

# u-connectXpress Throughput measurements

## Application Note

### Abstract

This application note provides throughput measurements for u-blox stand-alone modules with u-connectXpress software.

# Document Information

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This document applies to the following products:

<b>Product name</b>	<b>Type number</b>	<b>u-connectXpress software version</b>	<b>PCN reference</b>
NINA-B11x	NINA-B11x-02B-00	3.0.1	N/A
	NINA-B11x-03B-00	4.0.0	N/A
	NINA-B11x-04B-00	5.0.x	N/A
NINA-B22x	NINA-B22x-00B-00	1.0.x	N/A
ANNA-B112	ANNA-B112-01B-00	2.0.x	N/A
NINA-B31x	NINA-B31x-01B-00	2.0.x	N/A

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# Contents

<b>Document Information</b> .....	<b>2</b>
<b>Contents</b> .....	<b>3</b>
<b>1 Introduction</b> .....	<b>5</b>
<b>2 Test setup</b> .....	<b>6</b>
<b>3 Throughput results for NINA-B1 software v3.0.1</b> .....	<b>7</b>
3.1 Software versions .....	7
3.2 NINA-B1 (Central) - NINA-B1 (Peripheral).....	7
3.3 ODIN-W2 (Central) – NINA-B1 (Peripheral).....	7
3.4 ODIN-W2 (Peripheral) – NINA-B1 (Central).....	7
3.5 OBS421 (Central) – NINA-B1 (Peripheral).....	8
3.6 Android device (Central) – NINA-B1 (Peripheral) .....	8
3.7 iOS Device (Central) – NINA-B1 (Peripheral).....	8
<b>4 Throughput results for NINA-B1 software v4.0.0</b> .....	<b>9</b>
4.1 Software versions .....	9
4.2 NINA-B1 (Central) - NINA-B1 (Peripheral).....	9
4.3 ODIN-W2 (Central) – NINA-B1 (Peripheral).....	10
4.4 ODIN-W2 (Peripheral) – NINA-B1 (Central).....	10
4.5 OBS421 (Central) – NINA-B1 (Peripheral).....	10
4.6 Android device (Central) – NINA-B1 (Peripheral) .....	10
4.7 iOS Device (Central) – NINA-B1 (Peripheral).....	11
<b>5 Throughput results for NINA-B1 software v5.0.x/ANNA-B112 software v2.0.x</b> .....	<b>12</b>
5.1 Software versions .....	12
5.2 NINA-B1 – NINA-B1, Simplex.....	12
5.3 NINA-B1 – NINA-B1, Duplex .....	12
5.4 NINA-B1 – NINA-B3, Simplex.....	12
5.5 NINA-B1 – NINA-B3, Duplex .....	13
5.6 NINA-B1 – ODIN-W2, Simplex.....	13
5.7 NINA-B1 – ODIN-W2, Duplex.....	13
5.8 NINA-B1 – iOS, Simplex.....	13
5.9 NINA-B1 – iOS, Duplex.....	13
5.10 NINA-B1 – Android Device, Simplex.....	14
5.11 NINA-B1 – Android Device, Duplex.....	14
<b>6 Throughput results for NINA-B3 software v2.0.x</b> .....	<b>15</b>
6.1 Software versions .....	15
6.2 NINA-B3 - NINA-B3, Simplex.....	15
6.3 NINA-B3 - NINA-B3, Duplex.....	15
6.4 NINA-B3 - NINA-B1, Simplex.....	15
6.5 NINA-B3 - NINA-B1, Duplex.....	16
6.6 NINA-B3 – ODIN-W2, Simplex.....	16

6.7	NINA-B3 – ODIN-W2, Duplex.....	16
6.8	NINA-B3 – iOS, Simplex.....	16
6.9	NINA-B3 – iOS, Duplex.....	16
6.10	NINA-B3 – Android Device, Simplex.....	17
6.11	NINA-B3 – Android Device, Duplex.....	17
<b>7</b>	<b>Throughput results for NINA-B2 software v1.0.x.....</b>	<b>18</b>
7.1	Software versions .....	18
7.2	NINA-B2 – NINA-B2, Simplex .....	18
7.3	NINA-B2 – NINA-B2, Duplex .....	18
7.4	NINA-B2 – NINA-B1, Simplex .....	18
7.5	NINA-B2 – NINA-B1, Duplex .....	19
7.6	NINA-B2 – ODIN-W2, Simplex.....	19
7.7	NINA-B2 – ODIN-W2, Duplex.....	19
7.8	NINA-B2 – iOS Device, Simplex.....	19
7.9	NINA-B2 – iOS Device, Duplex.....	19
7.10	NINA-B2 – Android Device, Simplex.....	20
7.11	NINA-B2 – Android Device, Duplex.....	20
	<b>Appendix .....</b>	<b>21</b>
	<b>A Glossary .....</b>	<b>21</b>
	<b>Related documents .....</b>	<b>22</b>
	<b>Revision history .....</b>	<b>22</b>
	<b>Contact.....</b>	<b>23</b>

# 1 Introduction


This Application Note provides Bluetooth low energy throughput measurements for different device-to-device combinations for u-blox stand-alone modules with u-connectXpress software in different configurations of low energy data packet length extension (DLE), Long ATT MTU size (MTU) and physical layer (PHY). The measurements are done with the u-blox Low Energy Serial Port Service.

For more information regarding u-blox Serial Port Service (SPS) data transfer, see u-blox Low Energy Serial Port Service Protocol Specification [2].

The measurements are done in u-blox test environment and customers should test in their selected environment to get proper numbers for their use case. Chapter 2 provides some suggestions for the test setup.

Measurements have been performed with selected combinations of the devices listed below:

- NINA-B1 series
- NINA-B2 series
- NINA-B3 series
- ODIN-W2 series
- OBS421 series
- Android device
- iOS device

 The ANNA-B112 module is not measured separately, as it is based on the same chipset and software base as the NINA-B1 series. The relationship between ANNA-B112 and NINA-B1 software (SW) versions are described in Table 1 Relationship between NINA-B1 and ANNA-B112 u-connectXpress software versions

<b>ANNA-B112 u-connectXpress software version</b>	<b>NINA-B1 u-connectXpress software version</b>
ANNA-B112 SW 1.0	NINA-B1 SW 4.0
ANNA-B112 SW 2.0	NINA-B1 SW 5.0

**Table 1 Relationship between NINA-B1 and ANNA-B112 u-connectXpress software versions**

## 2 Test setup

- Use s-center evaluation software [3] for configuration and testing.
- Configure two Bluetooth low energy devices (Device A and Device B) to connect to each other using the configuration settings described in each row of the throughput result tables. The baud rate is set to the highest supported (AT+UMRS=1000000,1,8,1,1,1). The LL PDU payload size (Data Length Extension feature) is changed with the MTU size and is set to be 4 bytes larger than the MTU size. Configure LL PDU setting by AT+UBTLECFG=26,x where x should be set to 1 for the module to accept and negotiate an MTU size of 247 bytes and x should be set to 2 for the module to only accept an MTU size of 23 bytes.
- Configure the minimum and maximum connection interval for the module using AT+UBTLECFG=4,x and AT+UBTLECFG=5,x respectively, where x is the connection interval in 1.25 ms units.
- The physical layer (PHY) can be configured to 2 Mbps. The following AT command settings should be used to accept and request a PHY of 2 Mbps: AT+UBTLECFG=27,2, AT+UBTLECFG=28,2 and AT+UBTLEPHYR=[conn\_handle],2,2 where conn\_handle is the connection handle that identifies the connection.
- Simplex: Send continuous data from Device A to Device B during 60 seconds and calculate the mean throughput during this period.
- Duplex: Send continuous data from Device A to Device B and from Device B to Device A during 60 seconds and calculate the mean throughput of the data from Device A to Device B during this period.
- If nothing else is stated, the measurements are done with SPS flow control enabled.

## 3 Throughput results for NINA-B1 software v3.0.1

NINA-B1 SW version 3.0.1 is not capable of running 2 Mbit/s PHY.

### 3.1 Software versions

ODIN-W2 software v4.0.0

OBS421 software v5.3.2

Android v7.0 with u-blox Bluetooth low energy app

iOS v10.3.2 with u-blox Bluetooth low energy app

### 3.2 NINA-B1 (Central) - NINA-B1 (Peripheral)

Device A	Device B	Connection interval min, max (x * 1.25 ms)	MTU (bytes)	Dataflow	Throughput
NINA-B1 (central)	NINA-B1(peripheral)	6,6	23	Simplex	190 kbit/s
NINA-B1 (peripheral)	NINA-B1(central)	6,6	23	Simplex	190 kbit/s
NINA-B1 (central)	NINA-B1(peripheral)	6,6	23	Duplex	131 kbit/s
NINA-B1 (peripheral)	NINA-B1(central)	6,6	23	Duplex	131 kbit/s
NINA-B1 (central)	NINA-B1(peripheral)	24,40	247	Simplex	729 kbit/s
NINA-B1 (peripheral)	NINA-B1(central)	24,40	247	Simplex	729 kbit/s
NINA-B1 (central)	NINA-B1(peripheral)	24,40	247	Duplex	400 kbit/s
NINA-B1 (peripheral)	NINA-B1(central)	24,40	247	Duplex	400 kbit/s

### 3.3 ODIN-W2 (Central) – NINA-B1 (Peripheral)

Device A	Device B	Connection interval min, max (x * 1.25 ms)	MTU (bytes)	Dataflow	Throughput
ODIN-W2 (central)	NINA-B1 (peripheral)	6,6	23	Simplex	82 kbit/s
NINA-B1 (peripheral)	ODIN-W2 (central)	6,6	23	Simplex	31 kbit/s
ODIN-W2 (central)	NINA-B1 (peripheral)	6,6	23	Duplex	74 kbit/s
NINA-B1 (peripheral)	ODIN-W2 (central)	6,6	23	Duplex	16 kbit/s

### 3.4 ODIN-W2 (Peripheral) – NINA-B1 (Central)

Device A	Device B	Connection interval min, max (x * 1.25 ms)	MTU (bytes)	Dataflow	Throughput
NINA-B1 (central)	ODIN-W2 (peripheral)	6,6	23	Simplex	22 kbit/s
ODIN-W2 (peripheral)	NINA-B1(central)	6,6	23	Simplex	41 kbit/s

Device A	Device B	Connection interval min, max (x * 1.25 ms)	MTU (bytes)	Dataflow	Throughput
NINA-B1 (central)	ODIN-W2 (peripheral)	6,6	23	Duplex	9 kbit/s
ODIN-W2 (peripheral)	NINA-B1 (central)	6,6	23	Duplex	36 kbit/s

### 3.5 OBS421 (Central) – NINA-B1 (Peripheral)


Device A	Device B	Connection interval min, max (x * 1.25 ms)	MTU (bytes)	Dataflow	Throughput
OBS421 (central)	NINA-B1 (peripheral)	6,40	23	Simplex	85 kbit/s
NINA-B1 (peripheral)	OBS421 (central)	6,40	23	Simplex	55 kbit/s
OBS421 (central)	NINA-B1 (peripheral)	6,40	23	Duplex	72 kbit/s
NINA-B1 (peripheral)	OBS421 (central)	6,40	23	Duplex	36 kbit/s

### 3.6 Android device (Central) – NINA-B1 (Peripheral)

Device A	Device B	Connection interval min, max (x * 1.25 ms)	MTU (bytes)	Dataflow	Throughput
Galaxy S8 (central)	NINA-B1 (peripheral)	12,12	23	Simplex	40 kbit/s
NINA-B1 (peripheral)	Galaxy S8 (central)	12,12	23	Simplex	76 kbit/s
Galaxy S8 (central)	NINA-B1 (peripheral)	12,12	23	Duplex	38 kbit/s
Galaxy S8 (central)	NINA-B1 (peripheral)	39,39	247	Simplex	470 kbit/s
NINA-B1 (peripheral)	Galaxy S8 (central)	39,39	247	Simplex	685 kbit/s
NINA-B1 (peripheral)	Galaxy S8 (central)	39,39	247	Duplex	319 kbit/s

### 3.7 iOS Device (Central) – NINA-B1 (Peripheral)

Device A	Device B	Connection interval min, max (x * 1.25 ms)	MTU (bytes)	Dataflow	Throughput
iPhone 7 (central)	NINA-B1 (peripheral)	24,24	247	Simplex	194 kbit/s
NINA-B1 (peripheral)	iPhone 7 (central)	24,24	247	Simplex	182 kbit/s
iPhone 7 (central)	NINA-B1 (peripheral)	24,24	247	Duplex	68 kbit/s
NINA-B1 (peripheral)	iPhone 7 (central)	24,24	247	Duplex	74 kbit/s

 Preliminary tests of iPhone 7 with iOS 11 beta 2 shows a throughput of ~350 kbit/s.



## 4 Throughput results for NINA-B1 software v4.0.0

### 4.1 Software versions

ODIN-W2 software v4.0.0

OBS421 software v5.3.2

Android v7.0 with u-blox Bluetooth low energy app

iOS v11.0 with u-blox Bluetooth low energy app

### 4.2 NINA-B1 (Central) - NINA-B1 (Peripheral)

Device A	Device B	PHY	Connection interval min, max (x * 1.25 ms)	MTU (bytes)	Dataflow	Throughput
NINA-B1 (central)	NINA-B1(peripheral)	1 Mbps	6,6	23	Simplex	191 kbit/s
NINA-B1 (peripheral)	NINA-B1(central)	1 Mbps	6,6	23	Simplex	191 kbit/s
NINA-B1 (central)	NINA-B1(peripheral)	1 Mbps	6,6	23	Duplex	131 kbit/s
NINA-B1 (peripheral)	NINA-B1(central)	1 Mbps	6,6	23	Duplex	131 kbit/s
NINA-B1 (central)	NINA-B1(peripheral)	1 Mbps	24,40	247	Simplex	730 kbit/s
NINA-B1 (peripheral)	NINA-B1(central)	1 Mbps	24,40	247	Simplex	730 kbit/s
NINA-B1 (central)	NINA-B1(peripheral)	1 Mbps	24,40	247	Duplex	394 kbit/s
NINA-B1 (peripheral)	NINA-B1(central)	1 Mbps	24,40	247	Duplex	394 kbit/s
NINA-B1 (central)	NINA-B1(peripheral)	2 Mbps	6,6	23	Simplex	264 kbit/s
NINA-B1 (peripheral)	NINA-B1(central)	2 Mbps	6,6	23	Simplex	265 kbit/s
NINA-B1 (central)	NINA-B1(peripheral)	2 Mbps	6,6	23	Duplex	164 kbit/s
NINA-B1 (peripheral)	NINA-B1(central)	2 Mbps	6,6	23	Duplex	164 kbit/s
NINA-B1 (central)	NINA-B1(peripheral)	2 Mbps	6,6	247	Simplex	780 kbit/s
NINA-B1 (peripheral)	NINA-B1(central)	2 Mbps	6,6	247	Simplex	780 kbit/s
NINA-B1 (central)	NINA-B1(peripheral)	2 Mbps	24,40	247	Duplex	764 kbit/s
NINA-B1 (peripheral)	NINA-B1(central)	2 Mbps	24,40	247	Duplex	764 kbit/s

### 4.3 ODIN-W2 (Central) – NINA-B1 (Peripheral)

Device A	Device B	Connection interval min, max (x * 1.25 ms)	MTU (bytes)	Dataflow	Throughput
ODIN-W2 (central)	NINA-B1 (peripheral)	6,6	23	Simplex	82 kbit/s
NINA-B1 (peripheral)	ODIN-W2 (central)	6,6	23	Simplex	31 kbit/s
ODIN-W2 (central)	NINA-B1 (peripheral)	6,6	23	Duplex	74 kbit/s
NINA-B1 (peripheral)	ODIN-W2 (central)	6,6	23	Duplex	17 kbit/s

### 4.4 ODIN-W2 (Peripheral) – NINA-B1 (Central)

Device A	Device B	Connection interval min, max (x * 1.25 ms)	MTU (bytes)	Dataflow	Throughput
NINA-B1 (central)	ODIN-W2 (peripheral)	6,6	23	Simplex	22 kbit/s
ODIN-W2 (peripheral)	NINA-B1(central)	6,6	23	Simplex	42 kbit/s
NINA-B1 (central)	ODIN-W2 (peripheral)	6,6	23	Duplex	10 kbit/s
ODIN-W2 (peripheral)	NINA-B1(central)	6,6	23	Duplex	36 kbit/s

### 4.5 OBS421 (Central) – NINA-B1 (Peripheral)

Device A	Device B	Connection interval min, max (x * 1.25 ms)	MTU (bytes)	Dataflow	Throughput
OBS421 (central)	NINA-B1 (peripheral)	6,40	23	Simplex	85 kbit/s
NINA-B1 (peripheral)	OBS421 (central)	6,40	23	Simplex	56 kbit/s
OBS421 (central)	NINA-B1 (peripheral)	6,40	23	Duplex	72 kbit/s
NINA-B1 (peripheral)	OBS421 (central)	6,40	23	Duplex	36 kbit/s

### 4.6 Android device (Central) – NINA-B1 (Peripheral)

Device A	Device B	PHY	Connection interval min, max (x * 1.25 ms)	MTU (bytes)	Dataflow	Throughput
Galaxy S8 (central)	NINA-B1 (peripheral)	1 Mbps	6,40	23	Simplex	32 kbit/s
NINA-B1 (peripheral)	Galaxy S8 (central)	1 Mbps	6,40	23	Simplex	54 kbit/s
Galaxy S8 (central)	NINA-B1 (peripheral)	1 Mbps	6,40	23	Duplex	32 kbit/s
Galaxy S8 (central)	NINA-B1 (peripheral)	1 Mbps	6,40	247	Simplex	395 kbit/s

Device A	Device B	PHY	Connection interval min, max (x * 1.25 ms)	MTU (bytes)	Dataflow	Throughput
NINA-B1 (peripheral)	Galaxy S8 (central)	1 Mbps	6,40	247	Simplex	614 kbit/s
Galaxy S8 (central)	NINA-B1 (peripheral)	2 Mbps	6,40	23	Simplex	33 kbit/s
NINA-B1 (peripheral)	Galaxy S8 (central)	2 Mbps	6,40	23	Simplex	55 kbit/s
Galaxy S8 (central)	NINA-B1 (peripheral)	2 Mbps	6,40	23	Duplex	33 kbit/s
Galaxy S8 (central)	NINA-B1 (peripheral)	2 Mbps	6,6	247	Simplex	486 kbit/s
NINA-B1 (peripheral)	Galaxy S8 (central)	2 Mbps	6,6	247	Simplex	589 kbit/s

## 4.7 iOS Device (Central) – NINA-B1 (Peripheral)

Device A	Device B	Connection interval min, max (x * 1.25 ms)	MTU (bytes)	Dataflow	Throughput
iPhone 7 (central)	NINA-B1 (peripheral)	6,40	23	Simplex	43 kbit/s
NINA-B1 (peripheral)	iPhone 7 (central)	6,40	23	Simplex	40 kbit/s
iPhone 7 (central)	NINA-B1 (peripheral)	6,40	23	Duplex	25 kbit/s
NINA-B1 (peripheral)	iPhone 7 (central)	6,40	23	Duplex	25 kbit/s
iPhone 7 (central)	NINA-B1 (peripheral)	12,12	247	Simplex	378 kbit/s
NINA-B1 (peripheral)	iPhone 7 (central)	12,12	247	Simplex	357 kbit/s
iPhone 7 (central)	NINA-B1 (peripheral)	40,320	247	Duplex	126 kbit/s
NINA-B1 (peripheral)	iPhone 7 (central)	40,320	247	Duplex	146 kbit/s

## 5 Throughput results for NINA-B1 software v5.0.x/ANNA-B112 software v2.0.x

See the note in chapter 1 for ANNA-B112.

### 5.1 Software versions

ODIN-W2 software v6.0.0

NINA-B1 software v5.0.

NINA-B3 software v1.0

Samsung Galaxy S8 with u-blox Bluetooth low energy app

iPhone 8 with u-blox Bluetooth low energy app

### 5.2 NINA-B1 – NINA-B1, Simplex

Device A	Device B	PHY	MTU	Result (incl. conn.int (x * 1.25 ms))
DUT (central)	DUT (peripheral)	1M	23	191 kbit/s (6,6)
DUT (central)	DUT (peripheral)	1M	247	261 kbit/s (6,6) 743 kbit/s (24,40)
DUT (central)	DUT (peripheral)	2M	247	261 kbit/s (6,6) 743 kbit/s (24,40)

### 5.3 NINA-B1 – NINA-B1, Duplex

Device A	Device B	PHY	MTU	Result (incl. conn.int (x * 1.25 ms))
DUT (central)	DUT (peripheral)	1M	23	130 kbit/s (6,6) 26 kbit/s (24,40)
DUT (peripheral)	DUT (central)	1M	23	130 kbit/s (6,6) 25 kbit/s (24,40)
DUT (central)	DUT (peripheral)	1M	247	232 kbit/s (6,6) 401 kbit/s (24,40)
DUT (peripheral)	DUT (central)	1M	247	231 kbit/s (6,6) 399 kbit/s (24,40)
DUT (central)	DUT (peripheral)	2M	23	176 kbit/s (6,6) 103 kbit/s (24,40)
DUT (peripheral)	DUT (central)	2M	23	179 kbit/s (6,6) 109 kbit/s (24,40)
DUT (central)	DUT (peripheral)	2M	247	595 kbit/s (6,6) 766 kbit/s (24,40)
DUT (peripheral)	DUT (central)	2M	247	590 kbit/s (6,6) 749 kbit/s (24,40)

### 5.4 NINA-B1 – NINA-B3, Simplex

Device A	Device B	PHY	MTU	Result (incl. conn.int (x * 1.25 ms))
DUT (central)	NINA-B3 (peripheral)	1M	247	741 kbit/s (24,40)
DUT (peripheral)	NINA-B3 (central)	1M	247	741 kbit/s (24,40)
DUT (central)	NINA-B3 (peripheral)	2M	247	782 kbit/s (24,40)
DUT (peripheral)	NINA-B3 (central)	2M	247	782 kbit/s (24,40)

## 5.5 NINA-B1 – NINA-B3, Duplex

Device A	Device B	PHY	MTU	Result (incl. conn.int (x * 1.25 ms))
DUT (central)	NINA-B3 (peripheral)	1M	247	396 kbit/s (24,40)
DUT (peripheral)	NINA-B3 (central)	1M	247	401 kbit/s (24,40)
DUT (central)	NINA-B3 (peripheral)	2M	247	726 kbit/s (24,40)
DUT (peripheral)	NINA-B3 (central)	2M	247	762 kbit/s (24,40)

## 5.6 NINA-B1 – ODIN-W2, Simplex

Device A	Device B	PHY	MTU	Result (incl. conn.int (x * 1.25 ms))
DUT (peripheral)	ODIN-W2 (central)	1M	23	95 kbit/s (6,6)
DUT (central)	ODIN-W2 (peripheral)	1M	23	83 kbit/s (6,6)

## 5.7 NINA-B1 – ODIN-W2, Duplex

Device A	Device B	PHY	MTU	Result (incl. conn.int (x * 1.25 ms))
ODIN-W2 (central)	DUT (peripheral)	1M	23	67 kbit/s (6,6)
DUT (peripheral)	ODIN-W2 (central)	1M	23	53 kbit/s (6,6)
ODIN-W2 (peripheral)	DUT (central)	1M	23	59 kbit/s (6,6)
DUT (central)	ODIN-W2 (peripheral)	1M	23	76 kbit/s (6,6)

## 5.8 NINA-B1 – iOS, Simplex

Device A	Device B	PHY	MTU	Result (incl. conn.int (x * 1.25 ms))
iOS (central)	DUT (peripheral)	1M	23	42 kbit/s (24,40)
DUT (peripheral)	iOS (central)	1M	23	42 kbit/s (24,40)
iOS (central)	DUT (peripheral)	1M	247	173 kbit/s (24,40)
DUT (peripheral)	iOS (central)	1M	247	125 kbit/s (24,40)
iOS (central)	DUT (peripheral)	2M	23	60 kbit/s (24,40)
DUT (peripheral)	iOS (central)	2M	23	63 kbit/s (24,40)
iOS (central)	DUT (peripheral)	2M	247	263 kbit/s (24,40)
DUT (peripheral)	iOS (central)	2M	247	253 kbit/s (24,40)

## 5.9 NINA-B1 – iOS, Duplex

Device A	Device B	PHY	MTU	Result (incl. conn.int (x * 1.25 ms))
iOS (central)	DUT (peripheral)	1M	23	35 kbit/s (24,40)
DUT (peripheral)	iOS (central)	1M	23	33 kbit/s (24,40)
iOS (central)	DUT (peripheral)	1M	247	73 kbit/s (24,40)
DUT (peripheral)	iOS (central)	1M	247	66 kbit/s (24,40)
iOS (central)	DUT (peripheral)	2M	23	45 kbit/s (24,40)
DUT (peripheral)	iOS (central)	2M	23	53 kbit/s (24,40)
iOS (central)	DUT (peripheral)	2M	247	165 kbit/s (24,40)
DUT (peripheral)	iOS (central)	2M	247	164 kbit/s (24,40)

## 5.10 NINA-B1 – Android Device, Simplex

Device A	Device B	PHY	MTU	Result (incl. conn.int (x * 1.25 ms))
Android (central)	DUT (peripheral)	1M	23	26 kbit/s (24,40)
DUT (peripheral)	Android (central)	1M	23	29 kbit/s (24,40)
Android (central)	DUT (peripheral)	1M	247	373 kbit/s (24,40)
DUT (peripheral)	Android (central)	1M	247	702 kbit/s (24,40)
DUT (peripheral)	Android (central)	2M	23	40 kbit/s (24,40)
Android (central)	DUT (peripheral)	2M	247	307 kbit/s (24,40)
DUT (peripheral)	Android (central)	2M	247	777 kbit/s (24,40)

## 5.11 NINA-B1 – Android Device, Duplex

Device A	Device B	PHY	MTU	Result (incl. conn.int (x * 1.25 ms))
Android (central)	DUT (peripheral)	1M	23	21 kbit/s (24,40)
DUT (peripheral)	Android (central)	1M	23	21 kbit/s (24,40)
Android (central)	DUT (peripheral)	1M	247	383 kbit/s (24,40)
DUT (peripheral)	Android (central)	1M	247	392 kbit/s (24,40)
Android (central)	DUT (peripheral)	2M	23	26 kbit/s (24,40)
DUT (peripheral)	Android (central)	2M	23	32 kbit/s (24,40)
Android (central)	DUT (peripheral)	2M	247	327 kbit/s (24,40)
DUT (peripheral)	Android (central)	2M	247	608 kbit/s (24,40)

## 6 Throughput results for NINA-B3 software v2.0.x

### 6.1 Software versions

ODIN-W2 software v6.0.0

NINA-B1 software v4.0.

Android v9.0 with u-blox Bluetooth low energy app

iOS v12.1.2 with u-blox Bluetooth low energy app

In this chapter the DUT = NINA-B3 SW 2.0.0.

### 6.2 NINA-B3 - NINA-B3, Simplex

Device A	Device B	PHY	MTU	Result (incl. conn.int (x * 1.25 ms))
DUT (central)	DUT (peripheral)	1M	23	191 kbit/s (6,6) 26 kbit/s (24,40)
DUT (central)	DUT (peripheral)	1M	247	261 kbit/s (6,6) 741 kbit/s (24,40)
DUT (central)	DUT (peripheral)	2M	23	276 kbit/s (6,6) 227 kbit/s (24,40)
DUT (central)	DUT (peripheral)	2M	247	782 kbit/s (6,6) 625 kbit/s (24,40)

### 6.3 NINA-B3 - NINA-B3, Duplex

Device A	Device B	PHY	MTU	Result (incl. conn.int (x * 1.25 ms))
DUT (central)	DUT (peripheral)	1M	23	130 kbit/s (6,6) 26 kbit/s (24,40)
DUT (peripheral)	DUT (central)	1M	23	129 kbit/s (6,6) 25 kbit/s (24,40)
DUT (central)	DUT (peripheral)	1M	247	232 kbit/s (6,6) 401 kbit/s (24,40)
DUT (peripheral)	DUT (central)	1M	247	231 kbit/s (6,6) 399 kbit/s (24,40)
DUT (central)	DUT (peripheral)	2M	23	175 kbit/s (6,6) 105 kbit/s (24,40)
DUT (peripheral)	DUT (central)	2M	23	178 kbit/s (6,6) 110 kbit/s (24,40)
DUT (central)	DUT (peripheral)	2M	247	596 kbit/s (6,6) 763 kbit/s (24,40)
DUT (peripheral)	DUT (central)	2M	247	590 kbit/s (6,6) 754 kbit/s (24,40)

### 6.4 NINA-B3 - NINA-B1, Simplex

Device A	Device B	PHY	MTU	Result (incl. conn.int (x * 1.25 ms))
DUT (central)	NINA-B1 (peripheral)	1M	247	576 kbit/s (24,40)
NINA-B1 (central)	DUT (peripheral)	1M	247	613 kbit/s (24,40)

Device A	Device B	PHY	MTU	Result (incl. conn.int (x * 1.25 ms))
DUT (central)	NINA-B1 (peripheral)	2M	247	780 kbit/s (6,6)
NINA-B1 (central)	DUT (peripheral)	2M	247	780 kbit/s (6,6)

## 6.5 NINA-B3 - NINA-B1, Duplex

Device A	Device B	PHY	MTU	Result (incl. conn.int (x * 1.25 ms))
DUT (central)	NINA-B1 (peripheral)	1M	247	319 kbit/s (24,40)
NINA-B1 (peripheral)	DUT (central)	1M	247	318 kbit/s (24,40)
DUT (peripheral)	NINA-B1 (central)	1M	247	331 kbit/s (24,40)
NINA-B1 (central)	DUT (peripheral)	1M	247	332 kbit/s (24,40)
DUT (central)	NINA-B1 (peripheral)	2M	247	508 kbit/s (24,40)
NINA-B1 (peripheral)	DUT (central)	2M	247	504 kbit/s (24,40)
DUT (peripheral)	NINA-B1 (central)	2M	247	512 kbit/s (24,40)
NINA-B1 (central)	DUT (peripheral)	2M	247	517 kbit/s (24,40)

## 6.6 NINA-B3 – ODIN-W2, Simplex

Device A	Device B	PHY	MTU	Result (incl. conn.int (x * 1.25 ms))
ODIN-W2 (central)	DUT (peripheral)	1M	23	82 kbit/s (6,6)
DUT (peripheral)	ODIN-W2 (central)	1M	23	83 kbit/s (6,6)

## 6.7 NINA-B3 – ODIN-W2, Duplex

Device A	Device B	PHY	MTU	Result (incl. conn.int (x * 1.25 ms))
ODIN-W2 (central)	DUT (peripheral)	1M	23	45 kbit/s (6,6)
DUT (peripheral)	ODIN-W2 (central)	1M	23	68 kbit/s (6,6)

## 6.8 NINA-B3 – iOS, Simplex

Device A	Device B	PHY	MTU	Result (conn.int. factory default (x * 1.25 ms))
iOS (central)	DUT (peripheral)	1M	23	42 kbit/s (24,40)
DUT (peripheral)	iOS (central)	1M	23	47 kbit/s (24,40)
iOS (central)	DUT (peripheral)	1M	247	192 kbit/s (24,40)
DUT (peripheral)	iOS (central)	1M	247	188 kbit/s (24,40)
iOS (central)	DUT (peripheral)	2M	23	56 kbit/s (24,40)
DUT (peripheral)	iOS (central)	2M	23	62 kbit/s (24,40)
iOS (central)	DUT (peripheral)	2M	247	323 kbit/s (24,40)
DUT (peripheral)	iOS (central)	2M	247	314 kbit/s (24,40)

## 6.9 NINA-B3 – iOS, Duplex

Device A	Device B	PHY	MTU	Result (conn.int. factory default (x * 1.25 ms))
iOS (central)	DUT (peripheral)	1M	23	33 kbit/s (24,40)
DUT (peripheral)	iOS (central)	1M	23	33 kbit/s (24,40)
iOS (central)	DUT (peripheral)	1M	247	71 kbit/s (24,40)
DUT (peripheral)	iOS (central)	1M	247	67 kbit/s (24,40)
iOS (central)	DUT (peripheral)	2M	23	46 kbit/s (24,40)
DUT (peripheral)	iOS (central)	2M	23	52 kbit/s (24,40)



Device A	Device B	PHY	MTU	Result (conn.int. factory default (x * 1.25 ms))
iOS (central)	DUT (peripheral)	2M	247	183 kbit/s (24,40)
DUT (peripheral)	iOS (central)	2M	247	166 kbit/s (24,40)

## 6.10 NINA-B3 – Android Device, Simplex

Device A	Device B	PHY	MTU	Result (conn.int. factory default (x * 1.25 ms))
Android (central)	DUT (peripheral)	1M	23	26 kbit/s (24,40)
DUT (peripheral)	Android (central)	1M	23	150 kbit/s (24,40)
Android (central)	DUT (peripheral)	1M	247	670 kbit/s (24,40)
DUT (peripheral)	Android (central)	1M	247	708 kbit/s (24,40)
Android (central)	DUT (peripheral)	2M	23	26 kbit/s (24,40)
DUT (peripheral)	Android (central)	2M	23	100 kbit/s (24,40)
Android (central)	DUT (peripheral)	2M	247	364 kbit/s (24,40)
DUT (peripheral)	Android (central)	2M	247	768 kbit/s (24,40)

## 6.11 NINA-B3 – Android Device, Duplex

Device A	Device B	PHY	MTU	Result (conn.int. factory default (x * 1.25 ms))
Android (central)	DUT (peripheral)	1M	23	45 kbit/s (24,40)
DUT (peripheral)	Android (central)	1M	23	172 kbit/s (24,40)
Android (central)	DUT (peripheral)	1M	247	408 kbit/s (24,40)
DUT (peripheral)	Android (central)	1M	247	392 kbit/s (24,40)
Android (central)	DUT (peripheral)	2M	23	52 kbit/s (24,40)
DUT (peripheral)	Android (central)	2M	23	172 kbit/s (24,40)
Android (central)	DUT (peripheral)	2M	247	730 kbit/s (24,40)
DUT (peripheral)	Android (central)	2M	247	750 kbit/s (24,40)

## 7 Throughput results for NINA-B2 software v1.0.x

### 7.1 Software versions

ODIN-W2 software v6.0.0

NINA-B1 software v4.0.1 (unofficial)

Samsung Galaxy S8 with u-blox Bluetooth low energy app

iPhone 8 with u-blox Bluetooth low energy app

In this chapter the DUT = NINA-B2 SW 1.0.0.

### 7.2 NINA-B2 – NINA-B2, Simplex

Device A	Device B	PHY	MTU	Result (including connection interval)
DUT (central)	DUT (peripheral)	1M	23	95 (7.5 ms)
DUT (peripheral)	DUT (central)	1M	23	94 (7.5 ms)
DUT (central)	DUT (peripheral)	1M	247	385 (16.25 ms)
DUT (peripheral)	DUT (central)	1M	247	388 (16.25 ms)
DUT (central)	DUT (peripheral)	2M	23	N/A
DUT (peripheral)	DUT (central)	2M	23	N/A
DUT (central)	DUT (peripheral)	2M	247	N/A
DUT (peripheral)	DUT (central)	2M	247	N/A

### 7.3 NINA-B2 – NINA-B2, Duplex

Device A	Device B	PHY	MTU	Result (including connection interval)
DUT (central)	DUT (peripheral)	1M	23	56 (7.5 ms)
DUT (peripheral)	DUT (central)	1M	23	81 (7.5 ms)
DUT (central)	DUT (peripheral)	1M	247	212 (25 ms)
DUT (peripheral)	DUT (central)	1M	247	210 (25 ms)
DUT (central)	DUT (peripheral)	2M	23	N/A
DUT (peripheral)	DUT (central)	2M	23	N/A
DUT (central)	DUT (peripheral)	2M	247	N/A
DUT (peripheral)	DUT (central)	2M	247	N/A

### 7.4 NINA-B2 – NINA-B1, Simplex

Device A	Device B	PHY	MTU	Result ( including connection interval)
DUT (central)	NINA-B1 (peripheral)	1M	23	50 (7.5 ms)
DUT (peripheral)	NINA-B1 (central)	1M	23	124 (7.5 ms)
DUT (central)	NINA-B1 (peripheral)	1M	247	520 (18.75 ms)
DUT (peripheral)	NINA-B1 (central)	1M	247	540 (18.75 ms)
DUT (central)	NINA-B1 (peripheral)	2M	23	N/A
DUT (peripheral)	NINA-B1 (central)	2M	23	N/A
DUT (central)	NINA-B1 (peripheral)	2M	247	N/A

Device A	Device B	PHY	MTU	Result ( including connection interval)
DUT (peripheral)	NINA-B1 (central)	2M	247	N/A

## 7.5 NINA-B2 – NINA-B1, Duplex

Device A	Device B	PHY	MTU	Result (including connection interval)
DUT (central)	NINA-B1 (peripheral)	1M	23	30 (7.5 ms)
DUT (peripheral)	NINA-B1 (central)	1M	23	92 (18.5 ms)
DUT (central)	NINA-B1 (peripheral)	1M	247	263 (18.5 ms)
DUT (peripheral)	NINA-B1 (central)	1M	247	260 (18.75 ms)
DUT (central)	NINA-B1 (peripheral)	2M	23	N/A
DUT (peripheral)	NINA-B1 (central)	2M	23	N/A
DUT (central)	NINA-B1 (peripheral)	2M	247	N/A
DUT (peripheral)	NINA-B1 (central)	2M	247	N/A

## 7.6 NINA-B2 – ODIN-W2, Simplex

Device A	Device B	PHY	MTU	Result (including connection interval)
ODIN-W2 (central)	DUT (peripheral)	1M	23	81 (7.5 ms)
DUT (peripheral)	ODIN-W2 (central)	1M	23	81 (7.5 ms)
ODIN-W2 (peripheral)	DUT (central)	1M	23	122 (7.5 ms)
DUT (central)	ODIN-W2 (peripheral)	1M	23	142 (7.5 ms)

## 7.7 NINA-B2 – ODIN-W2, Duplex

Device A	Device B	PHY	MTU	Result (including connection interval)
ODIN-W2 (central)	DUT (peripheral)	1M	23	44 (7.5 ms)
DUT (peripheral)	ODIN-W2 (central)	1M	23	66 (7.5 ms)
ODIN-W2 (peripheral)	DUT (central)	1M	23	75 (7.5 ms)
DUT (central)	ODIN-W2 (peripheral)	1M	23	81 (7.5 ms)

## 7.8 NINA-B2 – iOS Device, Simplex

Device A	Device B	PHY	MTU	Result (including connection interval)
iOS (central)	DUT (peripheral)	1M	23	27 (7.5 ms)
DUT (peripheral)	iOS (central)	1M	23	27 (7.5 ms)
iOS (central)	DUT (peripheral)	1M	247	185 (30 ms)
DUT (peripheral)	iOS (central)	1M	247	131 (30 ms)
iOS (central)	DUT (peripheral)	2M	23	N/A
DUT (peripheral)	iOS (central)	2M	23	N/A
iOS (central)	DUT (peripheral)	2M	247	N/A
DUT (peripheral)	iOS (central)	2M	247	N/A

## 7.9 NINA-B2 – iOS Device, Duplex

Device A	Device B	PHY	MTU	Result (including connection interval)
iOS (central)	DUT (peripheral)	1M	23	22 (7.5 ms)
DUT (peripheral)	iOS (central)	1M	23	12 (7.5 ms)
iOS (central)	DUT (peripheral)	1M	182	65 (30 ms)

Device A	Device B	PHY	MTU	Result (including connection interval)
DUT (peripheral)	iOS (central)	1M	182	65 (30 ms)
iOS (central)	DUT (peripheral)	2M	23	N/A
DUT (peripheral)	iOS (central)	2M	23	N/A
iOS (central)	DUT (peripheral)	2M	247	N/A
DUT (peripheral)	iOS (central)	2M	247	N/A

## 7.10 NINA-B2 – Android Device, Simplex

Device A	Device B	PHY	MTU	Result (including connection interval)
Android (central)	DUT (peripheral)	1M	23	15 (7.5 ms) (High connection priority)
DUT (peripheral)	Android (central)	1M	23	122 (7.5 ms) (High connection priority)
Android (central)	DUT (peripheral)	1M	247	224 (7.5 ms) (High connection priority)
DUT (peripheral)	Android (central)	1M	247	442 (7.5 ms) (High connection priority)
Android (central)	DUT (peripheral)	2M	23	N/A
DUT (peripheral)	Android (central)	2M	23	N/A
Android (central)	DUT (peripheral)	2M	247	N/A
DUT (peripheral)	Android (central)	2M	247	N/A

## 7.11 NINA-B2 – Android Device, Duplex

Device A	Device B	PHY	MTU	Result (including connection interval)
Android (central)	DUT (peripheral)	1M	23	11 (7.5 ms) (High connection priority)
DUT (peripheral)	Android (central)	1M	23	121 (7.5 ms) (High connection priority)
Android (central)	DUT (peripheral)	1M	247	205 (7.5 ms) (High connection priority)
DUT (peripheral)	Android (central)	1M	247	328 (7.5 ms) (High connection priority)
Android (central)	DUT (peripheral)	2M	23	N/A
DUT (peripheral)	Android (central)	2M	23	N/A
Android (central)	DUT (peripheral)	2M	247	N/A
DUT (peripheral)	Android (central)	2M	247	N/A

# Appendix


## A Glossary

Abbreviation	Definition
ATT	Attribute Protocol
DUT	Device Under Test
LE	Low Energy
LL	Link Layer
MTU	Maximum Transmission Unit
PDU	Protocol Data Unit
PHY	Physical Layer
SPS	Serial Port Service
SW	Software
UART	Universal Asynchronous Receiver-Transmitter serial interface

**Table 2: Explanation of the abbreviations and terms used**

## Related documents

- [1] u-connect AT Commands Manual, document number [UBX-14044127](#)
- [2] u-blox Low Energy Serial Port Service Protocol Specification, document number [UBX-16011192](#)
- [3] s-center Evaluation software - <https://www.u-blox.com/en/product/s-center>
- [4] s-center User Guide, document number [UBX-16012261](#)

 For regular updates to u-blox documentation and to receive product change notifications, register on our homepage ([www.u-blox.com](http://www.u-blox.com)).

## Revision history

Revision	Date	Name	Comments
R01	30-Jun-2017	tvon, kgom	Initial release.
R02	24-Apr-2018	apet, kgom	Included support and throughput results for NINA-B1 software version 4.0.0. Added the AT commands for configuration.
R03	22-May-2019	mapc, kgom	Added results for NINA-B3, NINA-B2 and ANNA-B1 12. Renamed this document.

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