

Channel Sounding

From smart door locks and access systems to asset tracking and management, Channel Sounding unlocks the true potential of IoT and creates a seamless web of interconnectedness by enabling the highest accuracy distance measurement for intelligent and context-aware systems.

Benefits of Channel Sounding

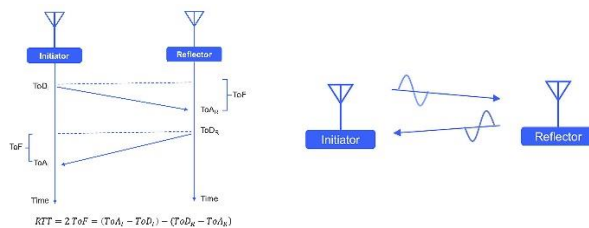
Channel Sounding, previously referred to as High Accuracy Distance Measurement (HADM), uses Phase-Based Ranging (PBR), Round Trip Time (RTT), or both to accurately measure the distance between two Bluetooth Low Energy connected devices. It enables connection-oriented 2-way ranging. Supports up to four antenna paths between devices - minimizes multipath effects and enhances accuracy. Offers enhanced built-in security features to mitigate the risks of man-in-the-middle or relay attacks.

How Does Channel Sounding Work?

Channel sounding is a method for estimating distances between two devices, designated as the initiator and the reflector. They exchange information across 72 RF physical channels, with the initiator transmitting first, followed by the reflector's response. This alternating transmission and reception enable precise distance measurements. The technique employs Phase-Based Ranging (PBR) or Round-Trip Time (RTT) or both for accurate coordination across the 2.4 GHz spectrum. It also supports one to four antenna paths to improve measurement accuracy and reliability.

Round Trip Time (RTT)

Round trip time (RTT) in a communication channel refers to the duration a signal takes to travel from the initiator to the reflector and back again. By assessing the Time of Flight (ToF) — the time it takes for a packet to be exchanged between the initiator and the reflector — the distance can be estimated. To achieve this, both devices record the Time of Arrival (ToA) and the Time of Departure (ToD). Analyzing the differences between ToA and ToD for both the initiator and the reflector provides the data necessary for a reliable distance calculation. Additionally, in terms of security, since time cannot be reversed, RTT is considered highly secure.



Phase-Based Ranging (PBR)

Phase-Based Ranging (PBR) utilizes the principle of phase rotation in RF signals to determine distances. In this process, the initiator sends a signal with specific frequency and amplitude information, and the reflector measures the phase of this received signal before sending a response. By comparing the phase differences between the signals from both devices, their relative distance can be determined. PBR offers a significant security advantage, especially

compared to methods like RSSI (Received Signal Strength Indicator). The complexity of manipulating phase information makes PBR a more secure technology for distance measurement.

Target Applications for Bluetooth Channel Sounding

Proximity Awareness

To develop Bluetooth Low Energy enabled devices that are used in securely controlling and restricting access to spaces.

Geofencing

Geofencing is used to automate and enhance security by restricting access to specific pre-defined areas and tracking smart devices and their movement. Channel Sounding can help optimize geofencing applications and improve performance and reliability of networks.

Door Locks

Smart Locks can be controlled remotely using a smart device, and allow entry only when the authorized device is within a specified range of access to the smart lock. Channel Sounding can be used to enhance the accuracy and reliability of these devices, and help make them more secure.

Keyless Entry

Channel Sounding ensures only authorized users and devices can access systems (like vehicles) if they are within a predefined range of proximity to that system.

Locating Solutions

For applications like asset management and personal item tracking. It provides the perfect blend of precision and convenience.

Warehouse Management

Warehouse Management can include monitoring the storage of goods in a warehouse, tracking their movement, inventory control, as well as managing other operations and logistics. Channel Sounding can help improve the efficiency of, as well as optimize warehouse management systems.

Pet Tracking

Pet tracking is another application where channel sounding can be used to improve the accuracy of location tracking and finding, which helps owners stay informed about their pet's whereabouts.

Item Tracking

Just like other locating solutions, Channel Sounding helps enhance the accuracy and dependability of devices that help track and locate items.

Channel Sounding Use Cases

Vehicle Access Entry

One primary use-case for Channel Sounding is remote keyless entry to a vehicle. It is used for zonal detection through ranging to authenticate approaching users and unlock the vehicle. It utilizes Bluetooth Ranging through the established connection between the data channels - in this case, the key fob or phone and the anchor points on the car.

Indoor Ranging

Channel Sounding offers a solution for facilities like hospitals and warehouses, enabling both restricted access and asset tracking. It authenticates and allows entry to authorized individuals at doorways, enhancing security. It can also be used to monitor assets such as medical equipment or other high-value items.

Is Channel Sounding the Right Choice for Me?

With the multitude of positioning solutions available in the market today, selecting the ideal one for your IoT project becomes crucial. Allow Silicon Labs to assist you in finding the perfect match for your requirements. Contact us now.

	RSSI	Angle or Arrival/ Angle of Departure	Channel Sounding
Localization Metric	Resolve distance estimation from transmitter signal strength	Resolve relative angle between two points	Resolve distance between two points using time of flight and phase-based ranging
Antenna Requirements	Single antenna	Multi-antenna required by spec	Multi-antenna not required, but useful for optimal position resolution
Bluetooth LE Connectivity	Connection-oriented and connectionless	Connection-oriented and connectionless	Connection-oriented
Performance Metrics	+/- 5m, high susceptibility to multipath interference	+/- 3 degrees accuracy – azimuth +/- 5 degrees accuracy – elevation	+/- 0.3 m < 5m with PBR ranging +/- 0.5 m > 5m with PBR ranging

**Solution
Advantages**

Ubiquitous support for
RSSI measurements in
existing Bluetooth Low
Energy products

Scalable solution
for real time
position tracking
Supports 5-10 year
battery life

Small form factor with
flexible antenna
design
Feature-add for
security by proximity

