1 Features

- Modules based on a 2.4-GHz IEEE 802.15.4 Compliant TI RF Transceiver
- Support ZigBee Pro, RF4CE, WHART, TIMAC, and Simplicity software stacks
- Highest Link Budget in Industry **-138dB** (with a 5dBi Antenna)
- Multiple designs with different form factors, antenna interfaces, and population options
- Robustness to Interference
- Programmable Output Power Up to 24dBm
- Compliant With Worldwide Radio-Frequency Regulations: ETSI EN 300 328 and EN 300 440 (Europe), FCC CFR47 Part 15 (US) and ARIB STD-T-66 (Japan)

Low Power

- Active-Mode RX (CPU Idle): 24 mA
- Active Mode TX at 1 dBm (CPU Idle): 29 mA
- Power Mode 1 (4 ms Wake-Up): 0.2 mA
- Power Mode 2 (Sleep Timer Running): 2 uA
- Power Mode 3 (External Interrupts): 0.5 uA
- Wide Supply-Voltage Range (2.7V–3.6 V)

Microcontroller

- High-Performance and Low-Power 8051 Microcontroller Core With Code Pre-fetch 256-KB In-System-Programmable Flash
- 8-KB RAM With Retention in All Power Modes
- Hardware Debug Support · Peripherals
- Powerful Five-Channel DMA
- IEEE 802.15.4 MAC Timer, General-Purpose Timers (One 16-Bit, Two 8-Bit)
- IR Generation Circuitry
- 32-kHz Sleep Timer With Capture
- CSMA/CA Hardware Support

Peripherals

- Powerful Five-Channel DMA
- IEEE 802.15.4 MAC Timer
- General-Purpose, One 16-Bit, Two 8-Bit Timers
- IR Generation Circuitry
- 32-kHz Sleep Timer with Capture
- CSMA/CA Hardware Support

2 Applications

- **PC Human Interface Devices (HID)**
- Wireless Keyboards and Mice
- VOIP and Wireless Headsets
- Wireless Game pads
- Remote Control

- **White Goods (Smart Appliances)**
- Air Conditioners
- Kitchen Compactors
- Dishwashers
- Washers
- Dryers

- **Consumer**
- Sports and Leisure Equipment
- Remote Controls
- Audio Subwoofer
- Presenter Tools
- Locator Alarms
- Toys

- **Building/Home Automation**
- Automatic Meter Readers (AMR)
- On-Site Paging Systems
- Garage door opener
- Alarm and Security
- Lighting Control
- Climate Control
- Fan Control

- **Industrial Control**
- Active RFID and asset tracking systems
- Inventory Management
- Point-of-sale systems
- Factory Automation
- Data Acquisition

3 Functional Description

The Artaflex Zigbee module family is based on TI 2.4 GHz IEEE 802.15.4 RF transceiver, providing a cost-effective solution for data links and wireless networks. The module design supports peer-to-peer, star, and mesh networking. For enhanced range performance over standard IEEE 802.15.4/Zigbee implementations Artaflex Zigbee module is offered with 250mW transmitter output power option. It is the highest RF power available on any Zigbee product in the market. Additionally, each module offers a Dynamic Power Configuration capability giving the ability to bypass the power amplifier for a 1mW power output when low power operation is imperative.

The Artaflex Zigbee module is available with different antenna options. AW24TH-C has an integrated chip antenna. The two other module types AW24TH-SR, and AW24TH-U have RP-SMA or U.FL connector for use with an external cabled antenna. The module is FCC, IC, and CE certified for fast and simple integration into end applications. These modules provide the lowest cost, best in class performance, in a compact form factor

4 ABSOLUTE MAXIMUM RATINGS

RATING	VALUE	UNIT
Power Supply Voltage	3.6	Vdc
Voltage on any Digital Pin	VDD+0.3, Max 3.6	Vdc
RF Input Power	+10	dBm
Storage Temperature Range	-40 to 125	C˚

Note : Exceeding the maximum ratings may cause permanent damage to the module of devices.

5 OPERATING CONDITIONS

CHARACTERISTIC	MIN	TYP	MAX	UNIT
Power Supply Voltage (Vdd)	2.7	3.3	3.6	Vdc
Input Frequency	2405		2480	MHz
Ambient Temperature Range	-40	25	85	C˚
Logic Input Low Voltage	0		30%	Vdd
Logic Input High Voltage	70% Vdd		Vdd	V

The CC2530 chipset building blocks can be roughly divided in to one of three categories.

a) CPU-and memory related:
b) Peripherals, clocks, and power management:
c) Radio related blocks.

In the following sub sections, a short description of important blocks is given. For more details about their usage, see the corresponding chapter in the CC253x SOC User's Guide available at http://www.ti.com.

6 CPU and Memory

The **8051 CPU core** is a single-cycle 8051-compatible core . It has three different memory access buses (SFR, DATA, and CODE/XDATA) with single-cycle access to SFR, DATA and the main SRAM. It also includes a debug interface and an 18-input extended interrupt unit.

The **interrupt controller** services a total of 18 interrupt sources, divided into six interrupt groups, each of which is associated with one of four interrupt priorities. Any interrupt service request is serviced also when the device is in idle mode by going back to active mode. Some interrupts can wake up the device from sleep mode (when in sleep mode, the device is in one of the three low-power modes PM1, PM2, or PM3).

The **memory arbiter** is at the heart of the system, as it connects the CPU and DMA controller with the physical memories and all peripherals through the SFR bus. The memory arbiter has four memory access points, access of which can map to one of three physical memories: SRAM, flash memory, and XREG/SFR registers. It is responsible for performing arbitration and sequencing between simultaneous memory accesses to the same physical memory.

The **4/6/8-KB SRAM** maps to the DATA memory space and to parts of the XDATA memory spaces. The SRAM is an ultralow-power SRAM that retains its contents in all power modes . This is an important feature for low-power applications.

The **32/64/96/128/256 KB flash block** provides in-circuit programmable non-volatile program memory for the device, and maps into the CODE and XDATA memory spaces. In addition to holding program code and constants, the non-volatile memory allows the application to save data that must be preserved such that it is available after restarting the device. Using this feature one can, for example: use saved network-specific data to avoid the need for a full start-up and network find-and-join process.

7 Clocks and Power Management

The digital core and peripherals are powered by a 1.8-V low-dropout **voltage regulator**. Additionally, the CC253x/CC2540 contains a power management functionality that allows the use of different low-power modes (PM1, PM2, and PM3) for low-power applications with a long battery life. Five different **reset** sources exist to reset the device.

8 Peripherals

The CC253x/CC2540 includes many different peripherals that allow the application designer to develop advanced applications. Not all peripherals are present on all devices.

The **debug interface** implements a proprietary two-wire serial interface that is used for in-circuit debugging. Through this debug interface, it is possible to perform an erasure of the entire flash-memory, control which oscillators are enabled, stop and start execution of the user program, execute

supplied instructions on the 8051 core, set code breakpoints, and single-step through instructions in the code. Using these techniques, it is possible to perform in-circuit debugging and external flash programming elegantly.

The device contains flash memory for storage of program code. The flash memory is programmable from the user software and through the debug interface (as mentioned previously). The **flash controller** handles writing and erasing the embedded flash memory. The flash controller allows page-wise erasure and 4-bytewise programming.

The **I/O controller** is responsible for all general-purpose I/O pins. The CPU can configure whether peripheral modules control certain pins or whether they are under software control, and if so, whether each pin is configured as an input or output and if a pull-up or pull down resistor in the pad is connected. CPU interrupts can be enabled on each pin individually. Each peripheral that connects to the I/O pins can choose between two different I/O pin locations to ensure flexibility in various applications.

A versatile five-channel **DMA controller** is also available in the system, accesses memory using the XDATA memory space, and thus has access to all physical memories. Each channel (trigger, priority, transfer mode, addressing mode, source and destination pointers, and transfer count) is configured with DMA descriptors any where in memory. Many of the hardware peripherals (AES core, flash controller, USARTs, timers, ADC interface) achieve highly efficient operation by using the DMA controller for data transfers between SFR or XREG addresses and flash/SRAM.

Timer 1 is a 16-bit timer with timer/counter/PWM functionality. It has a programmable pre-scalar, a 16-bit period value, and five individually programmable counter/capture channels, each with a 16-bit compare value. Each of the counter/capture channels can be used as a PWM output or to capture the timing of edges on input signals. It can also be configured in IR generation mode, where it counts Timer 3 periods and the output is ANDed with the output of Timer 3 to generate modulated consumer IR signals with minimal CPU interaction.

Timer 2 (the MAC Timer) is specially designed for supporting an IEEE 802.15.4 MAC or other time-slotted protocol in software. The timer has a configurable timer period and a 24-bit overflow counter that can be used to keep track of the number of periods that have transpired. A 40-bit capture register is also used to record the exact time at which a start-of-frame delimiter is received/transmitted or the exact time at which transmission ends, as well as two 16-bit output compare registers and two 24-bit overflow compare registers that can send various command strobes (start RX, start TX, etc.) at specific times to the radio modules.

Timer 3 and Timer 4 are 8-bit timers with timer/counter/PWM functionality. They have a programmable prescaler, an 8-bit period value, and one programmable counter channel with an 8-bit compare value. Each of the counter channels can be used as a PWM output. The **Sleep Timer** is an ultra low-power timer that counts 32-kHz crystal oscillator or 32-kHz RC oscillator periods. The Sleep Timer runs continuously in all operating modes except power mode 3 (PM3). Typical applications of this timer are as a real-time counter or as a wake-up timer for coming out of power mode 1 (PM1) or power mode 2 (PM2).

The **ADC** supports 7 bits (30 kHz bandwidth) to 12 bits (4 kHz bandwidth) of resolution. DC and audio conversions with up to eight input channels (Port 0) are possible. The inputs can be selected as single-ended or differential. The reference voltage can be internal, AVDD, or a single-ended or differential

external signal. The ADC also has a temperature-sensor input channel. The ADC can automate the process of periodic sampling or conversion over a sequence of channels.

The **battery monitor** (CC2533 only) enables simple voltage monitoring in devices that do not include an ADC. It is designed such that it is accurate in the voltage areas around 2 V, with lower resolution at higher voltages.

The **random-number generator** uses a 16-bit LFSR to generate pseudorandom numbers, which can be read by the CPU or used directly by the command strobe processor. It can be seeded with random data from noise in the radio ADC.

The **AES coprocessor** allows the user to encrypt and decrypt data using the AES algorithm with 128-bit keys. The core is able to support the security operations required by IEEE 802.15.4 MAC security, the ZigBee network layer, and the application layer.

A built-in **Watchdog Timer** allows the device to reset itself in case the firmware hangs. When enabled by software, the Watchdog Timer must be cleared periodically; otherwise, it resets the device when it times out. It can alternatively be configured for use as a general 32-kHz timer.

USART 0 and **USART 1** are each configurable as either a SPI master/slave or a UART. They provide double buffering on both RX and TX and hardware flow control, and are thus well suited to high-throughput full-duplex applications. Each has its own high-precision baud-rate generator, thus leaving the ordinary timers free for other uses.

The **I2C** module (CC2533 only) provides a digital peripheral connection with two pins and supports both master and slave operation.

The **operational amplifier** (CC2530, CC2531, and CC2540) is intended to provide front-end buffering and gain for the ADC. Both the inputs as well as the output are available on pins, so the feedback network is fully customizable. A chopper-stabilized mode is available for applications that need good accuracy with high gain.

The ultralow-power **analog comparator** (CC2530, CC2531 and CC2540) enables applications to wake up from PM2 or PM3 based on an analog signal. Both inputs are brought out to pins; the reference voltage must be provided externally. The comparator output is mapped into the digital I/O port and can be treated by the MCU as a regular digital input.

9 Radio

The CC253x device family provides an **IEEE 802.15.4-compliant radio transceiver**. The RF Core controls the analog radio modules. In addition, it provides an interface between the MCU and the radio which makes it possible to issue commands, read status, and automate and sequence radio events. The radio also includes a packet-filtering and address-recognition module. More details about the CC253x radio can be found in.

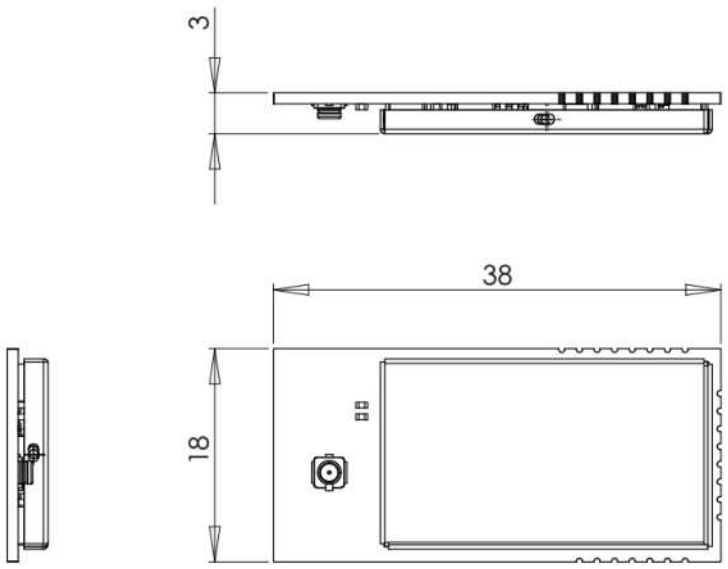
10 ELECTRICAL SPECIFICATION (@25 C, Vdd = 3.3V, unless otherwise noted)

PARAMETER	MIN	TYP	MAX	UNIT
General Characteristics				
RF Frequency Range	2400		2483.5	MHz
RF Data Range		250		Kbps
Host Data Rate			115.2	Kbps
Flash Memory	256			kB
RAM		8		kB
Power Consumption				
Transmit Mode (10mW)		50		mA
Transmit Mode @ **100mW, *250mW**		220	*280	mA
Receive Mode LGM, HGM	24	33		mA
Power down Mode 3		0.5		uA
Transmitter				
Maximum Output Power		24.2 or ***263mW**		dBm
Nominal Output Power (DPS)		-1		dBm
Programmable OP Power Range		30		dB
Error Vector Magnitude		12	35	%
Receiver				
Module Sensitivity HGM (1% PER)		-105		dBm
Module Sensitivity LGM (1%PER)		-93		dBm
Saturation HGM, LGM	-10	10		dBm
Control AC Characteristics				
RESET_N low pulse width	2.5			nS
Interrupt request pulse width	31.25			nS
Control DC Characteristics				
Logic Input Low	0	0.7	0.9	V
Logic Input High	VDD-0.25	VDD	VDD	V

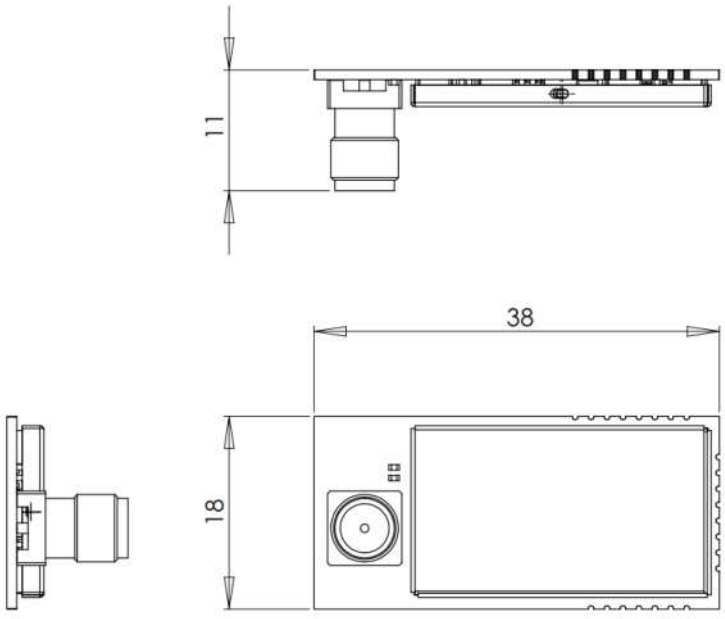
11 AW24TH Mechanical Information:

Shown Below is brief dimensional information, for a detailed drawings and information please contact Artaflex Support at www.artaflex.com

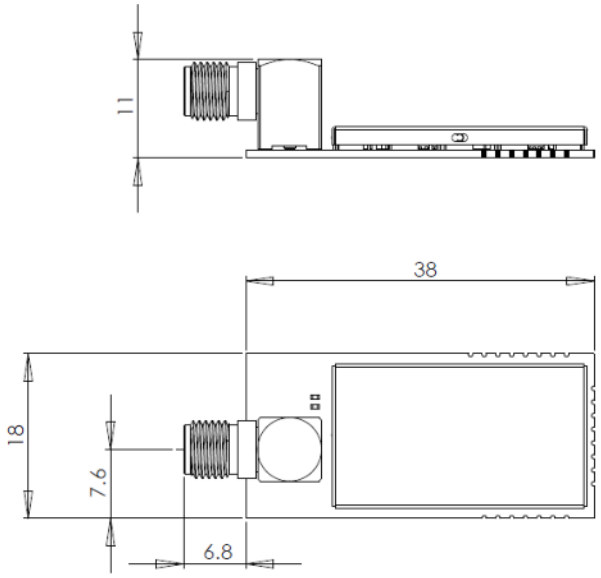
Module with U.FL Connector dimensions (mm):



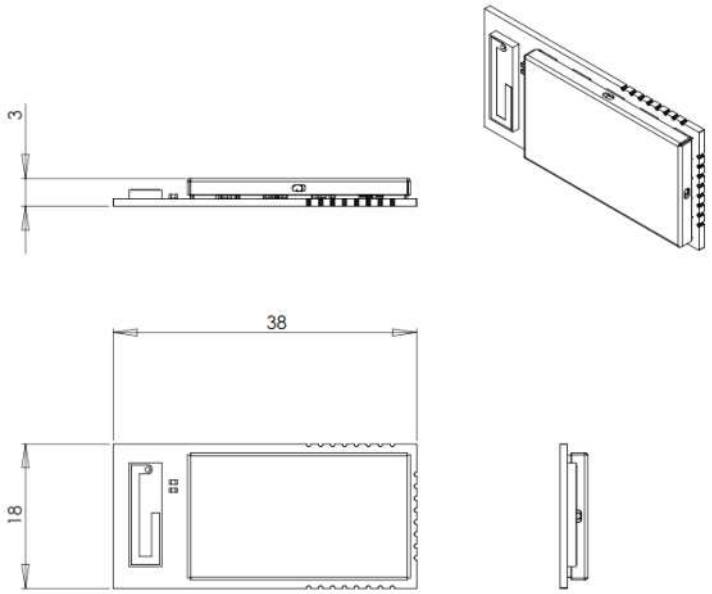
Module with SMA Connector dimensions (mm):



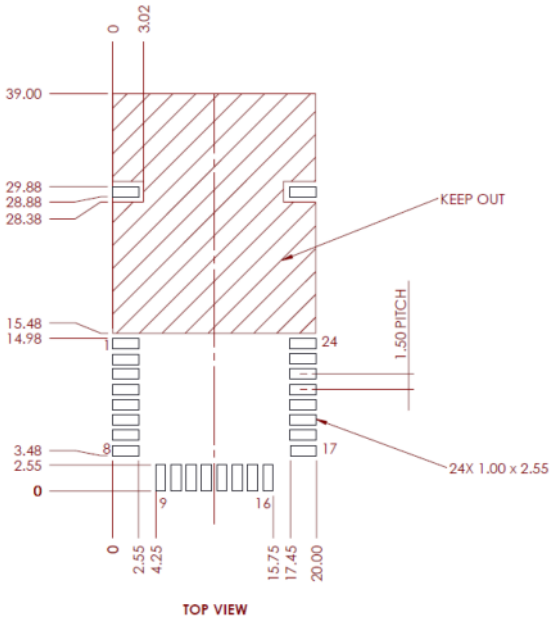
Module with Right Angle SMA Connector (mm):



Module with Chip Antenna dimensions (mm):

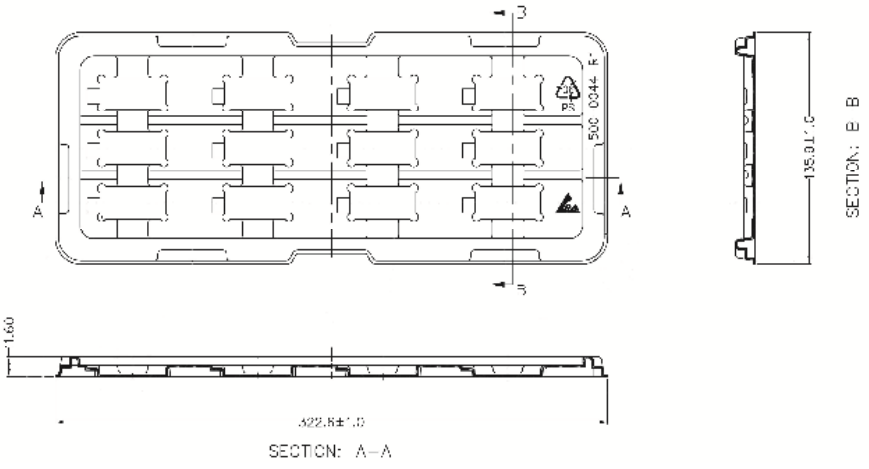


12 AW24TH Module PCB Foot Print :



13 AW24TH Packaging Tray:

AW24TH Module will be shipped on a tray meeting JEDEC standards. There will be 12 modules per tray. For more information about manufacturing and placement details contact Artaflex at support@artaflex.com.



14 AW24TH Pin Information (AW24TH-U, AW24TH-S, AW24TH-C)

PIN #	NAME	TYPE	DESCRIPTION
1	GND	Power	Ground
2	P2.2	DI/DO	General Purpose Digital I/O or Debug CLK
3	P2.1	DI/DO	General Purpose Digital I/O or Debug DATA
4	P2.0	DI/DO	General Purpose Digital I/O
5	P1.7	DI/DO	General Purpose Digital I/O
6	P1.6	DI/DO	General Purpose Digital I/O
7	P1.5	DI/DO	General Purpose Digital I/O or TXD
8	P1.4	DO	Mode Detect Output “1=Rx, 0 = Tx “ Put No Load
9	P1.2	DI/DO	General Purpose Digital I/O
10	P1.3	DI/DO	General Purpose Digital I/O
11	P1.1	DO	Mode Detect Output “0=Rx, 1 = Tx “ Put No Load
12	P1.0	DI/DO	General Purpose Digital I/O , 20mA drive capability
13	P0.6	DI/DO/AI	General Purpose Digital I/O, or ADC input 6
14	P0.7	DO	Mode Detect Output “1=HGM, 0 = LGM “ Put No Load
15	VDD	Power	DC Power 2.7-3.3V
16	GND	Power	Ground
17	NC	NC	NC
18	P0.4	DI/DO	PA/LNA DC Power Control, Setup by Chip
19	P0.3	DI/DO/AI	General Purpose Digital I/O, or ADC input 3
20	P0.2	DI/DO/AI	General Purpose Digital I/O, or ADC input 2
21	P0.1	DI/DO/AI	General Purpose Digital I/O, or ADC input 1
22	P0.0	DI/DO/AI	General Purpose Digital I/O, or ADC input 0
23	RESET	DI	Reset Active Low
24	GND	Power	Ground

15 I/O Pin Mapping

The DI/DO/ or AI pins available on the module can be configured in many different ways. A table below shows some possibilities. For a more detailed information on this please study CC253x SOC User Guide available at www.ti.com

Periphery/ Function	P0								P1								P2				
	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0	4	3	2	1	0
ADC	A7	A6	A5	A4	A3	A2	A1	A0													T
Operational Amplifier						O	–	+													
Analog Comparator			+	–																	
USART 0 SPI			C	SS	MO	MI															
Alt. 2											M0	MI	C	SS							
USART 0 UART			RT	CT	TX	RX															

Periphery/ Function	P0								P1								P2				
	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0	4	3	2	1	0
Alt. 2											TX	RX	RT	CT							
USART 1 SPI			MI	M0	C	SS															
Alt. 2									MI	M0	C	SS									
USART 1 UART			RX	TX	RT	CT															
Alt. 2									RX	TX	RT	CT									
TIMER 1		4	3	2	1	0															
Alt. 2	3	4												0	1	2					
TIMER 3												1	0								
Alt. 2									1	0											
TIMER 4															1	0					
Alt. 2																		1			0
32-kHz XOSC																	Q1	Q2			
DEBUG																			DC	DD	
OBSSEL											5	4	3	2	1	0					

16 ANTENNA

1. Artaflex power amp modules are available with different antenna interface options, like integrated chip antenna, SMA and U.FL connector for connecting external antennas. The module FCC,IC,CE regulatory certification has been completed on all module types. For external antenna types modular approval was obtained by using a ½ wave dipole antenna with the following specs. Customer can chose any similar (1/2 wave dipole) antenna with equal or lower gain.

    a. Frequency — 2.4GHz
    b. Connector Interface — RP-SMA or U.FL flying lead pigtail
    c. Antenna Type — Whip, ½ wave Dipole
    d. Gain — 5dBi
    e. RoHS Status — RoHS Compliant

2. The integrated chip antenna is an Inverted F-antenna. This antenna was chosen for its compact size, reasonably omni directional radiation pattern and efficiency. An adequate ground plane directly beneath the module but not under the antenna is necessary to provide good efficiency.
   The antenna radiation pattern is dependent upon the carrier board the module is placed upon. Measured radiation patterns of the module alone are available by contacting Artaflex support at www.artaflexmodules.com. The environment the module is placed in will dictate the range performance. The non-ideal characteristics of the transmission channel result in the transmitted signal producing reflection, diffraction, and/or scattering. All of these factors randomly combine to create extremely complex scenarios.

3. Therefore it is necessary to maintain a clearance of min 1.5cm between the antenna and nearby objects. This includes how the module is mounted in the product enclosure. Unless the items on the following list of recommendations are met, the radiation pattern can be heavily distorted.

   Following is a list of design guidelines to follow, to achieve the optimum performance level.

   i. Never place ground plane or copper trace routing underneath the antenna.
   ii. Never place the antenna within 2 cm of metallic objects.
   iii. In the final product, ensure that any wiring or other components do not get within 1.5cm of the antenna
   iv. The antenna will perform more efficiently if a > 2cm² ground plane area is provided behind the antenna.
   v. Do not use a metallic enclosure or metalized plastic for the chip antenna module
   vi. Keep any plastic enclosure greater than 1 cm from the antenna in any orientation.

17 RF Regulatory Requirements

To satisfy FCC RF exposure requirements for mobile transmitting devices, a separation distance of 20 cm or more should be maintained between the antenna of this device and persons during device operation. To ensure compliance, operations at closer than this distance is not recommended.

The chip antenna is integrated in the module and has been qualified and approved for use under the Modular Approval certification. This antenna is designed to be compatible with the RF impedance and frequency range of the AWP24S. This antenna may not be modified or altered in any way from the original design as represented by Artaflex Inc.

The external dipole antenna has been specifically tested with the Artaflex AW24TH Modules, and has been certified through the regulatory agencies in the US, Canada, and European Union for authorized use. Use of an altered antenna with higher gain in any Artaflex Zigbee module voids the MA grant for it. Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

NOTE: The manufacturer is not responsible for any radio or TV interference caused by unauthorized modifications to this equipment. Such modifications could void the user's authority to operate the equipment.

18 Reference Documentation

For further information on the technical details of the CC2530 SOC, such as register settings, timing, application interfaces, and clocking, refer to the device data sheet and application information, on the TI Web Site at http://focus.ti.com/docs/prod/folders/print/cc2530.html

19 Ordering Information

Standard Part Numbers

PART NUMBER	DESCRIPTION	TEMPERATURE
AW24TH-U	**Artaflex Zigbee Module SMT with, U.FL Connector**	-40 to 85ºC
AW24TH-S	Artaflex Zigbee Module SMT with , SMA Connector	-40 to 85ºC
AW24TH-SR	Artaflex Zigbee Module SMT with , SMA Right Angle Connector	-40 to 85ºC
AW24TH-C	Artaflex Zigbee Module SMT with , Integrated Chip Antenna	-40 to 85ºC
AW24TH-x[1]-EV	Artaflex Zigbee Module with Carrier board adaptor for TI DVK SmartRF05EB	-40 to 85ºC
AW24TH-x[1]-DM	Artaflex Zigbee Module Demo board	-40 to 85ºC

Note: x[1] - Put corresponding module type to create ordering part number for the Carrier or Evaluation board assembly

For example:

AW24TH-U-EV or AW24TH-U-DM

For Carrier or Evaluation board ordering, with Artaflex Zigbee module with a U.FL Connector.

20 SMT MANUFACTURING PROCESS

This section describes the process of module secondary SMT manufacturing including solder paste, placing SMD and preheat/reflow.

Moisture Sensitivity Level

As per J-STD-020, devices rated as MSL 3 and not stored in a sealed bag with desiccant pack should be baked prior to use. After opening packaging, devices that will be subjected to reflow must be mounted within 168 hours of factory conditions (<30°C and 60% RH) or stored at <10% RH.

Since the wireless modules are sensitive to moisture absorption, it is important that the moisture is removed before reflow soldering otherwise permanent damage will occur.

Since devices are shipped in low temperature polystyrene carriers, do not bake in temperatures over 40C otherwise carriers will be damaged.

As per IPC/JEDEC J-STD-033B, If a higher bake temperature is required, the devices must be removed from the low temperature carriers to thermally safe carriers, baked and returned to the low temperature carrier.

Below is a list of options for bake time, drying oven temperatures and important notes for the device.

- Bake @ 125 C for 48 hrs - Do not use supplied low temperature carrier for baking
- Bake @ 90 C ≤ 5% RH for 10 days - Do not use supplied low temperature carrier for baking
- Bake @ 40 C ≤ 5% RH for 79 days - Low temperature carrier for baking

Soldering Recommendations

Maximum temperature 230 C to 250 C

Follow paste manufacturer's recommended profile parameters

The time above reflow temp 221 C is 60 sec to 70 sec

Solder joint quality for castellated vias where the module contacts the host board should meet IPC-A-610-E or latest revision, Acceptability of Electronic Assemblies, Section 8.2.4 Castellated Terminations.

Solder Paste Printing

Design stencil as per IPC7525A Stencil Design Guidelines. Recommended stencil foil thickness is 0.13 mm (0.005")

Repeating Solder Reflow

It is recommended that only a single reflow process is used for host board.

Cleaning

Cleaning is not recommended since residuals cannot be easily removed. Aqueous cleaning will lead to water absorption in the gap between the host board and the module. The combination of soldering flux residuals and water could lead to short circuits. Cleaning with alcohol or a similar organic solvent will likely flood soldering flux residuals into the RF shield, which is not accessible for post-washing inspection. The solvent could also damage any stickers or labels. Ultrasonic cleaning could damage the module permanently.

Optical Inspection

After soldering the module to the host board, the following should be inspected:

- Proper alignment and centering of the module over the pads.
- Proper solder joints on all pads.
- Excessive solder or contacts to neighboring pads, or vias.
- Inspection shall conform to IPC-A-610-E or latest revision, Acceptability of Electronic Assemblies, Section 8.2.4 Castellated Terminations.

Rework

The module can be unsoldered from the host board if the Moisture Sensitivity Level (MSL) requirements are met as described in this datasheet.

Never attempt a rework on the module itself, e.g. replacing individual components. Such actions will terminate warranty coverage

Storage

Please use this product within 6 months after receipt. Any product used after 6 months of receipt needs to have solder ability confirmed before use.

The product shall be stored without opening the packing under the ambient temperature from 5 to 35deg.C and humidity from 20 to 70%RH. (Packing materials, in particular, may be deformed at the temperatures above this range.

Do not store in salty air or in an environment with a high concentration of corrosive gas, such as Cl2, H2S, NH3, SO2, or NOX.

Do not store in direct sunlight.

The product should not be subject to excessive mechanical shock

The information contained herein is subject to change without notice and may be found to contain errors of omission or changes in parameters. For feedback or technical support regarding Artaflex CyFi Radio Modem products please contact Artaflex at www.artaflex.com.

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