

## General Description

The Cypress CYBLE-022001-00 is a fully certified and qualified module supporting Bluetooth® Low Energy (BLE) wireless communication. The CYBLE-022001-00 is a turnkey solution and includes onboard crystal oscillators, chip antenna, passive components, and Cypress PROc™ BLE.

The CYBLE-022001-00 supports a number of peripheral functions (ADC, timers, counters, PWM) and serial communication protocols (I<sup>2</sup>C, UART, SPI) through its programmable architecture. The CYBLE-022001-00 includes a royalty-free BLE stack compatible with Bluetooth 4.1 and provides up to 16 GPIOs in a small 10 × 10 × 1.80 mm package.

The CYBLE-022001-00 is a complete solution and an ideal fit for applications requiring BLE wireless connectivity.

### Module Description

- Module size: 10.0 mm × 10.0 mm × 1.80 mm (with shield)
- Bluetooth 4.1 single-mode module
- Industrial temperature range: –40 °C to +85 °C
- 32-bit processor (0.9 DMIPS/MHz) with single-cycle 32-bit multiply, operating at up to 48 MHz
- 128-KB flash memory
- 16-KB SRAM memory
- Watchdog timer with dedicated internal low-speed oscillator (ILO)
- Two-pin SWD for programming
- Up to 16 GPIOs configurable as open drain high/low, pull-up/pull-down, HI-Z analog, HI-Z digital, or strong output
- Certified to FCC, CE MIC, KC, and IC regulations
  - FCC ID: WAP2001
  - IC ID: 7922A-2001
  - MIC ID: 005-101007
  - KC ID: MSIP-CRM-Cyp-2001
- Bluetooth SIG 4.1 qualified
  - QDID: [67366](#)
  - Declaration ID: [D026297](#)

### Power Consumption

- TX output power: –18 dbm to +3 dbm
- Received signal strength indicator (RSSI) with 1-dB resolution
- TX current consumption of 15.6 mA (radio only, 0 dbm)
- RX current consumption of 16.4 mA (radio only)
- Low power mode support
  - Deep Sleep: 1.3 µA with watch crystal oscillator (WCO) on
  - Hibernate: 150 nA with SRAM retention
  - Stop: 60 nA with XRES wakeup

### Functional Capabilities

- Up to 15 capacitive sensors for buttons or sliders with best-in-class signal-to-noise ratio (SNR) and liquid tolerance
- 12-bit, 1-Msps SAR ADC with internal reference, sample-and-hold (S/H), and channel sequencer
- Two serial communication blocks (SCBs) supporting I<sup>2</sup>C (master/slave), SPI (master/slave), or UART
- Four dedicated 16-bit timer, counter, or PWM blocks (TCPWMs)
- Programmable low voltage detect (LVD) from 1.8 V to 4.5 V
- I<sup>2</sup>S master interface
- Bluetooth Low Energy protocol stack supporting generic access profile (GAP) Central, Peripheral, Observer, or Broadcaster roles
- Switches between Central and Peripheral roles on-the-go
- Standard Bluetooth Low Energy profiles and services for interoperability
- Custom profile and service for specific use cases

### Benefits

The CYBLE-022001-00 module is provided as a turnkey solution, including all necessary hardware required to use BLE communication standards.

- Proven, qualified, and certified hardware design ready to use
- Small footprint (10 × 10 mm × 1.80 mm), perfect for space constrained applications
- Reprogrammable architecture
- Fully certified module eliminates the time needed for design, development and certification processes
- Bluetooth SIG qualified with QDID and Declaration ID
- Flexible communication protocol support
- PSoC Creator™ provides an easy-to-use integrated design environment (IDE) to configure, develop, program, and test a BLE application

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## Overview

### Module Description

The CYBLE-022001-00 module is a complete module designed to be soldered to the applications main board.

#### *Module Dimensions and Drawing*

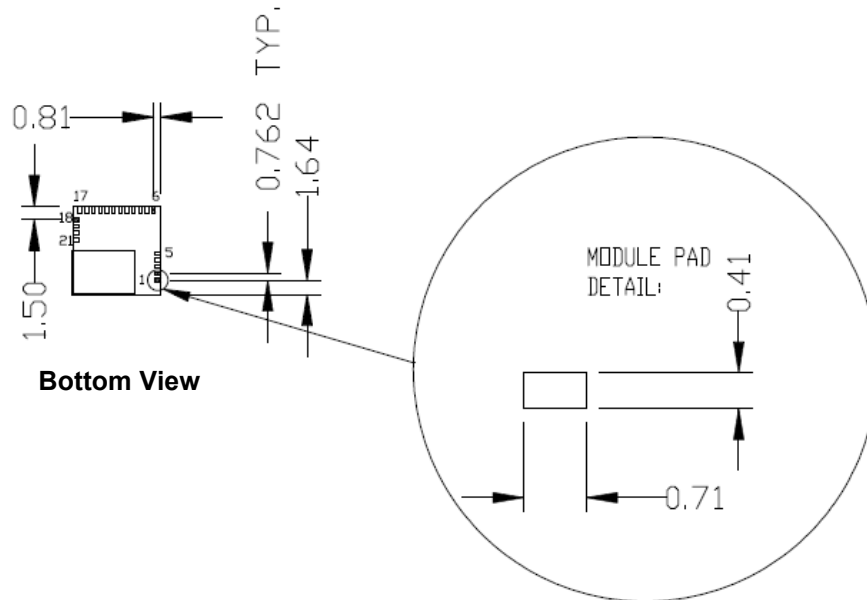
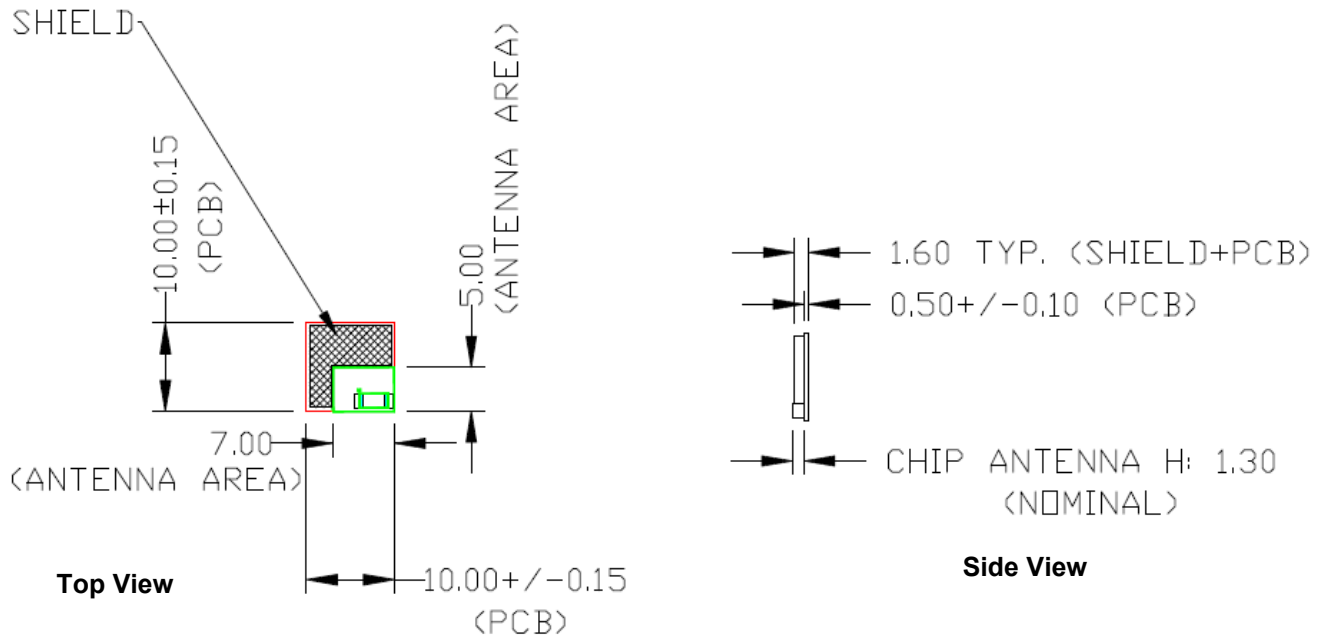
Cypress reserves the right to select components (including the appropriate BLE device) from various vendors to achieve the BLE module functionality. Such selections will still guarantee that all height restrictions of the component area are maintained. Designs should be held within the physical dimensions shown in the mechanical drawings in [Figure 1](#). All dimensions are in millimeters (mm).

**Table 1. Module Design Dimensions**

| Dimension Item                                                 |            | Specification                  |
|----------------------------------------------------------------|------------|--------------------------------|
| Module dimensions                                              | Length (X) | 10.00 ± 0.15 mm                |
|                                                                | Width (Y)  | 10.00 ± 0.15 mm                |
| Antenna location dimensions                                    | Length (X) | 7.00 ± 0.15 mm                 |
|                                                                | Width (Y)  | 5.00 ± 0.15 mm                 |
| PCB thickness                                                  | Height (H) | 0.50 ± 0.10 mm                 |
| Shield height                                                  | Height (H) | 1.10 ± 0.10 mm                 |
| Maximum component height                                       | Height (H) | 1.30 mm typical (chip antenna) |
| Total module thickness (bottom of module to highest component) | Height (H) | 1.80 mm typical                |

See [Figure 1](#) on page 4 for the mechanical reference drawing for CYBLE-022001-00.

**Figure 1. Module Mechanical Drawing**



**MODULE PAD ASSIGNMENT:**

PAD1:GND  
PAD2:P4.1  
PAD3:P5.1  
PAD4:P5.0  
PAD5:VDDR  
PAD6:P1.6  
PAD7:P0.7  
PAD8:P0.4  
PAD9:P0.5  
PAD10:GND  
PAD11:P0.6  
PAD12:P1.7  
PAD13:VDD  
PAD14:XRES  
PAD15:P3.5  
PAD16:P3.4  
PAD17:P3.7  
PAD18:P1.4  
PAD19:P1.5  
PAD20:P3.6  
PAD21:P1N4.0

**Note**

1. No metal should be located beneath or above the antenna area. Only bare PCB material should be located beneath the antenna area. For more information on recommended host PCB layout, see [Figure 3](#) and [Figure 4](#) on page 6.

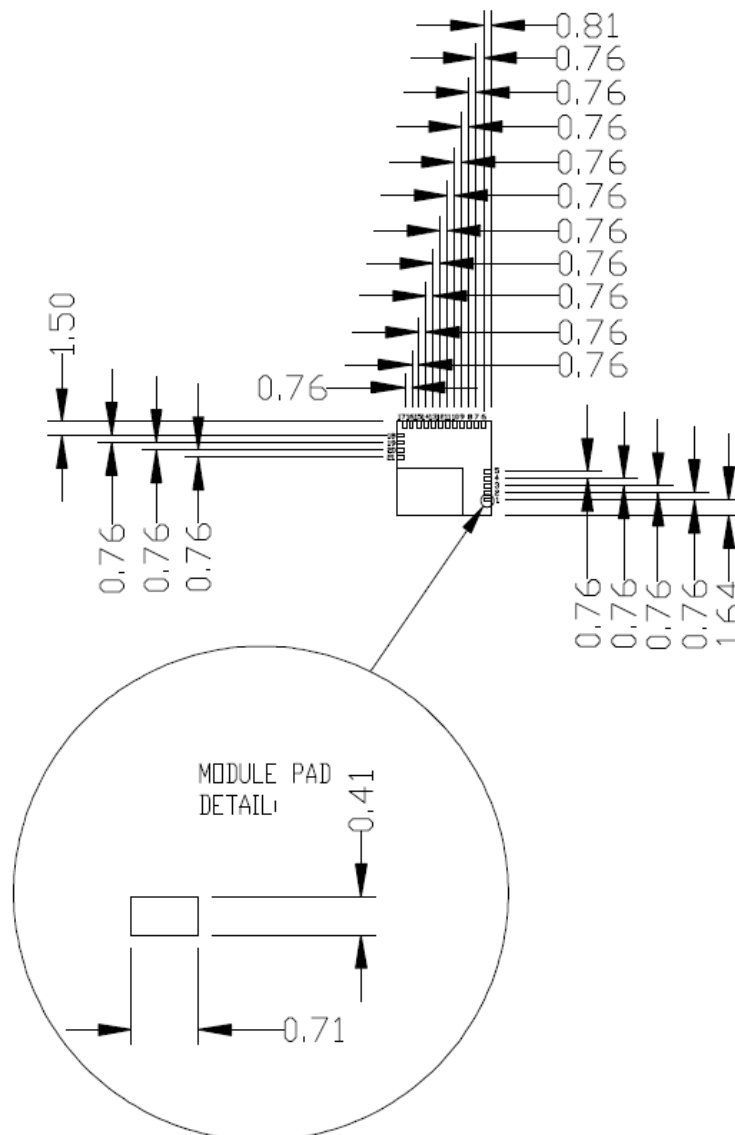
## Pad Connection Interface

As shown in the bottom view of [Figure 1](#) on page 4, the CYBLE-022001-00 connects to the host board via solder pads on the back of the module. [Table 2](#) and [Figure 2](#) detail the solder pad length, width, and pitch dimensions of the CYBLE-022001-00 module.

**Table 2. Solder Pad Connection Description**

| Name | Connections | Connection Type | Pad Length Dimension | Pad Width Dimension | Pad Pitch |
|------|-------------|-----------------|----------------------|---------------------|-----------|
| SP   | 21          | Solder Pads     | 0.71 mm              | 0.41 mm             | 0.76 mm   |

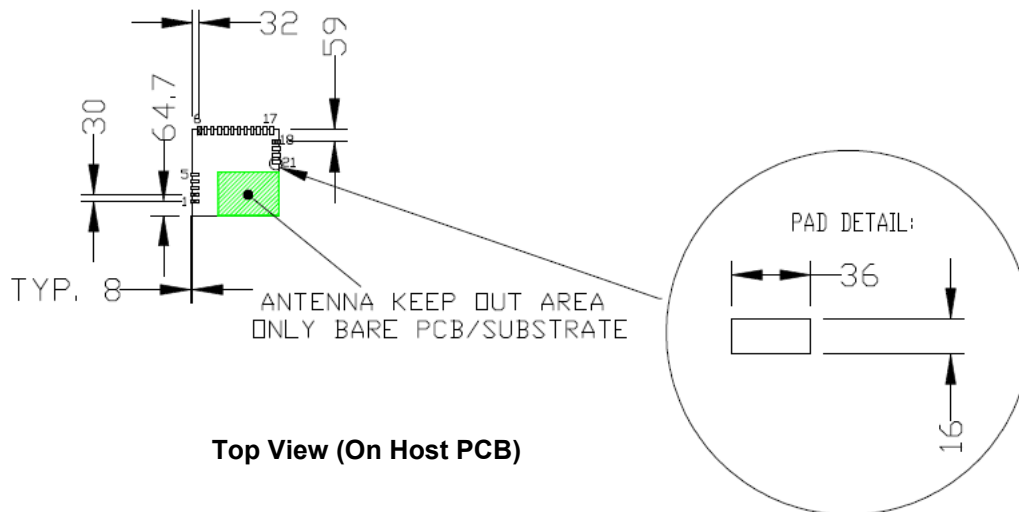
**Figure 2. Solder Pad Dimensions**



## Recommended Host PCB Layout

Figure 3 details the recommended PCB layout pattern for the host PCB. Dimensions are in mils.

**Figure 3. Recommended PCB Layout Pattern for CYBLE-022001-00**



To maximize RF performance, the host layout should follow these recommendations:

1. The ideal placement of the Cypress BLE module is in a corner of the host board with the chip antenna located at the far corner. This placement minimizes the additional recommended keep out area stated in item 2.
2. It is recommended that the area around the Cypress BLE module chip antenna should contain an additional keep out area, where no grounding or signal trace are contained. The keep out area applies to all layers of the host board. The recommended dimensions of the host PCB keep out area are shown in Figure 4 (dimensions are in mm).

**Figure 4. Recommended Host PCB Keep Out Area Around the CYBLE-022001-00 Chip Antenna**

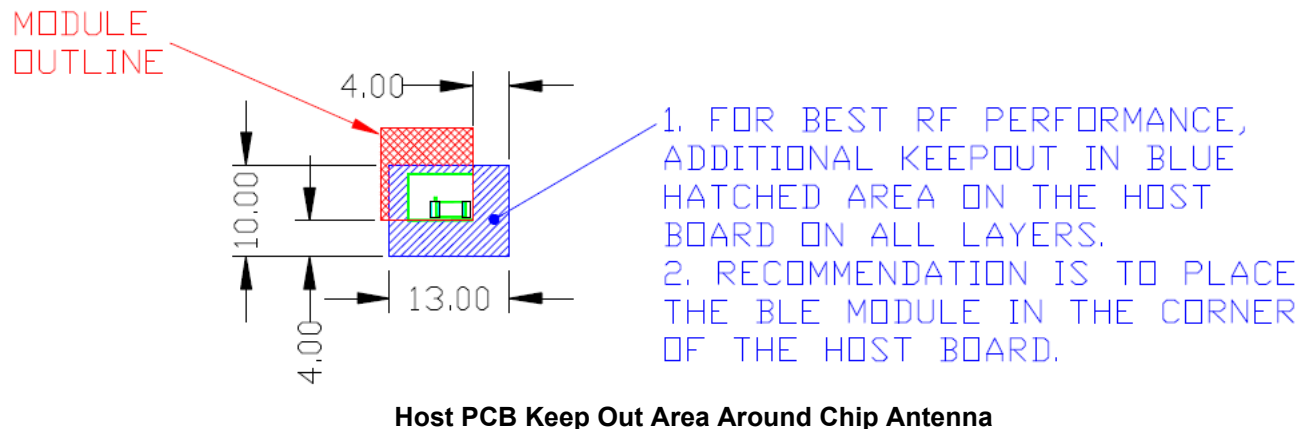


Table 3 details the solder pad pitch (center-to-center) for each of the neighboring connections.

**Table 3. Module Solder Pad Connection Dimensions**

| Pad X               | Pad Y | Pad Pitch (Pad X - Pad Y) | Comments                                          |
|---------------------|-------|---------------------------|---------------------------------------------------|
| Bottom Right Corner | 1     | 1.64 mm                   | Distance from bottom right corner to Pad 1 center |
| 1                   | 2     | 0.76 mm                   | Distance from Pad 1 center to Pad 2 center        |
| 2                   | 3     | 0.76 mm                   | Distance from Pad 2 center to Pad 3 center        |
| 3                   | 4     | 0.76 mm                   | Distance from Pad 3 center to Pad 4 center        |
| 4                   | 5     | 0.76 mm                   | Distance from Pad 4 center to Pad 5 center        |
| Top Right Corner    | 6     | 0.81 mm                   | Distance from top right corner to Pad 6 center    |
| 6                   | 7     | 0.76 mm                   | Distance from Pad 6 center to Pad 7 center        |
| 7                   | 8     | 0.76 mm                   | Distance from Pad 7 center to Pad 8 center        |
| 8                   | 9     | 0.76 mm                   | Distance from Pad 8 center to Pad 9 center        |
| 9                   | 10    | 0.76 mm                   | Distance from Pad 9 center to Pad 10 center       |
| 10                  | 11    | 0.76 mm                   | Distance from Pad 10 center to Pad 11 center      |
| 11                  | 12    | 0.76 mm                   | Distance from Pad 11 center to Pad 12 center      |
| 12                  | 13    | 0.76 mm                   | Distance from Pad 12 center to Pad 13 center      |
| 13                  | 14    | 0.76 mm                   | Distance from Pad 13 center to Pad 14 center      |
| 14                  | 15    | 0.76 mm                   | Distance from Pad 14 center to Pad 15 center      |
| 15                  | 16    | 0.76 mm                   | Distance from Pad 15 center to Pad 16 center      |
| 16                  | 17    | 0.76 mm                   | Distance from Pad 16 center to Pad 17 center      |
| Top Left Corner     | 18    | 1.50 mm                   | Distance from top left corner to Pad 18 center    |
| 18                  | 19    | 0.76 mm                   | Distance from Pad 18 center to Pad 19 center      |
| 19                  | 20    | 0.76 mm                   | Distance from Pad 19 center to Pad 20 center      |
| 20                  | 21    | 0.76 mm                   | Distance from Pad 20 center to Pad 21 center      |

Table 4 details the solder pad connection definitions and available functions for each connection pad. Table 4 lists the solder pads on CYBLE-022001-00, the BLE device port-pin, and denotes whether the function shown is available for each solder pad. Each connection is configurable for a single option shown with a ✓.

**Table 4. Solder Pad Connection Definitions**

| Solder Pad Number | Device Port Pin     | UART                                      | SPI     | I <sup>2</sup> C | TCPWM <sup>[2]</sup> | CapSense                       | WCOOut | ECO_OUT | LCD | SWD       | GPIO |
|-------------------|---------------------|-------------------------------------------|---------|------------------|----------------------|--------------------------------|--------|---------|-----|-----------|------|
| 1                 | GND <sup>[3]</sup>  | Ground Connection                         |         |                  |                      |                                |        |         |     |           |      |
| 2                 | P4.1 <sup>[4]</sup> | ✓(CTS)                                    | ✓(MISO) |                  | ✓                    | ✓(Sensor / C <sub>TANK</sub> ) | –      | –       | ✓   | –         | ✓    |
| 3                 | P5.1                | ✓(TX)                                     | ✓(SCLK) | ✓(SCL)           | ✓                    | ✓(Sensor)                      | –      | ✓       | ✓   | –         | ✓    |
| 4                 | P5.0                | ✓(RX)                                     | ✓(SS)   | ✓(SDA)           | ✓                    | ✓(Sensor)                      | –      | –       | ✓   | –         | ✓    |
| 5                 | V <sub>DDR</sub>    | Radio Power Supply (1.9V to 5.5V)         |         |                  |                      |                                |        |         |     |           |      |
| 6                 | P1.6                | ✓(RTS)                                    | ✓(SS)   | –                | ✓                    | ✓(Sensor)                      | –      | –       | ✓   | –         | ✓    |
| 7                 | P0.7                | ✓(CTS)                                    | ✓(SCLK) | –                | ✓                    | ✓(Sensor)                      | –      | –       | ✓   | ✓(SWDCLK) | ✓    |
| 8                 | P0.4                | ✓(RX)                                     | ✓(MOSI) | ✓(SDA)           | ✓                    | ✓(Sensor)                      | –      | ✓       | ✓   | –         | ✓    |
| 9                 | P0.5                | ✓(TX)                                     | ✓(MISO) | ✓(SCL)           | ✓                    | ✓(Sensor)                      | –      | –       | ✓   | –         | ✓    |
| 10                | GND                 | Ground Connection                         |         |                  |                      |                                |        |         |     |           |      |
| 11                | P0.6                | ✓(RTS)                                    | ✓(SS)   | –                | ✓                    | ✓(Sensor)                      | –      | –       | ✓   | ✓(SWDIO)  | ✓    |
| 12                | P1.7                | ✓(CTS)                                    | ✓(SCLK) | –                | ✓                    | ✓(Sensor)                      | –      | –       | ✓   | –         | ✓    |
| 13                | V <sub>DD</sub>     | Digital Power Supply Input (1.71 to 5.5V) |         |                  |                      |                                |        |         |     |           |      |
| 14                | XRES                | External Reset Hardware Connection Input  |         |                  |                      |                                |        |         |     |           |      |
| 15                | P3.5                | ✓(TX)                                     | –       | ✓(SCL)           | ✓                    | ✓(Sensor)                      | –      | –       | ✓   | –         | ✓    |
| 16                | P3.4                | ✓(RX)                                     | –       | ✓(SDA)           | ✓                    | ✓(Sensor)                      | –      | –       | ✓   | –         | ✓    |
| 17                | P3.7                | ✓(CTS)                                    | ✓(MISO) | –                | –                    | ✓(Sensor)                      | ✓      | –       | ✓   | –         | ✓    |
| 18                | P1.4                | ✓(RX)                                     | ✓(MOSI) | ✓(SDA)           | ✓                    | ✓(Sensor)                      | –      | –       | ✓   | –         | ✓    |
| 19                | P1.5                | ✓(TX)                                     | ✓(MISO) | ✓(SCL)           | ✓                    | ✓(Sensor)                      | –      | –       | ✓   | –         | ✓    |
| 20                | P3.6                | ✓(RTS)                                    | –       | –                | ✓                    | ✓(Sensor)                      | –      | –       | ✓   | –         | ✓    |
| 21                | P4.0 <sup>[5]</sup> | ✓(RTS)                                    | –       | –                | ✓                    | ✓(C <sub>MOD</sub> )           | –      | –       | ✓   | –         | ✓    |

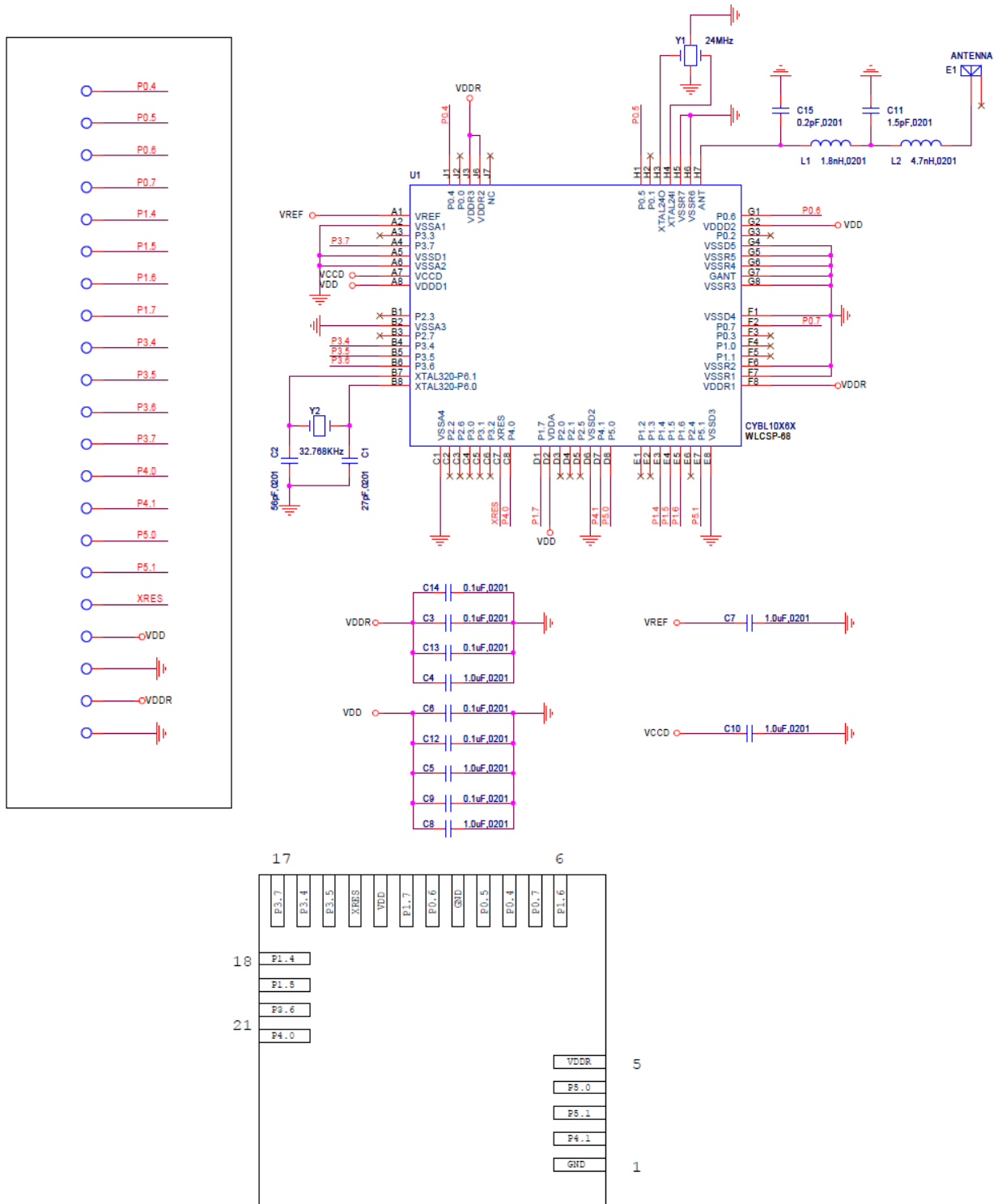
#### Notes

- TCPWM stands for timer, counter, and PWM. If supported, the pad can be configured to any of these peripheral functions.
- The main board needs to connect both GND connections (Pad 1 and Pad 10) on the module to the common ground of the system.
- When using the capacitive sensing functionality, Pad 2 (P4.1) can be connected to a C<sub>TANK</sub> capacitor (located off of Cypress BLE Module). C<sub>TANK</sub> should be used if implementing a shield layer on the capacitive sensor. If used, this capacitor should be placed as close to the module as possible.
- When using the capacitive sensing functionality, Pad 21 (P4.0) must be connected to a C<sub>MOD</sub> capacitor (located off of Cypress BLE Module). The value of this capacitor is 2.2 nF and should be placed as close to the module as possible.
- If the I<sup>2</sup>S feature is used in the design, the I<sup>2</sup>S pins shall be dynamically routed to the appropriate available GPIO by PSoC Creator.



Figure 7 shows the CYBLE-022001-00 schematic.

**Figure 7. CYBLE-022001-00 Schematic Diagram**



## Critical Components List

Table 5 details the critical components used in the CYBLE-022001-00 module.

**Table 5. Critical Component List**

| Component | Reference Designator | Description                                              |
|-----------|----------------------|----------------------------------------------------------|
| Silicon   | U1                   | 68-pin WLCSP Programmable Radio-on-Chip (PProC) with BLE |
| Crystal   | Y1                   | 24.000 MHz, 10PF                                         |
| Crystal   | Y2                   | 32.768 kHz, 12.5PF                                       |
| Antenna   | E1                   | 2.4 – 2.5 GHz chip antenna                               |

## Antenna Design

Table 6 details the chip antenna used in the CYBLE-022001-00 module. The specifications listed are according to the vendor's datasheet. The Cypress module performance improves many of these characteristics. For more information, see Table 8.

**Table 6. Chip Antenna Specifications**

| Item                      | Description              |
|---------------------------|--------------------------|
| Chip Antenna Manufacturer | Johanson Technology Inc. |
| Chip Antenna Part Number  | 2450AT18B100             |
| Frequency Range           | 2400 – 2500 MHz          |
| Peak Gain                 | 0.5 dBi typical          |
| Average Gain              | –0.5 dBi typical         |
| Return Loss               | 9.5 dB minimum           |

## Electrical Specification

Table 7 details the absolute maximum electrical characteristics for the Cypress BLE module.

**Table 7. CYBLE-022001-00 Absolute Maximum Ratings**

| Parameter                   | Description                                                                                                             | Min  | Typ | Max                   | Units | Details/Conditions                                    |
|-----------------------------|-------------------------------------------------------------------------------------------------------------------------|------|-----|-----------------------|-------|-------------------------------------------------------|
| V <sub>DDD_ABS</sub>        | Analog, digital, or radio supply relative to V <sub>SS</sub> (V <sub>SSD</sub> = V <sub>SSA</sub> )                     | −0.5 | –   | 6                     | V     | Absolute maximum                                      |
| V <sub>CCD_ABS</sub>        | Direct digital core voltage input relative to V <sub>SSD</sub>                                                          | −0.5 | –   | 1.95                  | V     | Absolute maximum                                      |
| V <sub>DDD_RIPPLE</sub>     | Maximum power supply ripple for V <sub>DD</sub> and V <sub>DDR</sub> input voltage                                      | –    | –   | 100                   | mV    | 3.0V supply<br>Ripple frequency of 100 kHz to 750 kHz |
| V <sub>GPIO_ABS</sub>       | GPIO voltage                                                                                                            | −0.5 | –   | V <sub>DD</sub> + 0.5 | V     | Absolute maximum                                      |
| I <sub>GPIO_ABS</sub>       | Maximum current per GPIO                                                                                                | −25  | –   | 25                    | mA    | Absolute maximum                                      |
| I <sub>GPIO_injection</sub> | GPIO injection current: Maximum for V <sub>IH</sub> > V <sub>DD</sub> and minimum for V <sub>IL</sub> < V <sub>SS</sub> | −0.5 | –   | 0.5                   | mA    | Absolute maximum current injected per pin             |
| LU                          | Pin current for latch up                                                                                                | −200 |     | 200                   | mA    | –                                                     |

Table 8 details the RF characteristics for the Cypress BLE module.

**Table 8. CYBLE-022001-00 RF Performance Characteristics**

| Parameter        | Description                   | Min  | Typ   | Max  | Units | Details/Conditions                              |
|------------------|-------------------------------|------|-------|------|-------|-------------------------------------------------|
| RF <sub>O</sub>  | RF output power on ANT        | −18  | 0     | 3    | dBm   | Configurable via register settings              |
| RX <sub>S</sub>  | RF receive sensitivity on ANT | –    | −91   | –    | dBm   | Guaranteed by design simulation; High Gain Mode |
| F <sub>R</sub>   | Module frequency range        | 2400 | –     | 2480 | MHz   | –                                               |
| G <sub>P</sub>   | Peak gain                     | –    | 0.5   | –    | dBi   | –                                               |
| G <sub>Avg</sub> | Average gain                  | –    | −0.5  | –    | dBi   | –                                               |
| RL               | Return loss                   | –    | −10.5 | –    | dB    | –                                               |

Table 9 through Table 37 list the module level electrical characteristics for the CYBLE-022001-00. All specifications are valid for −40 °C ≤ TA ≤ 85 °C and TJ ≤ 100 °C, except where noted. Specifications are valid for 1.71 V to 5.5 V, except where noted.

**Table 9. CYBLE-022001-00 DC Specifications**

| Parameter                                            | Description                            | Min  | Typ | Max  | Units | Details/Conditions                 |
|------------------------------------------------------|----------------------------------------|------|-----|------|-------|------------------------------------|
| V <sub>DD1</sub>                                     | Power supply input voltage             | 1.8  | –   | 5.5  | V     | With regulator enabled             |
| V <sub>DD2</sub>                                     | Power supply input voltage unregulated | 1.71 | 1.8 | 1.89 | V     | Internally unregulated supply      |
| V <sub>DDR1</sub>                                    | Radio supply voltage (radio on)        | 1.9  | –   | 5.5  | V     | –                                  |
| V <sub>DDR2</sub>                                    | Radio supply voltage (radio off)       | 1.71 | –   | 5.5  | V     | –                                  |
| <b>Active Mode, V<sub>DD</sub> = 1.71 V to 5.5 V</b> |                                        |      |     |      |       |                                    |
| I <sub>DD3</sub>                                     | Execute from flash; CPU at 3 MHz       | –    | 1.7 | –    | mA    | T = 25 °C, V <sub>DD</sub> = 3.3 V |
| I <sub>DD4</sub>                                     | Execute from flash; CPU at 3 MHz       | –    | –   | –    | mA    | T = −40 °C to 85 °C                |
| I <sub>DD5</sub>                                     | Execute from flash; CPU at 6 MHz       | –    | 2.5 | –    | mA    | T = 25 °C, V <sub>DD</sub> = 3.3 V |
| I <sub>DD6</sub>                                     | Execute from flash; CPU at 6 MHz       | –    | –   | –    | mA    | T = −40 °C to 85 °C                |
| I <sub>DD7</sub>                                     | Execute from flash; CPU at 12 MHz      | –    | 4   | –    | mA    | T = 25 °C, V <sub>DD</sub> = 3.3 V |

**Table 9. CYBLE-022001-00 DC Specifications (continued)**

| Parameter                                                                    | Description                           | Min | Typ  | Max | Units | Details/Conditions                                        |
|------------------------------------------------------------------------------|---------------------------------------|-----|------|-----|-------|-----------------------------------------------------------|
| I <sub>DD8</sub>                                                             | Execute from flash; CPU at 12 MHz     | –   | –    | –   | mA    | T = –40 °C to 85 °C                                       |
| I <sub>DD9</sub>                                                             | Execute from flash; CPU at 24 MHz     | –   | 7.1  | –   | mA    | T = 25 °C,<br>V <sub>DD</sub> = 3.3 V                     |
| I <sub>DD10</sub>                                                            | Execute from flash; CPU at 24 MHz     | –   | –    | –   | mA    | T = –40 °C to 85 °C                                       |
| I <sub>DD11</sub>                                                            | Execute from flash; CPU at 48 MHz     | –   | 13.4 | –   | mA    | T = 25 °C,<br>V <sub>DD</sub> = 3.3 V                     |
| I <sub>DD12</sub>                                                            | Execute from flash; CPU at 48 MHz     | –   | –    | –   | mA    | T = –40 °C to 85 °C                                       |
| <b>Sleep Mode, V<sub>DD</sub> = 1.8 to 5.5 V</b>                             |                                       |     |      |     |       |                                                           |
| I <sub>DD13</sub>                                                            | IMO on                                | –   | –    | –   | mA    | T = 25 °C, V <sub>DD</sub> = 3.3 V,<br>SYSCLK = 3 MHz     |
| <b>Sleep Mode, V<sub>DD</sub> and V<sub>DDR</sub> = 1.9 to 5.5 V</b>         |                                       |     |      |     |       |                                                           |
| I <sub>DD14</sub>                                                            | ECO on                                | –   | –    | –   | mA    | T = 25 °C, V <sub>DD</sub> = 3.3 V,<br>SYSCLK = 3 MHz     |
| <b>Deep-Sleep Mode, V<sub>DD</sub> = 1.8 to 3.6 V</b>                        |                                       |     |      |     |       |                                                           |
| I <sub>DD15</sub>                                                            | WDT with WCO on                       | –   | 1.5  | –   | μA    | T = 25 °C,<br>V <sub>DD</sub> = 3.3 V                     |
| I <sub>DD16</sub>                                                            | WDT with WCO on                       | –   | –    | –   | μA    | T = –40 °C to 85 °C                                       |
| I <sub>DD17</sub>                                                            | WDT with WCO on                       | –   | –    | –   | μA    | T = 25 °C,<br>V <sub>DD</sub> = 5 V                       |
| I <sub>DD18</sub>                                                            | WDT with WCO on                       | –   | –    | –   | μA    | T = –40 °C to 85 °C                                       |
| <b>Deep-Sleep Mode, V<sub>DD</sub> = 1.71 to 1.89 V (Regulator Bypassed)</b> |                                       |     |      |     |       |                                                           |
| I <sub>DD19</sub>                                                            | WDT with WCO on                       | –   | –    | –   | μA    | T = 25 °C                                                 |
| I <sub>DD20</sub>                                                            | WDT with WCO on                       | –   | –    | –   | μA    | T = –40 °C to 85 °C                                       |
| <b>Hibernate Mode, V<sub>DD</sub> = 1.8 to 3.6 V</b>                         |                                       |     |      |     |       |                                                           |
| I <sub>DD27</sub>                                                            | GPIO and reset active                 | –   | 150  | –   | nA    | T = 25 °C,<br>V <sub>DD</sub> = 3.3 V                     |
| I <sub>DD28</sub>                                                            | GPIO and reset active                 | –   | –    | –   | nA    | T = –40 °C to 85 °C                                       |
| <b>Hibernate Mode, V<sub>DD</sub> = 3.6 to 5.5 V</b>                         |                                       |     |      |     |       |                                                           |
| I <sub>DD29</sub>                                                            | GPIO and reset active                 | –   | –    | –   | nA    | T = 25 °C,<br>V <sub>DD</sub> = 5 V                       |
| I <sub>DD30</sub>                                                            | GPIO and reset active                 | –   | –    | –   | nA    | T = –40 °C to 85 °C                                       |
| <b>Stop Mode, V<sub>DD</sub> = 1.8 to 3.6 V</b>                              |                                       |     |      |     |       |                                                           |
| I <sub>DD33</sub>                                                            | Stop-mode current (V <sub>DD</sub> )  | –   | 20   | –   | nA    | T = 25 °C,<br>V <sub>DD</sub> = 3.3 V                     |
| I <sub>DD34</sub>                                                            | Stop-mode current (V <sub>DDR</sub> ) | –   | 40   | –   | nA    | T = 25 °C,<br>V <sub>DDR</sub> = 3.3 V                    |
| I <sub>DD35</sub>                                                            | Stop-mode current (V <sub>DD</sub> )  | –   | –    | –   | nA    | T = –40 °C to 85 °C                                       |
| I <sub>DD36</sub>                                                            | Stop-mode current (V <sub>DDR</sub> ) | –   | –    | –   | nA    | T = –40 °C to 85 °C,<br>V <sub>DDR</sub> = 1.9 V to 3.6 V |
| <b>Stop Mode, V<sub>DD</sub> = 3.6 to 5.5 V</b>                              |                                       |     |      |     |       |                                                           |
| I <sub>DD37</sub>                                                            | Stop-mode current (V <sub>DD</sub> )  | –   | –    | –   | nA    | T = 25 °C,<br>V <sub>DD</sub> = 5 V                       |
| I <sub>DD38</sub>                                                            | Stop-mode current (V <sub>DDR</sub> ) | –   | –    | –   | nA    | T = 25 °C,<br>V <sub>DDR</sub> = 5 V                      |
| I <sub>DD39</sub>                                                            | Stop-mode current (V <sub>DD</sub> )  | –   | –    | –   | nA    | T = –40 °C to 85 °C                                       |
| I <sub>DD40</sub>                                                            | Stop-mode current (V <sub>DDR</sub> ) | –   | –    | –   | nA    | T = –40 °C to 85 °C                                       |

**Table 10. AC Specifications**

| Parameter              | Description                 | Min | Typ | Max | Units | Details/Conditions                         |
|------------------------|-----------------------------|-----|-----|-----|-------|--------------------------------------------|
| F <sub>CPU</sub>       | CPU frequency               | DC  | –   | 48  | MHz   | 1.71 V ≤ V <sub>DD</sub> ≤ 5.5 V           |
| T <sub>SLEEP</sub>     | Wakeup from Sleep mode      | –   | 0   | –   | μs    | Guaranteed by characterization             |
| T <sub>DEEPSLEEP</sub> | Wakeup from Deep-Sleep mode | –   | –   | 25  | μs    | 24-MHz IMO. Guaranteed by characterization |
| T <sub>HIBERNATE</sub> | Wakeup from Hibernate mode  | –   | –   | 2   | ms    | Guaranteed by characterization             |
| T <sub>STOP</sub>      | Wakeup from Stop mode       | –   | –   | 2   | ms    | XRES wakeup                                |

**GPIO**
**Table 11. GPIO DC Specifications**

| Parameter                      | Description                                                          | Min                    | Typ | Max                   | Units | Details/Conditions                              |
|--------------------------------|----------------------------------------------------------------------|------------------------|-----|-----------------------|-------|-------------------------------------------------|
| V <sub>IH</sub> <sup>[7]</sup> | Input voltage HIGH threshold                                         | 0.7 × V <sub>DD</sub>  | –   | –                     | V     | CMOS input                                      |
|                                | LVTTL input, V <sub>DD</sub> < 2.7 V                                 | 0.7 × V <sub>DD</sub>  | –   | –                     | V     | –                                               |
|                                | LVTTL input, V <sub>DD</sub> ≥ 2.7 V                                 | 2.0                    | –   | –                     | V     | –                                               |
| V <sub>IL</sub>                | Input voltage LOW threshold                                          | –                      | –   | 0.3 × V <sub>DD</sub> | V     | CMOS input                                      |
|                                | LVTTL input, V <sub>DD</sub> < 2.7 V                                 | –                      | –   | 0.3 × V <sub>DD</sub> | V     | –                                               |
|                                | LVTTL input, V <sub>DD</sub> ≥ 2.7 V                                 | –                      | –   | 0.8                   | V     | –                                               |
| V <sub>OH</sub>                | Output voltage HIGH level                                            | V <sub>DD</sub> – 0.6  | –   | –                     | V     | I <sub>OH</sub> = 4 mA at 3.3-V V <sub>DD</sub> |
|                                | Output voltage HIGH level                                            | V <sub>DD</sub> – 0.5  | –   | –                     | V     | I <sub>OH</sub> = 1 mA at 1.8-V V <sub>DD</sub> |
| V <sub>OL</sub>                | Output voltage LOW level                                             | –                      | –   | 0.6                   | V     | I <sub>OL</sub> = 8 mA at 3.3-V V <sub>DD</sub> |
|                                | Output voltage LOW level                                             | –                      | –   | 0.6                   | V     | I <sub>OL</sub> = 4 mA at 1.8-V V <sub>DD</sub> |
|                                | Output voltage LOW level                                             | –                      | –   | 0.4                   | V     | I <sub>OL</sub> = 3 mA at 3.3-V V <sub>DD</sub> |
| R <sub>PULLUP</sub>            | Pull-up resistor                                                     | 3.5                    | 5.6 | 8.5                   | kΩ    | –                                               |
| R <sub>PULLDOWN</sub>          | Pull-down resistor                                                   | 3.5                    | 5.6 | 8.5                   | kΩ    | –                                               |
| I <sub>IL</sub>                | Input leakage current (absolute value)                               | –                      | –   | 2                     | nA    | 25 °C, V <sub>DD</sub> = 3.3 V                  |
| I <sub>IL_CTBM</sub>           | Input leakage on CTBM input pins                                     | –                      | –   | 4                     | nA    | –                                               |
| C <sub>IN</sub>                | Input capacitance                                                    | –                      | –   | 7                     | pF    | –                                               |
| V <sub>HYSTTL</sub>            | Input hysteresis LVTTL                                               | 25                     | 40  | –                     | mV    | V <sub>DD</sub> > 2.7 V                         |
| V <sub>HYSCMOS</sub>           | Input hysteresis CMOS                                                | 0.05 × V <sub>DD</sub> | –   | –                     | 1     | –                                               |
| I <sub>DIODE</sub>             | Current through protection diode to V <sub>DD</sub> /V <sub>SS</sub> | –                      | –   | 100                   | μA    | –                                               |
| I <sub>TOT_GPIO</sub>          | Maximum total source or sink chip current                            | –                      | –   | 200                   | mA    | –                                               |

**Note**

 7. V<sub>IH</sub> must not exceed V<sub>DD</sub> + 0.2 V.

**Table 12. GPIO AC Specifications**

| Parameter     | Description                                                                     | Min | Typ | Max  | Units | Details/Conditions                   |
|---------------|---------------------------------------------------------------------------------|-----|-----|------|-------|--------------------------------------|
| $T_{RISEF}$   | Rise time in Fast-Strong mode                                                   | 2   | –   | 12   | ns    | 3.3-V $V_{DD}$ , $C_{LOAD} = 25$ pF  |
| $T_{FALLF}$   | Fall time in Fast-Strong mode                                                   | 2   | –   | 12   | ns    | 3.3-V $V_{DD}$ , $C_{LOAD} = 25$ pF  |
| $T_{RISES}$   | Rise time in Slow-Strong mode                                                   | 10  | –   | 60   | ns    | 3.3-V $V_{DD}$ , $C_{LOAD} = 25$ pF  |
| $T_{FALLS}$   | Fall time in Slow-Strong mode                                                   | 10  | –   | 60   | ns    | 3.3-V $V_{DD}$ , $C_{LOAD} = 25$ pF  |
| $F_{GPIOUT1}$ | GPIO Fout; $3.3\text{ V} \leq V_{DD} \leq 5.5\text{ V}$<br>Fast-Strong mode     | –   | –   | 33   | MHz   | 90/10%, 25 pF load, 60/40 duty cycle |
| $F_{GPIOUT2}$ | GPIO Fout; $1.7\text{ V} \leq V_{DD} \leq 3.3\text{ V}$<br>Fast-Strong mode     | –   | –   | 16.7 | MHz   | 90/10%, 25 pF load, 60/40 duty cycle |
| $F_{GPIOUT3}$ | GPIO Fout; $3.3\text{ V} \leq V_{DD} \leq 5.5\text{ V}$<br>Slow-Strong mode     | –   | –   | 7    | MHz   | 90/10%, 25 pF load, 60/40 duty cycle |
| $F_{GPIOUT4}$ | GPIO Fout; $1.7\text{ V} \leq V_{DD} \leq 3.3\text{ V}$<br>Slow-Strong mode     | –   | –   | 3.5  | MHz   | 90/10%, 25 pF load, 60/40 duty cycle |
| $F_{GPIOIN}$  | GPIO input operating frequency<br>$1.71\text{ V} \leq V_{DD} \leq 5.5\text{ V}$ | –   | –   | 48   | MHz   | 90/10% $V_{IO}$                      |

**Table 13. OVT GPIO DC Specifications (P5\_0 and P5\_1 Only)**

| Parameter | Description                                          | Min | Typ | Max | Units         | Details/Conditions                                    |
|-----------|------------------------------------------------------|-----|-----|-----|---------------|-------------------------------------------------------|
| $I_{IL}$  | Input leakage (absolute value).<br>$V_{IH} > V_{DD}$ | –   | –   | 10  | $\mu\text{A}$ | 25°C, $V_{DD} = 0\text{ V}$ , $V_{IH} = 3.0\text{ V}$ |
| $V_{OL}$  | Output voltage LOW level                             | –   | –   | 0.4 | V             | $I_{OL} = 20\text{ mA}$ , $V_{DD} > 2.9\text{ V}$     |

**Table 14. OVT GPIO AC Specifications (P5\_0 and P5\_1 Only)**

| Parameter        | Description                                                                        | Min | Typ | Max | Units | Details/Conditions                           |
|------------------|------------------------------------------------------------------------------------|-----|-----|-----|-------|----------------------------------------------|
| $T_{RISE\_OVFS}$ | Output rise time in Fast-Strong mode                                               | 1.5 | –   | 12  | ns    | 25-pF load, 10%–90%, $V_{DD} = 3.3\text{ V}$ |
| $T_{FALL\_OVFS}$ | Output fall time in Fast-Strong mode                                               | 1.5 | –   | 12  | ns    | 25-pF load, 10%–90%, $V_{DD} = 3.3\text{ V}$ |
| $T_{RISESS}$     | Output rise time in Slow-Strong mode                                               | 10  | –   | 60  | ns    | 25 pF load, 10%–90%, $V_{DD} = 3.3\text{ V}$ |
| $T_{FALLSS}$     | Output fall time in Slow-Strong mode                                               | 10  | –   | 60  | ns    | 25 pF load, 10%–90%, $V_{DD} = 3.3\text{ V}$ |
| $F_{GPIOUT1}$    | GPIO $F_{OUT}$ ; $3.3\text{ V} \leq V_{DD} \leq 5.5\text{ V}$<br>Fast-Strong mode  | –   | –   | 24  | MHz   | 90/10%, 25 pF load, 60/40 duty cycle         |
| $F_{GPIOUT2}$    | GPIO $F_{OUT}$ ; $1.71\text{ V} \leq V_{DD} \leq 3.3\text{ V}$<br>Fast-Strong mode | –   | –   | 16  | MHz   | 90/10%, 25 pF load, 60/40 duty cycle         |

## XRES

**Table 15. XRES DC Specifications**

| Parameter     | Description                                            | Min                 | Typ | Max                 | Units         | Details/Conditions |
|---------------|--------------------------------------------------------|---------------------|-----|---------------------|---------------|--------------------|
| $V_{IH}$      | Input voltage HIGH threshold                           | $0.7 \times V_{DD}$ | –   | –                   | V             | CMOS input         |
| $V_{IL}$      | Input voltage LOW threshold                            | –                   | –   | $0.3 \times V_{DD}$ | V             | CMOS input         |
| $R_{PULLUP}$  | Pull-up resistor                                       | 3.5                 | 5.6 | 8.5                 | k $\Omega$    | –                  |
| $C_{IN}$      | Input capacitance                                      | –                   | 3   | –                   | pF            | –                  |
| $V_{HYSXRES}$ | Input voltage hysteresis                               | –                   | 100 | –                   | mV            | –                  |
| $I_{DIODE}$   | Current through protection diode to<br>$V_{DD}/V_{SS}$ | –                   | –   | 100                 | $\mu\text{A}$ | –                  |

**Table 16. XRES AC Specifications**

| Parameter               | Description       | Min | Typ | Max | Units | Details/Conditions |
|-------------------------|-------------------|-----|-----|-----|-------|--------------------|
| T <sub>RESETWIDTH</sub> | Reset pulse width | 1   | –   | –   | μs    | –                  |

**Serial Communication**
**Table 17. I<sup>2</sup>C DC Specifications**

| Parameter         | Description                                 | Min | Typ | Max  | Units | Details/Conditions |
|-------------------|---------------------------------------------|-----|-----|------|-------|--------------------|
| I <sub>I2C1</sub> | Block current consumption at 100 kHz        | –   | –   | 10.5 | μA    | –                  |
| I <sub>I2C2</sub> | Block current consumption at 400 kHz        | –   | –   | 135  | μA    | –                  |
| I <sub>I2C3</sub> | Block current consumption at 1 Mbps         | –   | –   | 310  | μA    | –                  |
| I <sub>I2C4</sub> | I <sup>2</sup> C enabled in Deep-Sleep mode | –   | –   | 1.4  | μA    | –                  |

**Table 18. Fixed I<sup>2</sup>C AC Specifications**

| Parameter         | Description | Min | Typ | Max | Units | Details/Conditions                                    |
|-------------------|-------------|-----|-----|-----|-------|-------------------------------------------------------|
| F <sub>I2C1</sub> | Bit rate    | –   | –   | 1   | Mbps  | Maximum is applicable to Port 5[0] and Port 5[1] only |

**Table 19. Fixed UART DC Specifications**

| Parameter          | Description                            | Min | Typ | Max | Units | Details/Conditions |
|--------------------|----------------------------------------|-----|-----|-----|-------|--------------------|
| I <sub>UART1</sub> | Block current consumption at 100 kbps  | –   | –   | 9   | μA    | –                  |
| I <sub>UART2</sub> | Block current consumption at 1000 kbps | –   | –   | 312 | μA    | –                  |

**Table 20. Fixed UART AC Specifications**

| Parameter         | Description | Min | Typ | Max | Units | Details/Conditions |
|-------------------|-------------|-----|-----|-----|-------|--------------------|
| F <sub>UART</sub> | Bit rate    | –   | –   | 1   | Mbps  | –                  |

**Table 21. Fixed SPI DC Specifications**

| Parameter         | Description                         | Min | Typ | Max | Units | Details/Conditions |
|-------------------|-------------------------------------|-----|-----|-----|-------|--------------------|
| I <sub>SPI1</sub> | Block current consumption at 1 Mbps | –   | –   | 360 | μA    | –                  |
| I <sub>SPI2</sub> | Block current consumption at 4 Mbps | –   | –   | 560 | μA    | –                  |
| I <sub>SPI3</sub> | Block current consumption at 8 Mbps | –   | –   | 600 | μA    | –                  |

**Table 22. Fixed SPI AC Specifications**

| Parameter        | Description                                        | Min | Typ | Max | Units | Details/Conditions |
|------------------|----------------------------------------------------|-----|-----|-----|-------|--------------------|
| F <sub>SPI</sub> | SPI operating frequency (master; 6x over sampling) | –   | –   | 8   | MHz   | –                  |

**Table 23. Fixed SPI Master Mode AC Specifications**

| Parameter        | Description                                                                  | Min | Typ | Max | Units | Details/Conditions               |
|------------------|------------------------------------------------------------------------------|-----|-----|-----|-------|----------------------------------|
| T <sub>DMO</sub> | MOSI valid after SCLK driving edge                                           | –   | –   | 18  | ns    | –                                |
| T <sub>DSI</sub> | MISO valid before SCLK capturing edge<br>Full clock, late MISO sampling used | 20  | –   | –   | ns    | Full clock, late MISO sampling   |
| T <sub>HMO</sub> | Previous MOSI data hold time                                                 | 0   | –   | –   | ns    | Referred to Slave capturing edge |

**Table 24. Fixed SPI Slave Mode AC Specifications**

| Parameter            | Description                                                                        | Min | Typ | Max                       | Units |
|----------------------|------------------------------------------------------------------------------------|-----|-----|---------------------------|-------|
| T <sub>DMI</sub>     | MOSI valid before SCLK capturing edge                                              | 40  | –   | –                         | ns    |
| T <sub>DSO</sub>     | MISO valid after SCLK driving edge                                                 | –   | –   | 42 + 3 × T <sub>CPU</sub> | ns    |
| T <sub>DSO_ext</sub> | MISO Valid after SCLK driving edge in external clock mode. V <sub>DD</sub> < 3.0 V | –   | –   | 50                        | ns    |
| T <sub>HSO</sub>     | Previous MISO data hold time                                                       | 0   | –   | –                         | ns    |
| T <sub>SSELSCK</sub> | SSEL valid to first SCK valid edge                                                 | 100 | –   | –                         | ns    |

Refer to the CYBL10X6X datasheet at [www.cypress.com/?rID=99422](http://www.cypress.com/?rID=99422) for details on Analog (ADC, CapSense) and Digital (TCPWM) Peripherals DC and AC specifications.

## Memory

**Table 25. Flash DC Specifications**

| Parameter         | Description                        | Min  | Typ | Max | Units | Details/Conditions       |
|-------------------|------------------------------------|------|-----|-----|-------|--------------------------|
| V <sub>PE</sub>   | Erase and program voltage          | 1.71 | –   | 5.5 | V     | –                        |
| T <sub>WS48</sub> | Number of Wait states at 32–48 MHz | 2    | –   | –   |       | CPU execution from flash |
| T <sub>WS32</sub> | Number of Wait states at 16–32 MHz | 1    | –   | –   |       | CPU execution from flash |
| T <sub>WS16</sub> | Number of Wait states for 0–16 MHz | 0    | –   | –   |       | CPU execution from flash |

**Table 26. Flash AC Specifications**

| Parameter                              | Description                                               | Min   | Typ | Max | Units   | Details/Conditions      |
|----------------------------------------|-----------------------------------------------------------|-------|-----|-----|---------|-------------------------|
| T <sub>ROWWRITE</sub> <sup>[8]</sup>   | Row (block) write time (erase and program)                | –     | –   | 20  | ms      | Row (block) = 128 bytes |
| T <sub>ROWERASE</sub> <sup>[8]</sup>   | Row erase time                                            | –     | –   | 13  | ms      | –                       |
| T <sub>ROWPROGRAM</sub> <sup>[8]</sup> | Row program time after erase                              | –     | –   | 7   | ms      | –                       |
| T <sub>BULKERASE</sub> <sup>[8]</sup>  | Bulk erase time (128 KB)                                  | –     | –   | 35  | ms      | –                       |
| T <sub>DEVPROG</sub> <sup>[8]</sup>    | Total device program time                                 | –     | –   | 25  | seconds | –                       |
| F <sub>END</sub>                       | Flash endurance                                           | 100 K | –   | –   | cycles  | –                       |
| F <sub>RET</sub>                       | Flash retention. T <sub>A</sub> ≤ 55 °C, 100 K P/E cycles | 20    | –   | –   | years   | –                       |
| F <sub>RET2</sub>                      | Flash retention. T <sub>A</sub> ≤ 85 °C, 10 K P/E cycles  | 10    | –   | –   | years   | –                       |

## System Resources

### Power-on-Reset (POR)

**Table 27. POR DC Specifications**

| Parameter             | Description          | Min  | Typ | Max  | Units | Details/Conditions |
|-----------------------|----------------------|------|-----|------|-------|--------------------|
| V <sub>RISEIPOR</sub> | Rising trip voltage  | 0.80 | –   | 1.45 | V     | –                  |
| V <sub>FALLIPOR</sub> | Falling trip voltage | 0.75 | –   | 1.40 | V     | –                  |
| V <sub>IPORHYST</sub> | Hysteresis           | 15   | –   | 200  | mV    | –                  |

**Table 28. POR AC Specifications**

| Parameter            | Description                                                             | Min | Typ | Max | Units | Details/Conditions |
|----------------------|-------------------------------------------------------------------------|-----|-----|-----|-------|--------------------|
| T <sub>PPOR_TR</sub> | Precision power-on reset (PPOR) response time in Active and Sleep modes | –   | –   | 1   | μs    | –                  |

### Note

- It can take as much as 20 ms to write to flash. During this time, the device should not be reset, or flash operations will be interrupted and cannot be relied on to have completed. Reset sources include the XRES pin, software resets, CPU lockup states and privilege violations, improper power supply levels, and watchdogs. Make certain that these are not inadvertently activated.

**Table 29. Brown-Out Detect**

| Parameter              | Description                                | Min  | Typ | Max | Units | Details/Conditions |
|------------------------|--------------------------------------------|------|-----|-----|-------|--------------------|
| V <sub>FALLPPOR</sub>  | BOD trip voltage in Active and Sleep modes | 1.64 | –   | –   | V     | –                  |
| V <sub>FALLDPSLP</sub> | BOD trip voltage in Deep Sleep             | 1.4  | –   | –   | V     | –                  |

**Table 30. Hibernate Reset**

| Parameter            | Description                   | Min | Typ | Max | Units | Details/Conditions |
|----------------------|-------------------------------|-----|-----|-----|-------|--------------------|
| V <sub>HBRTRIP</sub> | BOD trip voltage in Hibernate | 1.1 | –   | –   | V     | –                  |

#### Voltage Monitors (LVD)

**Table 31. Voltage Monitor DC Specifications**

| Parameter          | Description              | Min  | Typ  | Max  | Units | Details/Conditions |
|--------------------|--------------------------|------|------|------|-------|--------------------|
| V <sub>LVI1</sub>  | LVI_A/D_SEL[3:0] = 0000b | 1.71 | 1.75 | 1.79 | V     | –                  |
| V <sub>LVI2</sub>  | LVI_A/D_SEL[3:0] = 0001b | 1.76 | 1.80 | 1.85 | V     | –                  |
| V <sub>LVI3</sub>  | LVI_A/D_SEL[3:0] = 0010b | 1.85 | 1.90 | 1.95 | V     | –                  |
| V <sub>LVI4</sub>  | LVI_A/D_SEL[3:0] = 0011b | 1.95 | 2.00 | 2.05 | V     | –                  |
| V <sub>LVI5</sub>  | LVI_A/D_SEL[3:0] = 0100b | 2.05 | 2.10 | 2.15 | V     | –                  |
| V <sub>LVI6</sub>  | LVI_A/D_SEL[3:0] = 0101b | 2.15 | 2.20 | 2.26 | V     | –                  |
| V <sub>LVI7</sub>  | LVI_A/D_SEL[3:0] = 0110b | 2.24 | 2.30 | 2.36 | V     | –                  |
| V <sub>LVI8</sub>  | LVI_A/D_SEL[3:0] = 0111b | 2.34 | 2.40 | 2.46 | V     | –                  |
| V <sub>LVI9</sub>  | LVI_A/D_SEL[3:0] = 1000b | 2.44 | 2.50 | 2.56 | V     | –                  |
| V <sub>LVI10</sub> | LVI_A/D_SEL[3:0] = 1001b | 2.54 | 2.60 | 2.67 | V     | –                  |
| V <sub>LVI11</sub> | LVI_A/D_SEL[3:0] = 1010b | 2.63 | 2.70 | 2.77 | V     | –                  |
| V <sub>LVI12</sub> | LVI_A/D_SEL[3:0] = 1011b | 2.73 | 2.80 | 2.87 | V     | –                  |
| V <sub>LVI13</sub> | LVI_A/D_SEL[3:0] = 1100b | 2.83 | 2.90 | 2.97 | V     | –                  |
| V <sub>LVI14</sub> | LVI_A/D_SEL[3:0] = 1101b | 2.93 | 3.00 | 3.08 | V     | –                  |
| V <sub>LVI15</sub> | LVI_A/D_SEL[3:0] = 1110b | 3.12 | 3.20 | 3.28 | V     | –                  |
| V <sub>LVI16</sub> | LVI_A/D_SEL[3:0] = 1111b | 4.39 | 4.50 | 4.61 | V     | –                  |
| LVI_IDD            | Block current            | –    | –    | 100  | μA    | –                  |

**Table 32. Voltage Monitor AC Specifications**

| Parameter            | Description               | Min | Typ | Max | Units | Details/Conditions |
|----------------------|---------------------------|-----|-----|-----|-------|--------------------|
| T <sub>MONTRIP</sub> | Voltage monitor trip time | –   | –   | 1   | μs    | –                  |

#### SWD Interface

**Table 33. SWD Interface Specifications**

| Parameter               | Description                                   | Min             | Typ | Max            | Units | Details/Conditions               |
|-------------------------|-----------------------------------------------|-----------------|-----|----------------|-------|----------------------------------|
| F <sub>SWDCLK1</sub>    | $3.3\text{ V} \leq V_{DD} \leq 5.5\text{ V}$  | –               | –   | 14             | MHz   | SWDCLK ≤ 1/3 CPU clock frequency |
| F <sub>SWDCLK2</sub>    | $1.71\text{ V} \leq V_{DD} \leq 3.3\text{ V}$ | –               | –   | 7              | MHz   | SWDCLK ≤ 1/3 CPU clock frequency |
| T <sub>SWDI_SETUP</sub> | T = 1/f SWDCLK                                | $0.25 \times T$ | –   | –              | ns    | –                                |
| T <sub>SWDI_HOLD</sub>  | T = 1/f SWDCLK                                | $0.25 \times T$ | –   | –              | ns    | –                                |
| T <sub>SWDO_VALID</sub> | T = 1/f SWDCLK                                | –               | –   | $0.5 \times T$ | ns    | –                                |
| T <sub>SWDO_HOLD</sub>  | T = 1/f SWDCLK                                | 1               | –   | –              | ns    | –                                |

*Internal Main Oscillator*
**Table 34. IMO DC Specifications**

| Parameter         | Description                     | Min | Typ | Max  | Units | Details/Conditions |
|-------------------|---------------------------------|-----|-----|------|-------|--------------------|
| I <sub>IMO1</sub> | IMO operating current at 48 MHz | –   | –   | 1000 | μA    | –                  |
| I <sub>IMO2</sub> | IMO operating current at 24 MHz | –   | –   | 325  | μA    | –                  |
| I <sub>IMO3</sub> | IMO operating current at 12 MHz | –   | –   | 225  | μA    | –                  |
| I <sub>IMO4</sub> | IMO operating current at 6 MHz  | –   | –   | 180  | μA    | –                  |
| I <sub>IMO5</sub> | IMO operating current at 3 MHz  | –   | –   | 150  | μA    | –                  |

**Table 35. IMO AC Specifications**

| Parameter            | Description                          | Min | Typ | Max | Units | Details/Conditions          |
|----------------------|--------------------------------------|-----|-----|-----|-------|-----------------------------|
| F <sub>IMOTOL3</sub> | Frequency variation from 3 to 48 MHz | –   | –   | ±2  | %     | With API-called calibration |
| F <sub>IMOTOL3</sub> | IMO startup time                     | –   | 12  | –   | μs    | –                           |

*Internal Low-Speed Oscillator*
**Table 36. ILO DC Specifications**

| Parameter         | Description                     | Min | Typ | Max  | Units | Details/Conditions |
|-------------------|---------------------------------|-----|-----|------|-------|--------------------|
| I <sub>ILO2</sub> | ILO operating current at 32 kHz | –   | 0.3 | 1.05 | μA    | –                  |

**Table 37. ILO AC Specifications**

| Parameter              | Description              | Min | Typ | Max | Units | Details/Conditions |
|------------------------|--------------------------|-----|-----|-----|-------|--------------------|
| T <sub>STARTILO1</sub> | ILO startup time         | –   | –   | 2   | ms    | –                  |
| F <sub>ILOTRIM1</sub>  | 32-kHz trimmed frequency | 15  | 32  | 50  | kHz   | –                  |

**Table 38. ECO Trim Value Specification**

| Parameter           | Description                                | Value      | Details/Conditions                                                                         |
|---------------------|--------------------------------------------|------------|--------------------------------------------------------------------------------------------|
| ECO <sub>TRIM</sub> | 24-MHz trim value (firmware configuration) | 0x00003FFA | Optimum trim value that needs to be loaded to register CY_SYS_XTAL_BLERD_BB_XO_CAPTRIM_REG |

## Environmental Specifications

### Environmental Compliance

This Cypress BLE module is built in compliance with the Restriction of Hazardous Substances (RoHS) and Halogen Free (HF) directives. The Cypress module and components used to produce this module are RoHS and HF compliant.

### RF Certification

The CYBLE-022001-00 module is certified under the following RF certification standards:

- FCC: WAP2001
- CE
- IC: 7922A-2001
- MIC: 005-101007
- KC: MSIP-CRM-Cyp-2001

### Environmental Conditions

Table 39 describes the operating and storage conditions for the Cypress BLE module.

**Table 39. Environmental Conditions for CYBLE-022001-00**

| Description                                                     | Minimum Specification | Maximum Specification       |
|-----------------------------------------------------------------|-----------------------|-----------------------------|
| Operating temperature                                           | −40 °C                | 85 °C                       |
| Operating humidity (relative, non-condensation)                 | 5%                    | 85%                         |
| Thermal ramp rate                                               | –                     | 3 °C/minute                 |
| Storage temperature                                             | −40 °C                | 85 °C                       |
| Storage temperature and humidity                                | –                     | 85 °C at 85%                |
| ESD: Module integrated into system<br>Components <sup>[9]</sup> | –                     | 15 kV Air<br>2.2 kV Contact |

### ESD and EMI Protection

Exposed components require special attention to ESD and electromagnetic interference (EMI).

A grounded conductive layer inside the device enclosure is suggested for EMI and ESD performance. Any openings in the enclosure near the module should be surrounded by a grounded conductive layer to provide ESD protection and a low-impedance path to ground.

**Device Handling:** Proper ESD protocol must be followed in manufacturing to ensure component reliability.

#### Note

9. This does not apply to the RF pins (ANT, XTALI, and XTALO). RF pins (ANT, XTALI, and XTALO) are tested for 500-V HBM.

## Regulatory Information

### FCC

#### FCC NOTICE:



The device CYBLE-022001-00, including the antenna 2450AT18B100 from Johanson Technology, complies with Part 15 of the FCC Rules. The device meets the requirements for modular transmitter approval as detailed in FCC public Notice DA00-1407. Transmitter 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.

#### CAUTION:



The FCC requires the user to be notified that any changes or modifications made to this device that are not expressly approved by Cypress Semiconductor may void the user's authority to operate the equipment.

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

#### LABELING REQUIREMENTS:



The Original Equipment Manufacturer (OEM) must ensure that FCC labelling requirements are met. This includes a clearly visible label on the outside of the OEM enclosure specifying the appropriate Cypress Semiconductor FCC identifier for this product as well as the FCC Notice above. The FCC identifier is FCC ID: WAP2001.

In any case the end product must be labeled exterior with "Contains FCC ID: WAP2001"

#### ANTENNA WARNING:



This device is tested with a standard SMA connector and with the antennas listed below. When integrated in the OEMs product, these fixed antennas require installation preventing end-users from replacing them with non-approved antennas. Any antenna not in the following table must be tested to comply with FCC Section 15.203 for unique antenna connectors and Section 15.247 for emissions.

#### RF EXPOSURE:



To comply with FCC RF Exposure requirements, the Original Equipment Manufacturer (OEM) must ensure to install the approved antenna in the previous.

The preceding statement must be included as a CAUTION statement in manuals, for products operating with the approved antennas in [Table 6](#) on page 11, to alert users on FCC RF Exposure compliance. Any notification to the end user of installation or removal instructions about the integrated radio module is not allowed.

The radiated output power of CYBLE-022001-00 with the chip antenna mounted (FCC ID: WAP2001) is far below the FCC radio frequency exposure limits. Nevertheless, use CYBLE-022001-00 in such a manner that minimizes the potential for human contact during normal operation.

End users may not be provided with the module installation instructions. OEM integrators and end users must be provided with transmitter operating conditions for satisfying RF exposure compliance.

### Industry Canada (IC) Certification

CYBLE-022001-00 is licensed to meet the regulatory requirements of Industry Canada (IC),

License: IC: 7922A-2001

Manufacturers of mobile, fixed or portable devices incorporating this module are advised to clarify any regulatory questions and ensure compliance for SAR and/or RF exposure limits. Users can obtain Canadian information on RF exposure and compliance from [www.ic.gc.ca](http://www.ic.gc.ca).

This device has been designed to operate with the antennas listed in [Table 6](#) on page 11, having a maximum gain of 0.5 dBi. Antennas not included in this list or having a gain greater than 0.5 dBi are strictly prohibited for use with this device. The required antenna impedance is 50 ohms. The antenna used for this transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

#### IC NOTICE:



The device CYBLE-022001-00 including the antenna 2450AT18B100 from Johanson technology, complies with Canada RSS-GEN Rules. The device meets the requirements for modular transmitter approval as detailed in RSS-GEN. 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.

#### LABELING REQUIREMENTS:



The Original Equipment Manufacturer (OEM) must ensure that IC labelling requirements are met. This includes a clearly visible label on the outside of the OEM enclosure specifying the appropriate Cypress Semiconductor IC identifier for this product as well as the IC Notice above. The IC identifier is 7922A-2001. In any case, the end product must be labeled in its exterior with "Contains IC: 7922A-2001"

### European R&TTE Declaration of Conformity

Hereby, Cypress Semiconductor declares that the Bluetooth module CYBLE-022001-00 complies with the essential requirements and other relevant provisions of Directive 1999/5/EC. As a result of the conformity assessment procedure described in Annex III of the Directive 1999/5/EC, the end-customer equipment should be labeled as follows:



All versions of the CYBLE-022001-00 in the specified reference design can be used in the following countries: Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, The Netherlands, the United Kingdom, Switzerland, and Norway.

### MIC Japan

CYBLE-022001-00 is certified as a module with type certification number 005-101007. End products that integrate CYBLE-022001-00 do not need additional MIC Japan certification for the end product.

End product can display the certification label of the embedded module.

Model Name: EZ-BLE PROc Module

Part Number: CYBLE-022001-00

Manufactured by Cypress Semiconductor.



### KC Korea

CYBLE-022001-00 is certified for use in Korea with certificate number MSIP-CRM-Cyp-2001.

한국 인증 세부정보:

|                                                                                     |                                                                                                                                                                                                                                                                                          |
|-------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  | <ol style="list-style-type: none"><li>1. 제품명(모델명): 특정소출력무선기기(무선데이터통신시스템용 무선기기), CYBLE-022001-00</li><li>2. 인증 번호: MSIP-CRM-Cyp-2001</li><li>3. 라이선스 소유자: Cypress Semiconductor Corporation</li><li>4. 제조일자: 2015.04</li><li>5. 제조업체/국가명: Cypress Semiconductor Corporation/ 중국</li></ol> |
|-------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

해당 무선설비는 전파혼신 가능성이 있으므로 인명안전과 관련된 서비스는 할 수 없습니다.

## Ordering Information

Table 40 lists the CYBLE-022001-00 part number and features.

**Table 40. Ordering Information**

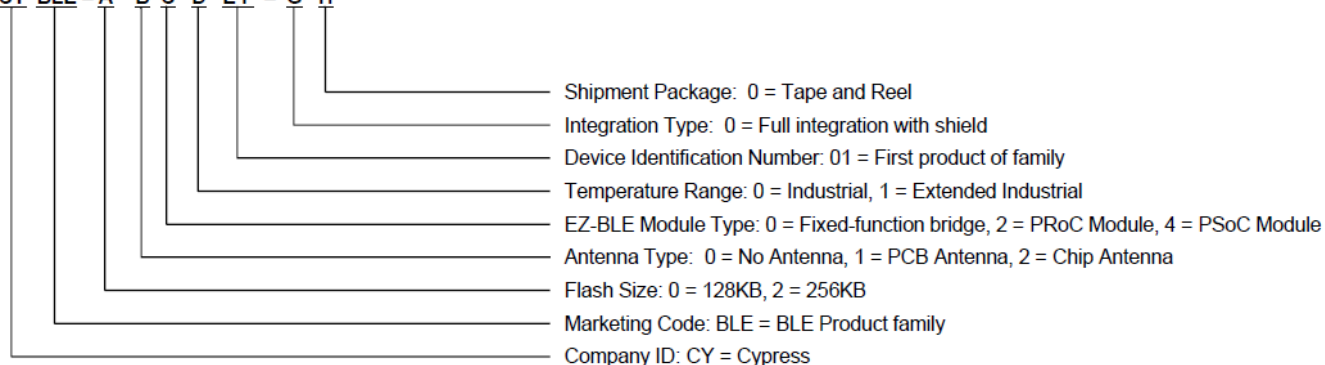
| Part Number     | CPU Speed (MHz) | Flash Size (KB) | CapSense | SCB | TCPWM | 12-Bit SAR ADC | I <sup>2</sup> S | LCD | Package | Packaging     |
|-----------------|-----------------|-----------------|----------|-----|-------|----------------|------------------|-----|---------|---------------|
| CYBLE-022001-00 | 48              | 128             | Yes      | 2   | 4     | 1 Msps         | Yes              | Yes | 21-SMT  | Tape and Reel |

## Ordering Code Definitions

The part numbers are of the form CYBLE-ABCDEF-GH where the fields are defined as follows.

Example

CY BLE - A B C D E F - G H



For additional information and a complete list of Cypress Semiconductor BLE products, contact your local Cypress sales representative. To locate the nearest Cypress office, visit our website.

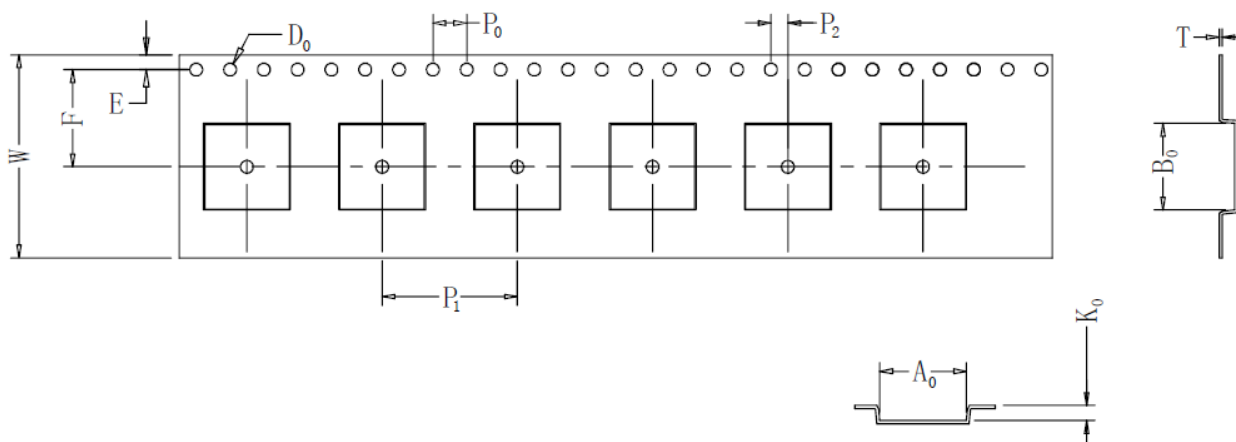
|                                       |                                                             |
|---------------------------------------|-------------------------------------------------------------|
| U.S. Cypress Headquarters Address     | 198 Champion Court, San Jose, CA 95134                      |
| U.S. Cypress Headquarter Contact Info | (408) 943-2600                                              |
| Cypress website address               | <a href="http://www.cypress.com">http://www.cypress.com</a> |

## Packaging

The CYBLE-022001-00 is offered in tape and reel packaging. [Figure 8](#) details the tape dimensions used for the CYBLE-022001-00.

**Figure 8. CYBLE-022001-00 Tape Dimensions**

| Item        | W                                      | A <sub>0</sub>                          | B <sub>0</sub>                          | K <sub>0</sub>                         | K <sub>1</sub>                    | P <sub>1</sub>                         | F                                      | E                                      | D <sub>0</sub>                         | D <sub>1</sub>                         | P <sub>0</sub>                         | P <sub>2</sub>                         | T                                      |
|-------------|----------------------------------------|-----------------------------------------|-----------------------------------------|----------------------------------------|-----------------------------------|----------------------------------------|----------------------------------------|----------------------------------------|----------------------------------------|----------------------------------------|----------------------------------------|----------------------------------------|----------------------------------------|
| Measurement | 24.0 <sup>+0.30</sup> <sub>-0.30</sub> | 10.26 <sup>+0.10</sup> <sub>-0.10</sub> | 10.26 <sup>+0.10</sup> <sub>-0.10</sub> | 2.00 <sup>+0.10</sup> <sub>-0.10</sub> | <sup>+0.10</sup> <sub>-0.10</sub> | 16.0 <sup>+0.10</sup> <sub>-0.10</sub> | 11.5 <sup>+0.10</sup> <sub>-0.10</sub> | 1.75 <sup>+0.10</sup> <sub>-0.10</sub> | 1.50 <sup>+0.10</sup> <sub>-0.00</sub> | 1.50 <sup>+0.10</sup> <sub>-0.10</sub> | 4.00 <sup>+0.10</sup> <sub>-0.10</sub> | 2.00 <sup>+0.10</sup> <sub>-0.10</sub> | 0.30 <sup>+0.05</sup> <sub>-0.05</sub> |



[Figure 9](#) details the orientation of the CYBLE-022001-00 in the tape as well as the direction for unreeling.

**Figure 9. Component Orientation in Tape and Unreeling Direction**

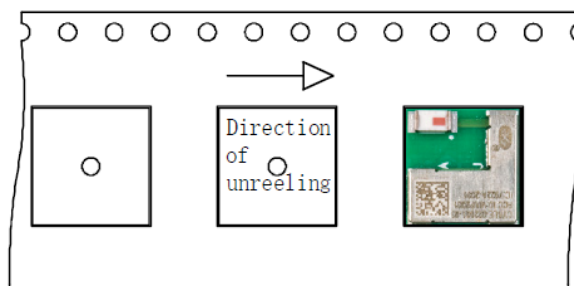
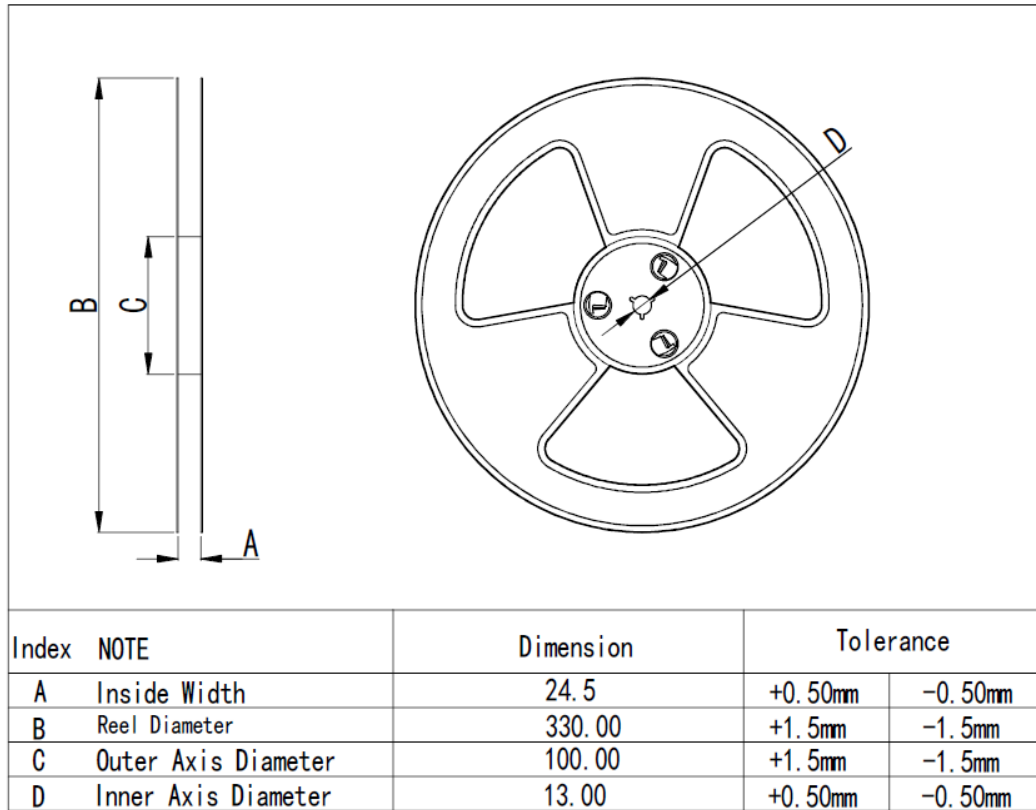


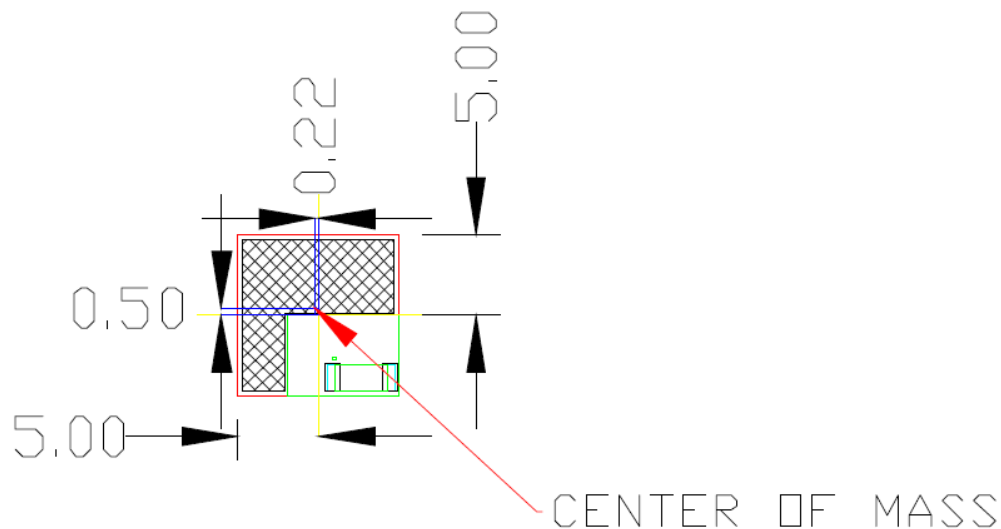
Figure 10 details reel dimensions used for the CYBLE-022001-00.

Figure 10. Reel Dimensions



The CYBLE-022001-00 is designed to be used with pick-and-place equipment in an SMT manufacturing environment. The center-of-mass for the CYBLE-022001-00 is detailed in Figure 11.

Figure 11. CYBLE-022001-00 Center of Mass



## Acronyms

**Table 41. Acronyms Used in this Document**

| Acronym       | Description                                                                                                                                |
|---------------|--------------------------------------------------------------------------------------------------------------------------------------------|
| BLE           | Bluetooth Low Energy                                                                                                                       |
| Bluetooth SIG | Bluetooth Special Interest Group                                                                                                           |
| CE            | European Conformity                                                                                                                        |
| CSA           | Canadian Standards Association                                                                                                             |
| EMI           | electromagnetic interference                                                                                                               |
| ESD           | electrostatic discharge                                                                                                                    |
| FCC           | Federal Communications Commission                                                                                                          |
| GPIO          | general-purpose input/output                                                                                                               |
| IC            | Industry Canada                                                                                                                            |
| IDE           | integrated design environment                                                                                                              |
| KC            | Korea Certification                                                                                                                        |
| MIC           | Ministry of Internal Affairs and Communications (Japan)                                                                                    |
| PCB           | printed circuit board                                                                                                                      |
| RX            | receive                                                                                                                                    |
| QDID          | qualification design ID                                                                                                                    |
| SMT           | surface-mount technology; a method for producing electronic circuitry in which the components are placed directly onto the surface of PCBs |
| TCPWM         | timer, counter, pulse width modulator (PWM)                                                                                                |
| TUV           | Germany: Technischer Überwachungs-Verein (Technical Inspection Association)                                                                |
| TX            | transmit                                                                                                                                   |

## Document Conventions

### Units of Measure

**Table 42. Units of Measure**

| Symbol | Unit of Measure |
|--------|-----------------|
| °C     | degree Celsius  |
| kV     | kilovolt        |
| mA     | milliamperes    |
| mm     | millimeters     |
| mV     | millivolt       |
| μA     | microamperes    |
| μm     | micrometers     |
| MHz    | megahertz       |
| GHz    | gigahertz       |
| V      | volt            |

## Document History Page

| Document Title: CYBLE-022001-00 EZ-BLE™ PRoC™ Module<br>Document Number: 001-95662 |         |                 |                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|------------------------------------------------------------------------------------|---------|-----------------|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Revision                                                                           | ECN     | Orig. of Change | Submission Date | Description of Change                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| **                                                                                 | 4662055 | DSO             | 02/18/2015      | Preliminary datasheet for CYBLE-022001-00 module.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| *A                                                                                 | 4679323 | DSO             | 03/09/2015      | Updated Pad 10 on module pinout from NC to GND.<br>Updated Module Pad Assignment in <a href="#">Figure 1</a> on page 4.<br>Updated title of <a href="#">Table 3</a> to “Module Solder Pad Connection Dimensions”.<br>Updated <a href="#">Table 4</a> to change Pad 10 from NC to GND.<br>Updated <a href="#">Figure 5</a> , <a href="#">Figure 6</a> , and <a href="#">Figure 7</a> to update Pad 10 from NC to GND.                                                                                                                                                                                                                                                                                                                                             |
| *B                                                                                 | 4710754 | DSO             | 04/01/2015      | Updated Title Page heading to “EZ-BLE™ PRoC™ Module”.<br>Updated <a href="#">Module Description</a> to correct GPIO number from “12” to “16”.<br>Updated <a href="#">Module Description</a> to add QDID and Declaration ID under <a href="#">Bluetooth SIG 4.1 qualified</a> item.<br>Updated <a href="#">Functional Capabilities</a> to correct number of capacitive sensors supported from nine to 13.<br>Updated <a href="#">Power Consumption</a> Stop mode as “60 nA with XRES wakeup”.<br>Updated terms “pre-certified” and “pre-qualified” to “certified” and “qualified” respectively.<br>Updated <a href="#">Table 10</a> to change Details/Conditions to “XRES wakeup”.<br>Updated <a href="#">Acronyms</a> to add “QDID”.                             |
| *C                                                                                 | 4812402 | DSO             | 06/26/2015      | Changed document status from “Preliminary” to “Final”.<br>Updated <a href="#">Functional Capabilities</a> to correct number of capacitive sensors supported from nine to 15.<br>Updated <a href="#">Module Description</a> to add identification numbers for FCC, IC, KC, and MIC regulatory agencies.<br>Updated <a href="#">Power Supply Connections and Recommended External Components</a> section to specify power supply ramp timing for VDD and VDDR.<br>Updated <a href="#">Figure 7</a> to final design schematic.<br>Update $IDD_{15}$ in <a href="#">Table 9</a> from 1.3 $\mu A$ to 1.5 $\mu A$ .<br>Added <a href="#">Packaging</a> section.<br>Added <a href="#">Ordering Code Definitions</a> .<br>Updated <a href="#">Acronyms</a> to add “SMT”. |

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