TB001 TECHNICAL BRIEF

MAXIMUM PERMITTED SPEED OF DW1000 NODES FOR CORRECT OPERATION

Version 2.2

This document is subject to change without notice

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1 MAXIMUM RELATIVE VELOCITY

Many customers are interested to know the maximum relative velocity that can exist between two DW1000 based nodes without causing degradation in operation.

The quick answer is that it depends on the duration of the packet: -

- For 110k, 128 byte packet with 4096 preamble, the max speed is 5 m/s, or 11 mph.
- For 6.8 mbps, 12 byte packet with length 64 preamble, the max speed is 706 m/s or 1554mph.

There are three main effects on performance.

1. The first, most obvious effect, is the Doppler shift caused by the relative velocity. This acts on the receiver exactly as if the transmitter was operating with a crystal at a frequency offset from its true frequency. At terrestrial speeds, this offset is very small and is easily taken care of by the carrier and timing recovery circuits in the receiving node.

2. A second effect is that if the relative location of the transceivers is being measured, it will be changing while the packet is being received. Obviously, the longer the duration of the packet, the bigger this effect will be.

3. The third effect, caused by movement during sending / receiving the packet, is that the channel impulse response will be changing while the packet is being received, because the various paths that the signal is taking will be getting longer or shorter over the duration of the packet. In a multipath channel, some of the paths will be getting longer and others will be getting shorter. For most channels, the signal will not be unduly degraded if the change in the direct path is kept to below about 7cm / 0.23 ns. Indeed, for very direct LOS channels, the timing recovery circuits will compensate for this change and it will not cause any degradation in performance.

Table 1 below assumes that the shift in the main path in the channel needs to be kept below 7 cm and calculates a maximum speed on that basis.

Table 1: DW1000 max relative velocity vs channel parameters

Parameter		Data Rate kb/s				
		110	110	850	6800	6800
Preamble length (symbols)		4096	2048	1024	256	64
Packet length (bytes)		128	128	20	20	12
Packet duration (ms)		13.4	3.5	1.2	0.4	0.1
Distance travelled (cm)		7.0	7.0	7.0	7.0	7.0
Channel movement (ns)		0.23	0.23	0.23	0.23	0.23
Induced clock offset (ppm)		0.02	0.07	0.19	0.55	2.35
Travelled in TWR exchange (cm)		21	21	21	21	21
Max DW1000 speed	m/s	5	20	57	154	706
	km / h	18	70	200	576	2486
	mph	11	44	125	360	1554

One interesting row in this table shows the distance apart the two transceivers will have travelled over the course of a three packet, two way ranging (TWR) exchange. This assumes a very short turn-around time (e.g. 20 µs) between packets. Depending on the application, this change in relative position may or may not be important. For instance, if the relative speed of two transceivers is being

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measured it is not important since only the difference in times between measurements is relevant. If however, the actual position at the end of the measurement is required, e.g. for collision avoidance, then this should be taken account of.

2 REFERENCES

Reference is made to the following documents in the course of this document: -

Table 2: Table of References

Ref	Author	Date	Version	Title
[1]	DecaWave		Current	DW1000 Data Sheet
[2]	DecaWave		Current	DW1000 User Manual

3 DOCUMENT HISTORY

Table 3: Document History

Revision	Date	Description
1.00	18th August 2015	Initial release
2.2	17th May 2024	Scheduled update.

4 MAJOR CHANGES

Revision 1.00

Page	Change Description
All	Initial release

Revision 2.0

Page	Change Description
All	Update with new logo

Revision 2.1

Page	Change Description
3	Match max speed for 6.8Mb/s with table.

Revision 2.2

Page	Change Description
All	Modification to footer.

5 FURTHER INFORMATION

Decawave develops semiconductors solutions, software, modules, reference designs - that enable real-time, ultra-accurate, ultra-reliable local area micro-location services. Decawave's technology enables an entirely new class of easy to implement, highly secure, intelligent location functionality and services for IoT and smart consumer products and applications.

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