

Proximity Search

ABSTRACT

Proximity search aids in device pairing by providing a means to acquire a master based on its relative distance to a slave. Standard search mechanisms search for any master with a matching channel ID within range of the slave device. Proximity search can limit the number of possible matches by searching for a master with a matching channel ID that is within a set range or threshold. If used correctly, proximity search can acquire the master that is closest to the slave. This application note provides an overview of the proximity search feature, and its impact on device pairing.

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1 Introduction

The *ANT Message Protocol and Usage* document describes the concept of ANT nodes and channels. The search process of a slave to acquire the appropriate master device is further described in the *ANT Channel Search* and *Device Pairing* application notes. The latter document also describes ANT channel ID in detail. It describes how it is used in device pairing (i.e. establishing a channel between two specific devices), and the events that are required to establish an ANT channel. Pairing is simple if the slave knows the specific channel ID of the master that it wishes to connect to. However, if some of the channel ID fields are wildcards, there is potential for a slave to establish a channel with an unintended master. In this case, the pairing bit can facilitate correct device pairing, but this typically requires intervention by the user.

Proximity Search is an advanced feature that extends the typical device pairing mechanisms described in the Device Pairing application note. This feature allows a master device to be acquired according to its proximity to the searching slave without the need for user intervention. This is particularly useful in crowded environments in which multiple slaves and masters are attempting to pair. Placing the devices close together and using proximity search can ensure the two devices are paired correctly.

2 Relevant Documents

It is recommended that the following documents be read and understood before using this application note:

- ANT Message Protocol and Usage
- ANT Chip/Module Datasheet
- AN02 Device Pairing Application Note
- AN11 – ANT Channel Search

3 Proximity Search

Attempting to pair using a channel ID that contains one or more wildcards can result in unpredictable pairing in a crowded environment. For example, in Figure 1, a slave (black & white dot) is trying to establish a channel with a specific device type (i.e. HRM). All other channel ID fields contain wildcards. If multiple masters that match the device type (black dots) are present, it is difficult to determine exactly which master the slave will connect to. It will establish a channel with the first master signal that it finds; which is not necessarily the closest.

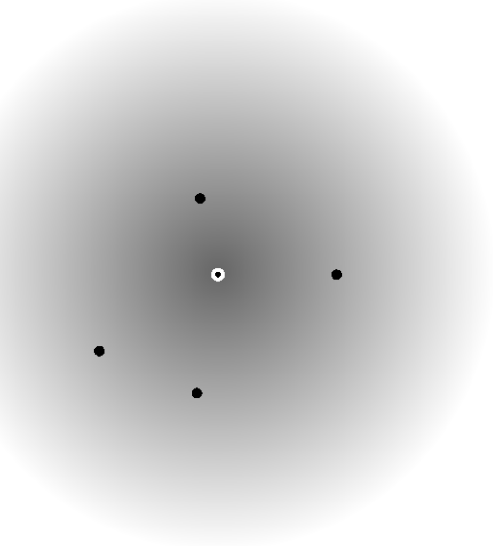
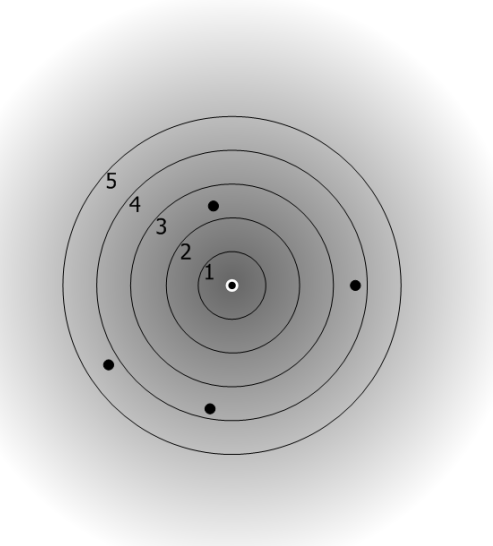


Figure 1. Standard Search

ANT's proximity search feature designates 'bins' of proximity ranging from 1 (closest) to 10 (furthest) as illustrated in

Figure 2. Enabling proximity search and setting an appropriate threshold (i.e. bin) value will limit the search to masters that are within that bin. Bin 1 will yield the most limited result as it provides the smallest radius. Similarly, bin 10 will yield the farthest reaching search but increases the possibility of pairing with the wrong master. Bins are inclusive; if bin 4 is set as the threshold, then any devices located in bins 1 through 4 can be found.



**Figure 2. Proximity Search Showing Threshold
Bins 1 to 5 (of max 10)**

4 Enabling Proximity Search

Proximity search is disabled by default (i.e. set to bin 0). If a proximity search is desired, it shall be enabled with the *Set Proximity Search* (0x71) command **before** opening the channel. For more details refer to *ANT Message Protocol and Usage*.

The proximity threshold value is valid for a single search only. Once a channel has been established, the threshold value returns to its default value (i.e. 0 or disabled). The exceptions to this are:

- Unsuccessful search (search timeout occurred). Threshold value is maintained
- Background scanning channel. Threshold value is maintained

5 Design Considerations

A device's range is heavily dependent on RF environment and system design (antenna design & orientation, device packaging, etc). Because of this dependency, there are no set correlations between proximity bin number and distance between devices or relative distance between bins. The specific use case should be thoroughly tested in order to determine an appropriate threshold for successful acquisition.

The recommended technique is to initially set the threshold value to bin 1. This provides the most limited threshold case, reducing the chance of connecting to the incorrect device.

Depending on the specific use case, a larger initial search radius may be more appropriate. For example, when pairing a watch and heart rate monitor (HRM), it is practical to hold the two devices in close proximity (Figure 3.).

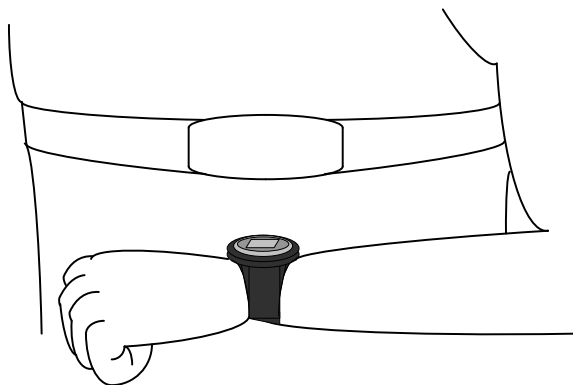


Figure 3. HRM and Watch Pairing

However, if pairing a bike computer and power sensor on the rear wheel, a threshold value of 1 may not guarantee pairing in a 'worst case' scenario (Figure 4).

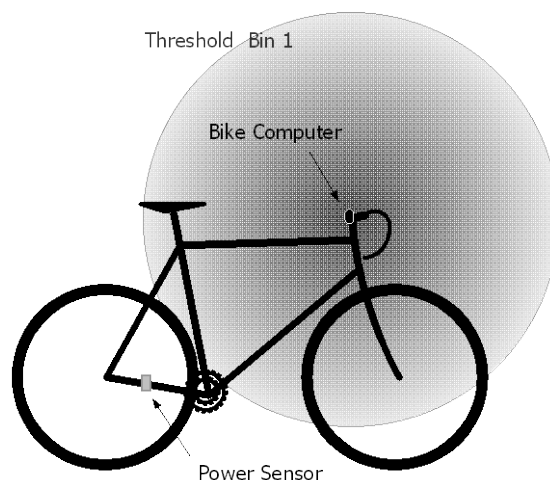


Figure 4. Bike Computer and Power Sensor Pairing

In this situation, a larger initial proximity threshold may be desired. In order to obtain a threshold value that corresponds to the appropriate range for pairing, testing should take into account:

- *specific manufacturer/model computer*
- *specific manufacturer/model power meter*
- *specific orientations*

The user should be made aware of the specific orientation required for pairing. Figure 5 gives an example of pairing orientations between a watch and heart rate monitor. Changing the orientation of the devices can affect proximity readings and may result in inaccurate pairing.

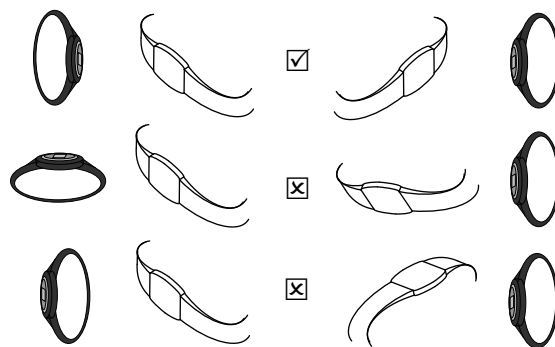


Figure 5. Watch and HRM Example Pairing Orientations

The user should also be advised of any conditions that may lead to incorrect pairing, such as several devices of the same device type within the proximity search threshold. In the bike power meter example, the user should be told of the

minimum distance from any other bikes with power meters in order to pair successfully. This is addressed in Figure 6.

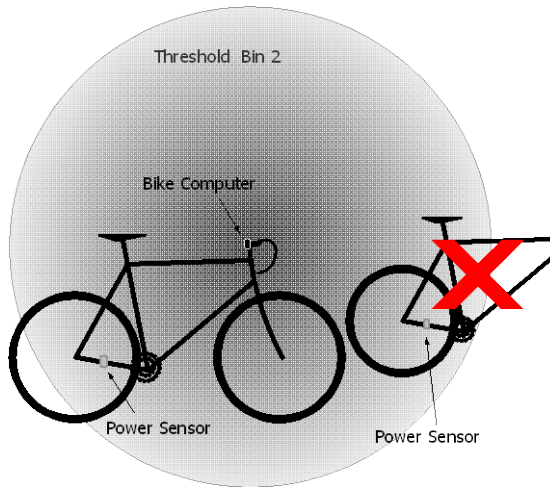


Figure 6. Two Similar Sensors in Range Could Result in Incorrect Pairing

RF environments can be unpredictable; exact distance to threshold correlations should not be expected. Even rigorously tested distance to threshold correlations should allow a significant margin of error due to the unpredictable nature of wireless communication. Some factors affecting performance that should be considered in your design include, but are not limited to:

- Varying performance (e.g. output power) of similar devices from same/different manufacturers
- Varying performance of the *same* devices from the *same* manufacturer
- The presence of continuous wave/ sporadic interference
- Antenna orientation

In an effort to account for all possible factors affecting wireless link performance, try to choose a threshold value that will still achieve successful pairing even under the worst case scenarios.

6 Closing Remarks

This application note is aimed at providing a description of the proximity search feature and design considerations for implementation. If used correctly, a proximity search will aid in device pairing in crowded environments.