

Datasheet

Sona™ IF513

Version 1.5

Revision History

Version	Date	Notes	Contributors	Approver
0.1	27 May 2024	Preliminary release	Jacky Kuo	Andy Ross
0.2	8 Aug 2024	Updated Specifications. Updated Reliability Test.	Jacky Kuo Connie Lin	Andy Ross
0.3	15 Oct 2024	Updates to Bluetooth Qualification process . Updated Control Signal Timing Diagram .	Dave Drogowski Jacky Kuo	Jonathan Kaye
1.0	17 Dec 2024	Updated to Ezurio formatting. Initial release.	Sue White Dave Drogowski	Andy Ross
1.1	13 Mar 2025	Updates to Table 37 and Table 38 .	Erik Strack Jacky Kuo	Dave Drogowski
1.2	26 Mar 2025	Updates to W_DISABLE1# , W_DISABLE2# and SDIO_DATA_2	Erik Strack	Dean Ramsier
1.3	16 May 2025	Update for Bluetooth Core 6.0	Dave Drogowski	Andy Ross
1.4	14 Aug 2025	Updated for supported authentication and encryption types.	Erik Strack	Andy Ross
1.5	11 Sep 2025	Corrected pins 42, 43, and 44 in Table 37: M.2 1216 pin definitions .	Jacky Kuo	Dave Drogowski

Contents

1	Scope.....	5
2	Introduction.....	5
2.1	General Description.....	5
3	Sona IF513 Series Feature Summary	6
4	Specifications	7
5	WLAN Functional Description.....	13
5.1	Overview	13
6	Bluetooth Functional Description.....	15
7	Block Diagrams.....	17
7.1	M.2 1216 Solder-Down type	17
7.2	M.2 2230 Key-E card	17
8	Electrical Characteristics.....	18
8.1	Absolute Maximum Ratings	18
8.2	Recommended Operating Conditions.....	18
8.3	DC Electrical Characteristics.....	18
8.4	WLAN Radio Receiver Characteristics	18
8.5	WLAN Transmitter Characteristics.....	21
9	Bluetooth Radio Characteristics	24
10	Crystal Oscillator Requirements.....	27
11	Host Interface Specifications	28
11.1	SDIO Specifications	28
11.1.1	Default mode and High-Speed mode	28
11.1.2	SDIO bus clock timing specifications in SDR mode.....	29
11.1.3	SDIO Bus Input Timing.....	29
11.1.4	SDIO Bus Output Timing	30
11.1.5	SDIO Bus Timing Specifications in DDR50 mode	31
11.2	PCM Interface Specifications	33
11.2.1	PCM Interface.....	33
11.2.2	Burst PCM mode	33
11.3	UART Interface	35
12	Power-Up Sequence and Timing	36
12.1	Description of Control Signals.....	36
12.2	Control Signal Timing Diagram	36
13	Pin Definitions	37
13.1	M.2 1216 Solder-Down	37
13.2	M.2 2230 Key-E	41
14	Host Platform Implementation Details	44

14.1	Bluetooth Interface Requirements	44
14.2	Low Power Clock	44
14.3	W_DISABLE1#, W_DISABLE2# and SDIO_DATA_2	44
15	Mechanical Specifications	45
15.1	M.2 1216	45
15.2	M.2 2230 Key-E	47
15.3	M.2 2230 Key-E Mounting	48
16	RF Layout Design Guidelines	50
17	Application Notes	51
17.1	Introduction	51
17.2	Shipping and Labeling	51
17.2.1	M.2 1216 Solder-Down	51
17.2.2	M.2 2230 Key-E Card	57
17.3	Required Storage Conditions	61
17.3.1	Prior to Opening the Dry Packing	61
17.3.2	After Opening the Dry Packing	61
17.3.3	Temporary Storage Requirements after Opening	62
17.4	Baking Conditions	62
18	Surface Mount Conditions	63
18.1	Recommended Stencil Aperture	63
18.2	Soldering	63
18.2.1	Cautions When Removing the M.2 1216 from the Platform for RMA	64
18.2.2	Precautions for Use	65
19	Reliability Test	66
19.1	Environmental and Mechanical	66
19.2	Reliability Prediction	67
20	Regulatory	69
20.1	Certified Antennas	69
21	Bluetooth Qualification process	70
21.1	Overview	70
21.2	Scope	70
21.3	Qualification Steps When Referencing multiple existing designs, (unmodified) – Option 2a in the QPRDv3	70
21.4	Example Design Combinations	71
21.5	Qualify More Products	72
22	Additional Information	73

1 Scope

This document describes key hardware aspects of the Ezurio Sona™ IF513 series wireless modules providing a SDIO 3.0 interface for WLAN connection and high-speed 4-wire UART interface for Bluetooth® connection. This document is intended to assist device manufacturers and related parties with the integration of this radio into their host devices. Data in this document is drawn from several sources and includes information found in the Infineon CYW55513IUBGT data sheet issued on March 23, 2023, along with other documents provided by Infineon.

Note: The information in this document is subject to change. Please contact Ezurio to obtain the most recent version of this document.

2 Introduction

2.1 General Description

The Sona IF513 series wireless module is an integrated, small form factor Wi-Fi/Bluetooth module that is optimized for low-power mobile devices, featuring:

- Wi-Fi 6E: Tri-band 1x1 MIMO IEEE 802.11a/b/g/n/ac/ax WLAN
- Bluetooth® Core 6.0: Dual Mode

The integration of all WLAN and Bluetooth functionality in a single package supports a low cost and simple implementation along with flexibility for platform-specific customization. The radio is pre-calibrated and integrates the complete transmit/receive RF paths including bandpass filter, diplexer, switches, reference crystal oscillator, and power management units (PMU). It is available in both M.2 2230 E-Key and M.2 1216 solder-down form factors with an MHF4 antenna connector and optional antenna diversity. The M.2 1216 module is also available with an RF trace pin for use with external antenna solutions. For a list of certified antennas see [Certified Antennas](#).

The Sona IF513 series device supports IEEE 802.11ax tri-band (2.4/5/6 GHz) 1x1 MIMO with data rates up to MCS11 (143 Mbps PHY data rate for 2.4/5/6 GHz). The device's low power consumption, radio architecture and power management unit (PMU) proprietary power save technologies allow for extended battery life.

In addition, its tri-band IEEE 802.11ax and Bluetooth radio includes full digital MAC and baseband engines that handle all 802.11 CCK/OFDM/OFDMA® 2.4/5/6 GHz and Bluetooth Core 6.0 (Basic Rate, Enhanced Data Rate, and Bluetooth Low Energy) baseband and protocol processing.

Ordering information is listed in [Table 1](#). Please contact Ezurio Sales/FAE for further information.

Table 1: Product ordering information

Part Number	Description
453-00184R	Module, Sona IF513, MHF4L, Tape and Reel
453-00184C	Module, Sona IF513, MHF4L, Cut Tape
453-00185R	Module, Sona IF513, Trace Pin, Tape and Reel
453-00185C	Module, Sona IF513, Trace Pin, Cut Tape
453-00186	Module, Sona IF513, M.2, Key E, SDIO, UART
453-00186-K1	Development Kit, Module, Sona IF513, M.2, Key E, SDIO, UART
453-00193R	Module, Sona IF513, Antenna Diversity, MHF4L, Tape and Reel
453-00193C	Module, Sona IF513, Antenna Diversity, MHF4L, Cut Tape
453-00194R	Module, Sona IF513, Antenna Diversity, Trace Pin, Tape and Reel
453-00194C	Module, Sona IF513, Antenna Diversity, Trace Pin, Cut Tape
453-00195	Module, Sona IF513, Antenna Diversity, M.2, Key E, SDIO, UART
453-00195-K1	Development Kit, Module, Sona IF513, Antenna Diversity, M.2, Key E, SDIO, UART

3 Sona IF513 Series Feature Summary

The Ezurio Sona IF513 series device features are described in [Table 2](#).

Table 2: Sona IF513 series wireless module feature

Feature	Description																											
Radio Front End	- Integrates the complete transmit/receive RF paths including bandpass filter, diplexer, switches, reference crystal oscillator, and power manage unit (PMU) - Supports tri-band (2.4/5/6 GHz) - Supports 20MHz channel bandwidth - Supports 1x1 WLAN/Bluetooth antenna configuration - Supports 1x1 WLAN antenna diversity configuration, with Bluetooth shared main antenna																											
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	One buck regulator, multiple LDO regulators, and a power management unit (PMU) are integrated into the CYW55513IUBGT. All regulators are programmable via the PMU. These blocks simplify power supply design for Bluetooth and WLAN functions in embedded designs.																											
Pre-Calibration	RF system tested and calibrated in production																											
Sleep Clock	The Sona IF513 series requires a 32.768 KHz sleep clock. There is an internal 32.768 KHz option on the Sona IF513 M.2 2230 card. The 32.768 kHz precision oscillator which meets the requirements listed following table must be used. <table><tr><th>Parameter</th><th>LPO Clock</th><th>Unit</th></tr><tr><td>Nominal input frequency</td><td>32.768</td><td>kHz</td></tr><tr><td>Frequency accuracy</td><td>±250</td><td>ppm</td></tr><tr><td>Duty cycle</td><td>30 – 70</td><td>%</td></tr><tr><td>Input signal amplitude</td><td>200 – 3300</td><td>mV, p-p</td></tr><tr><td>Signal type</td><td>Square-wave or sine-wave</td><td>-</td></tr><tr><td>Input impedance</td><td>> 100k</td><td>Ω</td></tr><tr><td></td><td>< 5</td><td>pF</td></tr><tr><td>Clock jitter (during initial startup)</td><td>< 10,000</td><td>ppm</td></tr></table>	Parameter	LPO Clock	Unit	Nominal input frequency	32.768	kHz	Frequency accuracy	±250	ppm	Duty cycle	30 – 70	%	Input signal amplitude	200 – 3300	mV, p-p	Signal type	Square-wave or sine-wave	-	Input impedance	> 100k	Ω		< 5	pF	Clock jitter (during initial startup)	< 10,000	ppm
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Clock jitter (during initial startup)	< 10,000	ppm																										
Host Interface	The Sona IF513 M.2 card support the “SDIO/UART” interfaces: SDIO/UART, Wi-Fi section provides support for SDIO v3.0 and is backward compatible with SDIO v2.0. Bluetooth section supports a high-speed 4-wire UART interface.																											
Advanced WLAN	- IEEE 802.11a/b/g/n/ac/ax compliant, tri-band capable (2.4/5/6 GHz) 1x1 MIMO providing up to 143 Mbps PHY data rate for 2.4/5/6 GHz (1024-QAM modulation) - Supports 20 MHz bandwidth with optional SGI (1024-QAM modulation) - On-chip power amplifiers and low-noise amplifiers for both bands - Support wide variety of WLAN encryption: WPA2/WPA3, AES and IEEE 802.11i compatibility																											
Advanced Bluetooth	- Bluetooth Core 6.0 (BDR + EDR + Bluetooth LE) - Bluetooth Class 1 or Class 2 transmitter operation - Support data rate: 1 Mbps (GFSK), 2 Mbps (π/4-DQPSK), 3 Mbps (8-DPSK), LE-1 Mbps, LE-2 Mbps, LE-LR-500K (S=2) and LE-LR-125K (S=8) - Supports extended synchronous connections (eSCO) for enhanced voice quality by allowing for retransmission of dropped packets - Adaptive frequency hopping (AFH) for reducing radio frequency interference - Host controller interface (HCI) using a highspeed UART and PCM/I2S for audio data - Low power consumption improves battery life of IoT and embedded devices - Supports multiple simultaneous Advanced Audio Distribution Profiles (A2DP) for stereo sound - On-chip memory includes 768 KB SRAM and 2 MB ROM																											

4 Specifications

Table 3: Specifications

Feature	Description
Physical Interface	M.2 2230 E-Key standard form factor M.2 1216 108-pin LGA package (including 8 thermal ground pads under the package)
Wi-Fi Interface	Secure Digital I/O 2.0/3.0
Bluetooth/BLE Interface	Host Controller Interface (HCI) using high speed UART
Main Chipset	Infineon AIROC™ CYW55513IUBGT
Input Voltage Requirements	Typical DC 3.3 V, operating range from DC 3.13V to 3.5V
I/O Signalling Voltage	Compliant with M.2 standard Typical DC 1.8 V ± 5%
Operating Temperature	-40° to +85°C (-40° to +185°F)
Operating Humidity	10 to 90% (non-condensing)
Storage Temperature	-40° to +85°C (-40° to +185°F)
Storage Humidity	10 to 90% (non-condensing)
MSL (Moisture Sensitivity Level)	4
Maximum Electrostatic Discharge	Conductive 8KV; Air coupled 12KV (follows EN61000-4-2)
Size	M.2 1216 - Length: 16 mm - Width: 12 mm - Thickness: 0.43 mm M.2 E-Key - Length: 30 mm - Width: 22 mm - Thickness: 3.1 mm
Weight – g (oz.)	M.2 1216 ~0.7 M.2 E-Key 3
Wi-Fi Media	Direct Sequence-Spread Spectrum (DSSS) Complementary Code Keying (CCK) Orthogonal Frequency Division Multiplexing (OFDM) Orthogonal Frequency Division Multiple Access (OFDMA)
Bluetooth Media	Frequency Hopping Spread Spectrum (FHSS)
Wi-Fi Multimedia	WMM Wi-Fi Multimedia - PowerSave (WMM-PS with U-APSD) WMM-Sequential Access (WMM-SA)
Network Architecture Types	Infrastructure (client operation)
Wi-Fi Standards	IEEE 802.11ax, 11ac, 11ac, 11a/b/g/n, 11d/h, 11i, 11r, 11w, 11e, 11k, 11ai, 11v
Bluetooth Standards	Bluetooth 2.1 + EDR, 3.0, 4.2, 5.0, 5.1, 5.2, 5.3, 5.4, Core 6.0
Wi-Fi Data Rates Supported	Support 802.11 ax/ac/a/b/g/n 1x1 MU-MIMO. 802.11b (DSSS, CCK) 1, 2, 5.5, 11 Mbps 802.11a/g (OFDM) 6, 9, 12, 18, 24, 36, 48, 54 Mbps 802.11n (OFDM, HT20, MCS0-7) 802.11ac (OFDM, VHT20, MCS0-8) 802.11ax (2.4 GHz / OFDM / HE20 / MCS0-11; 2.4 GHz / OFDMA / HE20 / MCS0-11) 802.11ax (5 GHz, 6 GHz / OFDM / HE20 / MCS0-11; 5 GHz, 6 GHz / OFDMA / HE20 / MCS0-11)

Feature		Description								
Modulation Table		BPSK, QPSK, CCK, 16-QAM, 64-QAM, 256-QAM, 1024-QAM								
Modulation Type						OFDM (IEEE 802.11n/ac)		OFDM (IEEE 802.11ax)		
MCS Index			Spatial Stream	Modulation	Coding	20MHz		20MHz		
HT	VHT	HE				0.8us GI	0.4us GI	0.8us GI	1.6us GI	3.2us GI
0	0	0	1	BPSK	1/2	6.5	7.2	8.6	8.1	7.3
1	1	1	1	QPSK	1/2	13	14.4	17.2	16.3	14.6
2	2	2	1	QPSK	3/4	19.5	21.7	25.8	24.4	21.9
3	3	3	1	16-QAM	1/2	26	28.9	34.4	32.5	29.3
4	4	4	1	16-QAM	3/4	39	43.3	51.6	48.8	43.9
5	5	5	1	64-QAM	2/3	52	57.8	68.8	65	58.5
6	6	6	1	64-QAM	3/4	58.5	65	77.4	73.1	65.8
7	7	7	1	64-QAM	5/6	65	72.2	86	81.3	73.1
	8	8	1	256-QAM	3/4	78	86.7	103.2	97.5	87.8
	9	9	1	256-QAM	5/6	N/A	N/A	114.7	108.3	97.5
		10	1	1024-QAM	3/4			129	121.9	109.7
		11	1	1024-QAM	5/6			143.4	135.4	121.9

OFDMA (IEEE 802.11ax)															
MCS Index HE	Spatial Stream	Modulation	Coding	26-tone RU			52-tone RU			106-tone RU			242-tone RU		
				0.8us GI	1.6us GI	3.2us GI	0.8us GI	1.6us GI	3.2us GI	0.8us GI	1.6us GI	3.2us GI	0.8us GI	1.6us GI	3.2us GI
0	1	BPSK	1/2	0.9	0.8	0.8	1.8	1.7	1.5	3.8	3.5	3.2	8.6	8.1	7.3
1	1	QPSK	1/2	1.8	1.7	1.5	3.5	3.3	3	7.5	7.1	6.4	17.2	16.3	14.6
2	1	QPSK	3/4	2.6	2.5	2.3	5.3	5	4.5	11.3	10.6	9.6	25.8	24.4	21.9
3	1	16-QAM	1/2	3.5	3.3	3	7.1	6.7	6	15	14.2	12.8	34.4	32.5	29.3
4	1	16-QAM	3/4	5.3	5	4.5	10.6	10	9	22.5	21.3	19.1	51.6	48.8	43.9
5	1	64-QAM	2/3	7.1	6.7	6	14.1	13.3	12	30	28.3	25.5	68.8	65	58.5
6	1	64-QAM	3/4	7.9	7.5	6.8	15.9	15	13.5	33.8	31.9	28.7	77.4	73.1	65.8
7	1	64-QAM	5/6	8.8	8.3	7.5	17.6	16.7	15	37.5	35.4	31.9	86	81.3	73.1
8	1	256-QAM	3/4	10.6	10	9	21.2	20	18	45	42.5	38.3	103.2	97.5	87.8
9	1	256-QAM	5/6	11.8	11.1	10	23.5	22.2	20	50	47.2	42.5	114.7	108.3	97.5
10	1	1024-QAM	3/4	13.2	12.5	11.3	26.5	25	22.5	56.3	53.1	47.8	129	121.9	109.7
11	1	1024-QAM	5/6	14.7	13.9	12.5	29.4	27.8	25	62.5	59	53.1	143.4	135.4	121.9

802.11ax/ac/n Spatial Streams	1 (1x1 MU-MIMO)
Bluetooth Data Rates Supported	1, 2, 3 Mbps
Bluetooth Modulation	GFSK @ 1 Mbps Pi/4-DQPSK @ 2 Mbps 8-DPSK @ 3 Mbps
Bluetooth LE Data Rates Supported	1, 2 Mbps, 500 Kbps (S=2), 125 Kbps (S=8)
Bluetooth LE Modulation	GFSK @ 1, 2 Mbps GFSK @ 125, 500 Kbps
Regulatory Certifications	United States (FCC) EU - Member countries of European Union (ETSI) Great Britain (UKCA) Canada (ISED) Australia/New Zealand (RCM) Japan (MIC)
2.4 GHz Frequency Bands	EU: 2.4 GHz to 2.483 GHz FCC/ISED: 2.4 GHz to 2.473 GHz UKCA: 2.4 GHz to 2.483 GHz MIC: 2.4 GHz to 2.483 GHz RCM: 2.4 GHz to 2.483 GHz

Feature	Description	
5 GHz Frequency Bands	EU	
	5.15 GHz to 5.35 GHz	
	5.47 GHz to 5.725 GHz	
	5.725 GHz to 5.85 GHz	
	FCC	
	5.15 GHz to 5.35 GHz	
	5.47 GHz to 5.725 GHz	
	5.725 GHz to 5.85 GHz	
	ISED	
	5.15 GHz to 5.35 GHz	
	5.47 GHz to 5.725 GHz	
	5.725 GHz to 5.85 GHz	
	UKCA	
	5.15 GHz to 5.35 GHz	
	5.47 GHz to 5.730 GHz	
	5.725 GHz to 5.850 GHz	
	MIC	
	5.15 GHz to 5.35 GHz	
	5.47 GHz to 5.725 GHz	
	RCM	
	5.15 GHz to 5.35 GHz	
	5.47 GHz to 5.725 GHz	
	5.725 GHz to 5.85 GHz	
6 GHz Frequency Bands	FCC / ISSED	
	UNII-5, 5.925 GHz to 6.415 GHz	
	UNII-6, 6.435 GHz to 6.515 GHz	
	UNII-7, 6.535 GHz to 6.875 GHz	
	UNII-8, 6.895 GHz to 7.115 GHz	
	EU	
	UNII-5, 5.945 GHz to 6.425 GHz	
	UKCA	
	UNII-5, 5.945 GHz to 6.425 GHz	
	MIC	
	UNII-5, 5.945 GHz to 6.425 GHz	
	RCM	
	UNII-5, 5.945 GHz to 6.425 GHz	
Transmit Power <i>Note: Transmit power on each channel varies per individual country regulations. All values are nominal with +/-2 dBm tolerance at room temperature. Tolerance could be up to +/-2.5 dBm across operating temperature.</i> <i>Note: HT20/VHT20/HE20 – 20 MHz-wide channels</i>	802.11a	
	6 Mbps	17 dBm (50.11 mW)
	54 Mbps	16.5 dBm (44.66 mW)
	802.11b	
	1 Mbps	18 dBm (63.09 mW)
	11 Mbps	18 dBm (63.09 mW)
	802.11g	
	6 Mbps	18 dBm (63.09 mW)
	54 Mbps	17 dBm (50.11 mW)
	802.11n (2.4 GHz)	
	HT20; MCS0-4	18 dBm (63.09 mW)
	HT20; MCS5-7	16 dBm (39.81 mW)
	802.11ax (2.4 GHz)	
	HE20; MCS0-4	18 dBm (63.09 mW)
	HE20; MCS5-7	16 dBm (39.81 mW)
	HE20; MCS8-9	14 dBm (25.11 mW)
	HE20; MCS13	10.5 dBm (19.95 mW)
	802.11n (5 GHz)	
	HT20; MCS0-4	17 dBm (50.11 mW)
	HT20; MCS5-7	16.5 dBm (44.66 mW)

Feature	Description
	802.11ac (5 GHz) VHT20; MCS0-4 17 dBm (50.11 mW) VHT20; MCS5-7 16.5 dBm (44.66 mW) VHT20; MCS8 14 dBm (25.12 mW)
	802.11ax (5 GHz) HE20; MCS0-4 17 dBm (50.11 mW) HE20; MCS5-7 16.5 dBm (44.66 mW) HE20; MCS8-9 14 dBm (25.12 mW) HE20; MC10-11 13 dBm (19.95 mW)
	802.11ax (6 Hz, UNII-5 / 6) 11a; 6M-24M 15.5 dBm (35.48 mW) HE20; MCS0-4 15.5 dBm (35.48 mW) HE20; MCS5-7 15 dBm (31.62 mW) HE20; MCS8-9 13.5 dBm (22.38 mW) HE20; MCS10-11 12 dBm (15.85 mW)
	802.11ax (6 Hz, UNII-7 / 8) 11a; 6M-24M 15 dBm (31.62 mW) HE20; MCS0-4 15 dBm (31.62 mW) HE20; MCS5-7 13 dBm (19.95 mW) HE20; MCS8-9 12 dBm (15.85 mW) HE20; MCS10-11 10.5 dBm (11.22 mW)
	Bluetooth 1 Mbps (1DH1, 3, 5) 7 dBm (5.01 mW), Maximum 2 Mbps (2DH1, 3, 5) 3 dBm (2.51 mW), Maximum 3 Mbps (3DH1, 3, 5) 3 dBm (2.51 mW), Maximum LE (1 Mbps, 2 Mbps) 7 dBm (5.01 mW), Maximum LE-LR (S=2, S=8) 7 dBm (5.01 mW), Maximum
Typical Receiver Sensitivity (PER <= 10%) <i>Note: All values nominal, +/-2 dBm.</i>	802.11a: 6 Mbps -90 dBm 54 Mbps -74 dBm 802.11b: 1 Mbps -97 dBm (PER < 8%) 11 Mbps -90 dBm (PER < 8%) 802.11g: 6 Mbps -93 dBm 54 Mbps -76 dBm 802.11n (2.4 GHz) 6.5 Mbps (MCS0; HT20) -93 dBm 65 Mbps (MCS7; HT20) -75 dBm 802.11ax (2.4 GHz) 7.3 Mbps (MCS0; HE20) -93 dBm 121.9 Mbps (MCS11; HE20) -62 dBm 7.3 Mbps (MCS0; HE20/RU242) -93 dBm 802.11n (5 GHz) 6.5 Mbps (MCS0; HT20) -90 dBm 65 Mbps (MCS7; HT20) -73 dBm 802.11ac (5 GHz) 6.5 Mbps (MCS0; VHT20) -90 dBm 78 Mbps (MCS8; VHT20) -70 dBm 802.11ax (5 GHz) 7.3 Mbps (MCS0; HE20) -90 dBm 121.9 Mbps (MCS11; HE20) -60 dBm 7.3 Mbps (MCS0; HE20/RU242) -90 dBm

Feature	Description
	802.11ax (6 GHz, UNII-5)
	6 Mbps -90 dBm
	24 Mbps -83 dBm
	7.3 Mbps (MCS0; HE20) -90 dBm
	121.9 Mbps (MCS11; HE20) -59 dBm
	7.3 Mbps (MCS0; HE20/RU242) -90 dBm
	802.11ax (6 GHz, UNII-6)
	6 Mbps -90 dBm
	24 Mbps -82 dBm
	7.3 Mbps (MCS0; HE20) -90 dBm
	121.9 Mbps (MCS11; HE20) -59 dBm
	7.3 Mbps (MCS0; HE20/RU242) -90 dBm
	802.11ax (6GHz, UNII-7)
	6 Mbps -89 dBm
	24 Mbps -81 dBm
	7.3 Mbps (MCS0; HE20) -89 dBm
	121.9 Mbps (MCS11; HE20) -58 dBm
	7.3 Mbps (MCS0; HE20/RU242) -89 dBm
	802.11ax (6 GHz, UNII-8)
	6 Mbps -88 dBm
	24 Mbps -80 dBm
	7.3 Mbps (MCS0; HE20) -88 dBm
	121.9 Mbps (MCS11; HE20) -56 dBm
	7.3 Mbps (MCS0; HE20/RU242) -88 dBm
	Bluetooth:
	1 Mbps (1DH5) -91 dBm
	2Mbps (2DH5) -93 dBm
	3 Mbps (3DH5) -87 dBm
	LE-1 Mbps -95 dBm
	LE-2 Mbps -92 dBm
	LE-LR (S=2) -102 dBm
	LE-LR (S=8) -107 dBm
Operating Systems Supported	Linux Android
Security	- WPA2 (Enterprise) and WPA3 (Enterprise) support for powerful encryption and authentication - AES in hardware for faster data encryption and IEEE 802.11i compatibility - Reference WLAN subsystem provides Wi-Fi Protected Setup (WPS)
Compliance	EU EN 300 328 EN 62368-1:2014 EN 301 489-1 EN 300 440 EN 301 489-17 EN 303 687 EN 301 893 2011/65/EU (RoHS) FCC 47 CFR FCC Part 15.247 RSS-247 47 CFR FCC Part 15.407 RSS-248 47 CFR FCC Part 2.1091 AS/NZS AS/NZS 4268:2017 MIC ARIB STD-T66/RCR STD-33 (2.4 GHz) ARIB STD-T71 (5 GHz) Article 2 Paragraph 1 of Item 80 : LPI (ZR), 6 GHz

Feature	Description
Certifications	<i>Bluetooth®</i> SIG Qualification D063147 
Warranty	One Year Warranty
<i>All specifications are subject to change without notice</i>	

5 WLAN Functional Description

5.1 Overview

The Sona IF513 series wireless module is designed based on the Infineon AIROC CYW555131 Wi-Fi 6E chipset. It is optimized for high speed, reliability, and low-power embedded applications. It is integrated with tri-band WLAN (2.4/5/6 GHz) and Bluetooth Core 6.0. Its functionality is listed in [Table 4](#).

Table 4: WLAN functions

Feature	Description																																																																																				
WLAN MAC	▪ Enhanced MAC for supporting IEEE 802.11 a/b/g/n/ac/ax features. ▪ Transmission and reception of HE-SU and HE-ER-SU PPDU. ▪ Reception of HE-MU PPDU -OFDMA/MU-MIMO Frame. ▪ Transmission of HE-TB PPDU (Uplink MU OFDMA). ▪ Trigger frame reception. ▪ QoS null transmission in triggered/non-triggered data. ▪ MU RTS and MU BA reception. ▪ Dual NAV. ▪ Target wake time. ▪ Transmission and reception of A-MPDUs/AMSDUs. ▪ Support for power management schemes, including WMM power-save. ▪ Support for all ACK and Block-ACK policies as per standard. ▪ Interframe space timing support, including RIFS. ▪ Support for RTS/CTS and CTS-to-nowhere frame sequences for protecting frame exchanges. ▪ Timing synchronization function (TSF), network allocation vector (NAV) maintenance, and target beacon transmission time (TBTT) generation in hardware and capturing the TSF timer on an external time synchronization pulse. ▪ Hardware offload for cipher suites/encryption types AES (WPA2), support for WPA3-SAE and key management. ▪ Support for MBSS, P2P Wi-Fi Direct ▪ Support for coexistence with Bluetooth ▪ RTS-CTS based BW signaling mechanism support																																																																																				
WLAN Security	▪ WLAN Encryption features supported include: - WPA2 (Personal/Enterprise) - WPA3 (Personal/Enterprise/192b)																																																																																				
WLAN Channel	Channel frequency supported. <table><tr><th colspan="2">2.4 GHz / 20 MHz</th><th colspan="2">5 GHz / 20 MHz</th></tr><tr><th>Channel</th><th>Frequency (MHz)</th><th>Channel</th><th>Frequency (MHz)</th></tr><tr><td>1</td><td>2412</td><td>36</td><td>5180</td></tr><tr><td>2</td><td>2417</td><td>40</td><td>5200</td></tr><tr><td>3</td><td>2422</td><td>44</td><td>5220</td></tr><tr><td>4</td><td>2427</td><td>48</td><td>5240</td></tr><tr><td>5</td><td>2432</td><td>52</td><td>5260</td></tr><tr><td>6</td><td>2437</td><td>56</td><td>5280</td></tr><tr><td>7</td><td>2442</td><td>60</td><td>5300</td></tr><tr><td>8</td><td>2447</td><td>64</td><td>5320</td></tr><tr><td>9</td><td>2452</td><td>100</td><td>5500</td></tr><tr><td>10</td><td>2457</td><td>104</td><td>5520</td></tr><tr><td>11</td><td>2462</td><td>108</td><td>5540</td></tr><tr><td>12</td><td>2467</td><td>112</td><td>5560</td></tr><tr><td>13</td><td>2472</td><td>116</td><td>5580</td></tr><tr><td></td><td></td><td>120</td><td>5600</td></tr><tr><td></td><td></td><td>124</td><td>5620</td></tr><tr><td></td><td></td><td>128</td><td>5640</td></tr><tr><td></td><td></td><td>132</td><td>5660</td></tr><tr><td></td><td></td><td>136</td><td>5680</td></tr><tr><td></td><td></td><td>140</td><td>5700</td></tr></table>	2.4 GHz / 20 MHz		5 GHz / 20 MHz		Channel	Frequency (MHz)	Channel	Frequency (MHz)	1	2412	36	5180	2	2417	40	5200	3	2422	44	5220	4	2427	48	5240	5	2432	52	5260	6	2437	56	5280	7	2442	60	5300	8	2447	64	5320	9	2452	100	5500	10	2457	104	5520	11	2462	108	5540	12	2467	112	5560	13	2472	116	5580			120	5600			124	5620			128	5640			132	5660			136	5680			140	5700
2.4 GHz / 20 MHz		5 GHz / 20 MHz																																																																																			
Channel	Frequency (MHz)	Channel	Frequency (MHz)																																																																																		
1	2412	36	5180																																																																																		
2	2417	40	5200																																																																																		
3	2422	44	5220																																																																																		
4	2427	48	5240																																																																																		
5	2432	52	5260																																																																																		
6	2437	56	5280																																																																																		
7	2442	60	5300																																																																																		
8	2447	64	5320																																																																																		
9	2452	100	5500																																																																																		
10	2457	104	5520																																																																																		
11	2462	108	5540																																																																																		
12	2467	112	5560																																																																																		
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		132	5660																																																																																		
		136	5680																																																																																		
		140	5700																																																																																		

Feature	Description
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144	5720
149	5745
153	5765
157	5785
161	5805
165	5825

6 GHz / UNII-5 / 20 MHz

Channel	Frequency (MHz)
1	5955
5	5975
9	5995
13	6015
17	6035
21	6055
25	6075
29	6095
33	6115
37	6135
41	6155
45	6175
49	6195
53	6215
57	6235
61	6255
65	6275
69	6295
73	6315
77	6335
81	6355
85	6375
89	6395
93	6415

6 GHz / UNII-6 / 20 MHz

Channel	Frequency (MHz)
97	6435
101	6455
105	6475
109	6495
113	6515

6 GHz / UNII-7 / 20 MHz

Channel	Frequency (MHz)
117	6535
121	6555
125	6575
129	6595
133	6615
137	6635
141	6655
145	6675
149	6695
153	6715
157	6735
161	6755
165	6775
169	6795
173	6815
177	6835
181	6855
185	6875

Feature	Description
	6 GHz / UNII-8 / 20 MHz
	Channel Frequency (MHz)
	189 6895
	193 6915
	197 6935
	201 6955
	205 6975
	209 6995
	213 7015
	217 7035
	221 7055
	225 7075
	229 7095
	233 7115

6 Bluetooth Functional Description

The Sona IF513 series wireless module includes a fully integrated Bluetooth baseband/radio. Several features and functions are listed in [Table 5](#).

Table 5: Bluetooth functions

Feature	Description
Bluetooth Interface	- Voice interface: - Supported by PCM and I2S transports and bi-directional operations. - PCM - Sample rates 8k for NBS and 16k for WBS supported. - Sample width is limited to 16-bits. - Synchronization clock width of 1 or 3 (short or long). - Bit clocks of 128k, 256k, 512k, 1024k and 2024k, the only difference being the number of 16bit slots. - HFP samples can be taken from any available slot. Slot 0 is the default slot. - I2S - Supports bit clocks of 256k (NBS) and 512k (WBS). - HFP samples can be taken from either left or right. Left is the default. - A2DP codec controller - Supported by I2S transport in a single direction, either in or out but not both. - Two channels, left and right. Mono is not supported. - Sample rates: 44.1k or 48k. - Sample width is limited to 16-bits. - Supports bit clocks of 32 times the sample rate, 1411200 (44.1k) or 1536000 (48k) and not adjustable. - High-Speed UART interface
Bluetooth Core functionality	- Supports all Bluetooth 5.3 and 4.2 features. - Dual-mode Bluetooth low energy. - Bluetooth LE LE-2Mbps mode, LE-Long Range mode, Advertising Extensions, Slot Availability Masks. - Extended inquiry response (EIR): Shortens the time to retrieve the device name, specific profile, and operating mode. - Encryption pause resume (EPR): Enables the use of Bluetooth technology in a much more secure environment. - Sniff subrating (SSR): Optimizes power consumption for low duty cycle asymmetric data flow, which subsequently extends battery life. - Secure simple pairing (SSP): Reduces the number of steps for connecting two devices, with minimal or no user interaction required. - Link supervision time out (LSTO): Additional commands added to HCI and link management protocol (LMP) for improved link time-out supervision.

Feature	Description
	QoS enhancements: Changes to data traffic control, which results in better link performance. Audio, human interface device (HID), bulk traffic. SCO, and enhanced SCO (eSCO) are improved with the erroneous data (ED) and packet boundary flag (PBF) enhancements.
Bluetooth Features	- Supports features of Bluetooth Core Specification version 5.3 - Supports features of Bluetooth Core Specification version 5.2: - LE Isochronous Channels - LE Power Control - eATT - ISOC - GATT Caching - Supports features of Bluetooth Core Specification version 5.1: - Control length extension - Periodic Advertising Sync Transfer (PAST) - Supports features of Bluetooth Core Specification version 5.0: - LE 2Mbps - LE Long Range (LE-LR) - Stable Modulation Index for LE - LE Advertising Extension - Slot Availability Masks (SAM) - Channel Selection Algorithm - High Duty Cycle Non-Connectable Advertising - Supports features of Bluetooth Core Specification version 4.0 + EDR - Adaptive frequency hopping (AFH) - Quality of service (QoS) - Extended synchronous connections (eSCO) – Voice Connections - Fast connect (interlaced page and inquiry scans) - Secure simple pairing (SSP) - Sniff subrating (SSR) - Encryption pause resume (EPR) - Extended inquiry response (EIR) - Link supervision timeout (LST) - UART baud rates up to 4 Mbps - Supports Bluetooth 4.2, 5.0, 5.1, 5.2, and 5.3 packet types - Supports maximum Bluetooth data rates over HCI UART - Multipoint operation with up to seven active slaves - Maximum of seven simultaneous active ACL links - Maximum of three simultaneous active SCO and eSCO connections with scatternet support - Narrowband and wideband packet loss concealment - Scatternet operation with up to four active piconets with background scan and support for scatter mode - High-speed HCI UART transport support with low-power out-of-band BT_DEV_WAKE and BT_HOST_WAKE signaling. - Channel quality driven data rate and packet type selection - Standard Bluetooth test modes - Extended radio and production test mode features - Full support for power saving modes - Bluetooth clock request - Bluetooth standard sniff - Deep-sleep modes and software regulator shutdown

7 Block Diagrams

7.1 M.2 1216 Solder-Down type

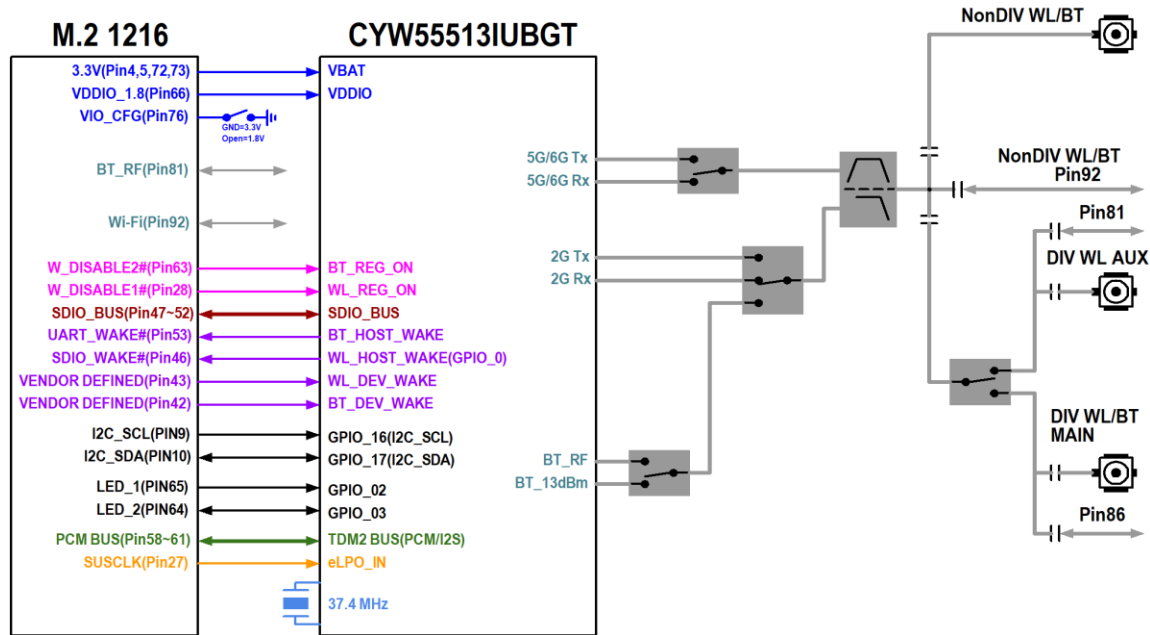


Figure 1: M.2 1216 Solder-Down type block diagram

7.2 M.2 2230 Key-E card

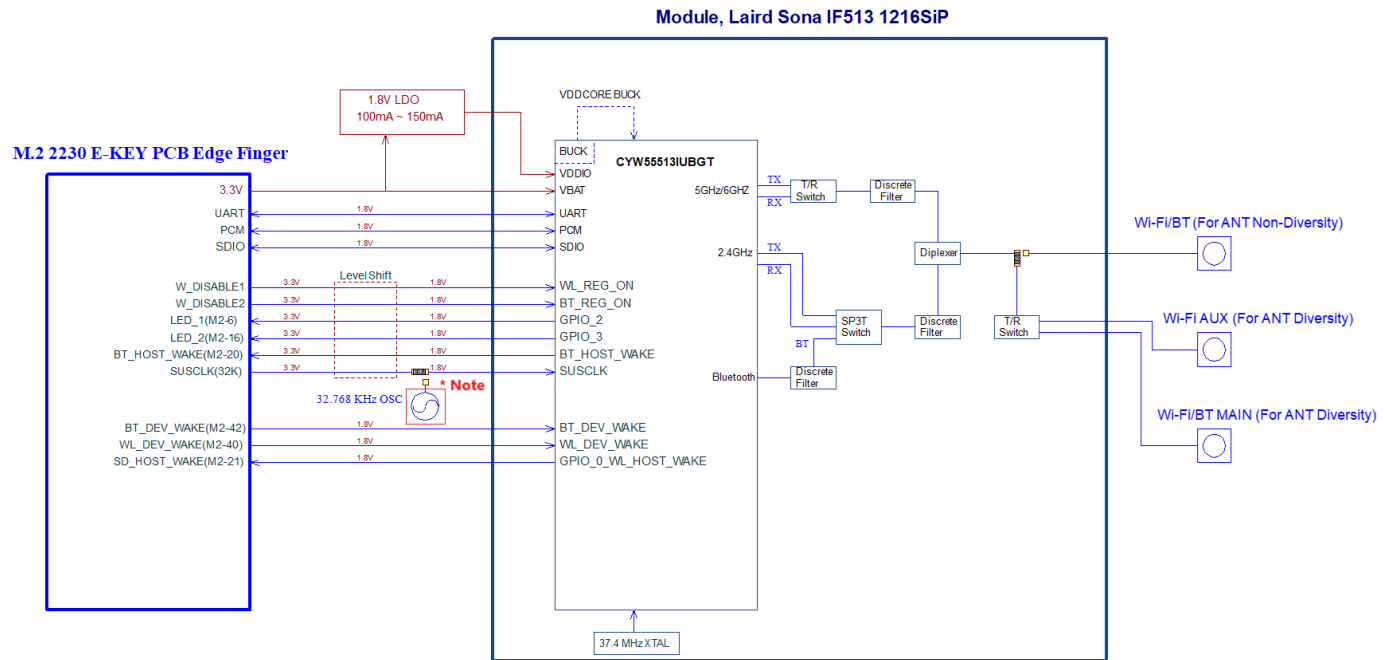


Figure 2: M.2 2230 Key-E card block diagram

*Note, The IF513 2230 module does support an on-board 32K clock option, please contact your sale/support contact if you need access to this option.

8 Electrical Characteristics

8.1 Absolute Maximum Ratings

Table 6 summarizes the absolute maximum ratings and Table 7 lists the recommended operating conditions for the Sona IF513 series wireless module. Absolute maximum ratings are those values beyond which damage to the device can occur. Functional operation under these conditions, or at any other condition beyond those indicated in the operational sections of this document, is not recommended.

Note: Maximum rating for signals follows the supply domain of the signals.

Table 6: Absolute maximum ratings

Symbol (Domain)	Description	Max Rating	Unit
VBAT	External DC power supply (M.2 1216)	+6.0	V
VDDIO	DC supply voltage for digital I/O (M.2 1216)	2.2	V
3V3	External 3.3V power supply (M.2 2230 E-Key)	3.6	V
Storage	Storage temperature	-40 to +125	°C
Antenna	Maximum RF input (reference to 50-Ω input)	+10	dBm
ESD	Electrostatic discharge tolerance	2000	V

8.2 Recommended Operating Conditions

Table 7: Recommended operating conditions

Symbol (Domain)	Parameter	Min	Typ	Max	Unit
VBAT	External DC power supply	3.13	3.3	3.5	V
VDDIO	DC supply voltage for digital I/O	1.71	1.8	1.89	V
T-ambient	Ambient temperature	-40	25	+85	°C

8.3 DC Electrical Characteristics

Table 8 list the general DC electrical characteristics over recommended operating conditions (unless otherwise specified).

Table 8: General DC electrical characteristics (For 1.8V operation VDDIO)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
VIH	High Level Input Voltage	—	0.65 x VDDIO	—	—	V
VIL	Low Level Input Voltage	—	—	—	0.35 x VDDIO	V
VOH	Output high Voltage	—	VDDIO - 0.4	—	—	V
VOL	Output low Voltage	—	—	—	0.45	V

8.4 WLAN Radio Receiver Characteristics

Table 9, Table 10, and Table 11 summarize the Sona IF513 series wireless module receiver characteristics.

Table 9: WLAN receiver characteristics for 2.4 GHz single chain operation

Item	Parameter	Conditions	Min	Typ	Max	Unit
Frequency Range	Receive input frequency range	—	2.412	—	2.484	GHz
Modulation Type	Sensitivity					
	CCK, 1 Mbps	See Note ¹	—	-97	—	dBm
	CCK, 11 Mbps		—	-90	—	

Item	Parameter	Conditions	Min	Typ	Max	Unit
	OFDM, 6 Mbps		—	-93	—	
	OFDM, 54 Mbps		—	-76	—	
	HT20, MCS0		—	-93	—	
	HT20, MCS7		—	-75	—	
	HE20, MCS0		—	-93	—	
	HE20, MCS11		—	-62	—	
ACI - CCK		Desired and interfering signal 30 MHz apart				
[Difference between interfering and desired signal (20 MHz apart)]	1 Mbps (-74 dBm)		—	>48	—	dB
	Desired and interfering signal 25 MHz apart					
	11 Mbps (-70 dBm)		—	>46	—	dB
ACI - OFDM			—	42.5	—	
[Difference between interfering and desired signal (20 MHz apart)]	6 Mbps (-79 dBm)	See Note ¹	—	25.5	—	dB
	54 Mbps (-62 dBm)		—	25.5	—	dB
ACI - MCS0-11			—	35.5	—	dB
[Difference between interfering and desired signal (20 MHz apart)]	MCS0 (-79dBm)		—	15	—	
	MCS7 (-61 dBm)		—	15	—	
	HE9 (-54 dBm)		—	10.3	—	dB
	HE11 (-49 dBm)		—	5.3	—	

Table 10: WLAN receiver characteristics for 5 GHz single chain operation

Item	Parameter	Conditions	Min	Typ	Max	Unit
Frequency Range	Receive input frequency range	—	5.15	—	5.825	GHz
Modulation Type	Sensitivity					
	OFDM, 6 Mbps	See Note ¹	—	-90	—	dBm
	OFDM, 54 Mbps		—	-74	—	
	HT20, MCS0		—	-90	—	
	HT20, MCS7		—	-73	—	
	VHT20, MCS0		—	-90	—	
	VHT20, MCS8		—	-70	—	
	HE20, MCS0		—	-90	—	
	HE20, MCS11		—	-60	—	
ACI - OFDM		Adjacent channel rejection				
[Difference between interfering and desired signal (20 MHz apart)]	6 Mbps (-79 dBm)	See Note ¹	—	29.5	—	dB
	54 Mbps (-62 dBm)		—	13	—	
ACI - MCS0-11			—	26	—	dB
[Difference between interfering and desired signal (20 MHz apart)]	MCS0 (-79 dBm)	See Note ¹	—	8.5	—	
	MCS7 (-61 dBm)		—	8.5	—	
	HE9 (-54 dBm)		—	0.4	—	
	HE11 (-49 dBm)		—	-5.3	—	
ACI - MCS0-11			—	29.5	—	dB
[Difference between interfering and desired signal (40 MHz apart)]	MCS0, N _{SS} = 1 (-76 dBm)	See Note ¹	—	9	—	
	MCS7, N _{SS} = 1 (-58 dBm)		—	9	—	
	MCS9, N _{SS} = 1 (-51 dBm)		—	4	—	
	MCS11, N _{SS} = 1 (-46 dBm)		—	-3	—	
ACI - MCS0-11			—	35.5	—	dB
	MCS0, N _{SS} = 1 (-73 dBm)	See Note ¹	—	35.5	—	
	MCS7, N _{SS} = 1 (-55 dBm)		—	8.5	—	
	MCS9, N _{SS} = 1 (-48 dBm)		—	4.5	—	

Item	Parameter	Conditions	Min	Typ	Max	Unit
[Difference between interfering and desired signal (80 MHz apart)]	MCS11, N _{ss} = 1 (-43 dBm)		–	-1.5	–	

Table 11: WLAN receiver characteristics for 6 GHz single chain operation

Item	Parameter	Conditions	Typical (Sensitivity)				Unit
			UNII-5	UNII-6	UNII-7	UNII-8	
Frequency Range	Receive input frequency range	–	5950 - 6415	6435 - 6515	6535 - 6875	6895 - 7115	MHz
Modulation Type	OFDM, 6Mbps	See Note ¹	-90	-90	-89	-88	dBm
	OFDM, 24Mbps		-83	-82	-81	-80	
	HE20, MCS0		-90	-90	-89	-88	
	HE20, MCS7		-74	-73	-72	-71	
	HE20, MCS8		-69	-69	-69	-68	
	HE20, MCS9		-68	-68	-68	-67	
	HE20, MCS11		-59	-59	-58	-56	
ACI - OFDM [Difference between interfering and desired signal (20 MHz apart)]	6 Mbps (-79 dBm)	See Note ¹	25	25	25	25	dB
ACI - MCS0-11 [Difference between interfering and desired signal (20 MHz apart)]	MCS0 (-79 dBm)	See Note ¹	25	25	25	25	
	MCS7 (-61 dBm)		5	5	5	5	
	MCS9 (-54 dBm)		4	3.5	5	4	
	MCS11 (-49 dBm)		-1.5	-2.5	-0.5	-2	

Note 1: Performance data are measured in single chain operation.

8.5 WLAN Transmitter Characteristics

Table 12 through Table 21 summarize the Sona IF513 series wireless module transmitter characteristics.

Table 12: WLAN transmitter characteristics for 2.4 GHz operation (VBAT = 3.3V, VDDIO = 1.8V)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Ftx	Transmit output frequency range	—	2.402	—	2.484	GHz
Pout	Output power	See Note ²	—	—	—	—
	11b mask compliant	1-11Mbps	—	18	—	dBm
	11g mask compliant	6-36Mbps	—	18	—	
	11g EVM compliant	48-54Mbps	—	17	—	
	11n HT20 mask compliant	MCS0-4	—	18	—	
	11n HT20 EVM compliant	MCS5-7	—	16	—	
	11ax HE20 mask compliant	MCS0-4	—	18	—	
	11ax HE20 EVM compliant	MCS5-7	—	16	—	
	11ax HE20 EVM compliant	MCS8-9	—	14	—	
	11ax HE20 EVM compliant	MCS10-11	—	13	—	
ATx	Transmit power accuracy at 25 °C	—	-2.0	—	+2.0	dB

Table 13: WLAN current consumption on 2.4 GHz (VBAT = 3.3V, VDDIO = 1.8V, BT_REG_ON = Low)

Modulation	Data Rate	Bandwidth (MHz)	Spatial Stream	RF Power Level (dBm)	VBAT Current Consumption (mA)	VIO Current Consumption (mA)
CCK	1 Mbps	20	1	20	255.8	4.6
CCK	11 Mbps	20	1	20	264.8	2.4
BPSK	6 Mbps	20	1	20	244.4	2.9
QPSK	MCS2	20	1	20	252.6	3.5
16-QAM	MCS4	20	1	20	211.8	2.8
64-QAM	MCS7	20	1	18	215.7	2.4
256-QAM	MCS9	20	1	16	197.7	2.1
1024-QAM	MCS11	20	1	15	190.5	1.8

Table 14: WLAN transmitter characteristics for 5 GHz operation (VBAT=3.3V, VDDIO=1.8V)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Ftx	Transmit output frequency range	—	5.15	—	5.925	GHz
Pout	Output power	See Note ²	—	—	—	—
	11a mask compliant	6-36Mbps	—	17	—	dBm
	11a EVM compliant	48-54Mbps	—	16.5	—	
	11n HT20 mask compliant	MCS0-4	—	17	—	
	11n HT20 EVM compliant	MCS5-7	—	16.5	—	
	11ac VHT20 mask compliant	MCS0-4	—	17	—	
	11ac VHT20 EVM compliant	MCS5-7	—	16.5	—	
	11ac VHT20 EVM compliant	MCS8	—	14	—	
	11ax HE20 mask compliant	MCS0-4	—	17	—	
	11ax HE20 EVM compliant	MCS5-7	—	16.5	—	
	11ax HE20 EVM compliant	MCS8-9	—	14	—	
	11ax HE20 EVM compliant	MCS10-11	—	13	—	
ATx	Transmit power accuracy at 25 °C	—	-2.0	—	+2.0	dB

Table 15: WLAN current consumption on 5 GHz (VBAT = 3.3V, VDDIO = 1.8V, BT_REG_ON = Low)

Modulation	Data Rate	Bandwidth (MHz)	Spatial Stream	RF Power Level (dBm)	VBAT Current Consumption (mA)	VIO Current Consumption (mA)
BPSK	6 Mbps	20	1	19	307.2	3.1
QPSK	MCS2	20	1	19	310.9	3.1
16-QAM	MCS4	20	1	19	315.8	3
64-QAM	MCS7	20	1	18.5	297.5	2.5
256-QAM	MCS9	20	1	16	274.8	2.2
1024-QAM	MCS11	20	1	15	257.7	2.1

Table 16: WLAN transmitter characteristics for UNII-5 and UNII-6 operation (VBAT = 3.3V, VDDIO = 1.8V)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Ftx	Transmit output frequency range	—	5.925	—	6.53	GHz
Pout	Output power	See Note ²	—	—	—	—
	11a mask compliant	6-24Mbps	—	15.5	—	dBm
	11ax HE20 mask compliant	MCS0-4	—	15.5	—	
	11ax HE20 EVM compliant	MCS5-7	—	15	—	
	11ax HE20 EVM compliant	MCS8-9	—	13.5	—	
	11ax HE20 EVM compliant	MCS10-11	—	12	—	
ATx	Transmit power accuracy at 25 °C	—	-2.0	—	+2.0	dB

Table 17: WLAN current consumption on UNII-5 band (VBAT = 3.3V, VDDIO = 1.8V, BT_REG_ON = Low)

Modulation	Data Rate	Bandwidth (MHz)	Spatial Stream	RF Power Level (dBm)	VBAT Current Consumption (mA)	VIO Current Consumption (mA)
BPSK	6 Mbps	20	1	17.5	332	3.1
BPSK	MCS0	20	1	17.5	327	2.7
QPSK	MCS2	20	1	17.5	325.4	3
16-QAM	MCS4	20	1	17.5	338.6	3
64-QAM	MCS7	20	1	17	317.4	2.4
256-QAM	MCS9	20	1	15.5	288.2	2.2
1024-QAM	MCS11	20	1	14	264.7	2

Table 18: WLAN current consumption on UNII-6 band (VBAT = 3.3V, VDDIO = 1.8V, BT_REG_ON = Low)

Modulation	Data Rate	Bandwidth (MHz)	Spatial Stream	RF Power Level (dBm)	VBAT Current Consumption (mA)	VIO Current Consumption (mA)
BPSK	6 Mbps	20	1	17.5	279.3	3.1
BPSK	MCS0	20	1	17.5	283.6	2.7
QPSK	MCS2	20	1	17.5	292.9	3
16-QAM	MCS4	20	1	17.5	298.1	3
64-QAM	MCS7	20	1	17	282	2.4
256-QAM	MCS9	20	1	15.5	266.1	2.2
1024-QAM	MCS11	20	1	14	251	2

Table 19: WLAN transmitter characteristics for UNII-7 and UNII-8 operation (VBAT = 3.3V, VDDIO = 1.8V)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Ftx	Transmit output frequency range	—	6.53	—	7.125	GHz
Pout	Output power	See Note ²	—	—	—	—
	11a mask compliant	6-24Mbps	—	15	—	dBm
	11ax HE20 mask compliant	MCS0-4	—	15	—	
	11ax HE20 EVM compliant	MCS5-7	—	13	—	
	11ax HE20 EVM compliant	MCS8-9	—	12	—	
	11ax HE20 EVM compliant	MCS10-11	—	10.5	—	
ATx	Transmit power accuracy at 25 °C	—	-2.0	—	+2.0	dB

Table 20: WLAN current consumption on UNII-7 band (VBAT = 3.3V, VDDIO = 1.8V, BT_REG_ON = Low)

Modulation	Data Rate	Bandwidth (MHz)	Spatial Stream	RF Power Level (dBm)	VBAT Current Consumption (mA)	VIO Current Consumption (mA)
BPSK	6 Mbps	20	1	17	286.4	3.1
BPSK	MCS0	20	1	17	289.4	2.7
QPSK	MCS2	20	1	17	290.1	3
16-QAM	MCS4	20	1	17	296.3	3
64-QAM	MCS7	20	1	15	265.4	2.4
256-QAM	MCS9	20	1	14	252.7	2.2
1024-QAM	MCS11	20	1	12.5	238.3	2

Table 21: WLAN current consumption on UNII-8 band (VBAT = 3.3V, VDDIO = 1.8V, BT_REG_ON = Low)

Modulation	Data Rate	Bandwidth (MHz)	Spatial Stream	RF Power Level (dBm)	VBAT Current Consumption (mA)	VIO Current Consumption (mA)
BPSK	6 Mbps	20	1	17	310.9	3.1
BPSK	MCS0	20	1	17	306.1	2.7
QPSK	MCS2	20	1	17	314.1	3
16-QAM	MCS4	20	1	17	318.6	3
64-QAM	MCS7	20	1	15	290.5	2.4
256-QAM	MCS9	20	1	14	270.4	2.2
1024-QAM	MCS11	20	1	12.5	253.5	2

Note 2: Final TX power values on each channel are limited by regulatory requirements.

9 Bluetooth Radio Characteristics

Table 22 through Table 26 describe the performance of the Bluetooth transmitter and receiver and the current consumption at 25°C.

Table 22: BR / EDR transmitter performance (VBAT = 3.3V, VDDIO = 1.8V)

Test Parameter		Min	Typ	Max	BT Spec.	Unit
Maximum RF Output Power	GFSK	—	—	7	0 ~ +20	dBm
	$\pi/4$ -DQPSK	—	—	4		
	8-DPSK	—	—	4		
Frequency Range		2.4	—	2.4835	$2.4 \leq f \leq 2.4835$	GHz
20 dB Bandwidth		—	930	—	≤ 1000	KHz
Δf_{1avg} Maximum Modulation		140	154	175	$140 < \Delta f_{1avg} < 175$	KHz
Δf_{2max} Minimum Modulation		115	147	—	≥ 115	KHz
$\Delta f_{2avg}/\Delta f_{1avg}$		—	0.95	—	≥ 0.80	—
Initial Carrier Frequency		—	± 25	± 75	$\leq \pm 75$	KHz
Frequency Drift (DH1 packet)		—	± 8	± 25	± 25	KHz
Frequency Drift (DH3 packet)		—	± 8	± 40	± 40	KHz
Frequency Drift (DH5 packet)		—	± 8	± 40	± 40	KHz
Drift rate		—	5	20	20	KHz/50us
EDR ω_i		—	—	± 75	$\leq \pm 75$	KHz
EDR ω_0		—	—	± 10	$\leq \pm 10$	KHz
EDR ($\omega_i + \omega_0$)		—	—	± 75	$\leq \pm 75$	KHz
RMS DEVM for $\pi/4$ -DQPSK		—	—	≤ 0.2	≤ 0.2	—
RMS DEVM for 8-DPSK		—	—	≤ 0.13	≤ 0.13	—
Peak DEVM for $\pi/4$ -DQPSK		—	—	≤ 0.35	≤ 0.35	—
Peak DEVM for 8-DPSK		—	—	≤ 0.25	≤ 0.25	—
99% DEVM for $\pi/4$ -DQPSK		—	—	≤ 0.30	≤ 0.30	—
99% DEVM for 8-DPSK		—	—	≤ 0.20	≤ 0.20	—
EDR In-Band Spurious Emission	IM-NI ≥ 2.5 MHz	—	-43	-40	< -40	dBm
	1.5 MHz $<$ IM-NI $<$ 2.5 MHz	—	-31	-20	≤ -20	dBm
	1.0 MHz $<$ IM-NI $<$ 1.5 MHz	—	-38	-26	≤ -26	dBm

Table 23: Basic Rate receiver performance (VBAT = 3.3V, VDDIO = 1.8V)

Test Parameter		Min	Typ	Max	Bluetooth Spec.	Unit
Sensitivity (1DH5)	BER ≤ 0.1%	—	-91	—	≤ -70	dBm
Maximum Input	BER ≤ 0.1%	—	—	-20	≥ -20	dBm
Interference Performance	Co-Channel	—	8.5	11	11	dB
	C/I 1 MHz adjacent channel	—	-1.4	0	0	dB
	C/I 2 MHz adjacent channel	—	-41	-30	-30	dB
	C/I ≥ 3 MHz adjacent channel	—	-42.5	-40	-40	dB
	C/I image channel	—	-31.5	-9	-9	dB
	C/I 1-MHz adjacent to image channel	—	-44.5	-20	-20	dB

Table 24: Enhanced Data Rate receiver performance (VBAT = 3.3V, VDDIO = 1.8V)

Test Parameter		Min	Typ	Max	Bluetooth Spec.	Unit
Sensitivity (BER ≤ 0.01%)	π/4-DQPSK	—	-93	—	≤ -70	dBm
	8-DPSK	—	-87	—	≤ -70	dBm
Maximum Input (BER ≤ 0.1%)	π/4-DQPSK	—	—	-20	≥ -20	dBm
	8-DPSK	—	—	-20	≥ -20	dBm
C/I Co-Channel (BER ≤ 0.1%)	π/4-DQPSK	—	10.5	13	≤ ±13	dB
	8-DPSK	—	18	21	≤ ±21	dB
C/I 1 MHz adjacent Channel	π/4-DQPSK	—	-6.5	0	≤ 0	dB
	8-DPSK	—	-1	5	≤ 5	dB
C/I 2 MHz adjacent Channel	π/4-DQPSK	—	-38.5	-30	≤ -30	dB
	8-DPSK	—	-36.5	-25	≤ -25	dB
C/I ≥ 3 MHz adjacent Channel	π/4-DQPSK	—	-42.5	-40	≤ -40	dB
	8-DPSK	—	-41.5	-33	≤ -33	dB
C/I image channel	π/4-DQPSK	—	-30	-7	≤ -7	dB
	8-DPSK	—	-22.5	0	≤ 0	dB
C/I 1 MHz adjacent to image channel	π/4-DQPSK	—	-47.5	-20	≤ -20	dB
	8-DPSK	—	-41.5	-13	≤ -13	dB
Out-of-Band Blocking Performance (CW) BER ≤ 0.1%	30-2000MHz	—	-10	—	—	dBm
	2-2.399GHz	—	-27	—	—	dBm
	2.484-3GHz	—	-27	—	—	dBm
	3-12.75GHz	—	-10	—	—	dBm

Table 25: BLE RF Specifications (VBAT = 3.3V, VDDIO = 1.8V)

Parameter	Conditions		Min	Typ	Max	Unit
Frequency range	—		2402	—	2480	MHz
Rx sensitivity ³	GFSK, PER ≤ 30.8%	1 Mbps	—	-95	—	dBm
		2 Mbps	—	-92	—	dBm
		500 Kbps	—	-102	—	dBm
		125 Kbps	—	-107	—	dBm
Tx power ⁴	—		—	—	7	dBm
Δf1 average		1 Mbps	225	255	275.5	KHz
		2 Mbps	450	500	550	KHz
		125 Kbps	225	255	275	KHz
Δf2 average		1 Mbps	185	230	—	KHz
Δf2 maximum ⁵		2 Mbps	370	450	—	KHz
Δf1 average (Stable Modulation)		1 Mbps	247.5	250	252.5	KHz
		2 Mbps	495	500	550	KHz
		125 Kbps	247.5	250	252.5	KHz
$\frac{\Delta f2 \text{ avg}}{\Delta f1 \text{ avg}}$ ratio		1 Mbps	0.8	1.0	—	%
		2 Mbps	0.8	1.0	—	%

Table 26: Bluetooth transmitter current consumption (VBAT = 3.3V, VDDIO = 1.8V, WL_REG_ON = OFF)

Operation Band	Operating Mode		VBAT Current Consumption (mA)	VIO Current Consumption (mA)
	Data Rate	RF Power Level (dBm)		
Basic Rate	1DH5	6.8	18.8	0.4
	2DH5	3.4	18.7	0.4
Enhanced Data Rate	3DH5	3.4	18.24	0.4
Low-Energy	1 Mbps	6.81	19.86	0.4
	2 Mbps	6.6	13.21	0.4
	500 Kbps	6.73	17.32	0.4
	125 Kbps	6.64	23.13	0.4

Notes:

[3] Dirty Tx is Off.

[4] The Bluetooth LE TX power cannot exceed 10 dBm EIRP specification limit. The front-end losses and antenna gain/loss must be factored in so as not to exceed the limit.

[5] At least 99.9% of all Δf2 maximum frequency values recorded over 10 packets must be greater than 185 KHz.

10 Crystal Oscillator Requirements

Table 27: Crystal Oscillator Specification

32.768 KHz Oscillator	
Frequency Accuracy	200 ppm
Duty Cycle	30% – 70%
Input Signal Amplitude	200-3300 mV, peak-peak
Signal Type	Square or Sine Wave
Clock Jitter	< 10,000 ppm

IMPORTANT: A 32.768 KHz crystal is required for the module to be functional. The module will not boot without this crystal.

11 Host Interface Specifications

11.1 SDIO Specifications

The Sona IF513 series provides support for SDIO 2.0/3.0, including the new UHS-I⁶ modes:

- DS: Default speed (DS) up to 25 MHz, including 1- and 4-bit modes (1.8 V signaling)
- HS: High speed up to 50 MHz (1.8 V signaling)
- SDR12: SDR up to 25 MHz (1.8V signaling)
- SDR25: SDR up to 50 MHz (1.8V signaling)
- SDR50: SDR up to 100 MHz (1.8V signaling)
- DDR50: DDR up to 500 MHz (1.8V signaling)

The Sona IF513 series wireless module SDIO host interface pins are powered from the VDDIO voltage supply, which is set internally at 1.8V⁷ on the M.2 module.

Note:

[6] The UHS-I rate SDR104, that is part of the SDIO 3.0 specification is not supported.

[7] The SDIO host signals must be 1.8V at all times as defined by the M.2 standard.

11.1.1 Default mode and High-Speed mode

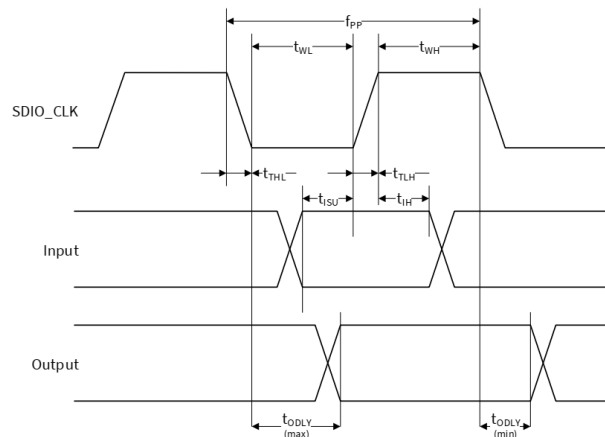


Figure 3: SDIO bus timing- Default mode (1.8V)

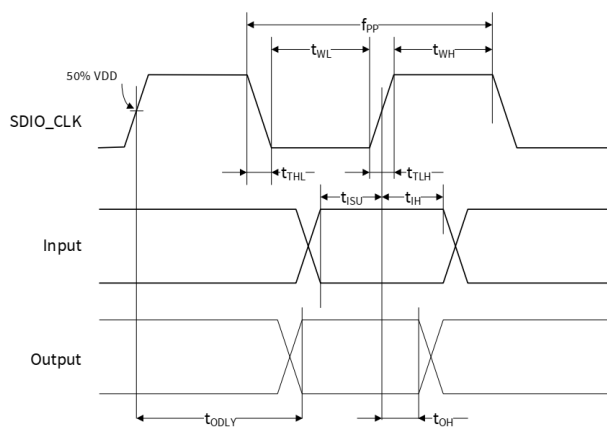


Figure 4: SDIO bus timing- High-Speed mode (1.8V)

Note: Over full range of values specified in the Recommended Operating Conditions unless otherwise specified.

Table 28: SDIO timing requirements

Symbol	Parameter	Condition	Min.	Typ.	Max.	Unit
f_{PP}	Clock Frequency	Default mode	0	-	25	MHz
		High-Speed mode	0	-	50	
t_{WL}	Clock low time	Default mode	10	-	-	ns
		High-Speed mode	7	-	-	
t_{WH}	Clock high time	Default mode	10	-	-	ns
		High-Speed mode	7	-	-	
t_{TLH}	Clock rise time	Default mode	-	-	10	ns
		High-Speed mode	-	-	3	
t_{THL}	Clock low time	Default mode	-	-	10	ns
		High-Speed mode	-	-	3	
t_{ISU}	Input Setup time	Default mode	5	-	-	ns
		High-Speed mode	6	-	-	

Symbol	Parameter	Condition	Min.	Typ.	Max.	Unit
t_{IH}	Input Hold time	Default Speed High-Speed mode	5 2	- -	- -	ns
t_{ODLY}	Output delay time – Data Transfer mode	Default mode High-Speed mode	0 -	- -	14 14	ns
	Output delay time – Identification mode	Default mode	0	-	50	ns
t_{OH}	Output hold time	High-Speed mode	2.5	-	-	ns
CL	Total system capacitance (each line)	High-Speed mode	-	-	40	pF

11.1.2 SDIO bus clock timing specifications in SDR mode

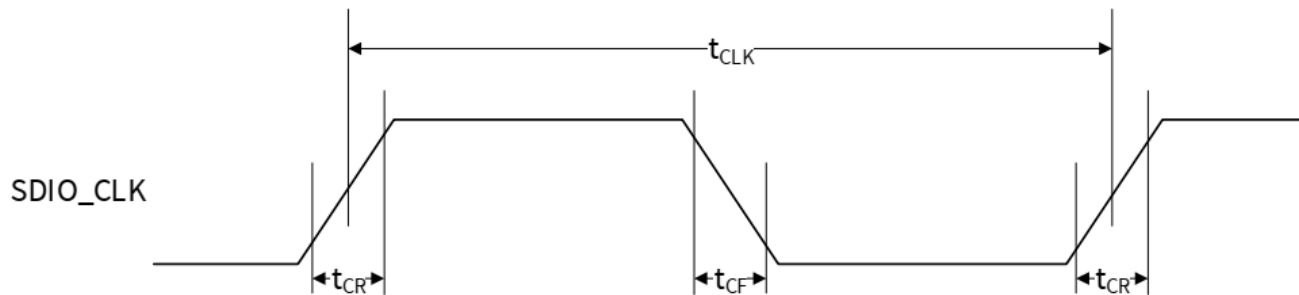


Figure 5: SDIO clock timing (SDR modes)

Note: Over full range of values specified in the Recommended Operating Conditions unless otherwise specified.

Table 29: SDIO clock timing parameters (SDR modes)

Symbol	Parameter	Condition	Min.	Typ.	Max.	Unit
t_{CLK}		SDR12	40	-	-	ns
		SDR25	20	-	-	
		SDR50	10	-	-	
t_{CR}, t_{CF}	$t_{CR}, t_{CF} < 2\text{ns (max)}$ at 100MHz $C_{CARD} = 10\text{pF}$		-	-	$0.2 \cdot t_{CLK}$	ns
-	Clock duty cycle	SDR12/25/50/104	30	-	70	%

11.1.3 SDIO Bus Input Timing

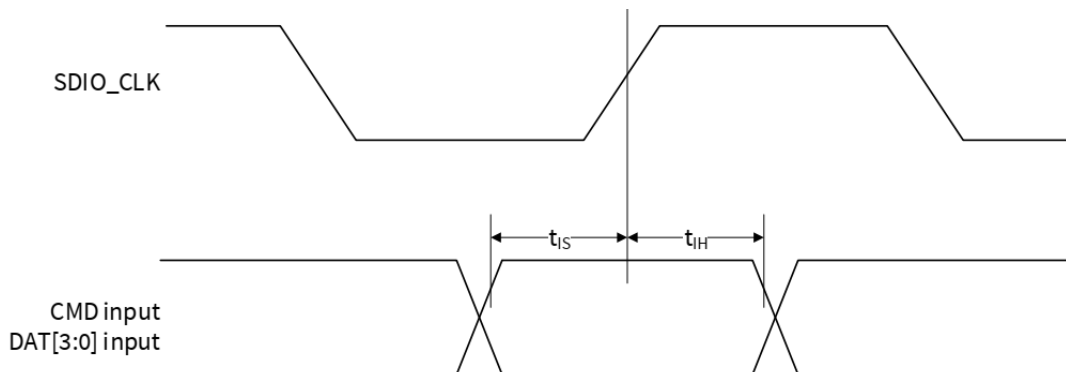


Figure 6: SDIO bus input timing (SDR mode)

Note: Over full range of values specified in the Recommended Operating Conditions unless otherwise specified.

Table 30: SDIO bus input timing requirements (SDR mode)

Symbol	Parameter	Condition	Min.	Typ.	Max.	Unit
t_{IS}	Input setup time, $C_{CARD}=10pF$, $V_{CT}=0.975V$	SDR50	3	-	-	ns
t_{IH}	Input Hold time, $C_{CARD}=5pF$, $V_{CT}=0.975V$	SDR50	0.8	-	-	ns

11.1.4 SDIO Bus Output Timing

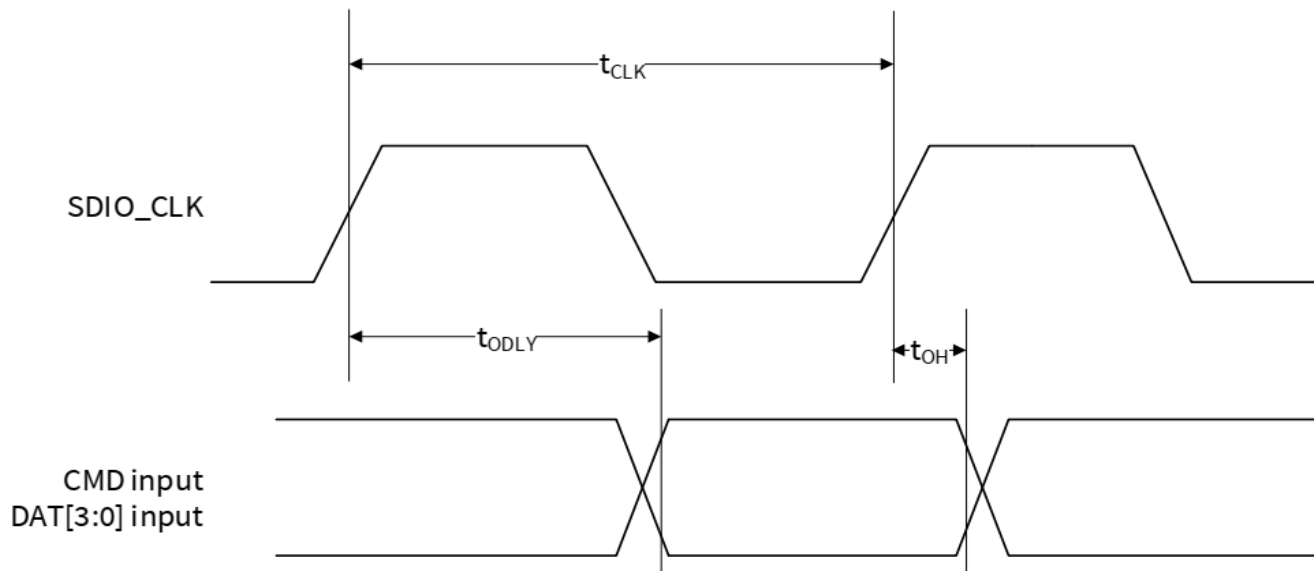


Figure 7: SDIO bus output timing (SDR modes)

Note: Over full range of values specified in the Recommended Operating Conditions unless otherwise specified.

Table 31: SDIO bus output timing requirements (SDR modes)

Symbol	Parameter	Condition	Min.	Typ.	Max.	Unit
t_{ODLY}	Delay time, $t_{CLK} \geq 20ns$, $C_L = 40pF$	SDR12/SDR25	-	-	14	ns
	Delay time, $t_{CLK} \geq 10ns$, $C_L = 30pF$	SDR50	-	-	7.5	ns
t_{OH}	Hold time, $C_L = 15pF$	SDR12/SDR25/SDR50	1.5	-	-	ns

11.1.5 SDIO Bus Timing Specifications in DDR50 mode

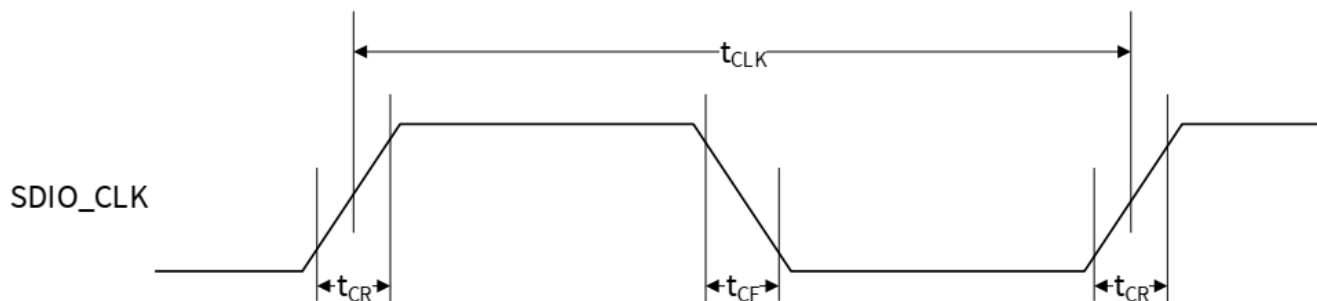


Figure 8: SDIO clock timing (DDR50 mode)

Note: Over full range of values specified in the Recommended Operating Conditions unless otherwise specified.

Table 32: SDIO bus clock timing requirements (DDR50 mode)

Symbol	Parameter	Condition	Min.	Typ.	Max.	Unit
t_{CLK}	-	DDR50	25	-	-	ns
t_{CR}, t_{CF}	$t_{CR}, t_{CF} < 4ns$ (max) at 50MHz $C_{CARD} = 10pF$		-	-	$0.2 * t_{CLK}$	ns
-	Clock duty cycle	DDR50	45	-	55	%

11.1.5.1 SDIO Bus Data Timing Specifications

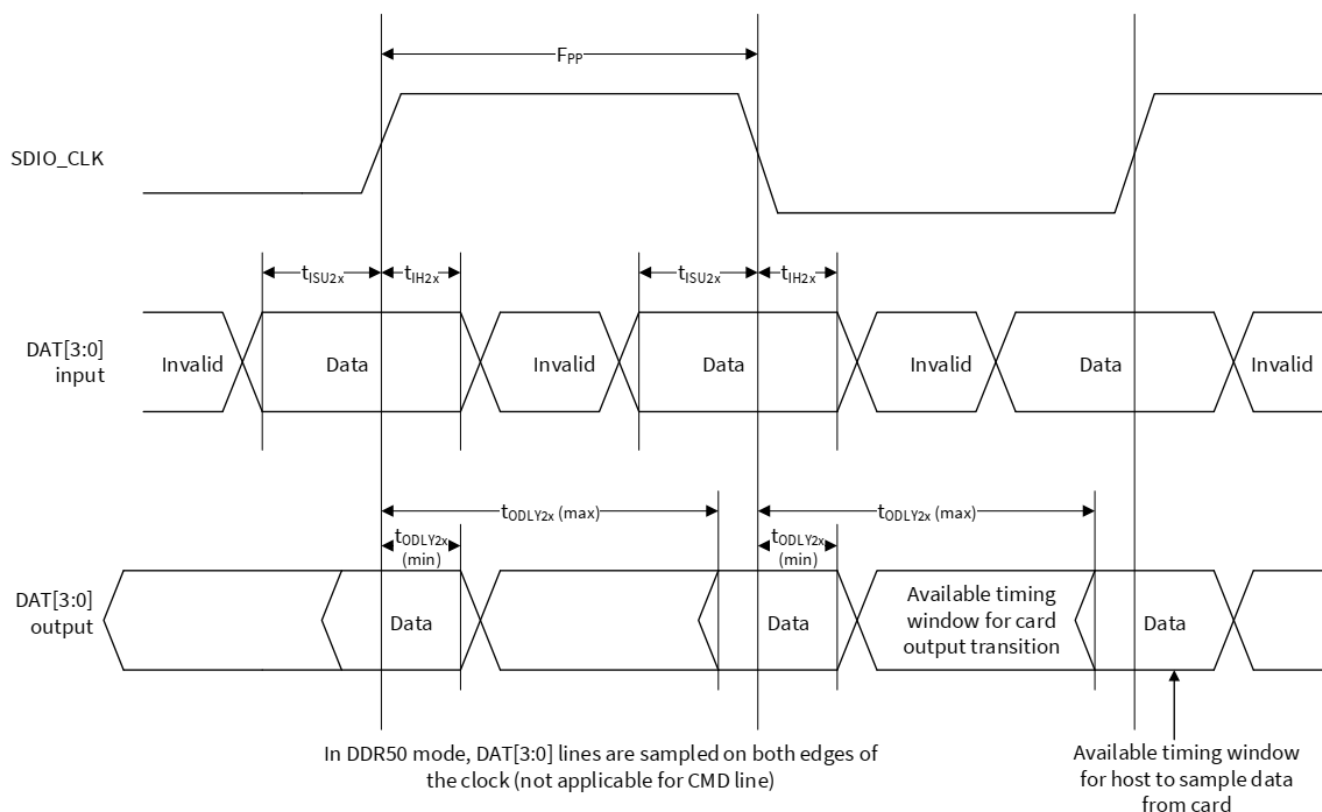


Figure 9: SDIO data timing (DDR50 mode)

Note: Over full range of values specified in the Recommended Operating Conditions unless otherwise specified.

Table 33: SDIO bus data timing requirements (DDR50 mode)

Symbol	Parameter	Condition	Min.	Typ.	Max.	Unit
Input CMD						
t_{ISU}	Input setup time	$C_{CARD} < 10pF$	6	-	-	ns
t_{IH}	Input hold time		0.8	-	-	ns
Output CMD						
t_{ODLY}	Output delay time		-	-	13.7	ns
t_{OH}	Output hold time	$C_{CARD} < 15pF$	1.5	-	-	ns
Input DAT						
t_{ISU2x}	Input setup time	$C_{CARD} < 10pF$	3	-	-	ns
t_{IH2x}	Input hold time		0.8	-	-	ns
Output DAT						
t_{ODLY2x}	Output delay time		-	-	7.5	ns
t_{ODLY2x}	Output hold time	$C_{CARD} < 15pF$	1.5	-	-	ns

11.2 PCM Interface Specifications

11.2.1 PCM Interface

The Sona IF513 series wireless module supports a PCM interface. The PCM interface on the Sona IF513 series wireless module can connect to linear PCM codec devices in Master/Slave mode. In Master mode, the Sona IF513 generates the BT_PCM_CLK and BT_PCM_SYNC signals, and in Slave mode, these signals are provided by another master on the PCM interface and are input to the Sona IF513 module.

The configuration of the PCM interface may be adjusted by the host through the use of vendor-specific HCI commands.

11.2.2 Burst PCM mode

In this mode of operation, the PCM bus runs at a significantly higher rate of operation to allow the host to duty cycle its operation and save current. In this mode of operation, the PCM bus can operate at a rate of up to 24 MHz. This mode of operation is initiated with an HCI command from the host.

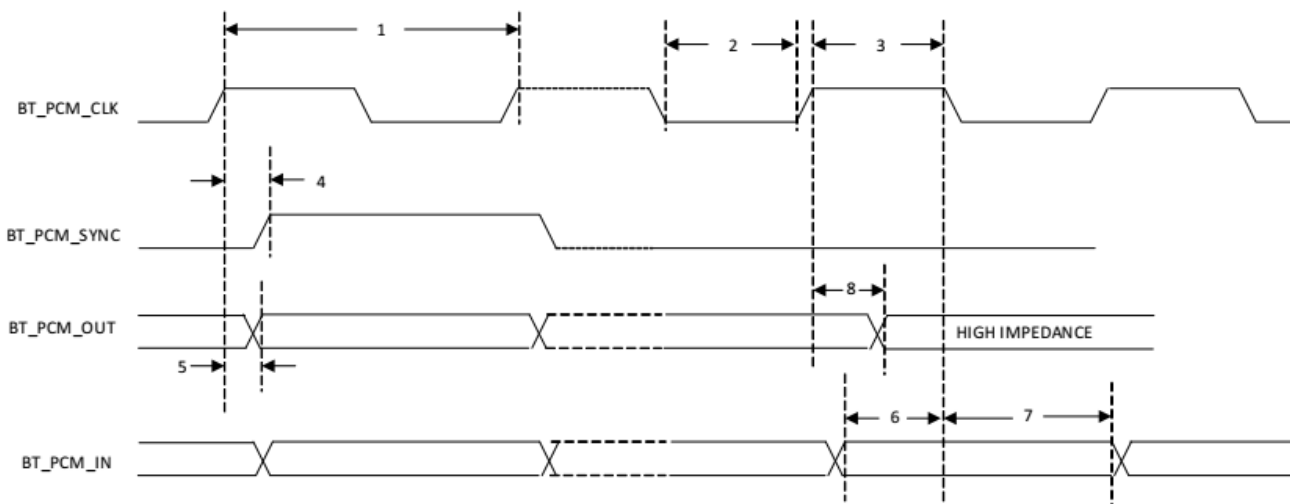


Figure 10: PCM timing diagram – Short Frames Sync, Master Mode

Table 34: PCM timing specification – Short Frames Sync, Master Mode

Reference	Characteristics	Min.	Typ.	Max.	Unit
1	PCM bit clock frequency	-	-	12.0	MHz
2	PCM bit clock LOW	41.0	-	-	ns
3	PCM bit clock HIGH	41.0	-	-	ns
4	BT_PCM_SYNC delay	0	-	25.0	ns
5	BT_PCM_OUT delay	0	-	25.0	ns
6	BT_PCM_IN setup	8.0	-	-	ns
7	BT_PCM_IN hold	8.0	-	-	ns
8	Delay from rising edge of BT_PCM_CLK during last bit period to BT_PCM_OUT becoming high impedance	0	-	25.0	ns

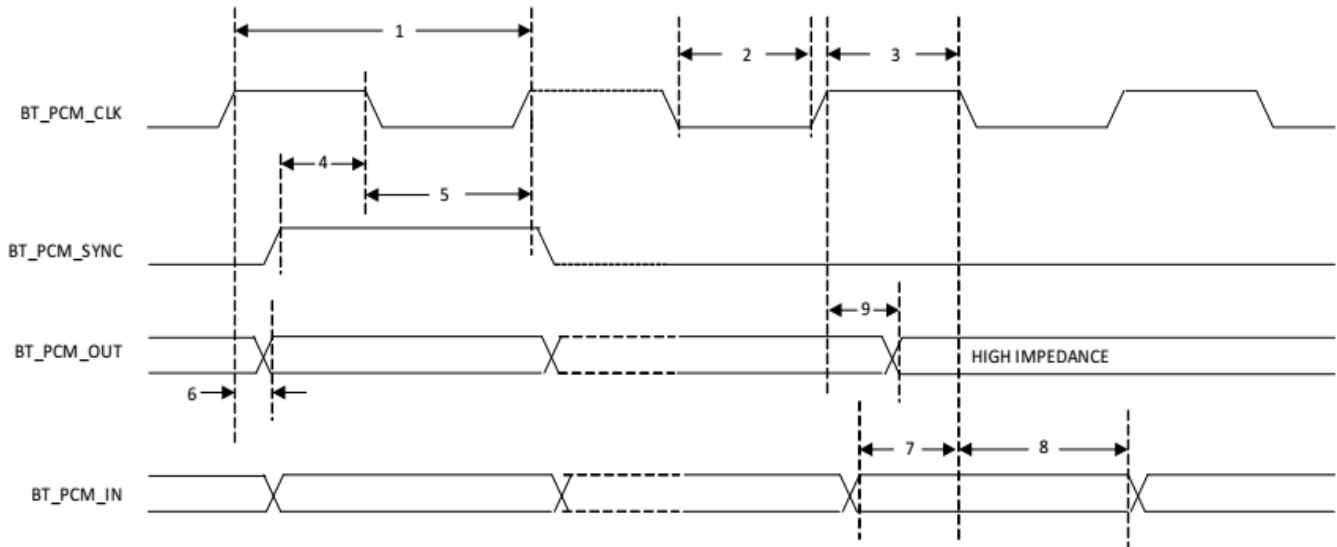


Figure 11: PCM timing diagram- Short Frame Sync, Slave Mode

Table 35: PCM timing specification - Short Frame Sync, Slave Mode

Reference	Characteristics	Min.	Typ.	Max.	Unit
1	PCM bit clock frequency	-	-	12.0	MHz
2	PCM bit clock LOW	41.0	-	-	ns
3	PCM bit clock HIGH	41.0	-	-	ns
4	BT_PCM_SYNC setup	8.0	-	-	ns
5	BT_PCM_SYNC hold	8.0	-	-	ns
6	BT_PCM_OUT delay	0	-	25.0	ns
7	BT_PCM_IN setup	8.0	-	-	ns
8	BT_PCM_IN hold	8.0	-	-	ns
9	Delay from rising edge of BT_PCM_CLK during last bit period to BT_PCM_OUT becoming high impedance	0	-	25.0	ns

11.3 UART Interface

The Sona IF513 series Bluetooth access through the UART interface that it is a standard 4-wire interface (RX, TX, RTS, and CTS) with adjustable rates from 9600 bps to 4.0 Mbps. The baud rate may be selected through a vendor-specific UART HCI command. The default baud rate is 115.2 K baud.

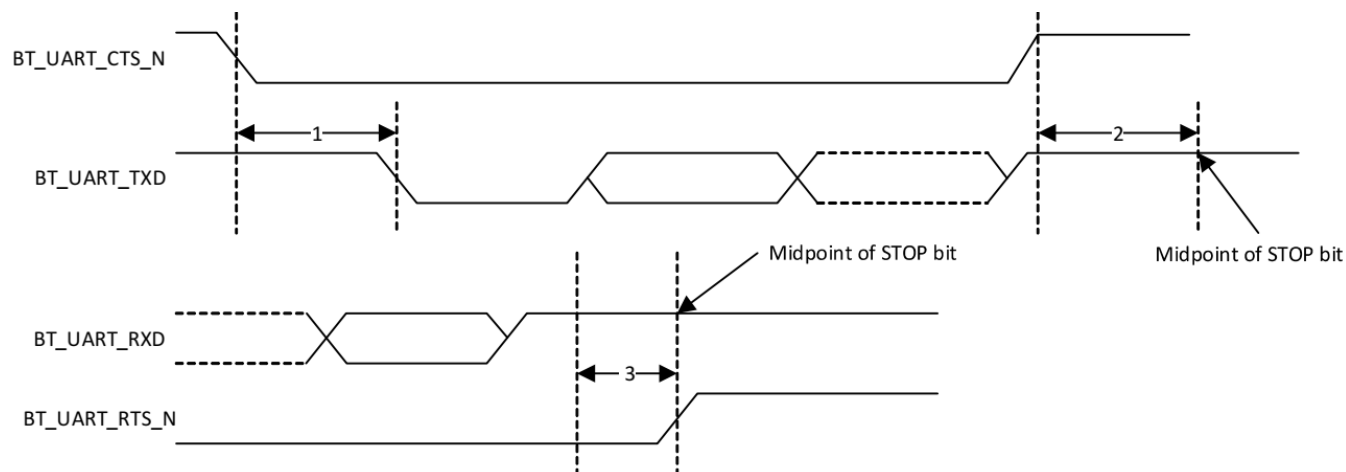


Figure 12: UART timing diagram

Table 36: UART timing specifications

Reference	Characteristics	Min.	Typ.	Max.	Unit
1	Delay time, BT_UART_CTS_N low to BT_UART_TXD valid	-	-	1.5	Bit periods
2	Setup time, BT_UART_CTS_N high before midpoint of stop bit	-	-	0.5	Bit periods
3	Delay time, midpoint of stop bit to BT_UART_RTS_N high	-	-	0.5	Bit periods

12 Power-Up Sequence and Timing

Sona IF513 has two signals that allow the host to control power consumption by enabling or disabling the Bluetooth, WLAN, and internal regulator block.

12.1 Description of Control Signals

- **WL_REG_ON:** Used to power up the WLAN. When this pin is high, the internal regulators are enabled, and the WLAN section is out of reset. When this pin is low the WLAN section is in reset. This signal is connected to the W_DISABLE1# pin on the M.2 interface.
- **BT_REG_ON:** Used to power up the Bluetooth section. If both the BT_REG_ON and WL_REG_ON pins are low, the regulators are disabled. When this pin is low and WL_REG_ON is high, the Bluetooth section is in reset. This signal is connected to the W_DISABLE2# pin on the M.2 interface.

12.2 Control Signal Timing Diagram

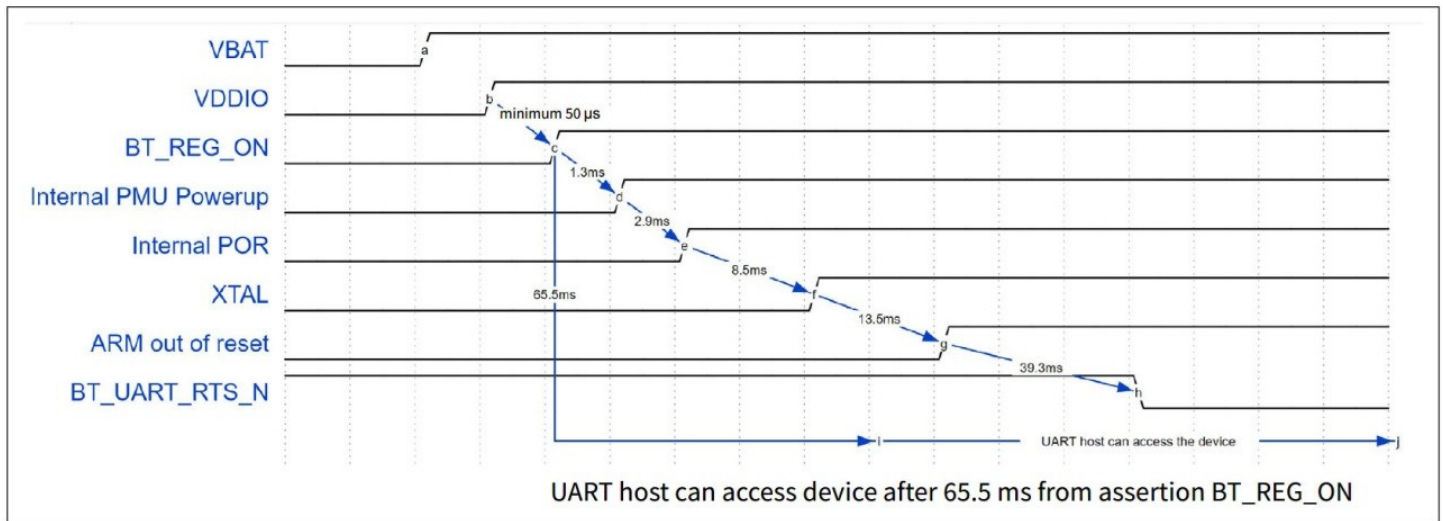


Figure 13: Bluetooth subsystem bootup sequence

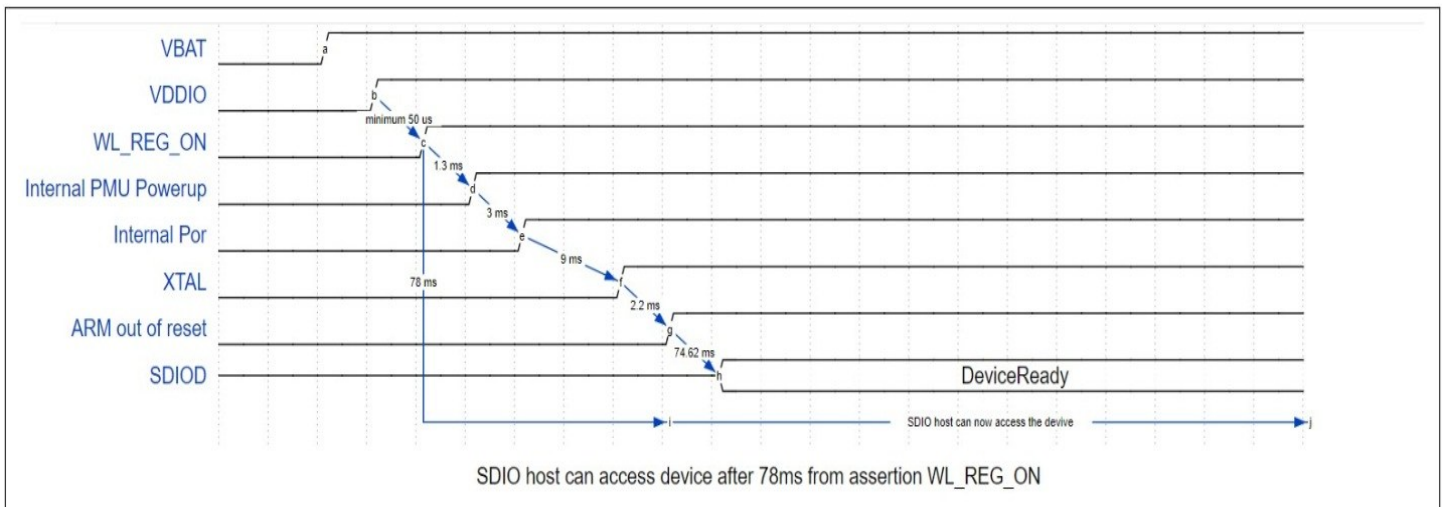


Figure 14: WLAN boot-up sequence for SDIO host

13 Pin Definitions

13.1 M.2 1216 Solder-Down

Table 37: M.2 1216 pin definitions

Pin #	Name	Type	Voltage Ref.	Function	If Not Used
1	-	-	-	-	Unused
2	-	-	-	-	Unused
3	-	-	-	-	Unused
4	VBAT	PWR	3.3V	DC supply voltage for module. Operational: VBAT is 3.0V to 4.8V ** VBAT at 3.13V to 3.5V has the same TX power but a better EVM/harmonic emissions margin	-
5	VBAT	PWR	3.3V	DC supply voltage for module. Operational: VBAT is 3.0V to 4.8V ** VBAT at 3.13V to 3.5V has the same TX power but a better EVM/harmonic emissions margin	-
6	GND	-	-	Ground	GND
7	-	-	-	-	Unused
8	-	-	-	-	Unused
9	I2C_CLK	I	1.8V	I2C clock signal input This signal has been reserved for other use, do not use this signal. This feature is not provided by the released IF513 firmware.	NC
10	I2C_SDA	I/O	1.8V	I2C signal data input/output This signal has been reserved for other use, do not use this signal. This feature is not provided by the released IF513 firmware.	NC
11	-	-	-	-	Unused
12	-	-	-	-	Unused
13	-	-	-	-	Unused
14	-	-	-	-	Unused
15	-	-	-	-	Unused
16	-	-	-	-	Unused
17	GND	-	-	Ground	GND
18	-	-	-	-	Unused
19	-	-	-	-	Unused
20	GND	-	-	Ground	GND

Pin #	Name	Type	Voltage Ref.	Function	If Not Used
21	-	-	-	-	Unused
22	-	-	-	-	Unused
23	GND	-	-	Ground	GND
24	-	-	-	-	Unused
25	-	-	-	-	Unused
26	GND	-	-	Ground	GND
27	LPO_IN	I	VDDIO	External sleep clock input (32.768 KHz)	-
28	WL_REG_ON	I	VDDIO	Enables WLAN regulators. There is an internal 50K pull down resistor on this signal.	-
29	-	-	-	-	Unused
30	-	-	-	-	Unused
31	-	-	-	-	Unused
32	GND	-	-	Ground	GND
33	-	-	-	-	Unused
34	-	-	-	-	Unused
35	GND	-	-	Ground	GND
36	-	-	-	-	Unused
37	-	-	-	-	Unused
38	GND	-	-	Ground	GND
39	-	-	-	-	Unused
40	-	-	-	-	Unused
41	GND	-	-	Ground	GND
42	-	-	-	-	Unused
43	BT_DEV_WAKE	I	VDDIO	Bluetooth Device Wake-up: Signal from host to Sona IF513.	NC
44	WL_DEV_WAKE	I	VDDIO	WLAN Device Wake-up: Signal from host to Sona IF513.	NC
45	-	-	-	-	Unused
46	GPIO_0_WL_HOST_WAKE	O	VDDIO	Host wake up. Signal from the Sona IF513.	NC
47	SDIO_DATA_3	I/O	VDDIO	SDIO Data line 3	NC

Pin #	Name	Type	Voltage Ref.	Function	If Not Used
48	SDIO_DATA_2	I/O	VDDIO	SDIO Data line 2 * SDIO_DATA2 must be high when the first of either WL_REG_ON or BT_REG_ON transitions to high	NC
49	SDIO_DATA_1	I/O	VDDIO	SDIO Data line 1	NC
50	SDIO_DATA_0	I/O	VDDIO	SDIO Data line 0	NC
51	SDIO_CMD	I/O	VDDIO	SDIO Command Line	NC
52	SDIO_CLK	I	VDDIO	SDIO Clock Input	NC
53	BT_HOST_WAKE	O	VDDIO	Host wake up. Signal from the Sona IF513.	NC
54	BT_UART_CTS_N	I	VDDIO	UART clear-to-send. Active-low clear-to-send signal for the HCI UART interface.	NC
55	BT_UART_TXD	O	VDDIO	UART Serial Output. Serial data output for the HCI UART interface.	NC
56	BT_UART_RXD	I	VDDIO	UART Serial Input. Serial data input for the HCI UART interface.	NC
57	BT_UART_RTS_N	O	VDDIO	UART request-to-send. Active-low request-to-send signal for the HCI UART interface.	NC
58	BT_PCM_SYNC	I/O	VDDIO	PCM Sync. Supported - Master (Output) or Slave (Input).	NC
59	BT_PCM_IN	I	VDDIO	PCM data input.	NC
60	BT_PCM_OUT	O	VDDIO	PCM data output	NC
61	BT_PCN_CLK	I/O	VDDIO	PCM clock. Supported - Master (Output) or Slave (Input).	NC
62	GND	-	-	Ground	GND
63	BT_REG_ON	I	VDDIO	Enables Bluetooth regulators. There is an internal 50K pull down resistor on this signal.	-
64	GPIO_3	I/O	VDDIO	Reserved for feature support	NC
65	GPIO_2	I/O	VDDIO	Reserved for feature support	NC
66	VDDIO	PWR	1.8V	IO supply for IF513 * It's recommended to reserve a "10uF" bypass capacitor for this pin.	NC
67	-	-	-	-	Unused
68	GND	-	-	Ground	GND
69	-	-	-	-	Unused
70	-	-	-	-	Unused
71	GND	-	-	Ground	GND
72	VBAT	PWR	3.3V	DC supply voltage for module. Operational: VBAT is 3.0V to 4.8V ** VBAT at 3.13V to 3.5V has the same TX power but a better EVM/harmonic emissions margin	-

Pin #	Name	Type	Voltage Ref.	Function	If Not Used
73	VBAT	PWR	3.3V	DC supply voltage for module. Operational: VBAT is 3.0V to 4.8V ** VBAT at 3.13V to 3.5V has the same TX power but a better EVM/harmonic emissions margin	-
74~75	GND	-	-	Ground	GND
76	-	-	-	-	NC
77~80	GND	-	-	Ground	GND
81	WL_C2	I/O	-	For the Sona IF513 Trace type module – Antenna diversity_WLAN port (AUX antenna port)	-
82~85	GND	-	-	Ground	GND
86	WL_C0	I/O	-	For the Sona IF513 Trace type module – Antenna diversity_WLAN/Bluetooth port (Main antenna port)	-
87~91	GND	-	-	Ground	GND
92	WL_C1	I/O	-	For the Sona IF513 Trace type module – Non-Antenna diversity_WLAN/Bluetooth port	-
93~96	GND	-	-	Ground	GND
G1~G12	GND	-	-	Ground	GND

13.2 M.2 2230 Key-E

Table 38: M.2 2230 Key-E pin definitions

Pin #	Name	Type	Voltage Ref.	Function	If Not Used
1	GND	-	-	Ground	GND
2	3.3V	PWR I/P	3.3V	DC supply voltage for module. ** VBAT at 3.13V to 3.5V has the same TX power but a better EVM/harmonic emissions margin	-
3	USB_D+	-	-	NC	Unused
4	3.3 V	PWR I/P	3.3 V	DC supply voltage for module. ** VBAT at 3.13V to 3.5V has the same TX power but a better EVM/harmonic emissions margin	-
5	USB_D-	-	-	NC	Unused
6	LED1#	O	3.3V	Reserved for the GPIO2	NC
7	GND	-	-	Ground	GND
8	PCM_CLK	I/O	1.8V	PCM clock. Can be master (Output) or slave (Input)	NC
9	SDIO CLK	I	1.8V	SDIO clock input	NC
10	PCM_SYNC	I/O	1.8V	PCM Sync. Can be master (Output) or slave (Input)	NC
11	SDIO CMD	I/O	1.8V	SDIO command line	NC
12	PCM_OUT	O	1.8V	PCM data output.	NC
13	SDIO DATA0	I/O	1.8V	SDIO data line0	NC
14	PCM_IN	I	1.8V	PCM data input.	NC
15	SDIO DATA1	I/O	1.8V	SDIO data line1	NC
16	LED2#	O	3.3V	Reserved for the GPIO3	NC
17	SDIO DATA2	I/O	1.8V	SDIO data line2 * SDIO_DATA2 must be high when the first of either WL_REG_ON or BT_REG_ON transitions to high	NC
18	GND	-	-	Ground	GND
19	SDIO DATA3	I/O	1.8V	SDIO data line3	NC
20	UART WAKE#	O	3.3 V	Reserved for BT_HOST_WAKE- Output signal to wake up Host.	NC
21	SDIO WAKE#	O	1.8V	Reserved for WL_HOST_WAKE- Output signal to wake up host.	NC
22	UART_TXD	O	1.8V	Serial data output for the HCI UART interface.	NC
23	SDIO RESET#	-	-	NC	Unused
32	UART_RXD	I	1.8V	Serial data input for the HCI UART interface.	NC
33	GND	-	-	Ground	GND
34	UART_RTS	O	1.8V	Active-Low request-to-send signal for the HCI UART interface.	NC
35	PERp0	-	-	-	Unused
36	UART_CTS	I	1.8V	Active-Low clear-to-send signal for the HCI UART interface.	NC
37	PERn0	-	-	-	Unused
38	VENDOR DEFINED38	-	-	-	Unused
39	GND	-	-	Ground	GND

Pin #	Name	Type	Voltage Ref.	Function	If Not Used
40	VENDOR DEFINED40	I	1.8V	Reserved for WL_DEVICE_WAKE- Input signal from host to wake up WLAN module.	NC
41	PETp0	-	-	-	Unused
42	VENDOR DEFINED42	I/O	1.8V	Reserved for BT_DEVICE_WAKE- Input signal from host to wake up Bluetooth.	NC
43	PETn0	-	-	-	Unused
44	COEX3	-	-	-	Unused
45	GND	-	-	Ground	GND
46	COEX2	-	-	-	Unused
47	REFCLKp0	-	-	-	Unused
48	COEX1	-	-	-	Unused
49	REFCLKn0	-	-	-	Unused
50	SUSCLK	I	3.3 V	External Sleep Clock input (32.768KHz) The sleep clock is always needed for using this module. If the 32.768 KHz signal is not available externally, a 32.768 KHz circuit has been reserved in the M.2 module but is not populated by default.	Required
51	GND	-	-	Ground	GND
52	PERST0#	-	-	-	Unused
53	CLKREQ0#	-	-	-	Unused
54	W_DISABLE2#	I	3.3 V	Enables Bluetooth regulators. Ground to disable Bluetooth.	--
55	PEWAKE0#	-	-	-	Unused
56	W_DISABLE1#	I	3.3 V	Enables WLAN regulators. Ground to disable WLAN.	--
57	GND	-	-	Ground	GND
58	I2C DATA	I/O	-	I2C signal data input/output <i>This signal has been reserved for other use, do not use this signal. This feature is not provided by the released IF513 firmware.</i>	NC
59	RESERVED	-	-	NC	NC
60	I2C CLK	I	-	I2C clock signal input <i>This signal has been reserved for other use, do not use this signal. This feature is not provided by the released IF513 firmware.</i>	NC
61	RESERVED	-	-	NC	NC
62	ALERT #	-	-	NC	NC
63	GND	-	-	Ground	GND
64	RESERVED	-	-	NC	NC
65	RESERVED	-	-	NC	NC
66	UIM_SWP	-	-	NC	NC
67	RESERVED	-	-	NC	NC
68	UIM_POWER_SNK	-	-	NC	NC
69	GND	-	-	Ground	GND
70	UIM_POWER_SRC	-	-	NC	NC

Pin #	Name	Type	Voltage Ref.	Function	If Not Used
71	RESERVED	-	-	NC	NC
72	3.3V	PWR I/P	3.3V	DC supply voltage for module. ** VBAT at 3.13V to 3.5V has the same TX power but a better EVM/harmonic emissions margin	--
73	RESERVED	-	-	NC	NC
74	3.3V	PWR I/P	3.3V	DC supply voltage for module. ** VBAT at 3.13V to 3.5V has the same TX power but a better EVM/harmonic emissions margin	--
75	GND	-	-	Ground	GND

14 Host Platform Implementation Details

14.1 Bluetooth Interface Requirements

The CYW55513 Bluetooth CPU core requires the UART_CTS input to be held low at the point in time the BT_REG_ON (W_DISABLE2#) signal goes high to enable secure firmware download. In addition, the HCI interface uses the standard H4 protocol which requires four-wire hardware handshaking.

This requires that the host implement GPIO control over BT_REG_ON/W_DISABLE2# and implement full RTS/CTS handshaking.

14.2 Low Power Clock

The Sona IF513 requires a 32KHz clock on the SUSCLK input. This clock drives various internal state machines and must be provided by the host even if low power operation is not needed.

14.3 W_DISABLE1#, W_DISABLE2# and SDIO_DATA_2

The Sona IF513 leaves the WL_REG_ON and BT_REG_ON (W_DISABLE1#/W_DISABLE2#) signals pulled low on both the M.2 2230 card and the M.2 1216 solder down module. The WL_REG_ON and BT_REG_ON (W_DISABLE#/W_DISABLE2#) signals MUST be controlled by host platform GPIO under software control.

The SDIO_DATA2 line **must be high** when the first of either WL_REG_ON or BT_REG_ON signals transitions from low to high. This would be a problem, for example, if a pull-up were used on either the W_DISABLE1# or W_DISABLE2# line and the SDIO_DATA2 line was pulled low, even briefly, by the processor during startup.

15 Mechanical Specifications

15.1 M.2 1216

Module dimensions of Sona IF513 M.2 1216 package is 12 x 16 x 1.9 mm. Detailed drawings are shown in [Figure 15](#).

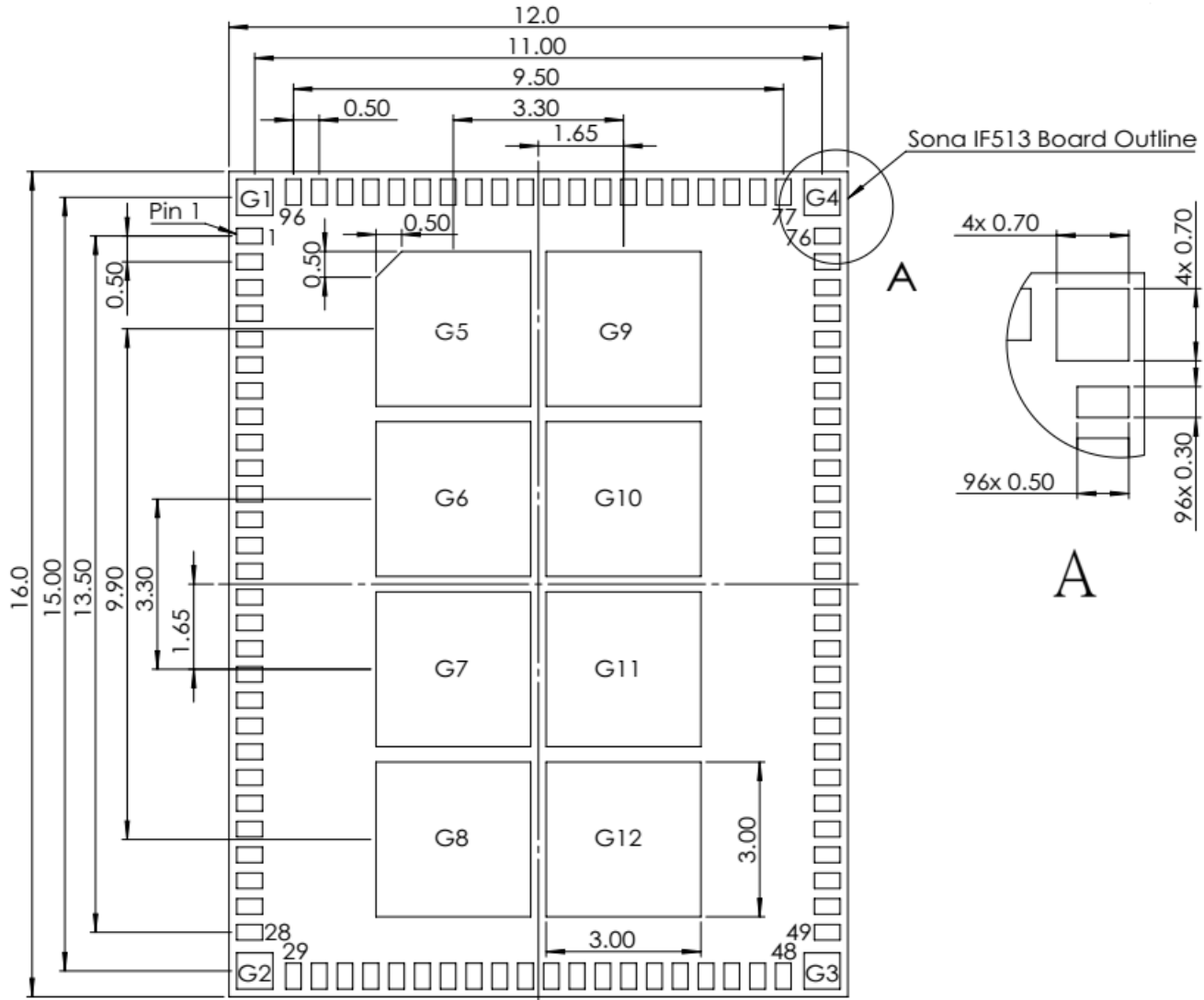


Figure 15: M.2 1216 PCB footprint (Top view)

Note: Dimensions are in millimeters tolerances:

Angular:	± 0.5
X.X:	± 0.1
X.XX:	± 0.05

There are 4 variants for the Sona IF513 solder-down type, and the detailed drawings are shown in [Figure 16](#), [Figure 17](#), [Figure 18](#), and [Figure 19](#).

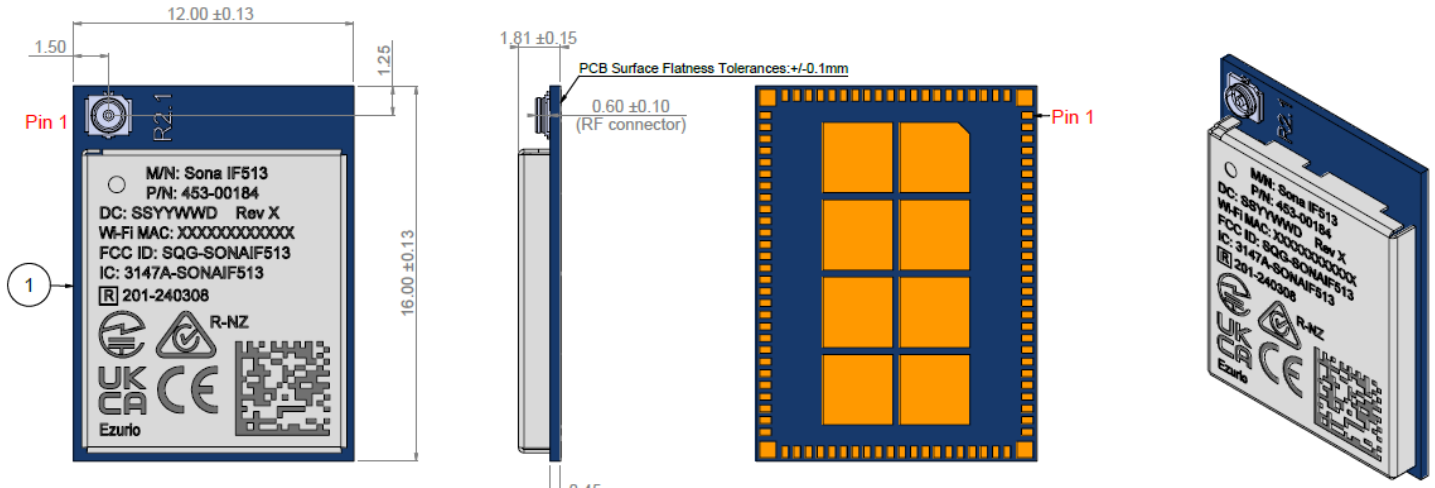


Figure 16: M.2 1216 (MHF4 variant) Non-Antenna Diversity type

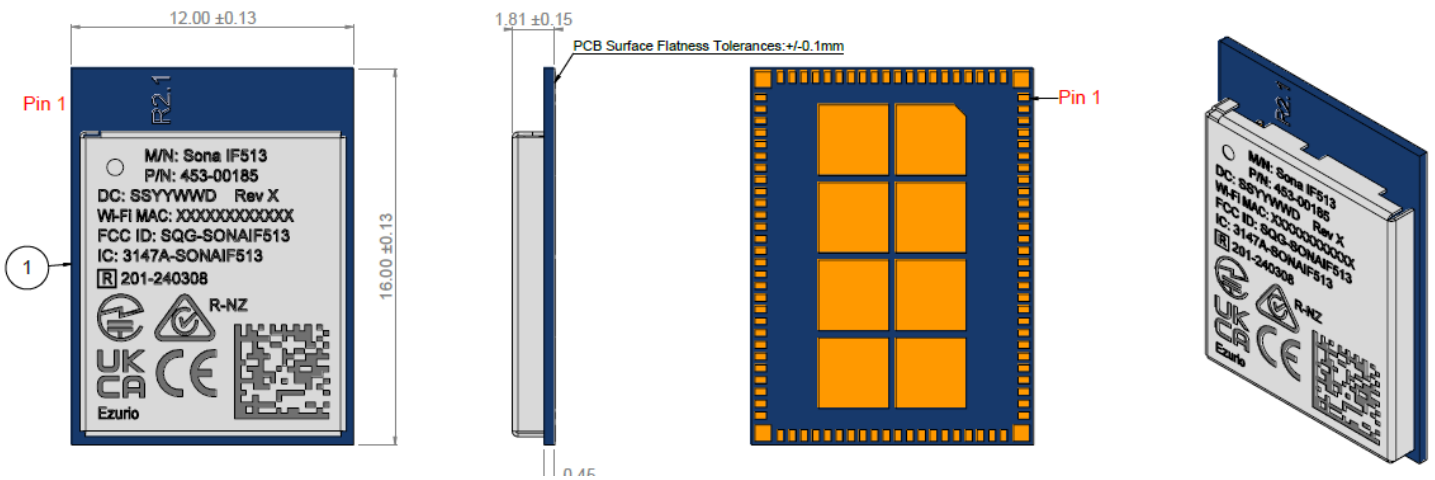


Figure 17: M.2 1216 (Trace variant) Non-Antenna Diversity type

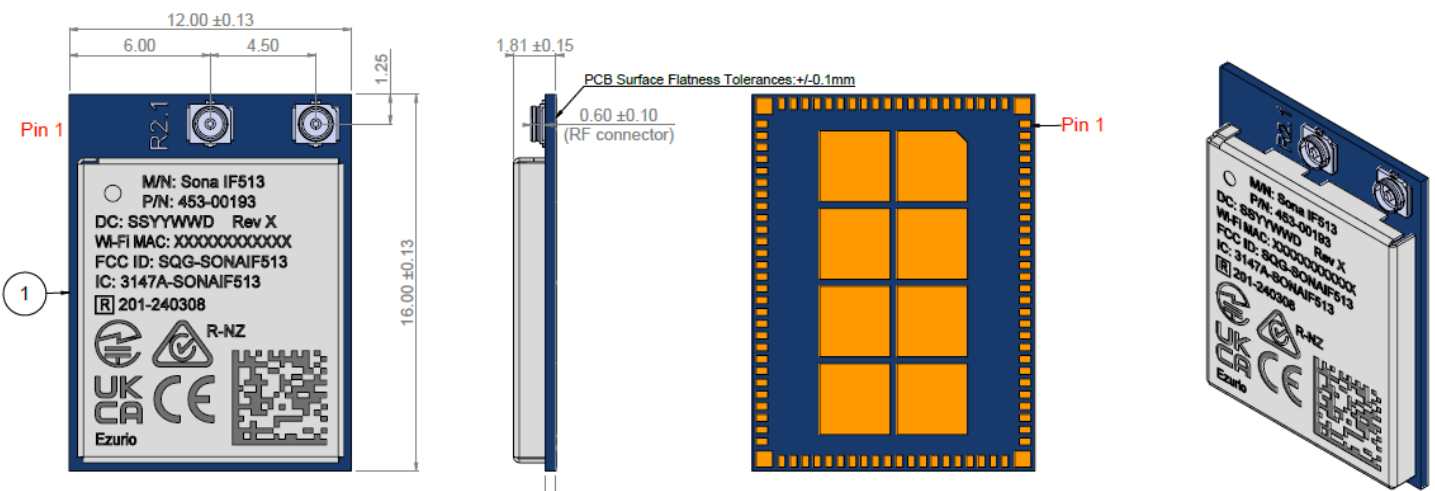


Figure 18: M.2 1216 (MHF4 variant) Antenna Diversity type

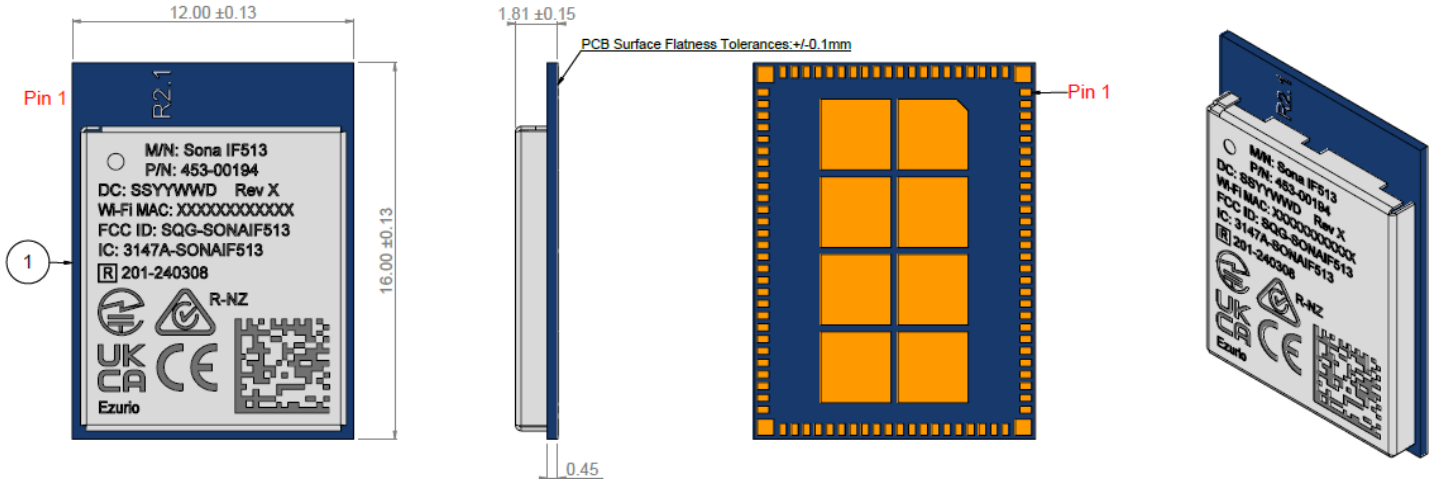


Figure 19: M.2 1216 (Trace variant) Antenna Diversity type

15.2 M.2 2230 Key-E

Module dimensions of Sona IF513 M.2 2230 E-Key module is 22 x 30 x 2.7 mm. Detailed drawings are shown in Figure 20 and Figure 21.

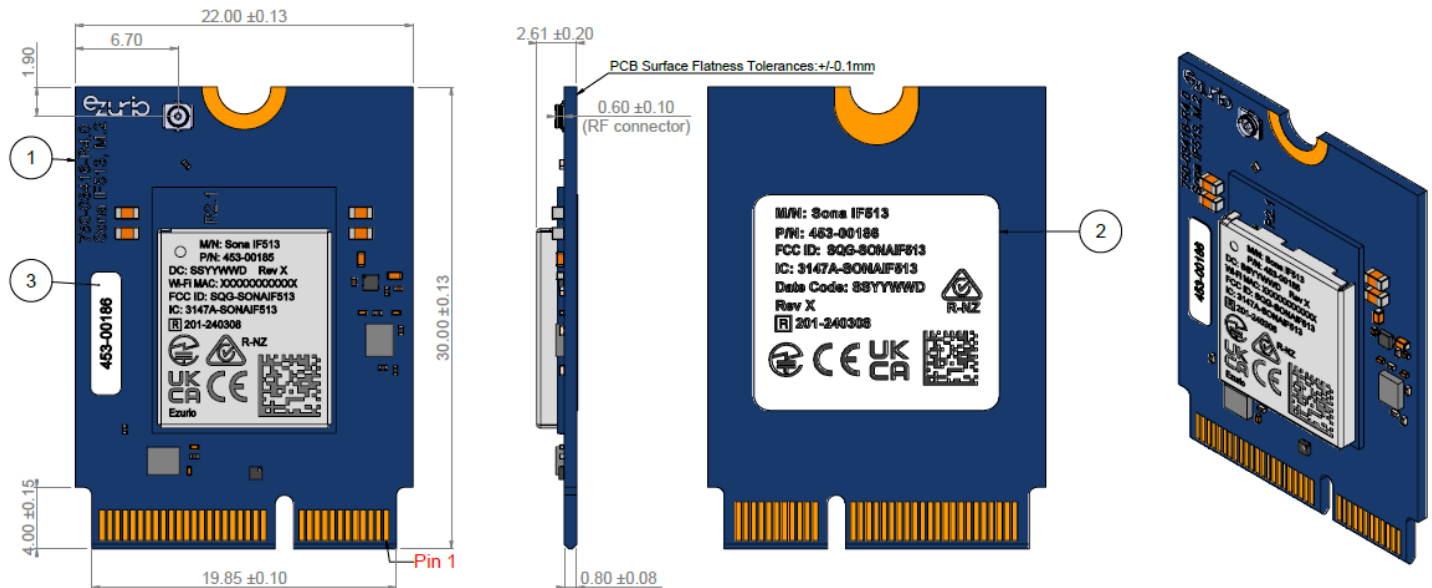


Figure 20: Sona IF513 M.2 2230 Non-Antenna Diversity type

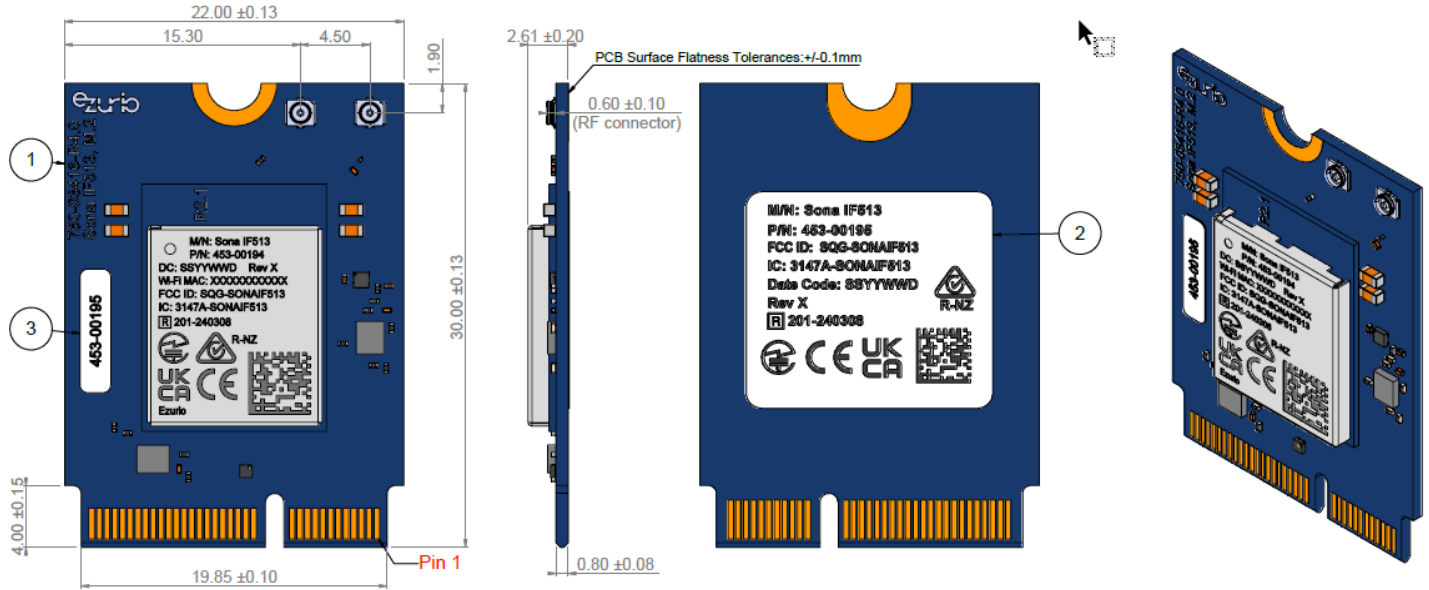


Figure 21: Sona IF513 M.2 2230 Antenna Diversity type

Note: The Wi-Fi MAC address is located on the product label.
The last digit of Wi-Fi MAC address is assigned to either 0, 2, 4, 6, 8, A, C, E.
The BT MAC address is the Wi-Fi MAC address plus 1.

15.3 M.2 2230 Key-E Mounting

The Sona IF513 M.2 2230 E-Key module connects to the host via a standard PCI EXPRESS M2 connector.

Kyocera's 6411 series provides 1.8mm, 2.3mm and 3.2mm connector heights. JAE's SM3 series provides 1.2mm, 2.15mm, 3.1mm and 4.1mm connector heights.

The Sona IF513 M.2 2230 E-Key module is a single-sided component module, so we recommend the connectors listed in Table 39.

Table 39: Recommended M.2 2230 E-Key Connectors

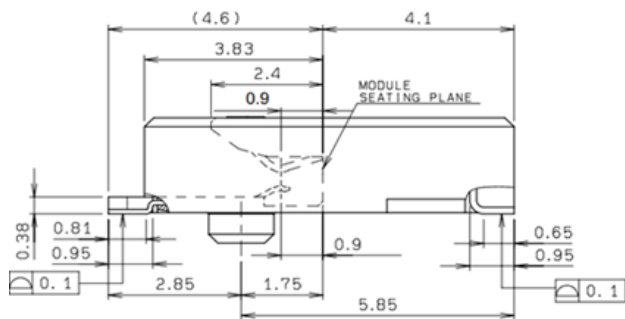
M.2 Key-E Connector	Connector Height
KYOCERA 24-6411-067-101-894E	2.3 mm
JAE SM3ZS067U310AERxxxx	3.1mm

The corresponding standoffs are listed in Table 40.

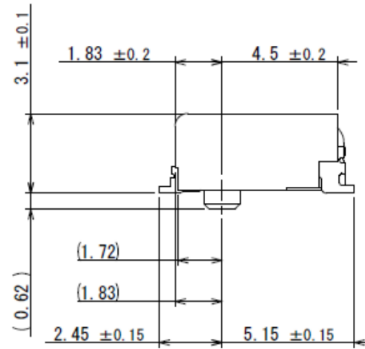
Table 40: Recommended M.2 E-Key Standoffs

M.2 Key-E Connector	Stand-off
KYOCERA 24-6411-067-101-894E	EMI STOP F50M16-041525P1D4M
JAE SM3ZS067U310AERxxxx	JAE SM3ZS067U310-NUT1-Rxxxx

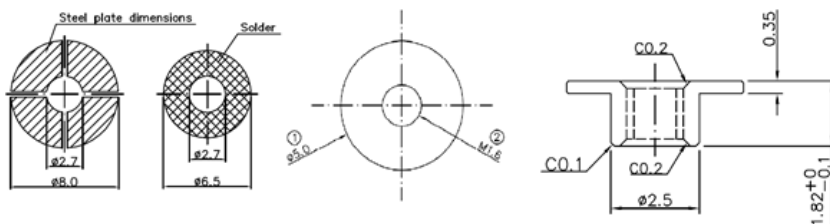
Detailed layout and stencil opening are show in Figure 22.



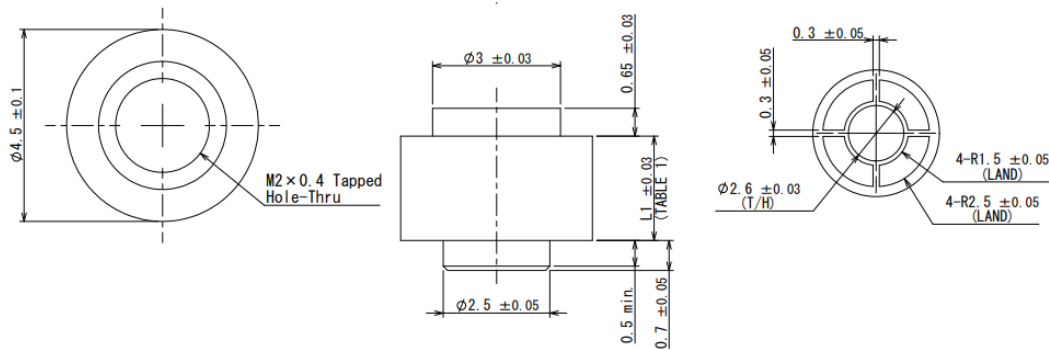
KYOCERA 24-6411-067-101-894E



JAE SM3ZS067U310AERxxx



EMI STOP F50M16-041525P1D4M



JAE SM3ZS067U310-NUT1-Rxxx

Figure 22: M.2 2230 Key-E connector/standoff mounting

16 RF Layout Design Guidelines

The following is a list of RF layout design guidelines and recommendations when installing a Ezurio radio into your device.

- Do not run antenna cables directly above or directly below the radio.
- Do not place any parts or run any high-speed digital lines below the radio.
- Ensure that there is the maximum allowable spacing separating the antenna connectors on the Ezurio radio from the antenna. In addition, do not place antennas directly above or directly below the radio.
- Ezurio recommends the use of a double-shielded cable for the connection between the radio and the antenna elements.
- Be sure to put a 10uF/16V/0603 capacitor on EACH 3.3V power pin. Place the capacitor as close as possible to the pin to ensure correct PMU operation.
- Use proper electro-static-discharge (ESD) procedures when installing the Ezurio radio module. To avoid negatively impacting Tx power and receiver sensitivity, do not cover the antennas with metallic objects or components.

17 Application Notes

17.1 Introduction

Ezurio's surface mount modules are designed to conform to all major manufacturing guidelines. This application note is intended to provide additional guidance beyond the information that is presented in the user manual. This application note is considered a living document and will be updated as new information is presented.

The modules are designed to meet the needs of several commercial and industrial applications. They are easy to manufacture and conform to current automated manufacturing processes.

17.2 Shipping and Labeling

17.2.1 M.2 1216 Solder-Down

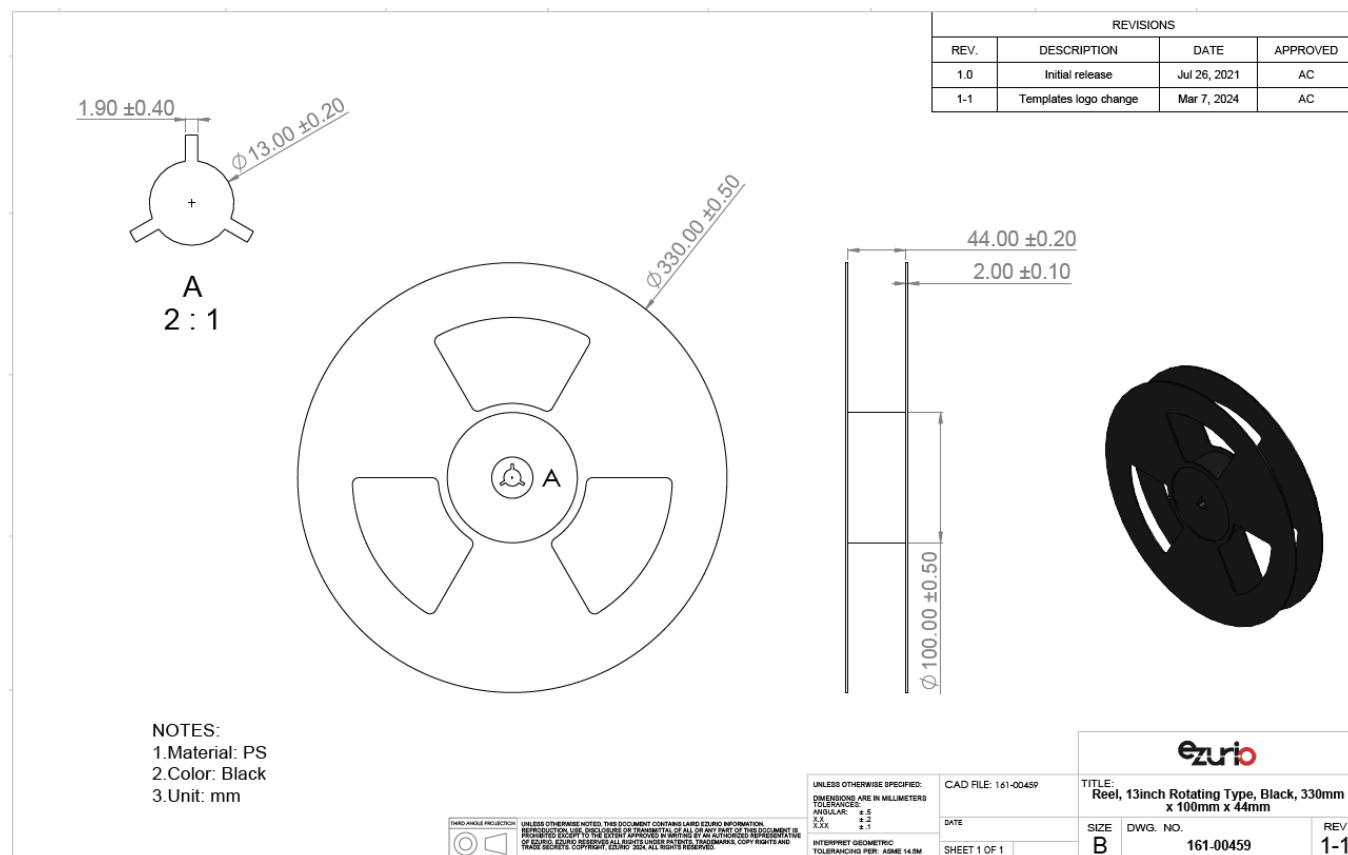
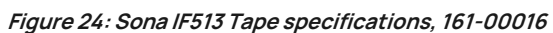


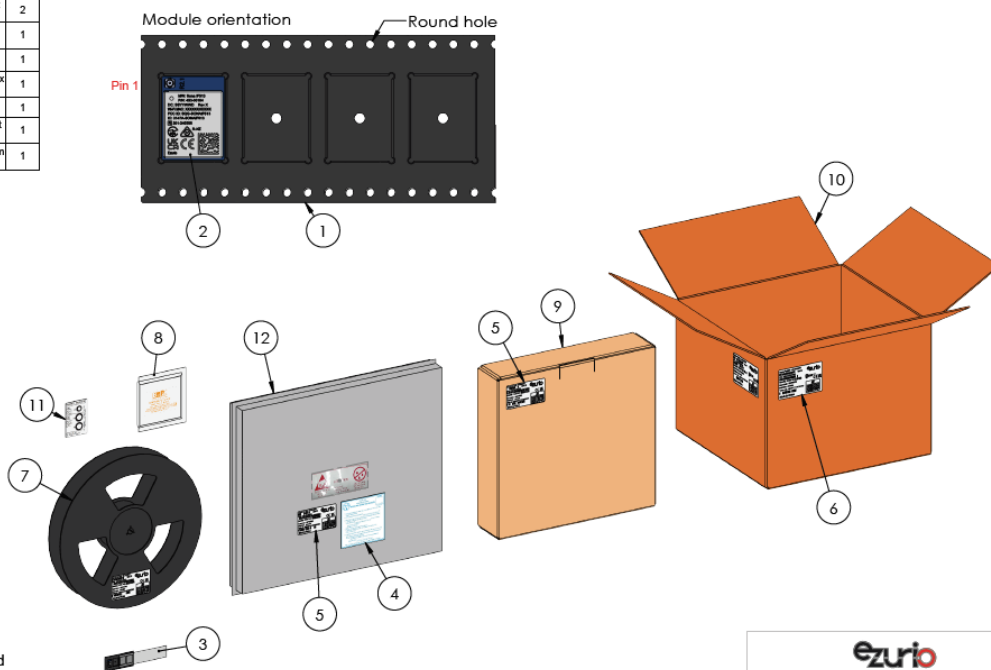
Figure 23: Sona IF513 Reel specifications, 161-00459



There are 1,000 Sona IF513 modules taped in a reel (and packaged in a pizza box) and two boxes per carton (2,000 modules per carton). Reel, boxes, and carton are labeled with the appropriate labels. See Figure 25 for more information.

NO.	ITEM NUMBER	REV.	DESCRIPTION	QTY.
1	161-00016	1-0	Carrier Tape, Conductive Polystyrene, Black, 12.4mm x 16.4mm x 2.2mm	1
2	453-00184	1-1	Module, Sona IF513, MHF4L	1000
3	161-00352	1-1	Cover Tape, Anti-static Polyester, 25.5mm x 0.05mm	1
4	160-02008	1-2	Label, Blank Moisture Sensitivity Level, 4in x 4in	1
5	160-00040	1-0	Label, Product Identifier, Sona IF513, 89mm x 51mm	3
6	160-00041	1-0	Label, Carton Product Identifier, Sona IF513, 101mm x 64mm	2
7	161-00459	1-1	Reel, 13inch Rotating Type, Black, 330mm x 100mm x 44mm	1
8	161-00508	1-1	Desiccant, Silica Gel, 66g, 110mm x 120mm	1
9	161-00507	1-1	Box, Single-Wall Corrugated E Flute, 362mm x 344mm x 53mm	1
10	161-00508	1-1	Carton, AB Flute, 365mm x 383mm x 279mm	1
11	161-00510	1-1	Humidity Indicator Card, Minimum 80% RH, Three Spot Indication, 75mm x 50mm, J-STD-033 Rev D	1
12	161-00544	1-1	Bag, ESD and Moisture Barrier, Silver, 420mm x 475mm x 0.15mm	1

REVISIONS			
REV.	REVISION NOTE	RELEASED DATE	REVISED BY
1-0	Initial release	Jun 18, 2024	IT



Notes:

1. Put the Module in the carrier tape and cover the tape.
2. Put the Reel, Desiccant and Humidity Indicator Card in the ESD bag.
3. Put the packed ESD bag (vacuum) in the box.
4. Put the box in the carton.
5. Module packaging quantity:
Per Reel: 1000 PCS
Per Carton: 2000PCS



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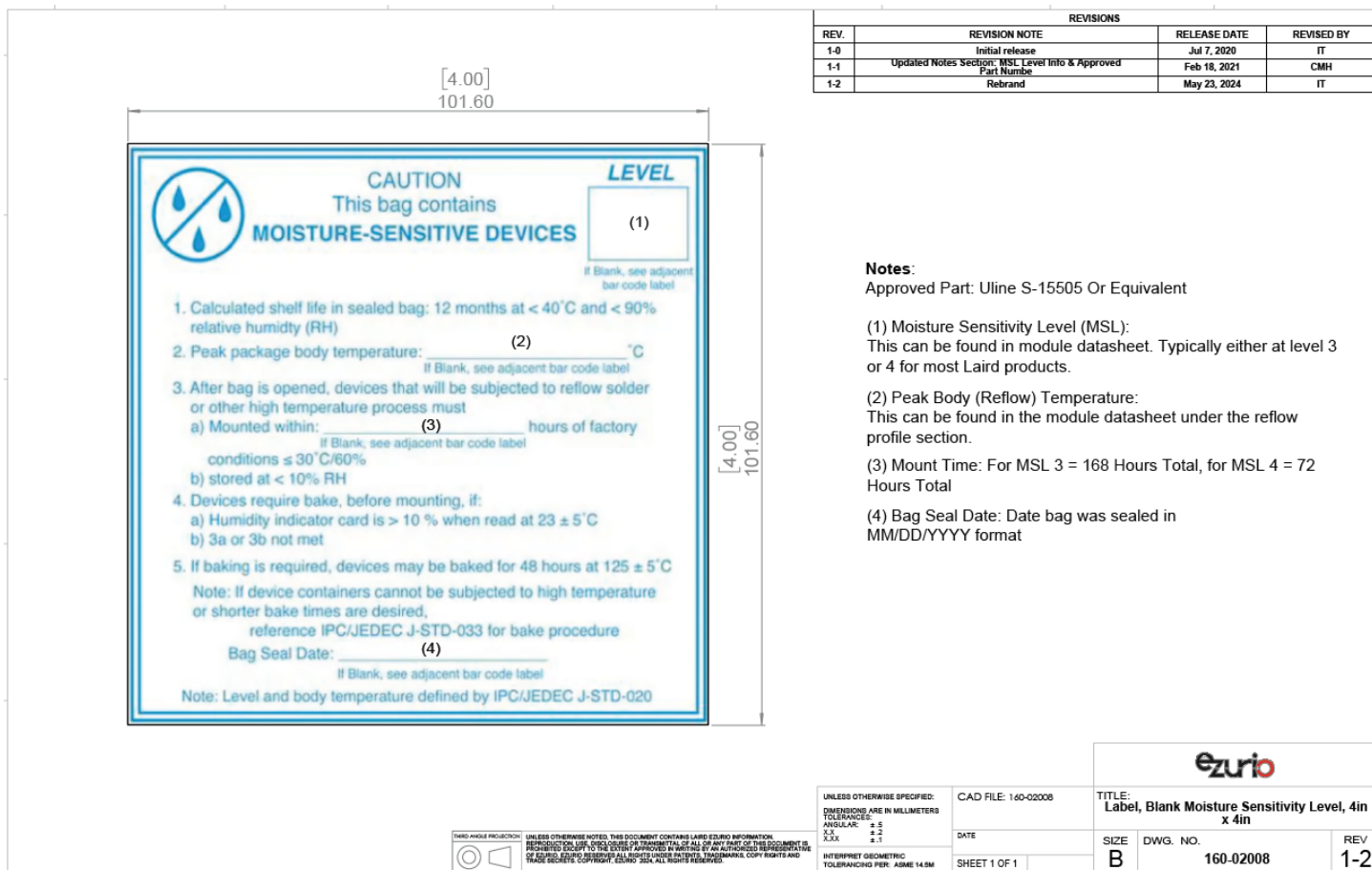
UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN MILLIMETERS
TOLERANCES:
X.XX ± 0.2
X.X ± 0.1
INTERPRET GEOMETRIC
TOLERANCING PER: ASME Y14.5M

CAD FILE: 453-00184R
DATE
SHEET 1 OF 1

		TITLE: Module, Sona IF513, MHF4L, Tape and Reel	
SIZE B	DWG. NO. 453-00184R	REV 1-0	

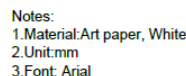
Figure 25: Sona IF513 packaging processes, 453-00184R

The following labels are located on the antistatic bag.



NO.	ITEM NUMBER	REV.	DESCRIPTION	QTY.
1	168-00065	1-1	Label Stock, Art Paper, White, 89mm x 51mm	1

REVISIONS			
REV.	REVISION NOTE	RELEASE DATE	REVISED BY
1-0	Initial release	Jun 18, 2024	IT



Label info:

- 1.Ezurio Part NO: The part number on the PO should be obtained from the "Item (no)"
- 2.P/N: Supplier part number
- 3.Quantity: According to the actual quantity
- 4.Rev X: X=The major revision of the ordering part number which can be found on the PO
- 5.Date Code: SSSYYYYWWD
SS: manufacturer number, 11 for USI
YY: last two numbers of the year
WW: Week number of the year
D: Sun=1, Mon=2, Tue=3, Wed=4, Thu=5, Fri=6, Sat=7
- 6.Seal Date: According to the actual date
- 7.Reel ID: BXXXXYYYYMMDDSSSS
B: Represent BOX LABEL
XXXX: Computer Code
YYYY: Year
MM: Month
DD: Date
SSSS: Serial number
- 8.Barcode Type: Code 128
- 9.CE logo, logo min size: 5mm
- 10.UKCA logo, logo min size: 5mm

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UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN MILLIMETER
TOLERANCES:
ANGULAR: $\pm .5$
X.X $\pm .2$
X.XX $\pm .1$

INTERPRET GEOMETRIC
TOLERANCING PER: ASME Y14.5-2009

CAD FILE: 160-00040

DATE _____

SHEET 1 OF 1

		
TITLE: Label, Product Identifier, Sona IF513, 89mm x 51mm		
SIZE B	DWG. NO. 160-00040	REV. 1-0

<https://www.ezurio.com/>

NO.	ITEM NUMBER	REV.	DESCRIPTION	QTY.
1	168-00066	1-1	Label Stock, Art Paper, White, 101mm x 64mm	1

REVISIONS			
REV.	REVISION NOTE	RELEASE DATE	REVISED BY
1-0	Initial release	Jun 18, 2024	IT



Label info:

- 1.Ezurio Part NO: The part number on the PO should be the same as the item from the "Item (no)"
- 2.P/N: Supplier part number
- 3.Quantity: According to the actual quantity
- 4.Rev X: X=The major revision of the ordering part number which can be found on the PO
- 5.Date Code: SSSYYWWD
- SS: manufacturer number, 11 for USI
- YY: last two numbers of the year
- WW: Week number of the year
- 6: Sun=1, Mon=2, Tue=3, Wed=4, Thu=5, Fri=6, Sat=7
- 6.Seal Date: According to the actual date
- 7.Carton NO: CXXXXXXYYMMDDSSSS
- C: Represent CARTON LABEL
- XXXX: Computer Code
- YYYY: Year
- MM: Month
- DD: Date
- SSSS: Serial number
- 8.Barcode Type: Code 128
- 9.CE logo, logo min size: 5mm
- 10.UKCA logo, logo min size: 5mm
- 11.RCM logo, logo min size: 3mm

UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN MILLIMETERS TOLERANCES: ANGULAR: ± 5 X.X ± 2 X.XX ± 1	CAD FILE: 160-00041	TITLE: Label, Carton Product Identifier, Sona IF513, 101mm x 64mm		
DATE	SIZE B	DWG. NO. 160-00041	REV 1-0	
INTERPRET GEOMETRIC TOLERANCING PER: ASME Y14.5M	SHEET 1 OF 1			

Figure 28: Sona IF513 Carton Product Identifier Label, 160-00041

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
1-0	Initial release	Jul 16, 2020	AC
1-1	Rebranding	Apr 11, 2024	AC

Top view dimensions: 235.0 ± 3.0, 210.0 ± 3.0, 22.2 ± 1.0, 1.60 ± 0.10, 2.30 ± 0.10, 27.80 ± 0.10.

Side view dimension: 27.80 ± 0.10.

Section A-A dimensions: 22.0 ± 1.0, 24.0 ± 1.0.

Notes:

1. Material: PET
2. Color: Transparent
3. Thickness: 1.0mm
4. Surface resistivity: 10⁶~10¹¹ Ohm/square
5. The use of CFC prohibited in either resin production or part production.

		TITLE: Tray, Bottom, PET, Anti-static, Transparent, 235mm x 210mm x 27.8mm	
UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN MILLIMETERS TOLERANCES: ANGULAR: ± 5 X.X: ± 0.2 X.XX: ± 0.1		CAD FILE: 161-00355	
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INTERPRET GEOMETRIC TOLERANCING PER: ASME 14.5M		SHEET 1 OF 1 REV: 1-1	

<https://www.ezurio.com/>

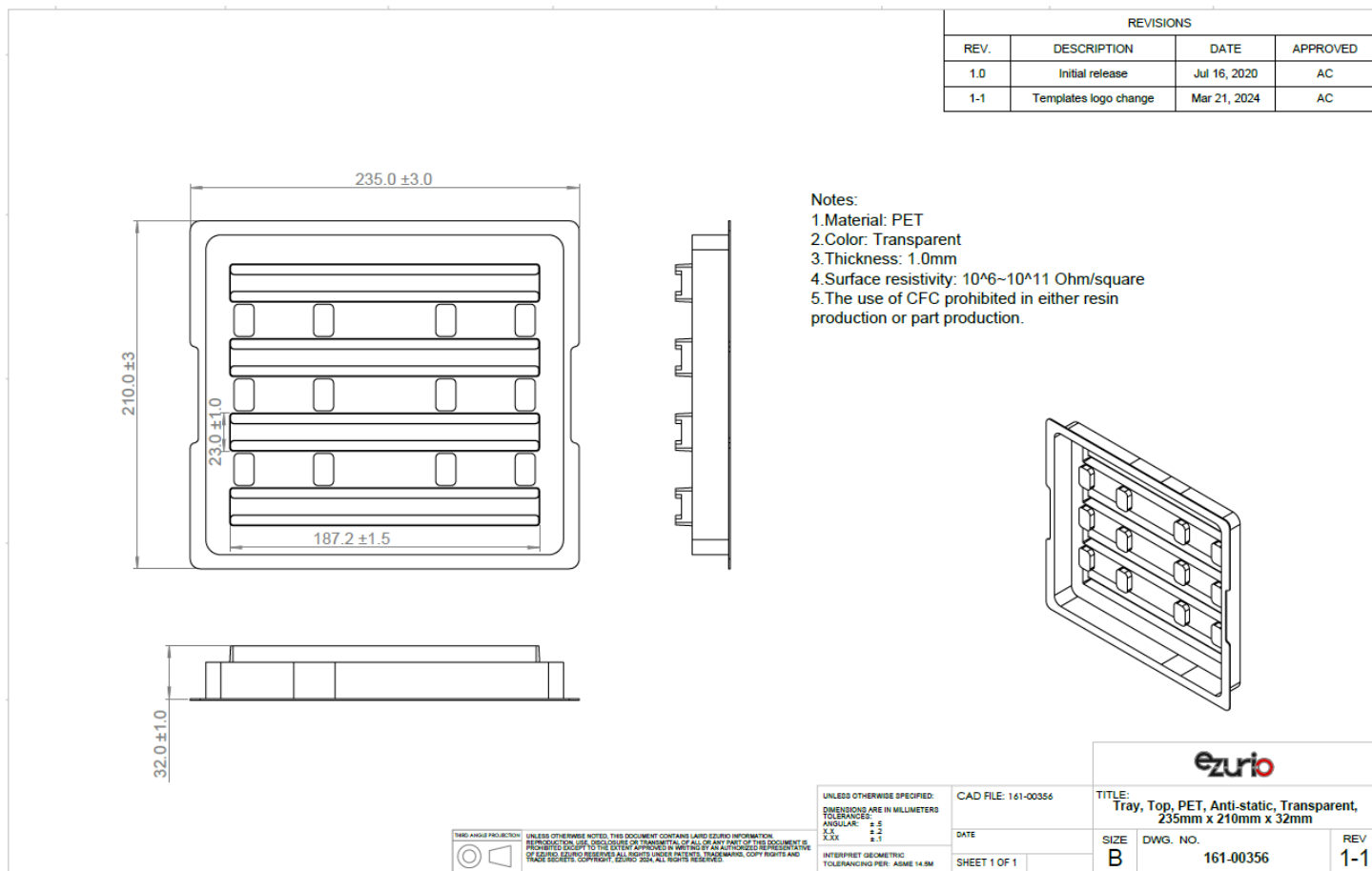


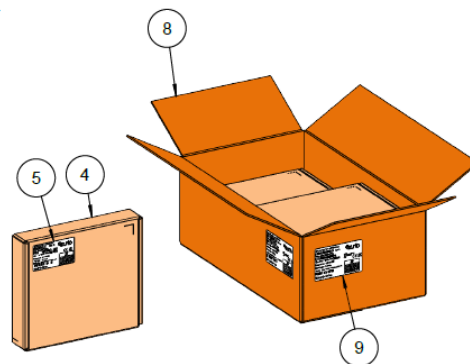
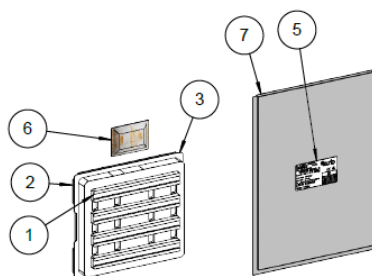
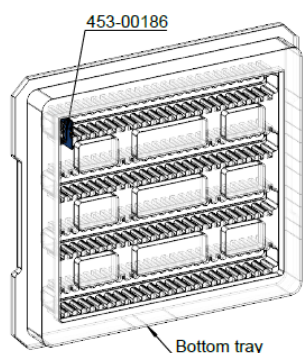
Figure 30: Sona IF513 M.2 2230 Shipping Tray, Top, 161-00356

NO.	ITEM NUMBER	REV.	DESCRIPTION	QTY.
1	453-00186	1-1	Module, Sona IF513, M.2, Key E, SDIO, UART	600
2	161-00355	1-1	Tray, Bottom, PET, Anti-static, Transparent, 235mm x 210mm x 27.8mm	6
3	161-00356	1-1	Tray, Top, PET, Anti-static, Transparent, 235mm x 210mm x 50mm	6
4	161-00357	1-1	Box, Kraft, B Flute, 252mm x 217mm x 41mm	6
5	160-00040	1-0	Label, Product Identifier, Sona IF513, 89mm x 51mm	12
6	161-00361	1-1	Desiccant, Silica Gel, 10g, 58mm x 80mm	6
7	161-00358	1-1	Bag, ESD and Moisture Barrier, Silver, 270mm x 360mm x 0.09mm	6
8	161-00359	1-1	Carton, Kraft, AB Flute, 455mm x 268mm x 170mm	1
9	160-00041	1-0	Label, Carton Product Identifier, Sona IF513, 101mm x 64mm	2

REVISIONS			
REV.	REVISION NOTE	RELEASE DATE	REVISED BY
0-1	Initial release	Jun 19, 2024	IT

Notes:

1. Put the Module in the bottom tray.
 2. Cover the top tray.
 3. Put the tray and Desiccant in the ESD bag.
 4. Put the packed ESD bag (vacuum) in the box.
 5. Put six boxes in the carton.
 6. Module packaging quantity:
- Per Tray: 100 PCS
Per Carton: 600PCS



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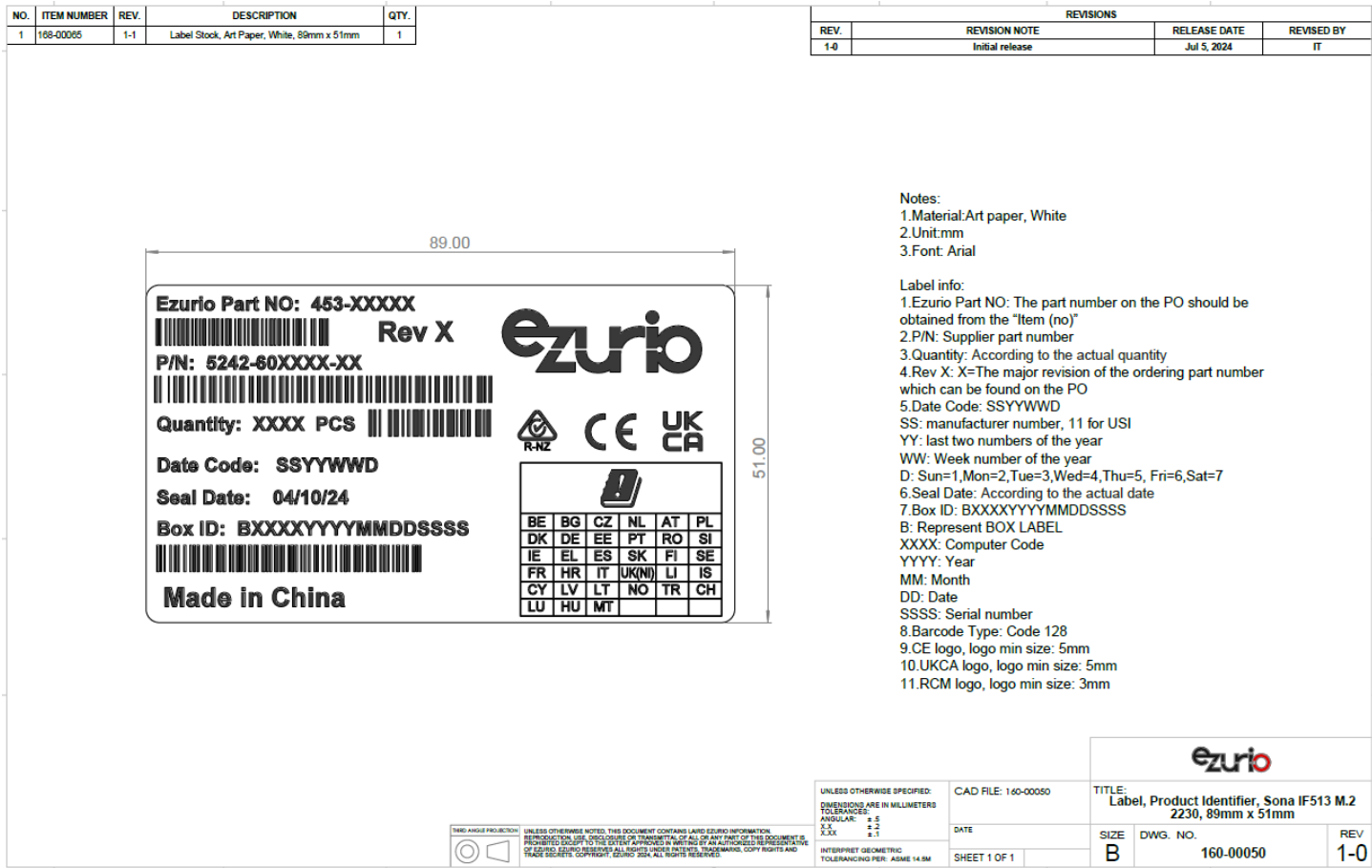
UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN MILLIMETERS
TOLERANCES:
ANGULAR: ± 5
X.X ± 2
X.XX ± 1
INTERPRET GEOMETRIC
TOLERANCING PER: ASME 14.5M

CAD FILE: 453-00186-PKG
DATE
SHEET 1 OF 1

ezurio			
TITLE: Module, Sona IF513, M.2, Key E, SDIO, UART, Packaging			
SIZE	DWG. NO.	REV	
B	453-00186-PKG	0-1	

Figure 31: Sona IF513 M.2 2230 Packaging Process, 453-00186-PKG

The following label is placed on the bag and the inner box.



The following label is located on the adjacent sides of the master carton.

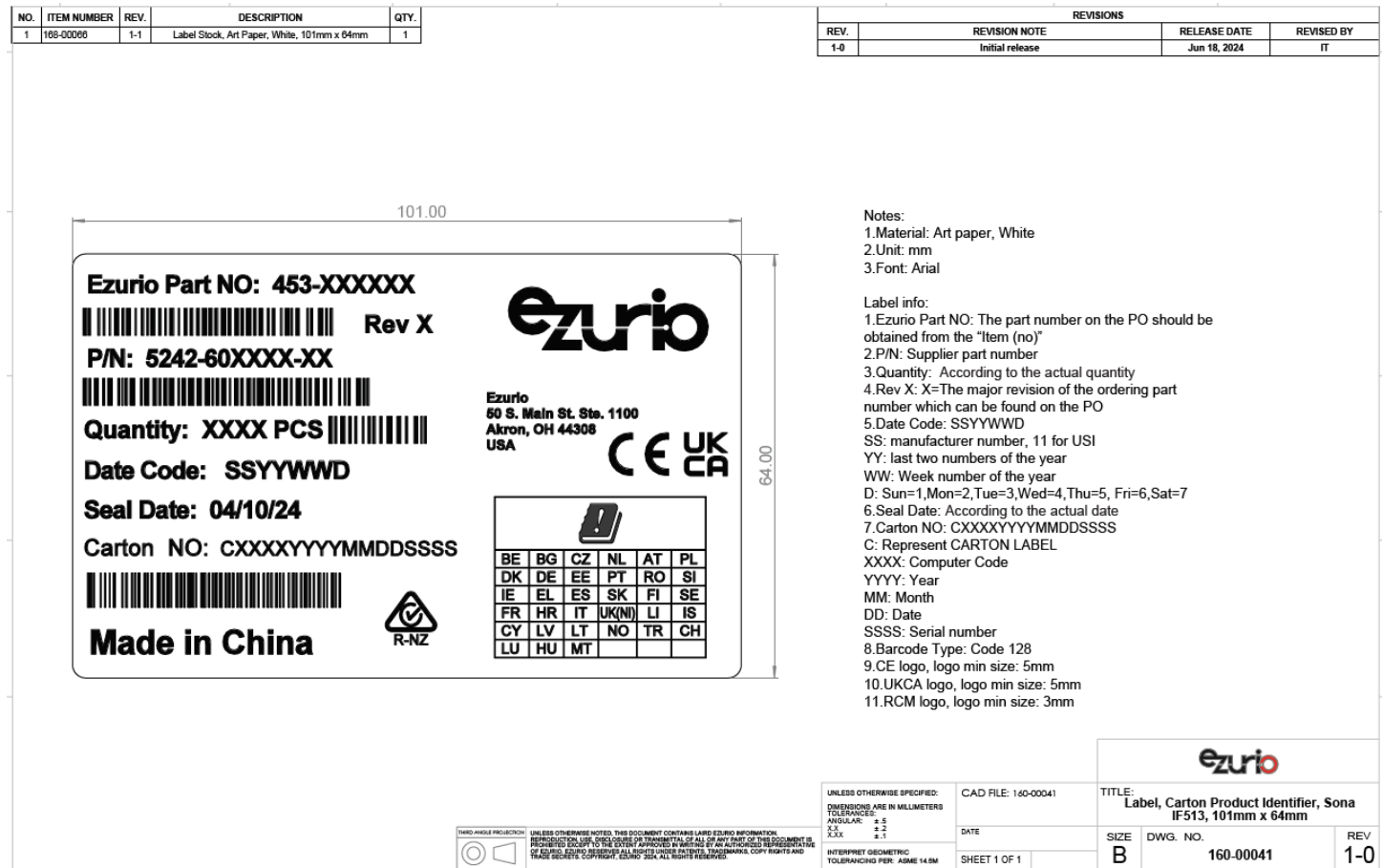


Figure 33: Sona IF513 Carton Product Identifier Label, 160-000041

17.3 Required Storage Conditions

17.3.1 Prior to Opening the Dry Packing

The following are required storage conditions *prior to opening the dry packing*:

- Normal temperature: 5~40 °C
- Normal humidity: 80% (Relative humidity) or less
- Storage period: One year or less

Note: Humidity means relative humidity.

17.3.2 After Opening the Dry Packing

The following are required storage conditions *after opening the dry packing* (to prevent moisture absorption):

- Storage conditions for one-time soldering:
 - Temperature: 5-25°C
 - Humidity: 60% or less
 - Period: 72 hours or less after opening
- Storage conditions for two-time soldering
 - Storage conditions following opening and prior to performing the 1st reflow:
 - Temperature: 5-25°C
 - Humidity: 60% or less
 - Period: A hours or less after opening

- Storage conditions following completion of the 1st reflow and prior to performing the 2nd reflow
 - Temperature: 5-25°C
 - Humidity: 60% or less
 - Period: 8 hours or less after completion of the 1st reflow

Note: Should keep A+B within 72 hours.

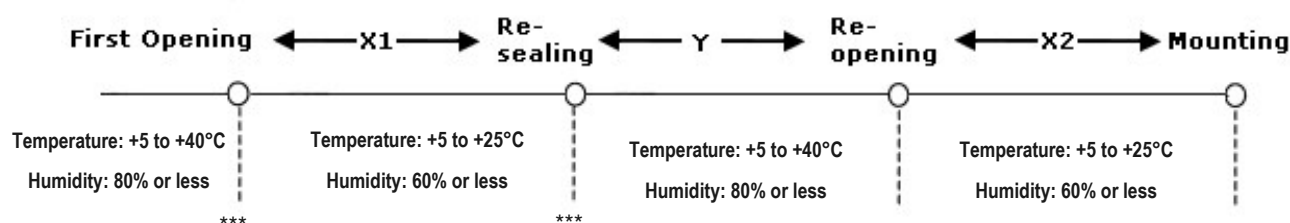
17.3.3 Temporary Storage Requirements after Opening

The following are temporary storage requirements after opening:

- Only re-store the devices once prior to soldering.
- Use a dry box or place desiccant (with a blue humidity indicator) with the devices and perform dry packing again using vacuumed heat-sealing.

The following indicate the required storage period, temperature, and humidity for this temporary storage:

- Storage temperature and humidity:



- Storage period:
 - X1+X2 - Refer to **Required Storage Conditions**. Keep is X1+X2 within 72 hours.
 - Y - Keep within two weeks or less.

17.4 Baking Conditions

Baking conditions and processes for the module follow the J-STD-033 standard which includes the following:

- The calculated shelf life in a sealed bag is 12 months at <40°C and <80% relative humidity.
- Once the packaging is opened, the SiP must be mounted (per MSL4/Moisture Sensitivity Level 4) within 72 hours at <30 °C and <60% relative humidity.

If the SiP is not mounted within 72 hours or if, when the dry pack is opened, the humidity indicator card displays >10% humidity, then the product must be baked for 48 hours at 125 °C (±5 °C).

18 Surface Mount Conditions

The following soldering conditions are recommended to ensure device quality.

18.1 Recommended Stencil Aperture

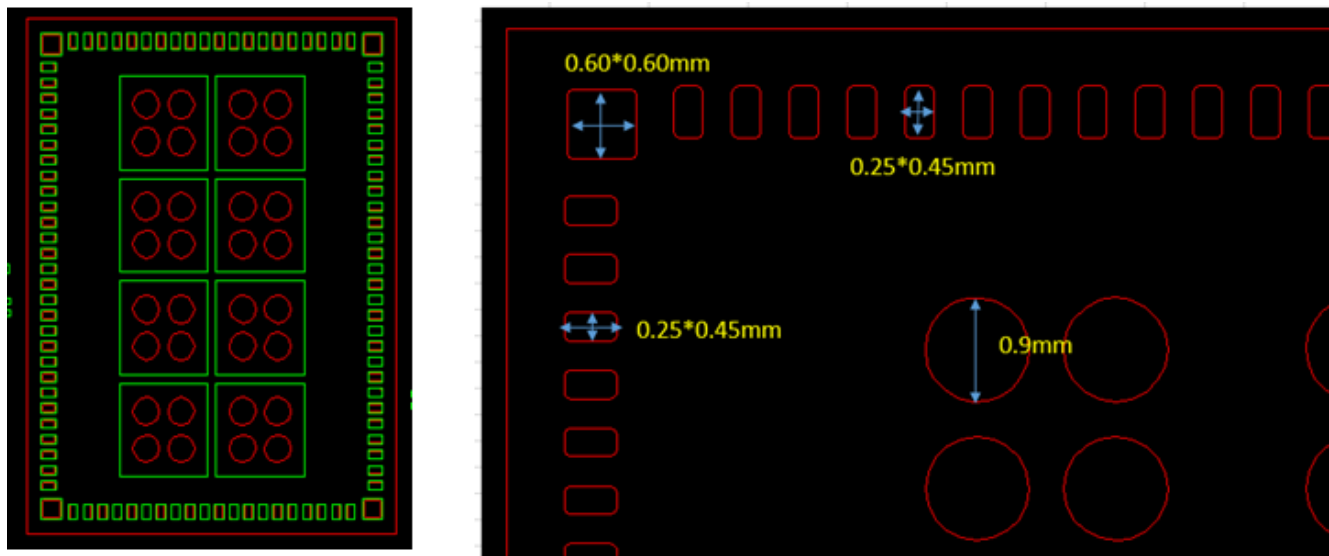


Figure 34: Sona IF513 M.2 1216 stencil aperture

Note: The stencil thickness is 0.12mm.

18.2 Soldering

Note: When soldering, the stencil thickness should be 0.12 mm.

Convection reflow or IR/Convection reflow (one-time soldering or two-time soldering in air or nitrogen environment)

Measuring point – IC package surface

Temperature profile:

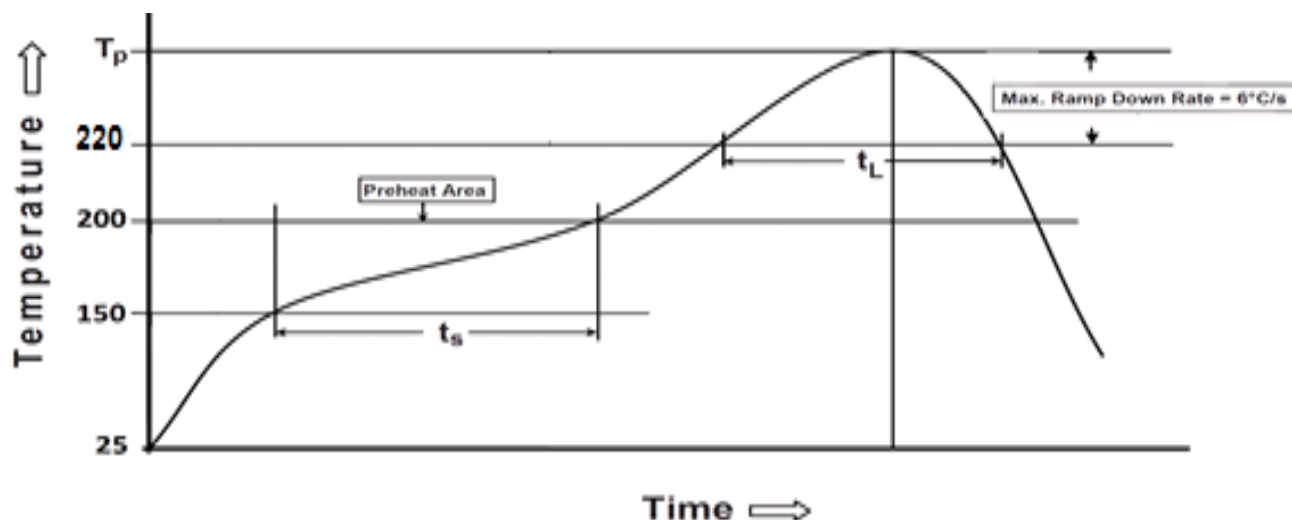


Figure 35: Temperature profile

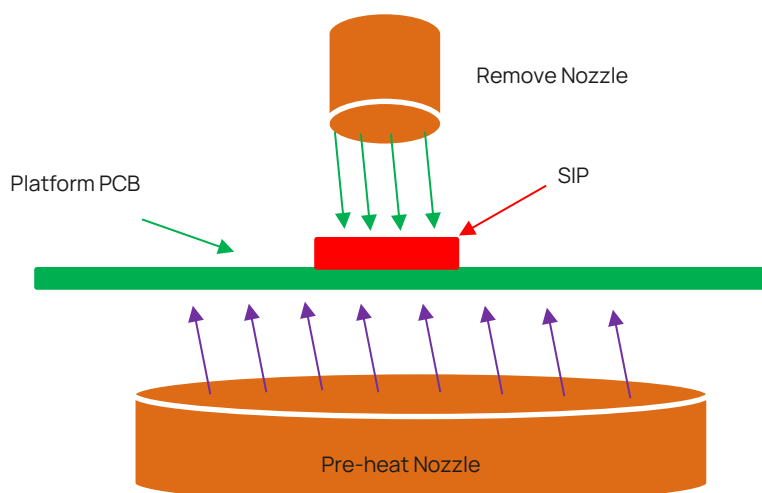
- Solder paste alloy: SAC305(Sn96.5 / Ag3.0 / Cu 0.5)
- Pre-heat temperature: 150°C ~ 200°C; Soak time: 60 second ~ 120 second
- Peak temperature: 235°C ~ 250°C
- Time above 220°C: 40 second ~ 90 second
- Optimal cooling rate < 3°C/second
- The oxygen concentration < 2000 ppm

18.2.1 Cautions When Removing the M.2 1216 from the Platform for RMA

- Bake the platform before removing the Sona IF513 module from the platform. Reference [Table 41](#) **Error! Reference source not found..**
- Remove the Sona IF513 module by using a hot air gun. This process should be carried out by a skilled technician.

Recommended conditions:

- One-side component platform:
 - Set the hot plate at 280°C.
 - Put the platform on the hot plate for 8~10 seconds.
 - Remove the device from platform.
- Two-side components platform:
 - Use two hot air guns.
 - On the bottom, use a pre-heated nozzle (temp setting of 200~250°C) at a suitable distance from the platform PCB.
 - On the top, apply a remove nozzle (temp setting of 330°C). Heat until device can be removed from platform PCB.



- Remove the residue solder under the bottom side of device. (Note: Alternate module pictured as an example)



(Not accepted for RMA)

Figure 36: Example M.2 1216 with residue solder on the bottom



(Accepted for RMA analysis)

Figure 37: Sona IF513 module without residue solder

- Remove and clean the residue flux as needed.

18.2.2 Precautions for Use

- Opening/handling/removing must be done on an anti-ESD treated workbench. All workers must also have undergone anti-ESD treatment.
- The devices should be mounted within one year of the date of delivery.
- The Sona IF513 modules are MSL level 4 rated.

19 Reliability Test

The Sona IF513 modules were tested for reliability. Test items and the corresponding standards are shown in [Table 41](#). **Error! Reference source not found..**

19.1 Environmental and Mechanical

The following are the followed reliability test procedures.

Table 41: Sona IF513 M.2 1216 Solder-down Module Reliability Test Items and Standards

Test Item	Specification	Standard	Test Result
Step 1: Pre-conditioning	Pre-check: - Function check (Tools and SOP supplied by customers). - Mechanical check.	JESD22-A113	Pass
	Pre-conditioning: - Bake: 125°C for 24 hours. - Moisture Soak: 30°C/60% RH for 192 hours - Not shorter than 15 minutes and not longer than 4 hours after removal from the temperature/humidity chamber, subject the sample to 3 cycles of the reflow.		
Step 2: Temperature Cycling Non-operating	Post-check: - Function check (Tools and SOP supplied by customers). - Mechanical check. - Perform inspections of short, open, delamination of DUTs by Optical Microscope (under 40X optical magnification). - X-RAY / CSAM (SAT) on any failed samples (Notify customers). - Cross-sections analysis based on X-RAY and CSAM results.	JESD22-A113	Pass
	- Dwell on -40°C for 15 minutes - Shock to 85°C with in ramp rate 15 °C/minute - Dwell on 85°C for 15 minutes - Shock to -40°C with in ramp rate 15 degree C/minute - Repeat step 1-4 and stop to check functions at 500/ 700 cycles		
Vibration Non-operating Unpackaged device	- Vibration Wave Form: Sine Waveform - Vibration frequency / Displacement: 20-80 Hz/1.5mm - Vibration frequency / Acceleration: 80-2000 Hz/20g - Cycle Time: 4 min/cycle - Number of Cycles: 4 cycle/axis - Vibration Axes: X, Y and Z (Rotate each axis on vertical vibration table)	JEDEC 22-B103B (2016)	Pass
Mechanical Shock Non-operating Unpackaged device	- Pulse shape: Half-sine waveform - Impact acceleration: 1500 g - Pulse duration: 0.5 ms - Number of shocks: 30 shocks (5 shocks for each face) - Orientation: Bottom, top, left, right, front and rear faces	JEDEC 22-B110B.01 (2019)	Pass

Table 42: Sona IF513 M.2 2230 E-Key Module Reliability Test Item and Standards

Test Item	Specification	Standard	Test Result
Thermal Shock	1. Temperature: -40 ~ 85°C 2. Ramp time: Less than 10 seconds. 3. Dwell Time: 10 minutes 4. Number of Cycles: 500 times	*JESD22-A106 *IEC 60068-2-14 for dwell time and number of cycles	Pass
Vibration Non-operating Unpackaged device	1. Vibration Wave Form: Sine Waveform 2. Vibration frequency / Displacement: 20-80 Hz/1.5mm 3. Vibration frequency / Acceleration: 80-2000 Hz/20g 4. Cycle Time: 4 min/cycle 5. Number of Cycles: 4 cycle/axis 6. Vibration Axes : X, Y and Z (Rotate each axis on vertical vibration table)	JEDEC 22-B103B (2016)	Pass
Mechanical Shock Non-operating Unpackaged device	1. Pulse shape: Half-sine waveform 2. Impact acceleration: 1500 g 3. Pulse duration: 0.5 ms 4. Number of shocks: 30 shocks (5 shocks for each face) 5. Orientation: Bottom, top, left, right, front and rear faces	JEDEC 22-B110B.01 (2019)	Pass

19.2 Reliability Prediction

Test Item	Specification	Standard
Mean Time Between Failure (MTBF)	1. Normal Operating Temperature: 45 °C Ground Fixed Ground Mobile 2. High Temperature: 85 °C Ground Fixed Ground Mobile	Telcordia SR-332 Issue 4 (2016)

Ezurio Part Number	Environment	Test Result 45 °C (Hours)
453-00184R		
453-00184C		
453-00185R		
453-00185C	Ground, Fixed, Uncontrolled	1,221,4794.22
453-00193R	Ground, Mobile	9,280,713.28
453-00193C		
453-00194R		
453-00194C		

Ezurio Part Number	Environment	Test Result 85 °C (Hours)
453-00184R		
453-00184C		
453-00185R		
453-00185C	Ground, Fixed, Uncontrolled	2,944,966.86
453-00193R	Ground, Mobile	2,244,523.16
453-00193C		
453-00194R		
453-00194C		

Ezurio Part Number	Environment	Test Result 45 °C (Hours)
453-00186	Ground, Fixed, Uncontrolled	3,880,182.6
453-00195	Ground, Mobile	2,921,415.1

Ezurio Part Number	Environment	Test Result 85 °C (Hours)
453-00186	Ground, Fixed, Uncontrolled	787,914.3
453-00195	Ground, Mobile	593,306.2

20 Regulatory

Note: For complete regulatory information, refer to the Sona IF513 Regulatory Information document which is also available from the [Sona IF513 product page](#).

The Sona IF513 holds current certifications in the following countries:

Country/Region	Regulatory ID
USA (FCC)	SQG-SONAIF513
EU	N/A
UKCA	N/A
Canada (ISED)	3147A-SONAIF513
Japan (MIC)	201-240308

20.1 Certified Antennas

The Sona IF513 module was tested with antennas listed in the following table. The OEM can choose a different manufacturer's antenna but must make sure it is of same type and that the gain is lesser than or equal to the antenna that is approved for use.

Manufacturer	Model	Ezurio Part Number	Type	Connector	Peak Gain (dBi)		
					2.4GHz	5GHz	6GHz
Ezurio (formerly Laird Connectivity)	FlexMIMO 6E	EFD2471A3S-10MH4L	PIFA	MHF4L	2.2	3.8	3.3
Ezurio (formerly Laird Connectivity)	FlexPIFA 6E	EFB2471A3S-10MH4L	PIFA	MHF4L	2.2	3.9	3.8
Ezurio (formerly Laird Connectivity)	Mini NanoBlade Flex 6 GHz	EMF2471A3S-10MH4L	PCB Dipole	MHF4L	2.4	4.4	5.2
Joymax Electronics	Dipole 6E	TWX-100BRSAX-2001 / TWX-100BRS3B	Dipole	RP-SMA	2	4.0	4.0

21 Bluetooth Qualification process

21.1 Overview

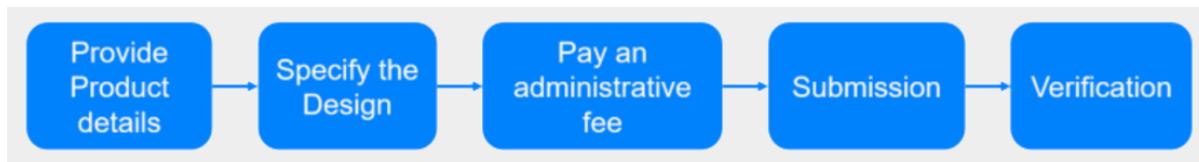
The Bluetooth Qualification Process promotes global product interoperability and reinforces the strength of the Bluetooth® brand and ecosystem to the benefit of all Bluetooth SIG members. The Bluetooth Qualification Process helps member companies ensure their products that incorporate Bluetooth technology comply with the Bluetooth Patent & Copyright License Agreement and the Bluetooth Trademark License Agreement (collectively, the Bluetooth License Agreement) and Bluetooth Specifications.

The Bluetooth Qualification Process is defined by the [Qualification Program Reference Document \(QPRD\) v3](#).

To demonstrate that a product complies with the Bluetooth Specification(s), each member must for each of its products:

- Identify the product, the design included in the product, the Bluetooth Specifications that the design implements, and the features of each implemented specification
- Complete the Bluetooth Qualification Process by submitting the required documentation for the product under a user account belonging to your company

The Bluetooth Qualification Process consists of the phases shown below:



To complete the Qualification Process the company developing a Bluetooth End Product shall be a member of the Bluetooth SIG. To start the application please use the following link: [Apply for Adopter Membership](#)

21.2 Scope

This guide is intended to provide guidance on the Bluetooth Qualification Process for End Products that reference multiple existing designs, that have not been modified, (refer to Section 3.2.2.1 of the [Qualification Program Reference Document v3](#)).

For a Product that includes a new Design created by combining two or more unmodified designs that have DNs or QDIDs into one of the permitted combinations in Table 3.1 of the QPRDv3, a Member must also provide the following information:

- DNs or QDIDs for Designs included in the new Design
- The desired Core Configuration of the new Design (if applicable, see Table 3.1 below)
- The active TCRL Package version used for checking the applicable Core Configuration (including transport compatibility) and evaluating test requirements

Any included Design must not implement any Layers using withdrawn specification(s).

When creating a new Design using Option 2a, the Inter-Layer Dependency (ILD) between Layers included in the Design will be checked based on the latest TCRL Package version used among the included Designs.

For the purposes of this document, it is assumed that the member is combining unmodified Core-Controller Configuration and Core-Host Configuration designs, to complete a Core-Complete Configuration.

21.3 Qualification Steps When Referencing multiple existing designs, (unmodified) – Option 2a in the QPRDv3

For this qualification option, follow these steps:

1. To start a listing, go to: <https://qualification.bluetooth.com/>
2. Select **Start the Bluetooth Qualification Process**.
3. Product Details to be entered:
 - Project Name (this can be the product name or the Bluetooth Design name).
 - Product Description
 - Model Number
 - Product Publication Date (the product publication date may not be later than 90 days after submission)
 - Product Website (optional)

- Internal Visibility (this will define if the product will be visible to other users prior to publication)
 - If you have multiple End Products to list then you can select 'Import Multiple Products', firstly downloading and completing the template, then by 'Upload Product List'. This will populate Qualification Workspace with all your products.
4. Specify the Design:
- Do you include any existing Design(s) in your Product? Answer Yes, I do.
 - Enter the multiple DNs or QDIDs used in your, (for Option 2a two or more DNs or QDIDs must be referenced)
 - Select 'I'm finished entering DN's
 - Once the DNs or QDIDs are selected they will appear on the left-hand side, indicating the layers covered by the design (should show Core-Controller and Core Host Layers covered).
 - What do you want to do next? Answer, 'Combine unmodified Designs'.
 - The Qualification Workspace Tool will indicate that a new Design will be created and what type of Core-Complete configuration is selected.
 - An active TCRL will be selected for the design.
 - Perform the Consistency Check, which should result in no inconsistencies
 - If there are any inconsistencies these will need to be resolved before proceeding
 - Save and go to Test Plan and Documentation
5. Test Plan and Documentation
- a. As no modifications have been made to the combined designs the tool should report the following message:
'No test plan has been generated for your new Design. Test declarations and test reports do not need to be submitted. You can continue to the next step.'
 - b. Save and go to Product Qualification fee
6. Product Qualification Fee:
- It's important to make sure a Prepaid Product Qualification fee is available as it is required at this stage to complete the Qualification Process.
 - Prepaid Product Qualification Fee's will appear in the available list so select one for the listing.
 - If one is not available select 'Pay Product Qualification Fee', payment can be done immediately via credit card, or you can pay via Invoice. Payment via credit will release the number immediately, if paying via invoice the number will not be released until the invoice is paid.
 - Once you have selected the Prepaid Qualification Fee, select 'Save and go to Submission'
7. Submission:
- Some automatic checks occur to ensure all submission requirements are complete.
 - To complete the listing any errors must be corrected
 - Once you have confirmed all design information is correct, tick all of the three check boxes and add your name to the signature page.
 - Now select 'Complete the Submission'.
 - You will be asked a final time to confirm you want to proceed with the submission, select 'Complete the Submission'.
 - Qualification Workspace will confirm the submission has been submitted. The Bluetooth SIG will email confirmation once the submission has been accepted, (normally this takes 1 working day).
8. Download Product and Design Details (SDoC):
- a. You can now download a copy of the confirmed listing from the design listing page and save a copy in your Compliance Folder

For further information, please refer to the following webpage:

<https://www.bluetooth.com/develop-with-bluetooth/qualification-listing/>

21.4 Example Design Combinations

The following gives an example of a design possible under option 2a:

Ezurio Controller Subsystem + BlueZ 5.50 Host Stack (Ezurio Sona IF513 based design)

Design Name	Owner	Declaration ID	QD ID	Link to listing on the SIG website
Sona IF513	Ezurio	D067612	241038	https://qualification.bluetooth.com/ListingDetails/220309
BlueZ 5.50 Host Stack	Ezurio	D046330	138224	https://qualification.bluetooth.com/ListingDetails/93911

21.5 Qualify More Products

If you develop further products based on the same design in the future, it is possible to add them free of charge. The new product must not modify the existing design i.e add ICS functionality, otherwise a new design listing will be required.

To add more products to your design, select 'Manage Submitted Products' in the [Getting Started](#) page, Actions, Qualify More Products. The tool will take you through the updating process.

22 Additional Information

Please contact your local sales representative or our support team for further assistance:

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Website	www.ezurio.com/
Technical Support	www.ezurio.com/resources/support
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