XB3-24 Performance vs XB24 Performance

A general performance comparison of XB3-24 based radio modules vs Series 1 XB24 based radio modules running DigiMesh and 802.15.4 protocols.

The XB24 based module will be replaced by the XB3-24 based module. This creates a need for backward compatibility to ensure current XB24 customers have the ability to continue their application without the need for complete redesign. The main focus of this paper is using the 802.15.4 protocol. As the DigiMesh protocol is based upon the 802.15.4 protocol most tests are done using only the 802.15.4 protocol. Any tests that list DigiMesh as the protocol were tested using DigiMesh strictly due to the features only being available in DigiMesh such as meshing.

Testing was conducted in order to compare XB3-24 homogenous, XB3-24 / XB24 mixed and XB24 homogenous network performance.

The testing includes the following:

1. Network Mapping (DigiMesh Protocol)
2. Adjacent Link Testing (DigiMesh Protocol)
3. Performance of Broadcasts while Unicasting is present on network (DigiMesh / 802.15.4)
4. Signal Strength at each power level (802.15.4)
5. Large File Transfer Reliability (802.15.4)
6. IO Sampling (802.15.4)

These tests were selected as they represent the majority of needs found in applications.

Test 1: Network Mapping

Procedure: Using Default settings with the AP parameter set to AP=1, the network mapping feature of XCTU was run from one XB3 node and one Series 1 node on a mixed network of 59 modules. This was done using 0dB attenuation within the network and tested again with 20dB attenuation added to the network. The time required to map the network of 59 nodes was recorded to the nearest 15 second interval.

Scanning Node (type)	Firmware (version)	Protocol	Number of nodes	Attenuation (dbm)	Time to reach 100% response (Best/Average)
XB24	8073	DigiMesh	59	0dBm	1:30 / 2:30
XB3	3000	DigiMesh	59	0dBm	1:00 / 2:00
XB24	8073	DigiMesh	59	20dBm	5:00 / 5:00
XB3	3000	DigiMesh	59	20dBm	3:15 / 5:30

Conclusion: While the best time recorded was better when using XB3-24 hardware, the average times were not much different.

Test 2: Adjacent Link Test

Procedure: Using the adjacent link testing feature of DigiMesh, link tests between Series 1 modules (XB24) and XB3 modules (XB3-24) were initiated.

Each test allowed 10 retries to occur per packet with 1000 packets being sent between two modules.

Additional attenuation was introduced on each network in order to mimic real world situations. While not perfect, comparisons may be extrapolated using current performance statistics found in deployed applications that are using the XB24 hardware.

Initiator	Receiver	Attenuation	Packets Received	Total Retries Needed	MaxRSSI	MinRSSI	AverageRSSI
XB24	XB24	0 dBm	100%	2	-54	-54	-54
		20 dBm	100%	2	-72	-73	-72
		40 dBm	100%	8	-89	-89	-89
XB3-24	XB24	0 dBm	100%	1	-51	-51	-51
		20 dBm	100%	3	-71	-72	-71
		40 dBm	92%	3214	-82	-90	-82
XB3-24	XB3-24	0 dBm	100%	0	-42	-42	-42
		20 dBm	100%	0	-62	-63	-62

		40 dBm	100%	0	-76	-77	-76
XB24	XB3-24	0 dBm	53.40%	5055	-46	-46	-46
		20 dBm	54.50%	5015	-54	-55	-54
		40 dBm	52.10%	5162	-85	-89	-85

Conclusion: In homogeneous networks the reliability is similar, however the XB3-24 hardware does perform better as far as signal strength. Also, it can be noted that mixed networks are less reliable especially when the XB24 is the initiator. This was true in past tests using S2C (Ember EM357) as the receiver. This is a known deficiency.

Test 3: Performance of Broadcasts while Unicast transmission are present on network (802.15.4)

Procedure: 2 nodes (1 x XB24, 1 x XB3-24) are setup to send 200 broadcast packets each @ 500ms spacing. 2 nodes (1 x XB24, 1 x XB3-24) are setup to unicast 100 packets each @ 500ms spacing to 2 specific nodes on the network, 1 of each type.

Each node in the test should receive 600 total packets, 400 unicast and 200 broadcast.

No differentiation was made as to source node of each packet received. The purpose of this test was to see how reliable the reception of broadcast and unicast data is from both types of nodes on the same network during the same duration of time.

	Packets	
Transmitter	Received	Transmitted
XB24		
Broadcast	186	200
Unicast	398	2 x 200
XB3-24		
Broadcast	184	200
Unicast	400	2 x 200

Conclusion: Both hardware platforms will perform nearly the same when unicast and broadcast traffic is present on the network.

Test 4: Signal Strength at Each Power Level (802.15.4)

Procedure: Using 1 node of each type as the transmitter and 1 node of each type as a receiver this test shows the signal strength of each transmission using homogeneous and mixed peer-to-peer communication at each transmitter (Tx) power level.

After each transmission a DB command is issued at the receiver to determine the signal strength of the received packet. No additional attenuation was used during this test. All nodes were within equal distance of one another.

Sender	**Receiver**	**Received Packet Signal Strength**				
		TxPL0	TxPL1	TxPL2	TxPL3	TxPL4
XB24	**XB3-24**	-59	-54	-53	-52	-50
XB24	**XB24**	-62	-57	-57	-55	-54
XB3-24	**XB3-24**	-53	-52	-48	-43	-41

Conclusion: In the signal strength test, the XB3-24 hardware outperforms the XB24 hardware with varying results. In open space with good RF line-of-sight, 6dB will essentially double the distance possible for transmission. At all equivalent power levels, the XB3-24 should be able to transmit substantially further than the XB24.

Test 5: Large File Transfer Reliability (802.15.4)

Procedure: Using 1 node of each type as the transmitter and 1 node of each type as the receiver this test shows the reliability of large packet transmission / reception and the maximum interval at which each large packet can be transmitted before data loss occurs. All data was sent using Unicast transmission. UART speeds were set to 57,600 bps.

*Note: Data packets that exceed the maximum data payload size are broken up into multiple fragments and reassembled at the receiving end. This process does increase transmission time as each data packet requires multiple transmissions. (Do we have fragmentation in 802.15.4 or just in Zigbee?) Are these API frames?

Transmitting	Receiving	Packet Size	# of Packets	Interval	Bytes transmitted	Bytes Received
XB3-24	**XB24**	200 bytes	200	100ms	40,000	40,000
XB3-24	**XB3-24**	200 bytes	200	100ms	40,000	40,000
XB24	**XB24**	200 bytes	200	100ms	40,000	40,000
XB3-24	**XB24**	200 bytes	200	50ms	40,000	40,000
XB3-24	**XB3-24**	200 bytes	200	50ms	40,000	40,000
XB24	**XB24**	200 bytes	200	50ms	40,000	40,000
XB3-24	**XB24**	200 bytes	200	25ms	40,000	40,000
XB3-24	**XB3-24**	200 bytes	200	25ms	40,000	40,000
XB24	**XB24**	200 bytes	200	25ms	40,000	40,000
XB3-24	**XB24**	200 bytes	200	15ms	40,000	29,025
XB3-24	**XB3-24**	200 bytes	200	15ms	40,000	38,014
XB24	**XB24**	200 bytes	200	15ms	40,000	27,007

Configuration 1 Settings		
	XB24	XB3-24
CH	B	B
ID	3232	3232
DL	1	2
MY	2	1
BD	6	6
TO		1
C8		1

Configuration 2 Settings		
	XB3-24	XB3-24
CH	B	B
ID	3232	3232
DL	1	2
MY	2	1
BD	6	6
TO	0	1
C8	0	0

Configuration 3 Settings		
	XB24	XB24
CH	D	D
ID	3232	3232
DL	1	2
MY	2	1
BD	6	6

Conclusion: Both hardware platforms will perform nearly the same until the 15ms interval. This is due to the fact that the XB24 platform is limited to lesser data payloads per RF packet. For better throughput performance, XB3-24 homogeneous networks will perform better.

Test 6: IO Sampling (802.15.4)

Procedure: Using 1 node of each type as the transmitter and 1 node of each type as the receiver this test shows compatibility between the two hardware platforms as it pertains to Digital and Analog IO.

Conclusion: IO Line Passing: XB3-24 behaves in the same manner as XB24 whether to another XB3-24 or XB24 modules. The main difference between the two variants is the XB3-24 allows for the addition of internal pull-up resistors that can be set to pull up or down. By default all internal pull-up resistors are enabled and in the up position.

General Digital IO: Performance remains the same regardless of network makeup.

General Analog IO: Performance remains the same regardless of network makeup.