

# **AN0514 - How to Avoid Diversity and Coexistence Problems**

1.0

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**Application Note**

AN0514 - How to Avoid Diversity and Coexistence Problems

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## 1. Introduction

During normal operation a swarm bee is most of the time in power down mode. Transmissions only take a small percentage of the operation time. However, sometimes it can be very important to know when exactly a transmission is happening. Or even, when a complete communication operation, with multiple transmissions involved, is going on. Such an operation could be, for instance, a ranging operation, which should not be interrupted for a successful result.

The swarm bee pin DIV\_COEX provides an indication to a host controller on when the device is transmitting or not, and can be used to identify the total ranging operation time.

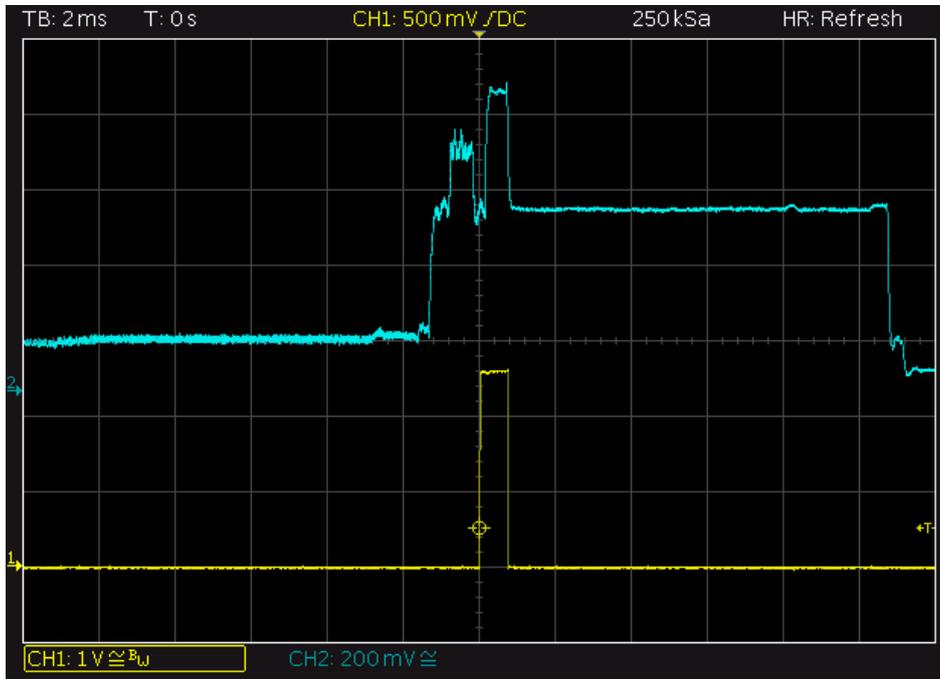
## 2. How does pin DIV\_COEX behave?

Pin DIV\_COEX is by default set to low level and only goes to high level to indicate transmissions going on. The transmission can be a nodeID broadcast, a range result broadcast, a data packet (either broadcast or unicast) or a ranging packet. But the behavior is not exactly the same in all cases. We will classify them in two cases: single transmissions, for the three first kinds of packets, and ranging.

### 2.1. Single transmission

When a single packet is transmitted, pin DIV\_COEX indicates it by raising its voltage to high level. As soon as the transmission starts pin DIV\_COEX goes to high level and it goes to low level when the transmission is completed.

This behavior has been verified with an oscilloscope, whose screenshot can be seen in Figure 2-1. The signal at pin DIV\_COEX is represented in yellow. The current profile, represented in blue, has been used as reference. The current profile shows that the device is in power down mode and at some point it wakes up and starts to initialize. After a short while it transmits the nodeID broadcast (thickest pulse) and opens its reception window. The level at pin DIV\_COEX is low, and only while the device is in transmission mode does it go to high level.

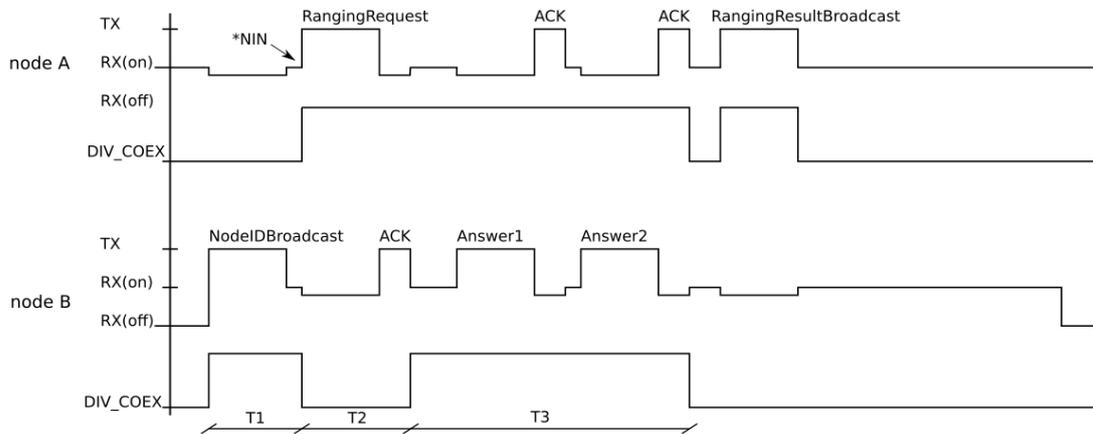


**Figure 2-1** Behavior of pin DIV\_COEX during single transmissions

As expected, pin DIV\_COEX is high as long as the transmission is going on.

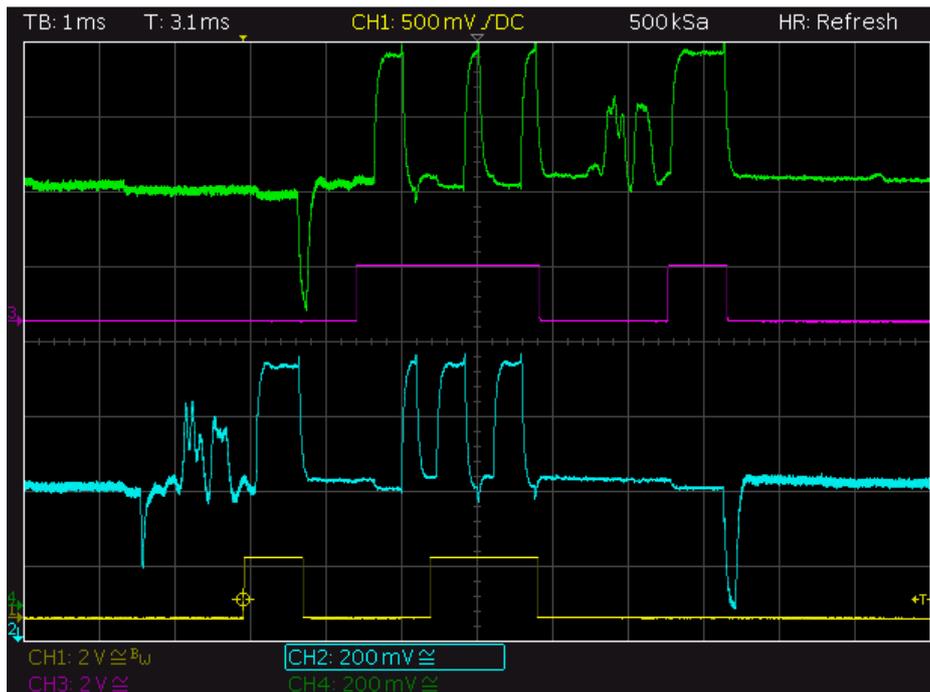
## 2.2. Ranging operation

During a ranging operation multiple packets are involved. In this case, it is not so important to know when each individual transmission is happening, but when a whole ranging process is going on. The behavior of pin DIV\_COEX during a ranging operation is represented in Figure 2-2. There are two swarm devices involved in a ranging operation. Node B will be the node sending the nodeID broadcast and node A the node receiving the nodeID broadcast and reacting to it by sending a ranging request.



**Figure 2-2** Behavior of pin DIV\_COEX during a ranging operation on both sides of the link.

As shown before, node B indicates the transmission of the nodeID broadcast by setting pin DIV\_COEX high only during the transmission time. When node A receives the nodeID notification, by default it reacts to it by sending a ranging request. When the transmission of the request starts pin DIV\_COEX goes high. Node A knows that it is initiating a ranging request and more transmissions will be involved, thus, after the transmission of the request, it keeps pin DIV\_COEX high. When node B receives the request, it sends an automatic acknowledgment (ack) to node A. As it is going to accept the request, immediately after finishing with the ack transmission, it sets pin DIV\_COEX to high level. Then the ranging packets can start. Node B sends a first answer to node A and later a second answer. Both answer should be acknowledged by node A by sending an ack. When node B receives the ack for the second answer, it considers that the ranging operation has finalized and sets pin DIV\_COEX low. The process is similar at node A, after it send the ack for the second answer, it considers that the ranging operation is finished and sets pin DIV\_COEX low. After this, of course, it indicates the transmission of the range result broadcast as any other individual packet.



**Figure 2-3** Behavior of pin DIV\_COEX during a ranging operation

Figure 2-3 confirms previous explanation. Node A is represented by the current profile, in green, and the behavior of its pin DIV\_COEX, in magenta. Node B is represented in the same manner, but with different colors, blue for the current profile and yellow for its pin DIV\_COEX. Like in Figure 2-2, the complete operation is represented, from the moment node B transmits its nodeID broadcast until node A sends the ranging result broadcast. The difference in the power levels shown in the screen shot is caused by the fact that node A is in power mode 0, always waiting to receive messages, while node B is in power mode 2.

### 3. How can the information at pin DIV\_COEX be used?

One of the many applications in which this feature can be useful is when multiple channels are used. By channel we can understand, using different antennas, changing the syncword, the transmission mode, etc. A swarm bee may be configured to repeat the same operation twice, each time on different channels. In this case, it is important that the switching is not done in the middle of a ranging operation or during communication involving multiple packets.

In the case of a ranging operation, for instance, the user should take into account that the nodeID packet often is also part of the process. Thus checking only the level of DIV\_COEX is not enough. Figure 2-2 indicates the times, T1, T2 and T3, involved at the node sending the nodeID broadcast.

T1 is the duration of the nodeID broadcast packet.

T2 is the time from the instant the nodeID packet is sent until a ranging request is acknowledged.

T3 is the time since the ack is received until the complete ranging operation is finished.

The user should avoid interrupting the transmission/reception by, for instance, changing the antenna during T2, when pin DIV\_COEX is low. For that purpose a timer, T, should be started at the rising edge of pin DIV\_COEX when the nodeID is sent. Its initial time, T<sub>timer</sub>, should be such that

$$T_{\text{timer}} < T3 \text{ and } T_{\text{timer}} > (T1+T2)$$

The condition to control whether the device switches channel or not would then be:

```
If (T = 0 and DIV_COEX = low)
    channel can be switched
else
    channel cannot be switched
```

**Document History**

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2016-2-5	MLA	1.0	Initial version

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For more information about products from nanotron Technologies GmbH, contact a sales representative at the following address:

nanotron Technologies GmbH  
Alt-Moabit 60  
10555 Berlin, Germany  
Phone: +49 30 399 954 – 0  
Fax: +49 30 399 954 – 188  
Email: [sales@nanotron.com](mailto:sales@nanotron.com)  
Internet: [www.nanotron.com](http://www.nanotron.com)