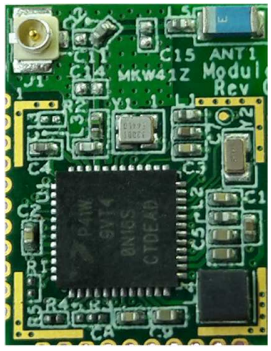
BLUETOOTH® LOW ENERGY, IEEE® 802.15.4 MODULE

KW41Z512VHT4

PRODUCT MANUAL

REVISION 0.1



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1 DOCUMENT DETAILS

1.1 Revision History

Rev.	Date	Description	Prepared By	Reviewed By	Approved By
0.1	24-Aug-16	Initial draft version released	Hitesh Gambhava		

1.2 References

Documents	Revision
MKW41Z512DS Datasheet - NXP	0.2

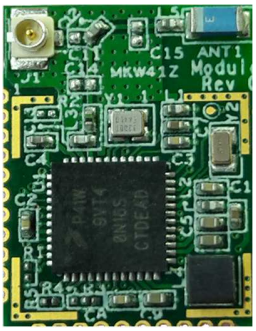
2 INTRODUCTION

This document describes the Volansys KW41Z module. Which has been designed to be easily integrated into another devices and to provide fast and low cost proven wireless network.

The KW41Z module is ultra-compact, low power high sensitivity module. It is based on NXP's MKW41Z512VHT4 SoC combined with Bluetooth Low energy and IEEE 802.15.4 network stacks like Thread, Zigbee pro etc.

No RF experience or expertise is required to add this powerful wireless networking capability to your products. This series of modules offer fast integration opportunities and the shortest possible time to market for your product.

3 PRODUCT OVERVIEW



The KW41Z Module is a fully self-contained, small form factor Bluetooth Low Energy 4.2 and IEEE 802.15.4 compliant module with low complexity and low power features. Based on NXP's Kinetis MCU wireless hardware platform, KW41Z offers superior low power radio performance.

The KW41Z module employs low power architecture and it has been optimized for all kind of application in home automation, smart grid, smart lighting, also networked building control, Medical equipment and Home automation application, HVAC and security.

For evaluation and development, Volansys also offers a complete set of evaluation and development tools.

Module Features

- Small form factor, SMT module 21mm x 16mm
- Side castellation for easy soldering and optical inspection
- Two antenna options: Integrated chip antenna or U.FL connector
- Max output power: +3.5dbm
- Typical Receiver Sensitivity (BLE) = -96 dBm
- Typical Receiver Sensitivity (802.15.4) = -100 dBm
- 32bit ARM® Cortex-M0+ MCU with 64K SRAM and 512K Flash
- Up to 48 MHz ARM® Cortex-M0+ core
- Integrated DC-DC converter enables a wide operating range from 0.9 V to 4.2 V
- Supports Buck and boost power mode with easy hardware configuration
- Extended Operation temp range: -40 °C to +105 °C
- Hardware supported encryption AES 128-bit, TRNG Supported
- 9 MCU Low-power modes to provide power optimization based on application requirements.
- Low Power Mode (VLLS0) Current: ≈180 nA
- All MCU pins accessible
- Serial wire debug(SWD) Interface and Micro Trace buffer
- On module 32MHz and 32.768kHz (RTC) crystal
- RoHS compliant
- Peripheral Interfaces: 2xSPI, 1xUART, 2xI2C, CMT, SWD, 16-bit ADC, Timers

Suggested Applications

- Extremely low-power embedded systems
- Portable health care devices
- Wearable sports
- Fitness devices
- Computer keyboards and mice
- Gaming controllers
- Access control
- Security systems
- Smart energy
- Home area networks
- Automated meter reading
- Medical Network
- HVAC Control
- Lighting control
- Asset tracking
- Environment monitoring and control

4 MODULE PINOUTS

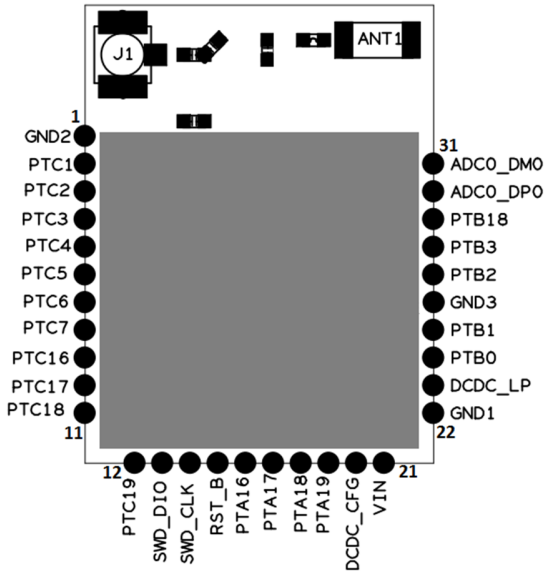


Figure 1: Module Overview

KW41Z module has 31 edge pin for connections as below:

Module PIN#	MKW41Z512 PIN#	Name	Default Use	Alternate Function	Remarks
1	26, 49 to 64	GND			
2	37	PTC1	DISABLED	PTC1, ANT_B, I2C0_SDA, UART0_RTS_b, TPM0_CH2, RF_ACTIVE	
3	38	PTC2	DISABLED	TSI0_CH14/DIAG1, PTC2/LLWU_P10, TX_SWITCH, I2C1_SCL, UART0_RX, CMT_IRO, DTM_RX	
4	39	PTC3	DISABLED	TSI0_CH15/DIAG2, PTC3/LLWU_P11, RX_SWITCH, I2C1_SDA, UART0_TX, TPM0_CH1, DTM_TX	

5	40	PTC4	DISABLED	TSI0_CH0/DIAG3, PTC4/LLWU_P12, ANT_A, EXTRG_IN, UART0_CTS_b, TPM1_CH0, BSM_DATA	
6	41	PTC5	DISABLED	TSI0_CH1/DIAG4, PTC5/LLWU_P13, RF_OFF, LPTMR0_ALT2, UART0_RTS_b, TPM1_CH1, BSM_CLK	
7	42	PTC6	DISABLED	TSI0_CH2, PTC6/LLWU_P14/XTAL_OUT_EN, I2C1_SCL, UART0_RX, TPM2_CH0, BSM_FRAME	
8	43	PTC7	DISABLED	TSI0_CH3, PTC7/LLWU_P15, SPI0_PCS2, I2C1_SDA, UART0_TX, TPM2_CH1, BSM_DATA	
9	45	PTC16	DISABLED	TSI0_CH4, PTC16/LLWU_P0, SPI0_SCK, I2C0_SDA, UART0_RTS_b, TPM0_CH3	
10	46	PTC17	DISABLED	TSI0_CH5, PTC17/LLWU_P1, SPI0_SOUT, I2C1_SCL, UART0_RX, BSM_FRAME, DTM_RX	
11	47	PTC18	DISABLED	TSI0_CH6, PTC18/LLWU_P2, SPI0_SIN, I2C1_SDA, UART0_TX, BSM_DATA,	

				DTM_TX	
12	48	PTC19	DISABLED	TSI0_CH7, PTC19/LLWU_P3, SPI0_PCS0, I2C0_SCL, UART0_CTS_b, BSM_CLK, RF_ACTIVE	
13	1	PTA0	SWD_DIO	TSIO_CH8, PTA0, SPI0_PCS1, TPM1_CH0, SWD_DIO	Provide 10K pull up
14	2	PTA1	SWD_CLK	TSI0_CH9, PTA1, SPI1_PCS0, TPM1_CH1, SWD_CLK	Provide 10K ohm pull-down
15	3	PTA2/ RESET_b	RESET_b	PTA2, TPM0_CH3, RESET_b	Provide 10K pull up
16	4	PTA16	DISABLED	TSI0_CH10 PTA16/LLWU_P4, SPI1_SOUT, TPM0_CH0	
17	5	PTA17	DISABLED	TSI0_CH11, PTA17/LLWU_P5/RF_RESET , SPI1_SIN, TPM_CLKIN1	
18	6	PTA18	DISABLED	TSI0_CH12, PTA18/LLWU_P6, SPI1_SCK, TPM2_CH0	
19	7	PTA19	DISABLED	TSI0_CH13/ADC0_SE5, PTA19/LLWU_P7, SPI1_PCS0, TPM2_CH1	
20	9	DCDC_CFG	DCDC_CFG		
21	10, 8	VIN	Supply Input		
22	26, 49 to 64	GND	GND		
23	11	DCDC_LP	DCDC_LP		
24	16	PTB0	DISABLED	PTB0/LLWU_P8/XTAL_OUT _EN, I2C0_SCL, CMP0_OUT,	

				TPM0_CH1, CLKOUT	
25	17	PTB1	DISABLED	ADC0_SE1/CMP0_IN5, PTB1, DTM_RX, I2C0_SDA, LPTMR0_ALT1, TPM0_CH2, CMT_IRO	
26	26, 49 to 64	GND			
27	18	PTB2	DISABLED	ADC0_SE3/CMP0_IN3, PTB2, RF_OFF, DTM_TX, TPM1_CH0	
28	19	PTB3	DISABLED	ADC0_SE2/CMP0_IN4, PTB3, CLKOUT, TPM1_CH1, RTC_CLKOUT	
29	23	PTB18	NMI_b	DAC0_OUT/ADC0_SE4/CMP0_IN2, PTB18, I2C1_SCL, TPM_CLKIN0, TPM0_CH0, NMI_b	
30	24	ADC0_DP0	ADC0_DP0 / CMP0_IN0	ADC0_DP0 / CMP0_IN0	
31	25	ADC0_DM0	ADC0_DM0 / CMP0_IN1	ADC0_DM0/ CMP0_IN1	

Note:

- Provide pull up at **Reset_b** pin
- Provide Pull down at **SWD_CLK** pin.
- Provide Pull up at **SWD_DIO** pin.
- Module's DC-DC Converter can be configured in **Buck Mode** (VIN= 1.8V to 4.2V), by providing **DCDC_CFG**= High and **DCDC_LP** = open.
- Module's DC-DC Converter can be configured in **Boost Mode** (VIN= 0.9V to 1.8V), by providing **DCDC_CFG**= Low and **DCDC_LP** = High.

5 HARDWARE DESCRIPTION

5.1 Hardware Block Diagram

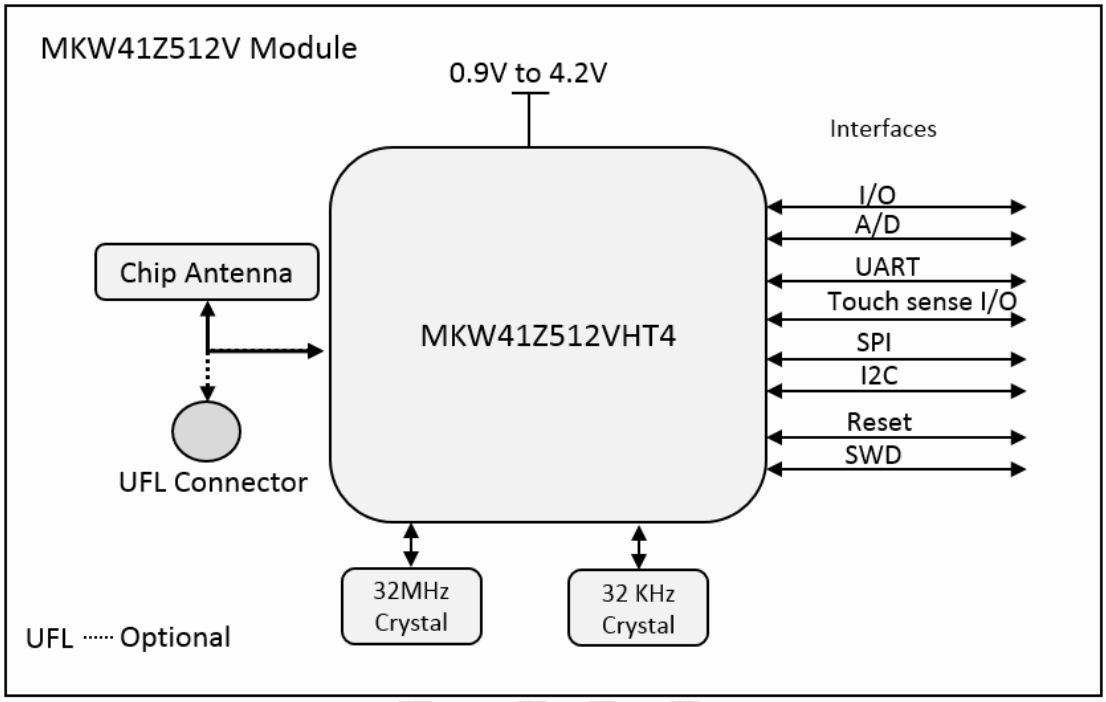


Figure 2: MKW41Z Module Hardware Block Diagram

The KW41Z512 Module families are based on the NXP's Kinetis MCU family MKW41Z512VHT4. KW41Z module are fully integrated 2.4GHz Bluetooth Low Energy (BLE 4.2) and IEEE 802.15.4 compliant transceiver and a powerful 32-bit ARM® Cortex M0+ MCU, up to 512kB flash and 128kB SRAM memory and rich peripherals. The industry standard Micro trace buffer and serial wire SWD programming and debugging interfaces together with the standard ARM system debug components help to streamline any custom software development.

Module has inbuilt antenna and has optional support for external antenna connection through U.FL connector. Inbuilt antenna supports BLE and IEEE 802.15.4 protocol ISM Band (2.4GHz). The voltages are monitored (brown-out detection) and the built in power-on-reset circuit eliminates the need for any external monitoring circuitry. An RTC 32.768 kHz watch crystal is also internally connected. The KW41Z512 module have fully integrated DC-DC converter with Buck, Boost and Bypass modes. Module can be easily configured for Buck and Boost mode power operations as per below table:

Supply Range (VIN)	Mode	DCDC_CFG	DCDC_LP
VIN= 1.8V to 4.2V	Buck	High	-
VIN= 0.9V to 1.8V	Boost	Low	High

5.2 Antenna

The KW2xD Module includes an integrated chip antenna. An optional U.FL connector can be specified, providing connection to a 50-ohm external antenna of the user's choice. However, use of an external antenna is not covered by the module's certification; For optimum antenna performance, the KW41Z Module should be mounted with the PCB chip antenna overhanging the edge of the host board. To further improve performance, a ground plane may be placed on the host board under the module up to the antenna keep out area. The installation of an uninterrupted ground plane on a layer directly beneath the module will also allow you to run traces under this layer.

The chip antenna is compact and highly efficient. To maximize range, an adequate ground plane must be provided on the host PCB. Correctly positioned, the ground plane on the host PCB will contribute significantly to the antenna performance; it should not be directly under the chip antenna. The position of the module on the host board and overall design of the product enclosure contribute to antenna performance. Poor design affects radiation patterns and can result in reflection, diffraction and/or scattering of the transmitted signal.

A few design guidelines to help ensure antenna performance:

- Never place the ground plane or route copper traces directly underneath the antenna portion of the module
- Never place the antenna close to metallic objects
- In the overall design, ensure that wiring and other components are not placed near the antenna
- Do not place the antenna in a metallic or metalized plastic enclosure
- Keep plastic enclosures 1cm or more away from the antenna in any direction

6 ELECTRICAL CHARACTERISTICS

6.1 Absolute Maximum Ratings

The absolute maximum ratings given below should under no circumstances be violated. Exceeding one or more of the limiting values may cause permanent damage to the device.

Description	Module		Unit
	Min	Max	
Power Supply Voltage (VIN)	-0.3	4.2	V
Voltage on I/O line	-0.3	VDD+0.3	V
RF Input power	-	+10	dbm
Storage temperature	-40	105	°C

6.2 Recommended (Operating Condition)

Description	Module			Unit
	Min	Typ	Max	
Bypass Mode Supply Voltage(Digital) (VIN)	1.71	3.6	V	
Boost Mode Supply Voltage (VIN)	0.9	1.795	V	
Buck Mode Supply Voltage (VIN)[1]	2.1	4.2	V	
RF Input Frequency	2400		2483.5	MHz
RF Input Power	-	-	10	dBm
SPI Clock Rate	-	-	12.0	MHz
Logic Input High voltage	0.7*VDD_1V8[3]	-	-	V
Logic Input Low voltage	-	-	0.3*VDD_1V8	V
DC-DC Converter Output Power	-	-	125	mW
Ambient temprature	-40	25	105	°C

Note:

1. In Buck mode, DC-DC converter needs 2.1V min to start, the supply can drop to 1.8V after DC-DC converter settles
2. Analog supply voltage is same as VDD_IO (VDD_1P8OUT)
3. VDD_1V8 is internal configurable LDO output referred as VDD_1P8OUT.

6.3 DC Electrical Characteristics

Buck Mode, VIN=3.6V, Tamb = 25°C, unless otherwise Specified

Description	Module			Unit
	Min	Typ	Max	
Transmit mode current @ +3.5dBm	-	TBD	-	mA
Receive mode current	-	TBD	-	mA
Idle mode				

Sleep/Reset/Power down mode current	-	TBD	-	uA

Please Note:

- The average current consumption during operation is dependent on the firmware and the network load.

6.4 Digital I/O Specification

Digital I/Os of KW41Z512 Module,

VIN = 3.3V, Tamb = 25°C, unless otherwise Specified

Symbol	Description	Module			Unit
		Min	Typ	Max	
VOH	Output high voltage — high drive strength • 2.7 V ≤ VDD ≤ 3.6 V, IOH = -20 mA • 1.71 V ≤ VDD ≤ 2.7 V, IOH = -10 mA	VDD-0.5	-	-	V
	Output high voltage — low drive strength • 2.7 V ≤ VDD ≤ 3.6 V, IOH = -5 mA • 1.71 V ≤ VDD ≤ 2.7 V, IOH = -2.5 mA	VDD-0.5	-	-	V
IOHT	IOHT Output high current total for all ports	-	-	100	mA
VOL	Output low voltage — high drive strength • 2.7 V ≤ VDD ≤ 3.6 V, IOL = 20 mA • 1.71 V ≤ VDD ≤ 2.7 V, IOL = 10 mA	-	-	0.5	V
	Output low voltage — low drive strength • 2.7 V ≤ VDD ≤ 3.6 V, IOL = 5 mA • 1.71 V ≤ VDD ≤ 2.7 V, IOL = 2.5 mA	-	-	0.5	V
VOLT	IOLT Output low current total for all ports	-	-	100	mA
RESET_b	Reset Pulse width to guarantee a reset	100	-	-	ns

6.5 RF Characteristics

Description	Module			Unit
	Min	Typ	Max	
RF Frequency range	2400	-	2483.5	MHz
Tx Power	-30	-	+3.5	dBm
BLE Rx Sensitivity	-	-96	-	dBm
IEEE 802.15.4 Rx Sensitivity	-	-100	-	dBm
GFSK Rx Sensitivity (250 kbps GFSK-BT=0.5, h=0.5)	-	-100	-	dBm

7 MODULE DIMENSION

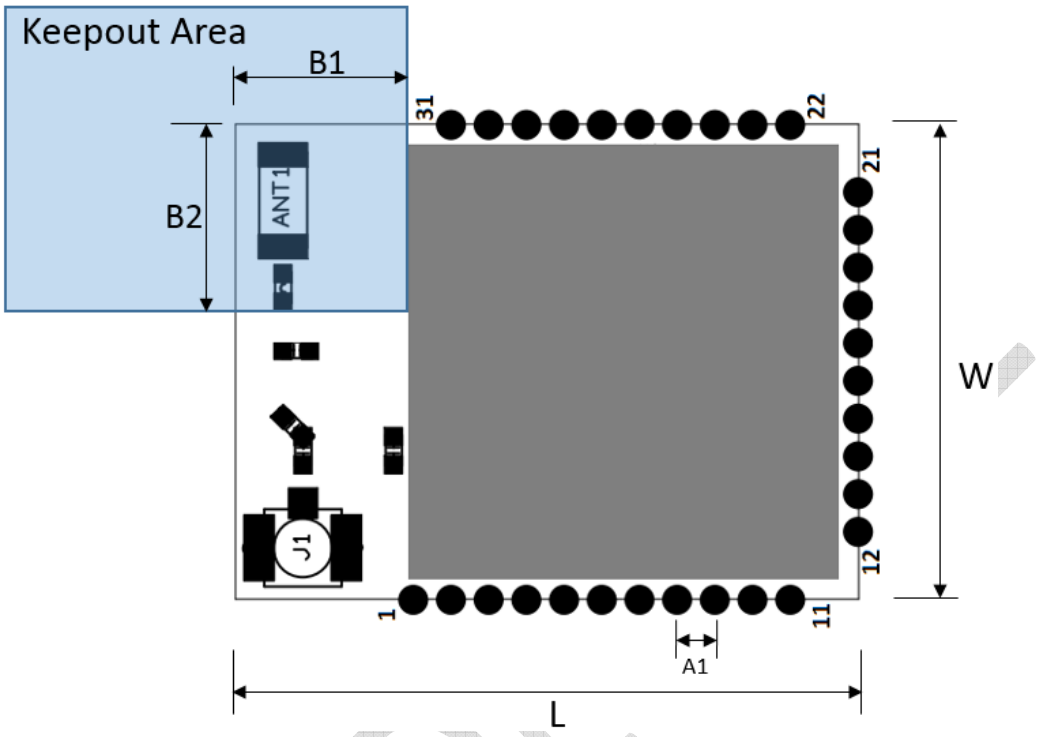


Figure 3: KW41Z Module Physical Dimensions

Symbol	Description	Typical Distance
L	Length of Module	21mm
W	Width of Modules	16mm
A1	Castellated holes pitch	1.27mm
B1	Keepout zone from corner of PCB	6.5mm
B2	Keepout zone from corner of PCB	6.5mm

For ideal RF performance when using the on-board antenna, the antenna should be located at the corner of the carrier PCB. There should be no components, tracks or copper planes in the Keepout area which should be as large as possible. When using the U.FL RF connector the keep-out area does not have to be obeyed. Note: The modules transmit/receive range will depend on the antenna used and also the housing of the finished product.

When placing the module please either locate the antenna in the corner edge of PCB. So that the recommended antenna keep out zone is being followed, or add a no copper zone as mentioned keep out area.

8 CERTIFICATIONS

<TBD>

9 RECOMMENDED REFLOW PROFILE

Recommended Reflow Profile

Parameters Values	
Ramp Up Rate (from T soak max to T peak)	3°/sec max
Minimum Soak Temperature	150°C
Maximum Soak Temperature	200°C
Soak Time	90 ±30 sec
T Liquids	220°C
Time above TL	60-150 sec
T peak	250°C
Time within 5º of T peak	20-30 sec
Time from 25° to T peak	8 min max
Ramp Down Rate	6°C/sec max

Figure 4: Reflow Soldering Profile

Use of "No-Clean" solder paste is recommended to avoid the requirement for a cleaning process. Cleaning the module is strongly discouraged because it will be difficult to ensure no cleaning agent and other residuals are remaining underneath the shielding can as well as in the gap between the module and the host board.

Please Note:

Maximum number of reflow cycles: 2

Opposite-side reflow is prohibited: Do not place the module on the bottom / underside of your PCB and re-flow

10 APPLICATION NOTE

10.1 Safety Precautions

These specifications are intended to preserve the quality assurance of products as individual components. Before use, check and evaluate the module's operation when mounted on your products. Abide by these specifications when using the products. These products may short-circuit. If electrical shocks, smoke, fire, and/or accidents involving human life are anticipated when a short circuit occurs, then provide the following failsafe functions as a minimum:

(1) Ensure the safety of the whole system by installing a protection circuit and a protection device.

(2) Ensure the safety of the whole system by installing a redundant circuit or another system to prevent a single fault causing an unsafe status.

10.2 Design Engineering Notes

(1) Heat is the major cause of shortening the life of the modules. Avoid assembly and use of the target equipment in conditions where the product's temperature may exceed the maximum allowable.

(2) Failure to do so may result in degrading of the product's functions and damage to the product.

(3) If pulses or other transient loads (a large load applied in a short time) are applied to the products, before use, check and evaluate their operation when assembled onto your products.

(4) These products are not intended for other uses, other than under the special conditions shown below. Before using these products under such special conditions, check their performance and reliability under the said special conditions carefully, to determine whether or not they can be used in such a manner.

(5) In liquid, such as water, salt water, oil, alkali, or organic solvent, or in places where liquid may splash. In direct sunlight, outdoors, or in a dusty environment. In an environment where condensation occurs. In an environment with a high concentration of harmful gas (ex. salty air, HCl, Cl2, SO2, H2S, NH3, and NOx)

(6) If an abnormal voltage is applied due to a problem occurring in other components or circuits, replace these products with new products because they may not be able to provide normal performance even if their electronic characteristics and appearances appear satisfactory.

(7) Mechanical stress during assembly of the board and operation has to be avoided.

(8) Pressing on parts of the metal cover or fastening objects to the metal cover is not permitted.

10.3 Storage Conditions

(1) The module must not be stressed mechanically during storage.

(2) Do not store these products in the following conditions or the performance characteristics of the product, such as RF performance, may well be adversely affected:

(3) Storage in salty air or in an environment with a high concentration of corrosive gas, such as Cl2, H2S, NH3, SO2, or NOX

(4) Storage (before assembly of the end product) of the modules for more than one year after the date of delivery at your company even if all the above conditions (1) to (3) have been met, should be avoided.

10.4 Shipment

The KW41Z Modules are delivered in trays of **TBD**.

10.5 Handling

<**TBD**> The KW41Z Modules are designed and packaged to be processed in an automated assembly line.

11 APPENDIX-A

11.1 Acronyms & Glossary

The following terms are used in this document

Sr No#	Terms	Definition
1.	MCU	Microcontroller Unit
2.	CPU	Central Processing Unit
3.	U.FL	Ultra-Miniature RF Connector
4.	BLE	Bluetooth Low Energy
5.	PWM	Pulse width Modulation
6.	ADC	Analog to Digital Convertor
7.	TBD	To Be Define
8.	MCU	Micro Controller Unit
9.	SRAM	Static Random Access Memory
10.	RTC	Real Time Clock