WISA Wireless Module
Hardware OEM/Integration Manual

Version 1.7

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1. Introduction

The purpose of this integration manual is to provide comprehensive specifications and details needed for engineers to integrate the WISA module into a novel or existing product.

NOTE: module is limited to OEM installation ONLY

NOTE: OEM integrator is responsible for ensuring that the end user has no manual instruction to remove or install module.

The module is limited to installation in mobile or fixed applications only. A separate approval is required for all other operating configurations, including portable configurations with respect to Part 2.1093 of the FCC and different antenna configurations.

The document collects and presents the WISA module:

- Functional specifications
- Electrical characteristics
- Pinout and connectivity interfaces
- Mechanical drawings

It also provides the necessary specifications to connect the WISA module to an external application processor that runs the ISA100 application layer firmware.

The WISA wireless module is pre-loaded with a ISA100 compliant communications stack.

1.1 *Audience*

This manual is intended for hardware and integration engineers.

1.2 *Revision History*

Revision History

Rev.	Date	Description
1.0	October 4, 2016	Initial baseline document.
1.1	December 14, 2017	Updated to include functional details related to connectivity.
1.2	March 9 ,2017	Revised pin definitions. Added PCB stack-up, drawings and block diagram.
1.3	June 30, 2017	Revised section 5 – connectivity to external application processor.
1.4	July 11, 2017	Added mechanical drawings.

1.3 *Definitions, Acronyms, and Abbreviations*

The following list defines the acronyms and abbreviations used in this document.

ADC	Analog to Digital Converter
AES	Advanced Encryption Standard
CTS	Clear to Send
DAC	Digital to Analog Converter
DMA	Direct Memory Access
FEM	Front End Module
I2C	Inter-Integrated Circuit is a multi-master serial computer bus
ISM	Industrial Scientific Medical 2.4 GHz radio frequency band
JTAG	Joint Test Action Group
LDO	Low Drop Regulator
LGA	Land Grid Array
MAC	Media Access Controller
MCU	Microcontroller Unit
MEMS	Micro Electro Mechanical Systems
MMCX	Micro Miniature CoaXial
NEXUS	An embedded processor development tool interface that helps design engineers identify software and hardware-level issues.
PA	Power Amplifier
PCB	Printed circuit board
SiP	Platform in Package
PWM	Pulse-width modulation
RTC	Real Time Clock
RTS	Request to Send
SPI	Serial Peripheral Interface
SSI	Synchronous Serial Interface
USB	Universal Serial Bus
VCP	Virtual Com Port

2. Description and Functional Specifications

2.1 *General Specifications*

The WISA wireless module is centered on the MKW21D512 chipset which is NXP's latest generation IEEE 802.15.4 platform. The chipset incorporates a complete low power 2.4 GHz radio frequency transceiver and a Kinetis family low power, mixed-signal ARM® Cortex™- M4 MCU into a single package. The WISA module was designed to meet all the requirements needed to accommodate standards compliant industrial wireless applications based on the IEEE 802.15.4 physical layer such as ISA100.11a, WirelessHART and Thread. The combination of the radio and a microcontroller in SoC (System on Chip) package allows for a cost-effective solution with a market leading, compact form factor and footprint.

The WISA module is offered in a surface mountable form factor, castellated PCB pins and the user interface provides exposes various serial interfaces, MCU digital and analog I/Os and power. Firmware development and debugging are supported through the JTAG SWD port which is also ex[psed through the castellated PCB pins.

The figure below depicts a rendering of the WISA module's form factor.

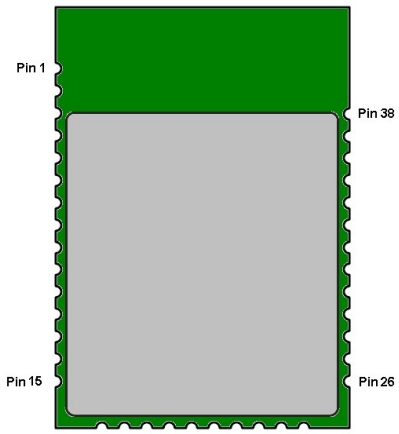

Figure 1 – WISA Module Form Factor

2.2 *Features and Functional Specifications*

- IEEE 802.15.4 compliant wireless module
- Based on Freescale's third-generation MKW21D512 platform which incorporates a complete, low power, 2.4 GHz radio frequency transceiver, 32-bit ARM core based MCU, hardware acceleration for both the IEEE 802.15.4 MAC and AES security, and a full set of MCU peripherals in a 63-pin LGA System in Package(SiP)
- WISA module serves as a proven >10 dBm range extension for the MKW2x series wireless MCUs with a maximum link budget of 123 dB
- Extended range RF capability
  - The MKW21D512 SiP provides a balanced output RF port used with an external PA for higher output power
  - Market leading -108 dBm sensitivity at MMCX port when LNA is enabled (Hi-Gain mode)
  - PA can be enabled for maximum RF output power of +14 dBm available
  - Programmable output power from -10 to +14 dBm
  - MKW21D512 provides hardware-based, dynamic control of external RF elements
  - External antenna MMCX RF direct connect
  - Faraday shield footprint provided as required for FCC and other wireless regulatory compliance requirements
- Power management circuitry
  - Powered trough the castellated user interface
  - On board LDO series regulator provides 3.0 VDD power to the MKW21D512chipset and FEM (Front-end-Module)
  - Low power mode control for external RF circuitry provided (LDO regulator included)
  - Design is optimized for battery operation
- Castellated pins for selected General Purpose Input/Output signals and serial data interfaces
  - One SPI serial port
  - Two UART serial ports with flow control [3.0V CMOS TX, RX, RTS, CTS]
  - Hardware nRESET input
  - Three A/D converter inputs
  - I^2C bus interface
  - Standard JTAG debug and development interface
- System clock options with support for ISA100 tight time synchronization requirements
  - Uses default 32.000 MHz crystal reference oscillator for MKW21D512 chipset
  - Uses a high-accuracy 32.768 kHz oscillator for very accurate real-time keeping as required by ISA100.11a and WirelessHART compliant operation

3. Specifications and Performance Parameters

3.1 *Electrical Specifications*

PARAMETER	MIN	TYPICAL	MAX	UNITS	NOTES/CONDITIONS
Supply Voltage (VCC)	3.2	3.3	4.2	V	Max 6V for 10 seconds
Supply Voltage Noise	0	0	200	mVPP	50Hz – 15MHz
Regulated Voltage Output	3.00	3.01	3.02	V	Supplied to external circuitry via pin V_LDO_OUT (PIN 29)
Regulated Voltage Output Noise	30	35	40	mVPP	Supplied to external circuitry via pin V_LDO_OUT (PIN 29)
LDO Output Max Current	0	0	25	mA	Maximum current supplied by V_LDO_OUT (PIN 29)
Voltage on any digital I/O	0	3.0	VCC+0.1	V	CMOS compatible
Voltage on any analog I/O	0	3.0	VREF	V	Internal VREF is 3.0 V
Idle mode current	8	9	10	mA	At 25° C
Idle WAIT mode current	4.5	5	5.5	mA	At 25° C
Transmit current a 0dBm	35	37	40	mA	At 25° C
Transmit current +10dBm	43	44	46	mA	At 25° C
Transmit current + 14dBm (max RF output power)	55	57	60	mA	At 25° C
Receive LPPS current – Bypass mode	20	20.5	21	mA	At 25° C
Receive LPPS current – High Gain mode	25.5	26	26.5	mA	At 25° C
Receive current – Bypass mode	22	23	23.5	mA	At 25° C
Receive current – High-gain mode	27	28	29	mA	At 25° C
Sleep mode current	3	4	5	µA	At 25° C

3.2 *RF Specifications*

Parameter	MIN	TYPICAL	MAX	Units	Notes/Conditions
802.15.4 Frequency range	2400	NA	2475	MHz	
Range (outdoor/line of sight)			1.25/2000	Miles/Meters	<5% PER for 20-byte packets (using +2 dBi antenna isotropic antenna)
Number of Frequency Channels		15			IEEE 802.15.4 frequency channels. Channel 26 is no used due to FCC regulatory limitations.
Occupied Channel BW		2.65 MHz			Per IEEE 802.15.4 standard specification.
Channel Separation		5 Mhz			Per IEEE 802.15.4 standard specification.
Modulation		Q-PSK			Per IEEE 802.15.4 standard specification.
Raw Data Rate		250 kbps			Per IEEE 802.15.4 standard specification.
Frequency Accuracy	-10	Frequency	+10	ppm	±4 ppm at +25 °C
RF Transmitter					
RF Output Power	-10	0	+14	dBm	Programmable. Note: When transmitting on channel 26, output power should not exceed -4 dBm to meet FCC Part 15 requirements.
RF Receiver					
RF Sensitivity – LNA High Gain Mode	-106	-107	-108	dBm	<1% PER for 20-byte packets per 802.15.4 -2003 standards specification.

RF Sensitivity - Bypass Mode	-99	-100	-101	dBm	<1% PER for 20-byte packets per 802.15.4 -2003 standards specification.
Antenna Port					
Connector		MMCX		NA	
Impedance		50		Ω	

3.3 *Mechanical Specifications*

Parameter	MIN	TYP	MAX	Units	Notes/Conditions
Size – Module with Shield Mounted		0.8" x 1" x 0.2" 20.5 x 25.5 x 5.25		inches mm	
Form Factor		Surface Mount		NA	
Layer build (PCB) width		1.6		mm	1.57mm option 4-Layer board
Dielectric material (PCB)		FR4		NA	FR4

3.4 *Environmental Specifications*

Parameter	MIN	TYP	MAX	Units	Notes/Conditions
Temperature					
Operating temperature (see note)	-40	+25	+85	°C	
Storage temperature	-40	+25	+85	°C	
Operating Relative Humidity	10		90	%	Non condesing humidity

3.5 *User Interfaces*

Interface	Count	Type	Notes/Conditions
UART serial port with full hardware flow control	2	Port	See table detailing WISA module pin definition.

SPI	1	Port	See table detailing WISA module pin definition.
I2C port	1	Port	Needs external pull-up resistors. See table detailing WISA module pin definition.
General purpose IOs (dedicated)	5	I/O	
ADC Inputs	3	I	One dedicated ADC input. Two inputs can also be used as GPIOs. Two additional pins provided for connectivity to external voltage reference.
JTAG debug port	1	Port	Accessible as programming & debug port trough castellated PCB pads.
Tamper/RTC Wakeup	1	NA	Tamper and RTC Wakeup functionality.
RF Port	1	I/O	RF port can be routed to an external antenna via a dedicated pin.
Regulated Voltage Output	1	O	3.0 V supplied to external circuitry. Current draw limited to 25 mA.

3.6 *Regulatory Compliance*

Compliance Type	Status	Notes
EMI/RF Compliance - USA	Certified	FCC Section 15, Part 247
EMI/RF Compliance - Canada	Certified	IC RSS 210
EMI/RF (Europe)	Compliant	CE-Approval –RE Directive EN 300-328 v2.1.1 (2016-11) radio testing
RoHS	Compliant	Compliant to the EU Directive 2002/95/EC of 27 January 2003

HAZLOC and Intrinsic Safety	Compliant	Designed to pass intrinsic safety compliance tests. This include following design considerations: • Minimizing overall lump capacitance • Minimizing overall lump inductance • Minimizing the passive component energy storage capacity of the WISA module to prevent sparking Does no use any voltage enhancing devices (such as boost regulators or multipliers)

4. Interface and Pinout

This chapter provides a description of the WISA module interfaces, pinout and associated functionality.

4.1 *User Interface*

The user interface is exposed through a standard castellated 1.27 mm pitch PCB pinout (see Figure 2 below).

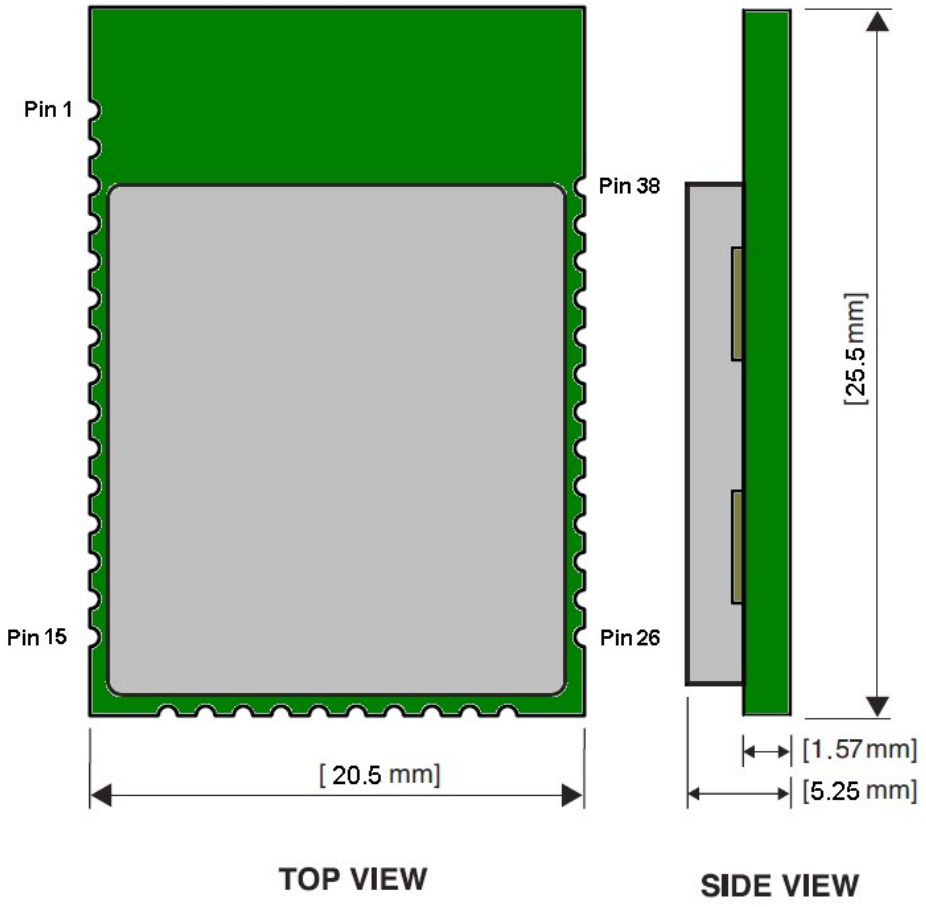

Figure 2 Interface Locations and Pinout

The interface provides access to selected micro-controller GPIOs and serial interface ports. Power is also provided through this interface.

The figure below depicts the pinout of the WISA module.

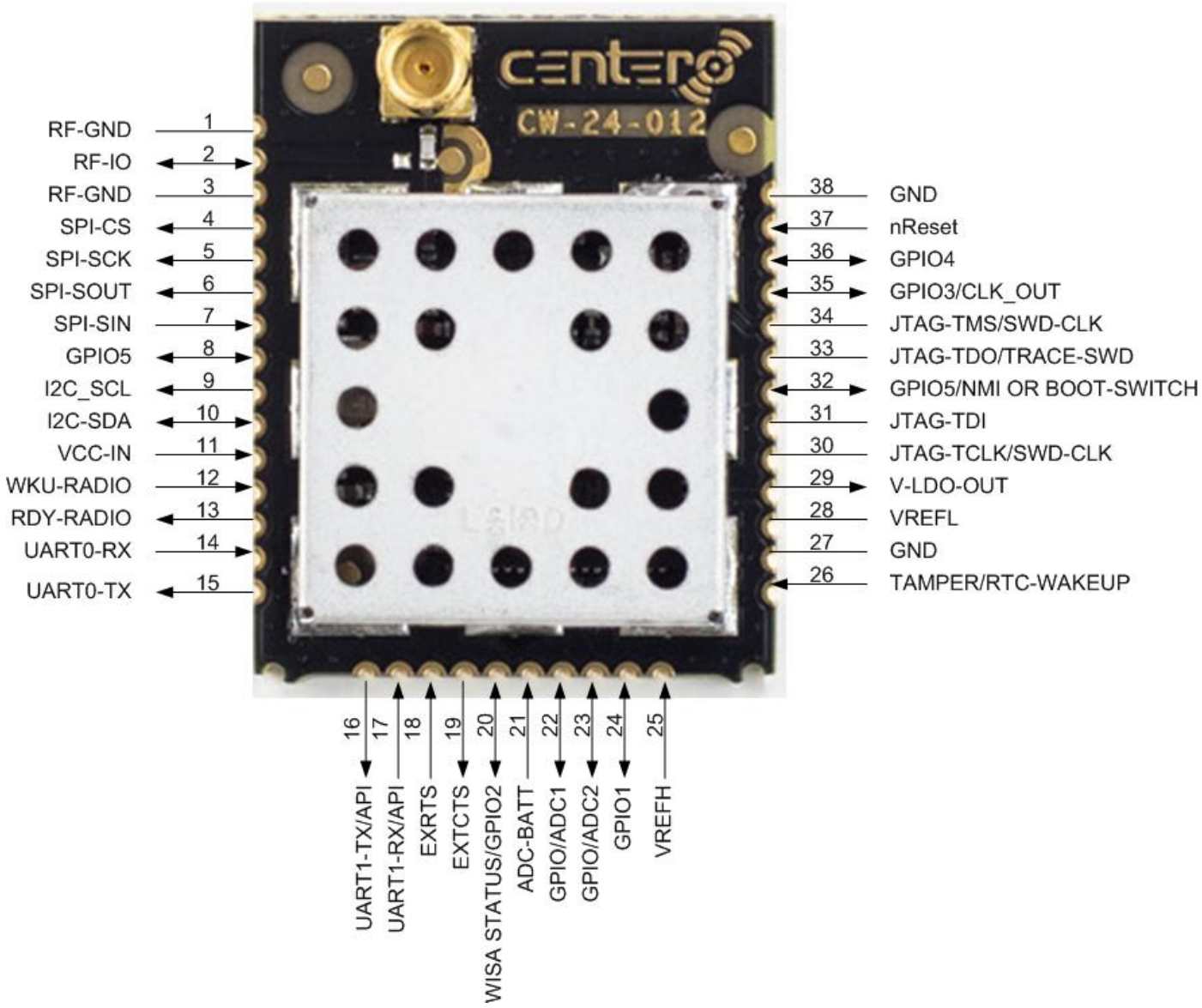

Figure 3 WISA Module - Interface and Pinout

4.2 *WISA Module- Pin Definition and Functionality*

The table below lists the pins exposed through the WISA module interface. It also describes the functionality associated with each pin.

No.	Name	Description	Type	Direction	Functionality
1	RF-GND	Ground	Power	NAPP	Ground to be used for RF IO signal.
2	RF-IO	RF Signal	RF	I/O	RF port signal routed to an external board when C26 is populated and C22 is not populated.
3	RF-GND	Ground	Power	NAPP	Ground to be used for RF IO signal.
4	SPI-CS	SPI Chip Select	DIG	OUT	Standard SPI communication chip select signal.
5	SPI-SCK	SPI Clock	DIG	OUT	Standard SPI communication clock signal.
6	SPI-SOUT	SPI Data Out	DIG	OUT	Standard SPI communication data out signal (MOSI – Master Output Slave Input).
7	SPI-SIN	SPI Data In	DIG	IN	Standard SPI communication data in signal (MISO – Master Input Slave Output).
8	GPIO5	General Purpose I/O	DIG	I/O	General purpose digital I/O.
9	I2C-SCL	I2C Clock	DIG	OUT	I2C clock output – pull-up resistors need to be provided externally.
10	I2C-SDA	I2C Serial Data Line	DIG	I/O	I2C serial data – pull-up resistors need to be provided externally.
11	VCC-IN	Supply Voltage	POWER	NAPP	Supply voltage – provide external 3.3 VDC.

12	WKU-RADIO	Wake-up signal for external connected to application processor	DIG	IN	Digital line used by the application processor to wake up WISA module from sleep mode. The signal is active high and notifies the WISA module that the application processor intends to communicate. When line is active the WISA module will not enter the low-power sleep mode.
13	RDY-RADIO	Ready signal for external application processor	DIG	OUT	Digital line used by WISA module to wake up the external application processor. This signal is active low and is generated in response to the application processor WKU_RADIO signal.
14	UART0-RX	UART0 Receive Data	DIG	IN	UART used for the bootloader and HW test app. Alternate functionality is to connect to the HART Modem UART transmit pin.
15	UART0-TX	UART0 Transmit Data	DIG	OUT	UART used for bootloader and HW test app. Alternate functionality is to connect to the HART Modem UART receive pin.
16	UART1-TX/ API	UART1 Transmit Data	DIG	OUT	UART communication with the external application processor. Connect to RX line of the application processor UART.
17	UART1-RX/ API	UART1 Receive Data	DIG	IN	UART communication with the external application processor. Connect to TX line of the application processor UART.
18	EXTRTS	UART1 Clear to Send	DIG	IN	UART communication with external application processor. Connect to RTS (OUTPUT) signal of the

					application processor UART.
19	EXTCTS	UART1 Request to Send	DIG	OUT	UART communication with external application processor. Connect to CTS (INPUT) signal of the application processor UART.
20	WISA STATUS/GPIO2	General Purpose I/O	DIG	I/O	ISA100 wakeup/status/provisioning signal, typically connected to a push-button. Holding this signal low for > 30 seconds will cause the WISA module ISA100 stack to erase its provisioning information to the factory default state and unjoin the ISA100 network.
21	ADC-BATT	Analog Input for Battery	ANALOG	NAPP	Analog input used to read battery voltage level.
22	GPIO/ADC1	General Purpose I/O	DIG	I/O	General purpose digital I/O. Alternate functionality: Analog input to ADC.
23	GPIO/ADC2	General Purpose I/O	DIG	I/O	General purpose digital I/O. Alternate functionality: Analog input to ADC.
24	GPIO1 OR HART_MODEM CD-IC	General Purpose I/O	DIG	I/O	General purpose digital I/O. Alternate functionality: HART-MODEM-CD-IC which is used to detect the carrier (CD) from an external, wired HART maintenance modem. This is a signal typically provided by a low-power HART SoC modem.
25	VREFH	ADC Voltage Reference	POWER	NAPP	External high voltage reference for the ADC. Connect to external 3.0 V. If not connected to and external 3.0 V reference, connect to WISA pin 29, V—LDO-OUT.

26	TAMPER/RTC-WAKEUP	Tamper detect.	DIG	IN	Tamper detect digital line. Alternate functionality: Real-time clock wake-up.
27	GND	Ground	POWER	NAPP	Ground.
28	VREFL	ADC Voltage Reference	POWER	NAPP	Voltage reference for the ADC. Connect to GND.
29	V—LDO-OUT	Power output.	POWER	NAPP	Voltage output of the internal LDO at 3.0 VDC. Limit current draw on this pin to <25 mA.
30	JTAG-TCLK/SWD-CLK	JTAG	DIG	NAPP	JTAG clock signal. Serial JTAG clock signal.
31	JTAG-TDI	JTAG	DIG	NAPP	JTAG TDI signal.
32	GPIO5/NMI OR BOOT-SWITCH	General Purpose I/O or BOOT-SWITCH	DIG	I/O	General purpose digital I/O with non-masking interrupt. Alternate functionality: BOOT-SWITCH signal read by the bootloader at start-up. The status of this pin dictates the firmware image that will be loaded (HIGH -> ISA100, LOW ->WirelessHART).
33	JTAG-TDO/TRACE-SWD	JTAG	DIG	NAPP	JTAG TDO signal. Serial JTAG Trace signal.
34	JTAG-TMS/SWD-CLK	JTAG	DIG	NAPP	JTAG TMS signal. Serial JTAG DIO signal.
35	GPIO3/CLK-OUT OR HART-MODEM-CD	General Purpose I/O	DIG	I/O	General purpose digital I/O Alternate functionality is HART-MODEM-CD which is used to detect the carrier (CD) from an external, wired HART maintenance modem. This signal is required for lower power consumption in WiHART

					compliant field devices.
36	GPIO4 OR HART-MODEM-PWR-CTRL	General Purpose I/O	DIG	I/O	General purpose digital I/O. Alternate functionality is HART-MODEM-PWR-CTRL which allows the WISA module to control the power to an external wired HART maintenance port's modem.
37	nReset	Reset	DIG	IN	Reset signal of the KW21 chipset.
38	GND	Ground	POWER	NAPP	Ground.

5. ISA100 Communication Stack - External Application Processor Interface

The WISA wireless module communicates with external application processors via a serial UART interface.

The figure below depicts the minimal recommended connectivity between the WISA wireless module and an external application processor. It also includes flow control signals to ensure that the UART serial connection is reliable.

Most ISA100 field instruments spend most of the time in deep sleep mode to conserve precious battery power which results in prolonged battery life. The interface includes wake-up signals that allow the two entities two wake each other up while in sleep mode.

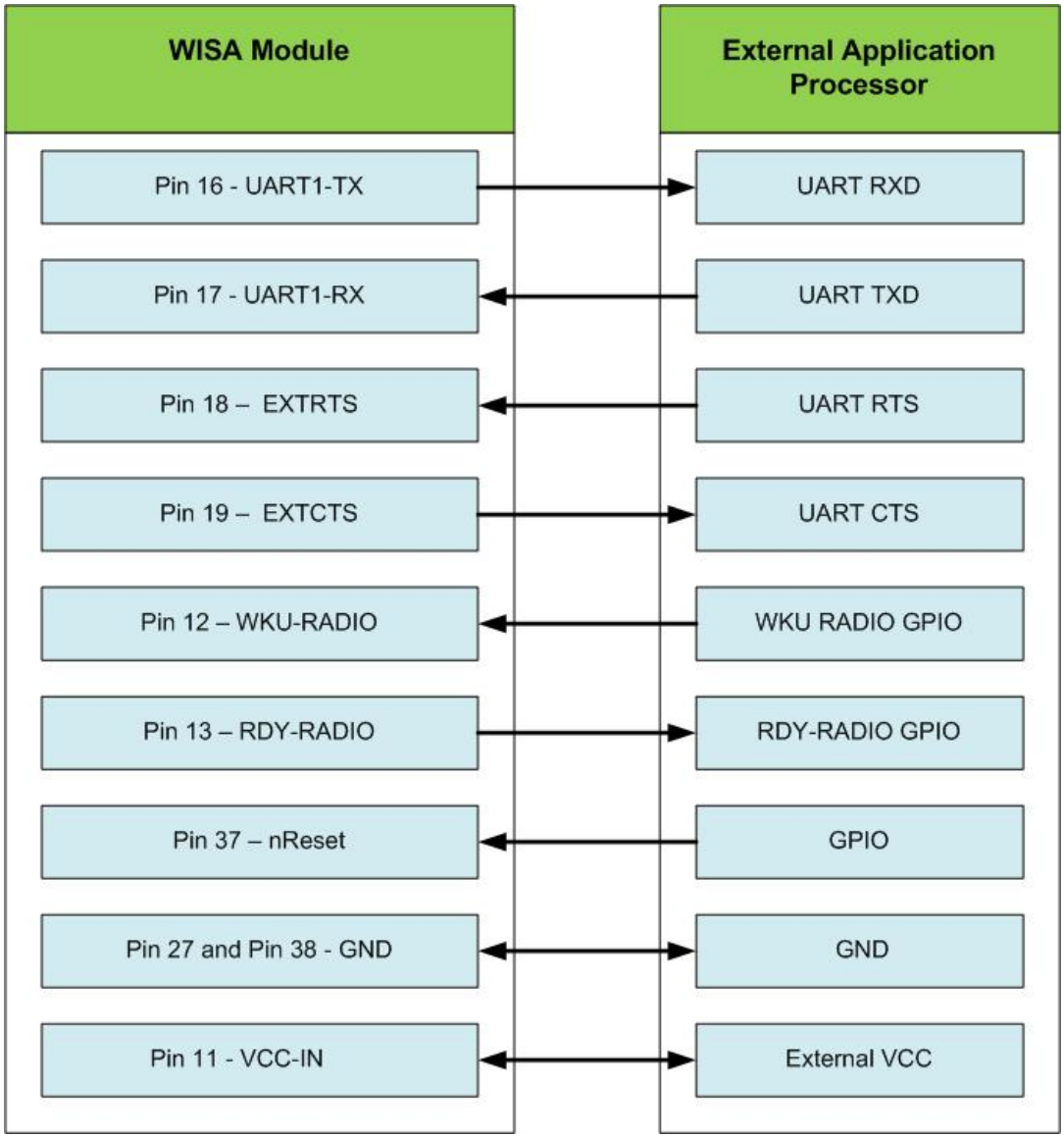

Figure 4 - Connectivity for UART Communication between WISA Module and External Application Processor

6. Detailed Mechanical Specifications

6.1 *Mechanical Drawings*

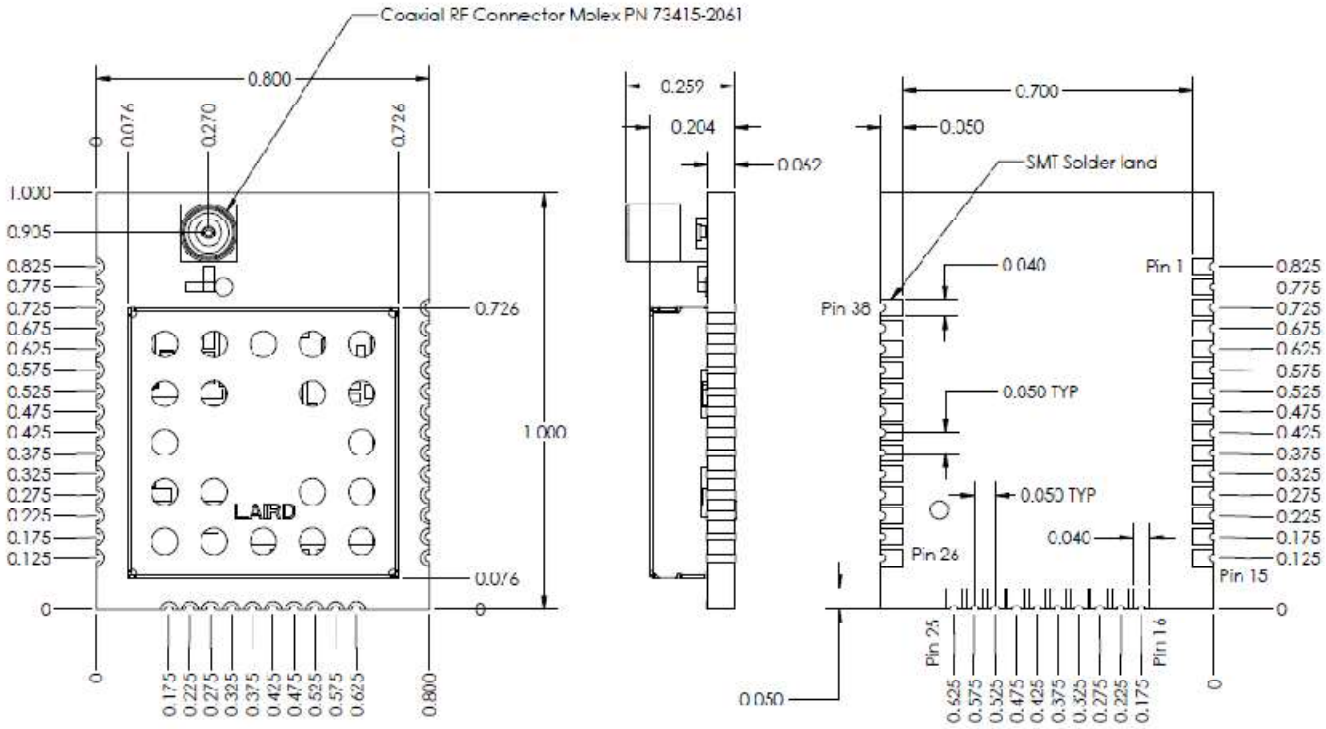

Figure 5 – WISA Module Installation Outline Drawing

6.2 *Recommended PCB Footprint Specifications*

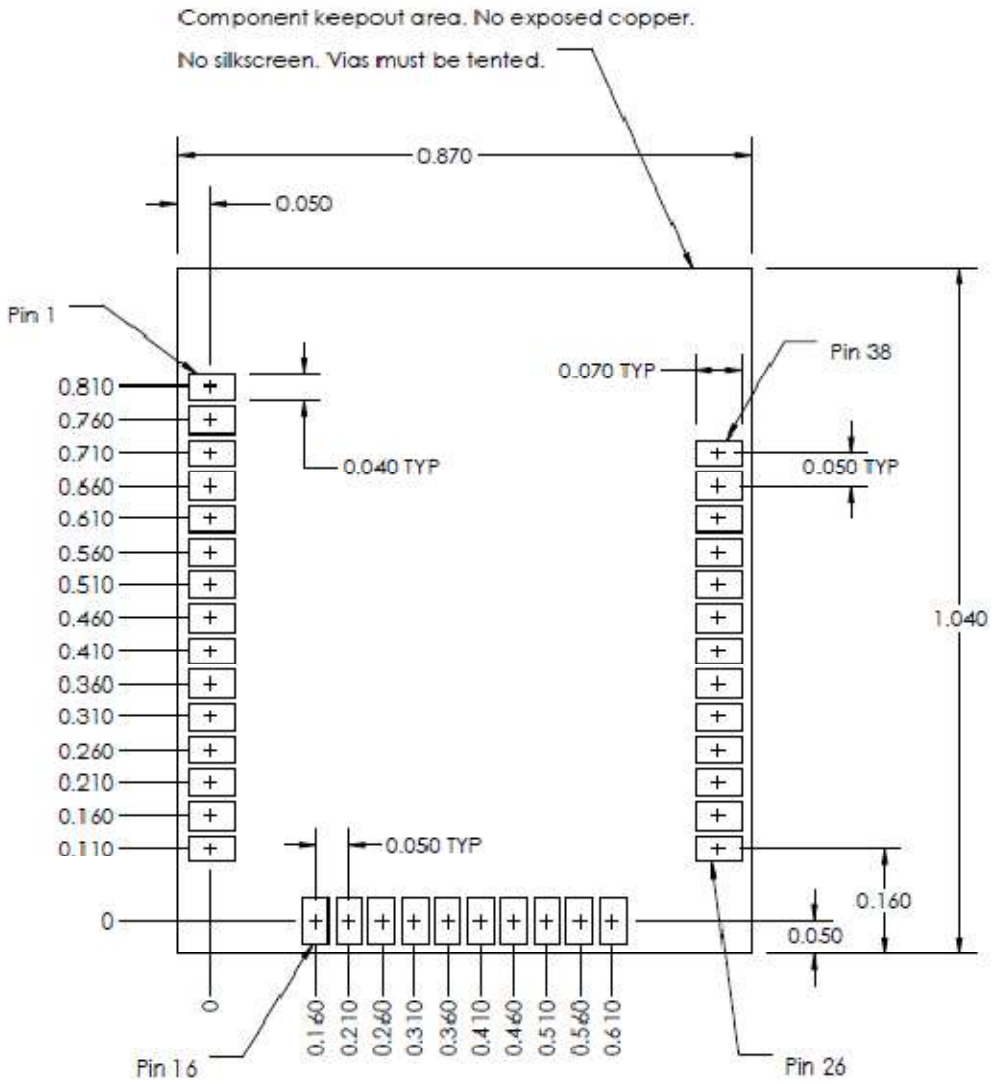

Figure 6 – WISA Module Recommended Footprint

Note: Soldermask to be per PCB vendor recommendation.

7. Regulatory Compliance Information

FCC ID: 2ANDP-CW24-012

IC: 23069-CW24012

When this transmitter is installed in a host device, you must place a permanent label, visible on the outside of the device which includes the following information:

Contains: FCC ID: 2ANDP-CW24-012

Contains: IC: 23069-CW24012

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.

Warning: Changes or modifications not expressly approved by the party responsible could void the user's authority to operate the product.

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures: —Reorient or relocate the receiving antenna. —Increase the separation between the equipment and receiver. —Connect the equipment into an outlet on a circuit different from that to which the receiver is connected. —Consult the dealer or an experienced radio/ TV technician for help.

This equipment uses the following Antennas and may not be used with other antenna types or with antennas of higher gain:
Mfg.: Nearson
Model: S181FL-5-RMM-2450S
Type: Omni Directional
Gain: 2.0 dBi

This equipment complies with FCC Radiation Exposure limits and should be installed and operated with a minimum distance of 20cm between the radiator and any part of the human body.

This device complies with Industry Canada licence-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Le présent appareil est conforme aux CNR d'Industrie 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, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

This radio transmitter, IC: 23069-CW24012, has been approved by Industry Canada to operate with the antenna types listed below with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Type: Omni Directional
Gain: 2.0 dBi

Le présent émetteur radio, IC: 23069-CW24012 a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés ci-dessous et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur.

Type: Omni Directional
Gain: 2.0 dBi

This equipment complies with the ICES RF radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with a minimum distance of 20cm between the radiator and any part of the human body.

Cet équipement est conforme aux limites d'exposition aux radiations ICES définies pour un environnement non contrôlé . Cet équipement doit être installé et utilisé à une distance minimale de 20 cm entre le radiateur et une partie de votre corps.

8. Guidance to Host Manufacturer

The OEM/Integrator can expect to receive guidance from the grantee to ensure compliance with Part 15 Subpart B requirements provide the module is being used within the grant restrictions and instruction detailed within this manual. In the event that these conditions cannot be met (for example certain host configurations or collocation configurations may results in deviations from Grantee's recommend practice) then the FCC authorization may no longer be consider valid and the FCC ID cannot be used on the final host product. In these circumstances, the OEM Integrator will be responsible for reevaluating the end product (including the transmitter) and obtaining a new separate FCC authorization. This device is intended only for OEM Integrators under and under the following conditions: As long as the conditions in this manual are met include RF Exposure requirements and Antenna requirements, further transmitter testing will not be required. However the OEM Integrator is responsible for testing their end product for any additional compliance requirements such as compliance with Part 15 Subpart B.