

Datasheet

Sona MT320

Version 0.1

REVISION HISTORY

Version	Date	Notes	Contributors	Approver
0.1	22 Sept. 2023	Initial version	Various	Andy Ross
0.2	5. Feb. 2024	Update BT standard to 5.4	Andrew Chen	Andy Ross

CONTENTS

1	Scope	5
2	Introduction.....	5
2.1	General Description.....	5
2.2	Sona MT320 Series Features Summary	6
2.3	SPECIFICATIONS	7
3	WLAN Functional Description.....	13
3.1	Overview	13
4	Bluetooth Functional Description	15
5	Block Diagrams	16
5.1	M.2 1420	16
5.2	M.2 2230 E-Key	16
6	Electrical Characteristics	17
6.1	Absolute Maximum Ratings.....	17
6.2	Recommended Operating Conditions	17
6.3	DC Electrical Characteristics.....	17
6.4	WLAN Radio Receiver Characteristics.....	18
6.5	WLAN Transmitter Characteristics	20
7	Bluetooth Radio Characteristics	23
8	Power-Up Sequence and Timing.....	26
8.1	Power On Sequence	26
8.2	Global Cold Reset	26
9	Pin Definitions.....	27
9.1	M.2 1420 Solder-down	27
9.2	M.2 2230 E-Key	30
10	Mechanical Specifications	32
10.1	M.2 1420	32
11	Sona MT320 Mechanical Dimension	34
11.1	M.2 2230 E-Key	36
11.2	M.2 2230 E-Key Mounting.....	36
12	RF Layout Design Guidelines.....	38
13	Application Notes.....	38
13.1	Introduction	38
13.2	Shipping and Labelling	39
13.2.1	Sona MT320 M.2 1420 Solder-Down	39
13.2.2	Sona MT320 M.2 2230 E-Key Module.....	43
13.3	Required Storage Conditions	45
13.3.1	Prior to Opening the Dry Packing	45

13.3.2	After Opening the Dry Packing	45
13.3.3	Temporary Storage Requirements after Opening.....	46
13.4	Baking Conditions	46
14	Surface Mount Conditions	47
14.1	Recommended Stencil Aperture	47
14.2	Soldering	48
14.2.1	Cautions When Removing the M.2 1420 from the Platform for RMA	49
14.2.2	Precautions for Use	49
15	Reliability Test	50
15.1	Environmental and Mechanical	50
15.2	Reliability Prediction	51
16	Regulatory	54
16.1	FCC Regulatory	54
16.2	Industry Canada Regulatory.....	57
16.3	Certified Antennas.....	60
17	Bluetooth SIG Qualification	61
17.1	Overview	61
17.2	Qualification Steps When Referencing a Laird Connectivity Controller Subsystem Design	61
18	Additional Information.....	62

1 SCOPE

This document describes key hardware aspects of the Laird Connectivity Sona™ MT320 series wireless modules providing SDIO 3.0 interface for WLAN connection and 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 Mediatek MT7921LSN data sheet issued on September 07, 2021, along with other documents provided by Mediatek.

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

2 INTRODUCTION

2.1 General Description

The Sona MT320 series wireless module is an integrated, small form factor 802.11 a/b/g/n/ac/ax dual-band Wi-Fi and a Bluetooth v5.3 system in SDIO 3.0 interface. Sona MT320 integrates MediaTek MT7921LSN SoC with a 32-bit RISC MCU that handles Wi-fi and Bluetooth protocols that provide easy to use for platform integration.

There are two physical sizes for Laird Sona MT320 M.2 module. One (M.2 2230) is following the standard M.2 2230, the other one (M.2 1420) is footprint compatible to the standard M.2 1216 but **with module PCB size extended to 14X20mm.**

This device is pre-calibrated and integrates the complete transmit/receive RF paths including bandpass filter, diplexer, switches, reference crystal oscillator, and power management units (PMU). Both variants support two RF output ports, one (ANT0) for WLAN only and the other (ANT1) is shared between WLAN and Bluetooth.

The M.2 1420 solder down module also supports an RF trace pin option for use with external antenna solutions. For a list of certified antennas see [Certified Antennas](#) in the datasheet.

The Sona MT320 series device supports IEEE 802.11ax 2x2 MIMO with data rates up to MCS11. The device's low power consumption, radio architecture and power management unit (PMU) proprietary power save technologies allow for extended battery life.

The Sona MT320 series wireless modules include three product SKUs which have different RF paths. Please contact Laird Connectivity Sales/FAE for further information. Ordering information is listed in [Table 1](#).

Table 1: Product ordering information

Part Number	Product Description
453-00176R	Module, Sona MT320, M.2 1420, MHF4
453-00177R	Module, Sona MT320, M.2 1420, Trace Pin
453-00178	Module, Sona MT320, M.2 2230, Key E, SDIO

2.2 Sona MT320 Series Features Summary

The Laird Connectivity Sona MT320 series device features are described in [Table 2](#).

Table 2: Sona MT320 series wireless module features

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 dual band (2.4/5 GHz) - Supports 20/40/80 MHz channel bandwidth. - Supports 2x2 MIMO, one antenna dedicates for WLAN, the other is shared with BT.
The <i>Bluetooth</i> ® word mark and logos are registered trademarks owned by Bluetooth SIG, Inc. Any use of such marks by Laird Connectivity is under license. Other trademarks and trade names are those of their respective owners.	
Power Management	Two buck regulator, multiple LDO regulators, and a power management unit (PMU) are integrated into the MT7921LSN. 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
Host Interface	SDIO 3.0 for WLAN and BT.
Advanced WLAN	- IEEE 802.11a/b/g/n/ac/ax compliant, dual-band capable (2.4/5 GHz) 2x2 MIMO, supports 20, 40, and 80 MHz channels with optional SGI (1024-QAM modulation) - DFS radar detection. - On-chip power amplifiers and low-noise amplifiers for both bands. - Security support for WFA WPA/WPA2/WPA3 personal, WPS2.0, WAPI
Advanced Bluetooth	- Bluetooth 5.3 (BDR + EDR + Bluetooth LE) - Bluetooth Class 1 or Class 2 transmitter operation - Support data rate: 1 Mbps (GFSK), 2 Mbps ($\pi/4$-DQPSK), 3 Mbps (8-DPSK), LE-1 Mbps, LE-2 Mbps - Fully functional Bluetooth baseband: AFH, forward error correction, header error control, access code correlation, CRC, whitening. - Single-ended, RF port with integrated Balun and T/R switch, Integrated high efficiency PA and TSSI

2.3 SPECIFICATIONS

Table 3: Specifications

Feature	Description
Physical Interface	M.2 2230 E-Key standard form factor M.2 1420 108-pin LGA package (including 8 thermal ground pads under the package)
Wi-Fi/BT Interface	Secure Digital I/O 2.0/3.0
Main Chipset	Mediatek MT7921LSN
Input Voltage Requirements	Typical DC 3.3 V, operating range from DC 3.13V to 3.6V
I/O Signalling Voltage	Compliant with M.2 standard Typical DC 1.8 V ± 10%
Operating Temperature	-40° to +85°C (-40° to +185°F) Note:
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 4KV; Air coupled 8KV (follows EN61000-4-2)
Size	M.2 1420 - Length: 20 mm - Width: 14 mm - Thickness: 2.42 mm M.2 E-Key - Length: 30 mm - Width: 22 mm - Thickness: 2.3 mm
Weight – g (oz.)	M.2 1420 ~1.0 M.2 E-Key 2.5
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)
Network Architecture Types	Infrastructure (client operation)
Wi-Fi Standards	IEEE 802.11ax, 11ac, 11a/b/g/n, 11d/h, 11i, 11r, 11w, 11e, 11k, 11j, 11v
Bluetooth Standards	Bluetooth 2.1 + EDR, 3.0, 4.2, 5.0, 5.1, 5.2, 5.3
Wi-Fi Data Rates Supported	Support 802.11 ax/ac/a/b/g/n 2x2 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/HT40, MCS0-15)

Feature	Description
	802.11ac (OFDM, VHT20, MCS0-8; OFDM, VHT40/HT80, MCS0-9)
	802.11ax (2.4 GHz / OFDM / HE20 / MCS0-11; 2.4 GHz / OFDMA / HE20 / MCS0-11)
	802.11ax (5 GHz / OFDM / HE20, HE40, HE80 / MCS0-11; 5 GHz / OFDMA / HE20, HE40, HE80 / MCS0-11)

Modulation Table

BPSK, QPSK, CCK, 16-QAM, 64-QAM, 256-QAM, 1024-QAM

Modulation Type					OFDM (IEEE 802.11n/ac)										OFDM (IEEE 802.11ax)																				
					20MHz		40MHz		80MHz		20MHz		40MHz		80MHz																				
HT	MCS Index	VHT	HE	Spatial Stream	Modulation	Coding	0.8us GI	0.4us GI	0.8us GI	0.4us GI	0.8us GI	0.4us 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	0.8us 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	0	0	1	1	BPSK	1/2	6.5	7.2	13.5	15	29.3	32.5	8.6	8.1	7.3	17.2	16.3	14.6	36	34	30.6	34	30.6	34	30.6	34	30.6	34	30.6	34	30.6	34	30.6	34	30.6
1	1	1	1	1	QPSK	1/2	13	14.4	27	30	58.5	65	17.2	16.3	14.6	34.4	32.5	29.3	72.1	68.1	61.3	72.1	68.1	61.3	72.1	68.1	61.3	72.1	68.1	61.3	72.1	68.1	61.3	72.1	68.1
2	2	2	1	1	QPSK	3/4	19.5	21.7	40.5	45	87.8	97.5	25.8	24.4	21.9	51.6	48.8	43.9	108.1	102.1	91.9	108.1	102.1	91.9	108.1	102.1	91.9	108.1	102.1	91.9	108.1	102.1	91.9	108.1	102.1
3	3	3	3	1	16-QAM	1/2	26	28.9	54	60	117	130	34.4	32.5	29.3	68.8	65	58.5	144.1	136.1	122.5	144.1	136.1	122.5	144.1	136.1	122.5	144.1	136.1	122.5	144.1	136.1	122.5	144.1	136.1
4	4	4	4	1	16-QAM	3/4	39	43.3	81	90	175.5	195	51.6	48.8	43.9	103.2	97.5	87.8	216.2	204.2	183.8	216.2	204.2	183.8	216.2	204.2	183.8	216.2	204.2	183.8	216.2	204.2	183.8	216.2	204.2
5	5	5	5	1	64-QAM	2/3	52	57.8	108	120	234	260	68.8	65	58.5	137.6	130	117	288.2	272.2	245	288.2	272.2	245	288.2	272.2	245	288.2	272.2	245	288.2	272.2	245	288.2	272.2
6	6	6	6	1	64-QAM	3/4	58.5	65	121.5	135	263.3	292.5	77.4	73.1	65.8	154.9	146.3	131.6	324.3	306.3	275	324.3	306.3	275	324.3	306.3	275	324.3	306.3	275	324.3	306.3	275	324.3	306.3
7	7	7	7	1	64-QAM	5/6	65	72.2	135	150	292.5	325	86	81.3	73.1	172.1	162.5	146.3	360.3	340.3	306.3	360.3	340.3	306.3	360.3	340.3	306.3	360.3	340.3	306.3	360.3	340.3	306.3	360.3	340.3
	8	8	8	1	256-QAM	3/4	78	86.7	162	180	351	390	103.2	97.5	87.8	206.5	195	175.5	432.4	408.3	367.5	432.4	408.3	367.5	432.4	408.3	367.5	432.4	408.3	367.5	432.4	408.3	367.5	432.4	408.3
	9	9	9	1	256-QAM	5/6	N/A	N/A	180	200	390	433.3	114.7	108.3	97.5	229.4	216.7	195	480.4	459.4	408.3	480.4	459.4	408.3	480.4	459.4	408.3	480.4	459.4	408.3	480.4	459.4	408.3	480.4	459.4
		10	10	1	1024-QAM	3/4	N/A	N/A	200	220	433.3	480	129	121.9	109.7	258.1	243.8	219.4	540.4	510.4	459.4	540.4	510.4	459.4	540.4	510.4	459.4	540.4	510.4	459.4	540.4	510.4	459.4	540.4	510.4
		11	11	1	1024-QAM	5/6	N/A	N/A	220	240	480	520	143.4	135.4	121.9	288.2	270.8	243.8	600.5	567.1	510.4	600.5	567.1	510.4	600.5	567.1	510.4	600.5	567.1	510.4	600.5	567.1	510.4	600.5	567.1
8	0	0	2	2	BPSK	1/2	13	14.4	27	30	58.5	65	17.2	16.3	14.6	34.4	32.5	29.3	72.1	68.1	61.3	72.1	68.1	61.3	72.1	68.1	61.3	72.1	68.1	61.3	72.1	68.1	61.3	72.1	68.1
9	1	1	2	2	QPSK	1/2	26	28.9	54	60	117	130	34.4	32.5	29.3	68.8	65	58.5	144.1	136.1	122.5	144.1	136.1	122.5	144.1	136.1	122.5	144.1	136.1	122.5	144.1	136.1	122.5	144.1	136.1
10	2	2	2	2	QPSK	3/4	39	43.3	81	90	175.5	195	51.6	48.8	43.9	103.2	97.5	87.8	216.2	204.2	183.8	216.2	204.2	183.8	216.2	204.2	183.8	216.2	204.2	183.8	216.2	204.2	183.8	216.2	204.2
11	3	3	3	2	16-QAM	1/2	52	57.8	108	120	234	260	68.8	65	58.5	137.6	130	117	288.2	272.2	245	288.2	272.2	245	288.2	272.2	245	288.2	272.2	245	288.2	272.2	245	288.2	272.2
12	4	4	4	2	16-QAM	3/4	78	86.7	162	180	351	390	103.2	97.5	87.8	206.5	195	175.5	432.4	408.3	367.5	432.4	408.3	367.5	432.4	408.3	367.5	432.4	408.3	367.5	432.4	408.3	367.5	432.4	408.3
13	5	5	5	2	64-QAM	2/3	104	115.6	216	240	468	520	137.6	130	117	275.3	260	234	576.5	544.4	490	576.5	544.4	490	576.5	544.4	490	576.5	544.4	490	576.5	544.4	490	576.5	544.4
14	6	6	6	2	64-QAM	3/4	117	130	243	270	520.5	585	154.9	146.3	131.6	309.7	292.5	263.3	648.5	612.5	551.3	648.5	612.5	551.3	648.5	612.5	551.3	648.5	612.5	551.3	648.5	612.5	551.3	648.5	612.5
15	7	7	7	2	64-QAM	5/6	130	144.4	270	300	585	650	172.1	162.5	146.3	344.1	325	292.5	720.6	680.6	612.5	720.6	680.6	612.5	720.6	680.6	612.5	720.6	680.6	612.5	720.6	680.6	612.5	720.6	680.6
	8	8	8	2	256-QAM	3/4	156	173.3	324	360	702	780	206.5	195	175.5	412.9	390	351	864.7	816.7	735	864.7	816.7	735	864.7	816.7	735	864.7	816.7	735	864.7	816.7	735	864.7	816.7
	9	9	9	2	256-QAM	5/6	N/A	N/A	360	400	780	866.7	229.4	216.7	195	458.8	433.3	390	960.0	907.4	816.7	960.0	907.4	816.7	960.0	907.4	816.7	960.0	907.4	816.7	960.0	907.4	816.7	960.0	907.4
		10	10	2	1024-QAM	3/4	N/A	N/A	400	440	866.7	960	258.1	243.8	219.4	516.2	487.5	438.8	1080.9	1020.8	918.8	1080.9	1020.8	918.8	1080.9	1020.8	918.8	1080.9	1020.8	918.8	1080.9	1020.8	918.8	1080.9	1020.8
		11	11	2	1024-QAM	5/6	N/A	N/A	440	480	960	1066.7	288.8	270.8	243.8	575.5	541.7	487.5	1201	1134.3	1020.8	1201	1134.3	1020.8	1201	1134.3	1020.8	1201	1134.3	1020.8	1201	1134.3	1020.8	1201	1134.3

MCS Index		Spatial Stream		Modulation		Coding		OFDMA (IEEE 802.11ax)																	
								26-tone RU			52-tone RU			106-tone RU			242-tone RU			484-tone RU			996-tone RU		
HE								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	0.8us GI	1.6us GI	3.2us GI	0.8us GI	1.6us GI	3.2us GI
0	1	1	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	17.2	16.3	14.6	36	34	30.6		
1	1	1	1	QPSK	1/2	1.6	1.7	1.5	3.5	3.3	3	7.5	7.1	6.4	17.2	16.3	14.6	34.4	32.5	29.3	72.1	68.1	61.3		
2	1	1	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	51.6	48.8	43.9	108.1	102.1	91.9		
3	1	1	1	16-QAM	1/2	3.5	3.5	3	7.1	6.7	6	15	14.2	12.8	34.4	32.5	29.3	68.8	65	58.5	144.1	136.1	122.5		
4	1	1	1	16-QAM	3/4	5.3	5.3	4.5	10.6	10	9	22.5	21.3	19.1	51.6	48.8	43.9	103.2	97.5	87.8	216.2	204.2	183.8		
5	1	1	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	137.6	130	117	288.2	272.2	245		
6	1	1	1	64-QAM	3/4	7.9	7.5	6.8	15.9	15	13.5	33.8	31.9	29.7	77.4	73.1	65.8	154.9	146.3	131.6	324.3	306.3	275.6		
7	1	1	1	64-QAM	5/6	8.6	8.3	7.5	17.6	16.7	15	37.5	35.4	31.9	86	81.3	73.1	172.1	162.5	146.3	360.3	340.3	306.3		
8	1	1	1	256-QAM	3/4	10.5	10	9	21.2	20	18	45	42.5	39.3	103.2	97.5	87.8	206.5	195	175.5	432.4	408.3	367.5		
9	1	1	1	256-QAM	5/6	11.8	11.1	10	35	22.2	20	50	47.2	42.5	114.7	108.3	97.5	229.4	216.7	195	480.4	459.4	408.3		
10	1	1	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	258.1	243.8	219.4	540.4	510.4	459.4		
11	1	1	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	288.2	270.8	243.8	600.5	567.1	510.4		
0	2	2	2	BPSK	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	34.4	32.5	29.3	72.1	68.1	61.3		
1	2	2	2	QPSK	1/2	3.5	3.3	3	7.1	6.7	6	15	14.2	12.8	34.4	32.5	29.3	68.8	65	58.5	144.1	136.1	122.5		
2	2	2	2	QPSK	3/4	5.3	5.3	4.5	10.6	10	9	22.5	21.3	19.1	51.6	48.8	43.9	103.2	97.5	87.8	216.2	204.2	183.8		
3	2	2	2	16-QAM	1/2	7.1	6.7	6	14.1	13.3	12	30	28.3	25.5	68.8	65	58.5	137.6	130	117	288.2	272.2	245		
4	2	2	2	16-QAM	3/4	10.6	10	9	21.2	20	18	45	42.5	39.3	103.2	97.5	87.8	206.5	195	175.5	432.4	408.3	367.5		
5	2	2	2	64-QAM	2/3	14.1	13.3	12	28.2	26.7	24	60	56.7	51	137.6	130	117	275.3	260	234	576.5	544.4	490		
6	2	2	2	64-QAM	3/4	15.9	15	13.5	31.8	30	27	67.5	63.8	57.4	154.9	146.3	131.6	309.7	292.5	263.3	648.5	612.5	551.3		
7	2	2	2	64-QAM																					

802.11ax/ac/n Spatial Streams	2 (2x2 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 (RCM): To be added in the feature. Japan (MIC): To be added in the feature.

Feature	Description
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
2.4 GHz Operating Channels (Wi-Fi)	EU: 13 (3 non-overlapping) FCC/ISED: 11 (3 non-overlapping) UKCA: 13 (3 non-overlapping) MIC: 13 (4 non-overlapping) RCM: 13 (3 non-overlapping)
5 GHz Frequency Bands	EU 5.15 GHz to 5.35 GHz (Ch 36/40/44/48/52/56/60/64) 5.47 GHz to 5.725 GHz (Ch 100/104/108/112/116/120/124/128/132/136/140) 5.725 GHz to 5.85 GHz (Ch 149/153/157/161/165) FCC 5.15 GHz to 5.35 GHz (Ch 36/40/44/48/52/56/60/64) 5.47 GHz to 5.725 GHz (Ch 100/104/108/112/116/120/124/128/132/136/140/144) 5.725 GHz to 5.85 GHz (Ch 149/153/157/161/165) ISED 5.15 GHz to 5.35 GHz (Ch 36/40/44/48/52/56/60/64) 5.47 GHz to 5.725 GHz (Ch 100/104/108/112/116/132/136/140/144) 5.725 GHz to 5.85 GHz (Ch 149/153/157/161/165) UKCA 5.15 GHz to 5.35 GHz (Ch 36/40/44/48/52/56/60/64) 5.47 GHz to 5.730 GHz (Ch 100/104/108/112/116/120/124/128/132/136/140/144) 5.725 GHz to 5.850 GHz (Ch 149/153/157/161/165) MIC 5.15 GHz to 5.35 GHz (Ch 36/40/44/48/52/56/60/64) 5.47 GHz to 5.725 GHz (Ch 100/104/108/112/116/120/124/128/132/136/140) RCM 5.15 GHz to 5.35 GHz (Ch 36/40/44/48/52/56/60/64) 5.47 GHz to 5.725 GHz (Ch 100/104/108/112/116/132/136/140) 5.725 GHz to 5.85 GHz (Ch 149/153/157/161/165)
5 GHz Operating Channels (Wi-Fi)	EU: 24 non-overlapping; FCC: 25 non-overlapping ISED: 22 non-overlapping; MIC: 19 non-overlapping RCM: 21 non-overlapping; UKCA: 25 non-overlapping
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>	802.11a 6 Mbps 16.5 dBm (44.66mW) 54 Mbps 16 dBm (39.81mW) 802.11b 1 Mbps 17 dBm (50.11 mW) 11 Mbps 17 dBm (50.11mW) 802.11g 6 Mbps 16.5 dBm (44.66 mW) 54 Mbps 16 dBm (39.81 mW) 802.11n (2.4 GHz) HT20; MCS0-4, MCS8-12 16 dBm (39.81 mW) HT20; MCS5-7, MCS13-15 15 dBm (31.62 mW)
Note: HT20/VHT20/HE20 – 20 MHz-wide channels	

Feature	Description
HT40/VHT40/HE40 – 40 MHz-wide channels	802.11ax (2.4 GHz)
	HE20; MCS0-4 16 dBm (39.81 mW)
HT80/VHT80/HE80 – 80 MHz-wide channels	HE20; MCS5-7 15 dBm (31.62 mW)
	HE20; MCS8-9 14 dBm (25.12 mW)
	HE20; MCS10-11 14 dBm (25.12 mW)
	802.11n (5 GHz)
	HT20; MCS0-4, MCS8-12 16.5 dBm (44.66 mW)
	HT20; MCS5-7, MCS13-15 16 dBm (39.81 mW)
	HT40; MCS0-4, MCS8-12 16 dBm (39.81 mW)
	HT40; MCS5-7, MCS13-15 16 dBm (39.81 mW)
	802.11ac (5 GHz)
	VHT20; MCS0-4 16.5 dBm (44.66 mW)
	VHT20; MCS5-7 16 dBm (39.81 mW)
	VHT20; MCS8 14 dBm (25.12mW)
	VHT40; MCS0-4 16 dBm (39.81 mW)
	VHT40; MCS5-7 15 dBm (31.62 mW)
	VHT40; MCS8-9 14 dBm (25.12 mW)
	VHT80; MCS0-4 16 dBm (39.81 mW)
	VHT80; MCS5-7 15 dBm (31.62 mW)
	VHT80; MCS8-9 14 dBm (25.12 mW)
	802.11ax (5 GHz)
	HE20; MCS0-4 16.5 dBm (44.66 mW)
	HE20; MCS5-7 16 dBm (39.81 mW)
	HE20; MCS8-9 14 dBm (25.12 mW)
	HE20; MC10-11 13 dBm (19.95 mW)
	HE40; MCS0-4 16 dBm (39.81 mW)
	HE40; MCS5-7 15 dBm (31.62 mW)
	HE40; MCS8-9 14 dBm (25.12 mW)
	HE40; MC10-11 12 dBm (15.85mW)
	HE80; MCS0-4 16 dBm (39.81 mW)
	HE80; MCS5-7 15 dBm (31.62 mW)
	HE80; MCS8-9 14 dBm (15.85 mW)
	HE80; MCS10-11 12 dBm (12.59 mW)
	Bluetooth
	1 Mbps (1DH1 3, 5) 7 dBm (5 mW), Maximum
	2 Mbps (2DH1, 3, 5) 7dBm (5 mW), Maximum
	3 Mbps (3DH1, 3, 5) 7dBm (5 mW), Maximum
	LE (1 Mbps, 2 Mbps) 7 dBm (5 mW), Maximum
	LE-LR (S=2, S=8) 7 dBm (5 mW), Maximum

Feature	Description
Typical Receiver Sensitivity (PER ≤ 10%) <i>Note: All values nominal, +/- 3 dBm.</i>	802.11a: 6 Mbps -92 dBm 54 Mbps -75 dBm
	802.11b: 1 Mbps -96 dBm (PER < 8%) 11 Mbps -89 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) -74.5 dBm
	802.11ax (2.4 GHz) 7.3 Mbps (MCS0; HE20) -93 dBm 121.9 Mbps (MCS11; HE20) -63 dBm 7.3 Mbps (MCS0; HE20/RU242) -93 dBm
	802.11n (5 GHz) 6.5 Mbps (MCS0; HT20) -92 dBm 65 Mbps (MCS7; HT20) -73 dBm 13.5Mbps (MCS0; HT40) -89 dBm 135Mbps (MCS7; HT40) -70 dBm
	802.11ac (5 GHz) 6.5 Mbps (MCS0; VHT20) -92 dBm 78 Mbps (MCS8; VHT20) -69 dBm 13.5 Mbps (MCS0; VHT40) -89 dBm 180 Mbps (MCS9; VHT40) -64 dBm 29.3 Mbps (MCS0; VHT80) -86 dBm 390 Mbps (MCS9; VHT80) -61 dBm
	802.11ax (5 GHz) 7.3 Mbps (MCS0; HE20) -91 dBm 121.9 Mbps (MCS11; HE20) -62 dBm 7.3 Mbps (MCS0; HE20/RU242) -92 dBm 14.6 Mbps (MCS0; HE40) -89 dBm 243.8 Mbps (MCS11; HE40) -59 dBm 14.6 Mbps (MCS0; HE40/RU484) -89 dBm 30.6 Mbps (MCS0; HE80) -86 dBm 510.4 Mbps (MCS11; HE80) -55 dBm 30.6 Mbps (MCS0; HE80/RU996) -86 dBm
	Bluetooth: 1 Mbps (1DH5) -94 dBm 2Mbps (2DH5) -93 dBm 3 Mbps (3DH5) -88 dBm LE-1 Mbps -96 dBm LE-2 Mbps -93 dBm LE-LR (S=2) -101 dBm LE-LR (S=8) -104 dBm
Operating Systems Supported	Linux

Feature	Description	
Security	- WPA, WPA2 (Enterprise) and WPA3 (Enterprise) support for powerful encryption and authentication - AES and TKIP 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	ISED Canada
Certifications	47 CFR FCC Part 15.247	RSS-247
	47 CFR FCC Part 15.407	RSS-248
	47 CFR FCC Part 2.1091	
	AS/NZS	MIC
	AS/NZS 4268:2017	ARIB STD-T66/RCR STD-33 (2.4 GHz)
		ARIB STD-T71 (5 GHz)
Warranty	Bluetooth® SIG Qualification	
	TBD	
All specifications are subject to change without notice		

3 WLAN FUNCTIONAL DESCRIPTION

3.1 Overview

The Sona MT320 series wireless module is designed based on the MediaTek MT7921LSN SoC chipset (2x2 MIMO). It is optimized for high speed, reliability, and low-power embedded applications. It is integrated with dual-band WLAN (2.4/5 GHz) and Bluetooth 5.3. Its functionality is listed in [Table 4](#).

Table 4: WLAN functions

Feature	Description
WLAN MAC	▪ Support all data rates of 802.11a/g including 6, 9, 12, 18, 24, 36, 48, and 54 Mbps. ▪ Support short GI and all data rates of 802.11n including MCS0 to MCS7 ▪ Support 802.11ac MCS0 to MCS9 ▪ Support 802.11ax MCS0 to MCS11 ▪ AMPDU/AMSDU RX (de-aggregation) and TX (aggregation) support ▪ TX rate adaptation ▪ TX power control ▪ Security - o 64-bit WEP (WEP-40) and 128-bit WEP (WEP-104) encryption with hardware TKIP and CKIP processing - o AES-CCMP hardware processing - o GCMP hardware processing - o SMS4-WPI (WAPI) hardware processing ▪ Low power beacon filtering ▪ Management/control frame filtering
WLAN Security	▪ WLAN Encryption features supported include: – Temporal Key Integrity Protocol (TKIP)/Wired Equivalent Privacy (WEP) – Advanced Encryption Standard (AES)/Wi-Fi Multi-Media (WMM) – WLAN Authentication and Private Infrastructure (WPAI)

Feature	Description							
WLAN Channel	Channel frequency supported.							
	2.4 GHz / 20 MHz		5 GHz / 20 MHz		5 GHz / 40 MHz		5 GHz / 80 MHz	
	Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)
	1	2412	36	5180	38	5190	42	5210
	2	2417	40	5200	46	5230	58	5290
	3	2422	44	5220	54	5270	106	5530
	4	2427	48	5240	62	5310	122	5610
	5	2432	52	5260	102	5510	138	5690
	6	2437	56	5280	110	5550	155	5775
	7	2442	60	5300	118	5590		
	8	2447	64	5320	126	5630		
	9	2452	100	5500	134	5670		
	10	2457	104	5520	142	5710		
	11	2462	108	5540	151	5755		
	12	2467	112	5560	159	5795		
	13	2472	116	5580				
			120	5600				
			124	5620				
			128	5640				
			132	5660				
			136	5680				
			140	5700				
			144	5720				
			149	5745				
			153	5765				
			157	5785				
			161	5805				
			165	5825				

4 BLUETOOTH FUNCTIONAL DESCRIPTION

The Sona MT320 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: PCM/I2S - SDIO interface
Bluetooth Features	- Bluetooth 5.4 - LE 2M PHY and LE Coded PHY - LE Extended Advertising and Periodic Advertising - LE high duty cycle non-connectable ADV - Channel Selection Algorithm #2 - Angle of Arrival (AoA) and Angle of Departure (AoD) - Connected Isochronous Stream master and slave. - Isochronous Broadcaster and Synchronized Receiver - Compatible Bluetooth 4.2 - LE privacy 1.2 - LE Data Packet Length Extension - LE security connection - Single-ended, RF port with integrated Balun and T/R switch - Integrated high efficiency PA and TSSI - Baseband and radio BDR and EDR packet types: 1Mbps (GFSK), 2Mbps ($\pi/4$-DQPSK), and 3Mbps (8PSK). - Fully functional Bluetooth baseband: AFH, forward error correction, header error control, access code correlation, CRC, whitening. - Standard pairing, authentication, link key, and encryption operation. - Standard power saving mechanisms: sniff mode and sniff-subrating. - Interlaced scan for faster connection setup - Up to 7 simultaneous active ACL connections with background inquiry and page scan - Up to 16 BLE links - Scatternet support - Channel quality driven data rate control - WB RSSI support. Monitor environment air condition to select good channel for AFH

5 BLOCK DIAGRAMS

5.1 M.2 1420

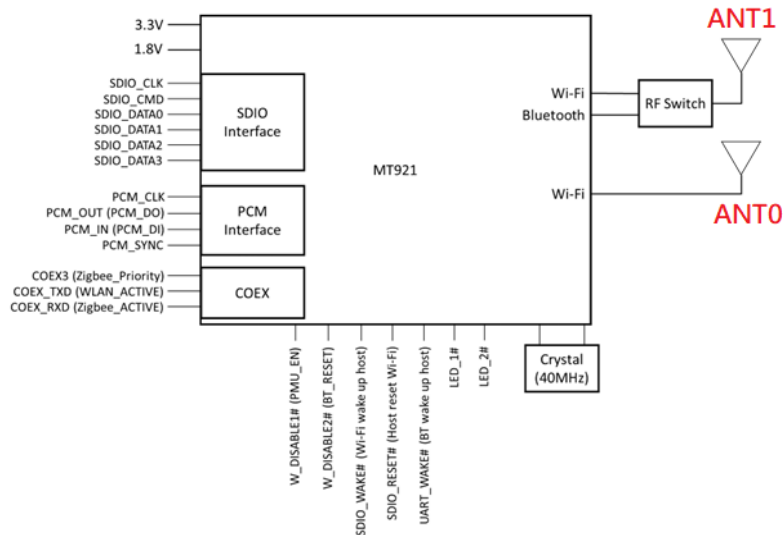


Figure 1: Block Diagram for M.2 1420 module.

5.2 M.2 2230 E-Key

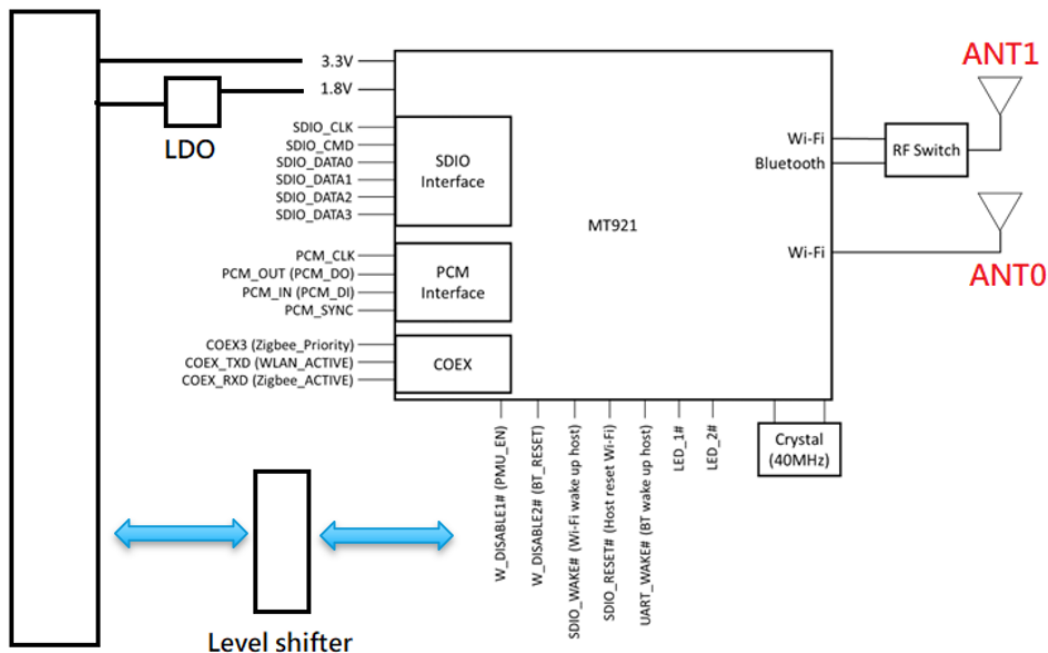


Figure 2: M.2 2230 E-Key

6 ELECTRICAL CHARACTERISTICS

6.1 Absolute Maximum Ratings

Table 6 summarizes the absolute maximum ratings and Table 7 lists the recommended operating conditions for the Sona MT320 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
3V3	External 3.3V power supply (M.2 2230 E-Key)	-0.3 to 3.63	V
VIO_1.8V	DC supply voltage for digital I/O (M.2 1318)	-0.3 to 1.98	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

6.2 Recommended Operating Conditions

Table 7: Recommended operating conditions

Symbol (Domain)	Parameter	Min	Typ	Max	Unit
3.3V	External DC power supply	3.13	3.30	3.6	V
VIO_1.8V	DC supply voltage for digital I/O	1.71	1.8	1.89	V
T-ambient	Ambient temperature	-40	25	+85	°C

6.3 DC Electrical Characteristics

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

Table 8: General DC electrical characteristics (For VIO_1.8V=1.8V operation)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
VIH	High Level Input Voltage	—	1.27	—	VIO_1.8V+0.3	V
VIL	Low Level Input Voltage	—	-0.3	—	0.58	V
VOH	Output high Voltage	—	1.4	—	VIO_1.8V+0.3	V
VOL	Output low Voltage	—	-0.3	—	0.45	V

6.4 WLAN Radio Receiver Characteristics

Table 9, Table 10, and Table 11 summarize the Sona MT320 series wireless module receiver characteristics.

Table 9: WLAN receiver characteristics for 2.4 GHz operation

Item	Parameter	Conditions	Min	Typ	Max	Unit
Frequency Range	Receive input frequency range	—	2.412	—	2.484	GHz
Modulation Type	Sensitivity	See Note ¹	—	—	—	dBm
	CCK, 1 Mbps		—	-96	—	
	CCK, 11 Mbps		—	-89	—	
	OFDM, 6 Mbps		—	-93	—	
	OFDM, 54 Mbps		—	-76	—	
	HT20, MCS0		—	-93	—	
	HT20, MCS7		—	-74	—	
	HE20, MCS0		—	-93	—	
	HE20, MCS11		—	-63	—	
Receive Adjacent channel rejection.	OFDM, 6 Mbps	See Note ¹	—	41	—	dB
	OFDM, 54 Mbps		—	25	—	
Receive Adjacent channel rejection. (HT20)	HT20, MCS0		—	36	—	
	HT20, MCS7		—	13	—	
Receive Adjacent channel rejection. (HT40)	HE20, MCS0		—	27	—	
	HE20, MCS7		—	7	—	

Table 10: WLAN receiver characteristics for 5 GHz operation

Item	Parameter	Conditions	Min	Typ	Max	Unit
Frequency Range	Receive input frequency range	—	5.15	—	5.825	GHz
Modulation Type	Sensitivity	See Note ¹	—	—	—	dBm
	OFDM, 6 Mbps		—	-92	—	
	OFDM, 54 Mbps		—	-75	—	
	HT20, MCS0		—	-92	—	
	HT20, MCS7		—	-73	—	
	HT40, MCS0		—	-89	—	
	HT40, MCS7		—	-70	—	
	VHT20, MCS0		—	-92	—	
	VHT20, MCS8		—	-69	—	
	VHT40, MCS0		—	-89	—	
	VHT40, MCS9		—	-64	—	
	VHT80, MCS0		—	-86	—	
	VHT80, MCS9		—	-61	—	
	HE20, MCS0		—	-91	—	
	HE20, MCS11		—	-62	—	
	HE40, MCS0		—	-89	—	
	HE40, MCS11		—	-59	—	
	HE80, MCS0		—	-86	—	
	HE80, MCS11		—	-55	—	

Item	Parameter	Conditions	Min	Typ	Max	Unit
Adjacent channel rejection (VHT20)	MCS0	See Note ¹	—	27	—	dB
	MCS8		—	0	—	
Adjacent channel rejection (VHT40)	MCS0	See Note ¹	—	27	—	dB
	MCS9		—	0	—	
Adjacent channel rejection (VHT80)	MCS0	See Note ¹	—	31	—	dB
	MCS9		—	12	—	

Note 1: Receiver sensitivity is measured at antenna port with 3.3V voltage within +/-5% of the typical values.

6.5 WLAN Transmitter Characteristics

Table 12 through Table 21 summarize the Sona MT320 series wireless module transmitter characteristics.

Table 11: WLAN transmitter characteristics for 2.4 GHz operation (3.3V, VIO_1.8V = 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	—	17	—	dBm
	11g mask compliant	6-24Mbps	—	16.5	—	
	11g mask compliant	36-48Mbps	—	16.5	—	
	11g EVM compliant	54Mbps	—	16	—	
	11n HT20 mask compliant	MCS0-4	—	16	—	
	11n HT20 mask compliant	MCS5-6	—	15	—	
	11n HT20 EVM compliant	MCS7	—	15	—	
	11ax HE20 mask compliant	MCS0-4	—	16	—	
	11ax HE20 mask compliant	MCS5-6	—	15	—	
	11ax HE20 EVM compliant	MCS7	—	15	—	
	11ax HE20 EVM compliant	MCS8	—	14	—	
	11ax HE20 EVM compliant	MCS9	—	14	—	
	11ax HE20 EVM compliant	MCS10-11	—	14	—	
ATx	Transmit power accuracy at 25 °C	—	-2.0	—	+2.0	dB

Table 12: WLAN current consumption on 2.4 GHz (3.3V, VIO_1.8V = 1.8V)

Modulation	Data Rate	Spatial Stream	Output Power (dBm)	3.3V Current Consumption (mA)	VIO_1.8V Current Consumption (mA)
CCK	1 Mbps	2	19.64	426	<1
BPSK	6 Mbps	2	19.75	430	<1
64-QAM	HT20 MCS7	2	19.53	346	<1
64-QAM	HT20 MCS15	2	19.51	282	<1
256-QAM	HE20 MCS9	2	19.75	356	<1
1024-QAM	HE20 MCS11	2	18.99	234	<1

Table 13: WLAN transmitter characteristics for 5 GHz operation (3.3V, VIO_1.8V = 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	6-48Mbps	—	16.5	—	dBm
	11a EVM compliant	54Mbps	—	16	—	
	11n HT20 mask compliant	MCS0-5	—	16.5	—	
	11n HT20 EVM compliant	MCS6-7	—	16	—	
	11n HT40 mask compliant	MCS0-5	—	16	—	
	11n HT40 EVM compliant	MCS6-7	—	16	—	
	11ac VHT20 mask compliant	MCS0-5	—	16.5	—	
	11ac VHT20 EVM compliant	MCS6-7	—	16	—	
	11ac VHT20 EVM compliant	MCS8	—	14	—	
	11ac VHT40 mask compliant	MCS0-5	—	16	—	
	11ac VHT40 EVM compliant	MCS6-7	—	15	—	
	11ac VHT40 EVM compliant	MCS8-9	—	14	—	
	11ac VHT80 mask compliant	MCS0-5	—	16	—	
	11ac VHT80 EVM compliant	MCS6-7	—	15	—	
	11ac VHT80 EVM compliant	MCS8-9	—	14	—	
	11ax HE20 mask compliant	MCS0-5	—	16.5	—	
	11ax HE20 EVM compliant	MCS6-7	—	16	—	
	11ax HE20 EVM compliant	MCS8-9	—	14	—	
	11ax HE20 EVM compliant	MCS10-11	—	13	—	
	11ax HE40 mask compliant	MCS0-5	—	16	—	
	11ax HE40 EVM compliant	MCS6-7	—	15	—	
	11ax HE40 EVM compliant	MCS8-9	—	14	—	
	11ax HE40 EVM compliant	MCS10-11	—	12	—	
	11ax HE80 mask compliant	MCS0-5	—	16	—	
	11ax HE80 EVM compliant	MCS6-7	—	15	—	
	11ax HE80 EVM compliant	MCS8-9	—	14	—	
	11ax HE80 EVM compliant	MCS10-11	—	12	—	
ATx	Transmit power accuracy at 25 °C	—	-2.0	—	+2.0	dB

Table 14: WLAN current consumption on 5 GHz (3.3V, VIO_1.8V = 1.8V)

Modulation	Bandwidth (MHz)	Data Rate	Spatial Stream	Output Power (dBm)	3.3V Current Consumption (mA)	VIO_1.8V Current Consumption (mA)
BPSK	20	6 Mbps	2	21.66	682	<1
64-QAM	20	54 Mbps	2	21.39	604	<1
BPSK	20	HE20 MCS0	2	20.27	642	<1
64-QAM	20	HE20 MCS7	2	21.08	608	<1
256-QAM	20	HE20 MCS9	2	20.09	632	<1
1024-QAM	20	HE20 MCS11	2	17.7	522	<1
BPSK	40	HE40 MCS0	2	21.01	790	<1
64-QAM	40	HE40 MCS7	2	21.72	450	<1
256-QAM	40	HE40 MCS9	2	20.48	390	<1
1024-QAM	40	HE40 MCS11	2	17.96	350	<1
BPSK	80	HE 80 MCS0	2	18.87	622	<1
64-QAM	80	HE 80 MCS7	2	20.02	330	<1
256-QAM	80	HE 80 MCS9	2	20.01	330	<1
1024-QAM	80	HE 80 MCS11	2	17.18	244	<1

Note 2: TX power is measured at 3.3V within 5% at antenna port. Temperature us at 25 degree C.

7 BLUETOOTH RADIO CHARACTERISTICS

Table 16 through Table 17 describe the performance of the Bluetooth transmitter and receiver and the current consumption at 25°C.

Table 15: BR / EDR transmitter performance (3.3V, VIO_1.8V = 1.8V)

Test Parameter		Min	Typ	Max	BT Spec.	Unit
Maximum RF Output Power	GFSK	—	—	7	0 ~ +20	dBm
	$\pi/4$ -DQPSK	—	—	7		
	8-DPSK	—	—	7		
Frequency Range		2.4	—	2.4835	$2.4 \leq f \leq 2.4835$	GHz
20 dB Bandwidth		—	922	—	≤ 1000	KHz
Δf_{1avg} Maximum Modulation		140	157	175	$140 < \Delta f_{1avg} < 175$	KHz
Δf_{2max} Minimum Modulation		115	145	—	≥ 115	KHz
$\Delta f_{2avg}/\Delta f_{1avg}$		—	0.98	—	≥ 0.80	—
Initial Carrier Frequency		—	± 18	± 75	$\leq \pm 75$	KHz
Frequency Drift (DH1 packet)		—	± 10	± 25	± 25	KHz
Frequency Drift (DH3 packet)		—	± 10	± 40	± 40	KHz
Frequency Drift (DH5 packet)		—	± 10	± 40	± 40	KHz
Drift rate		—	10	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		—	—	≤ 8	≤ 20	%
RMS DEVM for 8-DPSK		—	—	≤ 8	≤ 13	%
Peak DEVM for $\pi/4$ -DQPSK		—	—	≤ 15	≤ 35	%
Peak DEVM for 8-DPSK		—	—	≤ 15	≤ 25	%
99% DEVM for $\pi/4$ -DQPSK		—	—	≤ 11	—	—
99% DEVM for 8-DPSK		—	—	≤ 11	—	—
EDR In-Band Spurious Emission	$ M-N \geq 2.5$ MHz	—	-40	-40	< -40	dBm
	1.5 MHz $< M-N < 2.5$ MHz	—	-23	-20	≤ -20	dBm
	1.0 MHz $< M-N < 1.5$ MHz	—	-29	-26	≤ -26	dBm

Table 17: Basic Rate receiver performance (3.3V, VIO_1.8V = 1.8V)

Test Parameter		Min	Typ	Max	Bluetooth Spec.	Unit
Sensitivity (1DH5)	BER ≤ 0.1%	—	-94	—	≤ -70	dBm
Maximum Input	BER ≤ 0.1%	—	—	-20	≥ -20	dBm
Interference Performance	Co-Channel	—	6	11	11	dB
	C/I 1 MHz adjacent channel	—	-7	0	0	dB
	C/I 2 MHz adjacent channel	—	-40	-30	-30	dB
	C/I ≥ 3 MHz adjacent channel	—	-43	-40	-40	dB
	C/I image channel	—	-20	-9	-9	dB
	C/I 1-MHz adjacent to image channel	—	-35	-20	-20	dB
Out-of-Band Blocking Performance (CW)	30-2000MHz	—	-10	—	—	dBm
	2-2.399GHz	—	-27	—	—	dBm
	2.484-3GHz	—	-27	—	—	dBm
	3-12.75GHz	—	-10	—	—	dBm

Table 18: Enhanced Data Rate receiver performance (3.3V, VIO_1.8V = 1.8V)

Test Parameter		Min	Typ	Max	Bluetooth Spec.	Unit
Sensitivity (BER ≤ 0.01%)	π/4-DQPSK	—	-93	—	≤ -70	dBm
	8-DPSK	—	-88	—	≤ -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	—	9	13	≤ ±13	dB
	8-DPSK	—	15	21	≤ ±21	dB
C/I 1 MHz adjacent Channel	π/4-DQPSK	—	-12	0	≤ 0	dB
	8-DPSK	—	-6	5	≤ 5	dB
C/I 2 MHz adjacent Channel	π/4-DQPSK	—	-40	-30	≤ -30	dB
	8-DPSK	—	-36	-25	≤ -25	dB
C/I ≥ 3 MHz adjacent Channel	π/4-DQPSK	—	-43	-40	≤ -40	dB
	8-DPSK	—	-40	-33	≤ -33	dB
C/I image channel	π/4-DQPSK	—	-20	-7	≤ -7	dB
	8-DPSK	—	-15	0	≤ 0	dB
C/I 1 MHz adjacent to image channel	π/4-DQPSK	—	-40	-20	≤ -20	dB
	8-DPSK	—	-30	-13	≤ -13	dB

Table 19: BLE RF Specifications (3.3V, VIO_1.8V = 1.8V)

Parameter	Conditions	Min	Typ	Max	Unit
Frequency range	—	2402	—	2480	MHz
Rx sensitivity ¹	GFSK, PER ≤ 30.8%	1 Mbps	—	-96	dBm
		2 Mbps	—	-93	dBm
Tx power ²	—	—	—	7	dBm
Max. Usable Signal	BLE 1Mbps(PER < 30.8%)	-10	-	-	dBm
	BLE 2Mbps(PER < 30.8%)	-10	-	-	KHz
C/I Co-channel	BLE 1Mbps(PER < 30.8%)	-	6	21	dB
C/I 1MHz		-	-7	15	dB
C/I 2MHz		-	-30	-17	dB
C/I ≥ 3MHz		-	-33	-27	dB
C/I Image channel	BLE 2Mbps(PER < 30.8%)	-	-20	-9	dB
C/I Image 1MHz		-	-30	-15	dB
C/I Co-channel		-	9	21	dB
C/I 1MHz		-	-4	15	dB
C/I 2MHz	BLE 2Mbps(PER < 30.8%)	-	-27	-17	dB
C/I ≥ 3MHz		-	-30	-27	dB
C/I Image channel		-	-17	-9	dB
C/I Image 1MHz		-	-27	-15	dB
Out-of-band Blocking	30MHz to 2000MHz	-30	-	-	dBm
	2001MHz to 2339MHz	-35	-	-	dBm
	2501MHz to 3000MHz	-35	-	-	dBm
	3001MHz to 12.75GHz	-30	-	-	dBm

Table 160: Bluetooth transmitter current consumption (3.3V, VIO_1.8V = 1.8V)

Operation Mode	Data Rate	VBAT Current Consumption (mA)	VIO Current Consumption (mA)
Basic Data Rate	1DH5	94	<1
Enhanced Data Rate	2DH5	93.2	<1
	3DH5	92.4	<1
Low-Energy	1 Mbps	108	<1
	2 Mbps	92	<1
	500 Kbps	94	<1
	125 Kbps	93.2	<1

Notes:

[1] Dirty Tx is Off.

[2] 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.

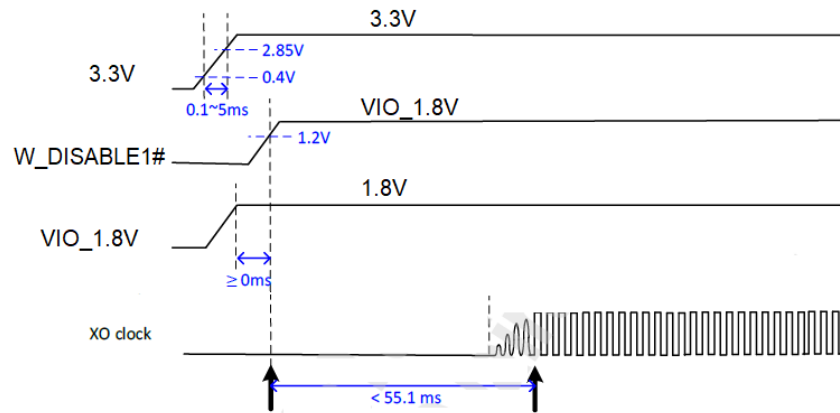
[3] At least 99.9% of all Δf₂ maximum frequency values recorded over 10 packets must be greater than 185 KHz.

8 POWER-UP SEQUENCE AND TIMING

Sona IF573 has two signals that allow the host to control power consumption by enabling or disabling the Bluetooth, WLAN, and internal regulator block.

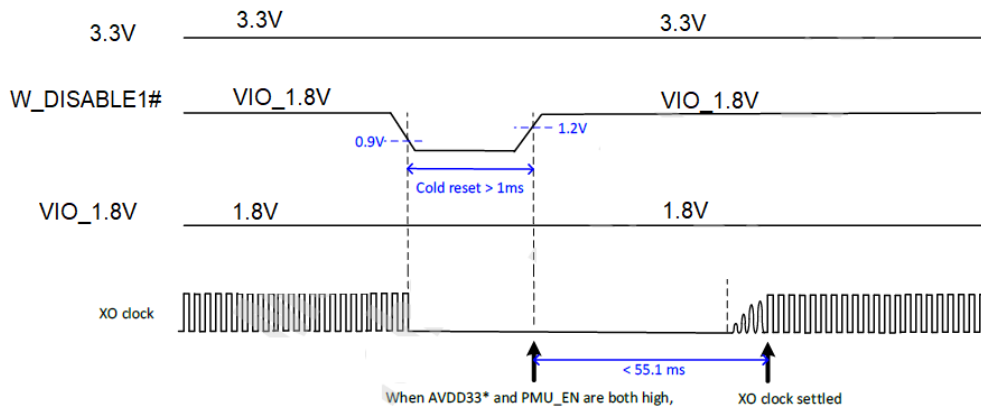
8.1 Power On Sequence

The 3.3V voltage and W_DISABLE1# are in high state, chip will start power-on sequence.



Note: Please keep the 3.3V and VIO_1.8V power at the same time.

8.2 Global Cold Reset



9 PIN DEFINITIONS

9.1 M.2 1420 Solder-down

Table 30: M.2 1420 pin definitions

Pin #	Name	Type	Voltage Ref.	Function	If Not Used
1	-	-	-	NC	NC
2	-	-	-	NC	NC
3	-	-	-	NC	NC
4	3.3V	PWR	3.3V	Power Supply Input	-
5	3.3V	PWR	3.3V	Power Supply Input	-
6	GND	-	-	Ground	GND
7	-	-	-	NC	NC
8	-	-	-	NC	NC
9	-	-	-	NC	NC
10	-	-	-	NC	NC
11	COEX_RXD	I	VIO_1.8V	3-wire coexistence for Zigbee; Zigbee_ACTIVE	NC
12	COEX_TXD	O	VIO_1.8V	3-wire coexistence for Zigbee; WLAN_ACTIVE	NC
13	COEX3	I	VIO_1.8V	3-wire coexistence for Zigbee; Zigbee_Priority	NC
14	-	-	-	NC	NC
15	-	-	-	NC	NC
16	-	-	-	NC	NC
17	GND	-	-	Ground	GND
18	-	-	-	NC	NC
19	-	-	-	NC	NC
20	GND	-	-	Ground	GND
21	-	-	-	NC	NC
22	-	-	-	NC	NC
23	GND	-	-	Ground	GND
24	-	-	-	NC	NC
25	-	-	-	NC	NC
26	GND	-	-	Ground	GND
27	-	-	-	NC	NC
28	W_DISABLE1#	I	VIO_1.8V	External 10K PU is needed for normal operation. Active low to disable the Sona MT320 module. W_DISABLE1# should be managed by an actual signal from the Host to have correct global reset. Please see detail timing on section 8.5	-
29	-	-	-	NC	NC

Pin #	Name	Type	Voltage Ref.	Function	If Not Used
30	-	-	-	NC	NC
31	-	-	-	NC	NC
32	GND	-	-	Ground	GND
33	-	-	-	NC	NC
34	-	-	-	NC	NC
35	GND	-	-	Ground	GND
36	-	-	-	NC	NC
37	-	-	-	NC	NC
38	GND	-	-	Ground	GND
39	-	-	-	NC	NC
40	-	-	-	NC	NC
41	GND	-	-	Ground	GND
42	-	-	-	NC	NC
43	-	-	-	NC	NC
44	-	-	-	NC	NC
45	SDIO_RESET#	I	VIO_1.8V	Host to reset Sona MT320 module, Active Low. External 10K PU is needed for normal operation.	10K;PU
46	SDIO_WAKE#	O	VIO_1.8V	Wi-Fi to Wake up Host; Active Low. Required pull up on the host side (recommended 15 kΩ to 100 kΩ).	NC
47	SDIO_DATA3	I/O	VIO_1.8V	SDIO Data line 3	NC
48	SDIO_DATA2	I/O	VIO_1.8V	SDIO Data line 2	NC
49	SDIO_DATA1	I/O	VIO_1.8V	SDIO Data line 1	NC
50	SDIO_DATA0	I/O	VIO_1.8V	SDIO Data line 0	NC
51	SDIO_CMD	I/O	VIO_1.8V	SDIO command line	NC
52	SDIO_CLK	I	VIO_1.8V	SDIO Clock Input	NC
53	UART_WAKE#	O	VIO_1.8V	Bluetooth to Wake up Host. Active Low. Required pull up on the host side (recommended 15 kΩ to 100 kΩ).	NC
54	-	-	-	NC	NC
55	-	-	-	NC	NC
56	-	-	-	NC	NC
57	-	-	-	NC	NC
58	PCM_SYNC	I/O	VIO_1.8V	BT_PCM Sync. In Master mode, SONA MT320 generates the BT_PCM_SYNC signal. In Slave mode, the signal is provided by another master on the PCM interface.	NC

Pin #	Name	Type	Voltage Ref.	Function	If Not Used
59	PCM_IN	I	VIO_1.8V	BT_PCM data input.	NC
60	PCM_OUT	O	VIO_1.8V	BT_PCM data output	NC
61	PCM_CLK	I/O	VIO_1.8V	BT_PCM Clock. In Master mode, SONA MT320 generates the BT_PCM_CLK signal. In Slave mode, the signal is provided by another master on the PCM interface.	NC
62	GND	-	-	Ground	GND
63	W_DISABLE2#	I	VIO_1.8V	Signal to reset the Bluetooth. Active Low. External 10K PU for normal operation.	10K;PU
64	LED_2#	O	VIO_1.8V	LED indicator.	NC
65	LED_1#	O	VIO_1.8V	LED indicator.	NC
66	VIO_1.8V	PWR	1.8V	1.8V power supply input for Sona MT320 module. Maximum current sink could up to 150mA.	-
67	-	-	-	NC	NC
68	GND	-	-	Ground	GND
69	-	-	-	NC	NC
70	-	-	-	NC	NC
71	GND	-	-	Ground	GND
72	3.3V	PWR	3.3V	Power Supply Input	-
73	3.3V	PWR	3.3V	Power Supply Input	-
74~ 75	GND	-	-	Ground	GND
76	VIO_CFG	O	-	M.2 sideband IO voltage indication output pin. This pin is NC on the module that allow host to use the 1.8V sideband signal from the module.	-
77~ 100	GND	-	-	Ground	GND
101~ 108	GND	-	-	Ground	GND
109	ANT0	-	-	WLAN RF Antenna 0 pin for SONA MT320 M.2 1420 trace pin variant, Wi-Fi only.	
110~ 112	GND	-	-	Ground	GND
113	ANT1	-	-	WLAN RF Antenna 1 pin for SONA MT320 M.2 1420 trace pin variant, Wi-Fi and BT sharing.	
114~ 116	GND	-	-	Ground	GND

9.2 M.2 2230 E-Key

Table 17: M.2 2230 E-Key pin definitions

Pin #	Name	Type	Volt. Ref.	Function	If Not Used
1	GND	-	-	Ground	GND
2	3.3V	PWR	3.3V	DC supply voltage input for module.	-
3	-	-	-	NC	NC
4	3.3V	PWR	3.3V	DC supply voltage input for module.	-
5	-	-	-	NC	NC
6	LED1#	O	3.3V	LED indicator	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 line 0	NC
14	PCM_IN	I	1.8V	PCM data input.	NC
15	SDIO_DATA1	I/O	1.8V	SDIO data line 1	NC
16	LED2#	O	3.3V	LED indicator	NC
17	SDIO_DATA2	I/O	1.8V	SDIO data line 2	NC
18	GND	-	-	Ground	GND
19	SDIO_DATA3	I/O	1.8V	SDIO data line3	NC
20	UART_WAKE#	O	3.3V	Bluetooth to Wake up Host. Active Low. Required pull up on the host side (recommended 15 kΩ to 100 kΩ).	NC
21	SDIO_WAKE#	O	1.8V	Wi-Fi to Wake up Host; Active Low. Required pull up on the host side (recommended 15 kΩ to 100 kΩ).	NC
22	-	-	-	NC	NC
23	SDIO_RESET#	I	1.8V	Host to reset Sona MT320; Active low. External 10K PU is needed for normal operation.	10K;PU
32	-	-	-	NC	NC
33	GND	-	-	Ground	GND
34	-	-	-	NC	NC
35	-	-	-	NC	NC
36	-	-	-	NC	NC
37	-	-	-	NC	NC

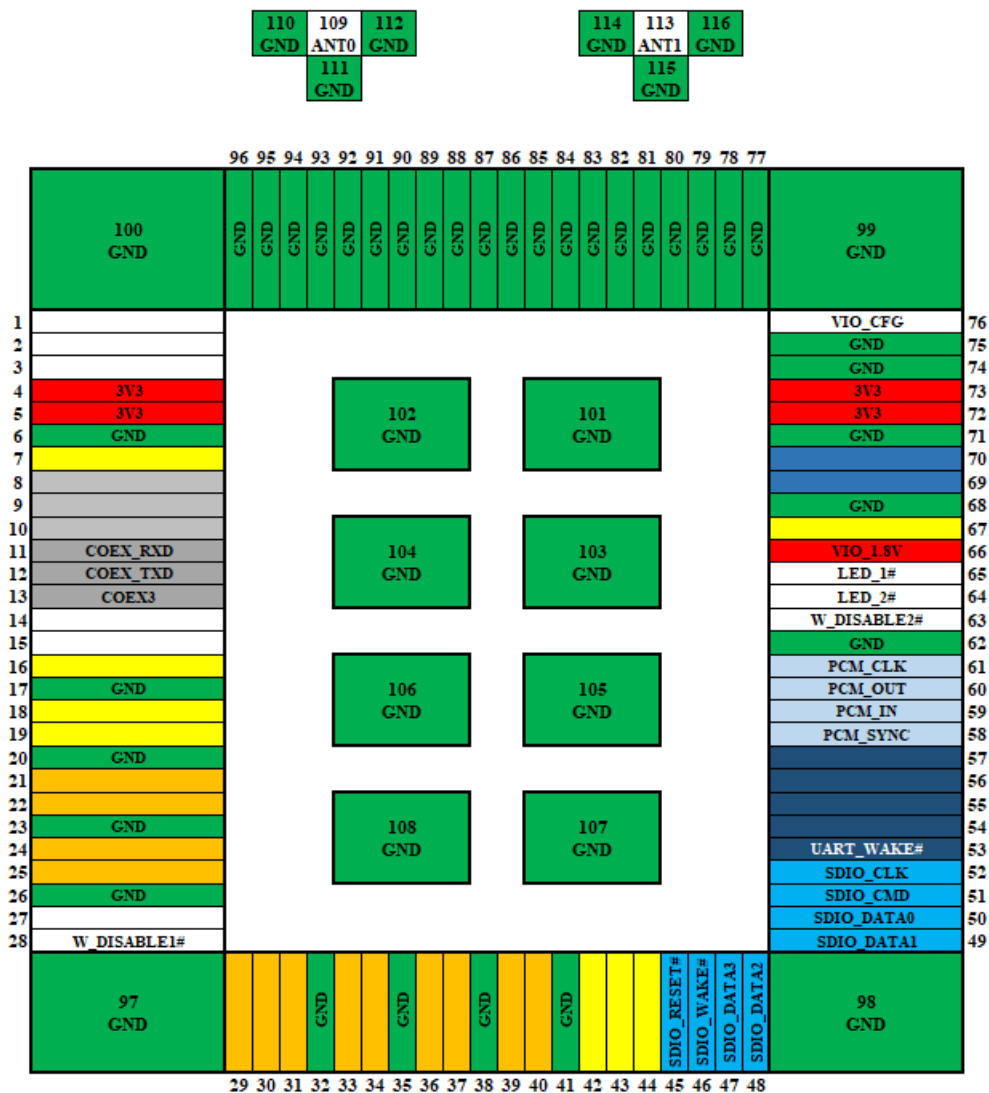
Pin #	Name	Type	Volt. Ref.	Function	If Not Used
38	-	-	-	NC	NC
39	GND	-	-	Ground	GND
40	-	-	-	NC	NC
41	-	-	-	NC	NC
42	-	-	-	NC	NC
43	-	-	-	NC	NC
44	COEX3	I	1.8V	3-wire coexistence for Zigbee; Zigbee_Priority	NC
45	GND	-	-	Ground	GND
46	COEX_TX	O	1.8V	3-wire coexistence for Zigbee; WLAN_ACTIVE	NC
47	-	-	-	NC	NC
48	COEX_RX	I	1.8V	3-wire coexistence for Zigbee; Zigbee_ACTIVE	NC
49	-	-	-	NC	NC
50	-	-	-	NC	-
51	GND	-	-	Ground	GND
52	-	-	-	NC	NC
53	-	-	-	NC	NC
54	W_DISABLE2#	I	3.3V	Signal to reset the Bluetooth. Active Low. External 10K PU is needed for normal operation.	10K;PU
55	-	-	-	NC	NC
56	W_DISABLE1#	I	3.3 V	External 10K PU is must for normal operation. Active low to disable the module. W_DISABLE1# should be managed by an actual signal from the Host to have correct global reset. Please see detail timing on section 8.5	-
57	GND	-	-	Ground	GND
58	-	-	-	NC	NC
59	-	-	-	NC	NC
60	-	-	-	NC	NC
61	-	-	-	NC	NC
62	-	-	-	NC	NC
63	GND	-	-	Ground	GND
64	VIO_1.8V	-	-	NC	NC
65	-	-	-	NC	NC
66	-	-	-	NC	NC
67	-	-	-	NC	NC
68	-	-	-	NC	NC
69	GND	-	-	Ground	GND

Pin #	Name	Type	Volt. Ref.	Function	If Not Used
70	-	-	-	NC	NC
71	-	-	-	NC	NC
72	3.3V	PWR	3.3V	DC supply voltage input for module.	-
73	-	-	-	NC	NC
74	3.3V	PWR	3.3V	DC supply voltage input for module.	-
75	GND	-	-	Ground	GND

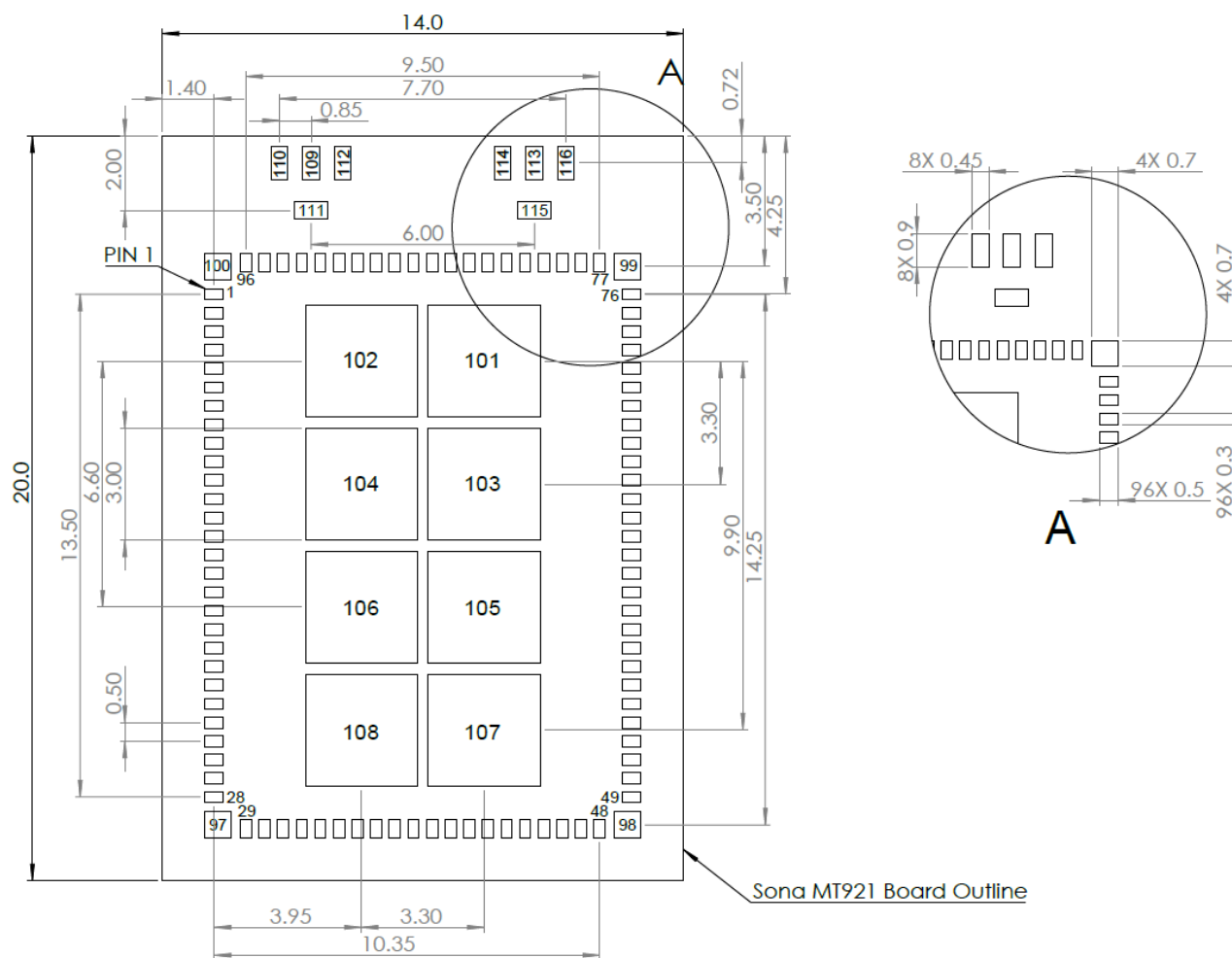
10 MECHANICAL SPECIFICATIONS

10.1 M.2 1420

Detail PCB footprint for the Sona MT320 M.2 1420 is shown in below.



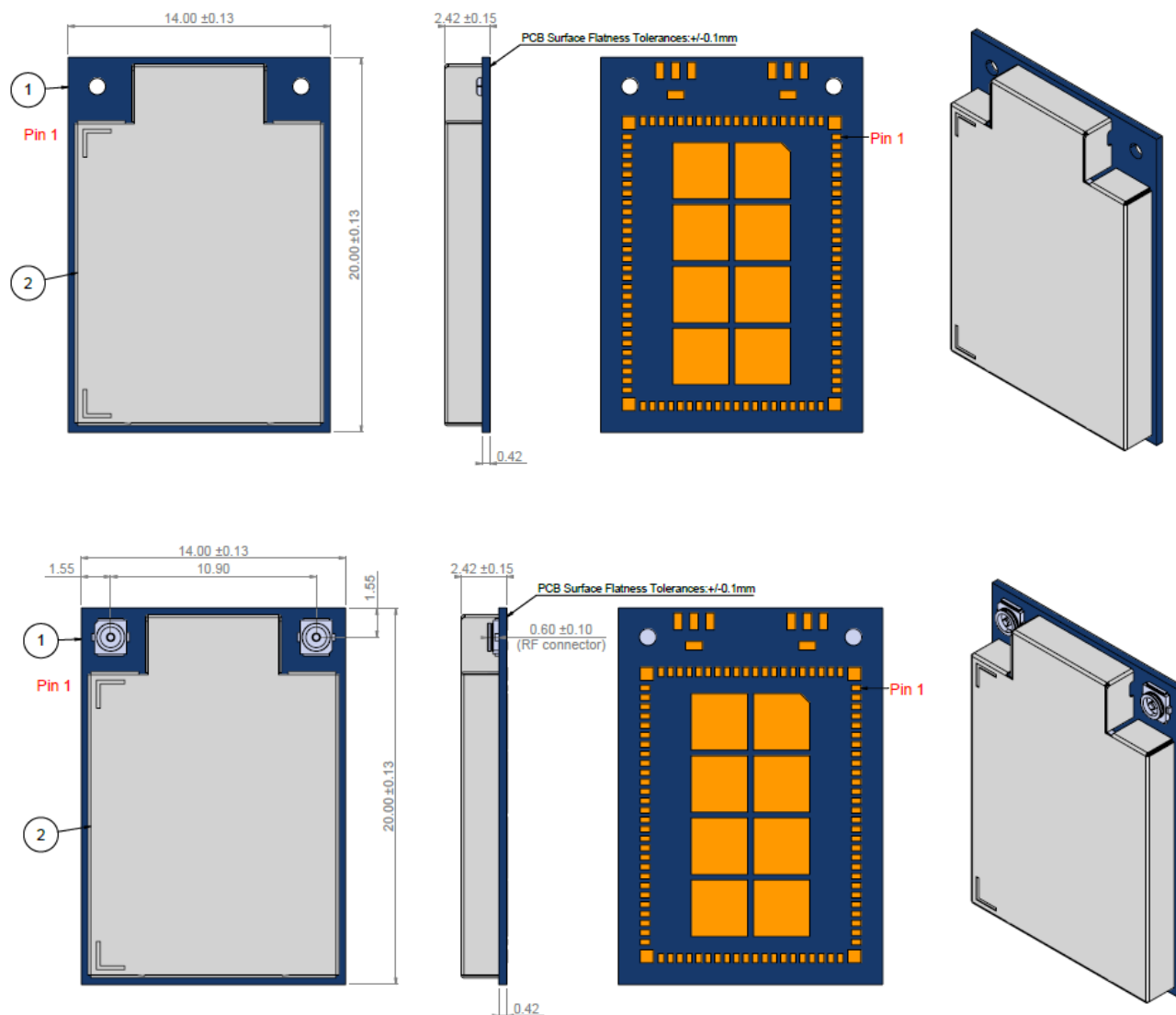
Note: The pin-109 to pin-116 are used for RF trace out when using Sona MT320 M.2 1420 trace pin variant.



TOP VIEW

(This is the recommended PCB footprint)

11 SONA MT320 MECHANICAL DIMENSION



Mechanical dimensions for the Sona MT320 M.2 1420 module.

11.1 M.2 2230 E-Key

Module dimensions of Sona MT320 M.2 2230 E-Key module is 22 x 30 x 2.3 mm. Detailed drawings are shown in Figure 23.

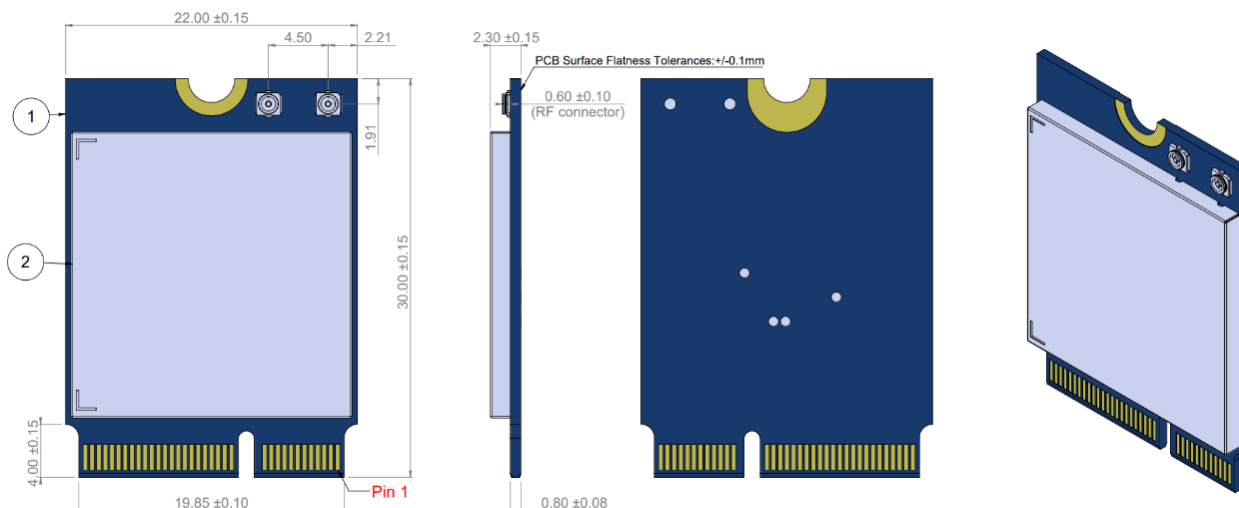


Figure 3: Sona MT320 M.2 2230

Note: The Wi-Fi MAC address is located on the product label.
The BT MAC address is the Wi-Fi MAC address plus 1.

11.2 M.2 2230 E-Key Mounting

The Sona MT320 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 MT320 M.2 2230 E-Key module is a single-sided component module so we recommend the connectors listed in Table 32.

Table 32: 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	3.1 mm

The corresponding standoffs are listed in Table 33.

Table 33: 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 shown in Figure 24.

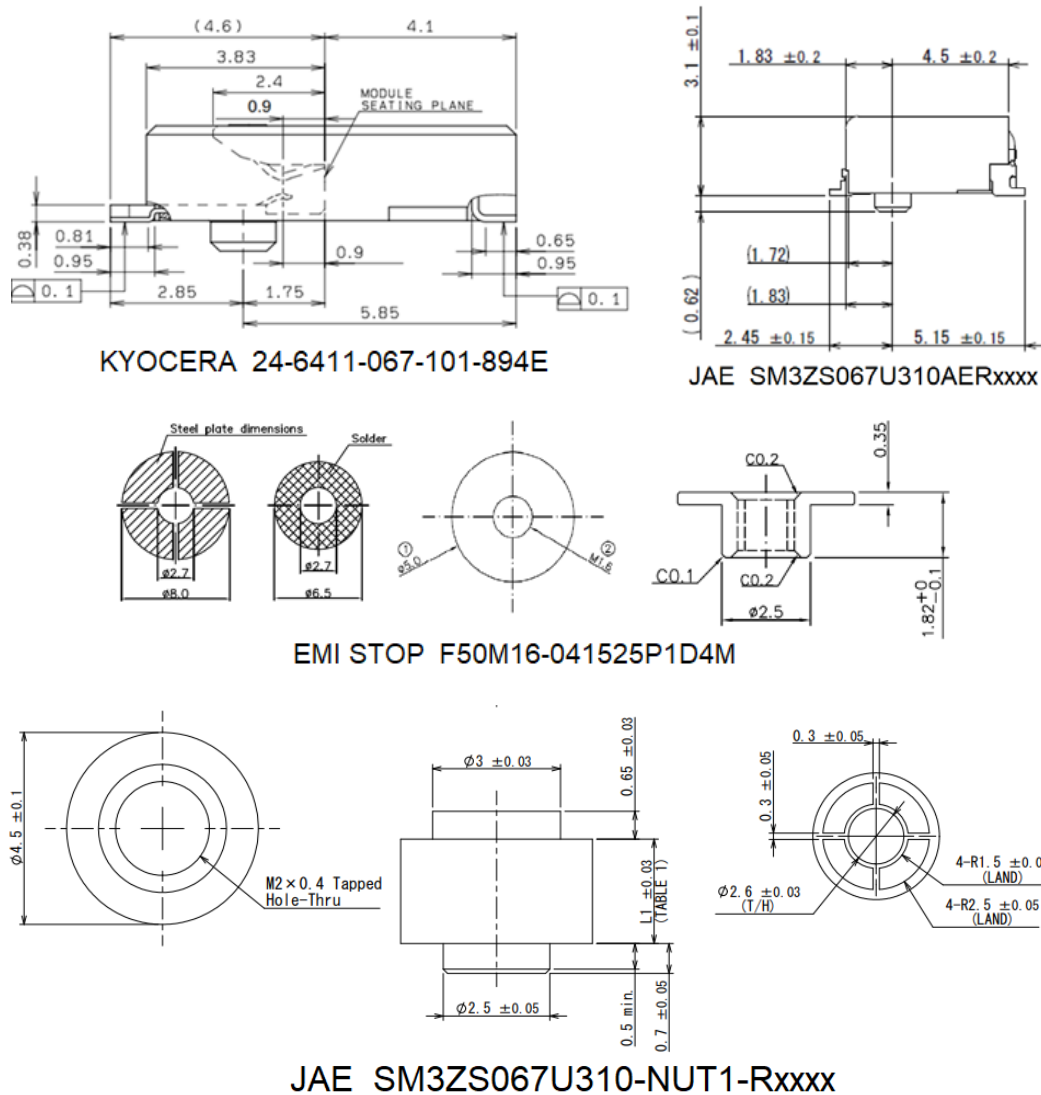
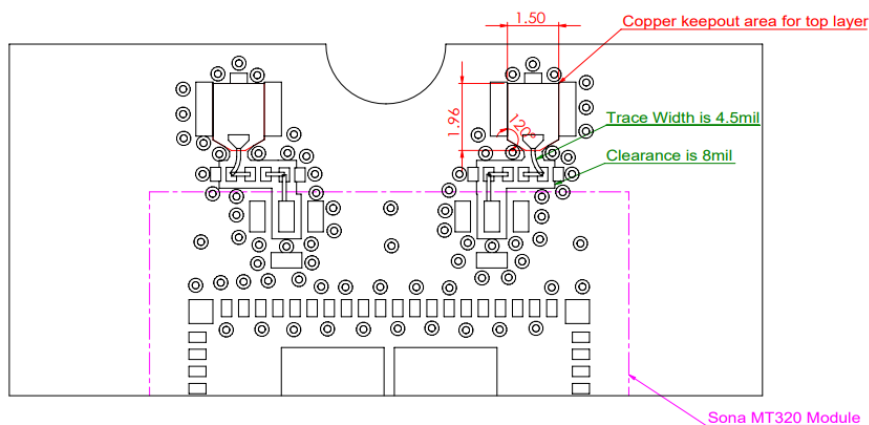


Figure 4: M.2 2230 E-Key connector/standoff mounting

12 RF LAYOUT DESIGN GUIDELINES

The following is a list of RF layout design guidelines and recommendations when installing a Laird Connectivity 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 Laird Connectivity radio from the antenna. In addition, do not place antennas directly above or directly below the radio.
- Laird Connectivity 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 Laird Connectivity radio module. To avoid negatively impacting Tx power and receiver sensitivity, do not cover the antennas with metallic objects or components.
- In order to use Laird MT320 1420 module certification, please follow exactly the same layout and board stack as shown below.



NOTES:

- Component size is 0201.
- Via size is drill 8mil, pad 16mil.

Layer	Layer Type	Layer Structure	Thickness (mil)	DK	Single-Coplanar (mil) (TraceWidth/ Clearance) 50ohm +/-10
	Top Solder Mask		0.9	3.5	
L1	Top	1 oz	1.4		4.5/8
		PP	3	4.1	
L2	Plane (GND)	1 oz	1.4		
		Core	18	4.1	
L3	Plane	1 oz	1.4		
		PP	3	4.1	
L4	Bottom	1 oz	1.4		
	Bottom Solder Mask		0.9	3.5	



UNLESS OTHERWISE NOTED, THIS DOCUMENT CONTAINS LAIRD CONNECTIVITY INFORMATION. REPRODUCTION, USE, DISCLOSURE OR TRANSMISSION OF ALL OR ANY PART OF THIS DOCUMENT IS PROHIBITED WITHOUT THE EXPRESS WRITTEN APPROVAL OF LAIRD CONNECTIVITY. LAIRD CONNECTIVITY RESERVES ALL RIGHTS UNDER PATENTS, TRADESECRETS, COPYRIGHTS AND TRADE SECRETS. COPYRIGHT © LAIRD CONNECTIVITY 2023. ALL RIGHTS RESERVED.

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN MILLIMETERS
TOLERANCES:
ANGULAR: B...
X.X: B...
XXX: B...

CAD FILE:
DATE: Oct 17, 2023
SHEET 1 OF 1

SCALE: 2:1

Laird ™ CONNECTIVITY	
TITLE: Sona MT320 M.2 Stackup and RF Information	
SIZE: DWG. NO. B	REV 1.0

13 APPLICATION NOTES

13.1 Introduction

Laird Connectivity'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.

13.2 Shipping and Labelling

13.2.1 Sona MT320 M.2 1420 Solder-Down

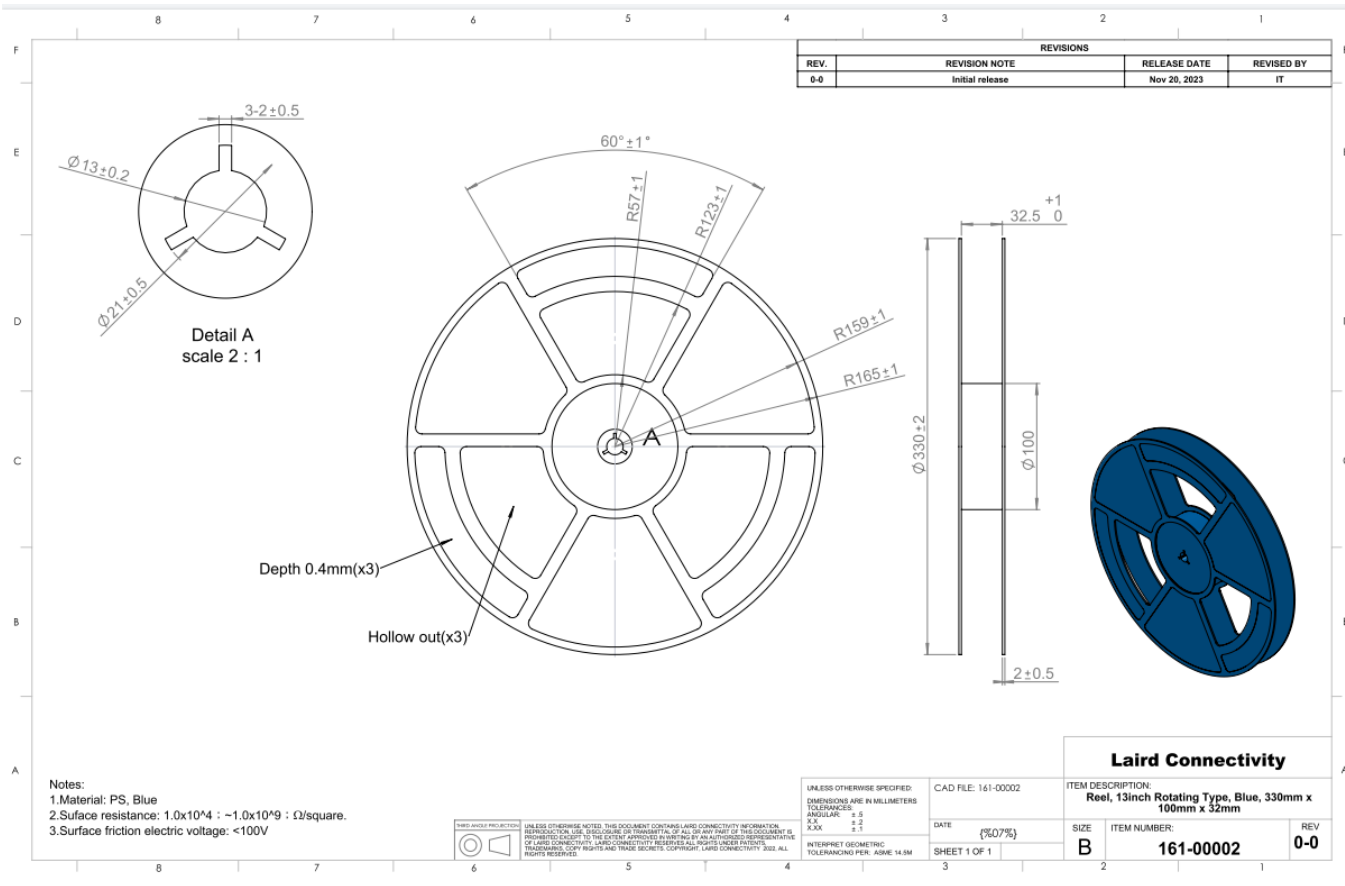


Figure 5: Sona MT320 M.2 1420 Reel specifications, 161-00002

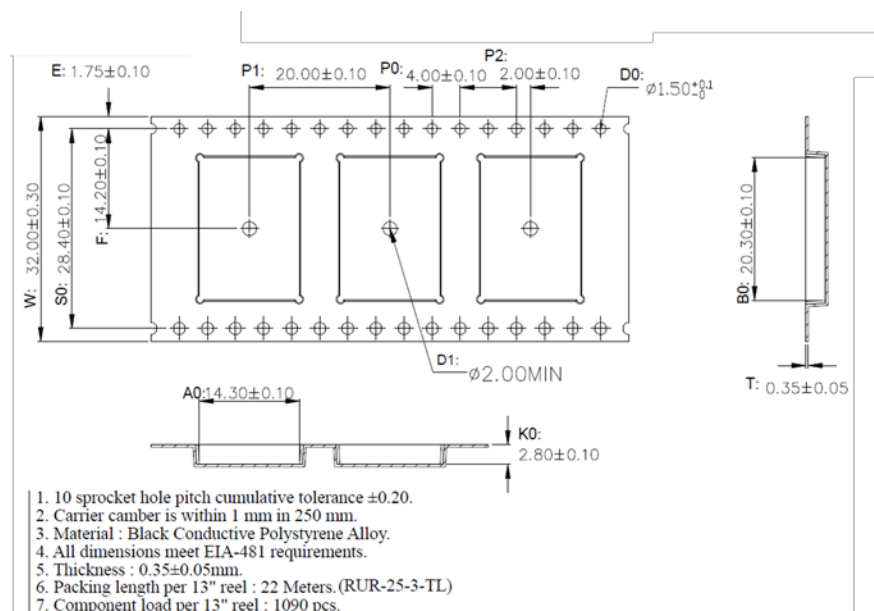
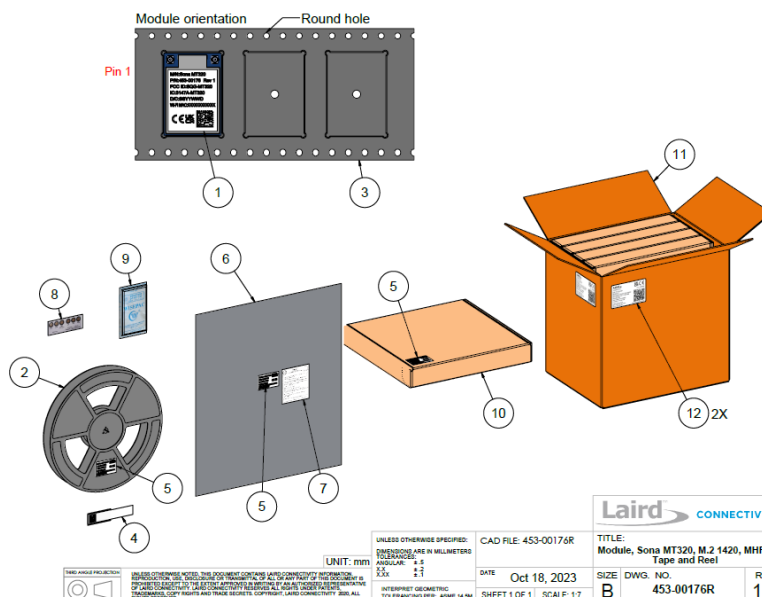


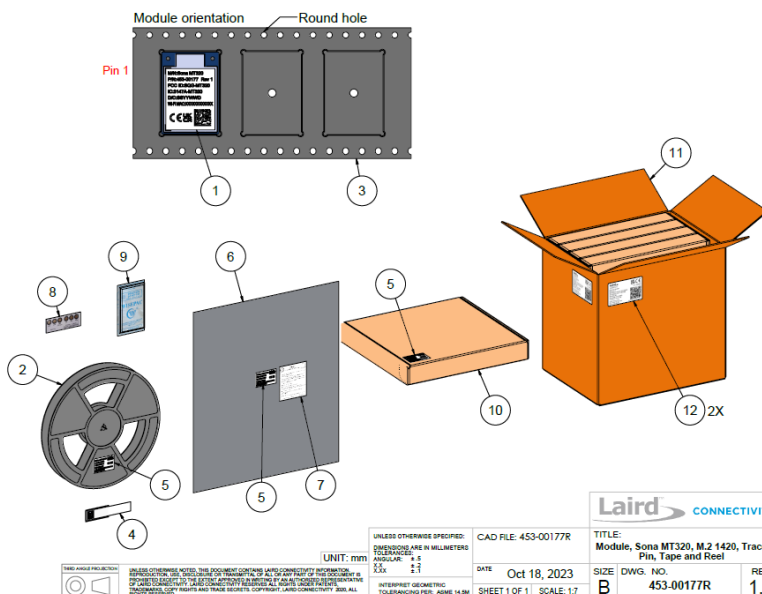
Figure 6: Sona MT320 M.2 1420 Tape specifications

There are 1,000 Sona MT320 M.2 1420 modules taped in a reel (and packaged in a pizza box) and five boxes per carton (5,000 modules per carton). Reel, boxes, and carton are labeled with the appropriate labels. See [Figure 27](#) for more information.

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
1.0	Initial release	Oct 18, 2023	AC



REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
1.0	Initial release	Oct 18, 2023	AC



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

The following labels are located on the antistatic bag. The Sona MT320 solder-down modules are classified as MSL4 devices.

	Caution	LEVEL
	This bag contains MOISTURE-SENSITIVE DEVICES	 If blank, see adjacent bar code label
1. Calculated shelf life in sealed bag : 12 months at <40 °C and <90% relative humidity (RH) 2. Peak package body temperature: _____ °C If blank, see adjacent bar code label 3. After bag is opened, devices that will be subjected to reflow solder or other high temperature process must be a) Mounted within: _____ hours of factory conditions If blank, see adjacent bar code label ≤30 °C/60% RH, or b) Stored per J-STD-033 4. Devices require bake, before mounting, if: a) Humidity Indicator Card reads >10% for level 2a - 5a devices or >60% for level 2 devices when read at 23 ± 5 °C b) 3a or 3b are not met. 5. If baking is required, refer to IPC/JEDEC J-STD-033 for bake procedure. Bag Seal Date: _____ If blank, see adjacent bar code label Note: Level and body temperature defined by IPC/JEDEC J-STD-020		

Figure 8: Sona MT320 M.2 1420 Moisture Sensitivity Level Label

The following label is placed on the anti-static bag.

M/N:Sona MT320 Rev1	Laird ™																																				
P/N:453-00177R	CONNECTIVITY																																				
D/C:SSYYWWD																																					
Q'TY:XXXXPCS																																					
BOX_ID:BXXXXXYMDXXXXXX	<table border="1"> <tr><td>BE</td><td>BG</td><td>CZ</td><td>NL</td><td>AT</td><td>PL</td></tr> <tr><td>DK</td><td>DE</td><td>EE</td><td>PT</td><td>RO</td><td>SI</td></tr> <tr><td>IE</td><td>EL</td><td>ES</td><td>SK</td><td>FI</td><td>SE</td></tr> <tr><td>FR</td><td>HR</td><td>IT</td><td>UKNI</td><td>LI</td><td>IS</td></tr> <tr><td>CY</td><td>LV</td><td>LT</td><td>NO</td><td>TR</td><td>CH</td></tr> <tr><td>LU</td><td>HU</td><td>MT</td><td></td><td></td><td></td></tr> </table>	BE	BG	CZ	NL	AT	PL	DK	DE	EE	PT	RO	SI	IE	EL	ES	SK	FI	SE	FR	HR	IT	UKNI	LI	IS	CY	LV	LT	NO	TR	CH	LU	HU	MT			
BE	BG	CZ	NL	AT	PL																																
DK	DE	EE	PT	RO	SI																																
IE	EL	ES	SK	FI	SE																																
FR	HR	IT	UKNI	LI	IS																																
CY	LV	LT	NO	TR	CH																																
LU	HU	MT																																			

Figure 9: Sona MT320 M.2 1420 Bag and Box Product Identifier Label

The following label is placed on the pizza box.

M/N:Sona MT320 Rev1	Laird ™																																				
P/N:453-00177R	CONNECTIVITY																																				
D/C:SSYYWWD																																					
Q'TY:XXXXPCS																																					
BOX_ID:BXXXXXYMDXXXXXX	<table border="1"> <tr><td>BE</td><td>BG</td><td>CZ</td><td>NL</td><td>AT</td><td>PL</td></tr> <tr><td>DK</td><td>DE</td><td>EE</td><td>PT</td><td>RO</td><td>SI</td></tr> <tr><td>IE</td><td>EL</td><td>ES</td><td>SK</td><td>FI</td><td>SE</td></tr> <tr><td>FR</td><td>HR</td><td>IT</td><td>UKNI</td><td>LI</td><td>IS</td></tr> <tr><td>CY</td><td>LV</td><td>LT</td><td>NO</td><td>TR</td><td>CH</td></tr> <tr><td>LU</td><td>HU</td><td>MT</td><td></td><td></td><td></td></tr> </table>	BE	BG	CZ	NL	AT	PL	DK	DE	EE	PT	RO	SI	IE	EL	ES	SK	FI	SE	FR	HR	IT	UKNI	LI	IS	CY	LV	LT	NO	TR	CH	LU	HU	MT			
BE	BG	CZ	NL	AT	PL																																
DK	DE	EE	PT	RO	SI																																
IE	EL	ES	SK	FI	SE																																
FR	HR	IT	UKNI	LI	IS																																
CY	LV	LT	NO	TR	CH																																
LU	HU	MT																																			

Figure 10: Sona MT320 Bag and Box Product Identifier Label

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



Figure 11: Sona MT320 M.2 1420 Carton Product Identifier Label

13.2.2 Sona MT320 M.2 2230 E-Key Module

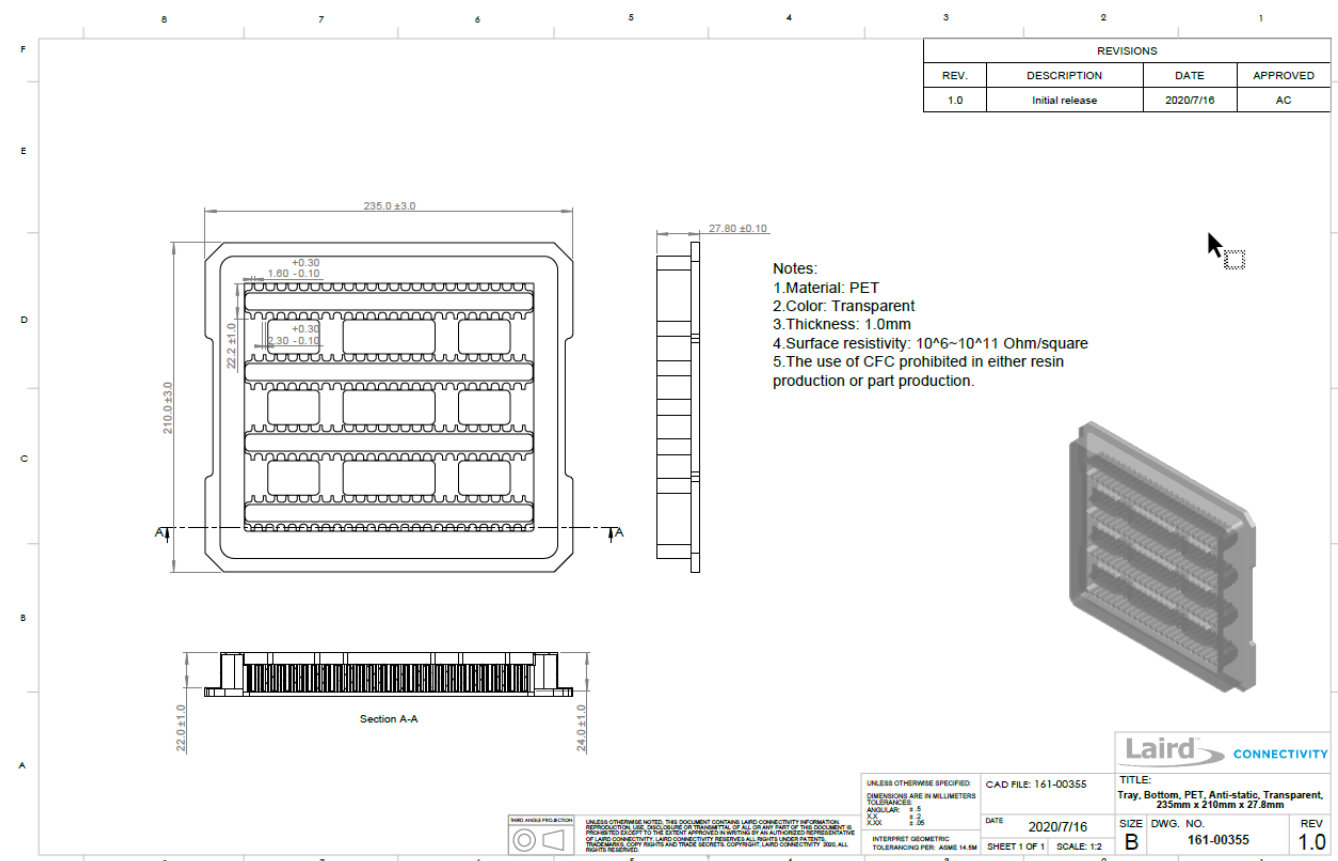


Figure 12: Sona MT320 M.2 2230 Shipping Tray, Bottom, 161-00355

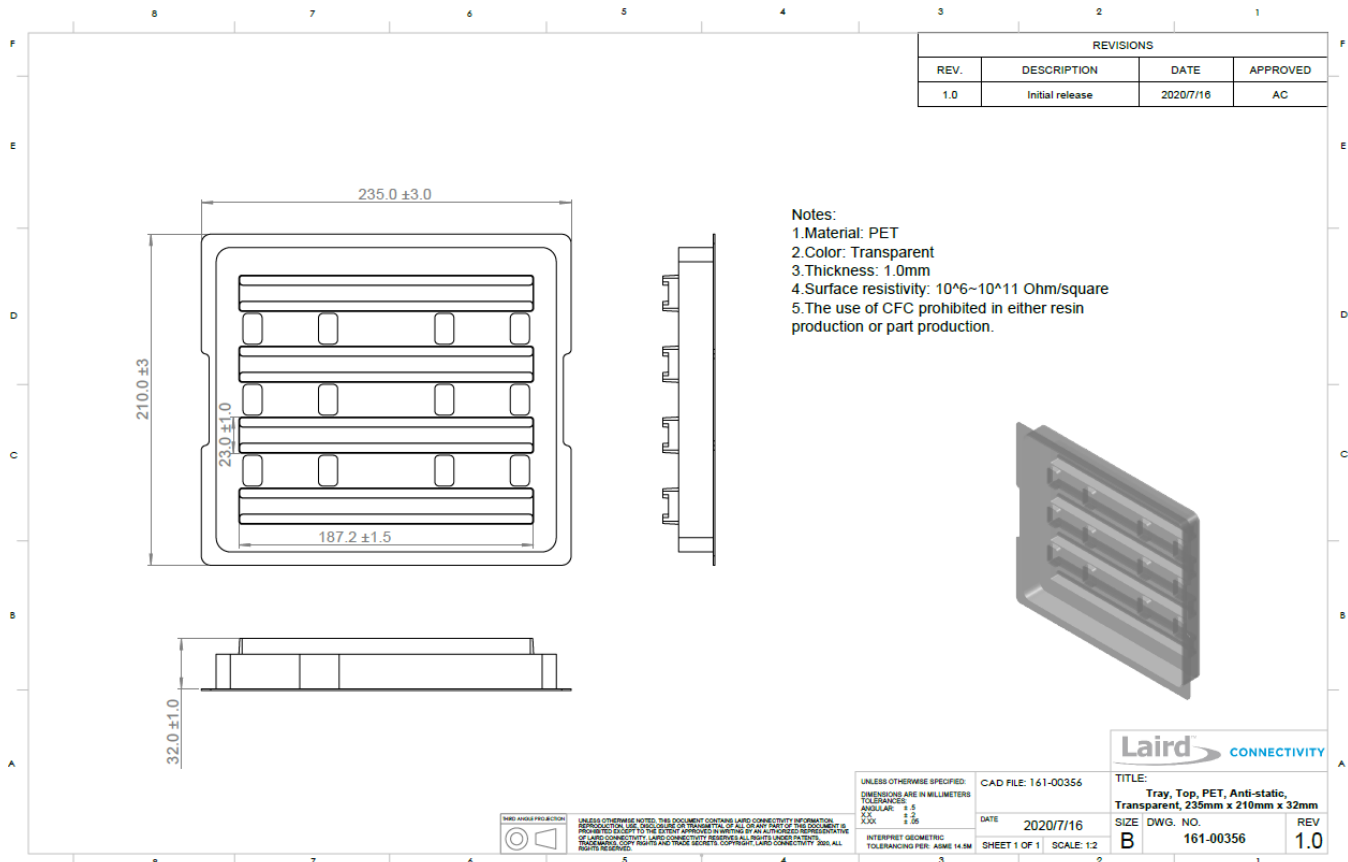


Figure 13: Sona MT320 M.2 2230 Shipping Tray, Top, 161-00356

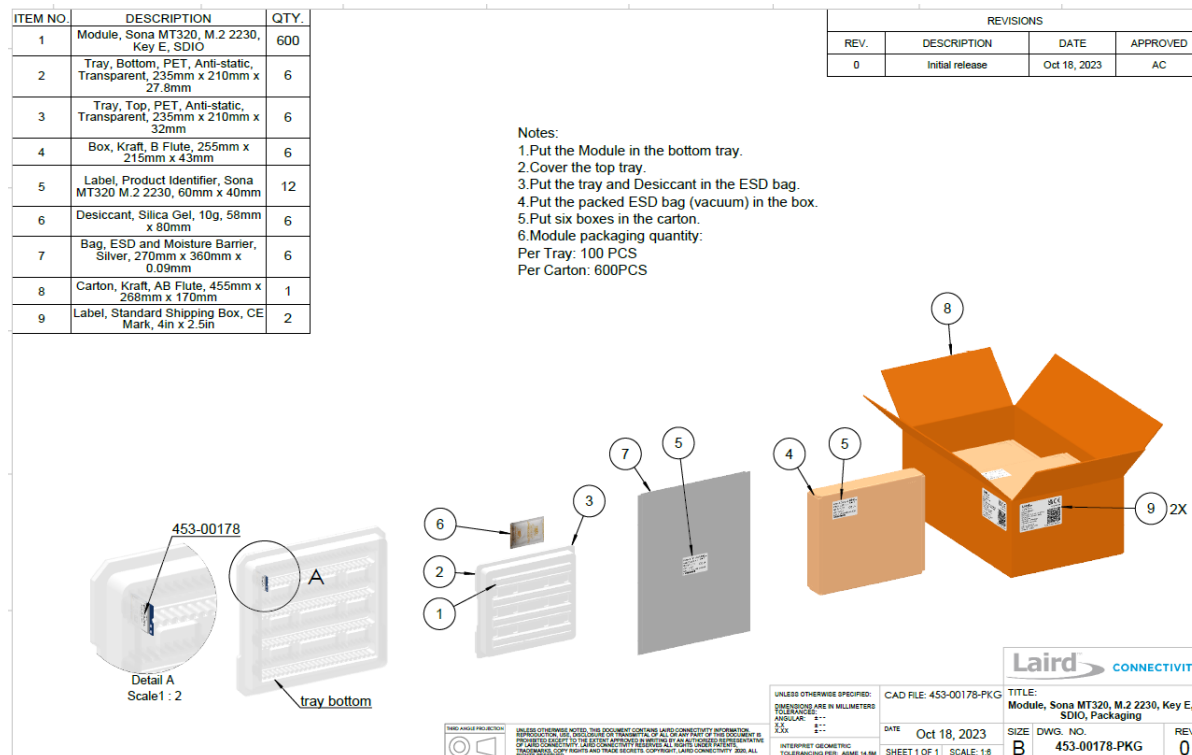


Figure 14: Sona MT320 M.2 2230 Packaging Process, 453-00178-PKG

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

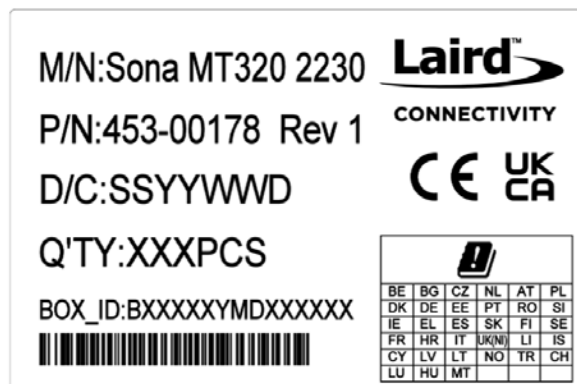


Figure 15: Sona MT320 M.2 2230 Bag and Box Product Identifier Label

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



Figure 16: Sona MT320 M.2 2230 Carton Product Identifier Label

13.3 Required Storage Conditions

13.3.1 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.

13.3.2 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: B hours or less after completion of the 1st reflow

Note: Should keep A+B within 72 hours.

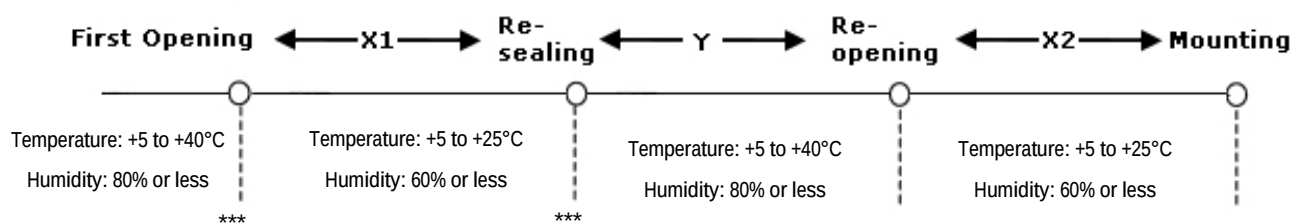
13.3.3 Temporary Storage Requirements after Opening

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:



*** - External atmosphere temperature and humidity of the dry packing

- Storage period:
 - X1+X2 – Refer to [After Opening the Dry Packing](#) storage requirements. Keep is X1+X2 within 72 hours.
 - Y – Keep within two weeks or less.

13.4 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).

14 SURFACE MOUNT CONDITIONS

The following soldering conditions are recommended to ensure device quality.

14.1 Recommended Stencil Aperture

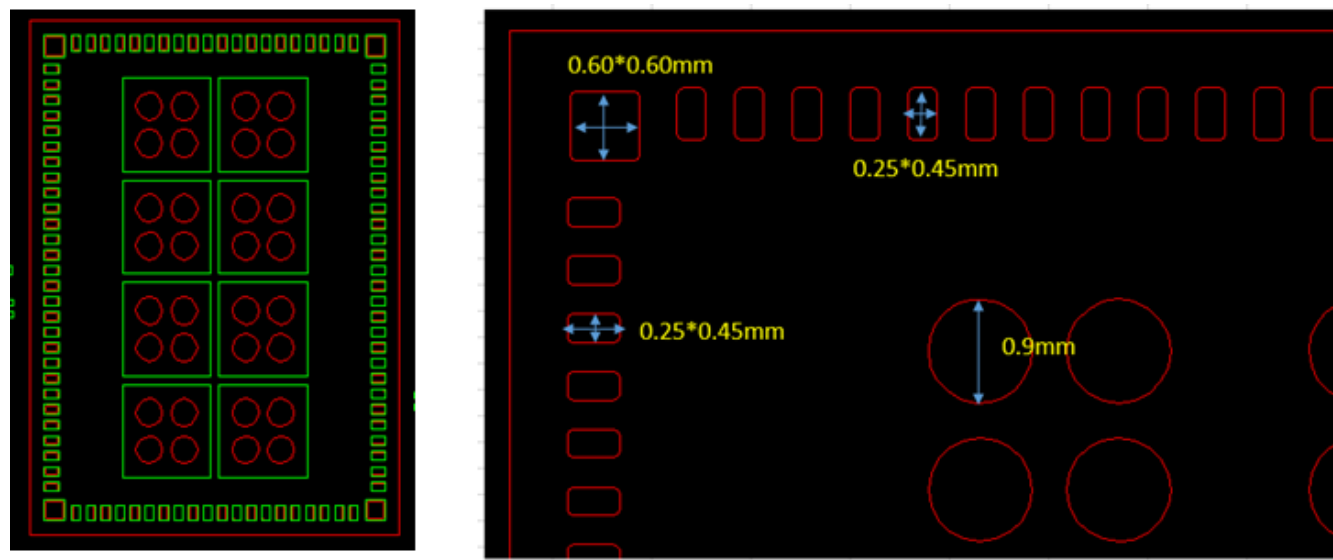


Figure 17: Sona MT320 M.2 1420 stencil aperture

Note: The stencil thickness is 0.12mm

14.2 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:

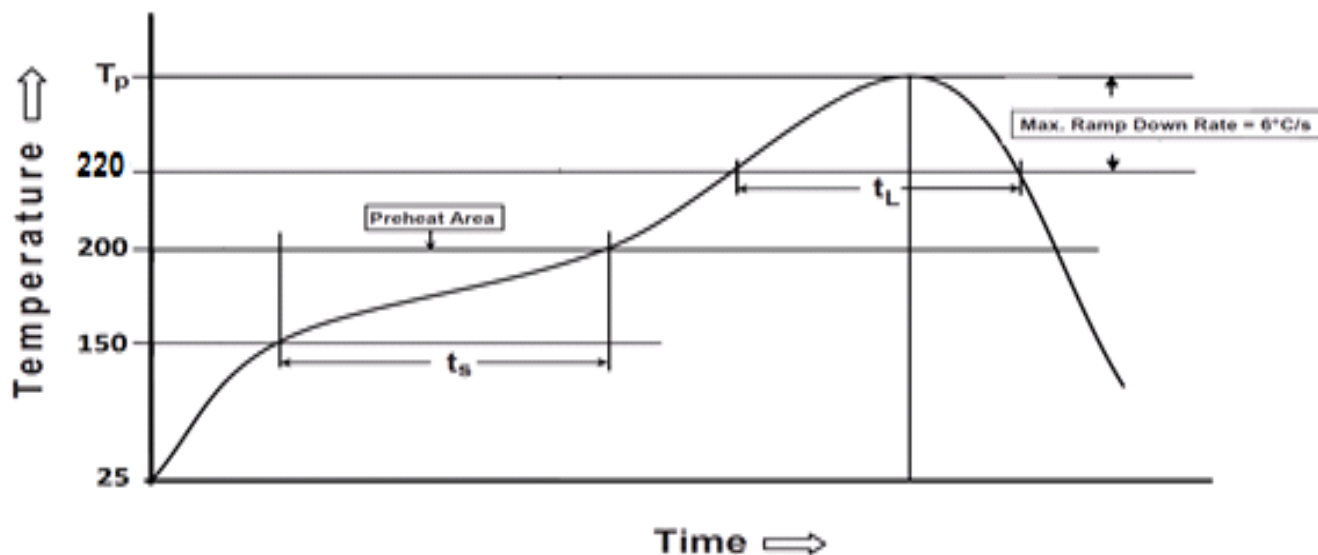


Figure 18: Temperature profile

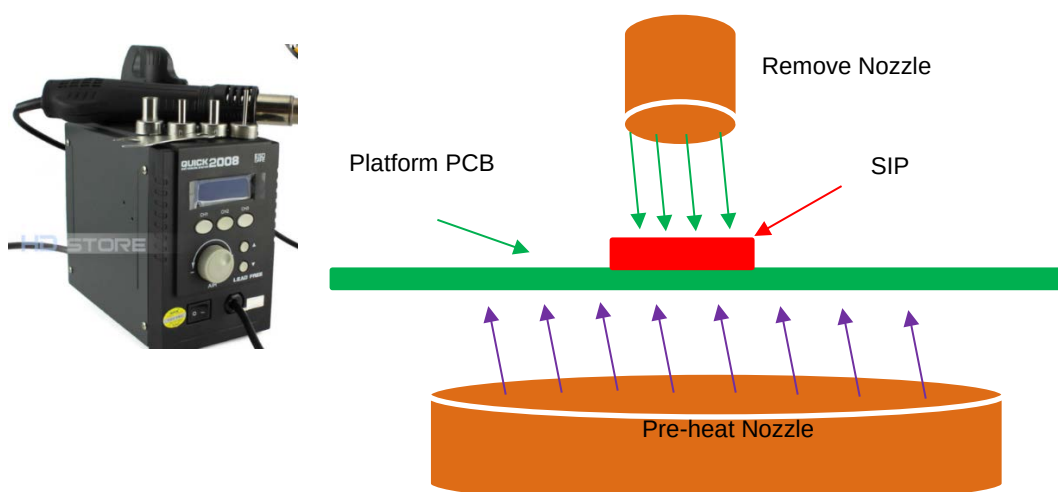
- Solder paste alloy: SAC305(Sn96.5 / Ag3.0 / Cu 0.5)
- Pre-heat temperature: 150°C ~ 200°C; Soak time: 60 second ~ 120 second
- Peak temperature: 235°C ~ 250°C
- Time above 220°C: 40 second ~ 90 second
- Optimal cooling rate < 3°C/second
- The oxygen concentration < 2000 ppm

14.2.1 Cautions When Removing the M.2 1420 from the Platform for RMA

- Bake the platform before removing the Sona MT320 M.2 1420 module from the platform. Reference [Baking Conditions](#).
- Remove the Sona MT320 M.2 1420 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.

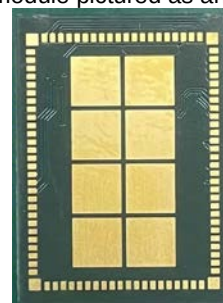


- Remove the residue solder under the bottom side of device. (note. Alternate module pictured as an example)



(Not accepted for RMA)

Figure 19: Example M.2 1420 with residue solder on the bottom



(Accepted for RMA analysis)

Figure 20: Sona MT320 M.2 1420 module without residue solder

- Remove and clean the residue flux as needed.

14.2.2 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 MT320 M.2 1420 and M.2 2230 modules are MSL level 4 rated.

15 RELIABILITY TEST

The Sona MT320 modules were tested for reliability. Test items and the corresponding standards are shown in [Table 42](#).

15.1 Environmental and Mechanical

The following are the followed reliability test procedures.

Table 18: Sona MT320 M.2 1420 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 19: Sona MT320 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

15.2 Reliability Prediction

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

Laird Part Number	Environment	Test Result 45 °C (Hours)
453-00176	Ground, Fixed, Uncontrolled Ground, Mobile	5,811,765 2,179,412

Laird Part Number	Environment	Test Result 85 °C (Hours)
453-00176	Ground, Fixed, Uncontrolled Ground, Mobile	1,391,674 521,878

Laird Part Number	Environment	Test Result 45 °C (Hours)
453-00177	Ground, Fixed, Uncontrolled Ground, Mobile	7,058,202 2,646,826

Laird Part Number	Environment	Test Result 85 °C (Hours)
453-00177	Ground, Fixed, Uncontrolled Ground, Mobile	2,177,692 816,635

Laird Part Number	Environment	Test Result 45 °C (Hours)
453-00178	Ground, Fixed, Uncontrolled	3,933,540
	Ground, Mobile	1,475,077

Laird Part Number	Environment	Test Result 85 °C (Hours)
453-00178	Ground, Fixed, Uncontrolled	867,635
	Ground, Mobile	325,363

16 REGULATORY

Note: For complete regulatory information, refer to the Sona MT320 Regulatory Information document which is also available from the TBD link

The Sona MT320 holds current certifications in the following countries:

Country/Region	Regulatory ID
USA (FCC)	SQG-MT320
EU	N/A
UKCA	N/A
Canada (ISED)	3147A-MT320
Japan (MIC)	N/A
Australia	N/A
New Zealand	N/A

16.1 FCC Regulatory

Federal Communication Commission Interference Statement

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

FCC Caution: Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment.

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

IMPORTANT NOTE:

Radiation Exposure Statement:

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20cm between the radiator & your body.

This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

Country Code selection feature to be disabled for products marketed to the US/CANADA

Integration instructions for host product manufacturers

Applicable FCC rules to module

FCC Part 15.247

Summarize the specific operational use conditions

The module is must be installed in mobile device.

This device is intended only for OEM integrators under the following conditions:

- 1) The antenna must be installed such that 20 cm is maintained between the antenna and users, and
- 2) The transmitter module may not be co-located with any other transmitter or antenna

As long as 2 conditions above are met, further transmitter test will not be required. However, the OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this module installed.

IMPORTANT NOTE: In the event that these conditions can not be met (for example certain laptop configurations or co-location with another transmitter), then the FCC authorization is no longer considered valid and the FCC ID can not be used on the final product. In these circumstances, the OEM integrator will be responsible for re-evaluating the end product (including the transmitter) and obtaining a separate FCC authorization. The OEM integrator has to be aware not to provide information to the end user regarding how to install or remove this RF module in the user's manual of the end product which integrates this module.

The end user manual shall include all required regulatory information/warning as show in this manual.

Limited module procedures

Not applicable

Trace antenna designs

Not applicable

RF exposure considerations

Co-located issue shall be met as mentioned in "Summarize the specific operational use conditions".

Product manufacturer shall provide below text in end-product manual

"Radiation Exposure Statement:

The product comply with the US portable RF exposure limit set forth for an uncontrolled environment and are safe for intended operation as described in this manual. The further RF exposure reduction can be achieved if the product can be kept as far as possible from the user body or set the device to lower output power if such function is available.."

Antennas

1.1.3 Antenna Details

Ant. No.	Manufacturer	Model	Part Number	Type	Connector	Gain (dBi)	
						2.4GHz	5GHz
1	Laird Connectivity	FlexMIMO 6E	EFD2471A3S-10 MH4L	PIFA	MHF4L	2.2	3.8
2	Laird Connectivity	FlexPIFA 6E	EFB2471A3S-10 MH4L	PIFA	MHF4L	2.2	3.9
3	Laird Connectivity	Mini NanoBlade Flex 6 GHz	EMF2471A3S-10 MH4L	PCB Dipole	MHF4L	2.4	4.4
4	Joymax Electronics	Dipole 6E	TWX-100BRS3B	Dipole	RP-SMA	2	4

Label and Compliance Information

Product manufacturers need to provide a physical or e-label stating

"Contains FCC ID: SQG-MT320" with finished product

Information on Test Modes and Additional Testing Requirements

Test tool: QA tool

Additional Testing, Part 15 Subpart B Disclaimer

The module is only FCC authorized for the specific rule parts listed on the grant, and that the host product manufacturer is responsible for compliance to any other FCC rules that apply to the host not covered by the modular transmitter grant of certification. The final host product still requires Part 15 Subpart B compliance testing with the modular transmitter installed

16.2 Industry Canada Regulatory

Industry Canada statement:

This device contains licence-exempt transmitter(s)/receiver(s) that comply with Innovation, Science and Economic Development Canada's licence-exempt RSS(s). Operation is subject to the following two conditions:

- (1) This device may not cause interference*
- (2) This device must accept any interference, including interference that may cause undesired operation of the device*

L'émetteur/récepteur exempt de licence contenu dans le présent appareil est conforme aux CNR d'Innovation, Sciences et Développement économique Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes :

- (1) L'appareil ne doit pas produire de brouillage;*
- (2) L'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.*

This radio transmitter [IC: 3147A-MT320] has been approved by Innovation, Science and Economic Development Canada to operate with the antenna types listed below, with the maximum permissible gain indicated. Antenna types not included in this list that have a gain greater than the maximum gain indicated for any type listed are strictly prohibited for use with this device.

Le présent émetteur radio [IC: 3147A-MT320] a été approuvé par Innovation, Sciences et Développement économique Canada pour fonctionner avec les types d'antenne énumérés ci-dessous et ayant un gain admissible maximal. Les types d'antenne non inclus dans cette liste, et dont le gain est supérieur au gain maximal indiqué pour tout type figurant sur la liste, sont strictement interdits pour l'exploitation de l'émetteur.

1.1.3 Antenna Details

Ant. No.	Manufacturer	Model	Part Number	Type	Connector	Gain (dBi)	
						2.4GHz	5GHz
1	Laird Connectivity	FlexMIMO 6E	EFD2471A3S-10 MH4L	PIFA	MHF4L	2.2	3.8
2	Laird Connectivity	FlexPIFA 6E	EFB2471A3S-10 MH4L	PIFA	MHF4L	2.2	3.9
3	Laird Connectivity	Mini NanoBlade Flex 6 GHz	EMF2471A3S-10 MH4L	PCB Dipole	MHF4L	2.4	4.4
4	Joymax Electronics	Dipole 6E	TWX-100BRS3B	Dipole	RP-SMA	2	4

Radiation Exposure Statement:

This equipment complies with Canada radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20cm between the radiator & your body.

Déclaration d'exposition aux radiations:

Cet équipement est conforme Canada limites d'exposition aux radiations dans un environnement non contrôlé. Cet équipement doit être installé et utilisé à distance minimum de 20cm entre le radiateur et votre corps.

This device is intended only for OEM integrators under the following conditions:

- 1) The transmitter module may not be co-located with any other transmitter or antenna.

As long as 1 condition above are met, further transmitter test will not be required. However, the OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this module installed.

Cet appareil est conçu uniquement pour les intégrateurs OEM dans les conditions suivantes:

- 1) Le module émetteur peut ne pas être coïmplanté avec un autre émetteur ou antenne.

Tant que les 1 condition ci-dessus sont remplies, des essais supplémentaires sur l'émetteur ne seront pas nécessaires. Toutefois, l'intégrateur OEM est toujours responsable des essais sur son produit final pour toutes exigences de conformité supplémentaires requis pour ce module installé.

IMPORTANT NOTE:

In the event that these conditions can not be met (for example certain laptop configurations or co-location with another transmitter), then the Canada authorization is no longer considered valid and the IC ID can not be used on the final product. In these circumstances, the OEM integrator will be responsible for re-evaluating the end product (including the transmitter) and obtaining a separate Canada authorization.

NOTE IMPORTANTE:

Dans le cas où ces conditions ne peuvent être satisfaites (par exemple pour certaines configurations d'ordinateur portable ou de certaines co-localisation avec un autre émetteur), l'autorisation du Canada n'est plus considéré comme valide et l'ID IC ne peut pas être utilisé sur le produit final. Dans ces circonstances, l'intégrateur OEM sera chargé de réévaluer le produit final (y compris l'émetteur) et l'obtention d'une autorisation distincte au Canada.

End Product Labeling

The final end product must be labeled in a visible area with the following: "Contains IC: 3147A-MT320".

Plaque signalétique du produit final

Le produit final doit être étiqueté dans un endroit visible avec l'inscription suivante: "Contient des IC: 3147A-MT320".

Manual Information To the End User

The OEM integrator has to be aware not to provide information to the end user regarding how to install or remove this RF module in the user's manual of the end product which integrates this module.

The end user manual shall include all required regulatory information/warning as show in this manual.

Manuel d'information à l'utilisateur final

L'intégrateur OEM doit être conscient de ne pas fournir des informations à l'utilisateur final quant à la façon d'installer ou de supprimer ce module RF dans le manuel de l'utilisateur du produit final qui intègre ce module.
Le manuel de l'utilisateur final doit inclure toutes les informations réglementaires requises et avertissements comme indiqué dans ce manuel.

16.3 Certified Antennas

The Sona MT320 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	Laird Connectivity Part Number	Type	Connector	Peak Gain	
					2.4 GHz	5 GHz
Laird Connectivity	FlexMIMO 6E	EFD2471A3S-10MH4L	PIFA	MHF4L	2.2 dBi	3.8 dBi
Laird Connectivity	FlexPIFA 6E	EFB2471A3S-10MH4L	PIFA	MHF4L	2.2 dBi	3.9 dBi
Laird Connectivity	Mini NanoBlade Flex 6 GHz	EMF2471A3S-10MH4L	PCB Dipole	MHF4L	2.4 dBi	4.4 dBi
JOYMAX Electronics	Dipole 6E	TWX-100BRS3B	Dipole	RP-SMA	2 dBi	4.0 dBi

17 BLUETOOTH SIG QUALIFICATION

17.1 Overview

The Sona MT320 Series module is listed on the Bluetooth SIG website as a qualified Controller Subsystem.

Design Name	Owner	Declaration ID	Link to listing on the SIG website
Sona MT320	Laird Connectivity	TBD	

It is a mandatory requirement of the Bluetooth Special Interest Group (SIG) that every product implementing Bluetooth technology has a Declaration ID. Every Bluetooth design is required to go through the qualification process, even when referencing a Bluetooth Design that already has its own Declaration ID. The Qualification Process requires each company to register as a member of the Bluetooth SIG – www.bluetooth.org

The following is a link to the Bluetooth Registration page: <https://www.bluetooth.org/login/register/>

For each Bluetooth Design, it is necessary to purchase a Declaration ID. This can be done before starting the new qualification, either through invoicing or credit card payment. The fees for the Declaration ID will depend on your membership status, please refer to the following webpage:

<https://www.bluetooth.org/en-us/test-qualification/qualification-overview/fees>

For a detailed procedure of how to obtain a new Declaration ID for your design, please refer to the following SIG document, (login is required to view this document):

https://www.bluetooth.org/DocMan/handlers/DownloadDoc.ashx?doc_id=283698&vId=317486

17.2 Qualification Steps When Referencing a Laird Connectivity Controller Subsystem Design

To qualify your product when referencing a Laird Connectivity Controller Subsystem design, follow these steps:

1. To start a listing, go to: https://www.bluetooth.org/tpg/QLI_SDoc.cfm

Note: A user name and password are required to access this site.

2. In step 1, select the option, New Listing and Reference a Qualified Design.
3. Enter D057578 in the Controller Subsystem table entry.
4. Enter your complimentary Host Subsystem and optional Profile Subsystem QDID in the table entry.
5. Select your pre-paid Declaration ID from the drop-down menu or go to the Purchase Declaration ID page.

Note: Unless the Declaration ID is pre-paid or purchased with a credit card, you cannot proceed until the SIG invoice is paid.

6. Once all the relevant sections of step 1 are finished, complete steps 2, 3, and 4 as described in the help document accessible from the site.

Your new design will be listed on the SIG website and you can print your Certificate and DoC.

For further information please refer to the following training material:

<https://www.bluetooth.org/en-us/test-qualification/qualification-overview/listing-process-updates>

If you require assistance with the qualification process please contact our recommended Bluetooth Qualification Expert (BQE), Steve Flooks, steve.flooks@eurexuk.com.

18 ADDITIONAL INFORMATION

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

Headquarters Laird Connectivity
50 S. Main St. Suite 1100
Akron, OH 44308 USA

Phone	Americas: +1-800-492-2320 Europe: +44-1628-858-940 Hong Kong: +852-2762-4823
-------	--

Website	www.lairdconnect.com/
---------	--

Technical Support	www.lairdconnect.com/resources/support
-------------------	--

Sales Contact	www.lairdconnect.com/contact
---------------	--

Note: Information contained in this document is subject to change.

Laird Connectivity's products are subject to standard [Terms & Conditions](#).

www.lairdconnect.com

© Copyright 2023 Laird Connectivity. All Rights Reserved. Patent pending. Any information furnished by Laird Connectivity and its agents is believed to be accurate and reliable. All specifications are subject to change without notice. Responsibility for the use and application of Laird Connectivity materials or products rests with the end user since Laird Connectivity and its agents cannot be aware of all potential uses. Laird Connectivity makes no warranties as to non-infringement nor as to the fitness, merchantability, or sustainability of any Laird Connectivity materials or products for any specific or general uses. Laird Connectivity or any of its affiliates or agents shall not be liable for incidental or consequential damages of any kind. All Laird Connectivity products are sold pursuant to the Laird Connectivity Terms and Conditions of Sale in effect from time to time, a copy of which will be furnished upon request. Nothing herein provides a license under any Laird Connectivity or any third-party intellectual property right.