MCU Embedded Wireless LAN 802.11ax
+ Bluetooth® Low Energy 5.4
+ 802.15.4 Module

WKR612AA1

Data Sheet

By purchase of any products described in this document, the customer is deemed to understand and accept contents of this document.

Note: This module requires a device driver that is subject to Japan's export control regulations. Depending on the customer's country or application (e.g., military use), we may not be able to provide the driver to all customers.

For more information or to contact your local sales office, please visit: https://www.kagafei.com/jp/eng/

Revision History

Date	Version No.	Description
2025/05/20	Ver. 1.0	Initial Release
2025/07/29	Ver. 1.1	Word correction
2025/09/12	Ver. 1.2	Correction of errors
2025/12/01	Ver. 1.3	Block diagram and notation corrections
2025/12/16	Ver. 1.4	Sentence correction
2026/02/04	Ver. 1.5	Correction of typos

Table of Contents

1 General Information

1.1 Scope

This specification (“Specification”) applies to the hybrid IC ″WKR612AA1″ for Wireless LAN and Bluetooth® (”Product”) manufactured by KAGA FEI Co., Ltd. (“KAGA FEI”).

1.2 Product Overview

① Part Number : WKR612AA1
Certified Model : WKR612
Please use the part number (WKR612AA1) when placing orders.

② Chipset : NXP RW612HN

③ MCU & Memory : 260MHz Arm® Coretex® -M33, 1.2MB SRAM, 8MB QSPI FLASH

④ Functionality : Wireless communication module
(Wi-Fi 6 1x1 dual band 2.4GHz and 5GHz + Bluetooth® Low Energy + 802.15.4)

⑤ Wireless LAN Support : IEEE 802. 11a/b/g/n/ac/ax, 20MHz band width, up to MCS9 data rates

⑥ Bluetooth® Support : Bluetooth® Low Energy 5.4, LE 2M, LE Coded
Design Number : Q345110

⑦ Interfaces : UART, SPI, SDIO, USB, I2C, I2S, GPIOs

⑧ Operating Temperature Range: -40℃ to +85℃

⑨ RoHS Compliance : Compliant

⑩ Dimensions and Weight : 26.9 x 19.0 x 2.1 mm (Max), 1.83 g

⑪ Terminal / Mounting : 183-pin Land Grid Array (LGA), Surface-mount type

⑫ MSL : 3

⑬ Identification Numbers of Regulatory Certifications : Japan 005-103473
U.S.A. FCC ID : 2A6NFWKR612
Canada IC : 28568-WKR612

⑭ Packaging : Packaging Method: Tray
Quantity per Tray: 45 pcs
Standard Order Quantity: Multiples of 900 pcs

⑮ Country of Origin : Thailand

⑯ Others :

1. Limitation of Warranty

ⅰ) KAGA FEI provide warranties only if the product is operated under the condition set forth in this specification. Please note that KAGA FEI shall not be liable for any defect and/or malfunction arising from use of the product under the terms and conditions other than the operating conditions hereof. In addition, when this product is used under environmental conditions such as over voltage which is not guaranteed, it may be destroyed in short mode. To ensure the security of customer' s product, please add an extra fuse or/and a protection circuit for over voltage.

ⅱ) In some cases, KAGA FEI may use replacements as component parts of products. Such replacement shall apply only to component part of products, which KAGA FEI deems it possible to replace or substitute according to (i) scope of warranty provided in this specification (e.g. electric characteristics, outline, dimension, conditions of use, reliability tests, official standard (type approvals etc.)) and (ii) quality of products. KAGA FEI also ensures traceability of such replacement on production lot basis.

2. Instruction for Use (CAUTION)

ⅰ) Because product is not designed for radiation durability, please refrain from exposing product to radiation in the use.

ⅱ) Communication between this product and other might not be established nor maintained depending upon radio environment or operating condition of this product and other products with wireless technology.

ⅲ) This product operates in the unlicensed ISM band at 2.4GHz/5GHz. In case this product is used around the other wireless devices which operate in same frequency band of this product, there is a possibility that interference occurs between this product and such other devices. If such interference occurs, please stop the operation of other devices or relocate this product before using this product or do not use this product around the other wireless devices. .

3. Support Conditions

ⅰ) In the case that customer requests KAGA FEI to customize the hardware of this Product in order to meet such customer' s specific needs, KAGA FEI will make commercially reasonable effort to modify such hardware or software at customer' s expense; provide however, the customer is kindly requested to agrees it doesn' t mean that KAGA FEI has obligations to do so even in the case it is technically difficult for KAGA FEI.

ⅱ) Any failure arising out of this Product will be examined by KAGA FEI regardless of before or after mass production. Customer agrees that once such failure is turned out not to be responsible for KAGA FEI after aforesaid examination, some of the technical support shall be conducted by KAGA FEI at customer' s expense; provided however, exact cost of this technical support can be agreed through the negotiation by the parties.

ⅲ) Do not alter hardware and/or software of this Product. Please note that KAGA FEI shall not be liable for any problem if it is caused by customer's alteration of Hardware without KAGA FEI 's prior approvals.

ⅳ) KAGA FEI does not guarantee functions and performances which depend on the customer's firmware. KAGA FEI does not assume liabilities for defects and failures.

4. Term of Warranty

KAGA FEI warrants only that this Product is in conformity with this Specification for one year after purchase and shall in no event give any other warranty.

5. Items of the Specification

Any question arising from the Specification shall be solved in good faith through mutual discussion by the parties hereof.

6. Caution for Export Control

ｉ) This Product may be subject to governmental approvals, consents, licenses, authorizations, declarations, filings, and registrations for export or re-export as required by Japanese Foreign Exchange and Foreign Trade Law (including related laws and regulations) and/or any other country's applicable laws or regulations related to export control.

ⅱ) If this Product will be exported or re-exported, it is strongly recommended that customers check and confirm the necessary procedures to export or re-export this Product as required by applicable laws and regulations, and if necessary, customers must obtain the necessary and appropriate approvals or licenses from governmental authority at their own risk and expense..

2 Electrical Characteristics

2.1 Absolute Maximum Ratings

Item	Symbol	Rating		Unit	Remark
		Min.	Max.		
Supply voltage	VBAT	-	3.96	V	
	VPA	-	3.96	V	
IO voltage	VIO_1	-	3.96	V	
	VIO_2+3	-	3.96	V	
	VIO_6	-	3.96	V	
Storage temperature range	Tstg	-40	85	Degrees C	

2.2 Recommended Operating Conditions

Item		Symbol	Rating			Unit	Remark
			Min.	Typ.	Max.		
Supply voltage		VBAT	3.14	3.3	3.46	V	
		VPA	3.14	3.3	3.46	V	
IO voltage 1	3.3V	VIO_1_3V3	3.14	3.3	3.46	V	
	1.8V	VIO_1_1V8	1.71	1.8	1.89	V	
IO voltage 2	3.3V	VIO_2+3_3V3	3.14	3.3	3.46	V	
	1.8V	VIO_2+3_1V8	1.71	1.8	1.89	V	
IO voltage 3	3.3V	VIO_6_3V3	3.14	3.3	3.46	V	
	1.8V	VIO_6_1V8	1.71	1.8	1.89	V	
Operating temperature range		Topr	-40	25	85	Degrees C	

2.3 Embedded Memory Specifications

Item	Rating			Unit	Remark
	Min.	Typ.	Max.		
Write/Erase Cycle	100,000	-	-	Times	

2.4 Interfaces

Features

- Up to four configurable universal serial interface modules (Flexcomm interfaces), supporting SPI / I²C / I²S / UARTSDIO 3.0
- High Speed USB 2.0 On-The-Go (OTG),with integrated PHY
- 16-bit ADC and 10-bit DAC
- 32-bit general-purpose timer/PWM

2.4.1. Universal Synchronous/ Asynchronous Receiver Transmitter (USART/ UART)

- Maximum UART bit rate: 6.25 Mbit/s
- Maximum USART bit rate: 20 Mbit/s
- Built-in baud rate generator and auto-baud detection
- Supports RTS/CTS hardware signals for automatic flow control

2.4.2. Serial Peripheral Interface (SPI)

- Maximum SPI bit rate: 30 Mbit/s
- Supports both controller and target modes

2.4.3. Inter-Integrated Circuit (I2C)

- Supports Standard, Fast-mode, and Fast-mode Plus: up to 1 Mbit/s
- Supports High-speed target mode: up to 3.4 Mbit/s
- Consists of Serial Data Line (SDL) and Serial Clock Line (SCL)
- Software-configurable 10-bit addressing
- Independent controller, target, and monitor functionality

2.4.4 Inter-IC Sound (I2S)

- I²S interface consists of Bit Clock (SCK), Word Select / Frame Trigger (WS), and Serial Data (SDA) lines

2.4.5 Analog-to-Digital Converter (ADC)

- The WKR612AA1 features an ADC with up to 16-bit resolution. Each ADC allows independent configuration of input channels and reference voltage.

    - Selectable resolution: 12, 14, or 16 bits
    - Supports single-ended and differential conversion
    - Configurable ADC gain: 0.5×, 1×, 2×
    - Selectable reference voltage (Vref)
        - Internal reference 1.2V (Vref_12)
        - Internal reference 1.8V (Vref_18)
        - External reference (1.8V must not exceed)

2.4.6 Digital-to-Analog Converter (DAC)

- The WKR612AA1 includes a 10-bit resolution DAC with two channels. Each channel supports single-ended output, and the two channels can be combined to output differential signals.
    - Supports generation of various waveforms (e.g., sine, triangle) across a wide frequency range
    - Selectable output modes: single-ended or differential
    - Supports internal or external reference voltage
    - Three selectable output ranges
    - Event triggering supported via GPT (General Purpose Timer) or GPIO

2.4.7 General-Purpose Input/Output (GPIO)

- The WKR612AA1 provides 34 GPIO pins.

2.5 Power Consumption

The Specification applies for Topr.= 25 degrees C, Supply voltage=Typical voltage

No.	Parameter	Condition	Symbol	Min.	Typ.	Max.	Unit	Remark
1	Peak Current	device initialization	Ip1	-	550	-	mA	
2	Tx Current1	Burst Tx 2.4GHz 11b CCK-11	Itx1	-	270	-	mA	+16dBm
3	Tx Current2	Burst Tx 5GHz 11a 54M	Itx2	-	380	-	mA	+15dBm
4	Tx Current3	Bluetooth® LE 2M Tx	Itx3	-	130	-	mA	+6dBm
5	Tx Current4	802.15.4 TX O-QPSK 250kbps	Itx4	-	130	-	mA	+6dBm
6	Rx Current1	Wi-Fi 2.4G Rx	Irx1	-	85	-	mA	
7	Rx Current2	Wi-Fi 5G Rx	Irx2	-	100	-	mA	
8	Rx Current3	Bluetooth® LE Rx	Irx3	-	110	-	mA	
9	Rx Current4	802.15.4 Rx	Irx4	-	110	-	mA	
10	Sleep Current	Wi-Fi subsystem in sleep mode, RAM retention	Iwslp	-	0.21	-	mA	Wi-Fi mode

2.6 DC Characteristics

Digital Pad (SDIO, PCM, GPIO) (VIO= 1.8 / 3.3V)

No.	Parameter	Condition	Symbol	Min.	Typ.	Max.	Unit	Remark
1	Input High Voltage		VIH	0.7xVIO		VIO+0.4	V	
2	Input Low Voltage		VIL	-0.4		0.3xVIO	V	
3	Output High Voltage		VOH	VIO-0.4		-	V	
4	Output Low Voltage		VOL	-		0.4	V	

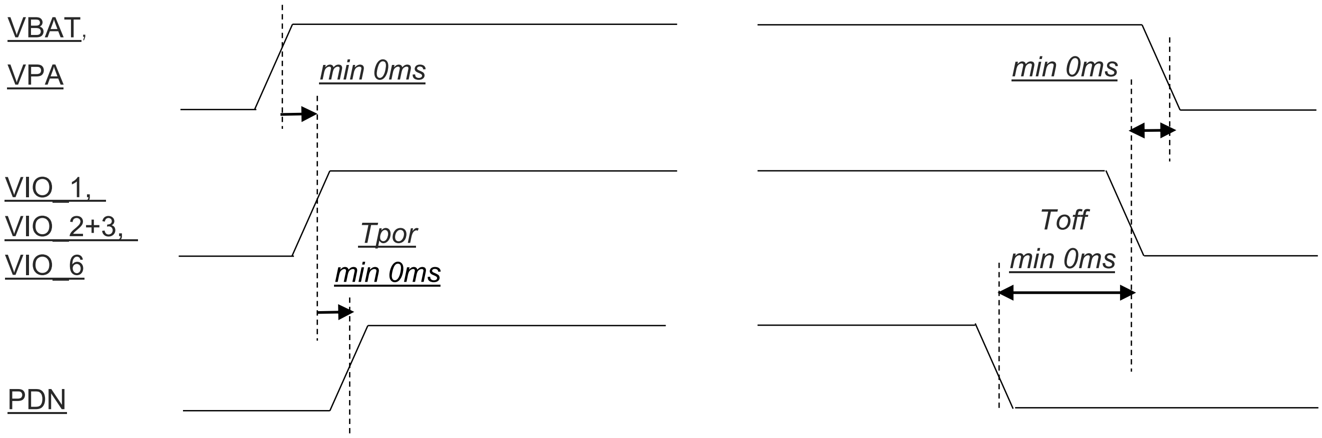
2.7 AC Characteristics

2.7.1 Power on sequence

Power-on timing / External sleep clock [Voltage level for SLP_CLK should be 1.8V]

	Parameter	Condition	Symbol	Min	Typ	Max	Unit	Remark
1	Valid Power to PDn de-asserted		Tpor	0			ms	
2	PDN down to Power off		Toff	0			ms	

<Power-On Sequence>
VBAT and VPA must be powered on before VIO.
The PDN signal must remain asserted for at least Tpor after VBAT, VPA, VIO_1, VIO_2+3, and VIO_6 have stabilized.



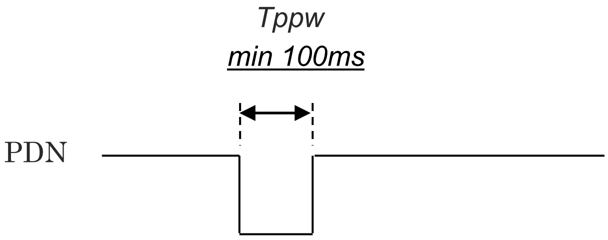
Power-On Sequence.　　Power-Off Sequence

2.7.2 Power down sequence

Power down (PDn)

	Parameter	Condition	Symbol	Min	Typ	Max	Unit	Remark
1	PDn pulse width		Tppw	100			ms	
2	V_{IH} (Input high voltage)			1.75		3.63	V	
3	V_{IL} (Input low voltage)			-0.4		0.2	V	

1. PDn should be asserted while VBAT/VPA/VIO_1/VIO_2+3/VIO_6 are stable.



2.7.3 External Sleep Clock

	Parameter	Condition	Symbol	Min	Typ	Max	Unit	Remark
1	Clock frequency			-	32.768	-	kHz	
2	Frequency accuracy			-20	-	+20	ppm	
3	Temperature tolerance(-40 to 120℃)			-	0.0192	-	%	
4	Duty cycle			46.7	47.4	49.7	%	
5	Crystal ESR resistance			-	50	80	kΩ	

2.8 RF Characteristics

2.8.1 WLAN 2.4GHz Band

The Specification applies for Topr.= 25 degrees C, Supply voltage=Typical voltage

No.	Parameter	Condition	Min	Typ	Max	Unit	Remark
1	RF frequency range		2412	-	2472	MHz	
2	Supported Bandwidth		-	20	-	MHz	
3	Transmitter Performance						
	Transmit Frequency Error		-25	-	25	ppm	
	Tx Power	11b, 11Mbps	-	16	-	dBm	Tolerance :±2dB
		11g, 54Mbps	-	15	-		
		11n, HT20, MCS7	-	15	-		
		11ax, HE20, MCS9	-	15	-		
4	Receiver Performance						
	Rx sensitivity	11b, 11Mbps	-	-88.4	-	dBm	
		11g, 54Mbps	-	-74.7	-		
		11n, HT20, MCS7	-	-72.6	-		
		11ax, HE20, MCS9	-	-66.5	-		
	Receiver maximum input level DSSS	802.11b DSSS MIL 802.11b CCK MIL	-	-0.2	-	dBm	
	Receiver maximum input level OFDM	OFDM MIL	-	-5	-	dBm	

2.8.2 WLAN 5GHz Band

The Specification applies for Topr.= 25 degrees C, Supply voltage=Typical voltage

No.	Parameter	Condition	Min	Typ	Max	Unit	Remark
1	RF frequency range		5180	-	5825		
2	Supported Bandwidth		-	20	-		
3	Transmitter Performance						
	Transmit Frequency Error		-20	-	20		
	Tx Power	11a, 54Mbps	-	15	-	dBm	Tolerance :±2dB
		11n, HT20, MCS7	-	15	-		
		11ac, VHT20, MCS8	-	13	-		
		11ax, HE20, MCS9	-	13	-		
4	Receiver Performance						
	Rx sensitivity	11a, 54Mbps	-	-74.8	-	dBm	
		11n, HT20, MCS7	-	-72.9	-		
		11ac, VHT20, MCS8	-	-69.2	-		
		11ax, HE20, MCS9	-	-66.3	-		
	Receiver maximum input level OFDM	OFDM MIL	-	-7	-	dBm	

2.8.3 Bluetooth® LE

The Specification applies for Topr.= 25 degrees C, Supply voltage =Typical voltage.

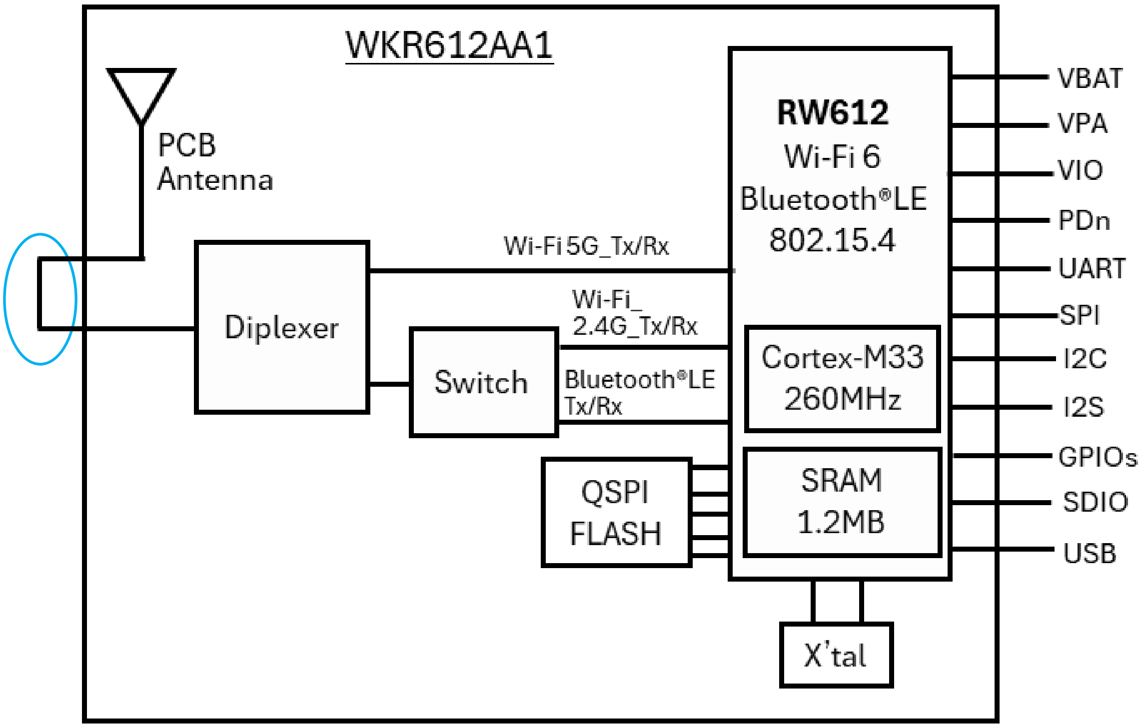
No.	Parameter	Condition	Min	Typ	Max	Unit	Remark
1	RF frequency range		2402	-	2480	MHz	
2	Tx Power		-	6	-	dBm	
3	Rx Sensitivity	Bluetooth® LE 1M	-	-99.9	-	dBm	
		Bluetooth® LE 2M	-	-99.0	-		
		Bluetooth® LE Coded 125k	-	-106.5	-		
4	Receiver maximum input level	Bluetooth® LE 1M	-	-3	-	dBm	
		Bluetooth® LE 2M	-	-3	-		
		Bluetooth® LE Coded 125k	-	-3	-		
		Bluetooth® LE Coded 500k	-	-3	-		

2.8.4 IEEE802.15.4

The Specification applies for Topr.= 25 degrees C, Supply voltage =Typical voltage.

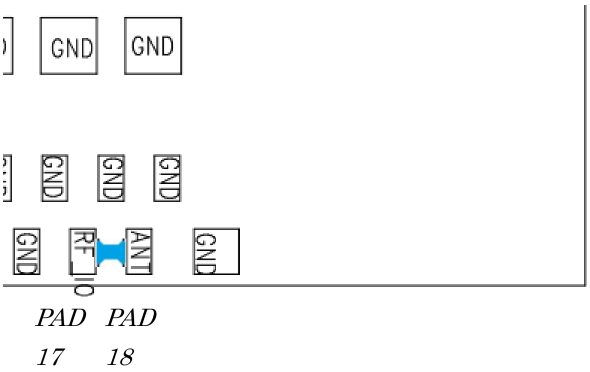
No.	Parameter	Condition	Min	Typ	Max	Unit	Remark
1	RF frequency range		2405	-	2480	MHz	
2	Tx Power		-	6	-	dBm	
3	Rx Sensitivity		-	-103.2	-	dBm	
4	Receiver maximum input level		-	3	-	dBm	

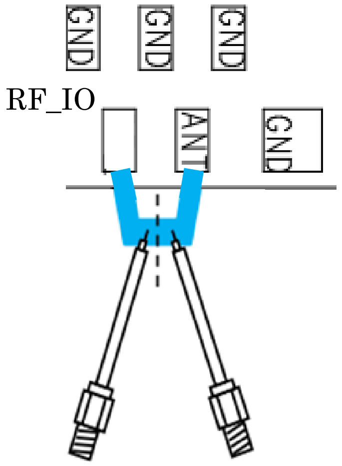
3 Block Diagram



When using the module's built-in antenna, it is recommended to connect PAD17 (RF_IO) and PAD18 (ANT) with the shortest possible trace length.

If it is necessary to measure antenna performance or RF conducted performance, a tie line connecting PAD17 (RF_IO) and PAD18 (ANT) should be routed outside the module in advance.
For measurement, disconnect the tie line and connect an RF coaxial cable to the signal line.



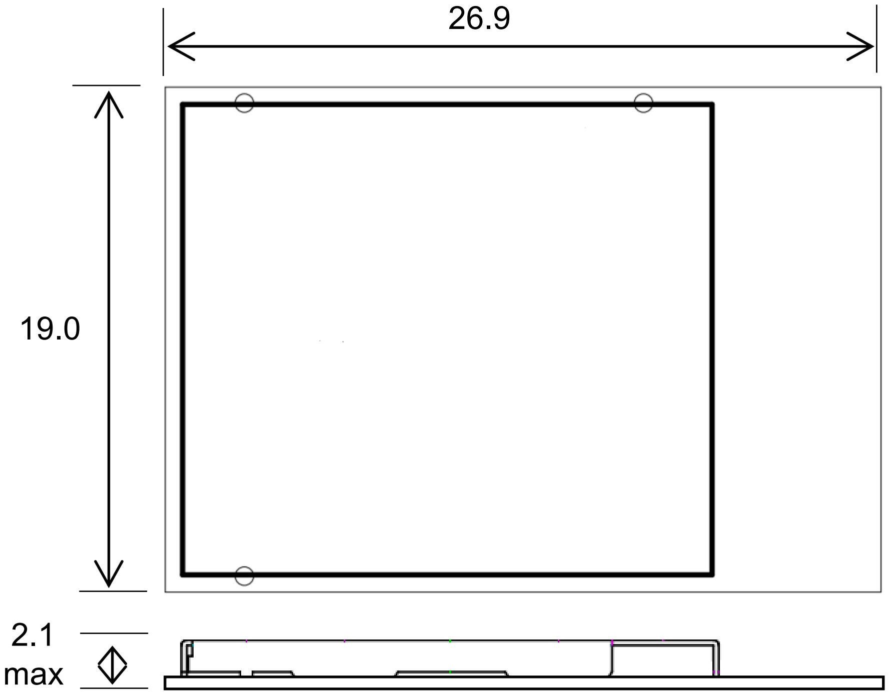


RF connector cable

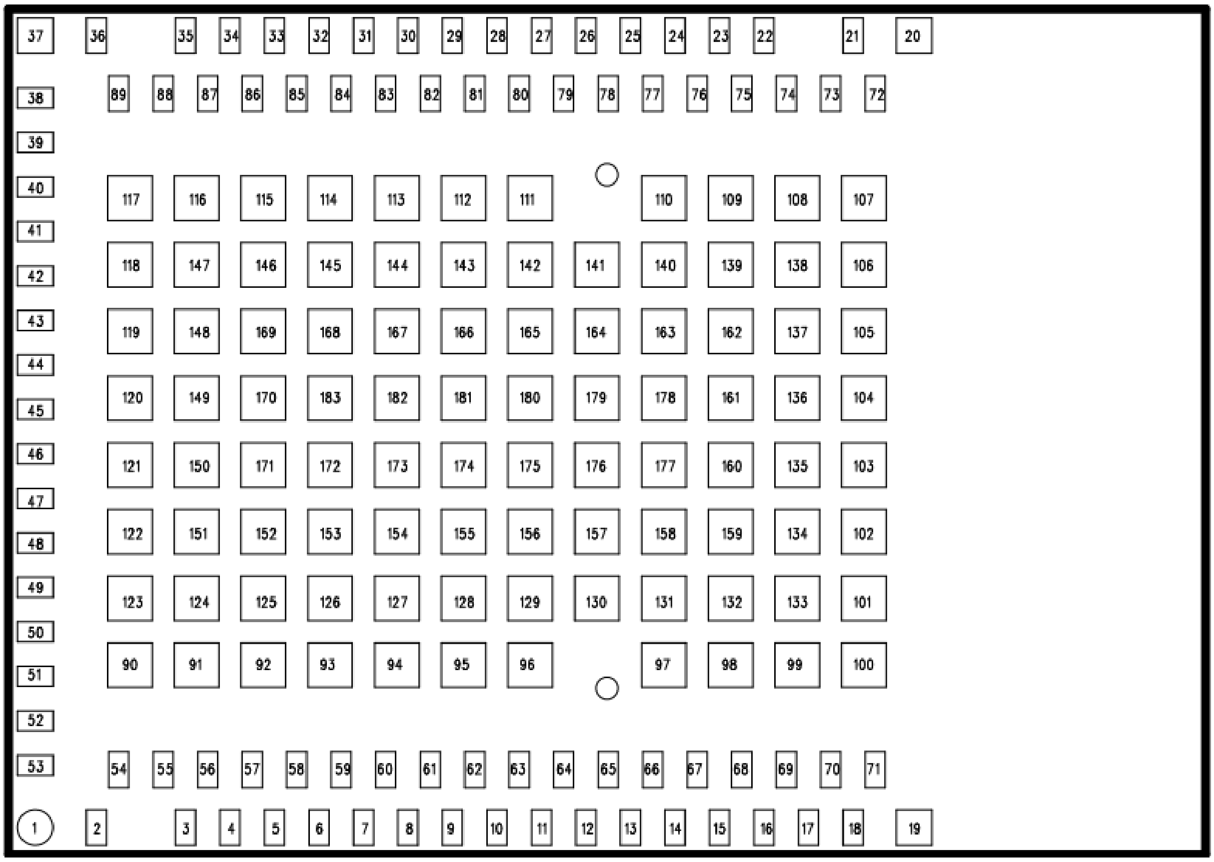
4. Mechanical Outline

4.1 Outline Dimensions

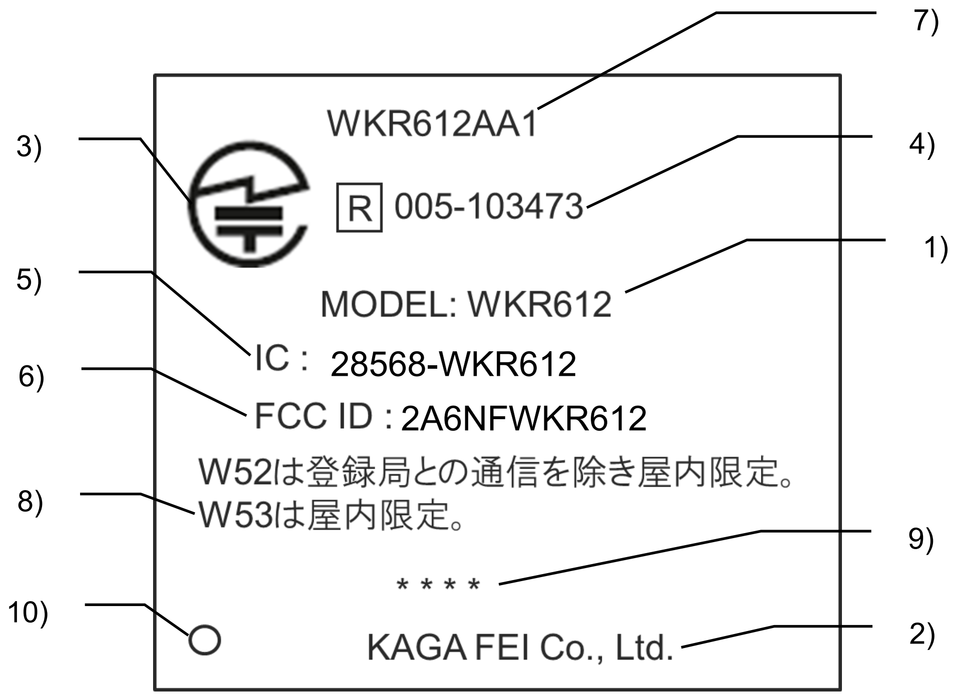
Unit: mm Unless otherwise specified, tolerance: ±0.2 mm



Pin Number (TOP VIEW)



4.2 Shield Case Marking

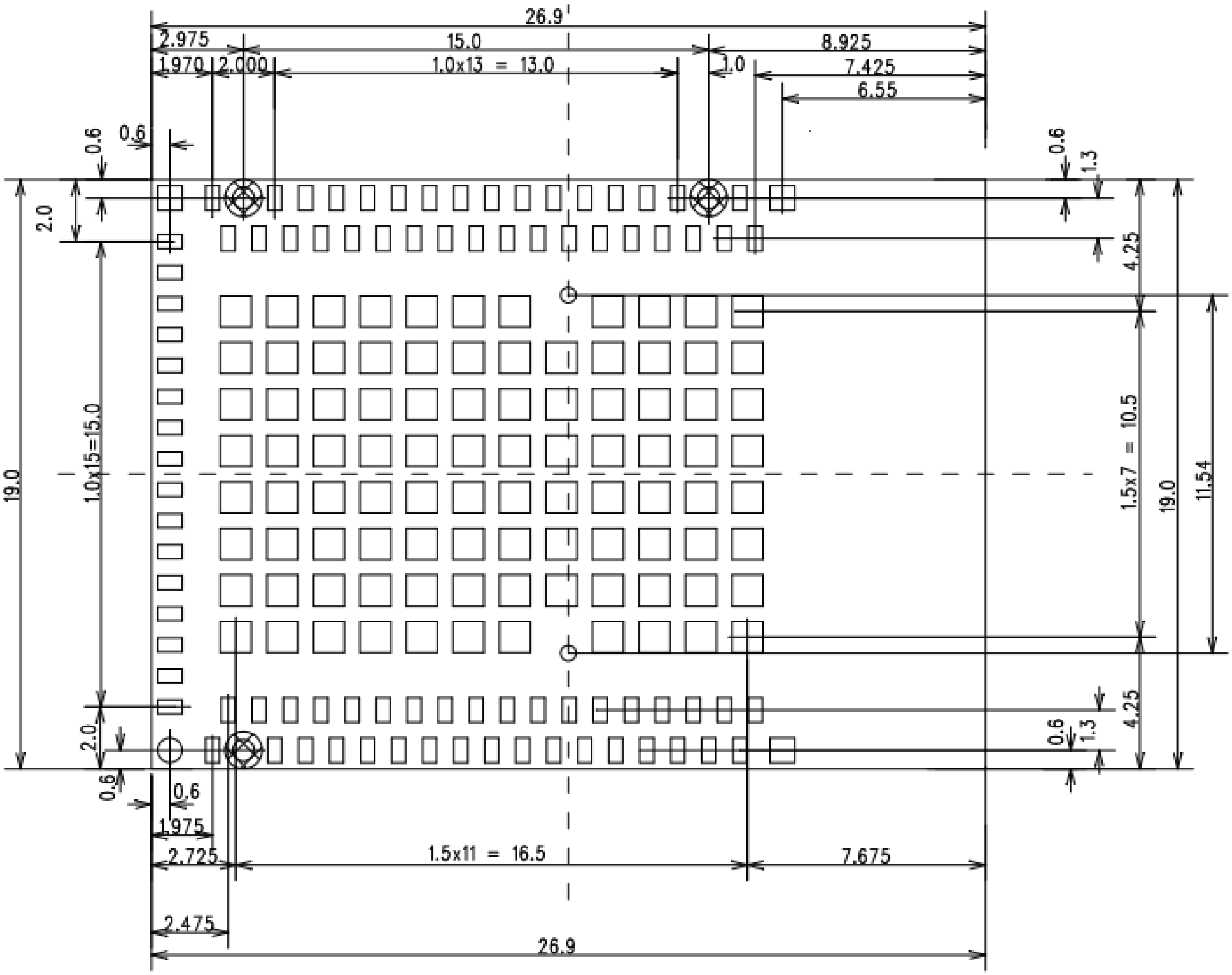


1)	Model	: WKR612
2)	Manufacture	: KAGA FEI Co., Ltd.
3)	Japan technical conformity mark	
4)	Technical Standards Conformity Certification Number for Japan	: 005−103473
5)	ISED certification number	: 28568−WKR612
6)	FCC Identifier	: 2A6NFWKR612
7)	Part Number	: WKR612AA1
8)	Note	: W52 は登録局との通信を除き屋内限定。W53 は屋内限定。
9)	Lot number	: Four digits
10)	Pin 1 mark	: O

4.3 Module Pad Dimensions

Unit: mm **Unless otherwise specified, tolerance: ±0.2 mm**

(TOP VIEW)



Signal pad (85) : 0.45 x 0.8 mm
Corner pad (1) : ϕ0.8 mm
Corner pad (3) : □0.8 mm
Center pad (94) : □1.0 mm
Fiducial mark (2) : ϕ0.5 mm

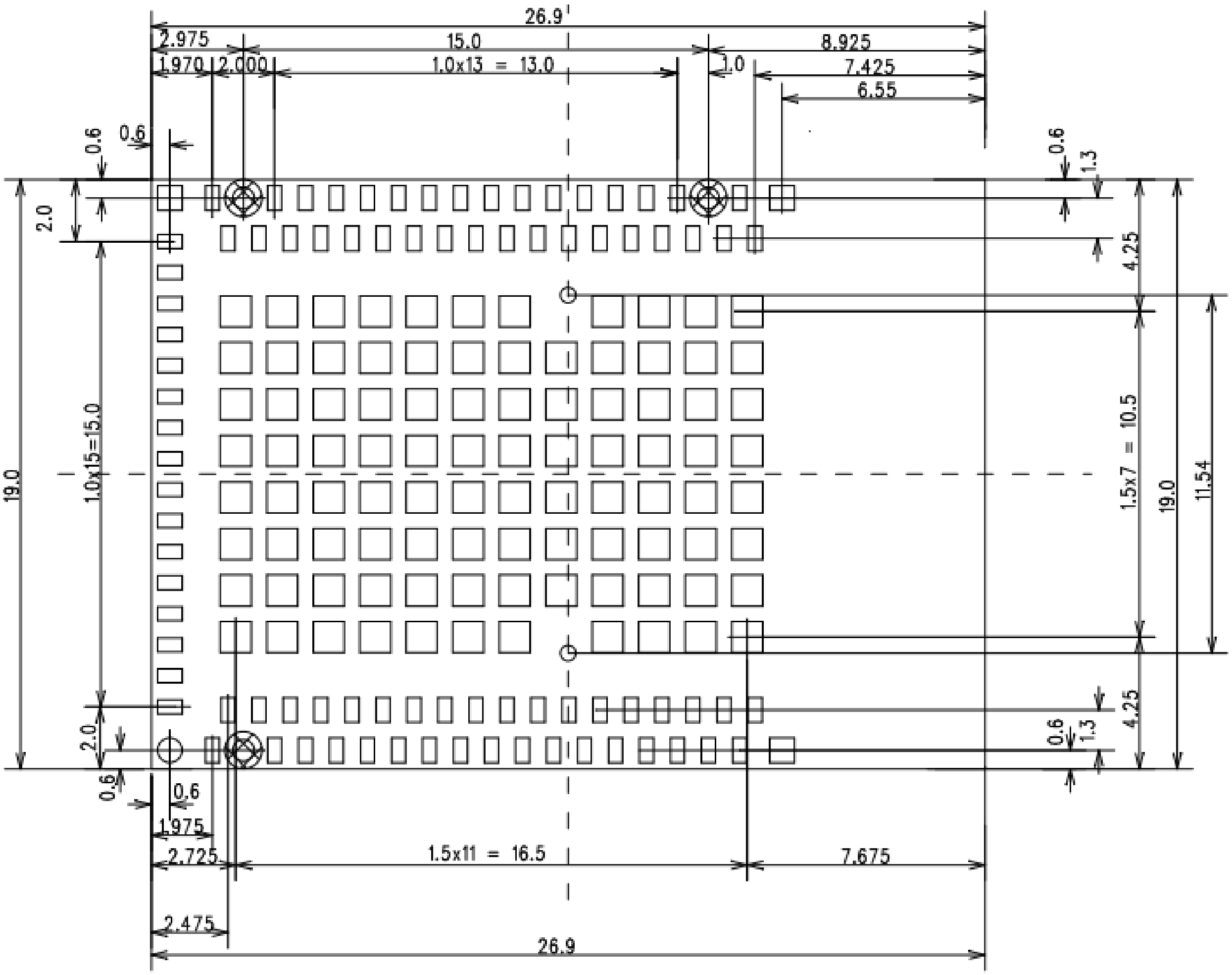
4.4 Recommended Land Pattern Dimensions

It is recommended that the pad size on the motherboard be the same as that of the module.

4.5 Recommended Solder Paste Stencil Dimensions

Please refer to the dimensions below for the stencil design.
A metal mask thickness of **0.1 mm** is recommended.

Unit: mm



Signal pad (85) :	0.45 x 0.8 mm
Corner pad (1) :	ϕ0.65 mm
Corner pad (3) :	□0.65 mm
Center pad (94) :	□1.0 mm

5 Pin Configuration

Pin No.	Module pin name	Type	Power domain	Description	Remark
1	GND	-	Ground	GND	-
2	GPIO[5]	I/O	VIO_1	General Purpose I/O 5/ MCLK/FC0_RTS_SCL_SSELN1_USART	-
3	GPIO[6]	I/O	VIO_1	General Purpose I/O 6/ JTAG_TCK/FC1_CTS_SDA_SSELN0_USART//FC1_CTS_SDA_SSELN0_SPI	-
4	GPIO[9]	I/O	VIO_1	General Purpose I/O 9/ JTAG_TDO/ FC1_RXD_SDA_MOSI_DATA_USART/ FC1_RXD_SDA_MOSI_DATA_I2C/ FC1_RXD_SDA_MOSI_DATA_I2S/ FC1_RXD_SDA_MOSI_DATA_SPI	-
5	CONFIG_HOST[3]	I	AVDD18	Host configuration pin [3]. Please see Table-1./ EXT_FREQ	-
6	CONFIG_HOST[2]	I	AVDD18	Host configuration pin [2]. Please see Table-1./ EXT_PRI	-
7	CONFIG_HOST[1]	O	AVDD18	Host configuration pin [1] . Please see Table-1./ EXT_GNT	-
8	CONFIG_HOST[0]	I	AVDD18	Host configuration pin [0] . Please see Table-1./ EXT_REQ	-
9	GPIO[12]	I/O	VPA	General Purpose I/O 12/ USB_DRV_VBUS/ CT0_MAT2/ CT_INP2/SD_HOST_INT	-
10	RESERVED2	-	-	No Connect. Should be left open.	-
11	GND	-	Ground	GND	-
12	RF_CNTL3	O	VPA	RF front-end control line 3.	-
13	VPA	I	Power	3.3V analog power supply	-
14	GND	-	Ground	GND	-
15	RF_CNTL1	O	VPA	RF front-end control line 1.	-
16	GND	-	Ground	GND	-
17	RF_IO	I/O	-	RF I/O pin. It should be connected to Pin 18 for using internal antenna.	-
18	ANT	I/O	-	Internal antenna I/O pin. It should be connected to Pin 17 for using internal antenna.	-
19	GND	-	Ground	GND	-
20	GND	-	Ground	GND	-
21	GPIO[49]	I/O	VIO_6	General Purpose I/O 49/ LCD SPI mode/ADC0_7/ADC1_7/ACOMP7/ Secure GPIO mode	-
22	VIO_6	I	Power	Digital I/O power supply	-
23	GPIO[2]	I/O	VIO_6	General Purpose I/O 2/ FC0_RXD_SDA_MOSI_DATA_USART/ FC0_RXD_SDA_MOSI_DATA_I2C/ FC0_RXD_SDA_MOSI_DATA_I2S/ FC0_RXD_SDA_MOSI_DATA_SPI	-
24	GPIO[3]	I/O	VIO_6	General Purpose I/O 3/ SCT0_OUT0/SCT0_PIN_INP0 FC0_TXD_SCL_MISO_WS_USART/ FC0_TXD_SCL_MISO_WS_I2C/ FC0_TXD_SCL_MISO_WS_I2S/ FC0_TXD_SCL_MISO_WS_SPI	-
25	GPIO[4]	I/O	VIO_6	General Purpose I/O 4 Coexistence mode/ SCT0_OUT1/SCT0_PIN_INP1/CLKIN_FRM_PD/FC0_SCK_USART/ FC0_SCK_I2S/ FC0_SCK_SPI	–

Pin No.	Module pin name	Type	Power domain	Description	Remark
26	PDN	I	VBAT	RESET signal (Active low) Pulled up to VBAT with 51kohm register inside the module	-
27	VBAT	I	Power	Input power supply to internal buck regulators	-
28	GND	-	Ground	GND	-
29	USB_DP	I/O	VBAT	USB bus data +	-
30	USB_DM	I/O	VBAT	USB bus data -	-
31	GND	-	Ground	GND	-
32	USB_VBUS	I/O	Power	VBUS selection, 5V analog power supply	-
33	GPIO[44]	I/O	VIO_6	General Purpose I/O 44/ DAC_A/ADC0_2/ACOMP2/LCD SPI mode /Secure GPIO mode	-
34	GPIO[42]	I/O	VIO_6	General Purpose I/O 42/ ADC0_0/ACOMP0 /Secure GPIO mode	-
35	GPIO[23]	I/O	VIO_2+3	General Purpose I/O 23/ AON_XTAL32K_OUT/SCT0_PIN_INP3/ENET_RX_DATA1	-
36	GND	-	Ground	GND	-
37	GND	-	Ground	GND	-
38	GPIO[25]	I/O	VIO_2+3	General Purpose I/O 25/ AON_WAKEUP/CT1_MAT3/CT_INP7/ ENET_CLK/ FC3_SCK_USART/ FC3_SCK_I2S/FC3_SCK_SPI	-
39	GPIO[26]	I/O	VIO_2+3	General Purpose I/O 26/ AON_CAPT/SCT0_OUT4/SCT0_PIN_INP4/ENET_TIMER3/FC3_TXD_SCL_MISO_WS_USART/FC3_TXD_SCL_MISO_WS_I2C/FC3_TXD_SCL_MISO_WS_I2S/FC3_TXD_SCL_MISO_WS_SPI	-
40	GPIO[27]	I/O	VIO_2+3	General Purpose I/O 27/ AON_OUT/SCT0_OUT5/SCT0_PIN_INP5/ENET_TIMER0	-
41	GPIO[14]	I/O	VIO_2+3	General Purpose I/O 14/ CT_INP4/CT1_MAT0/SWDIO/FC2_TXD_SCL_MISO_WS_USART/FC2_TXD_SCL_MISO_WS_I2C/FC2_TXD_SCL_MISO_WS_I2S/FC2_TXD_SCL_MISO_WS_SPI	-
42	GPIO[13]	I/O	VIO_2+3	General Purpose I/O 13/ CT_INP3/CT0_MAT3/SWCLK/FC2_RXD_SDA_MOSI_DATA_USART/FC2_RXD_SDA_MOSI_DATA_I2C/FC2_RXD_SDA_MOSI_DATA_I2S/FC2_RXD_SDA_MOSI_DATA_SPI	-
43	GND	-	Ground	GND	-
44	GPIO[15]	I/O	VIO_2+3	General Purpose I/O 15/ SD_CLK/UTICK_CAP0/UCLK/FC2_SCK_USART/FC2_SCK_I2S/FC2_SCK_SPI	-
45	GPIO[16]	I/O	VIO_2+3	General Purpose I/O 16/ SDIO_DATA3/UTICK_CAP1/URST/FC2_CTS_SDA_SSELN0_USART/FC2_CTS_SDA_SSELN0_SPI/FC2_CTS_SDA_SSELN0_I2C_COPY	-
46	GPIO[17]	I/O	VIO_2+3	General Purpose I/O 17/ SDIO_CMD/UTICK_CAP2/UIO/FC2_RTS_SCL_SSELN1_USART/FC2_RTS_SCL_SSELN1_I2C_COPY	-
47	GPIO[18]	I/O	VIO_2+3	General Purpose I/O 18/ SDIO_DATA2/UTICK_CAP3/UVS/GPIO_INT_BMAT	-

Pin No.	Module pin name	Type	Power domain	Description	Remark
48	GPIO[19]	I/O	VIO_2+3	General Purpose I/O 19/ SDIO_DATA0/FC3_RTS_SCL_SSELN1_USART/FC3_RTS_SCL_SSELN1_I2C_COPY	-
49	GPIO[20]	I/O	VIO_2+3	General Purpose I/O 20/ SDIO_DATA1/FC3_CTS_SDA_SSELN0_USART/FC3_CTS_SDA_SSELN0_SPI/FC3_CTS_SDA_SSELN0_I2C_COPY	-
50	GND	-	Ground	GND	-
51	GPIO[7]	I/O	VIO_1	General Purpose I/O 7/ JTAG_TMS/FC1_SCK_USART/ FC1_SCK_I2S/ FC1_SCK_SPI	-
52	GPIO[8]	I/O	VIO_1	General Purpose I/O 8/ JTAG_TDI/FC1_TXD_SCL_MISO_WS_USART/FC1_TXD_SCL_MISO_WS_I2C/FC1_TXD_SCL_MISO_WS_I2S/FC1_TXD_SCL_MISO_WS_SPI	-
53	VIO_1	I	Power	Digital I/O power supply	-
54	GND	-	Ground	GND	-
55	RESERVED3	-	-	No Connect. Should be left open.	-
56	GPIO[10]	I/O	VIO_1	General Purpose I/O 10/ JTAG_TRSTN/ FC1_RTS_SCL_SSELN1_USART	-
57	GPIO[11]	I/O	VIO_1	General Purpose I/O 11/ SCT0_OUT8	-
58	GND	-	Ground	GND	-
59	GND	-	Ground	GND	-
60	GND	-	Ground	GND	-
61	RF_CNTL2	O	VPA	Configuration pin for debug access control. 0 = DAP uses SWD (To set a configuration bit to 0, pulled down to GND with 51kohm register outside the module). 1=DAP uses JTAG (default) RF front-end control line 2.	-
62 ~ 71	GND	-	Ground	GND	-
72	GPIO[50]	I/O	VIO_6	General Purpose I/O 50/ FREQME_GPIO_CLK/ADC_DAC_TRIGGER0/Secure GPIO mode: SPIO0[18]	-
73	GPIO[48]	I/O	VIO_6	General Purpose I/O 48/LCD SPI interface clock/ADC0_6/ADC1_6/ACOMP6/SPIO0[16]	-
74	GPIO[47]	I/O	VIO_6	General Purpose I/O 47/LCD SPI interface data/ADC0_5/ACOMP5/SPIO0[15]	-
75	RESERVED1	-	-	No Connect. Should be left open.	-
76 ~ 82	GND	-	Ground	GND	-
83	USB_ID	I	VBAT	USB OTG ID pin	-
84	GPIO[46]	I/O	VIO_6	General Purpose I/O 46/ LCD SPI interface data input_output/ADC0_4/ACOMP4/SPIO0[14]	-
85	GPIO[45]	I/O	VIO_6	General Purpose I/O 45/LCD tearing effect input signal used to synchronize MCU frame writing/ADC0_3/ACOMP3/EXT_VREF_ADC0_DAC/SPIO0[13]	-
86	GPIO[43]	I/O	VIO_6	General Purpose I/O 43/ADC0_1/ACOMP1/DAC_B/SPIO0[11]	-
87	GPIO[22]	I/O	VIO_2+3	General Purpose I/O 22/ AON_XTAL32K_IN/SLP_CLK_32K/SCT0_PIN_INP2/ENET_RX_DATA0	-

Pin No.	Module pin name	Type	Power domain	Description	Remark
88	GPIO[24]	I/O	VIO_2+3	General Purpose I/O 24/ AON_WAKEUP/CT1_MAT2/CT_INP6/ENET_TIMER2/FC3_RXD_SDA_MOSI_DATA_USART/ FC3_RXD_SDA_MOSI_DATA_I2C/FC3_RXD_SDA_MOSI_DATA_I2S/FC3_RXD_SDA_MOSI_DATA_SPI	-
89	VIO_2+3	I	Power	Digital I/O power supply	-
90 ~ 183	GND	-	Ground	GND	-

Table-1 Host Configuration Options

The definitions of these pins change to their normal functions immediately after reset.
To set a configuration bit to 0, connect a resistor of 51 kΩ or less between the pin and ground.
To set a configuration bit to 1, no external circuitry is required.

[Table-1]

Config Host				Boot
[3]	[2]	[1]	[0]	
1	1	1	1	Boot from FlexSPI Flash (default)
1	1	1	0	ISP boot (UART/I2C/SPI/USB)
1	1	0	1	Serial boot (UART/I2C/SPI/USB)
1	1	0	0	ISP boot (SDIO)
1	0	1	1	Serial boot (SDIO)
1	0	1	0	Reserved

6 Mac Address Format

The MAC and BD address are hexadecimal codes composed of either 6 bytes or 8 bytes.
These codes have been written into the OTP (One Time Programmable ROM) of the WKR612AA1.

Wireless Application	Upper 3 bytes						Lower 3 or 5 bytes							
	Manufacturer code						User code							
Wireless LAN	F	C	3	3	5	7	*	*	*	*	*	*	-	-
Bluetooth® LE	F	C	3	3	5	7	*	*	*	*	*	*	-	-
802.15.4	F	C	3	3	5	7	*	*	*	*	*	*	*	*

・Manufacturer Code : Unique hexadecimal code assigned to Kaga FEI. (FC:33:57)
Please note that the code may change in the future, but in that case,
it will be changed automatically without any notice to you.

・User Code : Arbitrary hexadecimal code assigned to each module.

7 Handling Precautions

This specification describes desire and conditions especially for mounting.

Desire/Conditions

(1) Environment conditions for use and storage

1. Store the components in an environment of **< 40deg-C/90%RH** if they are in a moisture barrier bag packed by KAGA FEI.
2. Keep the factory ambient conditions at **< 30deg-C/60%RH** .
3. Store the components in an environment of **< 25±5deg-C/10%RH** after the bag is opened.
   (The condition is also applied to a stay in the manufacture process).

(2) Conditions for handling of products

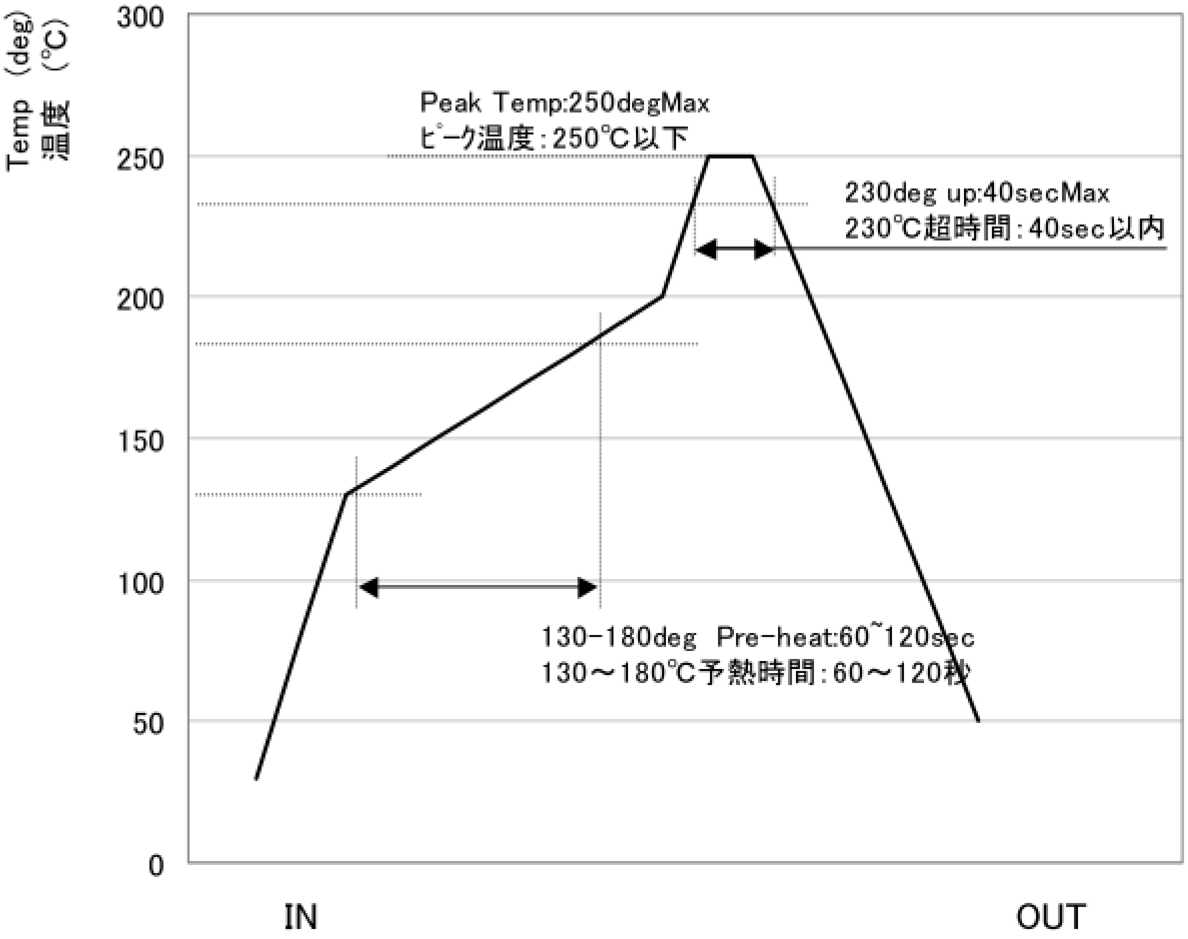
Make sure all of the moisture barrier bags have no holes, cracks or damages at receiving. If an abnormality is found on the bag, its moisture level must be checked in accordance with 2 in (2).

Refer to the label on the bag.

1. All of the surface mounting process (reflow process) must be completed **in 12 months** from the bag sea date.
2. Make sure humidity in the bag is less than **10%RH** immediately after open, using a humidity indicator card sealed with the components.
3. **All** of the surface mounting process (reflow process including rework process) must be completed in **168 hours** after the bag is opened (inclusive of any other processes).
4. If any conditions in (1) or condition 2 and 3 in (2) are not met, bake the components in accordance with the conditions at **125deg-C 24hours**.
5. As a rule, baking the components in accordance with conditions 4 in (2) shall be once.
6. Since semi-conductors are inside of the components, they must be free from static electricity while handled.(<100V) Use ESD protective floor mats, wrist straps, ESD protective footwear, air ionizers etc. , if necessary.
7. Please make sure that there are lessen mechanical vibration and shock for this module, and do not drop it.
8. Please recognize pads of back side at surface mount.
9. Washing the module is not recommended. If washing cannot be avoided, please test module functionality and performance after thoroughly drying the module.
   We cannot be held responsible for any failure due washing the module.

10. Please perform temperature conditions of module at reflow within the limits of the following ranges.
 Please give the number of times of reflow as a maximum of 2 times.

<u>Recommended Reflow Soldering Profile</u>



8 Packaging Specifications

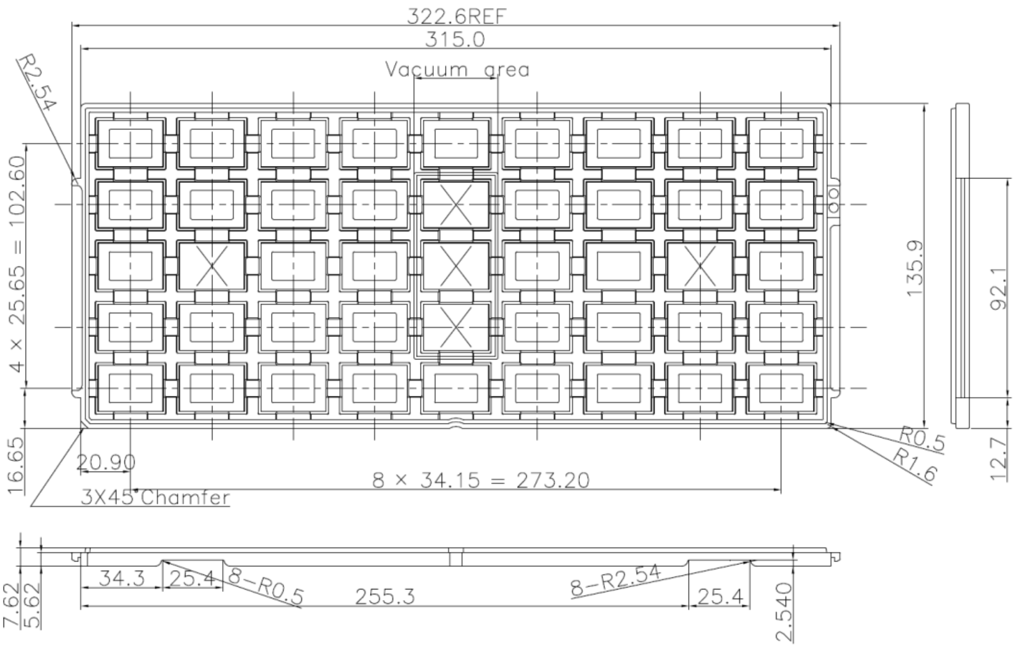
(1) Packaging Materials

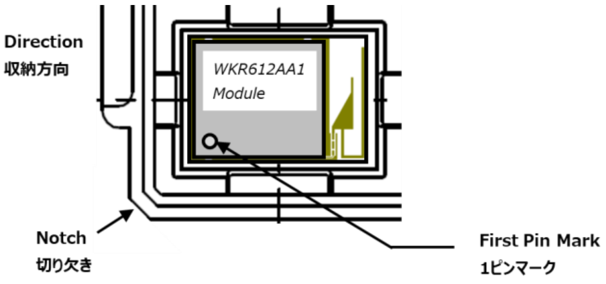
Name	Outline	Materials	Note
Tray	315 × 135.9 × 7.62(mm)	Conductive PPE	45 pieces/tray
Antistatic band	8mm wide	Antistatic PP	–
Desiccant	–	Desi-Pak	–
Humidity indicator card	–	–	–
Aluminum moisture barrier bag	260 × 460(mm)	(AS)PET / AL/NY / PE(AS)	–
Buffer corrugated paper	–	Corrugated fiberboard	–
Label	–	–	–
Corrugated cardboard box (Inner)	345 × 205 × 95(mm)	Corrugated fiberboard	–
Corrugated cardboard box (Outer)	436 × 361 × 220(mm)	Corrugated fiberboard	–

(2) Packaging Unit

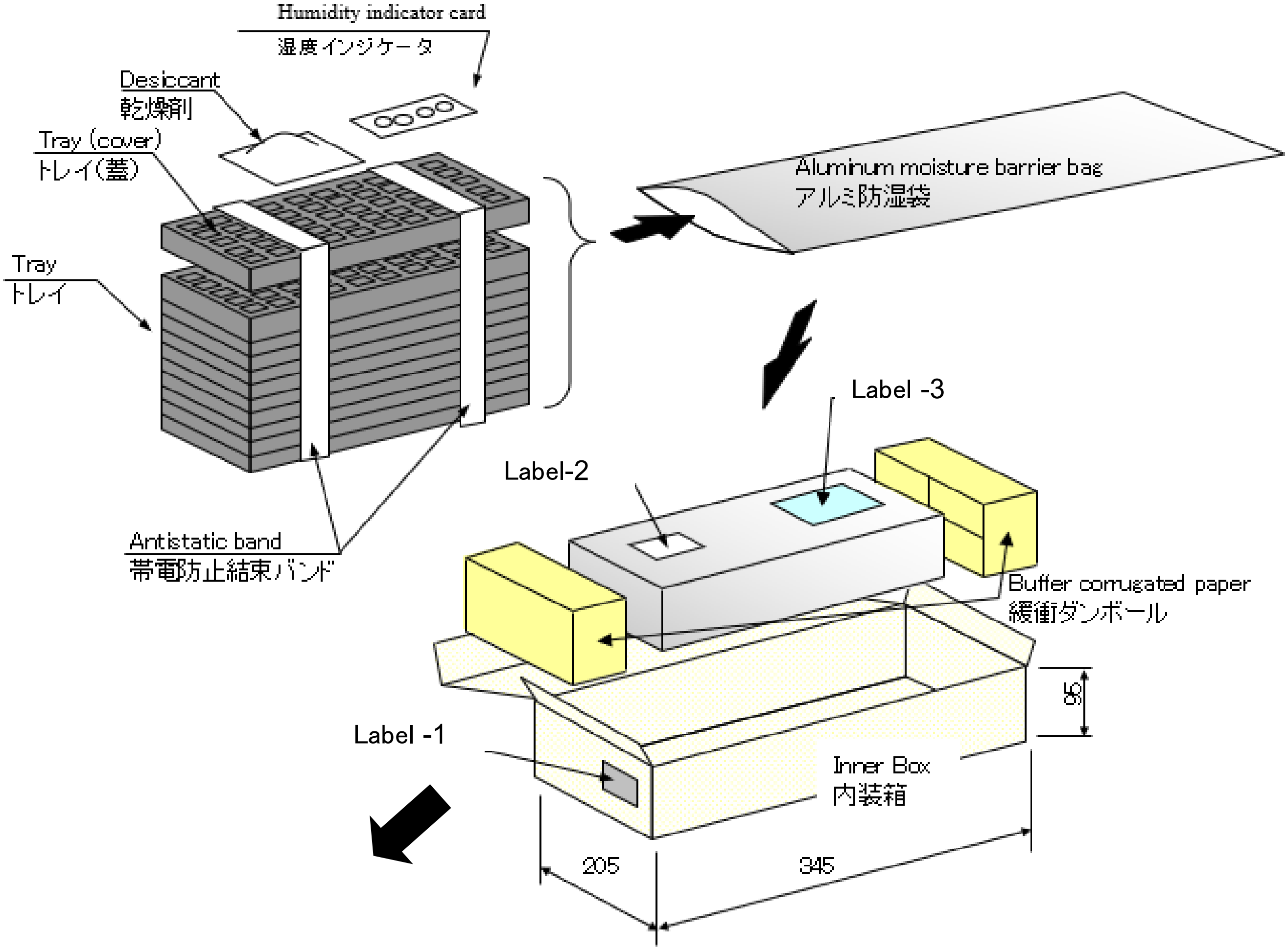
45 pieces/tray × 10 trays = 450 pieces

(3) Packaging Figure

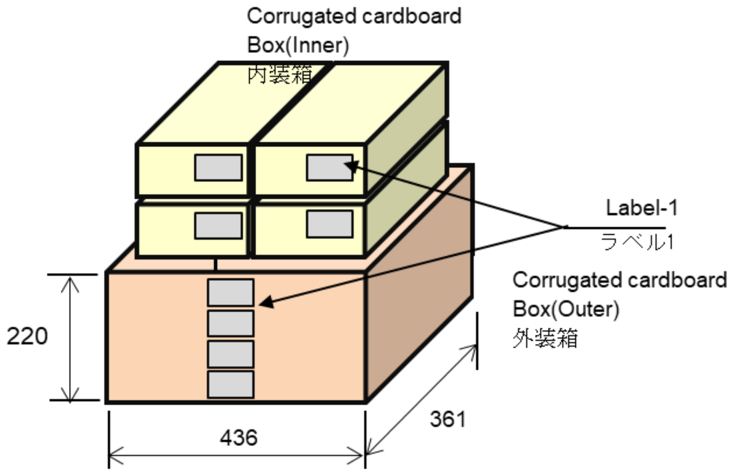




Inner Box
内装箱



Outer Box



(4) Label

Label−1

- ･Purchase order
- ･Part No.
- ･Quantity
- ･Lot No.
- ･Country of origin

Label−2

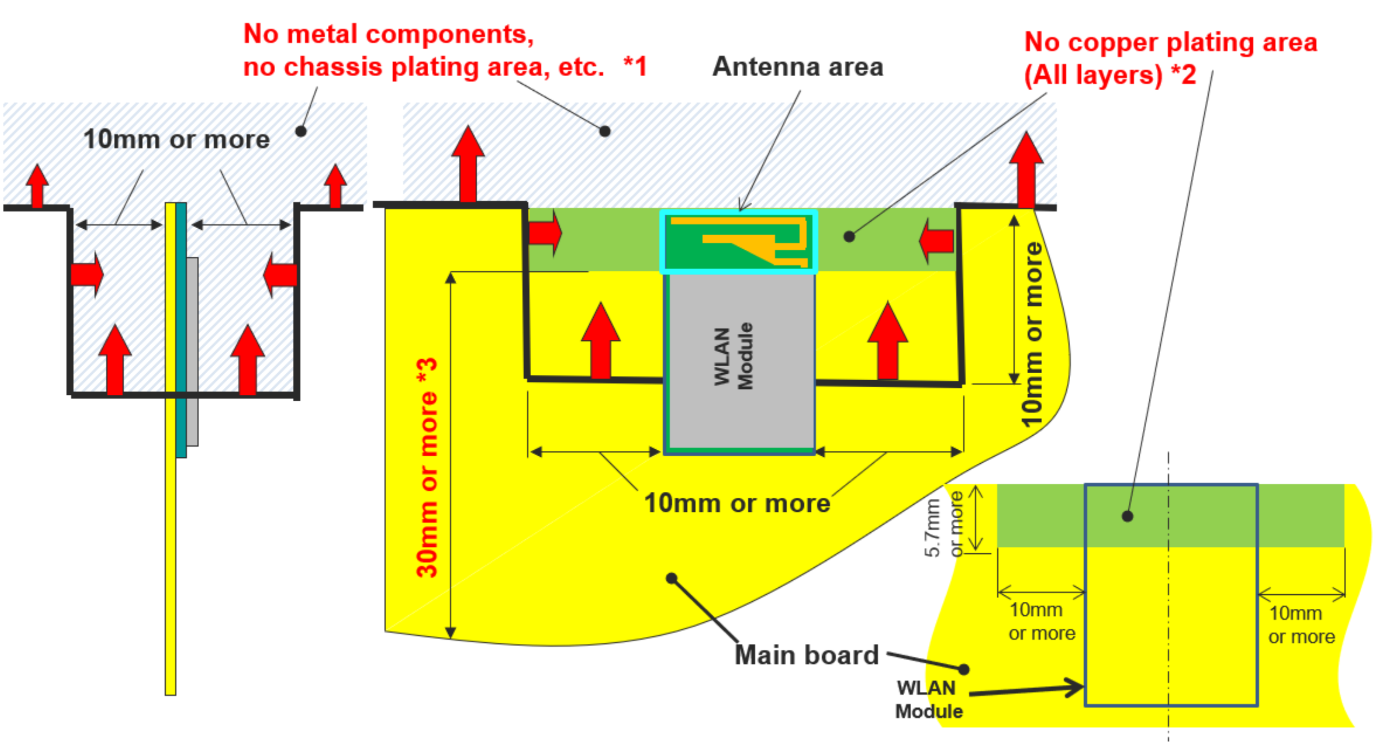
- ･Serial No.
- ･Part No.
- ･Quantity
- ･Country of origin

Label−3

- ･Caution label
- ･Moisture Sensitivity Level

9 Antenna Application Note

1. Recommended module mounting example



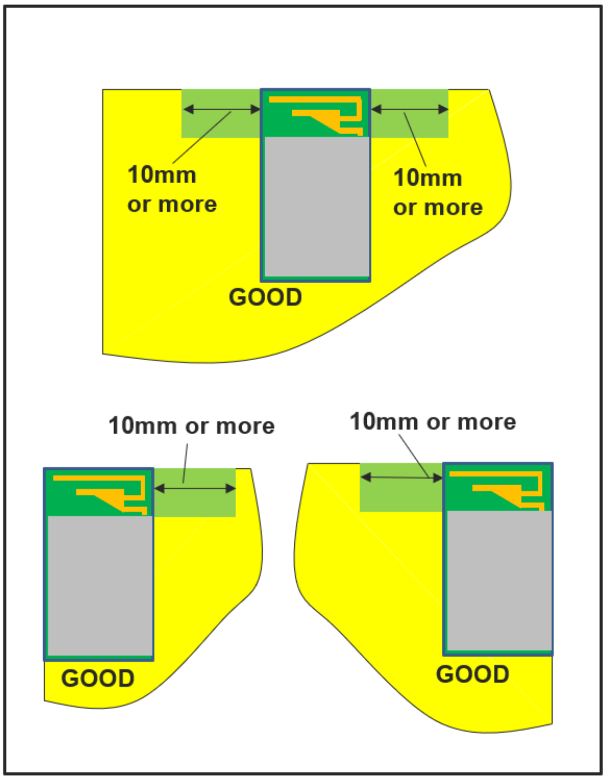
*1 Please do not place any metal components in blue shaded space.(*1) We do not recommend placing any metal objects upper space of the module in the above figure. If it needs to place metal objects, please consider keeing the metal off from the antenna as far as you can. Such as signal line and metal chassis as possible except for main board while mounting the components in *1 space on the main board is allowed except for no copper plating area. (*2).

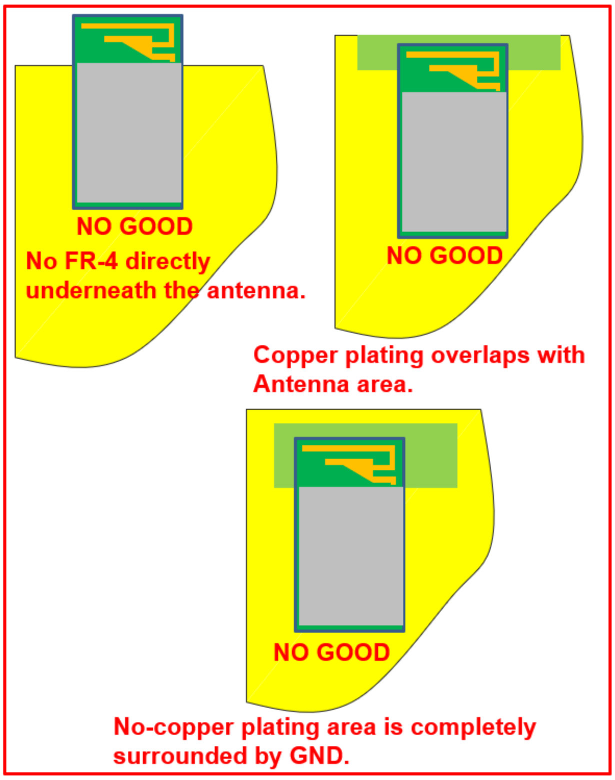
*2 This area is routing prohibited area on the main board. Please do not place copper on any layer. Please remain use of FR-4 dielectric material. The antenna is tuned with the FR-4.

*3 Characteristics may deteriorate when GND pattern length is less than 30mm. It should be 30 mm or more as possible.

Even when above mentioned condition is satisfied, communication performance may be significantly deteriorated depending on the structure of the product.

2. Other module mounting examples



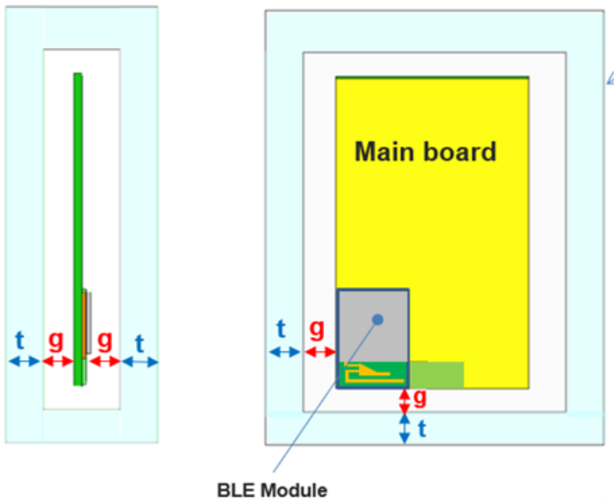


No FR-4 directly underneath the antenna.

Copper plating overlaps with Antenna area.

No-copper plating area is completely surrounded by GND.

3. Placement of resin or plastic parts



Resin or Plastic parts
(ex. Cover, Chassis, etc.)

t: Thickness of resin or plastic

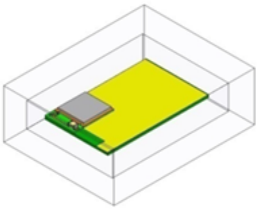
g: Distance between module and parts

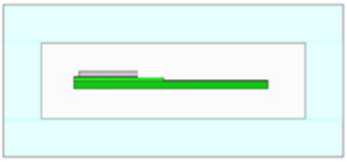
$g \geq t$

$g \geq 1.5$

$t < 5$

It is recommended that the design should be done in accordance with above formula.





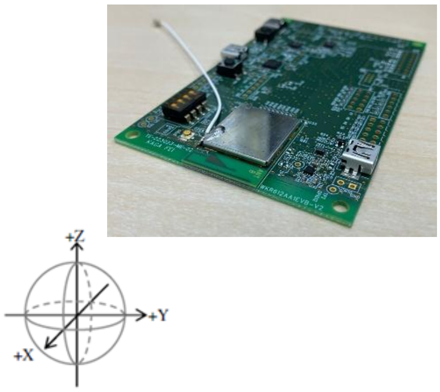
Please do not apply molding over the antenna area of WLAN module.

4. Directional characteristics example (when mounted on evaluation board)

2.4GHz Band

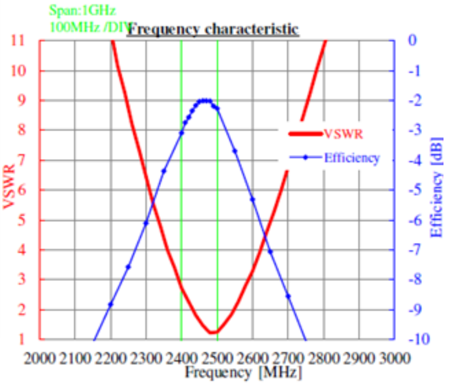
Measurement data of antenna

Appearance and coordinates definition

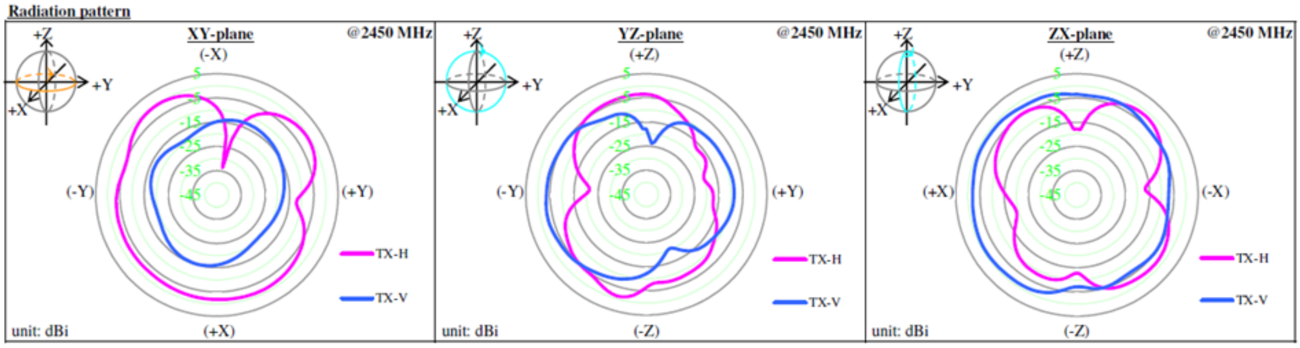


Frequency	[MHz]	@2400	@2450	@2500
Peak gain		[dBi]		
3-plane	TX-H	-1.7	-0.4	-0.7
	TX-V	-2.1	-0.8	-0.9
		-1.7	**-0.4**	**-0.7**
Average gain		[dBi]		
XY-plane	TX-H	-4.5	-3.1	-3.3
	TX-V	-17.3	-16.5	-16.8
	Plus(H,V)	-4.3	-2.9	-3.1
YZ-plane	TX-H	-7.9	-6.9	-6.7
	TX-V	-8.5	-7.3	-7.9
	Plus(H,V)	-5.2	-4.1	-4.2
XZ-plane	TX-H	-6.9	-6.3	-7.1
	TX-V	-4.6	-3.2	-3.2
	Plus(H,V)	-2.6	-1.5	-1.7
3plane	TX-H	-6.2	-5.1	-5.3
	TX-V	-7.7	-6.4	-6.6
		-3.9	**-2.7**	**-2.9**
Efficiency	[dB]	**-3.1**	**-2.0**	**-2.3**
VSWR	[:1]	2.7	1.6	1.3

*Note:The value is average value in 1 round of each inclination direction angle.



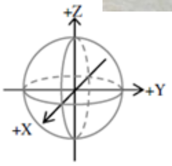
Radiation pattern

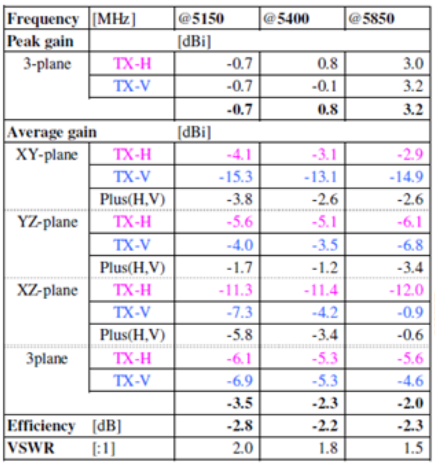


5GHz Band

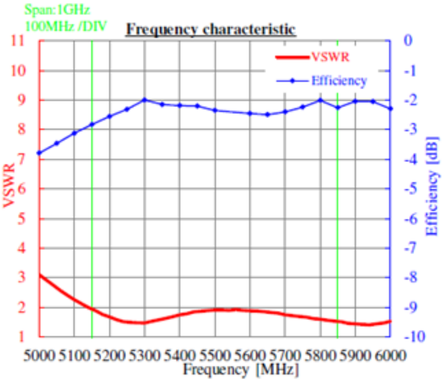
Measurement data of antenna

Appearance and coordinates definition



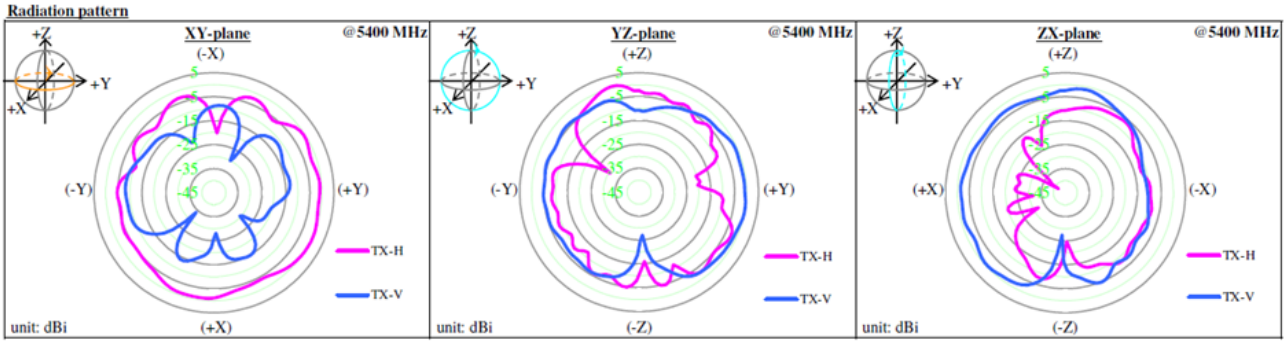


Frequency	[MHz]	@5150	@5400	@5850
Peak gain		[dBi]		
3-plane	TX-H	-0.7	0.8	3.0
	TX-V	-0.7	-0.1	3.2
		-0.7	**0.8**	**3.2**
Average gain		[dBi]		
XY-plane	TX-H	-4.1	-3.1	-2.9
	TX-V	-15.3	-13.1	-14.9
	Plus(H,V)	-3.8	-2.6	-2.6
YZ-plane	TX-H	-5.6	-5.1	-6.1
	TX-V	-4.0	-3.5	-6.8
	Plus(H,V)	-1.7	-1.2	-3.4
XZ-plane	TX-H	-11.3	-11.4	-12.0
	TX-V	-7.3	-4.2	-0.9
	Plus(H,V)	-5.8	-3.4	-0.6
3plane	TX-H	-6.1	-5.3	-5.6
	TX-V	-6.9	-5.3	-4.6
		-3.5	**-2.3**	**-2.0**
Efficiency	[dB]	**-2.8**	**-2.2**	**-2.3**
VSWR	[:1]	2.0	1.8	1.5



*Note:The value is average value in 1 round of each inclination direction angle.

Radiation pattern



5. About this Application Note

- This Application Note has been prepared as a reference material to help obtaining the antenna performance mounted on **WKR612AA1** module better while it is not guaranteed or assured to obtain better communication performance and distance.
- This product **“WKR612AA1** module” has been certified and matching circuit constant for antenna within module cannot be changed when ambient environment condition changes. The product must be re-certified when matching circuit constant is changed.

Other Precautions

- Please conduct validation and verification of our products in actual condition of mounting and operating environment before using our products.

- The products listed in this Specification are intended for use in general electronic equipment (e.g., AV equipment, OA equipment, home electric appliances, office equipment, information and communication equipment including, without limitation, mobile phone, and PC). Please be sure to contact KAGA FEI for further information before using the products for any equipment which may directly cause loss of human life or bodily injury (e.g., transportation equipment including, without limitation, automotive power train control system, train control system, and ship control system, traffic signal equipment, disaster prevention equipment, medical equipment classified as Class I, II or III by IMDRF, highly public information network equipment including, without limitation, telephone exchange, and base station).

  Please do not incorporate our products into any equipment requiring high levels of safety and/or reliability (e.g., aerospace equipment, aviation equipment, medical equipment classified as Class IV by IMDRF, nuclear control equipment, undersea equipment, military equipment).

  When our products are used even for high safety and/or reliability-required devices or circuits of general electronic equipment, it is strongly recommended to perform a thorough safety evaluation prior to use of our products and to install a protection circuit as necessary.

  Please note that unless you obtain prior written consent of KAGA FEI, KAGA FEI shall not be in any way responsible for any damages incurred by you or third parties arising from use of the products listed in this Specification for any equipment requiring inquiry to KAGA FEI or prohibited for use by KAGA FEI as described above.

- Information contained in this Specification is intended to convey examples of typical performances and/or applications of our products and is not intended to make any warranty with respect to the intellectual property rights or any other related rights of KAGA FEI or any third parties nor grant any license under such rights.

- Please note that the scope of warranty for our products is limited to the delivered our products themselves and KAGA FEI shall not be in any way responsible for any damages resulting from a fault or defect in our products.

- The contents of this Specification are applicable to our products which are purchased from our sales offices or authorized distributors (hereinafter "KAGA FEI' s official sales channel"). Please note that the contents of this specification are not applicable to our products purchased from any seller other than KAGA FEI' s official sales channel.

- The contents of this Specification are applied in preference to any agreement between you and KAGA FEI or KAGA FEI's official sales channel (e.g., supply and purchase agreement, quality assurance agreement).

- You will have deemed accepted the contents of this Specification upon usage of our products.

- Caution for Export

  Some of our products listed in this specification may require specific procedures for export according to ″U.S. Export Administration Regulations″ and other applicable regulations.