



# ESP-C3-13U Specification

Version V1.0

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### Document development/revision/revocation resume

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## 1 Product Overview

ESP-C3-13U is a Wi-Fi module developed by Ai-Thinker. This module core processor ESP32-C3 is a Wi-Fi+ BLE combination of system-level chips (SoC), designed for various applications such as internet of things (IoT), mobile devices, wearable electronics, smart home, etc.

ESP32-C3 with industry-leading low power and RF performance, supporting Wi-Fi IEEE802.11b/g/n agreements and BLE 5.0. ESP32-C3 chip is equipped with a RISC-V 32-bit single-core processor, operating frequency up to 160 MHz. The chip is support to have secondary development without using other microcontrollers or processors. The chip has a built-in 400 KB SRAM, 384 KB ROM, 8KB RTC SRAM. The chip also support external Flash while it built-in 4Mbit Flash. ESP32-C3 chip supports a variety of low-power consumption working states, which can meet the power consumption requirements of various application scenarios. The chip's unique features such as fine clock gating function, dynamic voltage clock frequency adjustment function, and RF output power adjustable function can achieve the best balance between communication distance, communication speed and power consumption.

ESP-C3-13U module provides a wealth of peripheral interfaces, including UART, PWM, SPI, I2S, I2C, ADC, temperature sensor and there are 15 GPIOs.

ESP-C3-13U has a variety of unique hardware safety mechanisms. The hardware encryption accelerator supports AES、SHA and RSA algorithm. Among them, RNG、HMAC and Digital Signature module provide more security features. Other security features include flash encryption and se-cure boot signature verification, etc. The perfect security mechanism enables the chip to be perfectly applied to various encryption products.

ESP-C3-13U support low-power Bluetooth: Bluetooth5, Bluetooth mesh.

Bluetooth rate support: 125Kbps, 500Kbps, 1Mbps, 2Mbps. Support broadcast extension, multi-broadcasting, channel selection.

## 1.1. Characteristics

- Support Wi-Fi 802.11b/g/n, 1T1R mode data rate up to 150Mbps.
- Support BLE5.0, and rate support: 125Kbps, 500Kbps, 1Mbps,2Mbps.
- 32-bit RISC-V single-core processor, supports a clock frequency of up to 160 MHz, with 400 KB SRAM, 384 KB ROM, 8KB RTC SRAM
- Support UART/PWM/GPIO/ADC/I2C/I2S interface, temperature sensor, pulse counter
- SMD-18 package
- Integrated Wi-Fi MAC/ BB/RF/PA/LNA/BLE
- Support multiple sleep modes, deep sleep electric current is less than 5uA
- UART rate up to 5Mbps

- Support STA/AP/STA+AP mode and mix mode
- Support Smart Config (APP)/AirKiss (WeChat) of Android and IOS One-click network configuration
- Support UART port local upgrade and remote firmware upgrade (FOTA)
- General AT commands can be better understand
- Support secondary development, integrated Linux development environment
- ESP-C3-13U module acquiesce in using the built-in 4MByte Flash, meanwhile support external Flash version

## 1.2. Main parameters

**Table 1 main parameter descriptions**

<b>Model Name</b>	ESP-C3-13U
<b>Package</b>	SMD-18
<b>Size</b>	14.0*18.0*3.1(±0.2)mm
<b>Antenna</b>	IPEX
<b>Frequency Range</b>	2400 ~ 2483.5MHz
<b>Operating Temperature</b>	-40 °C ~ 85 °C
<b>Store Temperature</b>	-40 °C ~ 125 °C , < 90% RH
<b>Power supply range</b>	Supply voltage:3.0V ~ 3.6V, Supply current >500mA
<b>Support Interface</b>	UART/GPIO/ADC/PWM/I2C/I2S
<b>IO</b>	IO0,IO1,IO2,IO3,IO4,IO5,IO6,IO7,IO8,IO9,IO10,IO18,IO19, IO20,IO21
<b>UART Rate</b>	Support 110 ~ 4608000 bps, default 115200 bps
<b>Bluetooth</b>	BLE 5.0
<b>Security</b>	WEP/WPA-PSK/WPA2-PSK
<b>SPI Flash</b>	Default 4MByte, support 2MByte version

## 2 Electrical parameters

ESP-C3-13U module is electrostatic sensitive devices and special precautions need to be taken when handling



### 2.1 Electrical characteristics

Parameters		Conditions	Min	Typical values	Max	Unit
Supply voltage		VDD	3.0	3.3	3.6	V
I/O	$V_{IL}/V_{IH}$	-	-0.3/0.75VIO	-	0.25VIO/3.6	V
	$V_{OL}/V_{OH}$	-	N/0.8VIO	-	0.1VIO/N	V
	$I_{MAX}$	-	-	-	12	mA

### 2.2. WIFI RF performance

Description	Typical values	Unit
Operating frequency	2400 - 2483.5	MHz
<b>Output Power</b>		
11n mode HT40, PA output power	-	dBm
11n mode HT20, PA output power	-	dBm
11g mode, PA output power	-	dBm
11b mode, PA output power	-	dBm
<b>Receiving sensitivity</b>		
CCK, 1 Mbps	-96±2	dBm
CCK, 11 Mbps	-88±2	dBm



6 Mbps (1/2 BPSK)	-92±2	dBm
54 Mbps (3/4 64-QAM)	-75±2	dBm
HT20 (MCS7)	-73±2	dBm
HT40 (MCS7)	-70±2	dBm

## 2.3. BLE RF performance

Description	Typical values	Unit
<b>Output Power</b>		
Transmit power	-	dBm
Receiving sensitivity Low Energy consumption BLE: 1M		
Sensitivity@30.8%PER	-96±2	dBm

## 2.4. Power Consumption

The following power consumption data are based on a 3.3 V power supply, 25°C ambient temperature and measured using an internal voltage regulator.

- All measurements were completed at the antenna interface without SAW filters
- All emission data are based on a duty cycle of 100%, measured in the mode of continuous emission.

Mode	Min	Typical values	Max	Unit
Tx 802.11b, CCK 1Mbps, POUT=+20dBm	-	350	-	mA
Tx 802.11g, OFDM 54Mbps, POUT =+18dBm	-	290	-	mA
Tx 802.11n, MCS7, POUT =+17dBm	-	280	-	mA
Rx 802.11b, 1024 bit	-	90	-	mA
Rx 802.11g, 1024 bit	-	90	-	mA
Rx 802.11n, 1024 bit	-	93	-	mA
Modem-Sleep①	-	20	-	mA

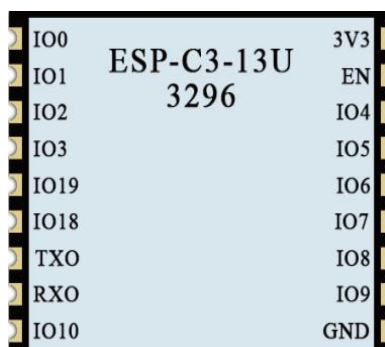
Light-Sleep②	-	130	-	μA
Deep-Sleep③	-	5	-	μA
Power Off	-	1	-	μA

### 3 Appearance dimensions

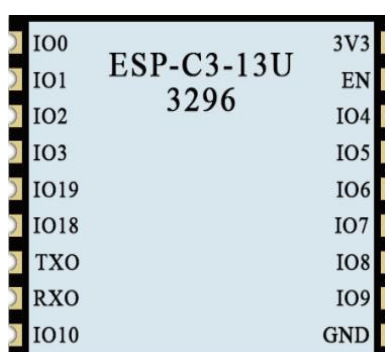
ESP-C3-13U have two FLASH, including external FLASH and build-in FLASH

(The rendering is for reference only, the actual product shall prevail)

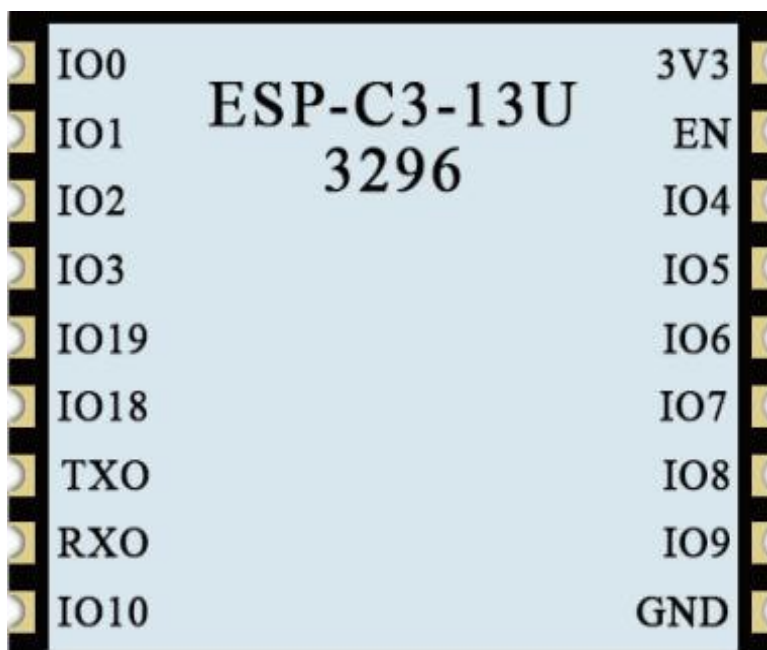
External 2MByte FLASH:



Build-in 4MByte FLASH:



## 4 Pin definition



ESP-C3-13U Diagram of Pin

ESP-C3-13U module is connected to 18 interfaces, refer to pin diagram, pin function definition table is interface definition.

ESP-C3-13U Pin function definition

No.	Name	Function
1	VCC	VCC
2	EN	High level: chip enabled; Low level: chip shutdown; Pay attention not to leave the CHIP_PU pin floating;
3	IO4	GPIO04,ADC1_CH4,FSPIHD,MTMS
4	IO5	GPIO05,ADC2_CH0,FSPIWP,MTDI
5	IO6	GPIO6,FSPICLK,MTCK
6	IO7	GPIO7,FSPID,MTDO
7	IO8	GPIO8
8	IO9	GPIO9
9	GND	GND
10	IO10	GPIO10,FSPICSO
11	RXD	RX0,GPIO20

12	TXD	TX0,GPIO21
13	IO18	GPIO18
14	IO19	GPIO19
15	IO3	GPIO03,ADC1_CH3
16	IO2	GPIO2,ADC1_CH2,FSPIQ
17	IO1	GPIO1,ADC1_CH1,XTAL_32K_N
18	IO0	GPIO0,ADC1_CH0,XTAL_32K_N

Table Module Start-up Mode Description

System start-up mode			
Pin	Default	SPI Start up mode	Download Start up Mode
IO8	Non	/	1
IO9	Pull up	1	0

Note: Some pins have been internally pulled up, please refer to the schematic

## 5 Design guidance

### 5.1.Note:

- (1) When GPIO20 is used as U1RXD, a pull-up resistor needs to be added externally.

### 5.2.Antenna layout requirements

- Ø ESP-C3-13U Need an external antenna: Place the module on the edge of the motherboard, and the IPEX antenna base is close to the edge.
- Ø In order to meet the performance of the on-board antenna, metal parts are forbidden to be placed around the antenna, away from high frequency devices.

### 5.3.Power supply

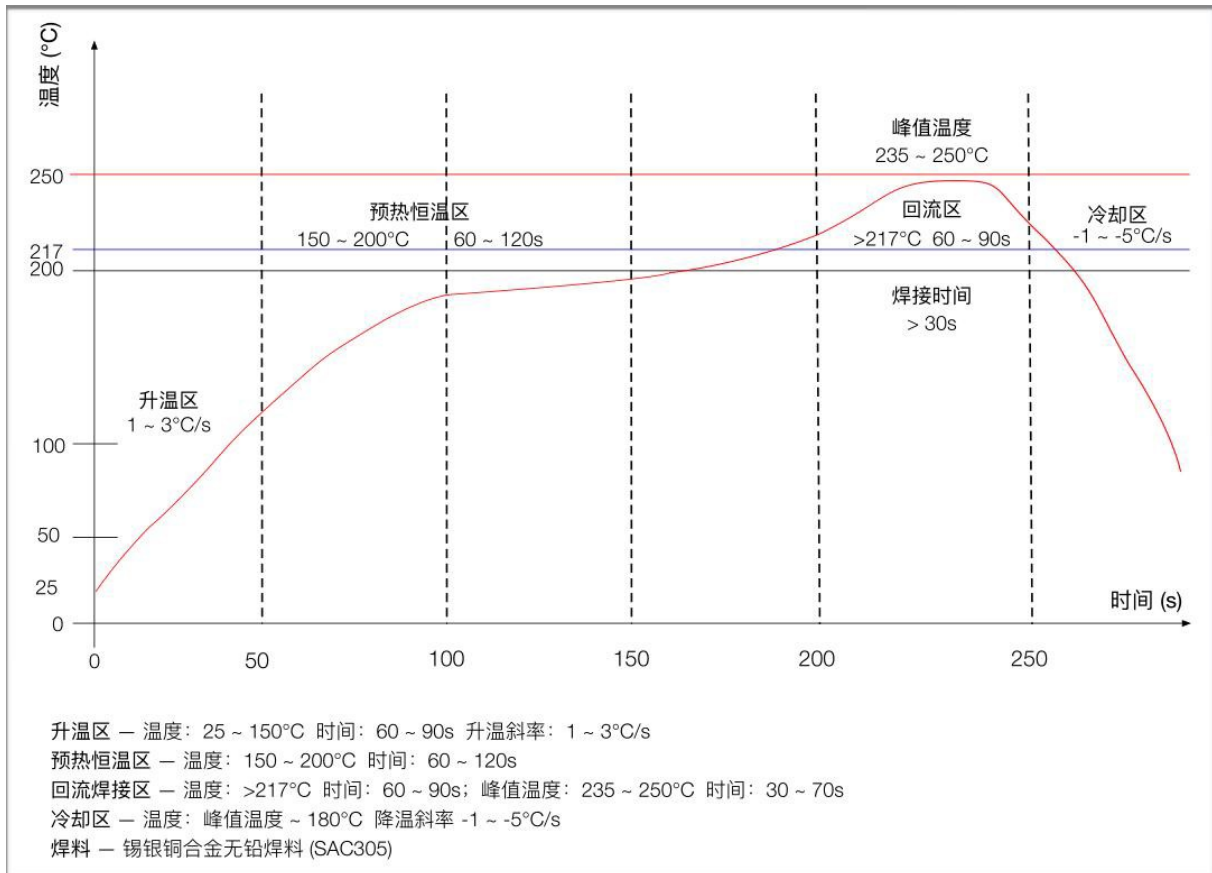
- (1) Recommend 3.3V voltage, peak current above 500mA
- (2) It is recommended to use LDO for power supply; if DC-DC is used, the ripple is recommended to be controlled within 30mV.
- (3) DC-DC the power supply circuit, it is suggested to reserve the position of output ripple can be optimized when the load changes greatly.
- (4) It is recommended to add ESD devices to the 3.3V power interface.

#### 5.4.GPIO Interface

- (1) The module periphery leads to some GPIO ports, such as the recommended resistance of 10-100 Ohms in series on the IO port. This can suppress overshoot, to ensure both sides of the level more stable. helpful for both EMI and ESD.
- (2) For special IO, please refer to the specification, which will affect the starting configuration of the module.
- (3) The IO port of the module voltage is 3.3 V, if the main control does not match the IO level of the module, require to add the level conversion circuit.
- (4) When the IO port is connected directly to the peripheral interface, or the pin header and other terminals, it is recommended to reserve ESD device near the terminal.

Table Electrical level conversion circuit

## 6 Reflow soldering





## 7 Packaging information

Refer to below image,ESP-C3-13U package is in Tape/Reel.



## 8 Contact us

Official website: <https://www.ai-thinker.com>

Development DOCS: <https://docs.ai-thinker.com>

Official Forum: <http://bbs.ai-thinker.com>

Sample purchase: <https://ai-thinker.en.alibaba.com/>

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## FCC WARNING

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

This device complies with Part 15 of the FCC Rules.

Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

This device and its antenna(s) must not be co-located or operating in conjunction with any other antenna or transmitter.

15.105 Information to the user.

(b) For a Class B digital device or peripheral, the instructions furnished the user shall include the following or similar statement, placed in a prominent location in the text of the manual:

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules.

These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20cm between the radiator and your body. Radiation Exposure Statement:

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment.

This transmitter must not be co-located or operating in conjunction with any other

antenna or transmitter.

The availability of some specific channels and/or operational frequency bands are country dependent and are firmware programmed at the factory to match the intended destination.

The firmware setting is not accessible by the end user.

The final end product must be labelled in a visible area with the following:

“Contains Transmitter Module “FCC ID: 2ATPO-ESPC313U”

## **Requirement per KDB996369 D03**

### **2.2 List of applicable FCC rules**

List the FCC rules that are applicable to the modular transmitter. These are the rules that specifically establish the bands of operation, the power, spurious emissions, and operating fundamental frequencies. DO NOT list compliance to unintentional-radiator rules (Part 15 Subpart B) since that is not a condition of a module grant that is extended to a host manufacturer. See also Section 2.10 below concerning the need to notify host manufacturers that further testing is required.<sup>3</sup>

**Explanation:** This module meets the requirements of FCC part 15C (15.247). It specifically identified AC Power Line Conducted Emission, Radiated Spurious emissions, Band edge and RF Conducted Spurious Emissions, Conducted Peak Output Power, Bandwidth, Power Spectral Density, Antenna Requirement.

### **2.3 Summarize the specific operational use conditions**

Describe use conditions that are applicable to the modular transmitter, including for example any limits on antennas, etc. For example, if point-to-point antennas are used that require reduction in power or compensation for cable loss, then this information must be in the instructions. If the use condition limitations extend to professional users, then instructions must state that this information also extends to the host manufacturer's instruction manual. In addition, certain information may also be needed, such as peak gain per frequency band and minimum gain, specifically for master devices in 5 GHz DFS bands.

**Explanation:** The product antenna uses an irreplaceable antenna with a gain of 2dBi

### **2.4 Single Modular**

If a modular transmitter is approved as a "Single Modular," then the module manufacturer is responsible for approving the host environment that the Single Modular is used with. The manufacturer of a Single Modular must describe, both in the filing and in the installation instructions, the alternative means that the Single Modular manufacturer uses to verify that the host meets the necessary requirements to satisfy the module limiting conditions.

A Single Modular manufacturer has the flexibility to define its alternative method to address the conditions that limit the initial approval, such as: shielding, minimum signaling amplitude, buffered modulation/data inputs, or power supply regulation. The alternative method could include that the limited

module manufacturer reviews detailed test data or host designs prior to giving the host manufacturer approval.

This Single Modular procedure is also applicable for RF exposure evaluation when it is necessary to demonstrate compliance in a specific host. The module manufacturer must state how control of the product into which the modular transmitter will be installed will be maintained such that full compliance of the product is always ensured. For additional hosts other than the specific host originally granted with a limited

module, a Class II permissive change is required on the module grant to register the additional host as a specific host also approved with the module.

**Explanation:** The module is a single module.

## 2.5 Trace antenna designs

For a modular transmitter with trace antenna designs, see the guidance in Question 11 of KDB Publication 996369 D02 FAQ – Modules for Micro-Strip Antennas and traces. The integration information shall include for the TCB review the integration instructions for the following aspects: layout of trace design, parts list (BOM), antenna, connectors, and isolation requirements.

a) Information that includes permitted variances (e.g., trace boundary limits, thickness, length, width, shape(s), dielectric constant, and impedance as applicable for each type of antenna); b) Each design shall be considered a different type (e.g., antenna length in multiple(s) of frequency, the wavelength, and antenna shape (traces in phase) can affect antenna gain and must be considered); c) The parameters shall be provided in a manner permitting host manufacturers to design the printed circuit (PC) board layout; d) Appropriate parts by manufacturer and specifications; e) Test procedures for design verification; and f) Production test procedures for ensuring compliance. The module grantee shall provide a notice that any deviation(s) from the defined parameters of the antenna trace, as described by the instructions, require that the host product manufacturer must notify the module grantee that they wish to change the antenna trace design. In this case, a Class II permissive change application is required to be filed by the grantee, or the host manufacturer can take responsibility through the change in FCC ID (new application) procedure followed by a Class II permissive change application.

## 2.6 RF exposure considerations

It is essential for module grantees to clearly and explicitly state the RF exposure conditions that permit a host product manufacturer to use the module. Two types of instructions are required for RF exposure information: (1) to the host product manufacturer, to define the application conditions (mobile, portable – xx cm from a person's body); and (2) additional text needed for the host product manufacturer to provide to end users in their end-product manuals. If RF exposure statements and use conditions are not provided, then the host product manufacturer is required to take responsibility of the module through a change in FCC ID (new application).

**Explanation:** The module complies with FCC radiofrequency radiation exposure limits for uncontrolled environments. The device is installed and operated with a distance of more than 20 cm between the radiator and your body." This module follows FCC statement design, FCC ID : 2ATPO-ESPC313U

## 2.7 Antennas

A list of antennas included in the application for certification must be provided in the instructions. For modular transmitters approved as limited modules, all applicable professional installer instructions must be included as part of the information to the host product manufacturer. The antenna list shall also identify the antenna types (monopole, PIFA, dipole, etc. (note that for example an "omni-directional antenna" is not considered to be a specific "antenna type").

For situations where the host product manufacturer is responsible for an external connector, for example with an RF pin and antenna trace design, the integration instructions shall inform the installer that unique antenna connector must be used on the Part 15 authorized transmitters used in the host product.

The module manufacturers shall provide a list of acceptable unique connectors.

**Explanation:** The product antenna uses an irreplaceable antenna with a gain of 2dBi

## **2.8 Label and compliance information**

Grantees are responsible for the continued compliance of their modules to the FCC rules. This

includes advising host product manufacturers that they need to provide a physical or e-label stating “Contains FCC ID” with their finished product. See Guidelines for Labeling and User Information for RF Devices – KDB Publication 784748.

**Explanation:** The host system using this module, should have label in a visible area indicated the following texts: "Contains FCC ID: 2ATPO-ESPC313U

## **2.9 Information on test modes and additional testing requirements<sup>5</sup>**

Additional guidance for testing host products is given in KDB Publication 996369 D04 Module Integration Guide. Test modes should take into consideration different operational conditions for a stand-alone modular transmitter in a host, as well as for multiple simultaneously transmitting modules or other transmitters in a host product.

The grantee should provide information on how to configure test modes for host product evaluation for different operational conditions for a stand-alone modular transmitter in a host, versus with multiple, simultaneously transmitting modules or other transmitters in a host.

Grantees can increase the utility of their modular transmitters by providing special means, modes, or instructions that simulates or characterizes a connection by enabling a transmitter. This can greatly simplify a host manufacturer’s determination that a module as installed in a host complies with FCC requirements.

**Explanation:** Shenzhen Ai-Thinker Technology Co., Ltd can increase the utility of our modular transmitters by providing instructions that simulates or characterizes a connection by enabling a transmitter.

## **2.10 Additional testing, Part 15 Subpart B disclaimer**

The grantee should include a statement that the modular transmitter is only FCC authorized for the specific rule parts (i.e., FCC transmitter rules) listed on the grant, and that the host product manufacturer is responsible for compliance to any other FCC rules that apply to the host not covered by the modular transmitter grant of certification. If the grantee markets their product

as being Part 15

Subpart B compliant (when it also contains unintentional-radiator digital circuitry), then the grantee shall provide a notice stating that the final host product still requires Part 15 Subpart B compliance testing with the modular transmitter installed.

**Explanation:** The module without unintentional-radiator digital circuitry, so the module does not require an evaluation by FCC Part 15 Subpart B. The host should be evaluated by the FCC Subpart B.