



AN1242: Bluetooth Low Energy Interoperability Test Report

This document includes results of interoperability testing of Silicon Labs ICs and the Bluetooth stack with leading iOS and Android smart phones.

KEY POINTS

- Scan, connection, discovery, and GATT operations tested
- Test coverage for iOS and Android smart phones
- EFR32xG13, xG21, xG22 tested

1. Test Setup Details

Tests were performed using Silicon Labs evaluation hardware, with each product family under test running functionally equivalent embedded test software. Mobile phones were tested running iOS and Android versions of the the same test procedure, with tests defined below.

Setup Parameter	Description
Bluetooth SDK version under test	2.12.5
Mobile phone and operating system under test	See test results
Silicon Labs product families under test	EFR32xG13, xG21, xG22

2. Test Hardware and Environment

Tests execution permutations combine one device under test with one phone as shown in the diagram below. Simplicity Studio programs the Flash of the device under test and then maintains a Network Analyser log for the duration of test execution. Testing is then initiated by running a testing feature in a mobile app. As tests execute, the mobile app maintains a log file of test results that is sent to a collector for review and test result compilation.

The mobile phone's operating system is specified per test iteration in the test results in this document. The Bluetooth SDK version used for all devices under tests is specified in this document.

The tests were executed in a real world environment with signals from WiFi and other Bluetooth systems present.

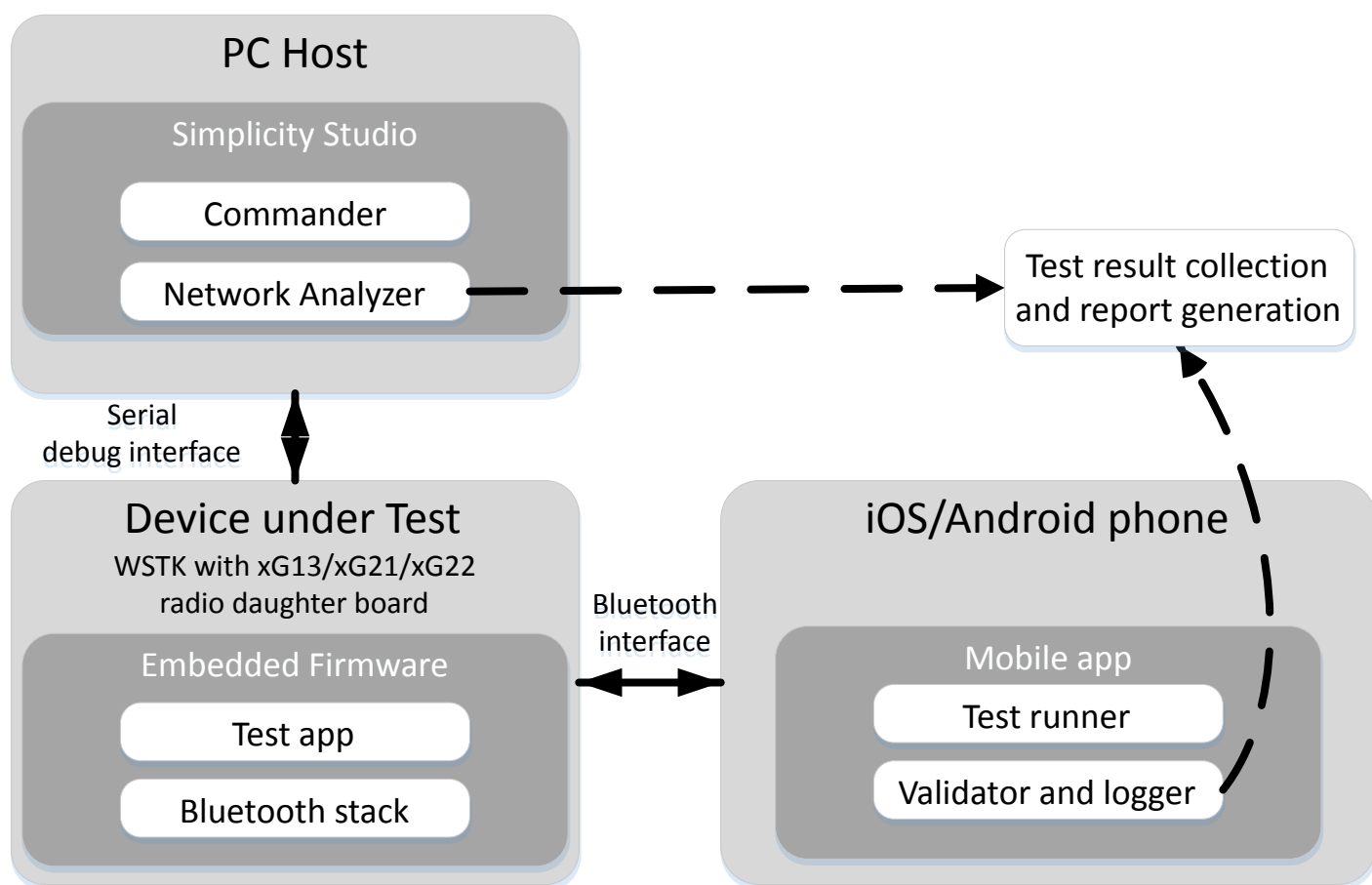


Figure 2.1. Interoperability Test Hardware

3. Test Case Details

Test Set	Test Case	Test Type	Test Sub-Type	Procedure
1	1	BLE Scanning		Reset device, scan on phone. Pass if device is found by phone within 1000ms from scanning start time. Maximum number of retries: 5
2	1	BLE Connection		Attempt connection between phone as central and device as peripheral. Measure connection time from start to successful completion. Pass if the connection is established successfully within 1000ms. Maximum number of retries: 5
3	1	BLE Discovery		Pass if all GATT services from device under test are read by phone within 1200ms.
4	1	GATT operations	IOP Test Read Only Length 1	<ul style="list-style-type: none"> Type = hex Length = 1 Read value = 0x55 Pass if expected value is read by phone.
4	2	GATT operations	IOP Test Read Only Length 255	<ul style="list-style-type: none"> Type = hex Length = 255 Properties = Read Value = 0-254 Pass if phone reads all 255 bytes match the value described above.
4	3	GATT operations	IOP Test Write Only Length 1	<ul style="list-style-type: none"> Type = hex Length = 1 Properties = Write Phone writes 1 byte to the characteristic with value 0. Pass if the operation does not generate an error on the phone.
4	4	GATT operations	IOP Test Write Only length 255	<ul style="list-style-type: none"> Type = hex Length = 255 Properties = Write Phone writes 255 bytes to the characteristic with value 0. Pass if the operation does not generate an error on the phone.
4	5	GATT operations	IOP Test Write Without Response Length 1	<ul style="list-style-type: none"> Type = hex Length = 1 Properties = Write Without Response Phone writes 1 byte to the characteristic with value 0. Pass if the operation does not generate an error on the phone.
4	6	GATT operations	IOP Test Write Without Response Length 255	<ul style="list-style-type: none"> Type = hex Length = 255 Properties = Write Without Response Phone writes 255 bytes to the characteristic with value 0. Pass if the operation does not generate an error on the phone.

Test Set	Test Case	Test Type	Test Sub-Type	Procedure
4	7	GATT operations	IOP Test Notify length 1	<ul style="list-style-type: none"> Type = hex Length = 1 Properties = Notify Value = 0x55 <p>Phone subscribes to notifications on the characteristic which shall trigger a one-shot 100ms timer on the embedded firmware. Once the timer expires, the notification shall be sent with defined value. Pass if the the subscription is done successfully, notification is received within 300ms after subscribing, and the value is 0x55.</p> <p>Maximum number of retries: 5</p>
4	8	GATT operations	IOP Test Notify length MTU - 3	<ul style="list-style-type: none"> Type = hex Length = 255 Properties = Notify <p>Phone subscribes to indications on the characteristic which shall trigger a one-shot 100ms timer on the embedded firmware. Once the timer expires the indication shall be sent. The amount of bytes sent shall be MTU - 3 bytes (maximum supported by an indication) where the first byte value is 0 and the subsequent bytes will previous one +1 (e.g. byte 0 value is, byte 1 value is 1 ... and byte N value is N). Pass if the subscription is done successfully, indication is received within 300ms after subscribing and the value matches as described above.</p> <p>Maximum number of retries: 5</p>
4	9	GATT operations	IOP Test Indicate Length 1	<ul style="list-style-type: none"> Type = hex Length = 1 Properties = Indicate Value = 0x55 <p>Phone subscribes to indications on the characteristic which shall trigger a one-shot 100ms timer on the embedded firmware. Once the timer expires the indication shall be sent with defined value. Pass if the the subscription is done successfully, indication is received within 300ms after subscribing and the value is 0x55.</p>
4	10	GATT operations	IOP Test Indicate length MTU - 3	<ul style="list-style-type: none"> Type = hex Length = 255 Properties = Indicate <p>Phone subscribes to indications on the characteristic which shall trigger a one-shot 100ms timer on the embedded firmware. Once the timer expires the indication shall be sent. The amount of bytes sent shall be MTU - 3 bytes (maximum supported by an indication) where the first byte value is 0 and the subsequent bytes will previous one +1 (e.g. byte 0 value is, byte 1 value is 1 ... and byte N value is N). Pass if the the subscription is done successfully, indication is received within 300ms after subscribing and the value matches as described above.</p> <p>Maximum number of retries: 5</p>
5	1	Characteristic length tests	IOP Test Length 1	<ul style="list-style-type: none"> Type = hex Length = 1 Properties = Read, Write Value = 0x00 <p>Write 1 byte with value 0x55 then read value back. Pass if value read is 0x55.</p>

Test Set	Test Case	Test Type	Test Sub-Type	Procedure
5	2	Characteristic length tests	IOP Test Length 255	<ul style="list-style-type: none"> Type = hex Length = 255 Properties = Read, Write Value = 0x00 on all bytes <p>Phone writes 255 bytes where the first byte value is 0 and the subsequent bytes will previous one +1 (e.g. byte 0 value is, byte 1 value is 1 ... and byte 255 value is 255). Read values back Pass if all 255 bytes match the value described above.</p>
5	3	Characteristic length tests	IOP Test Length Variable 4	<ul style="list-style-type: none"> Type = hex Length = 4 Variable Length = True Properties = Read, Write Value = 0x00 (only 1 byte so that length is also 1) <p>1: Phone writes 1 byte with value 0x55 and read back. Pass if get only 1 byte with value 0x55.</p> <p>2: Phone writes 4 bytes with value 0x66 and read back. Pass if get 4 bytes with value 0x66.</p>
5	4	Characteristic length tests	IOP Test Const Length 1	<ul style="list-style-type: none"> Type = hex Length = 1 Properties = Read, Write, Const Value = 0x55 <p>1: Phone reads 1 byte. Pass if the value is 0x55.</p> <p>2: Phone writes value 0 Pass if you get ATT error code 0x03 "Write Not Permitted" (5.1 Core spec, page 2302).</p>
5	5	Characteristic length tests	IOP Test Const Length 255	<ul style="list-style-type: none"> Type = hex Length = 255 Properties = Read, Write, Const Value = The first byte value is 0 and the subsequent bytes will previous one +1 (e.g. byte 0 value is, byte 1 value is 1 ... and byte 255 value is 255) <p>1: Phone reads 255 byte. Pass if the value is as described above.</p> <p>2: Phone writes value 0 to all bytes. Pass if you get ATT error code 0x03 "Write Not Permitted" (5.1 Core spec, page 2302).</p>
5	6	Characteristic length tests	IOP Test User Len 1	<ul style="list-style-type: none"> Type = user Length = 1 Properties = Read, Write <p>Phone writes 1 byte with value 0x55 then read value back. Pass if value read is 0x55.</p>
5	7	Characteristic length tests	IOP Test User Len 255	<ul style="list-style-type: none"> Type = user Length = 1 Properties = Read, Write <p>Phone writes 255 bytes where the first byte value is 0 and the subsequent bytes will previous one +1 (e.g. byte 0 value is, byte 1 value is 1 ... and byte 255 value is 255) Pass if value read is as described above.</p>

Test Set	Test Case	Test Type	Test Sub-Type	Procedure
5	8	Characteristic length tests	IOP Test User Len Variable 4	<ul style="list-style-type: none">Type = userLength = 4Variable Length = TrueProperties = Read, Write <p>1: Phone writes 1 byte with value 0x55 and read back. Pass if get only 1 byte (so the length is 1) with value 0x55.</p> <p>2: Phone writes 4 bytes with value 0x66 and read back. Pass if get 4 bytes (so the length is 4) with value 0x66.</p>

4. Test Results

Manufacturer	Model	Operating system	1	2	3	4.1-4.10	5.1-5.8
Asus	Nexus 7	Marshmallowv6.0 API Level:23	Pass	Pass	Pass	Pass	Pass
Google	Pixel 3 XL	Piev9.0 API Level:28	Pass	Pass	Pass	Pass	Pass
Google	Pixel 2	Piev9.0 API Level:28	Pass	Pass	Pass	Pass	Pass
Google	Pixel	Piev9.0 API Level:28	Pass	Pass	Pass	Pass	Pass
Google	Pixel 2 XL	Piev9.0 API Level:28	Pass	Pass	Pass	Pass	Pass
Google	Pixel XL	Piev10.0 API Level:29	Pass	Pass	Pass	Pass	Pass
Google	Pixel 3	Piev9.0 API Level:28	Pass	Pass	Pass	Pass	Pass
HUAWEI	INE-LX2r	Oreo8.1 API Level:27	Pass	Pass	Pass	Pass	Pass
HUAWEI	STK-L22	Piev9.0 API Level:28	Pass	Pass	Pass	Pass	Pass
HUAWEI	MAR-LX2	Piev9.0 API Level:28	Pass	Pass	Pass	Pass	Pass
HUAWEI	VNS-L31	Marshmallowv6.0 API Level:23	Pass	Pass	Pass	Pass	Pass
HUAWEI	DUB-LX2	Oreo8.1 API Level:27	Pass	Pass	Pass	Pass	Pass
iPhone	8 Plus	iOS 13.3	Pass	Pass	Pass	Pass	Pass
iPhone	6	iOS 12.4.1	Pass	Pass	Pass	Pass	Pass
iPhone	5S	iPhone OS 9.2	Pass	Pass	Pass	Pass	Pass
iPhone	XS	iOS 13.2.3	Pass	Pass	Pass	Pass	Pass
iPhone	6 Plus	iOS 12.4.4	Pass	Pass	Pass	Pass	Pass
iPhone	4S	iPhone OS 9.3.1	Pass	Pass	Pass	Pass	Pass
iPhone	5C	iOS 10.3.3	Pass	Pass	Pass	Pass	Pass
iPhone	X	iOS 13.3	Pass	Pass	Pass	Pass	Pass
iPhone	8	iOS 13.3	Pass	Pass	Pass	Pass	Pass
iPhone	6S	iOS 13.3	Pass	Pass	Pass	Pass	Pass
iPhone	7	iOS 13.2.3	Pass	Pass	Pass	Pass	Pass
iPhone	7 Plus	iOS 13.1.2	Pass	Pass	Pass	Pass	Pass
LGE	Nexus 5	Marshmallowv6.0 API Level:23	Pass	Pass	Pass	Pass	Pass
LGE	LG-H818	Marshmallowv6.0 API Level:23	Pass	Pass	Pass	Pass	Pass
Motorola	Nexus 6	Nougatv7.0 API Level:24	Pass	Pass	Pass	Pass	Pass
OPPO	CPH1917	Piev9.0 API Level:28	Pass	Pass	Pass	Pass	Pass
OPPO	CPH1905	Oreo8.1 API Level:27	Pass	Pass	Pass	Pass	Pass
OPPO	CPH1923	Piev9.0 API Level:28	Pass	Pass	Pass	Pass	Pass
OPPO	CPH1969	Piev9.0 API Level:28	Pass	Pass	Pass	Pass	Pass
OPPO	CPH1912	Oreo8.1 API Level:27	Pass	Pass	Pass	Pass	Pass
Samsung	SM-A105G	Piev9.0 API Level:28	Pass	Pass	Pass	Pass	Pass
Samsung	SM-G935F	Oreo8.0 API Level:26	Pass	Pass	Pass	Pass	Pass
Samsung	SM-A305F	Piev9.0 API Level:28	Pass	Pass	Pass	Pass	Pass

Manufacturer	Model	Operating system	1	2	3	4.1-4.10	5.1-5.8
Samsung	SM-A920F	Piev9.0 API Level:28	Pass	Pass	Pass	Pass	Pass
Samsung	SM-J510FN	Nougatv7.1 API Level:25	Pass	Pass	Pass	Pass	Pass
Samsung	SM-G975F	Piev9.0 API Level:28	Pass	Pass	Pass	Pass	Pass
Samsung	SM-J710F	Marshmallowv6.0 API Level:23	Pass	Pass	Pass	Pass	Pass
Samsung	SM-N950F	Piev9.0 API Level:28	Pass	Pass	Pass	Pass	Pass
Samsung	SM-G950F	Piev9.0 API Level:28	Pass	Pass	Pass	Pass	Pass
Samsung	SM-A805F	Piev9.0 API Level:28	Pass	Pass	Pass	Pass	Pass
Samsung	SM-A107F	Piev9.0 API Level:28	Pass	Pass	Pass	Pass	Pass
Samsung	SM-G955F	Oreov8.0 API Level:26	Pass	Pass	Pass	Pass	Pass
Samsung	SM-A510F	Marshmallowv6.0 API Level:23	Pass	Pass	Pass	Pass	Pass
Samsung	SM-N960F	Oreov8.1 API Level:27	Pass	Pass	Pass	Pass	Pass
Samsung	SM-T585	Marshmallowv6.0 API Level:23	Pass	Pass	Pass	Pass	Pass
Samsung	SM-A720F	Oreov8.0 API Level:26	Pass	Pass	Pass	Pass	Pass
Samsung	SM-G970F	Piev10.0 API Level:29	Pass	Pass	Pass	Pass	Pass
Samsung	SM-A705F	Piev9.0 API Level:28	Pass	Pass	Pass	Pass	Pass
Samsung	SM-A605G	Oreov8.0 API Level:26	Pass	Pass	Pass	Pass	Pass
Samsung	SM-G930F	Oreov8.0 API Level:26	Pass	Pass	Pass	Pass	Pass
Samsung	SM-A505F	Piev9.0 API Level:28	Pass	Pass	Pass	Pass	Pass
Samsung	SM-M205G	Oreov8.1 API Level:27	Pass	Pass	Pass	Pass	Pass
Xiaomi	Mi A2	Piev9.0 API Level:28	Pass	Pass	Pass	Pass	Pass
Xiaomi	MI 9	Piev10.0 API Level:29	Pass	Pass	Pass	Pass	Pass
Xiaomi	MI 8 Lite	Oreov8.1 API Level:27	Pass	Pass	Pass	Pass	Pass
Xiaomi	Redmi Note 7	Piev9.0 API Level:28	Pass	Pass	Pass	Pass	Pass
Xiaomi	Mi A3	Piev9.0 API Level:28	Pass	Pass	Pass	Pass	Pass
Xiaomi	Mi 9T	Piev9.0 API Level:28	Pass	Pass	Pass	Pass	Pass
Xiaomi	Mi A2 Lite	Oreov8.1 API Level:27	Pass	Pass	Pass	Pass	Pass
Xiaomi	Redmi 7A	Piev9.0 API Level:28	Pass	Pass	Pass	Pass	Pass

5. Revision History

Revision 0.2

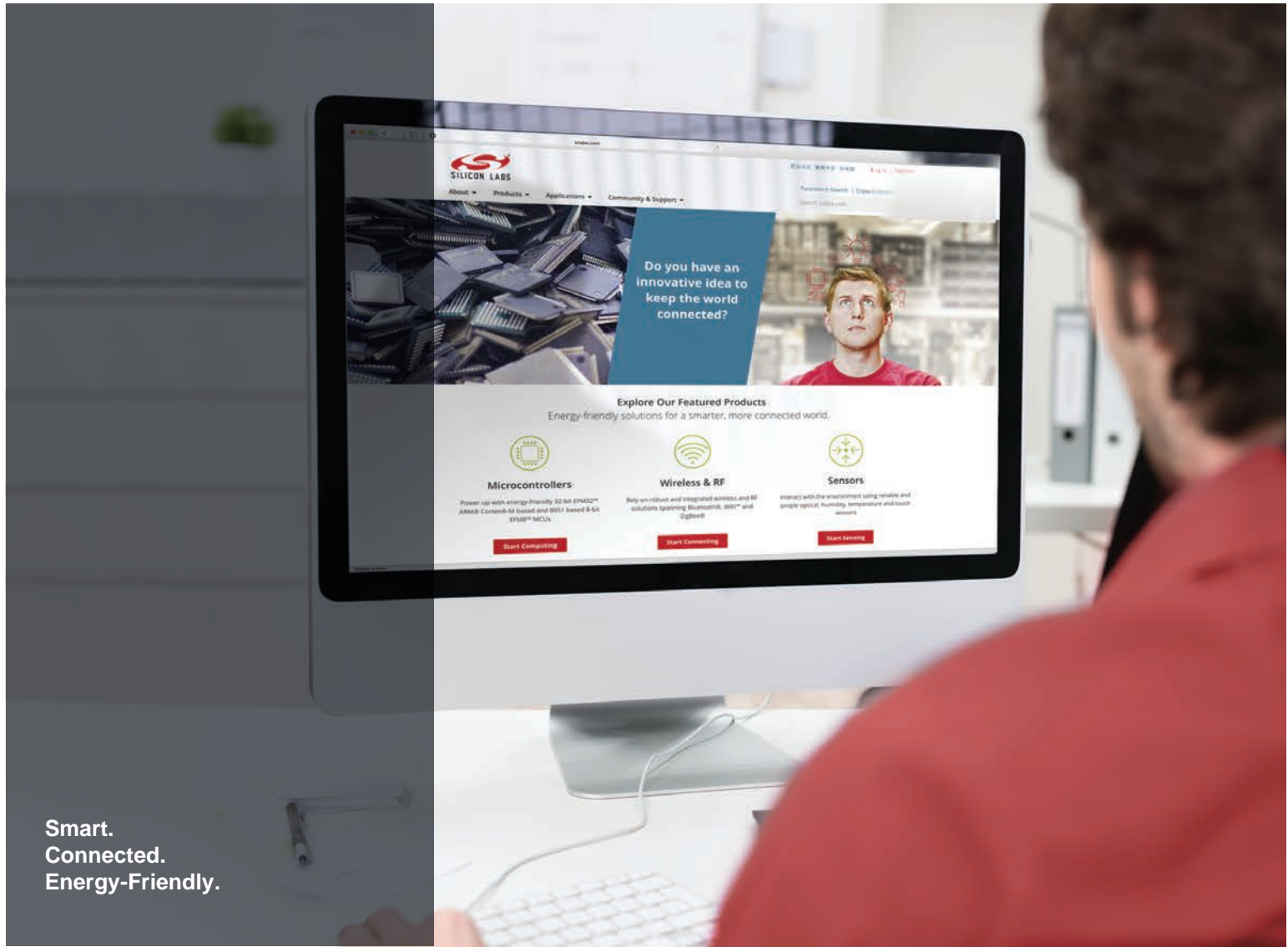
April, 2020

- Added description of test setup
- Included additional information about max number of test re-tries before fail

Revision 0.1

March, 2020

- Initial revision
- Includes test results current to Feb 2020.



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