our server on the cloud. We have decided to use the Bluetooth transmission standard to get the data from the LogiSteps sensors to a user’s mobile device wirelessly, and from there send the data over the internet to our server. In the event that we decide to make our product using a microcontroller that does not have a Bluetooth transmitter embedded in its design, there are numerous standalone Bluetooth transmitters we can connect into the design to transmit the sensor data. The main advantage that would be found in using a separate Bluetooth transmitter is being able to use a simpler microcontroller, a smaller microcontroller. One that might use less energy, and lessen the overall designs power requirements.

There are a few features to be taken into account when selecting a Bluetooth transmitter for our LogiSteps. Below are the most important factors of each chip to be taken into consideration for LogiSteps.

* **Power** – The LogiSteps device will function off of very low power, so any Bluetooth transmitter will have to use Bluetooth LE (Low energy), requiring only a small current to send and receive data. To be considered with each chip is its peak current draw, which will occur during the Bluetooth advertising event. The current draw after a connection has been made, which should be much smaller than the advertising current draw. And how much current will be drawn in sleep/off modes. Ensuring that the transmitter draws less power than the passive power gain from the sensors paired with capacitors can supply is the key to LogiSteps. Also, to be noted is the supply voltage range of the chip, to make sure it is within the LogiSteps range.
* **Size** – The physical size of the chip selected to be put into the LogiSteps must be taken into consideration. As the LogiSteps is to be an embedded system put into a user’s shoe, the entire system must be small enough to not be a hindrance during normal usage. Any Bluetooth transmitter put into the system will have to be small enough to conform with that rule. The smaller the transmitter is, the better.
* **Data Rate** – The working range, and data transmission rate of the transmitter must be noted. The LogiSteps will not require a long range, as it is expected to only transmit from the user’s shoe to their phone, which should never be a range greater than a few meters. It is also not expected to be transmitting that much data. Only the ADC data for each sensor. But of course, the better the range and transmission rate of the chips, the better to consider them.
* **Interface** – The interfaces the transmitter supports between itself and the host microcontroller are very important to ensure accurate communication of the sensor data between the transmitter and the host microcontroller.
* **Cost and Lead Time** – To ensure an adequate number of transmitters can be acquired soon and cost effectively enough, the cost and factory lead time to get each chip must be taken into consideration.

There are many Bluetooth transmitter modules on the market, of the research done on these modules here is a comparison of some of the better chips found in research.

* The [Microchip BM70](https://www.mouser.com/ProductDetail/Microchip-Technology/BM70BLE01FC2-0B04AA?qs=sGAEpiMZZMsGelYiB%252bjhZoug4L%2fWODSMDiW%2fylgEGWPQdFoV%252bM6JxA%3d%3d) is a Bluetooth 5.0 module that takes a supply voltage of 1.9V to 3.6V. Its peak current draw at 3V in Tx and Rx is 13mA, with a low power mode giving an average transmission current draw of 60µA. The Physical size of the chip is 12 x 15 x 2.4mm. It uses serial UART to interface with the host microcontroller. And the cost of the chip is $6.00 per unit with a factory lead time of 3 weeks. It also has an advertised data rate of 8.6kb/s.
* The [Sierra Wireless BC118](https://www.digikey.com/product-detail/en/sierra-wireless/BC118-1103394/1495-1003-2-ND/4860035) is a Bluetooth 4.0 module that takes a supply voltage of 3.3V to 4.7V. At 3.3V its peak current draw is 16mA, and sleep mode of 5µA. This chip is 14.4 x 19.3 x 2.2mm in size. It can utilize UART, GPIO, and I2C for its interfacing with the host microcontroller. The cost of the chip is $10.86 per unit with a factory lead time of 8 weeks. And its data rate of 270kb/s with a range of 30m.
* The [Microchip RN4020](https://www.mouser.com/ProductDetail/Microchip-Technology/RN4020-V-RMBEC133?qs=sGAEpiMZZMsGelYiB%252bjhZoug4L%2fWODSMf7RLIRJcHE%2fxGp2LukTiJw%3d%3d) is a Bluetooth 4.1 module with a supply voltage range of 1.8V to 3.6V and a peak current draw at 3V of 16mA in Tx and Rx. At idle it is 1.5mA with a sleep mode of 5µA. The chip dimensions are 19.5 x 11.5 x 2.5mm. It can use both I2C and UART to communicate with its host. It costs $9.10 per unit with a 14-week lead time. It also has a maximum data rate of 1Mb/s.
* The [Murata LBCA2HNZYZ-711](https://www.digikey.com/product-detail/en/murata-electronics-north-america/LBCA2HNZYZ-711/490-10561-2-ND/5037166) is a Bluetooth 4.1 module using a supply voltage range of 2.35V to 3.3V. It has a peak current draw for Tx at 4.8mA, and Rx at 5.1mA. Its dimensions are 7.4 x 7.0 x 1mm. It uses I2C, and UART to communicate with its host. The cost per unit is $10.41 with a lead time of 24 weeks. It’s data rate is 1Mb/s.

## Power

Power wise, their supply voltages are all comparable, with the Sierra Wireless BC118 having the largest difference with its lower end at 3.3V. All of these chips fall within the accepted range currently for power supply. For their current supply requirements during transmission, their peaks are also comparable, although it should be noted every chip’s requirements vary depending on supply voltage and transmission power, the Murata chip has the lowest peak current requirement. However, the Microchip BM70 has a much better documented current consumption, with an ultra-low power mode giving a much lower average transmission cost. That, along with its voltage supply range being correct makes the Microchip BM70 the best of these chips where power is concerned.

## Size

The Microchip BM70, Sierra Wireless BC118, and Microchip RN4020 are all between 1 and 2 cm wide and long, with a width of between 2.2 and 2.5mm. The Murata chip distinguishes itself here, being less than half the size of all the other chips at 0.74 and 0.7 cm wide and long, and only 1 mm thick. Should our size requirements become greater, needing smaller a design and chips, then the Murata chip might become the chip of choice based solely upon its much smaller size.

## Data

Range wise the only difference is the Sierra chip at 30m instead of 100m like the other chips, however this does not have much impact upon the LogiSteps design but is noted. The data rate of the chips does vary more however. The Microchip BM70 goes up to 8.6kb/s, and the Sierra up to 270kb/s, with the other two chips going to 1Mb/s. Of course, these are maximums, and can change depending on the amount of energy that can be used. For LogiSteps we do not need a high data rate, so the lower rates are acceptable in our current designs. If that were to change the RN4020 and Murata chips might be better suited.

## Interface

The only difference the chips have in their interfacing with a host microcontroller is that the BM70 cannot use I2C from default, whereas all the others use UART and I2C from default. So, for interfacing no chip is preferable over another.

## Cost and Leadtime

For cost there is not much to be noted other than the Sierra BC118, Microchip RN4020, and Murata Chips are all about $10 for single units. However, the Microchip BM70 is costs only $6.00 for single units. For the factory lead-times the Microchip RN4020 and Murata chips have very long lead times at 3 ½ months and 6 months respectively, while the Sierra and Microchip BM70 only have 3 weeks and 8 weeks lead time. Of course, for our purposes these are not all too impactful, as the costs are all low, and all of these chips have plenty in supply, so we most likely do not have to worry about the lead times. But if supplies change, the Microchip BM70 is clearly the best option.

## Conclusion

So, should the LogiSteps use a microcontroller that does not have its own Bluetooth module on the chip, we would consider these standalone Bluetooth transmitters. For their costs and lead-times, the BM70 is the best, although the difference is negligible. For their interfacing capabilities they are all the same, with the BM70 only needing some firmware changes. For their data rate and range, the RN4020 and Murata chip are the best at 100m and 1Mb/s, while the BM70 is the worst as its data rate is the lowest. For size the Murata is the best and smallest, being half the size. For power consumption the Microchip BM70 has its ultra-low power mode, taking that into consideration as the most important aspect, and being good enough or comparable to the other chips in everything else, for the LogiSteps the Microchip BM70 would be the best option.

<https://www.mouser.com/ProductDetail/Microchip-Technology/BM70BLE01FC2-0B04AA?qs=sGAEpiMZZMsGelYiB%252bjhZoug4L%2fWODSMDiW%2fylgEGWPQdFoV%252bM6JxA%3d%3d>

<https://www.digikey.com/product-detail/en/sierra-wireless/BC118-1103394/1495-1003-2-ND/4860035>

<https://www.mouser.com/ProductDetail/Microchip-Technology/RN4020-V-RMBEC133?qs=sGAEpiMZZMsGelYiB%252bjhZoug4L%2fWODSMf7RLIRJcHE%2fxGp2LukTiJw%3d%3d>

<https://www.digikey.com/product-detail/en/murata-electronics-north-america/LBCA2HNZYZ-711/490-10561-2-ND/5037166>