

**CPU Embedded Wireless LAN Module
IEEE802.11b/g/n**

WKM320

User Manual

Please note that this user manual should not be provided to end-users.

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

ATTENTION: Software related to this module may be under Japan export control. Depending on the customer's country and application (e.g. weapons), KAGA FEI may not be able to provide the software to all customers. Please contact your local KAGA FEI sales office for additional information.

To contact your local sales office and for additional product information, please visit <https://www.kagafei.com/jp/eng/>.

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Rev. record

15-Jul. 2022> Ver.0.1 Release tentative version

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Control No. KM-AG-A223019	(1/6)	Control name General Items
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Scope

This specification ("Specification") applies to the hybrid IC "WKM320" for use **Wireless LAN** module ("Product") manufacture by KAGA FEI Co., Ltd. ("KAGA FEI")

1. User Code: WKM320AA1
Type: WKM320

The part number listed in this data report may be different from actual production part number.

2. Chip: NXP 88MW320
3. Function: CPU embedded Radio frequency transfer Module. (**IEEE802.11b/g/n** standard conformity)
4. Application: IoT equipments
5. Structure: Hybrid IC loaded with silicon monolithic semiconductor
Ability of lead free mounting at customer's assembly (Heat resistance of this Product) : Yes
Containment of hazardous substance in this Product;
*This product conforms to RoHS Directive.
6. Outline: 44-pin leadless chip carrier
7. Marking: Japan ID, IC ID, FCC ID, Manufacture, Model, Lot number, Part number on Shielding Case
8. Features:
 - IEEE802.11b/g/n** standard conformity
 - Transmit speed: WLAN11n (72.2/65/58.5/57.8/52/43.3/39/28.9/26/21.7/19.5/14.4/13.0/7.2/6.5),
WLAN11g (54/48/36/24/18/12/9/6Mbps), WLAN11b (11/5.5/2/1 Mbps),
 - Channel Number: 1 to 11 channel (USA/Canada)
1 to 13 channel (Japan /EU)
 - Host interface: UART
 - Built-in WLAN front end, Flash Memory (4MB), Xtal, Power circuits
 - Embedded CPU (Cortex-M4F)
9. Security: WPA-2 using AES/CCMP along with legacy security features
10. Packing:
 - Packaging method: Tray
 - Packaging unit: 84 pieces/Tray, 840pieces/Box
 - Standard order quantity : 840 pcs multiples

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11. Notes:

- a. Please conduct validation and verification of our products in actual condition of mounting and operating environment before using our products.
- b. 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 powertrain control system, train control system, and ship control system, traffic signal equipment, disaster prevention equipment, medical equipment, 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, 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.
- c. Please note that KAGA FEI shall have no responsibility for any controversies or disputes that may occur in connection with a third party's intellectual property rights and other related rights arising from use of our products. KAGA FEI grants no license for such rights.
- d. 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, 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.
- e. 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.))
- f. Because product is not designed for radiation durability, please refrain from exposing product to radiation in the use.

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- g. 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.
- h. This product operates in the unlicensed ISM band at (#9). 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.
- i. 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.
- j. 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 (i) in functions, performances and quality of the Customer's product incorporating the Products and (ii) which may occur as the Product is incorporated in the Customer's product.
- k. Caution for Export
Some of our products listed in this specification may require specific procedures for export according to "U.S. Export Administration Regulations", "Foreign Exchange and Foreign Trade Control Law" of Japan, and other applicable regulations. Should you have any questions on this matter, please contact our sales staff.

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12. Radio type approval

a. Japan Regulatory Information

This module is approved with the specific antenna on this module. Please ensure that your product shall bear a label with the following information. If the product is so small that it is not practicable to place the label, please place it in the instruction manual and package.

This product installs a radio system which has been approved as a radio station in a low power data communication system based on the Radio Law.

WKM320 : ***_****

b. Canada Regulatory Information

i) The following statements in rectangle must be described on the user manual of the host device of this module;

This device complies with Innovation, Science and Economic Development Canada license-exempt RSS standards. 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.

Le présent appareil est conforme aux CNR 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'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

This equipment complies with ISED radiation exposure limits set forth for an uncontrolled environment and meets RSS-102 of the IC radio frequency (RF) Exposure rules. This equipment should be installed and operated keeping the radiator at least 20cm or more away from person's body.

Cet équipement est conforme aux limites d'exposition aux rayonnements énoncées pour un environnement non contrôlé et respecte les règles d'exposition aux fréquences radioélectriques (RF) CNR-102 de l'ISED. Cet équipement doit être installé et utilisé en gardant une distance de 20 cm ou plus entre le dispositif rayonnant et le corps.

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ii) Please notify certified ID by either one of the following method on your product.

Specifiez ID certifiée dans votre produit par une de méthode suivante.

- Contains Transmitter module IC : 28568-WKM320
- Contains IC : 28568-WKM320

c. FCC Regulatory Information

i) The following statements in rectangle must described on the user manual of the host device of this module;

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.

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

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment and meets the FCC radio frequency (RF) Exposure Guidelines. This equipment should be installed and operated keeping the radiator at least 20cm or more away from person's body.

ii) Please notify certified ID by either one of the following method.

- Contains Transmitter Module FCC ID: 2A6NFWKM320
- Contains FCC ID: 2A6NFWKM320

iii) The antenna used for this transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

iv) This module can set the output power by the application software which is developed by module installer. Any end user cannot change the output power.

v) Wireless LAN of this module complies with the following standards:
• FCC part 15 Subpart C (2.4GHz band)

vi) This product is FCC approved only as a module. Manufacturers of final devices has a responsibility for the conditions which are not approved as a module. Please carry out the tests of FCC Part 15 Subpart B in case your final device installs this module.

vii) Co-location of this module with other transmitters that operate simultaneously are required to be evaluated using the FCC multi-transmitter procedures. When installing this module to your final devices, please make sure to carry out all the necessary evaluations according to the

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applicable guidelines like follows:

- for RF exposure: KDB 447498, KDB 996369 and any other relevant guidelines
- for EMC: KDB 996369 D04 and any other relevant guidelines

viii) When you install this module to your final devices, please ensure that your final composite product complies with the applicable FCC rules in reference to a guidance in KDB 996369.

ix) When you install this module to your final devices, please ensure to perform all the required equipment authorization and testing for the technical parameters which are not covered by the module grant (e.g., unintentional radiator Part 15 Subpart B requirements, or transmitters used in the host which are not previously approved as modules).

x) Antenna List

This module is approved along with the following antennas.

You cannot use any antennas other than the listed ones because it deviates from the accredited conditions

No.	Manufacture	Part No.	Antenna Type	Antenna Gain
1	KAGA FEI	N/A (Printed on PCB)	Monopole	-2.9dBi @2.4GHz Band

d. CE Regulatory Information

- i) When your end product installs this module, it is required to proceed additional certification processes before placing on the market in EU member states to make your products fully comply with relative EU standards.
- ii) KAGA FEI can provide you the test reports of conducted measurement portion for the radio module. You can utilize the test reports for the certification processes of your end product as it requires radio testing.

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Control No. KM-AM-A223019	(1/1)	Control name Absolute maximum ratings
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Absolute maximum ratings

Item	Symbol	Rating				Remark
		Min.	Typ.	Max.	Unit	
Supply voltage 1	VIO	-		3.63	V	
Supply voltage 2	VIOH	-		3.63	V	
Supply voltage 3	VIOF	-		3.63	V	
Supply voltage 4	V33	-		3.63	V	
Storage temperature range	Tstg	-40		85	Degrees C	
Operation temperature range	Topr	-30	25	85	Degrees C	

Recommendation operating range

Item	Symbol	Rating				Remark
		Min.	Typ.	Max.	Unit	
Supply voltage 1	VIO	3.0	3.3	3.6	V	
Supply voltage 2	VIOH	3.0	3.3	3.6	V	
Supply voltage 3	VIOF	3.0	3.3	3.6	V	
Supply voltage 4	V33	3.0	3.3	3.6	V	

Built in flash memory characteristics

Item	Rating				Remark
	Min.	Typ.	Max.	Unit	
Write/Erase Cycle	10,000	-	-	Times	

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DIGITAL IO FEATURES

Inter-Integrated Circuit (I2C)

The I2C bus interface complies with the common I2C protocol and can operate in standard mode (with data rates up to 100Kb/s), fast mode (with data rate up to 400Kb/s) and high-speed mode (with data rate up to 2Mb/s). Additionally, high-speed mode devices and fast mode devices are downward compatible.

The I2C bus interface unit has the following features:

- I2C serial interfaces consisting of a serial data line (SDL) and serial clock (SCL)
- Three speeds:
 - Standard mode (up to 100Kb/s)
 - Fast mode (up to 400Kb/s)
 - High-speed mode (2Mb/s)
- Master or Slave I2C operation
- 7 or 10 bit addressing
- 16 * 32 bits deep transmit and receive buffers, respectively
- interrupt operation
- DMA function

Synchronous Serial Protocol(SSP)

An SSP port is a synchronous serial controller that can be connected to a variety of external Analog-to-Digital converters (ADC), audio and telecommunication codecs, and many other devices that use serial protocols for data transfer.

The SSP ports are configurable to operate in Master mode (the attached peripheral function as a slave) or Slave mode (the attached peripheral functions as a master).

The SSP ports support serial bit rates from 1Mbps (minimum recommended speed) up to 25 Mbps. A FIFO is provided for Transmit data and a second independent FIFO is provided for Receive data. The two FIFOs are both 16 x 32 bits wide or both are 32 x 16 bits wide. The FIFOs can be loaded or emptied by the Cortex-M4F Processor or by DMA burst transfers.

The SSP port features are as follows:

- Supports Motorola Serial Peripheral Interface (SPI)
- Supports DMA transfer

Universal Asynchronous Receiver Transmitter (UART)

- Separate 64x8 transmit and 64x11 receive FIFO memory buffers to reduce CPU interrupts
- Programmable baud rate generator
- Ability to add or delete standard asynchronous communication bits (start ,stop, and parity) in the serial data
- Flow control
 - RTS(output) controlled by the UART Receive FIFO
 - CTS(input) from modem control UART transmitter
- Separate DMA requests for Transmit and Receive data services

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Analog Digital Converter (ADC)

WKM320 has ADCs with up to 16-bit resolution. ADCs has individually configurable channels, and reference voltage.

- Selectable resolution (12 to 16 bits)
- Single-ended and differential conversions
- ADC gain setting: 0.5x, 1x, 2x
- Selectable reference voltage (Vref)
 - Internal reference 1.2V
 - Internal reference 1.8V
 - External reference (do not exceed 1.8V)

Digital Analog Converter (DAC)

WKM320 has DAC with 10-bit resolution. It includes 2 channels. Each channel can output a single-ended signal or combine both channels to output a differential signal.

- 10-bit resolution
- Flexible waveform generator (sinusoidal, triangle, etc.) at various frequency range
- Selectable output mode: single-ended or differential
- Internal or external reference voltage
- Three selectable output ranges
- Supports event trigger from GPIO

Analog Comparator (ACOMP)

WKM320 has analog comparators which operate over the full range of power supply VIO. ACOMP can select many positive inputs and negative inputs.

- 7 selectable external positive inputs
- 7 selectable external negative inputs
- 2 selectable internal positive inputs
 - DACA output
 - DACB output
- 5 selectable internal negative inputs
 - DACA output
 - DACB output
 - VIO, VIO*0.75, VIO*0.5, VIO*0.25
 - Internal reference 1.2V (Vref_12)
 - GND
- Selectable positive and negative hysteresis between 0 and 70mV with 10mV step
- Comparator output on GPIOs through alternate functionality, output inversion available

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General Purpose Input Output (GPIO)

WKM320 provides GPIO pins.

- General purpose IO – Configurable IO state as Input high / low or Output high/low
- Be able to accept external signals as interrupt source.
The type of interrupt is programmable with either a rising edge or falling edge.

General Purpose Timers (GPT)

- 4 independent channels with multiple modes
- Edge-aligned and Center-aligned Pulse Width Modulation(PWM) with frequency range from 1KHz to 25MHz
- 1-shot mode to trigger a 1-time output change

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DC Specifications

Peak Current / 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	V33I	Ip1	-	-	400	mA	
2	Power consumption3	Burst Tx (72.2Mbps)	Pc3	-	267	-	mW	Duty 4.2%
3	Power consumption4	Continuous Rx (72.2Mbps)	Pc4	-	271	-	mW	
4	Power consumption5	Burst Tx (54Mbps)	Pc5	-	347	-	mW	Duty 25.4%
5	Power consumption6	Continuous Rx (54Mbps)	Pc6	-	267	-	mW	
6	Power consumption7	Burst Tx (11Mbps)	Pc7	-	545	-	mW	Duty 46.8%
7	Power consumption8	Continuous Rx (11Mbps)	Pc8	-	267	-	mW	
8	Power consumption9	Sleep (MPU: Stand By (Low Power Mode in PM2) WLAN: Deep sleep)	Pc9	-	2	-	mW	

Digital Pad Ratings

No.	Parameter	Condition	Symbol	Min.	Typ.	Max.	Unit	Remark
1	Input high voltage		VIH	0.7*VIO	-	VIO+0.4	V	Note1
				0.7*VIOH	-	VIOH+0.4	V	Note2
2	Input low voltage		VIL	-0.4	-	0.3*VIO	V	Note1
				-0.4	-	0.3*VIOH	V	Note2
3	Output high voltage	I _{OH} =3mA	VOH	VIO-0.5V	-	-	V	Note1
				VIOH-0.5V	-	-	V	Note2
4	Output low voltage	I _{OL} =4mA	VOL	-	-	0.4	V	

Note1: Apply to IO pads which IO domain is VIO.

Note2: Apply to IO pads which IO domain is VIOH.

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ADC Electrical Characteristics

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

	Parameter	Condition	Min	Typ	Max	Unit	Remark
Reference Voltage							
1	Internal Reference Voltage		1.20	1.22	1.23	V	
2	External Reference Voltage		0.6	-	1.8	V	
Analog Inputs							
3	Absolute Input Voltage		0	-	VIO	V	Note1
4	Input Voltage Range	Single-ended with input buffer gain=0.5x	0	-	2*Vref	V	
5		Single-ended with input buffer gain=1x	0	-	Vref		
6		Single-ended with input buffer gain=2x	0	-	0.5*Vref		
7		Differential with input buffer gain=0.5x	-2*Vref	-	2*Vref		Note2
8		Differential with input buffer gain=1x	-Vref	-	Vref		Note2
9		Differential with input buffer gain=2x	-0.5*Vref	-	0.5*Vref		Note2
DC Accuracy							
10	Resolution	Single-ended	-	-	15	bits	
11		Differential	-	-	16		

Notes:

1. The input voltage for each channel must be positive and cannot exceed the VIO voltage level.
2. Differential value: (Positive channel input voltage) – (Negative channel input voltage)

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DAC Electrical Characteristics

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

No.	Parameter	Condition	Min	Typ	Max	Unit	Remark
Conversion Range							
1	Voltage Conversion Range	x_RANGE[1:0] ^{*1} : 00 REF_SEL ^{*2} : 0		0.16+(0.64 * input data/1023)		V	
2		x_RANGE[1:0] : 01/10 REF_SEL : 0		0.19+(1.01 * input data/1023)		V	
3		x_RANGE[1:0] : 11 REF_SEL : 0		0.18+(1.42 * input data/1023)		V	
4		x_RANGE[1:0] : 00 REF_SEL : 1		0.08*Vref_ext+(0.32* Vref_ext*input data /1023)		V	
5		x_RANGE[1:0] : 01/10 REF_SEL : 1		0.095*Vref_ext+(0.505* Vref_ext*input data /1023)		V	
6		x_RANGE[1:0] : 11 REF_SEL : 1		0.09*Vref_ext+(0.71* Vref_ext*input data /1023)		V	
DC Accuracy							
7	Resolution				10	bits	

^{*1}Register for output voltage range control^{*2}Register for reference selector (0x0:internal reference, 0x1:external reference(Vref_ext))**ACOMP Electrical Characteristics**

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

No.	Parameter	Condition	Min	Typ	Max	Unit	Remark
Analog Input							
1	Analog Input Voltage		0	-	V _{IO}	V	
Reference Voltage							
2	Internal Reference Voltage		1.20	1.22	1.23	V	
Hysteresis							
3	Hysteresis	Programming in 7 steps and 0	-	0	-	mV	
			-	10	-		
			-	20	-		
			-	30	-		
			-	40	-		
			-	50	-		
			-	60	-		
-	70	-					

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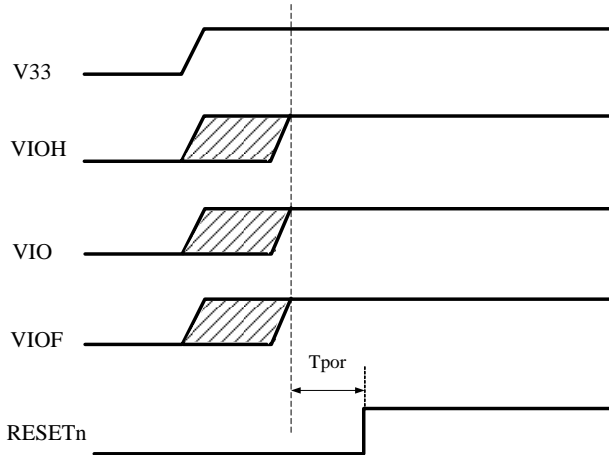
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AC Specifications

Power on sequence

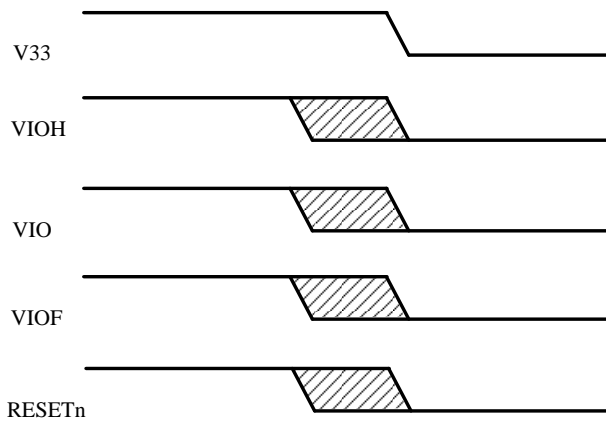
	Parameter	Condition	Symbol	Min	Typ	Max	Unit	Remark
1	Valid Power to RESETN de-asserted		Tpor	300	-	-	mS	

V33 should be powered up with or before VIOH or VIO or VIOF.
 RESETn must remain asserted for minimum of Tpor after V33 and VIOH, VIO, VIOF are stable.
 V33, VIOH, VIO and VIOF should start up from less than 0.15V.



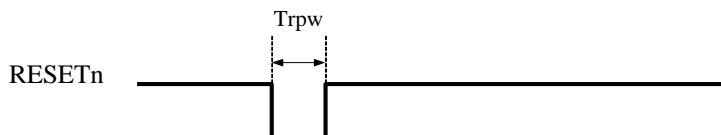
Power off sequence

V33 should be powered off with or after VIOH or VIO or VIOF.
 RESETn should not exceed VIO+0.4V.



RESETn Pulse Width

Parameter	Condition	Symbol	Min	Typ	Max	Unit
Minimum reset pulse width on RESETn pin	-	Trpw	300			Ms



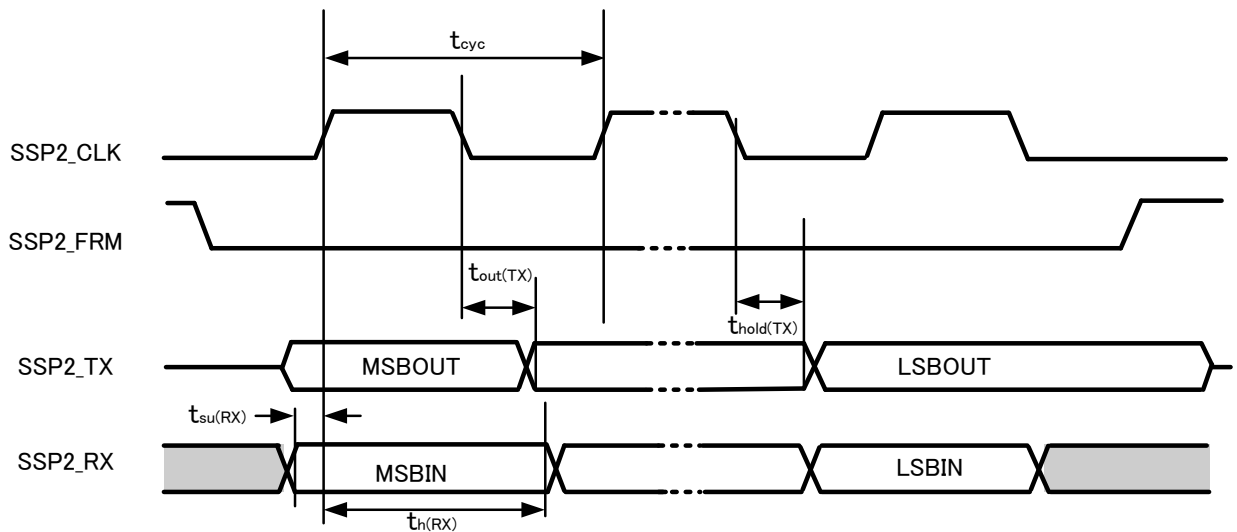
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SSP timing specification

	Parameter	Symbol	Condition	Min	Typ	Max	Unit	Remark
1	TX delay time	$t_{out(TX)}$	Master	-	-	3	ns	
			Slave	-	-	15		
2	TX hold time	$t_{hold(TX)}$	Master	-2	-	-	ns	
			Slave	0	-	-		
	RX set up time	$t_{su(RX)}$	Master	12	-	-	ns	
			Slave	4				
3	RX hold time	$t_h(RX)$	Master	2	-	-	ns	
			Slave					
4	Serial Bit Clock cycle time	T_{cyc}	Master	40	-	1000	ns	
			Slave					



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RF Specifications (WLAN 11n/72.2Mbps, OFDM)

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

No.	Parameter	Condition	Symbol	Min	Typ	Max	Unit	Remark
1	RF frequency range		FREQ	2412		2462	MHz	
2	TX Power		Po	7	9	11	dBm	Note1
3	Spectrum Mask	1 st Side Lobe	M1	-		-20	dBc	
		2 nd Side Lobe	M2	-		-28	dBc	
		3 rd Side Lobe	M3	-		-45	dBc	
4	Symbol clock tolerance		Ft	-25		25	ppm	
5	Frequency tolerance		Ft	-25		25	ppm	
6	EVM	Rms	EVM	-		-28	dB	
7	TX Out of band spurious1	30MHz to 1GHz	TOS1	-		-36	dBm	
8	TX Out of band spurious2	1GHz to 12.75GHz	TOS2	-		-30	dBm	
9	TX Out of band spurious3	1.8GHz to 1.9GHz 5.15GHz to 5.3GHz	TOS3			-47	dBm	
10	Rx sensitivity	PER<10%	SEN	-	-68	-64	dBm	
11	Maximum Input Level	PER<10%	MIL	-20		-	dBm	
12	RX Out of band spurious1	30MHz to 1GHz	ROS1	-		-57	dBm	
13	RX Out of band spurious2	1GHz to 12.75GHz	ROS2	-		-47	dBm	

Note1:Tx power should be set as typical value. If not, it may violate radio regulations of each country.

RF Specifications (WLAN 11g/54Mbps, OFDM)

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

No.	Parameter	Condition	Symbol	Min	Typ	Max	Unit	Remark
1	RF frequency range		FREQ	2412		2462	MHz	
2	TX Power		Po	7	9	11	dBm	Note2
3	Spectrum Mask	1 st Side Lobe	M1	-		-20	dBc	
		2 nd Side Lobe	M2	-		-28	dBc	
		3 rd Side Lobe	M3	-		-40	dBc	
4	Symbol clock tolerance		Ft	-25		25	ppm	
5	Frequency tolerance		Ft	-25		25	ppm	
6	EVM	Rms	EVM	-		-25	dB	
7	TX Out of band spurious1	30MHz to 1GHz	TOS1	-		-36	dBm	
8	TX Out of band spurious2	1GHz to 12.75GHz	TOS2	-		-30	dBm	
9	TX Out of band spurious3	1.8GHz to 1.9GHz 5.15GHz to 5.3GHz	TOS3			-47	dBm	
10	Rx sensitivity	PER<10%	SEN	-	-71	-65	dBm	
11	Maximum Input Level	PER<10%	MIL	-20		-	dBm	
12	RX Out of band spurious1	30MHz to 1GHz	ROS1	-		-57	dBm	
13	RX Out of band spurious2	1GHz to 12.75GHz	ROS2	-		-47	dBm	

Note2: Tx power should be set as typical value. If not, it may violate radio regulations of each country.

WKM320

KAGA FEI Co., Ltd.

Control No. KM-AE-A223019 (10/10)	Control name Electrical characteristics
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RF Specifications (WLAN 11b/11Mbps, CCK)

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

No	Parameter	Condition	Symbol	Min	Typ	Max	Unit	Remark
1	RF frequency range		FREQ	2412		2462	MHz	
2	TX Power		Po	13	15	17	dBm	Note1
3	Spectrum Mask	1 st Side Lobe	M1	-		-30	dBc	
		2 nd Side Lobe	M2	-		-50	dBc	
4	Power up-down rump	Power up	TU	-		2	us	
		Power down	TD	-		2	us	
5	Frequency tolerance		Ft	-25		25	ppm	
6	EVM	Peak	EVM	-		35	%	
7	TX Out of band spurious1	30MHz to 1GHz	TOS1	-		-36	dBm	
8	TX Out of band spurious2	1GHz to 12.75GHz	TOS2	-		-30	dBm	
9	TX Out of band spurious3	1.8GHz to 1.9GHz 5.15GHz to 5.3GHz	TOS3			-47	dBm	
10	Rx sensitivity	PER<8%	SEN		-86	-76	dBm	
11	Maximum Input Level	PER<8%	MIL	-10			dBm	
12	RX Out of band spurious1	30MHz to 1GHz	ROS1	-		-57	dBm	
13	RX Out of band spurious2	1GHz to 12.75GHz	ROS2	-		-47	dBm	

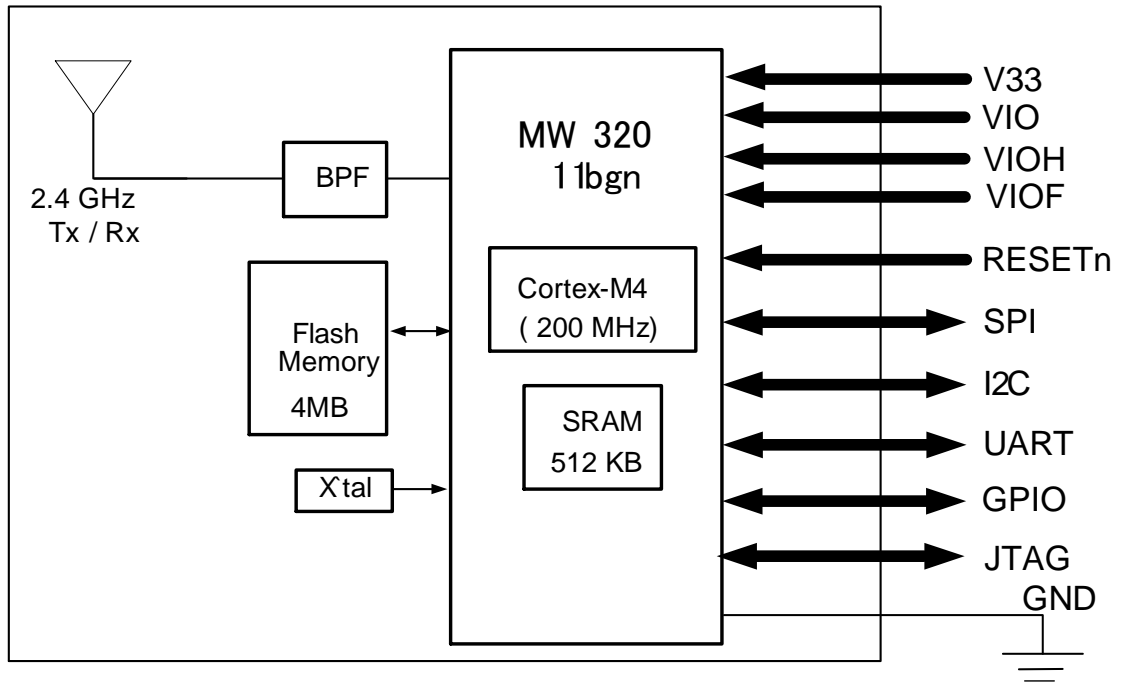
Note1: Tx power should be set as typical value. If not, it may violate radio regulations of each country.

WKM320

KAGA FEI Co., Ltd.

Control No. KM-MC-A223019	(1/2)	Control name Circuit Schematic
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Block Diagram

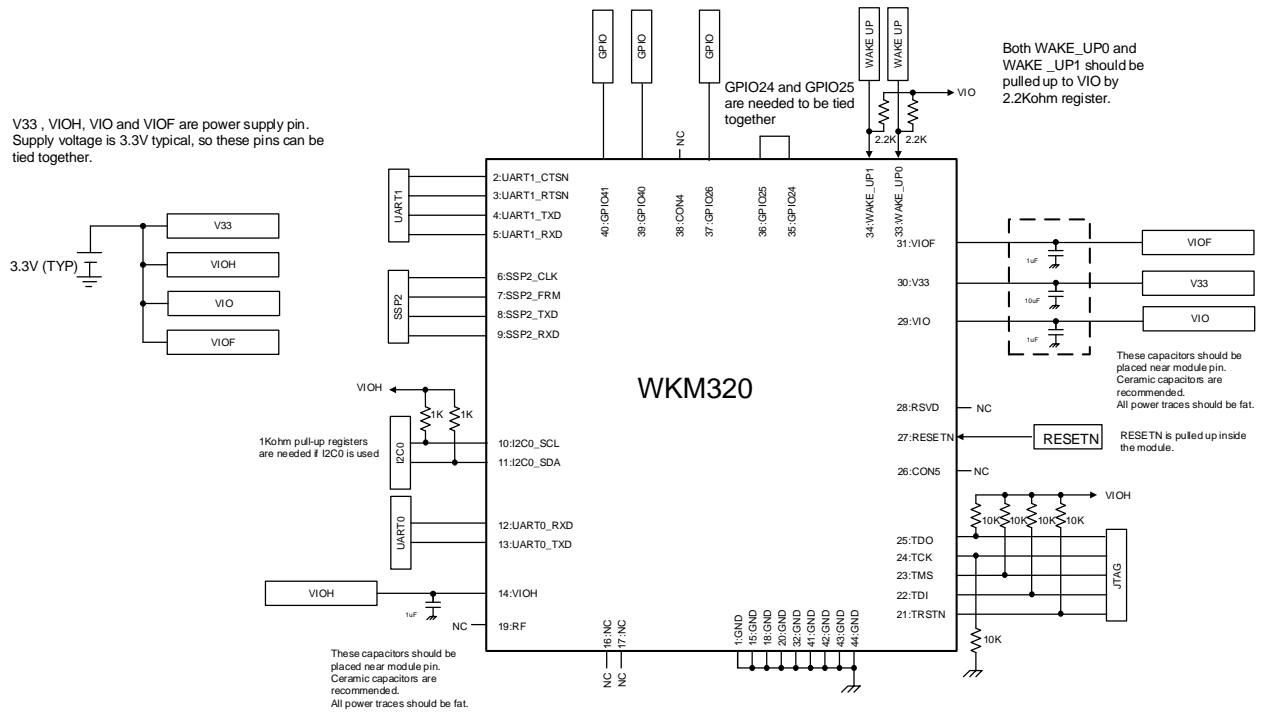


WKM320

KAGA FEI Co., Ltd.

Control No. KM-MC-A223019	(2/2)	Control name Circuit Schematic
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Example of peripheral circuit schematics



Note1: All IO pins should be left open (no need to pull-up or pull-down) if not used.

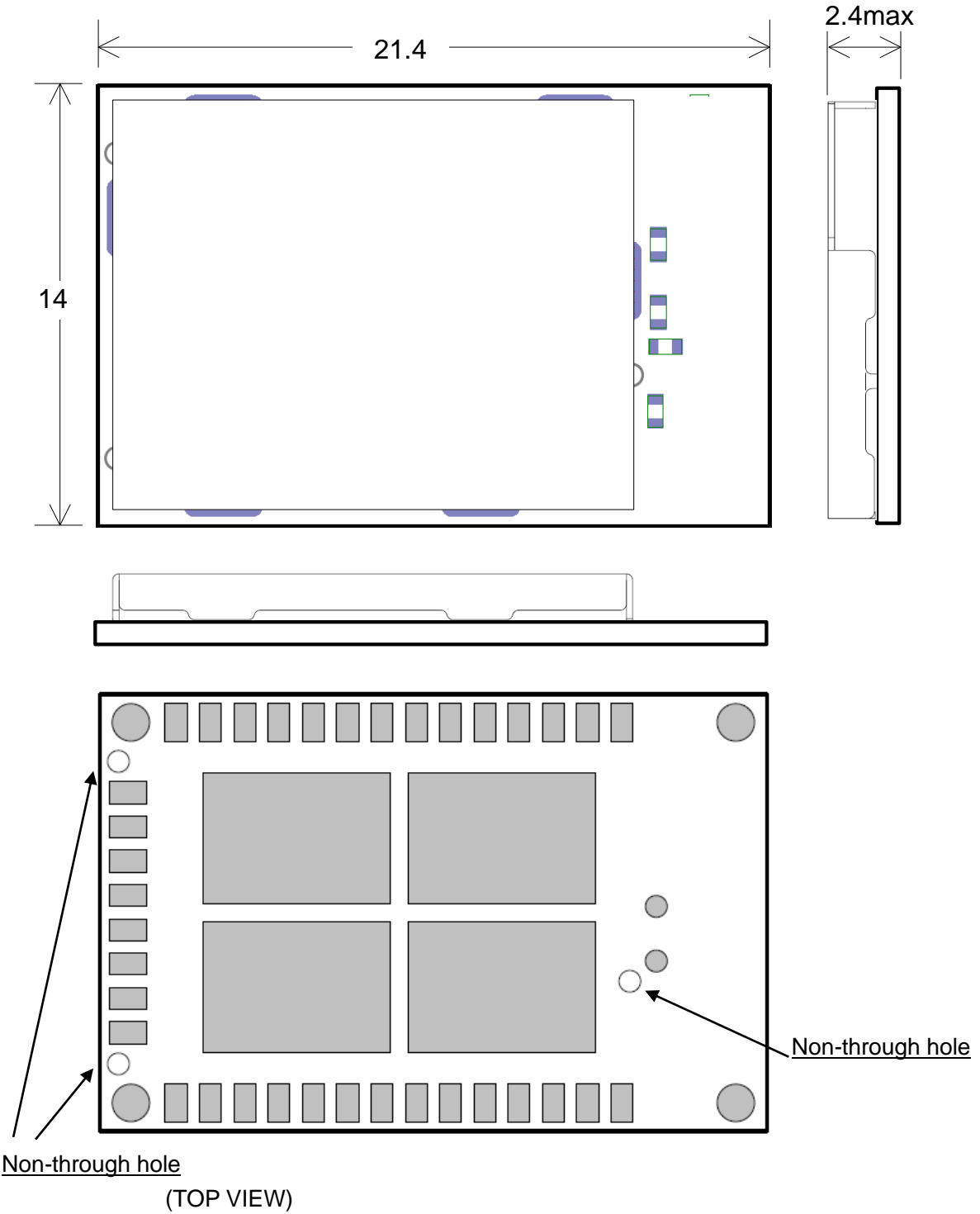
WKM320

KAGA FEI Co., Ltd.

Control No. KM-AD-A223019	(1/5)	Control name Outline/Appearance
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OUTLINE

Unit: mm, Tolerances unless otherwise specified:

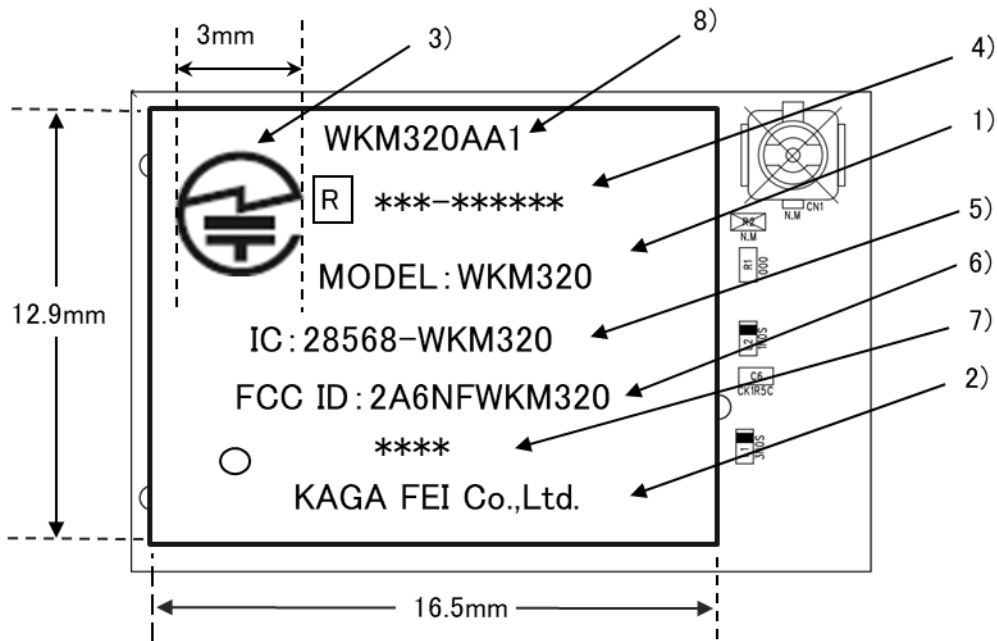


WKM320

KAGA FEI Co., Ltd.

Control No. KM-AD-A223019	(2/5)	Control name Outline/Appearance
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Indication of Shield Case



- 1) Model : WKM320
- 2) Manufacture : KAGA FEI Co.,Ltd.
- 3) Japan logo mark : Specified logo mark
- 4) Japan ID : -
- 5) IC ID : 28568-WKM320
- 6) FCC ID : 2A6NFWKM320
- 7) Part Number : WKM320AA1
- 8) Lot number : -
- 9) 1pin mark : φ0.6mm hole on the shield case

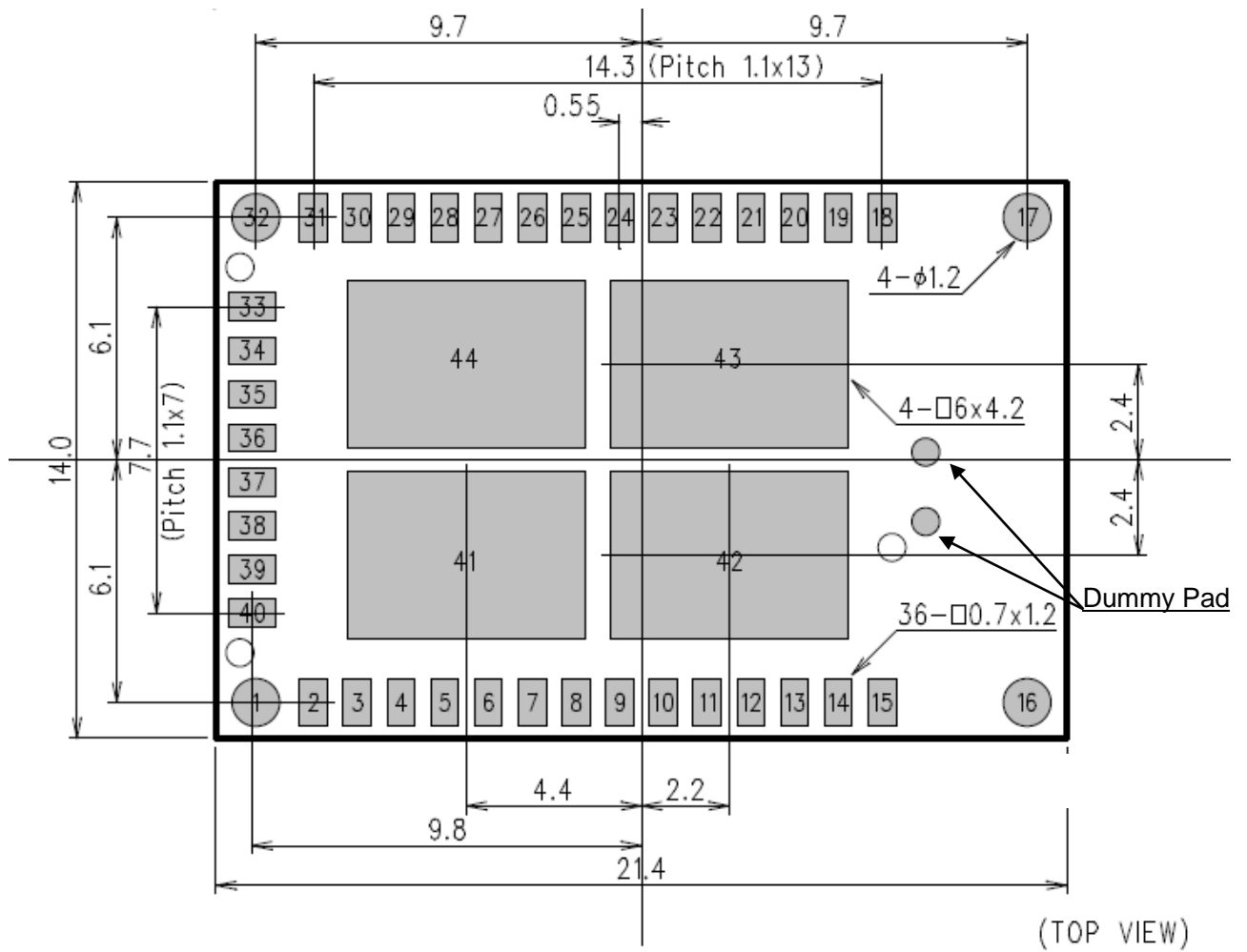
WKM320

KAGA FEI Co., Ltd.

Control No. KM-AD-A223019	(3/5)	Control name Outline/Appearance
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Module Pad Dimension

Unit: mm



WKM320

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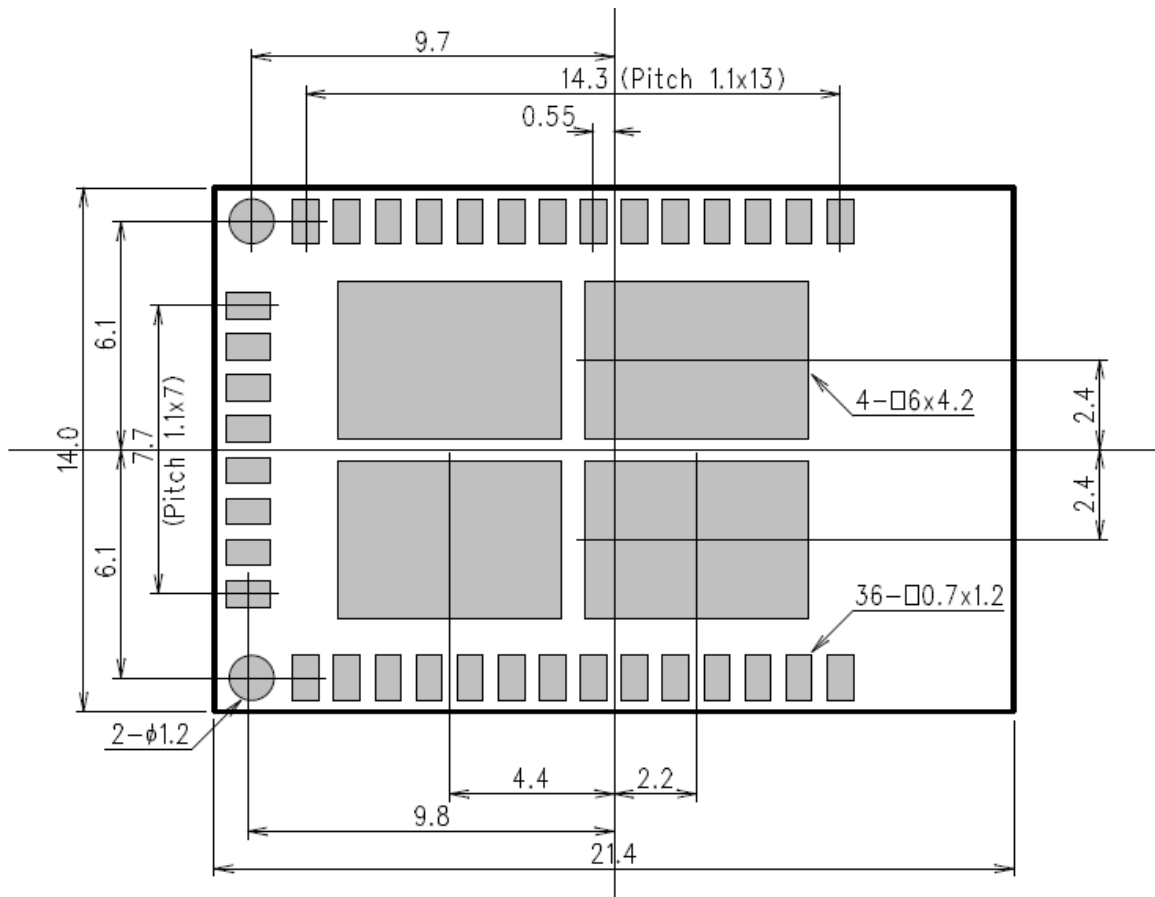
Control No. KM-AD-A223019	(4/5)	Control name Outline/Appearance
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Recommended Land Pattern Dimension

We recommend that pad sizes on mother board and pad sizes on module should be the same except for Pad-16 and Pad-17. Pad-16 and Pad-17 are not needed to solder on mother board and Land patterns for these pads are not needed.

Unit: mm

(Top View)



WKM320

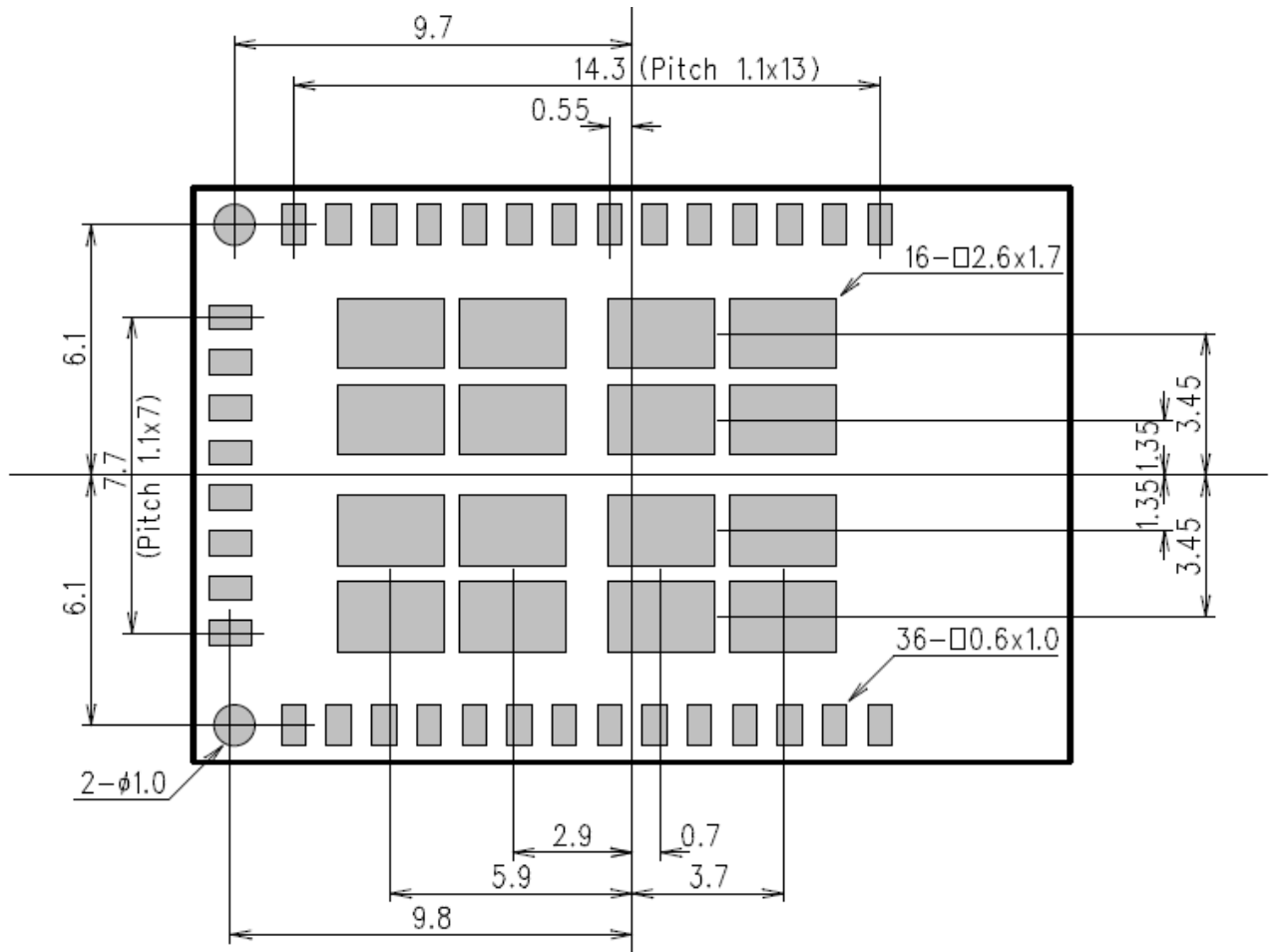
KAGA FEI Co., Ltd.

Control No. KM-AD-A223019	(5/5)	Control name Outline/Appearance
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Recommended Metal Mask (Solder Mask) Conditions

Mask size see bellow. Thickness of the Metal Mask should be in the range 0.1 mm

Unit: mm



WKM320

KAGA FEI Co., Ltd.

Control No. KM-BA-A223019	(1/4)	Control name Pin Layout
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Pin layout

Pin No	module pin name	Type	power domain	Description	88mw320 GPIO No
1	GND	-	Ground	GND	-
2	UART1_CTSn	I	VIO	UART1 CTSn (L:Clear to send, H:Not clear to send)	GPIO42
3	UART1_RTSn	O	VIO	UART1 RTSn(L:Request to send, H:Not request to send)	GPIO43
4	UART1_TXD	O	VIO	UART1 TXD	GPIO44
5	UART1_RXD	I	VIO	UART1 RXD	GPIO45
6	SSP2_CLK	I/O	VIO	Synchronous Serial Interface (SPI_CLK)	GPIO46
7	SSP2_FRM	I/O	VIO	Synchronous Serial Interface (SPI_CSN)	GPIO47
8	SSP2_TXD	O	VIO	Synchronous Serial Interface (SPI_DO)	GPIO48
9	SSP2_RXD	I	VIO	Synchronous Serial Interface (SPI_DI)	GPIO49
10	I2C0_SCL	I/O	VIOH	I2C0 SCL. Pull up to VIOH with 1Kohm register if use this pin.	GPIO5
11	I2C0_SDA	I/O	VIOH	I2C0 SDA. Pull up to VIOH with 1Kohm register if use this pin.	GPIO4
12	UART0_RXD	I	VIOH	UART0 RXD	GPIO3
13	UART0_TXD	O	VIOH	UART0 TXD	GPIO2
14	VIOH	I	VIOH	I/O Digital Power Supply	-
15	GND	-	Ground	GND	-
16	N.C	-	-	Dummy pad. No connect and do not solder.	-
17	N.C	-	-	Dummy pad. No connect and do not solder.	-
18	GND	-	Ground	GND	-
19	RF	I/O	-	WLAN RF Interface (2.4 GHz Transmit/Receive) Should be left open and do not trace longer than land pattern.	-
20	GND	-	Ground	GND	-
21	TRSTn	I	VIOH	JTAG-TRSTN (Active L)	GPIO10
22	TDI	I	VIOH	JTAG-TDI	GPIO9
23	TMS	I	VIOH	JTAG-TMS	GPIO8
24	TCK	I	VIOH	JTAG-TCK	GPIO7
25	TDO	O	VIOH	JTAG-TDO	GPIO6

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Control No. KM-BA-A223019	(2/4)	Control name Pin Layout
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Pin No	module pin name	Type	power domain	Description	88mw320 GPIO No
26	CON5	I/O	VIO	Configuration Pin. Should be left open. (Boot from internal flash memory)	GPIO16
27	RESETn	I	VIO	RESET signal (Active low) Pulled up to VIO with 51Kohm register inside the module.	-
28	RSVD	-	-	No Connect. Should be left open.	-
29	VIO	I	VIO	I/O Digital Power Supply	-
30	V33	I	V33	3.3V Power Supply	-
31	VIOF	I	VIO_F	I/O Digital Power Supply	-
32	GND	-	Ground	GND	-
33	WAKE_UP0	I	VIO	Wakeup-0 signal (Active L). Should be pulled up to VIO with 2.2K ohm register outside the module.	GPIO22
34	WAKE_UP1	I	VIO	Wakeup-1 signal (Active L). Should be pulled up to VIO with 2.2K ohm register outside the module.	GPIO23
35	GPIO24	I/O	VIO	GPIO24 and GPIO25 are used to calibrate RC32k inside the module. Tie GPIO24 and GPIO25 outside the module and do not tie other signal.	GPIO24
36	GPIO25	I/O	VIO	GPIO24 and GPIO25 are used to calibrate RC32k inside the module. Tie GPIO24 and GPIO25 outside the module and do not tie other signal.	GPIO25
37	GPIO26	I/O	VIO	General Purpose I/O 26	GPIO26
38	CON4	I/O	VIO	Configuration Pin. Should be left open. (Boot from internal flash memory)	GPIO27
39	GPIO40	I/O	VIO	General Purpose I/O 40.	GPIO40
40	GPIO41	I/O	VIO	General Purpose I/O 41.	GPIO41
41	GND	-	Ground	GND	-
42	GND	-	Ground	GND	-
43	GND	-	Ground	GND	-
44	GND	-	Ground	GND	-

*Note: IO pins should be left open if not used, unless otherwise noted.

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WKM320

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Control No. KM-BA-A223019	(3/4)	Control name Pin Layout
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IO Pin alternate functions

Pin No	Function0	Function1	Function2	Function3	Function4	Note
2	GPIO_42	ADC0_Channel0/ ACOMP0 Channel0/ ACOMP1 Channel0	UART1_CTSn	SSP1_CLK		
3	GPIO_43	ADC0_Channel1/ ACOMP0 Channel1/ ACOMP1 Channel1 DAC Channel B Output	UART1_RTSn	SSP1_FRM		
4	GPIO_44	ADC0_Channel2/ ACOMP0_Channel2/ ACOMP1_Channel2/ DAC Channel A Output	UART1_TXD	SSP1_TXD		
5	GPIO_45	ADC0_Channel3/ ACOMP0 Channel3/ ACOMP1 Channel3/ EXT_VREF – ADC or DAC external voltage reference input	UART1_RXD	SSP1_RXD		
6	GPIO_46	ADC0_Channel 4/ ACOMP0 Channel 4/ ACOMP1 Channel 4/	UART2_CTSn	SSP2_CLK		
7	GPIO_47	ADC0_Channel 5/ ACOMP0 Channel 5/ ACOMP1 Channel 5/	UART2_RTSn	SSP2_FRM		
8	GPIO_48	ADC0_Channel 6/ ACOMP0_Channel 6/ ACOMP1_Channel 6/	UART2_TXD	SSP2_TXD		
9	GPIO_49	ADC0_Channel 7/ ACOMP0_Channel 7/ ACOMP1_Channel 7/	UART2_RXD	SSP2_RXD		
10	GPIO_5	GPT0_Channel5	I2C0_SCL			
11	GPIO_4	GPT0_Channel4	I2C0_SDA			
12	GPIO_3	GPT0_Channel3	UART0_RXD	SSP0_RXD		
13	GPIO_2	GPT0_Channel2	UART0_TXD	SSP0_TXD		
21	TRSTn	GPIO_10	UART2_RXD	SSP2_RXD	I2C1_SCL	
22	TDI	GPIO_9	UART2_TXD	SSP2_TXD	I2C1_SDA	
23	TMS	GPIO_8	UART2_RTSn	SSP2_FRM	I2C0_SCL	
24	TCK	GPIO_7	UART2_CTSn	SSP2_CLK	I2C0_SDA	
25	TDO	GPIO_6	I2C1_SDA			

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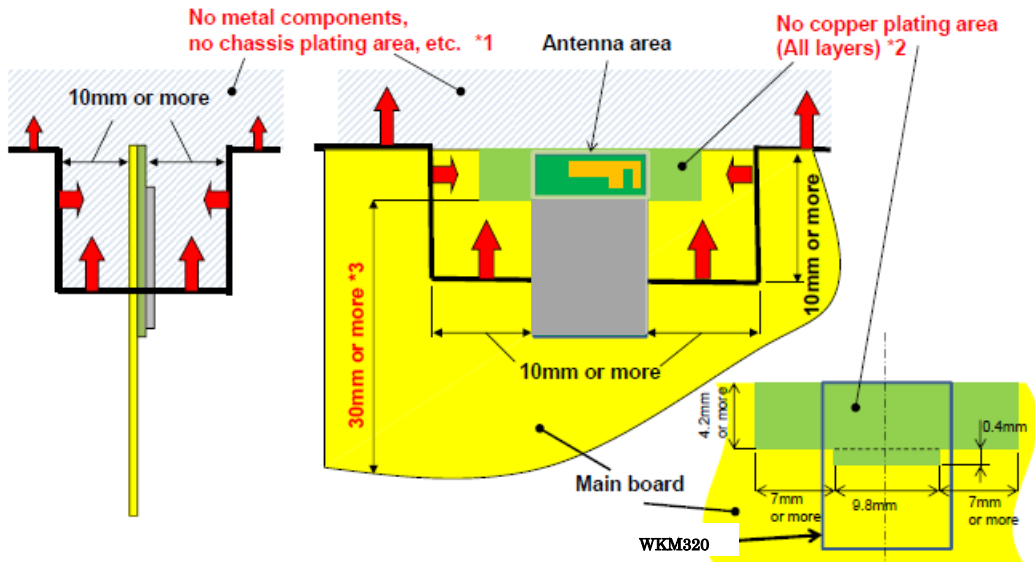
26	GPIO_16	CON[5]				
Control No. KM-BA-A223019			(4/4)	Control name Pin Layout		

Pin No	Function0	Function1	Function2	Function3	Function4	Note
33	WAKE_UP0	GPIO_22				
34	WAKE_UP1	GPIO_23				
35		GPIO_24				
36		GPIO_25				
37		GPIO_26				
38	GPIO_27	CON[4]				
39	GPIO_40	DAC_External_Tri gger0	ACOMP0_GPIO_ OUT	ACOMP1_GPIO_ OUT		
40	GPIO_41	DAC_External_Tri gger1	ACOMP0_EDGE_ PULSE	ACOMP1_EDGE_ PULSE		

Note: **Bold** indicates default function configured in the board file named "TY_MW320_brd_vxx.C"

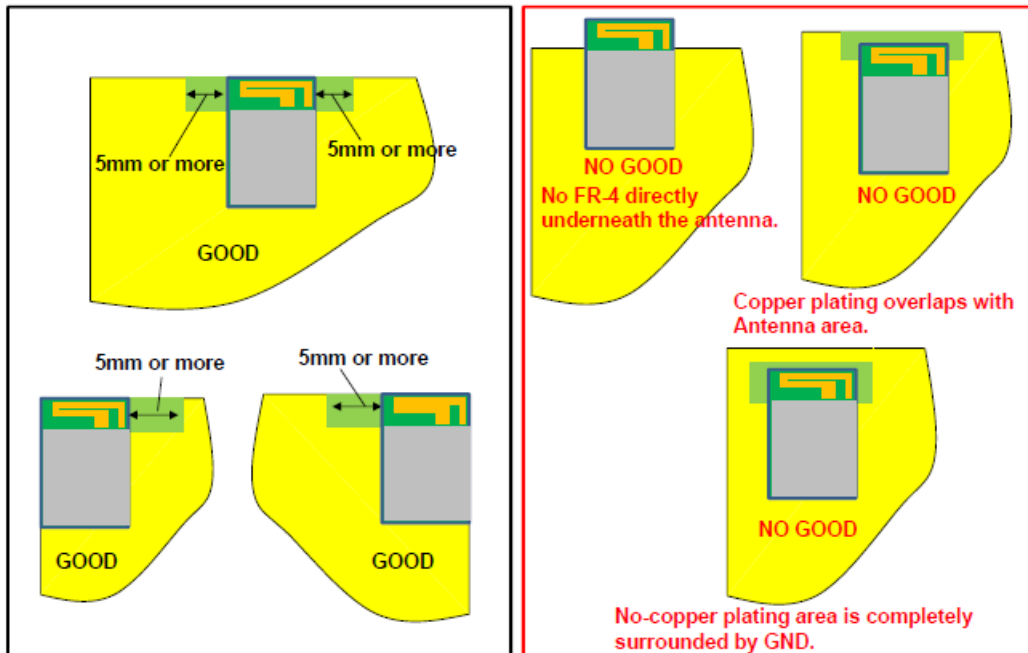
Control No. (1/3)	Control name Antenna Application Note
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1. Recommended module mounting example



*1 Please do not place any metal components in blue shaded space,(*1) 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

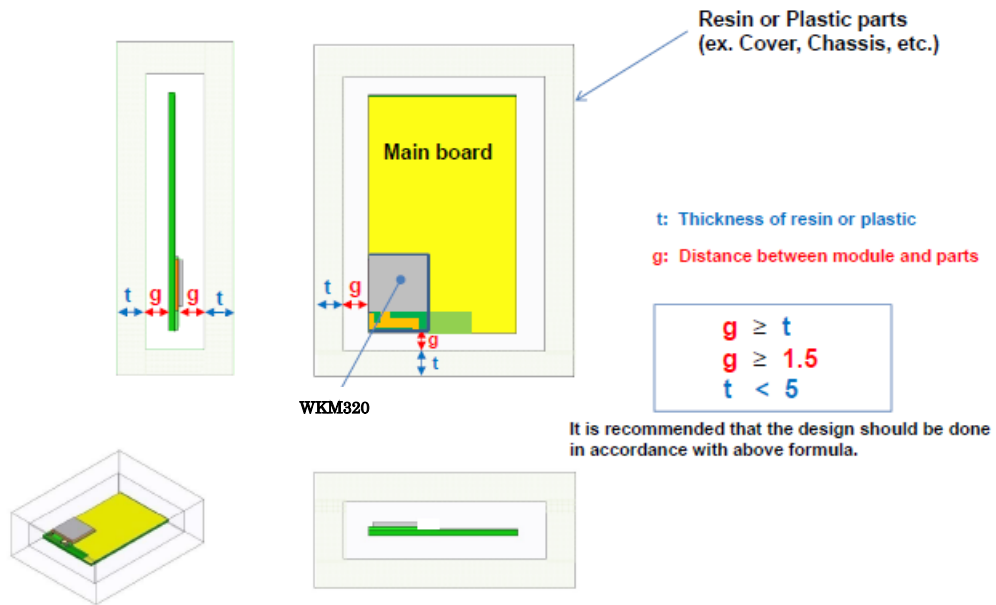


WKM320

KAGA FEI Co., Ltd.

Control No. (2/3)	Control name Antenna Application Note
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3. Placement of resin or plastic parts



Please do not apply molding over the antenna area of WKM320

WKM320

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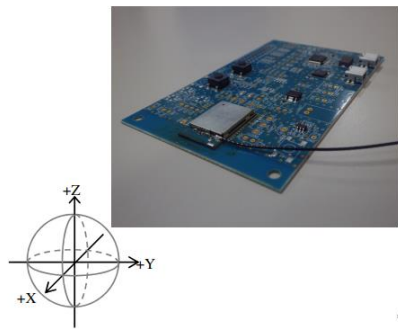
Control No.	Control name
(3/3)	Antenna Application Note

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

Measured in Satimo Stargate system at TAIYO YUDEN R&D CENTER.

Measurement data of antenna

Appearance and coordinates definition



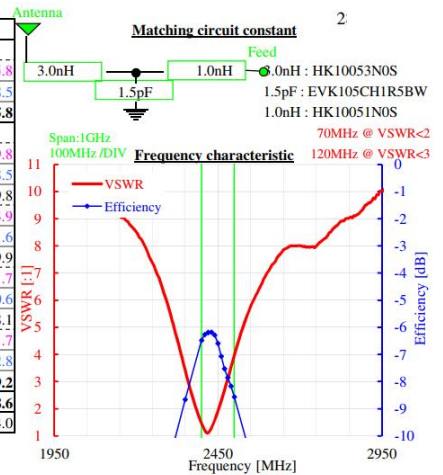
Frequency [MHz]	@2400	@2450	@2500	
Peak gain [dBi]	TX-H	-2.9	-3.5	-5.8
	TX-V	-6.7	-6.5	-8.5

Average gain [dBi]	TX-H	-7.7	-7.6	-9.8
	TX-V	-28.0	-27.2	-28.5
XY-plane	Plus(H,V)	-7.6	-7.6	-9.8
	TX-H	-14.6	-14.0	-14.9
YZ-plane	TX-V	-10.1	-9.8	-11.6
	Plus(H,V)	-8.8	-8.4	-9.9
ZX-plane	TX-H	-8.4	-9.2	-11.7
	TX-V	-9.5	-9.2	-10.6
3-plane	Plus(H,V)	-5.9	-6.2	-8.1
	TX-H	-9.3	-9.5	-11.7
Efficiency [dB]	TX-V	-11.5	-11.2	-12.8
	Plus(H,V)	-7.3	-7.3	-9.2
VSWR [1]	1.5	1.9	4.0	

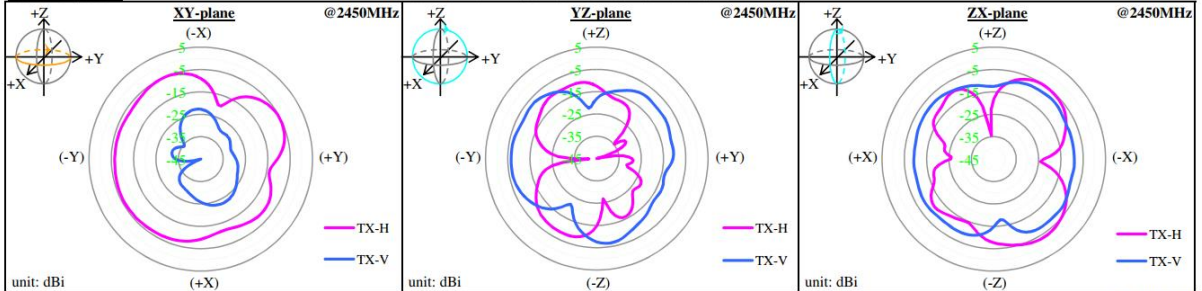
*Note: Peak gain(3-plane)=Peak(XY[H],XY[V],YZ[H],YZ[V],ZX[H],ZX[V])

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

*Note: Average gain(3-plane)=Average(XY[Plus(H,V)],YZ[Plus(H,V)],ZX[Plus(H,V)])



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 **WKM320** module better while it is not guaranteed or assured to obtain better communication performance and distance.

-This product “**WKM320** 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.

WKM320

KAGA FEI Co., Ltd.

Control No. (1/3)	Control name Handling Precaution
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This specification describes desire and conditions especially for mounting.

本書類では特に実装時の 御願ひ・条件 について記載します。

Desire/Conditions

御願ひ・条件

(1) Environment conditions for use and storage

使用・保管環境の管理

1. Store the components in an environment of < 40°C/90%RH if they are in a moisture barrier bag packed by KAGA FEI.

弊社出荷時の防湿梱包状態で保管する場合、40°C/90%RH 以下の環境で保管してください。

2. Keep the factory ambient conditions at < 30°C/60%RH.

工程の環境は 30°C/60%RH 以下に管理してください。

3. Store the components in an environment of < 25±5°C/10%RH after the bag is opened.

(The condition is also applied to a stay in the manufacture process).

モジュールを開梱状態で保管する(工程間の滞留含む)場合、25±5°C/10%RH 以下の環境で保管してください。

(2) Conditions for handling of products

製品取扱時の御願ひ・条件

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).

防湿梱包品入庫後、防湿袋に穴、裂け、キズ等のない事を確認してください。万が一異常があった場合、

(2)-2項に従い、処置をお願い致します。

Refer to the label on the bag.

梱包に貼付のラベルをご参照ください。

1. All of the surface mounting process (reflow process) must be completed in 12 months from the bag sea date.

梱包日から12ヶ月以内に全ての実装(リフロー)作業(リワーク含む)を終了してください。

2. Make sure humidity in the bag is less than 10%RH immediately after open, using a humidity indicator card sealed with the components.

防湿梱包開梱後、直ちに湿度インジケータにて梱包内の環境が<10%RH であることを確認してください。

KAGA FEI Co., Ltd.

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KAGA FEI Co., Ltd.

Control No. (2/3)	Control name Handling Precaution
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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).

開封後**168時間以内**に**全ての**実装作業(リワーク含むリフロー作業)を終了してください。
本モジュール以外の実装作業含みます

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 **125°C 24h**

(1)項、及び(2)-2・(2)-3の基準からはずれた場合、**125°C 24h**にてベーキングを行ってください。

5. As a rule, baking the components in accordance with conditions 4 in (2) shall be once.

(2)-4 項記載の条件によるベーキングは 1 回を原則とします。

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.

本モジュールは内部に半導体を有するため、取扱中には静電気に留意してください。(100V以下)

必要に応じて、導電マット・アースバンド・静電靴・イオナイザー等を用いて、静電気の対策を講じてください。

7. Please make sure that there are lessen mechanical vibration and shock for this module, and do not drop it.

機械的振動、衝撃を極力少なくし、落下させないでください。

8. Please recognize pads of back side at surface mount.

モジュールを実装する際には、裏面の電極を認識してください。

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.

本製品の洗浄は推奨しません。洗浄を行う場合は、洗浄、乾燥後に本製品機能を十分に確認してからご使用ください。尚、本製品への洗浄における不具合に関しましては、当社は一切の責任を負いません。

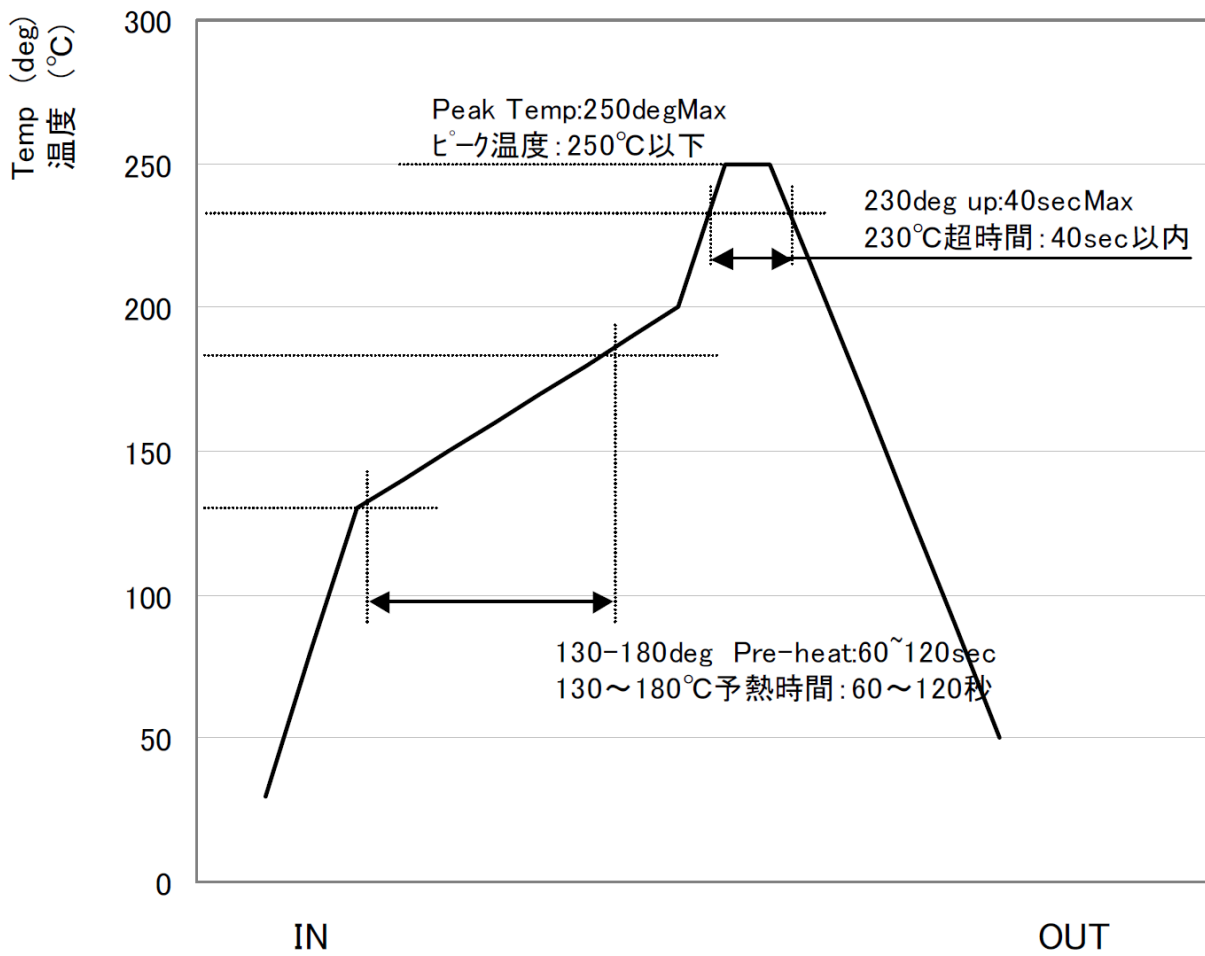
WKM320

KAGA FEI Co., Ltd.

Control No. (3/3)	Control name Handling Precaution
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10. Please perform temperature conditions of module at reflow within the limits of the following.
モジュールのリフロー時温度条件は、下記の範囲内で行って下さい。

Please give the number of times of reflow as a maximum of 2 times.
リフロー回数は最大2回として下さい。



WKM320

KAGA FEI Co., Ltd.

Control No. (1/2)	Control name Packaging Specification
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Packaging Specification
梱包仕様

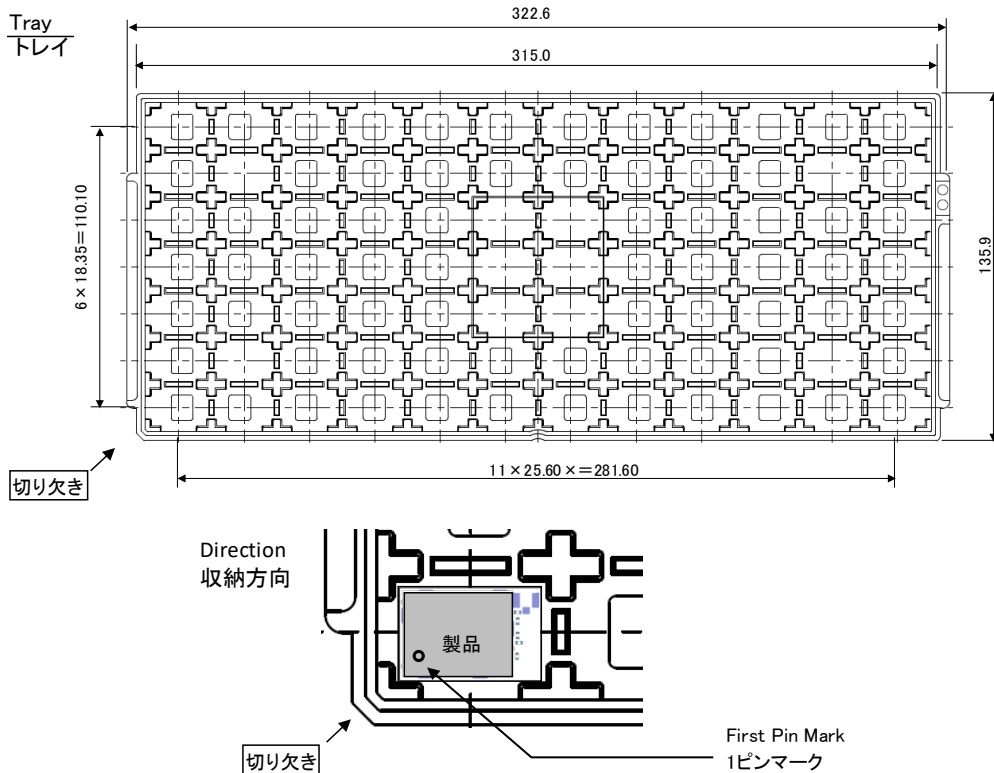
(1) Packaging Material
梱包材料

Name 部材名	Outline 概要	Materials 材質	Note 備考
Tray トレイ	315 × 135.9 × 7.62(mm)	Conductive PPE 導電性PPE	84 pieces/tray 84 個/トレイ
Antistatic band 帯電防止結束バンド	8mm wide 8mm幅	Antistatic PP 帯電防止 PP	—
Desiccant 乾燥剤	—	Desi-Pak デシパック	—
Humidity indicator card 湿度インジケータ	—	—	—
Aluminum moisture barrier bag アルミ防湿袋	260 × 460(mm)	(AS)PET/AL/NY/PE(AS)	—
Buffer corrugated paper 緩衝ダンボール	—	Corrugated fiberboard. ダンボール	—
Label ラベル	—	—	—
Corrugated cardboard boxx 個装箱	345 × 205 × 95(mm)	Corrugated fiberboard. ダンボール	—

(2) Packaging Unit
梱包数量

84 pieces/tray × 10 tray = 840 pieces
84 個/トレイ × 10 トレイ = 840 個

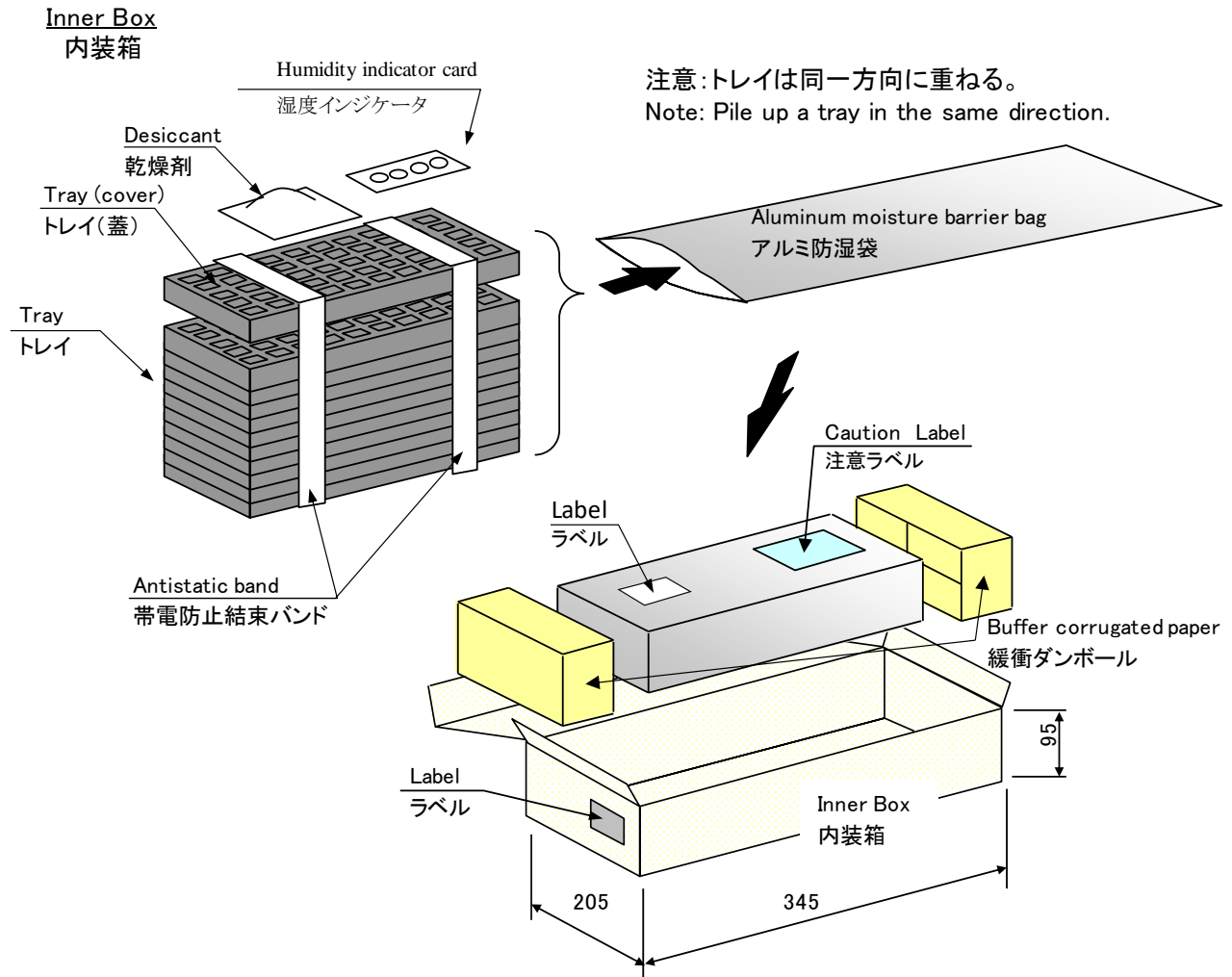
(3) Packaging Figure
梱包形態



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(4) Label
ラベル

The entry item to a label
ラベルへの記載内容

COMPANY NAME	御社名
DESCRIPTION	品名
QUANTITY	納入数量
LotNo.	ロット
NOTE	備考
COUNTRY OF ORIGIN	原産国

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(1/2)	Precautions

その他、注意事項について (Precautions)

- 弊社製品のご使用に際しては、使用する機器に実装された状態および実際の使用環境での評価および確認を必ず行ってください。
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■ 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 powertrain 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. Notwithstanding the foregoing, if there is a written agreement (e.g., supply and purchase agreement, quality assurance agreement) signed by KAGA FEI and your company, KAGA FEI will warrant our products in accordance with such agreement.

■ 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.

■ Caution for Export

Some of our products listed in this specification may require specific procedures for export according to "U.S. Export Administration Regulations", "Foreign Exchange and Foreign Trade Control Law" of Japan, and other applicable regulations. Should you have any questions on this matter, please contact our sales staff.