



# Time Sync Application Note

DEPRECATED

THIS DOCUMENT IS DEPRECATED AND PROVIDED "AS IS" WITH NO SUPPORT FROM THE ANT TEAM. USE IS AT THE SOLE DISCRETION OF ANT+ ADOPTERS.

## Copyright Information and Usage Notice

This information disclosed herein is the exclusive property of Dynastream Innovations Inc. No part of this publication may be reproduced or transmitted in any form or by any means including electronic storage, reproduction, execution or transmission without the prior written consent of Dynastream Innovations Inc. The recipient of this document by its retention and use agrees to respect the copyright of the information contained herein.

The information contained in this document is subject to change without notice and should not be construed as a commitment by Dynastream Innovations Inc. unless such commitment is expressly given in a covering document.

The Dynastream Innovations Inc. ANT Products described by the information in this document are not designed, intended, or authorized for use as components in systems intended for surgical implant into the body, or other applications intended to support or sustain life, or for any other application in which the failure of the Dynastream product could create a situation where personal injury or death may occur. If you use the Products for such unintended and unauthorized applications, you do so at your own risk and you shall indemnify and hold Dynastream and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that Dynastream was negligent regarding the design or manufacture of the Product.

©2016 Dynastream Innovations Inc. All Rights Reserved.

THIS DOCUMENT IS DEPRECATED AND PROVIDED "AS IS" WITH NO SUPPORT  
FROM THE ANT TEAM. USE IS AT THE SOLE DISCRETION OF ANT+ ADOPTERS.

## Revision History

Revision	Effective Date	Description
1.0	November 2016	Initial Release.

DEPRECATED

THIS DOCUMENT IS DEPRECATED AND PROVIDED "AS IS" WITH NO SUPPORT FROM THE ANT TEAM. USE IS AT THE SOLE DISCRETION OF ANT+ ADOPTERS.

## Table of Contents

<b>1</b>	<b>Overview .....</b>	<b>5</b>
<b>2</b>	<b>Reference Documents .....</b>	<b>6</b>
<b>3</b>	<b>API .....</b>	<b>7</b>
3.1	Time Base API .....	7
3.1.1	ANT_TIME_BASE_TYPE Definitions .....	7
3.1.2	ANT_TIME_STAMP_CONFIG Structure .....	7
3.1.3	sd_ant_time_stamp_config_get/set Functions .....	7
3.2	Time Sync API .....	8
3.2.1	ANT_TIME_SYNC_CONFIG Structure .....	8
3.2.2	sd_ant_time_sync_config_get/set Functions .....	8
3.2.3	sd_ant_time_sync_broadcast_tx Function .....	8
<b>4</b>	<b>Time Sync Operation .....</b>	<b>9</b>
4.1	Packet format .....	9
4.2	Transmit side operation .....	10
4.3	Receive side operation .....	11
4.4	Receive side calculation .....	11
<b>5</b>	<b>ANT Frequency .....</b>	<b>12</b>
5.1	Normalized ANT traffic .....	12
5.2	High frequency ANT traffic .....	13
5.3	Low frequency ANT traffic .....	13
<b>6</b>	<b>Limitations .....</b>	<b>14</b>
6.1	Margin of Error .....	14
6.2	Prescaler .....	14
6.3	Counter Size .....	14
6.4	ANT Frequency .....	14

THIS DOCUMENT IS DEPRECATED AND PROVIDED "AS IS" WITH NO SUPPORT FROM THE ANT TEAM. USE IS AT THE SOLE DISCRETION OF ANT+ ADOPTERS.

## 1 Overview

The Time Sync feature is designed to help two devices synchronize periodic data. Examples of this could include making LEDs blink at the same time or synchronizing sensor data. This document will cover details of how to use the time sync functionality and its limitations.

This Application Note is for use with the ANT stack on the NRF52.

DEPRECATED

THIS DOCUMENT IS DEPRECATED AND PROVIDED "AS IS" WITH NO SUPPORT FROM THE ANT TEAM. USE IS AT THE SOLE DISCRETION OF ANT+ ADOPTERS.

## 2 Reference Documents

Below is a list of documents that were used to create this document.

**Table 2-1. Reference Documents**

Doc ID	Doc Title	Link
D00000652	ANT Message Protocol and Usage	<a href="https://www.thisisant.com/resources/ant-message-protocol-and-usage/">https://www.thisisant.com/resources/ant-message-protocol-and-usage/</a>

DEPRECATED

THIS DOCUMENT IS DEPRECATED AND PROVIDED "AS IS" WITH NO SUPPORT FROM THE ANT TEAM. USE IS AT THE SOLE DISCRETION OF ANT+ ADOPTERS.

### 3 API

The section describes the APIs that are associated with the time sync feature.

#### 3.1 Time Base API

This API allows the application to configure the receiver.

##### 3.1.1 *ANT\_TIME\_BASE\_TYPE Definitions*

```
#define ANT_TIME_BASE_ANT      ((uint8_t)0x00)
#define ANT_TIME_BASE_ALT1     ((uint8_t)0x01)
#define ANT_TIME_BASE_ALT2     ((uint8_t)0x02)
```

This enumeration contains the type of time base to use. Only ANT\_TIME\_BASE\_ALT1(RTC1) and ANT\_TIME\_BASE\_ALT2(RTC2) should be used with the time sync feature.

##### 3.1.2 *ANT\_TIME\_STAMP\_CONFIG Structure*

```
typedef struct
{
    uint8_t ucTimeBase;
    bool bTimeStampEnabled;
} ANT_TIME_STAMP_CONFIG;
```

This structure is passed into the configuration function to set the time base and enable timestamps if needed. It is to be used in the application of the receiver of time sync messages. The ucTimeBase field is the time base to use. When bTimeStampEnabled field is set to true it will enable timestamps that will appear in the extended data of the received time sync message. The receiver should have timestamps enabled in order to calculate the next period of the timing event.

##### 3.1.3 *sd\_ant\_time\_stamp\_config\_get/set Functions*

```
uint32_t sd_ant_time_stamp_config_set(ANT_TIME_STAMP_CONFIG* pstTimeStampConfig)
uint32_t sd_ant_time_stamp_config_get(ANT_TIME_STAMP_CONFIG* pstTimeStampConfig)
```

This function allows the application to configure the time stamp feature for the receiver. It will set the time base and enable/disable timestamps. All channels are affected by these settings.

THIS DOCUMENT IS DEPRECATED AND PROVIDED "AS IS" WITH NO SUPPORT FROM THE ANT TEAM. USE IS AT THE SOLE DISCRETION OF ANT+ ADOPTERS.

## 3.2 Time Sync API

This API allows the application to configure the transmitter and allows the transmitter to send time sync packets

### 3.2.1 *ANT\_TIME\_SYNC\_CONFIG Structure*

```
typedef struct
{
    uint8_t ucTimeBase;
    bool bInvalidationEnabled;
    uint8_t ucInvalidationByte;
} ANT_TIME_SYNC_CONFIG;
```

This structure allows the transmitter to configure the SoftDevice for time sync packets. The `ucTimeBase` sets the time base to be used. Only `ANT_TIME_BASE_ALT1(RTC1)` and `ANT_TIME_BASE_ALT2(RTC2)` should be used with the time sync feature. The `bInvalidationEnabled` field allows the page number to be invalidated. This is useful for detecting stale data on the receiver side in case where the transmitter hasn't updated the data from the last timing event. The `ucInvalidationByte` field sets the value that will be used to invalidate the page. This value will overwrite the page number in the case of error such as stale data.

### 3.2.2 *sd\_ant\_time\_sync\_config\_get/set Functions*

```
uint32_t sd_ant_time_sync_config_set(ANT_TIME_SYNC_CONFIG* pstTimeSyncConfig)
uint32_t sd_ant_time_sync_config_get(ANT_TIME_SYNC_CONFIG* pstTimeSyncConfig)
```

This function allows the user to configure the time sync feature for the transmitter. It will set the time base and configure the invalidation byte. All channels are affected by these settings.

### 3.2.3 *sd\_ant\_time\_sync\_broadcast\_tx Function*

```
uint32_t sd_ant_time_sync_broadcast_tx(uint8_t ucChannel, uint8_t ucSize, uint8_t* aucMesg)
```

This function allows the application to send time sync data from the transmitter to the receiver. It behaves similarly to `sd_ant_time_sync_broadcast_tx` and will set the data to be transmitted during the next ANT traffic period. `ucChannel` is the channel to transmit on. `ucSize` is the size of the message. A time sync packet will always be eight bytes long. `aucMesg` is the buffer that contains the time sync packet. It should be formatted as described in section 4.1.

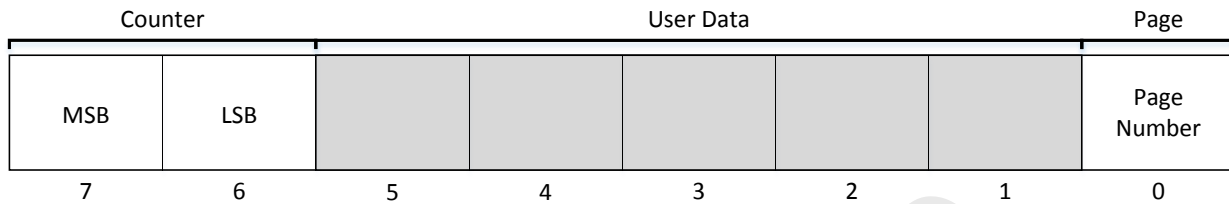
THIS DOCUMENT IS DEPRECATED AND PROVIDED "AS IS" WITH NO SUPPORT FROM THE ANT TEAM. USE IS AT THE SOLE DISCRETION OF ANT+ ADOPTERS.

## 4 Time Sync Operation

The time sync packets have to be formatted for the stack to work with them. This section will describe how to format the packet, what the stack does with the data, and how it is to be used upon reception.

### 4.1 Packet format

The sync packet will be sent from a transmitter. It should be formatted as follows:



**Figure 4-1. Time Sync Packet Format**

The page number is one byte in size and is stored in offset zero. It is optional if the page is used or not. If it is used then the page value can be invalidated to let the receiver side know that there has been a problem on the transmit side.

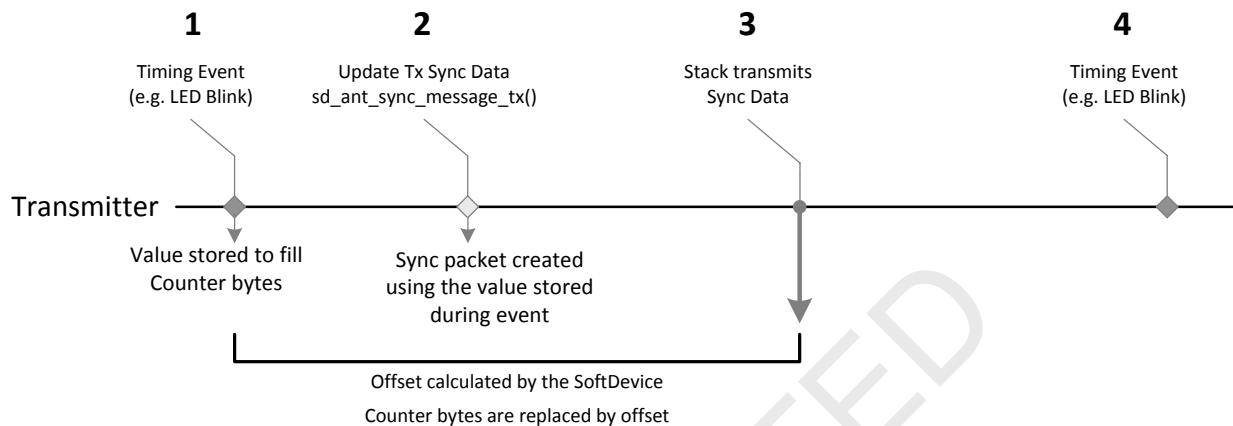
The user data is not managed or manipulated by the stack. It can be used to help the application synchronize the events. For example, in the case of LEDs that should blink at the same time you may want to tell the receiver if the LED is on or off so the blink pattern is not reversed between the two LEDs.

The counter is the last time that the timing event occurred. This value is then used by the stack to calculate the offset between the timing event and the transmission time. This offset is used by the receiver along with the time stamp of the received packet to determine when the next interval should be.

THIS DOCUMENT IS DEPRECATED AND PROVIDED "AS IS" WITH NO SUPPORT FROM THE ANT TEAM. USE IS AT THE SOLE DISCRETION OF ANT+ ADOPTERS.

## 4.2 Transmit side operation

This section describes the timeline for sending time sync packets to a receiver.



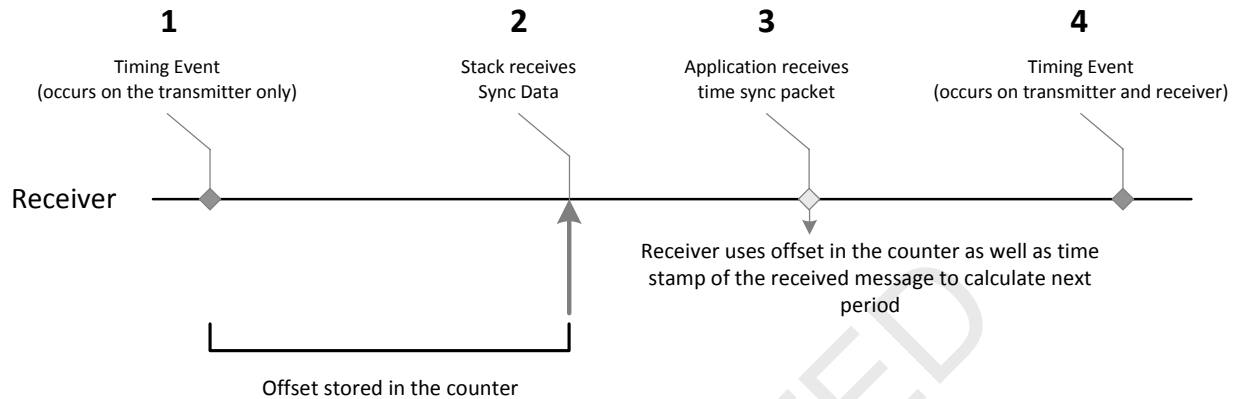
**Figure 4-2. Transmitter Timeline**

1. A timing event occurs that you want to synchronize with the receiver. The tick counter is captured, this value will be used to send to the ANT stack.
2. Format the time sync packet. This will include the two least significant bytes captured during 1. These two bytes will be placed into the counter value of the packet. A call to `sd_ant_time_sync_broadcast_tx` is made.
3. When the ANT stack is ready to transmit it will use the counter value passed in by `sd_ant_time_sync_broadcast_tx` to calculate the total offset between the timing event and the transmission. The counter value will be replaced by this offset.
4. Another event occurs. The receiver will be able to align itself with this event by using the offset in the time sync packet.

THIS DOCUMENT IS DEPRECATED AND PROVIDED "AS IS" WITH NO SUPPORT FROM THE ANT TEAM. USE IS AT THE SOLE DISCRETION OF ANT+ ADOPTERS.

### 4.3 Receive side operation

This section is the timeline for receiving time sync data and using that data to calculate the next timing event.



**Figure 4-3. Receiver Timeline**

1. This event happens on the transmitter side. No information has been given to the receiver yet.
2. The receiver receives the time sync packet. The ANT stack will time stamp the message (This has to be configured ahead of time).
3. The application receives an event that a time sync packet has arrived. It uses the offset stored in the counter value and the time stamp to determine the next timing event.
4. The receiver fires a timing event. At this point the devices will be synchronized.

### 4.4 Receive side calculation

The receiver will need to calculate the when the next event will happen on the transmitter device. To do this you can use the following calculation:

$$\text{Next} = \text{RxTS} - \text{Offset} + \text{Period}$$

Next: The tick count of the next event, the RTC's CC should be set to this.

RxTS: The timestamp of the received time sync packet

Offset: The value in the counter portion of the time sync packet

Period: The time between timing events in ticks

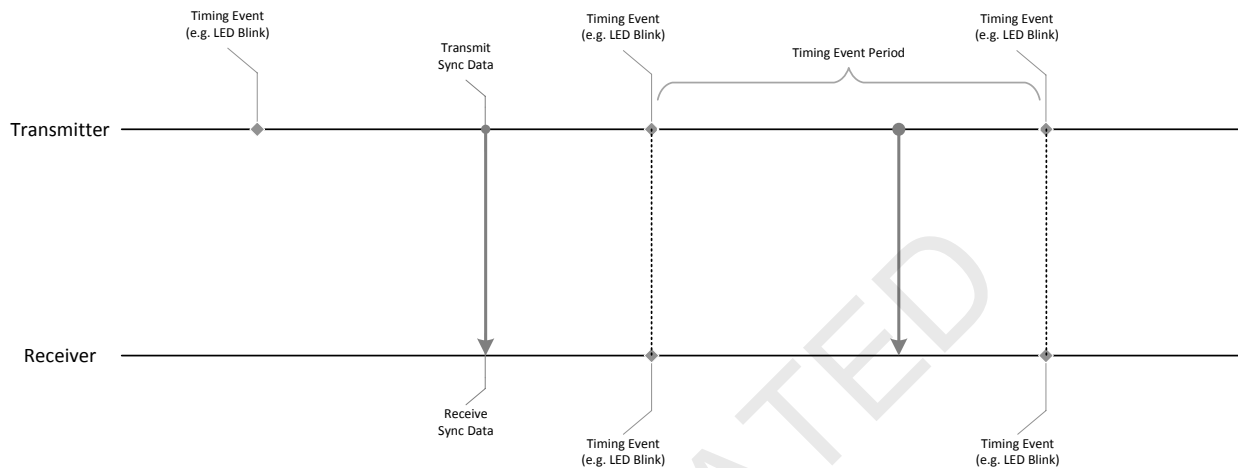
THIS DOCUMENT IS DEPRECATED AND PROVIDED "AS IS" WITH NO SUPPORT FROM THE ANT TEAM. USE IS AT THE SOLE DISCRETION OF ANT+ ADOPTERS.

## 5 ANT Frequency

This section talks about what happens when you use the time sync feature with different ANT frequencies.

### 5.1 Normalized ANT traffic

If you run the timing event frequency at a similar frequency to the ANT channel the traffic will appear like:



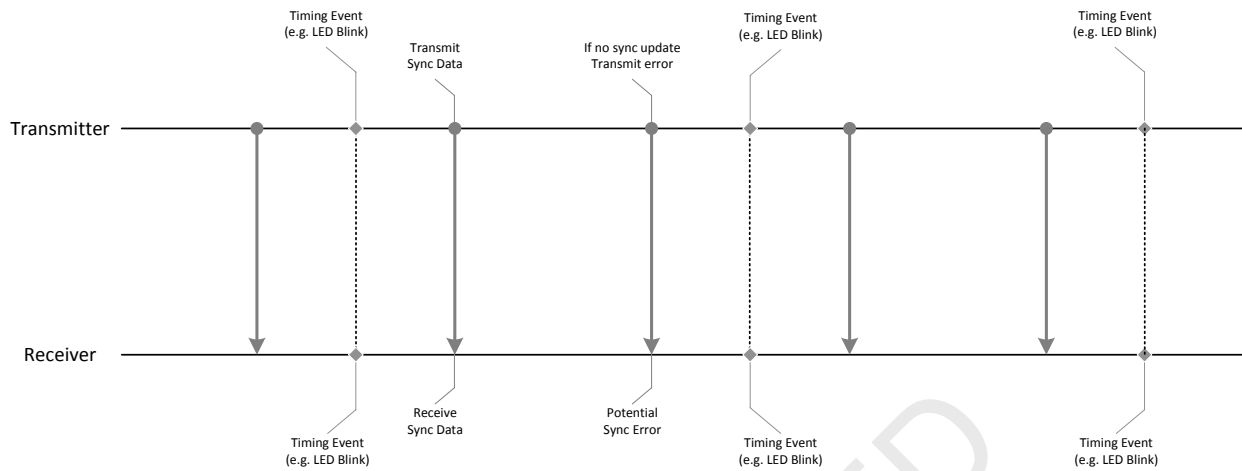
**Figure 5-1. Normalized ANT frequency**

Each timing event should have a call to replace the time sync data. When a transmission occurs it will update the receiver each timing period.

THIS DOCUMENT IS DEPRECATED AND PROVIDED "AS IS" WITH NO SUPPORT FROM THE ANT TEAM. USE IS AT THE SOLE DISCRETION OF ANT+ ADOPTERS.

## 5.2 High frequency ANT traffic

If the ANT channel is running at a higher frequency then the timing events you will see traffic like this:

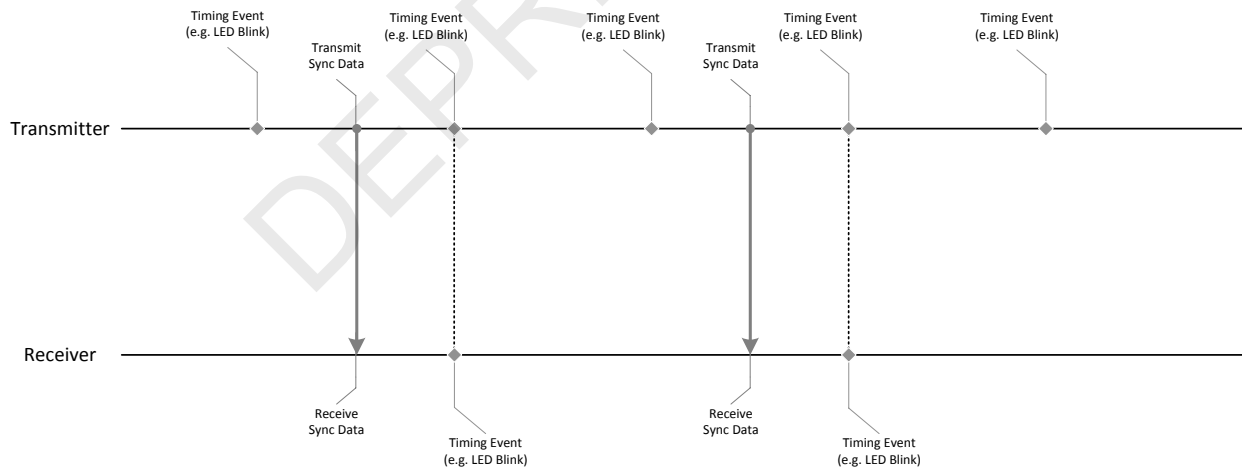


**Figure 5-2. High ANT frequency**

Unless you update the time sync packet each ANT interval on the transmitter the receiver will receive a stale data error. This will only happen in the page invalidation is enabled. If the page invalidation is not turned on the receiver may receive information that is incorrect.

## 5.3 Low frequency ANT traffic

If the ANT channel is running at a lower frequency then the timing events you will see traffic like this:



**Figure 5-3. Low ANT frequency**

The time sync won't keep up with the timing events and only the next timing event after a time sync packet will be able to synchronize. The receiver can derive that more events should be occurring.

THIS DOCUMENT IS DEPRECATED AND PROVIDED "AS IS" WITH NO SUPPORT FROM THE ANT TEAM. USE IS AT THE SOLE DISCRETION OF ANT+ ADOPTERS.

## 6 Limitations

This section describes the limitations of the time sync features

### 6.1 Margin of Error

The time sync feature uses a clock tick for its time base. This means that there will be a margin of error the width of two ticks, one for each clock being used. In the case of a 32k RTC the margin of error will be 61us.

### 6.2 Prescaler

The prescaler shall not be used with the time sync feature.

### 6.3 Counter Size

The counter size is two bytes. The period between two timing events should not exceed the amount of time that can be stored in two bytes. For a 32k RTC this means that the timing period should be less than two seconds.

### 6.4 ANT Frequency

It is recommended that the ANT channel frequency is not the same as the frequency of the timing events. There can be some issues if the time sync packet data is updated in sync with the ANT channel.

THIS DOCUMENT IS DEPRECATED AND PROVIDED "AS IS" WITH NO SUPPORT  
FROM THE ANT TEAM. USE IS AT THE SOLE DISCRETION OF ANT+ ADOPTERS.