AN1385: Performance Results for Multi-PAN RCP for OpenThread and Zigbee

This document summarizes the results of simultaneous Thread and Zigbee throughput performance testing for the concurrent multiprotocol / multi-PAN RCP, running both OpenThread and Zigbee on the host processor.

KEY POINTS

- Test plan strategy
- Approach and dependencies
- Test methodology
- Testbed and topologies
- Summary of results
- Results comparisons

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1 Introduction

This document summarizes the results of simultaneous Thread and Zigbee throughput performance testing for the concurrent multiprotocol / multi-PAN Radio Co-Processor (RCP), running both OpenThread and Zigbee on the host processor. The multiprotocol RCP architecture relies heavily on the serial transport and multiplexing capabilities provided by the Co-processor Communication daemon (CPCd), so this is one of the crucial components under test in the system.

The goal of this testing is to validate the performance of the Multiprotocol RCP solution, including CPCd. In particular, results demonstrate that throughput performance of the multiprotocol RCP for both Zigbee and Thread is comparable to that of a single-protocol SoC device.

See AN1333: Running Zigbee, OpenThread, and Bluetooth Concurrently on a Linux Host with a Multiprotocol RCP for a detailed description of the Multiprotocol RCP system's architecture, configuration, and usage, including CPCd

Terms used in this document:

OT OpenThread

Zig Zigbee protocol

DuT Device Under Test

DMP Dynamic Multiprotocol

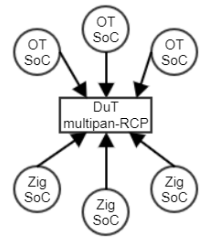
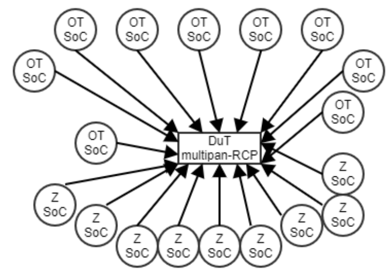
RCP Radio co-processor

SoC System-on-chip

CPCd Co-processor Communication Daemon

2 Test Plan Strategy

This test plan is focused on the performance of CPC using mixed protocol traffic streams over a variety of scenarios and configurations, such as serial baud rates and traffic payload sizes.

Scenario	Devices	Notes	Illustrated Topology
3x3	3 SoC Devices OT 3 Soc Devices Zigbee	Basic setup and validation.	
9x9	9 SoC Devices OT 9 Soc Devices Zigbee	Ideal setup to stress and prove.	
15x15	15 SoC Devices OT 15 Soc Devices Zigbee	Stays under the default route table size (16), as well as under the REED min for router role.	The same setup as above but with more devices
Greater sizes (y)x(z)	(y) SoC Devices OT (z) Soc Devices Zigbee		The same setup as above but with more devices.

Variables for the above scenario include but are not limited to vectors for payload size, transmit rate, jitter rate, board type, interface type (UART-USB, UART-EXP, SPI) and comparisons to non-CPC devices.

3 Test Approach and Dependencies

This test effort uses open wireless devices in the Silicon Labs Boston office. The automation is written in Java™ and leverages a set of utilities for communicating with the test device via TCP. This supports simultaneous command transmission to many devices via the application console ports.

Networks are created for OpenThread (OT) and Zigbee (Zig) using the wireless SoC devices around the office. This is independent of the DuT (Device Under Test). Normally, these networks can stay up for days or weeks while the DuT continually changes code when needed and just reattaches/rejoins to these existing test networks.

The DuT starts and checks CPCd, then initiates and checks the OT and Zig processes. Next, the DuT either forms or attaches to each network.

For these tests, the DuT is not a leader or coordinator of either network, but a router on both.

Traffic is generated from the Zig and OT SoC devices (whether 3x3, 9x9, NxN) by providing the address of the DuT for each protocol.

Collection is based on CLI output from OT ping and Zigbee throughput component. These consoles are parsed and mined for discrete data metrics that are written to .csv files on completion of test runs.

4 Test Methodology

Java classes and utilities are used to control and collect data from the SoCs around the office as they transmit bursts of traffic data to the DuT.

The test measurement tools provide some basic metrics by using OT ping and Zig throughput component at the same time for mixed traffic streams. Initiatives exist to develop better traffic measurement APIs tools in the future.

The OT and Zig data streams are not equivalent. OT uses the Internet Control Message Protocol (ICMP), for which the receiver (DuT) encapsulates the received payload by adding a 4-byte header to it to be sent back to sender. This effectively transmits the payload twice and exacerbates stress with greater size and fragmentation.

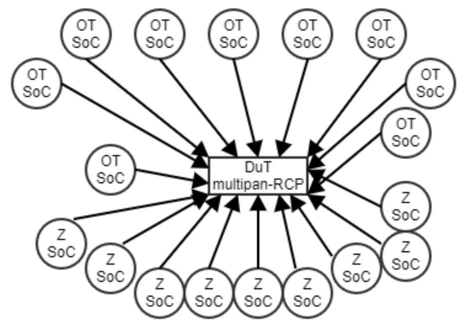
Zigbee throughput does not return the sent payload. ACKs, and counters are used to determine success and provide measurements. Zigbee traffic is minimal compared to OT traffic.

The following illustrates the test setup.

Traffic flow is being directed at the DuT.

Many->One, where the One is the DuT.

Current testing assumes all devices are within 1 hop.



The following sections provide additional details on the traffic created.

4.1 Open Thread

OT testing used ping (ICMP) with a variable payload of 8 bytes up to a maximum of 1232 bytes.

https://github.com/openthread/openthread/blob/main/src/cli/README.md#ping--i-source-ipaddr-size-count-interval-hoplimit-timeout

```
ping [-I source] <ipaddr> [size] [count] [interval] [hoplimit] [timeout]
```

Example:

```
> ping -I fd00:db8:0:0:76b:6a05:3ae9:a61a ff02::1 100 1 1 1
> 108 bytes from fd00:db8:0:0:f605:fb4b:d429:d59a: icmp_seq=4 hlim=64 time=7ms
1 packets transmitted, 1 packets received. Round-trip min/avg/max = 7/7.0/7 ms.
Done
```

For the 100-byte payload specified above, the total packet size = ~55 bytes for header + payload. Therefore the packet transmitted over-the-air for the above command had a total packet size of ~155 bytes.

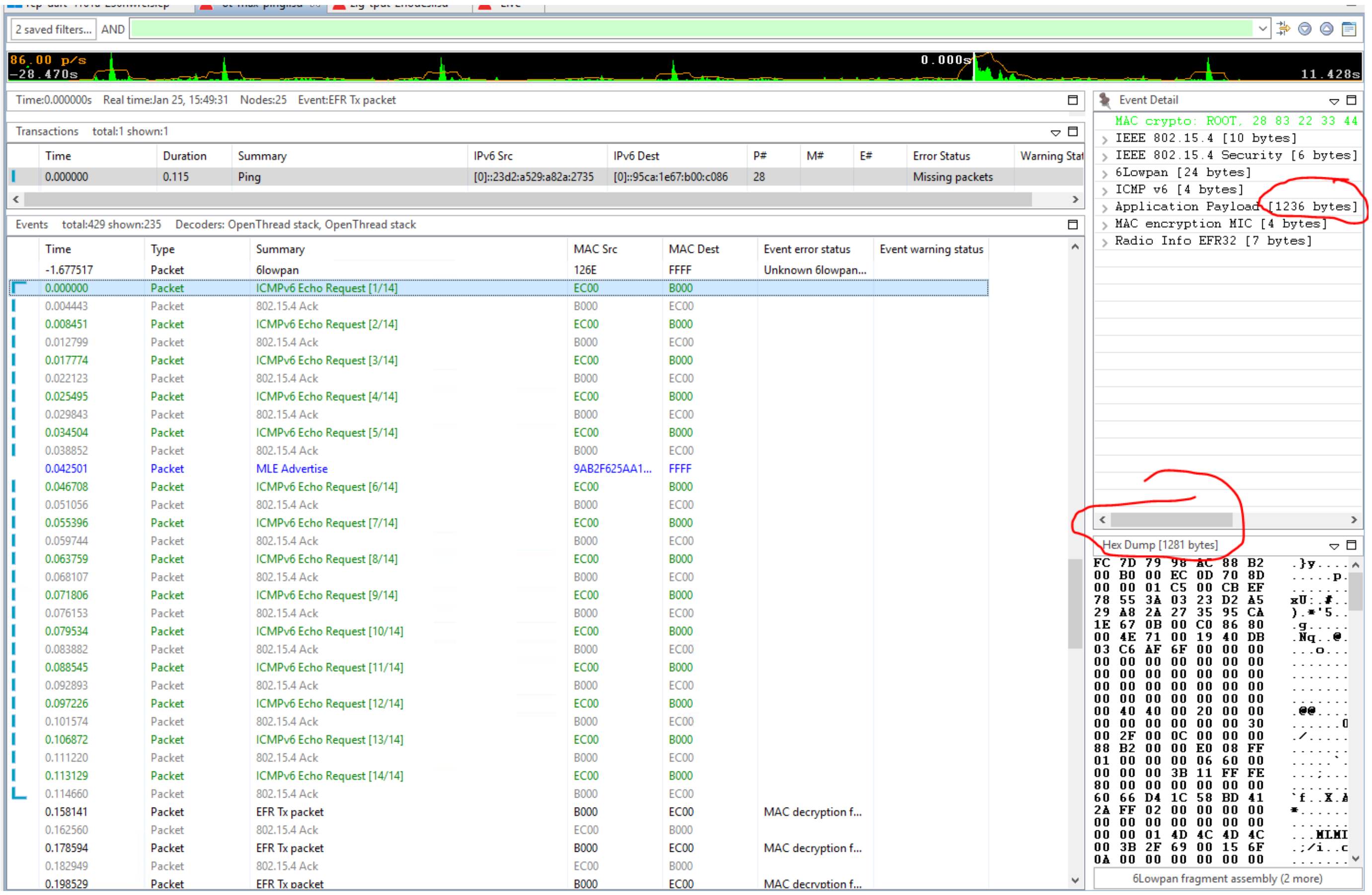
The ping API’s count was set to 1000 total iterations. Each discrete ping response and time was printed before the final summary. The following is the discrete data collected and used for the latency charts, for example:

```
ping fe80:0:0:0:6066:d41c:58bd:412a 8 3 1 1 1
16 bytes from fe80:0:0:0:6066:d41c:58bd:412a: icmp_seq=23861 hlim=64 time=14ms
16 bytes from fe80:0:0:0:6066:d41c:58bd:412a: icmp_seq=23862 hlim=64 time=13ms
16 bytes from fe80:0:0:0:6066:d41c:58bd:412a: icmp_seq=23863 hlim=64 time=12ms
3 packets transmitted, 3 packets received. Packet loss = 0.0%. Round-trip min/avg/max = 12/13.0/14
ms.
Done
```

At around 80 bytes of payload (~135 total bytes) OT packets are fragmented.

OT maximum payload size=1232 bytes and uses 14 packet fragments each way.

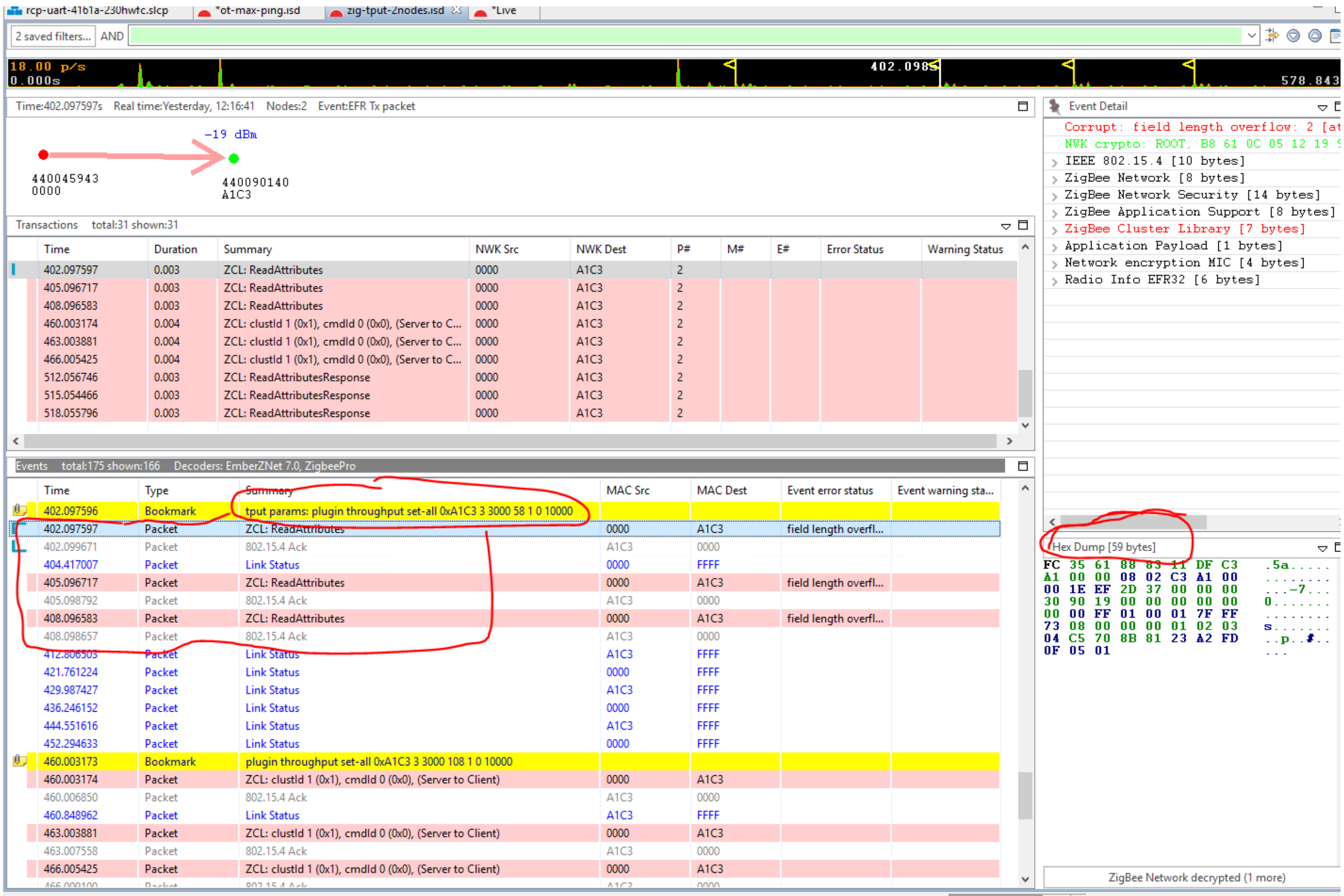
The following is a snapshot from a Network Analyzer (NA) capture trace. Notice the timing and payload sizes (NA combines the fragment sizes to display total of all fragments).



4.2 Zigbee

Zigbee testing used the Zigbee Throughput component.

This API cannot send fragmented packets. The maximum payload size is 72 bytes with a 57-byte header, for a maximum packet size of 129 bytes. The following Network Analyzer capture trace snapshot shows the Zigbee timing and payload sizes.



5 Testbed and Topologies

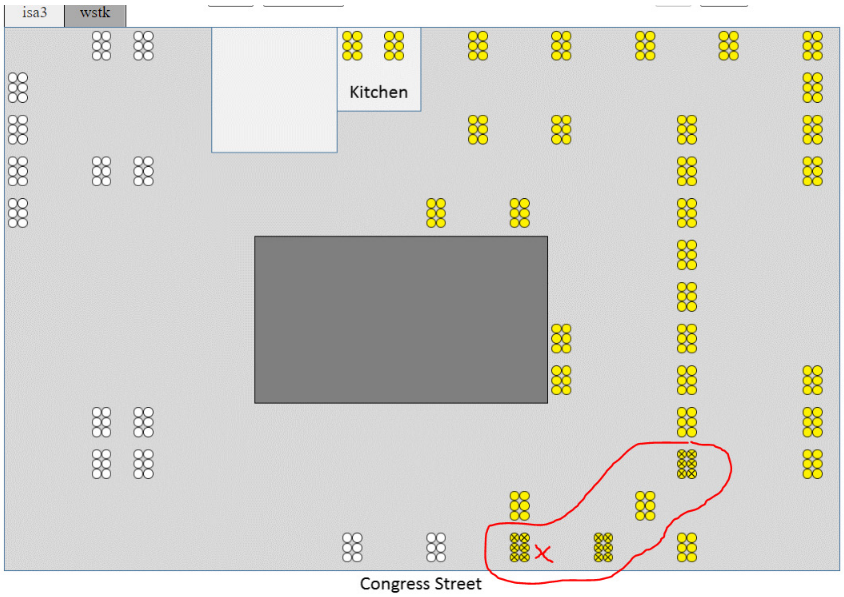
The DuT uses Silicon Labs' wireless starter kit (WSTK) debug adapter and a Raspberry Pi as the host to cover the configurations of varying baud rates and UART serial configurations, as well as SPI. The UART setup uses the USB connection for the VCOM serial configuration and expansion ports on the WSTK and Raspberry Pi for GPIO configuration.

This serial link can be a big bottleneck given that the 15.4 protocols can operate at around 250 kbps. Additionally, without flow control there are no guarantees that data is not lost over this serial link.

The test topology used for this document is the open wireless network around the software quality assurance (SQA) pod at the Silicon Labs Boston office. This office space is approximately 20,000 square feet with hundreds of test devices uniformly distributed.

The three clusters of six shown below and marked with 'x' are approximately 8 m apart (25 feet).

The red 'x' identifies the DuT location.



6 Test Results Summary

Discrete data is not yet available for Zigbee, so it is not charted. The summary data from the Zigbee Throughput component is shown in the table to the left of the chart.

When reading these charts, note the left vertical y-axis markings, as they change for each chart. That is the high-water mark for time for Round Trip Time (RTT) for an OT ping. The horizontal x-axis shows each iteration of the test run.

The rate shown in the tables is how often that device is transmitting data. We increase this value as traffic increases. Finding the sweet spot with zero data loss at the highest possible traffic rates is one goal of this test effort.

Also note that when very high discrete data is recorded, there may be a bug in the GitHub OT logic for calculating ping returns when greater than a certain threshold. It does not seem to be linear nor does it correlate with the time to return that data. The issue is under investigation.

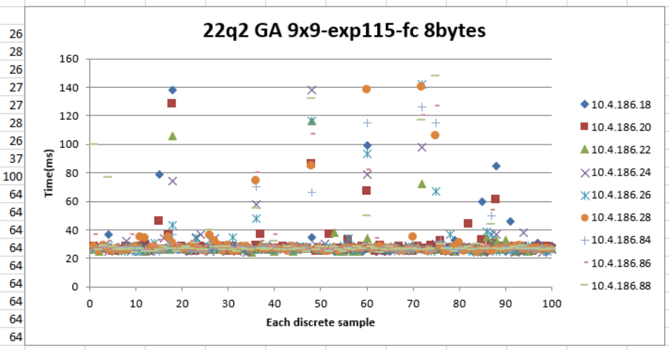
The following results are from a 9x9 topology and baud rates of 115 kbps, 230 kbps, 460 kbps, and 921 kbps using hardware flow control (HWFC). The charts use OT discrete data only. The Min/Max/Avg is shown for both OT and Zigbee.

Table 6.1. UART EXP 115k HWFC

Size	Results
8	(see below)
256	(see below)
1024	(see below)

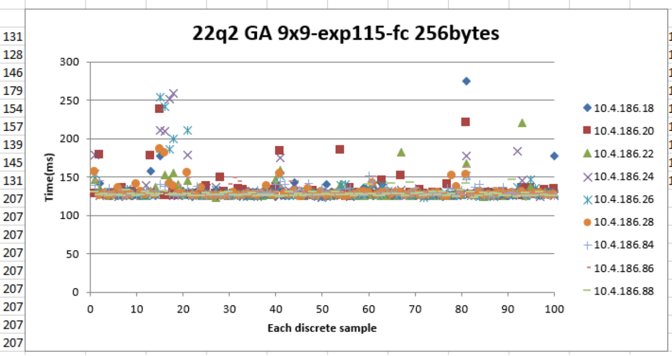
Size 8

PROTO	SIZE	RATE	JIT	TX	RX	LOSS	MIN	AVG	MAX	
OT	8	1000	50	100	100	0	24	30	138	26
OT	8	1000	50	100	100	0	25	29	128	28
OT	8	1000	50	100	100	0	24	29	116	26
OT	8	1000	50	100	100	0	24	30	138	27
OT	8	1000	50	100	100	0	24	30	142	27
OT	8	1000	50	100	100	0	24	31	140	28
OT	8	1000	50	100	100	0	25	30	126	26
OT	8	1000	50	100	100	0	24	31	127	37
OT	8	1000	50	100	100	0	24	32	148	100
ZIG	8	1000	50	100	100	0	52	53	68	64
ZIG	8	1000	50	100	100	0	52	53	62	64
ZIG	8	1000	50	100	100	0	52	55	64	64
ZIG	8	1000	50	100	100	0	52	53	60	64
ZIG	8	1000	50	100	100	0	52	54	69	64
ZIG	8	1000	50	100	100	0	51	53	64	64
ZIG	8	1000	50	100	100	0	52	53	68	64
ZIG	8	1000	50	100	100	0	52	54	65	64
ZIG	8	1000	50	100	100	0	51	53	59	64



Size 256

PROTO	SIZE	RATE	JIT	TX	RX	LOSS	MIN	AVG	MAX	
OT	256	3000	150	100	100	0	124	131	275	131
OT	256	3000	150	100	100	0	124	132	238	128
OT	256	3000	150	100	100	0	123	132	220	146
OT	256	3000	150	100	100	0	123	135	259	179
OT	256	3000	150	100	100	0	123	133	254	154
OT	256	3000	150	100	100	0	124	130	186	157
OT	256	3000	150	100	100	0	124	130	151	139
OT	256	3000	150	100	100	0	124	129	163	145
OT	256	3000	150	100	100	0	123	128	147	131
ZIG	77	3000	150	100	100	0	54	55	69	207
ZIG	77	3000	150	100	100	0	54	55	68	207
ZIG	77	3000	150	100	100	0	54	55	63	207
ZIG	77	3000	150	100	100	0	54	55	64	207
ZIG	77	3000	150	100	100	0	54	55	60	207
ZIG	77	3000	150	100	100	0	54	55	58	207
ZIG	77	3000	150	100	100	0	54	55	67	207
ZIG	77	3000	150	100	100	0	54	55	63	207
ZIG	77	3000	150	100	100	0	54	56	71	207



Size 1024

PROTO	SIZE	RATE	JIT	TX	RX	LOSS	MIN	AVG	MAX	
OT	1024	5000	300	100	100	0	528	886	8355	579
OT	1024	5000	300	100	96	4	597	947	8343	635
OT	1024	5000	300	100	96	4	627	1062	8332	729
OT	1024	5000	300	100	96	4	623	1196	8329	832
OT	1024	5000	300	100	92	8	750	1345	8326	920
OT	1024	5000	300	100	94	6	550	1463	8313	1039
OT	1024	5000	300	100	96	4	587	1475	8354	1077
OT	1024	5000	300	100	94	6	661	1563	10644	1072
OT	1024	5000	300	100	95	5	603	1576	10647	1078
ZIG	77	5000	300	100	100	0	54	56	70	124
ZIG	77	5000	300	100	100	0	53	56	83	124
ZIG	77	5000	300	100	100	0	54	56	68	124
ZIG	77	5000	300	100	100	0	54	55	76	124
ZIG	77	5000	300	100	100	0	54	55	66	124
ZIG	77	5000	300	100	100	0	54	55	65	124
ZIG	77	5000	300	100	100	0	54	55	77	124
ZIG	77	5000	300	100	100	0	54	55	67	124
ZIG	77	5000	300	100	100	0	54	56	68	124

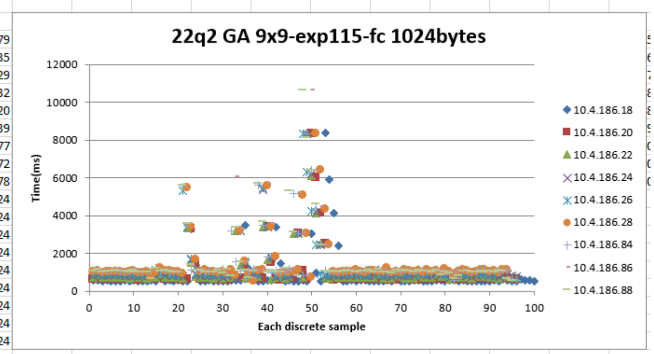
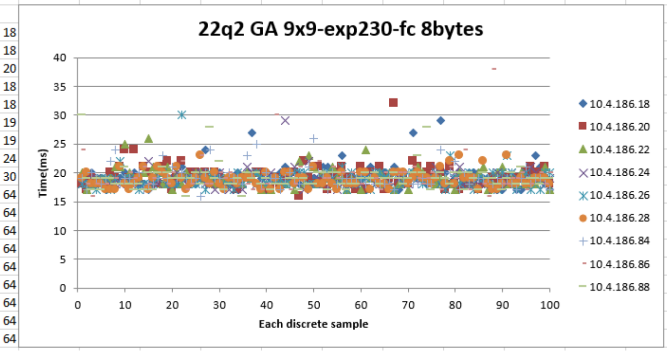


Table 6.2. UART EXP 230k HWFC

Size	Results

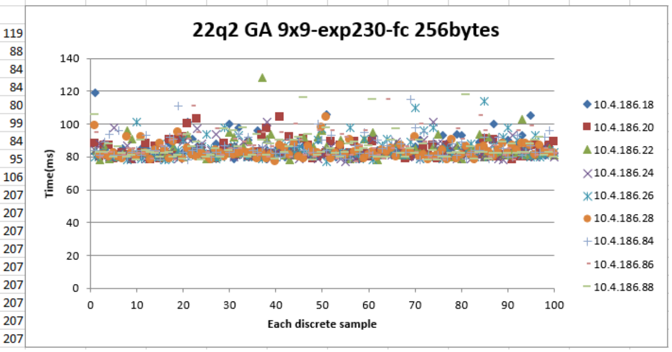
8

PROTO	SIZE	RATE	JIT	TX	RX	LOSS	MIN	AVG	MAX	
OT	8	1000	50	100	100	0	17	19	29	18
OT	8	1000	50	100	100	0	16	19	32	18
OT	8	1000	50	100	100	0	17	19	26	20
OT	8	1000	50	100	100	0	17	18	29	18
OT	8	1000	50	100	100	0	17	18	30	18
OT	8	1000	50	100	100	0	17	18	23	19
OT	8	1000	50	100	100	0	16	19	26	19
OT	8	1000	50	100	100	0	16	19	38	24
OT	8	1000	50	100	100	0	16	19	30	30
ZIG	8	1000	50	100	100	0	51	53	62	64
ZIG	8	1000	50	100	100	0	51	54	68	64
ZIG	8	1000	50	100	100	0	52	53	61	64
ZIG	8	1000	50	100	100	0	52	53	62	64
ZIG	8	1000	50	100	100	0	51	54	63	64
ZIG	8	1000	50	100	100	0	52	55	69	64
ZIG	8	1000	50	100	100	0	51	55	68	64
ZIG	8	1000	50	100	100	0	51	53	58	64
ZIG	8	1000	50	100	100	0	51	53	57	64



256

PROTO	SIZE	RATE	JIT	TX	RX	LOSS	MIN	AVG	MAX	
OT	256	3000	150	100	100	0	79	85	119	119
OT	256	3000	150	100	100	0	78	83	104	88
OT	256	3000	150	100	100	0	78	84	128	84
OT	256	3000	150	100	100	0	77	83	101	84
OT	256	3000	150	100	100	0	77	84	114	80
OT	256	3000	150	100	100	0	77	83	104	99
OT	256	3000	150	100	100	0	78	85	115	84
OT	256	3000	150	100	100	0	77	86	115	95
OT	256	3000	150	100	100	0	78	85	118	106
ZIG	77	3000	150	100	100	0	54	56	83	207
ZIG	77	3000	150	100	100	0	54	55	65	207
ZIG	77	3000	150	100	100	0	54	56	68	207
ZIG	77	3000	150	100	100	0	54	57	91	207
ZIG	77	3000	150	100	100	0	53	56	64	207
ZIG	77	3000	150	100	100	0	54	57	119	207
ZIG	77	3000	150	100	100	0	53	56	72	207
ZIG	77	3000	150	100	100	0	54	56	67	207
ZIG	77	3000	150	100	100	0	54	56	68	207



1024

PROTO	SIZE	RATE	JIT	TX	RX	LOSS	MIN	AVG	MAX	
OT	1024	5000	300	100	100	0	286	314	398	299
OT	1024	5000	300	100	100	0	285	304	391	308
OT	1024	5000	300	100	100	0	288	311	396	312
OT	1024	5000	300	100	100	0	285	312	407	338
OT	1024	5000	300	100	100	0	284	312	392	319
OT	1024	5000	300	100	100	0	289	317	397	310
OT	1024	5000	300	100	100	0	294	335	412	349
OT	1024	5000	300	100	100	0	298	336	425	372
OT	1024	5000	300	100	100	0	289	323	395	324
ZIG	77	5000	300	100	100	0	54	56	68	124
ZIG	77	5000	300	100	100	0	54	56	64	124
ZIG	77	5000	300	100	100	0	54	56	68	124
ZIG	77	5000	300	100	100	0	54	56	67	124
ZIG	77	5000	300	100	100	0	54	55	64	124
ZIG	77	5000	300	100	100	0	54	59	114	124
ZIG	77	5000	300	100	100	0	54	56	74	124
ZIG	77	5000	300	100	100	0	54	56	68	124
ZIG	77	5000	300	100	100	0	54	58	75	124

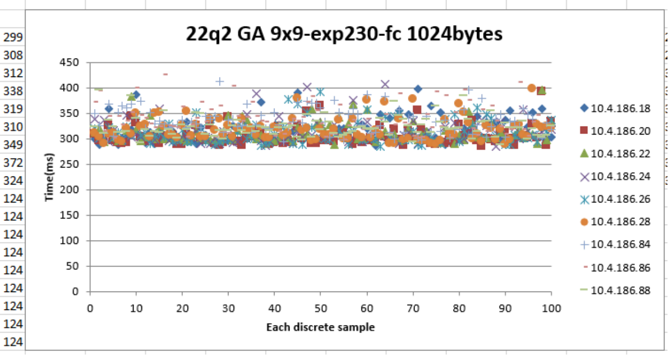
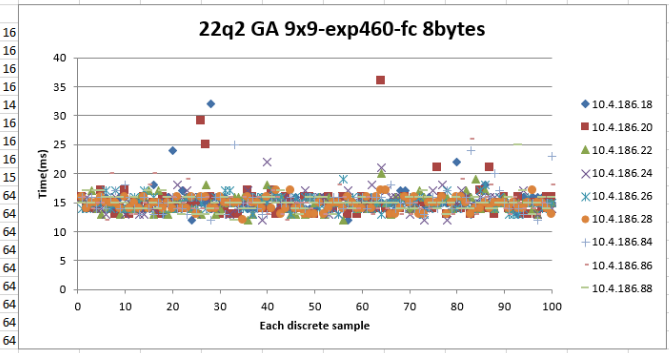
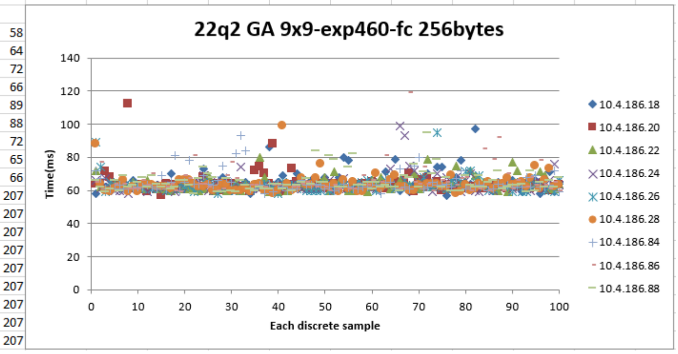


Table 6.3. UART EXP 460k HWFC

Size	PROTO	SIZE	RATE	JIT	TX	RX	LOSS	MIN	AVG	MAX	
8	OT	8	1000	50	100	100	0	12	15	32	16
	OT	8	1000	50	100	100	0	13	15	36	16
	OT	8	1000	50	100	100	0	12	15	20	16
	OT	8	1000	50	100	100	0	12	15	22	16
	OT	8	1000	50	100	100	0	13	15	19	14
	OT	8	1000	50	100	100	0	12	14	17	16
	OT	8	1000	50	100	100	0	12	15	25	16
	OT	8	1000	50	100	100	0	12	15	26	16
	OT	8	1000	50	100	100	0	12	15	25	15
	ZIG	8	1000	50	100	100	0	52	53	64	64
	ZIG	8	1000	50	100	100	0	51	53	64	64
	ZIG	8	1000	50	100	100	0	52	53	58	64
	ZIG	8	1000	50	100	100	0	51	55	69	64
	ZIG	8	1000	50	100	100	0	52	53	58	64
	ZIG	8	1000	50	100	100	0	52	53	66	64
	ZIG	8	1000	50	100	100	0	52	53	58	64
	ZIG	8	1000	50	100	100	0	52	53	65	64
	ZIG	8	1000	50	100	100	0	52	53	58	64



Size	PROTO	SIZE	RATE	JIT	TX	RX	LOSS	MIN	AVG	MAX	
256	OT	256	3000	150	100	100	0	57	64	97	58
	OT	256	3000	150	100	100	0	57	63	112	64
	OT	256	3000	150	100	100	0	59	63	80	72
	OT	256	3000	150	100	100	0	58	63	99	66
	OT	256	3000	150	100	100	0	58	63	95	89
	OT	256	3000	150	100	100	0	58	63	99	88
	OT	256	3000	150	100	100	0	58	64	93	72
	OT	256	3000	150	100	100	0	59	65	119	65
	OT	256	3000	150	100	100	0	58	65	95	66
	ZIG	77	3000	150	100	100	0	54	55	69	207
	ZIG	77	3000	150	100	100	0	54	55	64	207
	ZIG	77	3000	150	100	100	0	54	55	61	207
	ZIG	77	3000	150	100	100	0	54	56	74	207
	ZIG	77	3000	150	100	100	0	53	56	71	207
	ZIG	77	3000	150	100	100	0	53	55	60	207
	ZIG	77	3000	150	100	100	0	53	56	70	207
	ZIG	77	3000	150	100	100	0	54	55	67	207
	ZIG	77	3000	150	100	100	0	54	56	75	207



Size	PROTO	SIZE	RATE	JIT	TX	RX	LOSS	MIN	AVG	MAX	
1024	OT	1024	5000	300	100	100	0	214	227	255	222
	OT	1024	5000	300	100	100	0	212	226	263	237
	OT	1024	5000	300	100	100	0	211	225	267	267
	OT	1024	5000	300	100	100	0	214	227	279	228
	OT	1024	5000	300	100	100	0	215	225	259	236
	OT	1024	5000	300	100	100	0	215	231	263	233
	OT	1024	5000	300	100	100	0	217	234	299	222
	OT	1024	5000	300	100	100	0	218	235	302	227
	OT	1024	5000	300	100	100	0	221	232	276	226
	ZIG	77	5000	300	100	100	0	54	55	67	124
	ZIG	77	5000	300	100	100	0	53	55	61	124
	ZIG	77	5000	300	100	100	0	54	55	74	124
	ZIG	77	5000	300	100	100	0	54	55	61	124
	ZIG	77	5000	300	100	100	0	54	55	59	124
	ZIG	77	5000	300	100	100	0	54	55	63	124
	ZIG	77	5000	300	100	100	0	54	55	63	124
	ZIG	77	5000	300	100	100	0	54	55	60	124
	ZIG	77	5000	300	100	100	0	54	55	59	124

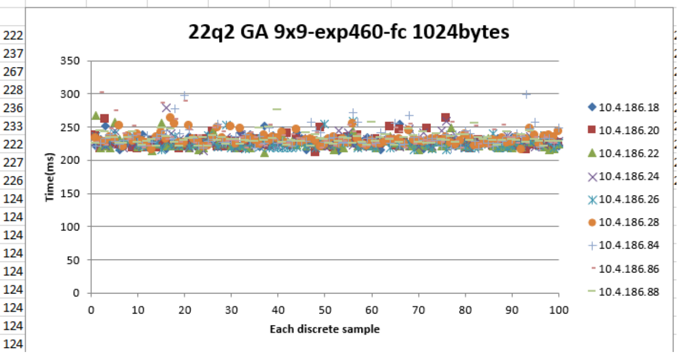
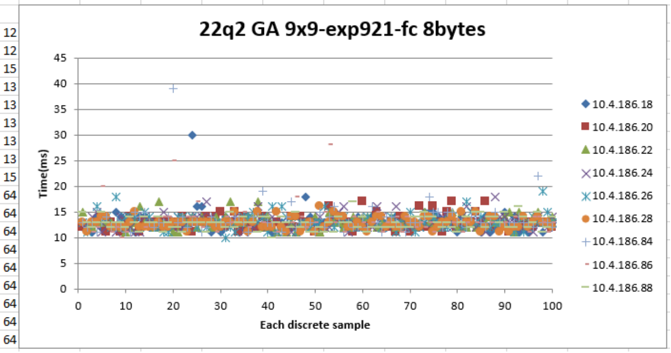


Table 6.4 UART EXP 921k HWFC

Size	Results
8	see below
256	see below
1024	see below

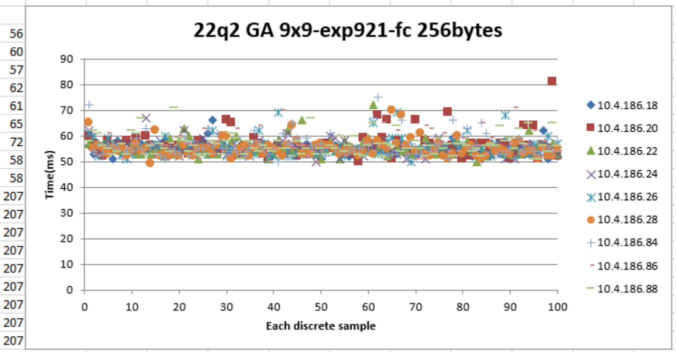
Size: 8

PROTO	SIZE	RATE	JIT	TX	RX	LOSS	MIN	AVG	MAX	
OT	8	1000	50	100	100	0	11	13	30	12
OT	8	1000	50	100	100	0	11	12	17	12
OT	8	1000	50	100	100	0	11	13	17	15
OT	8	1000	50	100	100	0	11	13	18	13
OT	8	1000	50	100	100	0	10	13	19	13
OT	8	1000	50	100	100	0	11	12	16	13
OT	8	1000	50	100	100	0	11	13	39	13
OT	8	1000	50	100	100	0	10	13	28	13
OT	8	1000	50	100	100	0	10	12	17	15
ZIG	8	1000	50	100	100	0	52	53	72	64
ZIG	8	1000	50	100	100	0	52	53	68	64
ZIG	8	1000	50	100	100	0	51	54	65	64
ZIG	8	1000	50	100	100	0	52	55	64	64
ZIG	8	1000	50	100	100	0	52	53	62	64
ZIG	8	1000	50	100	100	0	52	54	67	64
ZIG	8	1000	50	100	100	0	51	54	67	64
ZIG	8	1000	50	100	100	0	52	53	55	64
ZIG	8	1000	50	100	100	0	52	53	64	64



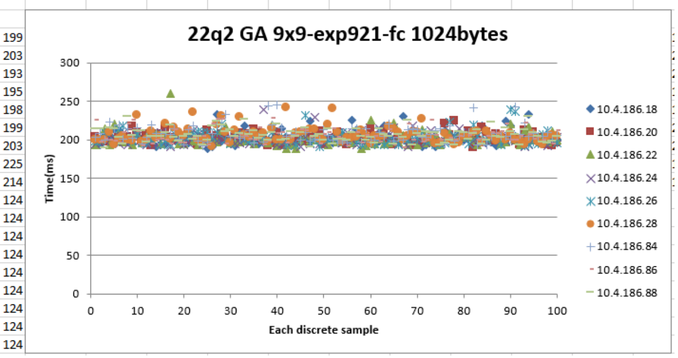
Size: 256

PROTO	SIZE	RATE	JIT	TX	RX	LOSS	MIN	AVG	MAX	
OT	256	3000	150	100	100	0	51	54	66	56
OT	256	3000	150	100	100	0	50	56	81	60
OT	256	3000	150	100	100	0	50	55	72	57
OT	256	3000	150	100	100	0	50	54	67	62
OT	256	3000	150	100	100	0	50	55	69	61
OT	256	3000	150	100	100	0	49	55	70	65
OT	256	3000	150	100	100	0	50	56	75	72
OT	256	3000	150	100	100	0	50	56	71	58
OT	256	3000	150	100	100	0	51	56	71	58
ZIG	77	3000	150	100	100	0	54	55	60	207
ZIG	77	3000	150	100	100	0	53	55	65	207
ZIG	77	3000	150	100	100	0	54	55	69	207
ZIG	77	3000	150	100	100	0	54	55	62	207
ZIG	77	3000	150	100	100	0	54	55	65	207
ZIG	77	3000	150	100	100	0	54	55	63	207
ZIG	77	3000	150	100	100	0	54	55	61	207
ZIG	77	3000	150	100	100	0	54	55	71	207
ZIG	77	3000	150	100	100	0	54	55	59	207



Size: 1024

PROTO	SIZE	RATE	JIT	TX	RX	LOSS	MIN	AVG	MAX	
OT	1024	5000	300	100	100	0	189	202	233	199
OT	1024	5000	300	100	100	0	190	202	224	203
OT	1024	5000	300	100	100	0	189	201	260	193
OT	1024	5000	300	100	100	0	191	200	239	195
OT	1024	5000	300	100	100	0	191	202	239	198
OT	1024	5000	300	100	100	0	191	206	242	199
OT	1024	5000	300	100	100	0	192	207	245	203
OT	1024	5000	300	100	100	0	190	204	228	225
OT	1024	5000	300	100	100	0	190	206	230	214
ZIG	77	5000	300	100	100	0	54	55	71	124
ZIG	77	5000	300	100	100	0	54	55	66	124
ZIG	77	5000	300	100	100	0	53	56	66	124
ZIG	77	5000	300	100	100	0	54	55	61	124
ZIG	77	5000	300	100	100	0	54	55	64	124
ZIG	77	5000	300	100	100	0	54	55	71	124
ZIG	77	5000	300	100	100	0	54	55	78	124
ZIG	77	5000	300	100	100	0	54	55	73	124
ZIG	77	5000	300	100	100	0	54	55	62	124



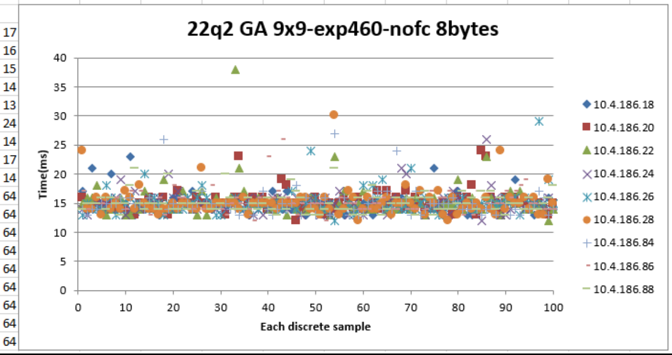
The above tables for UART EXP GPIO configuration all use HWFC (Hardware Flow Control). The following tables show results from the same tests when flow control was disabled. Note that in practice flow control should always be used.

Table 6.5. UART EXP 460k No Flow Control

Size	Results

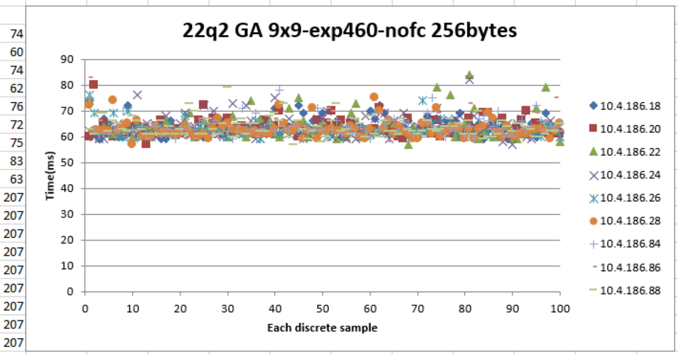
8

PROTO	SIZE	RATE	JIT	TX	RX	LOSS	MIN	AVG	MAX	
OT	8	1000	50	100	100	0	13	14	23	17
OT	8	1000	50	100	100	0	12	15	24	16
OT	8	1000	50	100	100	0	12	15	38	15
OT	8	1000	50	100	100	0	12	15	26	14
OT	8	1000	50	100	100	0	12	15	29	13
OT	8	1000	50	100	100	0	12	15	30	24
OT	8	1000	50	100	100	0	13	14	27	14
OT	8	1000	50	100	100	0	12	15	26	17
OT	8	1000	50	100	100	0	13	15	21	14
ZIG	8	1000	50	100	100	0	51	53	60	64
ZIG	8	1000	50	100	100	0	51	54	68	64
ZIG	8	1000	50	100	100	0	51	55	163	64
ZIG	8	1000	50	100	100	0	51	53	64	64
ZIG	8	1000	50	100	100	0	51	55	67	64
ZIG	8	1000	50	100	100	0	52	55	123	64
ZIG	8	1000	50	100	100	0	52	55	161	64
ZIG	8	1000	50	100	100	0	52	53	68	64
ZIG	8	1000	50	100	100	0	51	53	59	64



256

PROTO	SIZE	RATE	JIT	TX	RX	LOSS	MIN	AVG	MAX	
OT	256	3000	150	100	100	0	59	63	74	74
OT	256	3000	150	100	100	0	57	63	80	60
OT	256	3000	150	100	100	0	57	64	84	74
OT	256	3000	150	100	100	0	57	64	82	62
OT	256	3000	150	100	100	0	59	62	76	76
OT	256	3000	150	100	100	0	57	62	75	72
OT	256	3000	150	100	100	0	59	63	78	75
OT	256	3000	150	100	100	0	58	63	83	83
OT	256	3000	150	100	100	0	57	63	79	63
ZIG	77	3000	150	100	100	0	54	55	59	207
ZIG	77	3000	150	100	100	0	53	56	67	207
ZIG	77	3000	150	100	100	0	54	57	115	207
ZIG	77	3000	150	100	100	0	54	56	63	207
ZIG	77	3000	150	100	100	0	54	56	77	207
ZIG	77	3000	150	100	100	0	54	59	247	207
ZIG	77	3000	150	100	100	0	54	57	108	207
ZIG	77	3000	150	100	100	0	54	56	68	207
ZIG	77	3000	150	100	100	0	54	55	63	207



1024

PROTO	SIZE	RATE	JIT	TX	RX	LOSS	MIN	AVG	MAX	
OT	1024	5000	300	100	100	0	217	227	249	233
OT	1024	5000	300	100	100	0	215	228	259	242
OT	1024	5000	300	100	100	0	209	226	251	223
OT	1024	5000	300	100	100	0	216	230	264	232
OT	1024	5000	300	100	100	0	213	227	255	223
OT	1024	5000	300	100	100	0	216	230	274	221
OT	1024	5000	300	100	100	0	221	233	268	228
OT	1024	5000	300	100	100	0	214	232	285	227
OT	1024	5000	300	100	100	0	218	231	253	243
ZIG	77	5000	300	100	100	0	53	55	60	124
ZIG	77	5000	300	100	100	0	54	55	65	124
ZIG	77	5000	300	100	100	0	53	59	110	124
ZIG	77	5000	300	100	100	0	54	56	91	124
ZIG	77	5000	300	100	100	0	54	57	180	124
ZIG	77	5000	300	100	100	0	54	56	114	124
ZIG	77	5000	300	100	100	0	54	56	71	124
ZIG	77	5000	300	100	100	0	54	55	63	124
ZIG	77	5000	300	100	100	0	53	56	67	124

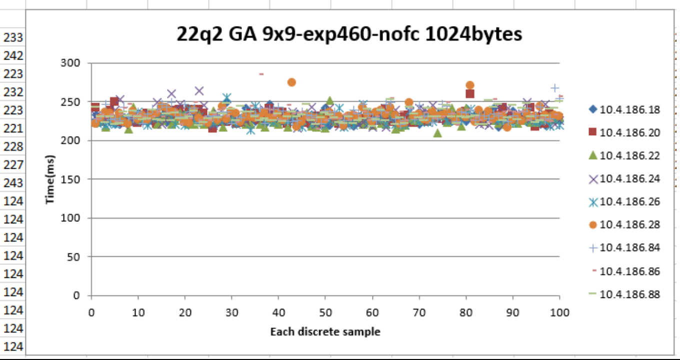
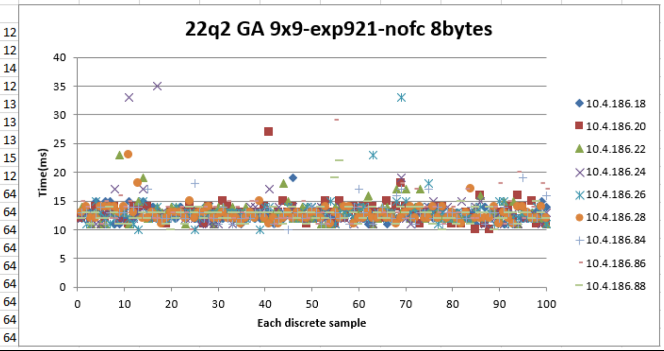


Table 6.6. UART EXP 921k No Flow Control

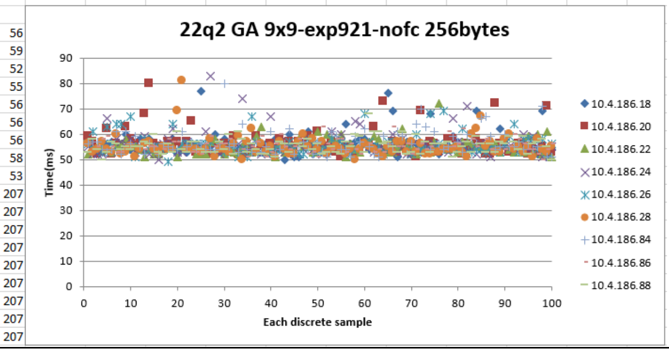
Size	Results
8	(table and chart below)

PROTO	SIZE	RATE	JIT	TX	RX	LOSS	MIN	AVG	MAX	
OT	8	1000	50	100	100	0	11	12	19	12
OT	8	1000	50	100	100	0	10	13	27	12
OT	8	1000	50	100	100	0	11	13	23	14
OT	8	1000	50	100	100	0	11	13	35	12
OT	8	1000	50	100	100	0	10	13	33	13
OT	8	1000	50	100	100	0	11	12	23	13
OT	8	1000	50	100	100	0	10	12	19	13
OT	8	1000	50	100	100	0	10	13	29	15
OT	8	1000	50	100	100	0	10	12	22	12
ZIG	8	1000	50	100	100	0	51	53	58	64
ZIG	8	1000	50	100	100	0	51	53	57	64
ZIG	8	1000	50	100	100	0	52	55	64	64
ZIG	8	1000	50	100	100	0	52	54	71	64
ZIG	8	1000	50	100	100	0	51	54	68	64
ZIG	8	1000	50	100	100	0	52	53	63	64
ZIG	8	1000	50	100	100	0	52	54	68	64
ZIG	8	1000	50	100	100	0	52	53	67	64
ZIG	8	1000	50	100	100	0	52	53	60	64



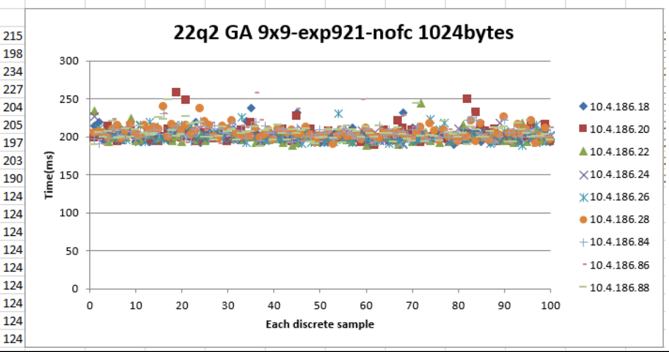
Size	Results
256	(table and chart below)

PROTO	SIZE	RATE	JIT	TX	RX	LOSS	MIN	AVG	MAX	
OT	256	3000	150	100	100	0	50	56	77	56
OT	256	3000	150	100	100	0	51	56	80	59
OT	256	3000	150	100	100	0	51	55	72	52
OT	256	3000	150	100	100	0	50	56	83	55
OT	256	3000	150	100	100	0	49	55	69	56
OT	256	3000	150	100	100	0	50	55	81	56
OT	256	3000	150	100	100	0	51	56	80	56
OT	256	3000	150	100	100	0	50	55	63	58
OT	256	3000	150	100	100	0	50	55	68	53
ZIG	77	3000	150	100	100	0	54	55	63	207
ZIG	77	3000	150	100	100	0	54	55	60	207
ZIG	77	3000	150	100	100	0	54	55	58	207
ZIG	77	3000	150	100	100	0	54	55	60	207
ZIG	77	3000	150	100	100	0	54	55	63	207
ZIG	77	3000	150	100	100	0	54	56	116	207
ZIG	77	3000	150	100	100	0	53	56	66	207
ZIG	77	3000	150	100	100	0	54	55	80	207
ZIG	77	3000	150	100	100	0	54	55	65	207



Size	Results
1024	(table and chart below)

PROTO	SIZE	RATE	JIT	TX	RX	LOSS	MIN	AVG	MAX	
OT	1024	5000	300	100	100	0	190	202	238	215
OT	1024	5000	300	100	100	0	189	202	258	198
OT	1024	5000	300	100	100	0	189	200	244	234
OT	1024	5000	300	100	100	0	190	201	227	227
OT	1024	5000	300	100	100	0	189	200	231	204
OT	1024	5000	300	100	100	0	190	205	239	205
OT	1024	5000	300	100	100	0	191	205	230	197
OT	1024	5000	300	100	100	0	188	204	257	203
OT	1024	5000	300	100	100	0	187	205	249	190
ZIG	77	5000	300	100	100	0	54	55	63	124
ZIG	77	5000	300	100	100	0	54	55	65	124
ZIG	77	5000	300	100	100	0	54	55	62	124
ZIG	77	5000	300	100	100	0	54	56	69	124
ZIG	77	5000	300	100	100	0	54	55	61	124
ZIG	77	5000	300	100	100	0	54	55	60	124
ZIG	77	5000	300	100	100	0	54	55	66	124
ZIG	77	5000	300	100	100	0	54	55	62	124
ZIG	77	5000	300	100	100	0	54	55	63	124



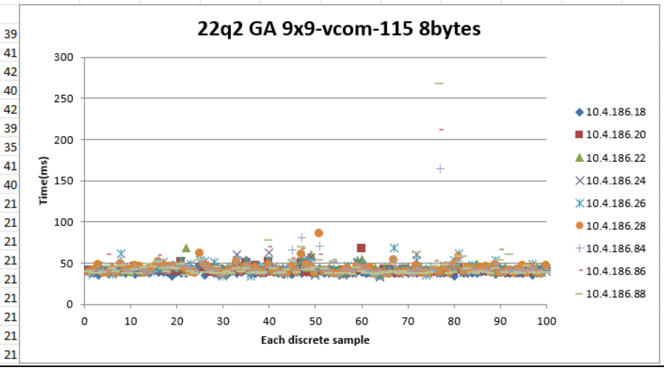
The next set of tables show the results using UART VCOM configurations.

Table 6.7. UART VCOM 115k HWFC

Size	Results

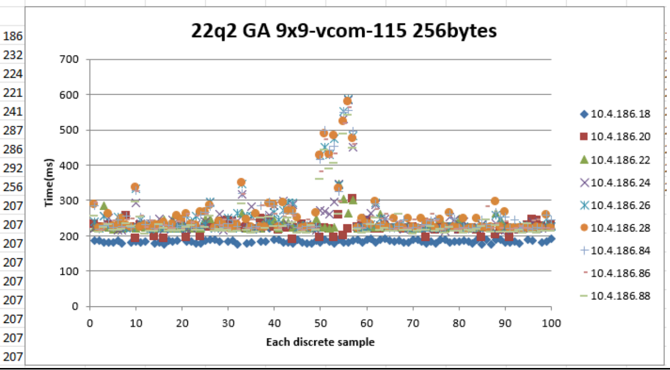
8

PROTO	SIZE	RATE	JIT	TX	RX	LOSS	MIN	AVG	MAX	
OT	8	3000	50	100	100	0	34	38	53	39
OT	8	3000	50	100	100	0	37	41	67	41
OT	8	3000	50	100	100	0	36	44	69	42
OT	8	3000	50	100	100	0	33	42	63	40
OT	8	3000	50	100	100	0	34	44	69	42
OT	8	3000	50	100	100	0	36	42	86	39
OT	8	3000	50	100	100	0	35	44	165	35
OT	8	3000	50	100	100	0	34	45	212	41
OT	8	3000	50	100	100	0	35	44	267	40
ZIG	8	3000	50	100	100	0	51	55	76	21
ZIG	8	3000	50	100	100	0	51	54	100	21
ZIG	8	3000	50	100	100	0	52	56	122	21
ZIG	8	3000	50	100	100	0	52	54	81	21
ZIG	8	3000	50	100	100	0	51	55	117	21
ZIG	8	3000	50	100	100	0	51	56	128	21
ZIG	8	3000	50	100	100	0	51	57	119	21
ZIG	8	3000	50	100	100	0	51	54	72	21
ZIG	8	3000	50	100	100	0	51	53	63	21



256

PROTO	SIZE	RATE	JIT	TX	RX	LOSS	MIN	AVG	MAX	
OT	256	3000	150	100	100	0	177	187	240	186
OT	256	3000	150	100	100	0	190	222	305	232
OT	256	3000	150	100	100	0	218	231	347	224
OT	256	3000	150	100	100	0	214	245	584	221
OT	256	3000	150	100	100	0	218	254	586	241
OT	256	3000	150	100	100	0	219	258	579	287
OT	256	3000	150	100	100	0	219	256	554	286
OT	256	3000	150	100	100	0	216	253	562	292
OT	256	3000	150	100	100	0	204	237	541	256
ZIG	77	3000	150	100	100	0	54	56	108	207
ZIG	77	3000	150	100	100	0	54	57	107	207
ZIG	77	3000	150	100	100	0	54	56	76	207
ZIG	77	3000	150	100	100	0	54	56	62	207
ZIG	77	3000	150	100	100	0	54	58	153	207
ZIG	77	3000	150	100	100	0	54	56	75	207
ZIG	77	3000	150	100	100	0	54	57	146	207
ZIG	77	3000	150	100	100	0	54	55	65	207
ZIG	77	3000	150	100	100	0	54	56	69	207



1024

PROTO	SIZE	RATE	JIT	TX	RX	LOSS	MIN	AVG	MAX	
OT	1024	5000	300	100	61	39	853	32181	48396	853
OT	1024	5000	300	100	42	58	1124	34347	53066	1124
OT	1024	5000	300	100	25	75	9150	35058	53217	9150
OT	1024	5000	300	100	31	69	9338	35327	53353	9338
OT	1024	5000	300	100	23	77	18921	33719	48011	18921
OT	1024	5000	300	100	22	78	15173	34840	51380	15173
OT	1024	5000	300	100	17	83	15510	35784	50677	15510
OT	1024	5000	300	100	10	90	23056	33729	47227	24875
OT	1024	5000	300	100	8	92	10947	28348	42768	10947
ZIG	77	5000	300	100	100	0	54	56	69	124
ZIG	77	5000	300	100	100	0	54	55	66	124
ZIG	77	5000	300	100	100	0	54	58	122	124
ZIG	77	5000	300	100	100	0	54	55	64	124
ZIG	77	5000	300	100	100	0	54	56	126	124
ZIG	77	5000	300	100	100	0	54	56	76	124
ZIG	77	5000	300	100	100	0	54	56	73	124
ZIG	77	5000	300	100	100	0	54	56	65	124
ZIG	77	5000	300	100	100	0	54	56	67	124

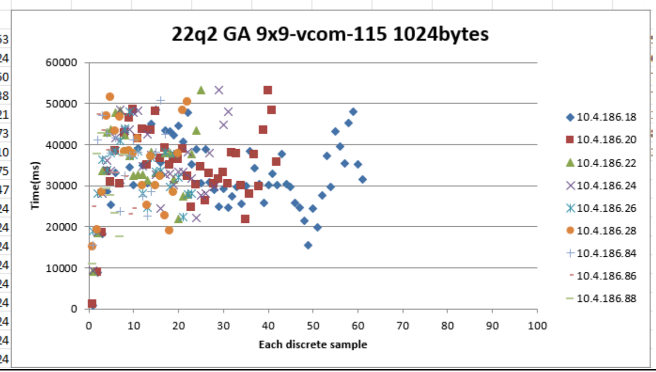
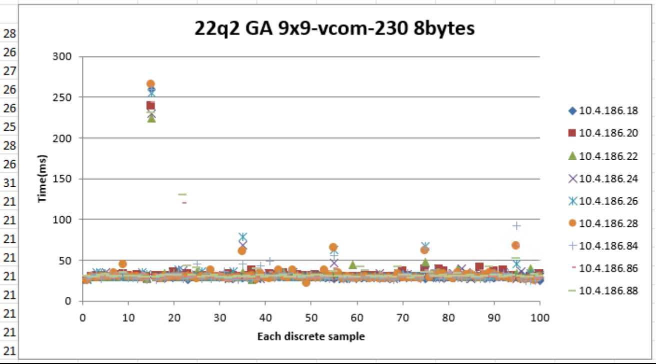


Table 6.8. UART VCOM 230k HWFC

Size | **Results**

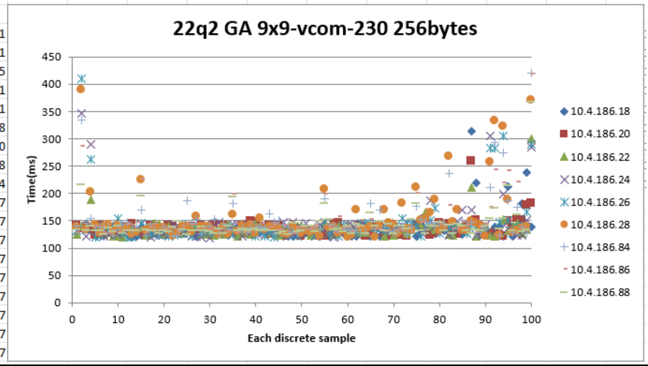
8

PROTO	SIZE	RATE	JIT	TX	RX	LOSS	MIN	AVG	MAX	
OT	8	3000	50	100	100	0	25	31	259	28
OT	8	3000	50	100	100	0	26	33	239	26
OT	8	3000	50	100	100	0	26	33	224	27
OT	8	3000	50	100	100	0	26	32	230	26
OT	8	3000	50	100	100	0	26	34	255	26
OT	8	3000	50	100	100	0	22	33	265	25
OT	8	3000	50	100	100	0	25	33	259	28
OT	8	3000	50	100	100	0	25	32	244	26
OT	8	3000	50	100	100	0	28	34	231	31
ZIG	8	3000	50	100	100	0	52	54	62	21
ZIG	8	3000	50	100	100	0	51	57	140	21
ZIG	8	3000	50	100	100	0	52	54	80	21
ZIG	8	3000	50	100	100	0	52	55	126	21
ZIG	8	3000	50	100	100	0	52	53	63	21
ZIG	8	3000	50	100	100	0	52	58	132	21
ZIG	8	3000	50	100	100	0	52	57	124	21
ZIG	8	3000	50	100	100	0	52	53	70	21
ZIG	8	3000	50	100	100	0	52	53	68	21



256

PROTO	SIZE	RATE	JIT	TX	RX	LOSS	MIN	AVG	MAX	
OT	256	3000	150	100	100	0	119	135	313	141
OT	256	3000	150	100	100	0	121	135	258	141
OT	256	3000	150	100	100	0	120	136	300	125
OT	256	3000	150	100	100	0	118	142	347	131
OT	256	3000	150	100	100	0	120	144	409	131
OT	256	3000	150	100	100	0	120	152	390	138
OT	256	3000	150	100	100	0	121	150	421	140
OT	256	3000	150	100	100	0	124	148	419	128
OT	256	3000	150	100	100	0	125	142	367	134
ZIG	77	3000	150	100	100	0	54	56	66	207
ZIG	77	3000	150	100	100	0	54	56	66	207
ZIG	77	3000	150	100	100	0	54	55	68	207
ZIG	77	3000	150	100	100	0	54	56	126	207
ZIG	77	3000	150	100	100	0	53	56	67	207
ZIG	77	3000	150	100	100	0	54	57	95	207
ZIG	77	3000	150	100	100	0	54	59	159	207
ZIG	77	3000	150	100	100	0	54	56	62	207
ZIG	77	3000	150	100	100	0	54	56	62	207



1024

PROTO	SIZE	RATE	JIT	TX	RX	LOSS	MIN	AVG	MAX	
OT	1024	5000	300	100	95	5	512	840	3972	570
OT	1024	5000	300	100	94	6	607	988	3992	675
OT	1024	5000	300	100	94	6	737	1164	7248	802
OT	1024	5000	300	100	93	7	560	1334	7281	899
OT	1024	5000	300	100	91	9	674	1434	5965	1066
OT	1024	5000	300	100	90	10	814	1613	6369	3492
OT	1024	5000	300	100	94	6	583	1889	10818	6254
OT	1024	5000	300	100	90	10	589	1712	10870	3791
OT	1024	5000	300	100	85	15	680	1750	10876	3872
ZIG	77	5000	300	100	100	0	54	57	79	124
ZIG	77	5000	300	100	100	0	54	57	78	124
ZIG	77	5000	300	100	100	0	54	57	136	124
ZIG	77	5000	300	100	100	0	54	56	85	124
ZIG	77	5000	300	100	100	0	54	56	68	124
ZIG	77	5000	300	100	100	0	54	57	116	124
ZIG	77	5000	300	100	100	0	54	58	119	124
ZIG	77	5000	300	100	100	0	53	56	71	124
ZIG	77	5000	300	100	100	0	54	57	69	124

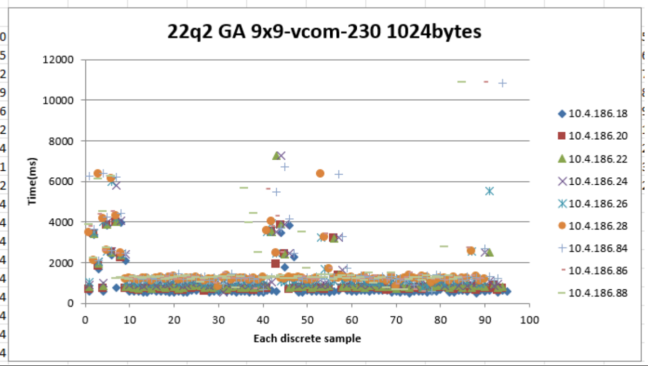
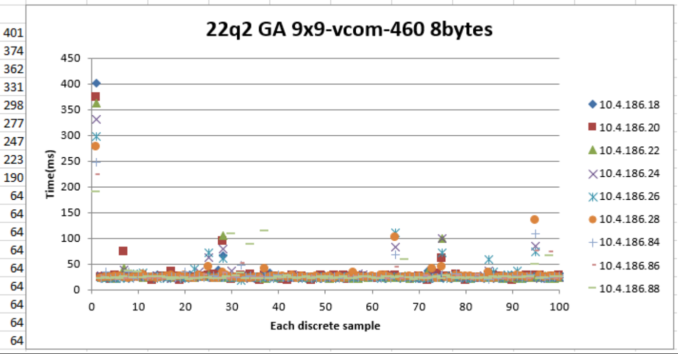


Table 6.9. UART VCOM 460k HWFC

Size	Results

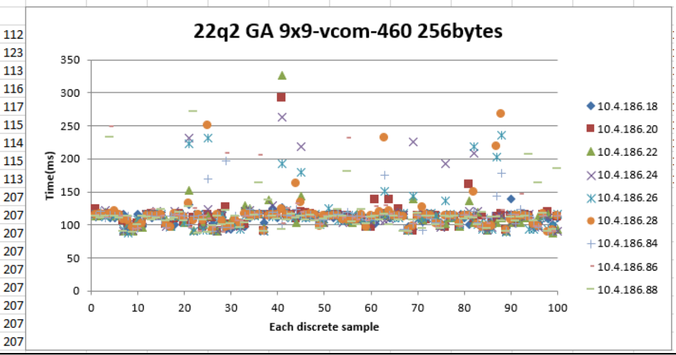
8

PROTO	SIZE	RATE	JIT	TX	RX	LOSS	MIN	AVG	MAX	
OT	8	1000	50	100	100	0	21	29	401	401
OT	8	1000	50	100	100	0	19	29	374	374
OT	8	1000	50	100	100	0	21	29	362	362
OT	8	1000	50	100	100	0	22	31	331	331
OT	8	1000	50	100	100	0	19	30	298	298
OT	8	1000	50	100	100	0	21	29	277	277
OT	8	1000	50	100	100	0	20	28	247	247
OT	8	1000	50	100	100	0	20	26	223	223
OT	8	1000	50	100	100	0	20	28	190	190
ZIG	8	1000	50	100	100	0	51	54	71	64
ZIG	8	1000	50	100	100	0	52	53	71	64
ZIG	8	1000	50	100	100	0	52	55	96	64
ZIG	8	1000	50	100	100	0	51	55	79	64
ZIG	8	1000	50	100	100	0	51	54	70	64
ZIG	8	1000	50	100	100	0	51	53	62	64
ZIG	8	1000	50	100	100	0	51	54	94	64
ZIG	8	1000	50	100	100	0	52	53	64	64
ZIG	8	1000	50	100	100	0	52	53	58	64



256

PROTO	SIZE	RATE	JIT	TX	RX	LOSS	MIN	AVG	MAX	
OT	256	3000	150	100	100	0	91	108	139	112
OT	256	3000	150	100	100	0	90	111	292	123
OT	256	3000	150	100	100	0	88	112	327	113
OT	256	3000	150	100	100	0	90	115	263	116
OT	256	3000	150	100	100	0	88	116	236	117
OT	256	3000	150	100	100	0	89	115	267	115
OT	256	3000	150	100	100	0	90	112	197	114
OT	256	3000	150	100	100	0	89	113	248	115
OT	256	3000	150	100	100	0	88	114	272	113
ZIG	77	3000	150	100	100	0	54	56	74	207
ZIG	77	3000	150	100	100	0	54	56	69	207
ZIG	77	3000	150	100	100	0	53	56	71	207
ZIG	77	3000	150	100	100	0	54	55	60	207
ZIG	77	3000	150	100	100	0	54	57	120	207
ZIG	77	3000	150	100	100	0	54	56	66	207
ZIG	77	3000	150	100	100	0	54	56	66	207
ZIG	77	3000	150	100	100	0	54	56	65	207
ZIG	77	3000	150	100	100	0	54	55	71	207



1024

PROTO	SIZE	RATE	JIT	TX	RX	LOSS	MIN	AVG	MAX	
OT	1024	5000	300	100	99	1	343	441	550	478
OT	1024	5000	300	100	100	0	434	524	613	524
OT	1024	5000	300	100	100	0	478	560	720	535
OT	1024	5000	300	100	98	2	517	592	803	576
OT	1024	5000	300	100	100	0	539	629	850	580
OT	1024	5000	300	100	100	0	544	669	877	595
OT	1024	5000	300	100	100	0	557	710	889	658
OT	1024	5000	300	100	99	1	609	711	864	707
OT	1024	5000	300	100	100	0	563	675	891	718
ZIG	77	5000	300	100	100	0	54	57	78	124
ZIG	77	5000	300	100	100	0	53	56	77	124
ZIG	77	5000	300	100	100	0	54	57	109	124
ZIG	77	5000	300	100	100	0	54	56	103	124
ZIG	77	5000	300	100	100	0	53	56	111	124
ZIG	77	5000	300	100	100	0	54	56	66	124
ZIG	77	5000	300	100	100	0	53	56	80	124
ZIG	77	5000	300	100	100	0	54	55	61	124
ZIG	77	5000	300	100	100	0	54	56	65	124

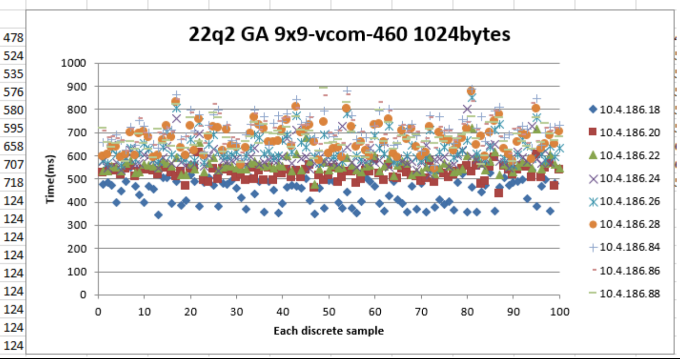
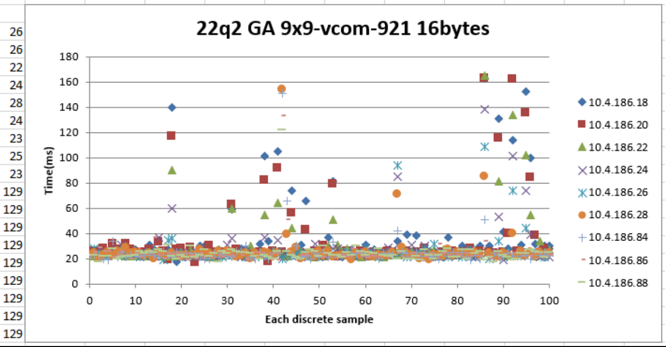


Table 6.10. UART VCOM 921k HWFC

Size	Results
16	(see below)
256	(see below)
1024	(see below)

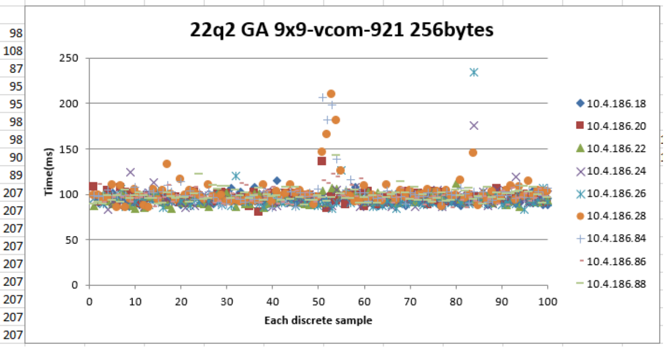
Size: 16

PROTO	SIZE	RATE	JIT	TX	RX	LOSS	MIN	AVG	MAX	
OT	16	1000	50	100	100	0	18	36	163	26
OT	16	1000	50	100	100	0	17	33	163	26
OT	16	1000	50	100	100	0	21	30	165	22
OT	16	1000	50	100	100	0	19	28	138	24
OT	16	1000	50	100	100	0	19	26	109	28
OT	16	1000	50	100	100	0	19	25	154	24
OT	16	1000	50	100	100	0	19	25	151	23
OT	16	1000	50	100	100	0	19	24	133	25
OT	16	1000	50	100	100	0	18	24	122	23
ZIG	16	1000	50	100	100	0	52	53	59	129
ZIG	16	1000	50	100	100	0	51	55	75	129
ZIG	16	1000	50	100	100	0	52	55	85	129
ZIG	16	1000	50	100	100	0	51	55	67	129
ZIG	16	1000	50	100	100	0	52	55	70	129
ZIG	16	1000	50	100	100	0	52	54	68	129
ZIG	16	1000	50	100	100	0	52	53	65	129
ZIG	16	1000	50	100	100	0	52	56	70	129
ZIG	16	1000	50	100	100	0	51	54	68	129



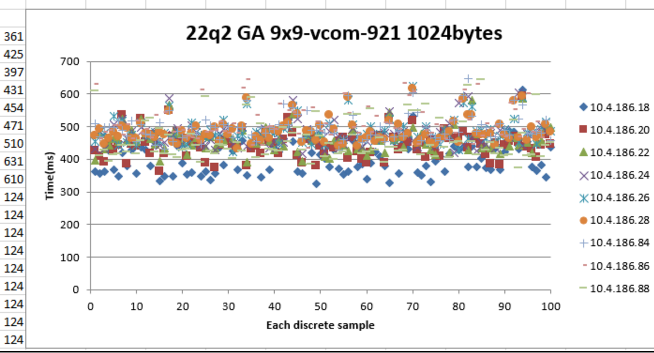
Size: 256

PROTO	SIZE	RATE	JIT	TX	RX	LOSS	MIN	AVG	MAX	
OT	256	3000	150	100	100	0	86	93	115	98
OT	256	3000	150	100	100	0	80	96	135	108
OT	256	3000	150	100	100	0	84	94	112	87
OT	256	3000	150	100	100	0	83	95	176	95
OT	256	3000	150	100	100	0	83	94	234	95
OT	256	3000	150	100	100	0	85	102	210	98
OT	256	3000	150	100	100	0	85	102	206	98
OT	256	3000	150	100	100	0	85	97	122	90
OT	256	3000	150	100	100	0	88	98	143	89
ZIG	77	3000	150	100	100	0	54	55	65	207
ZIG	77	3000	150	100	100	0	54	55	64	207
ZIG	77	3000	150	100	100	0	54	56	70	207
ZIG	77	3000	150	100	100	0	54	55	65	207
ZIG	77	3000	150	100	100	0	54	56	109	207
ZIG	77	3000	150	100	100	0	54	56	77	207
ZIG	77	3000	150	100	100	0	54	56	81	207
ZIG	77	3000	150	100	100	0	54	55	66	207
ZIG	77	3000	150	100	100	0	54	55	62	207



Size: 1024

PROTO	SIZE	RATE	JIT	TX	RX	LOSS	MIN	AVG	MAX	
OT	1024	5000	300	100	100	0	324	403	613	361
OT	1024	5000	300	100	100	0	362	444	591	425
OT	1024	5000	300	100	100	0	391	460	593	397
OT	1024	5000	300	100	99	1	416	474	604	431
OT	1024	5000	300	100	100	0	422	485	625	454
OT	1024	5000	300	100	100	0	430	484	615	471
OT	1024	5000	300	100	100	0	427	496	646	510
OT	1024	5000	300	100	98	2	433	509	643	631
OT	1024	5000	300	100	100	0	373	458	645	610
ZIG	77	5000	300	100	100	0	54	56	76	124
ZIG	77	5000	300	100	100	0	54	55	66	124
ZIG	77	5000	300	100	100	0	54	57	77	124
ZIG	77	5000	300	100	100	0	53	55	64	124
ZIG	77	5000	300	100	100	0	54	56	118	124
ZIG	77	5000	300	100	100	0	54	57	92	124
ZIG	77	5000	300	100	100	0	54	57	117	124
ZIG	77	5000	300	100	100	0	54	56	76	124
ZIG	77	5000	300	100	100	0	54	58	116	124

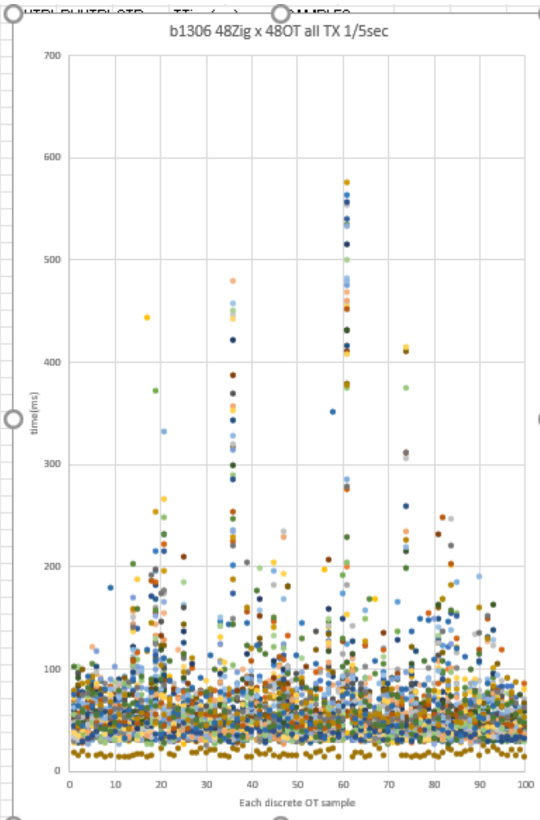


The following table shows the results using a larger network topology of 48 OT devices and 48 Zig devices, where all are sending 8 bytes to the DuT at a rate of one every five seconds. The spikes shown are expected under the traffic stress of 96 devices sending (and receiving) from 1 device.

Table 6.11. UART EXP 460k 48Zig x 48OT Network

Results

SRC	PROTO	SIZE(byt	RATE(m	JIT(ms)	TX	RX	LOSS(%)	MIN(ms)	AVG(ms	MAX(ms					
10.4.186.18	OT	8	5000	50	100	100	0	29	47	121					
10.4.186.20	OT	8	5000	50	100	100	0	28	43	200					
10.4.186.22	OT	8	5000	50	100	100	0	41	59	182					50
10.4.186.24	OT	8	5000	50	100	92	8	27	50	443					
10.4.186.26	OT	8	5000	50	100	100	0	28	46	196					
10.4.186.28	OT	8	5000	50	100	100	0	27	52	372					
10.4.186.84	OT	8	5000	50	100	100	0	38	56	183					50
10.4.186.86	OT	8	5000	50	100	100	0	28	40	154					
10.4.186.88	OT	8	5000	50	100	100	0	29	42	197					
10.4.186.6	OT	8	5000	50	100	100	0	14	21	110					
10.4.186.8	OT	8	5000	50	100	100	0	28	37	168					37
10.4.186.10	OT	8	5000	50	100	100	0	27	37	126					36
10.4.186.12	OT	8	5000	50	100	100	0	30	41	117					43
10.4.186.14	OT	8	5000	50	100	100	0	27	43	133					37
10.4.186.16	OT	8	5000	50	100	100	0	27	54	183					43
10.4.186.36	OT	8	5000	50	100	100	0	28	54	266					35
10.4.186.38	OT	8	5000	50	100	100	0	40	72	332					53
10.4.186.40	OT	8	5000	50	100	100	0	27	51	248					42
10.4.186.42	OT	8	5000	50	100	100	0	40	66	539					51
10.4.186.44	OT	8	5000	50	100	100	0	41	74	276					42
10.4.186.46	OT	8	5000	50	100	100	0	26	49	176					34
10.4.186.48	OT	8	5000	50	100	100	0	42	74	575					95
10.4.186.50	OT	8	5000	50	100	100	0	39	74	563					71
10.4.186.52	OT	8	5000	50	100	100	0	41	76	535					76
10.4.186.90	OT	8	5000	50	100	100	0	27	55	533					36
10.4.186.92	OT	8	5000	50	100	100	0	39	74	479					82
10.4.186.94	OT	8	5000	50	100	100	0	30	55	458					56
10.4.186.96	OT	8	5000	50	100	100	0	29	52	454					52
10.4.186.98	OT	8	5000	50	100	100	0	40	69	482					48
10.4.186.100	OT	8	5000	50	100	100	0	42	74	500					44
10.4.186.102	OT	8	5000	50	100	100	0	39	70	515					81
10.4.186.104	OT	8	5000	50	100	100	0	41	74	410					58
10.4.186.106	OT	8	5000	50	100	100	0	39	72	431					57
10.4.186.108	OT	8	5000	50	100	100	0	42	78	410					57
10.4.186.110	OT	8	5000	50	100	100	0	29	64	416					103
10.4.186.112	OT	8	5000	50	100	100	0	40	70	431					59
10.4.186.114	OT	8	5000	50	100	99	1	41	76	475					117
10.4.186.116	OT	8	5000	50	100	100	0	29	65	460					83
10.4.186.118	OT	8	5000	50	100	100	0	40	77	553					97
10.4.186.120	OT	8	5000	50	100	100	0	40	75	415					85
10.4.186.122	OT	8	5000	50	100	100	0	42	75	479					68
10.4.186.124	OT	8	5000	50	100	100	0	27	58	375					54
10.4.186.126	OT	8	5000	50	100	100	0	28	55	557					39
10.4.186.128	OT	8	5000	50	100	100	0	39	72	452					48
10.4.186.130	OT	8	5000	50	100	100	0	45	76	311					45
10.4.186.132	OT	8	5000	50	100	100	0	41	75	377					54
10.4.186.134	OT	8	5000	50	100	94	6	32	74	351					56
10.4.186.136	OT	8	5000	50	100	100	0	28	69	228					56
10.4.186.19	ZIG	8	5000	50	100	100	0	4	5	16	12	93	2	495026	
10.4.186.21	ZIG	8	5000	50	100	100	0	52	56	88	12	93	7	495083	
10.4.186.23	ZIG	8	5000	50	100	100	0	52	54	68	12	93	3	495079	
10.4.186.25	ZIG	8	5000	50	100	100	0	52	55	74	12	93	5	495078	
10.4.186.27	ZIG	8	5000	50	100	100	0	51	58	127	12	93	10	495081	
10.4.186.29	ZIG	8	5000	50	100	100	0	52	59	121	12	93	14	495087	
10.4.186.85	ZIG	8	5000	50	100	100	0	52	56	114	12	93	8	495079	
10.4.186.87	ZIG	8	5000	50	100	100	0	52	56	72	12	93	8	495085	
10.4.186.89	ZIG	8	5000	50	100	100	0	52	59	124	12	93	12	495076	
10.4.186.7	ZIG	8	5000	50	100	100	0	52	56	110	12	93	9	495082	
10.4.186.9	ZIG	8	5000	50	100	100	0	52	60	186	12	93	19	495079	
10.4.186.11	ZIG	8	5000	50	100	100	0	52	56	112	12	93	8	495074	
10.4.186.13	ZIG	8	5000	50	100	100	0	52	58	116	12	93	12	495077	
10.4.186.15	ZIG	8	5000	50	100	100	0	52	57	121	12	93	12	495099	

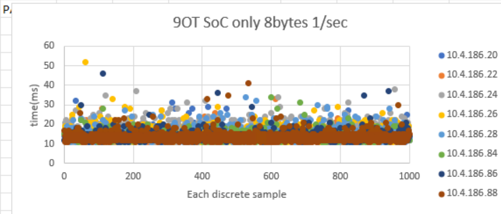


7 Additional Test Results Comparisons

Brd4161a	8 bytes

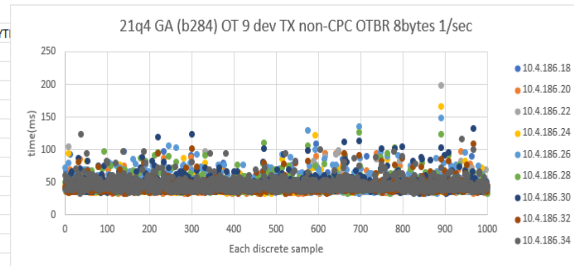
SOC

PROTO	SIZE(byte:	RATE(ms)	JIT(ms)	TX	RX	LOSS(%)	MIN(ms)	AVG(ms)	MAX(ms)	PA
OT	8	1000	50	1000	1000	0	11	13.7	32	
OT	8	1000	50	1000	1000	0	11	13.523	33	
OT	8	1000	50	1000	1000	0	11	15.576	38	
OT	8	1000	50	1000	1000	0	11	14.64	52	
OT	8	1000	50	1000	1000	0	11	14.558	34	
OT	8	1000	50	1000	1000	0	11	13.678	34	
OT	8	1000	50	1000	1000	0	11	13.923	46	
OT	8	1000	50	1000	1000	0	11	13.605	41	



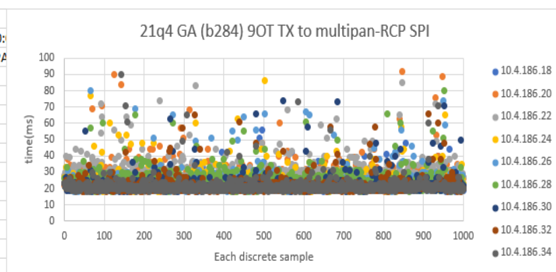
NON-CPC-OTBR (UART)

1:0:0:1:1:1	1:1:1:0:1:1	1:1:1:0:1:1	1:1:1:0:1:1	1:1:1:0:1:1	1:1:1:0:1:1	1:1:1:0:1:1	1:1:1:0:1:1	1:1:1:0:1:1:0:0	
PROTO	SIZE(byte:	RATE(ms)	TX	RX	LOSS	MIN(ms)	AVG(ms)	MAX(ms)	PAYTI
OT	8	1000	1000	1000	0	33	40.649	109	
OT	8	1000	1000	1000	0	33	41.9	98	
OT	8	1000	1000	1000	0	32	40.925	199	
OT	8	1000	1000	1000	0	33	41.875	166	
OT	8	1000	1000	1000	0	33	48.101	148	
OT	8	1000	1000	1000	0	33	44.479	126	
OT	8	1000	1000	1000	0	33	46.792	133	
OT	8	1000	1000	1000	0	33	42.998	109	
OT	8	1000	1000	1000	0	32	46.834	124	
B:P									
10.4.186.1	10.4.186.2	10.4.186.2	10.4.186.2	10.4.186.2	10.4.186.2	10.4.186.3	10.4.186.3	10.4.186.34	
1:0:0:1:1:1	1:1:1:0:1:1	1:1:1:0:1:1	1:1:1:0:1:1	1:1:1:0:1:1	1:1:1:0:1:1	1:1:1:0:1:1	1:1:1:0:1:1	1:1:1:0:1:1:0:0	



CPC-SPI

10.4.186.1	10.4.186.2	10.4.186.2	10.4.186.2	10.4.186.2	10.4.186.2	10.4.186.3	10.4.186.3	10.4.186.34	
1:0:0:1:1:1	1:1:1:0:1:1	1:1:1:0:1:1	1:1:1:0:1:1	1:1:1:0:1:1	1:1:1:0:1:1	1:1:1:0:1:1	1:1:1:0:1:1	1:1:1:0:1:1:0:	
PROTO	SIZE(byte:	RATE(ms)	TX	RX	LOSS	MIN(ms)	AVG(ms)	MAX(ms)	PA
OT	8	1000	1000	1000	0	18	22.416	56	
OT	8	1000	1000	1000	0	18	24.742	92	
OT	8	1000	1000	1000	0	18	26.298	85	
OT	8	1000	1000	1000	0	18	22.935	86	
OT	8	1000	1000	1000	0	18	22.995	80	
OT	8	1000	1000	1000	0	18	23.652	80	
OT	8	1000	1000	1000	0	18	21.816	74	
OT	8	1000	1000	1000	0	18	21.656	66	
OT	8	1000	1000	1000	0	18	21.589	90	
B:P									
10.4.186.1	10.4.186.2	10.4.186.2	10.4.186.2	10.4.186.2	10.4.186.2	10.4.186.3	10.4.186.3	10.4.186.34	
1:0:0:1:1:1	1:1:1:0:1:1	1:1:1:0:1:1	1:1:1:0:1:1	1:1:1:0:1:1	1:1:1:0:1:1	1:1:1:0:1:1	1:1:1:0:1:1	1:1:1:0:1:1:0:0	

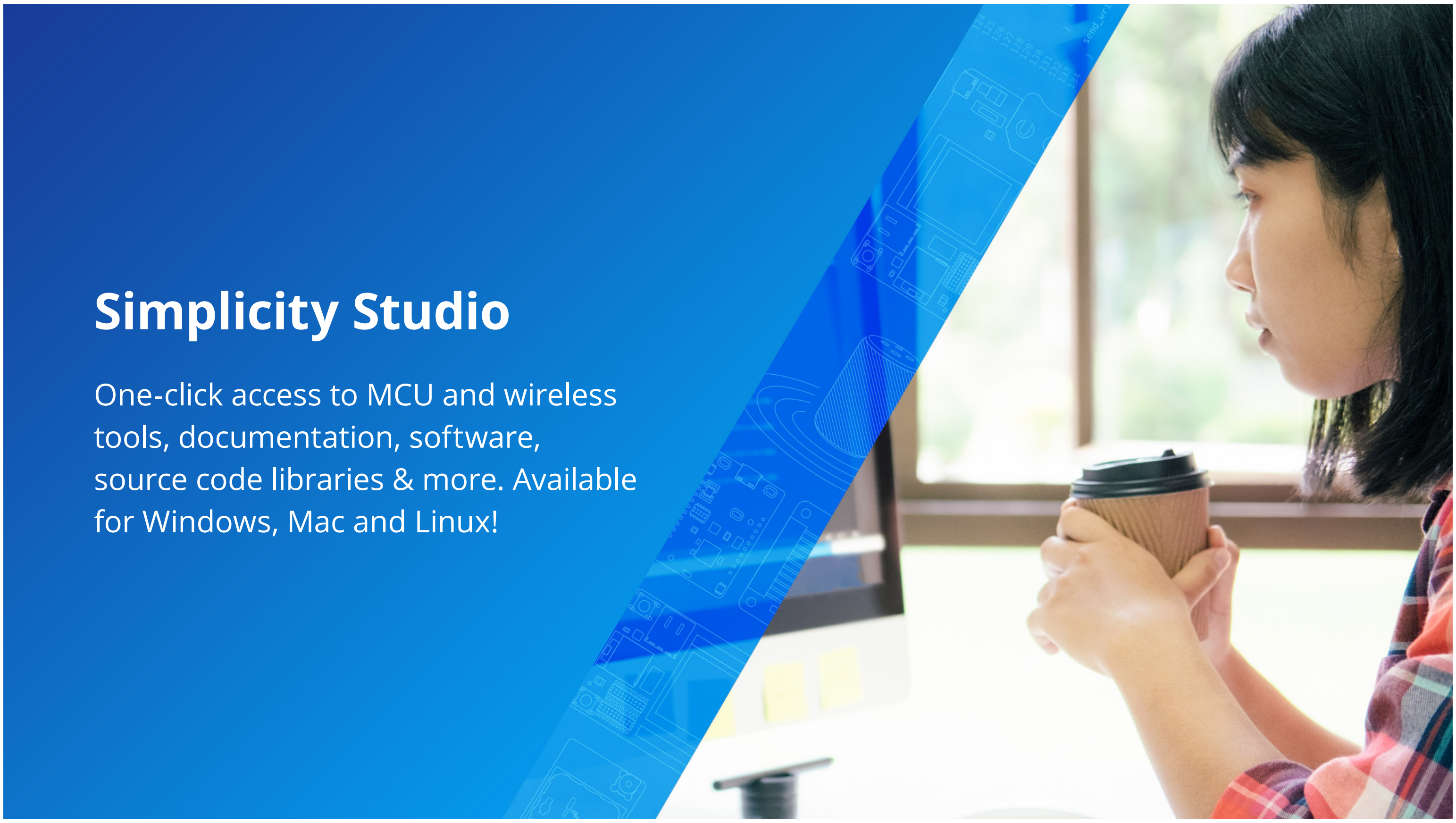


8 Document Revision History

Revision 0.1

June 2022

Initial public release



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