

SPECIFICATION

TR6S621U1

WIFI/BT Module+5G



If one receives this document from Truly Electronics Co., Ltd. (hereinafter referred to as "Truly Electronics"), it indicates that one has agreed to the following terms. If one does not consent to the following terms, please cease the use of this document.

The copyright of this document is owned by Truly Electronics Co., Ltd., and any rights not explicitly granted herein are reserved. This document involves the proprietary information of Truly Electronics. Without the prior written permission of Truly Electronics, no entity or individual may duplicate, disseminate, distribute, utilize or disclose this document, as well as any pictures, tables, data and other information contained therein.

This product conforms to the design requirements regarding environmental protection and personal safety. The storage, use and disposal of the product should comply with the requirements stipulated in the product manual, relevant contracts or relevant national laws and regulations.

The company reserves the right to modify and improve the products described in this manual without prior notification; meanwhile, it reserves the right to revise or withdraw this manual at any time.

If there is any ambiguity or obscurity in the text of this user manual, please consult the company or the distributor promptly.

Address: North Of The Dong Chong Road, Truly Industrial Area, Shanwei City, Guangdong Province, China.

Website: <https://www.truly.com.hk>

Contents

1. Device Overview	3
1.1 Descriptions	3
1.2 Features	3
1.2.1 General Features	3
1.2.2 Wi-Fi Key Features	3
1.2.3 Bluetooth Key Features	4
1.3 Functional Block Diagram	5
2. Pin Configuration and Functions	5
2.1 Module Pin Diagram	5
2.2 Pin Functions	6
3. Specifications	7
3.1 WIFI RF Specifications	7
3.2 Bluetooth RF Specifications	9
4. Application and Implementation	10
4.1 Application Diagram	10
4.2 Reference design	10
4.3 Power on/off Timing	10
5. Mechanical and Package	15
5.1 Mechanical Size	15
5.2 Recommended Land Pattern	15
5.3 Package Information	16
6. Thermal Reflow	17
7. Ordering Information	18
8. Revision History	18

1. Device Overview

1.1 Descriptions

The TR6S621U1 is a highly integrated module that supports 1T1R 802.11 a/b/g/n/ac/ax with Wireless LAN (WLAN) USB 2.0 interface controller and Bluetooth 5.4 HS-UART interface controller. The high speed FFT/IFFT paths, combined with BPSK, QPSK, 16QAM, 64QAM, 256QAM and up to 1024QAM modulation of the individual subcarriers, and compatible coding rate of 1/2, 2/3, 3/4, 5/6, provide up to 600.5Mbps for IEEE 802.11ax. The TR6S621U1 MAC supports 802.11e for multimedia applications, 802.11i and WAPI for security. The TR6S621U1 provides a complete solution for a high-performance integrated wireless and Bluetooth device. It is suitable for STB, TVs, tablets, phones, IPC and other fields such as consumer electronic devices, and can also be applied to the fields with high reliability requirements, such as industrial interconnection.

The TR6A621U1 provides a complete solution for a high-performance integrated wireless and Bluetooth device.

1.2 Features

1.2.1 General Features

- Supports 3.3V power supply
- Complies with USB 2.0
- CMOS MAC, Baseband PHY and RF in a single module for IEEE 802.11a/b/g/n/ac/ax compatible WLAN
- IEEE 802.11i (WPA, WPA2, WPA3). Open, shared key, and pair-wise key authentication services
- Multiple BSSID feature allows the module to assume multiple MAC identities when used as a wireless bridge
- IEEE 802.11k Radio Resource Measurement
- WAPI (Wireless Authentication Privacy Infrastructure) certified
- Wi-Fi Direct supports wireless peer to peer application
- IEEE 802.11h DFS, TPC, Spectrum Measurement

1.2.2 Wi-Fi Key Features

- IEEE 802.11a/b/g/n/ac/ax compatible WLAN
- Supports IEEE 802.11 d/e/h/i/k/m/r/v/w
- Supports Wi-Fi STA, AP, P2P, TDLS modes
- Supports LDPC, STBC
- Supports UL/DL OFDMA, DL MU-MIMO

- Supports QoS, WFA WMM, WMM PS
- Supports WPA, WPA2, WPA3 encryption, WAPI
- Supports BSS Color, Spatial Reuse
- Supports TWT, Intra-PPDU PS, VHT txop PS
- Supports WOW
- Supports 2.4Ghz and 5Ghz band channels
- 20MHz / 40MHz/80MHz Bandwidth transmission
- Maximum PHY data rate up to 600.5Mbps in 802.11ax
- OFDM with BPSK, QPSK, 16QAM, 64QAM and 256QAM and 1024QAM modulation.
Convolutional Coding Rate: 1/2, 2/3, 3/4, and 5/6
- DSSS with DBPSK and DQPSK, CCK modulation with long and short preamble

1.2.3 Bluetooth Key Features

- Bluetooth v2.1, v3.0, v4.2, v5.4
- HS-UART /USB2.0 as HCI
- PCM interface for audio data transmission
- Supports VoHCI
- Support BR/EDR/LE 1M/LE 2M/LE LR
- Support SCO and eSCO link
- CVSD/MSBC/PLC
- SSP/Secure Connection
- Low power mode (sniff, sniff sub-rating)
- Supports LE Audio
- Supports AOA/AOD

1.3 Functional Block Diagram

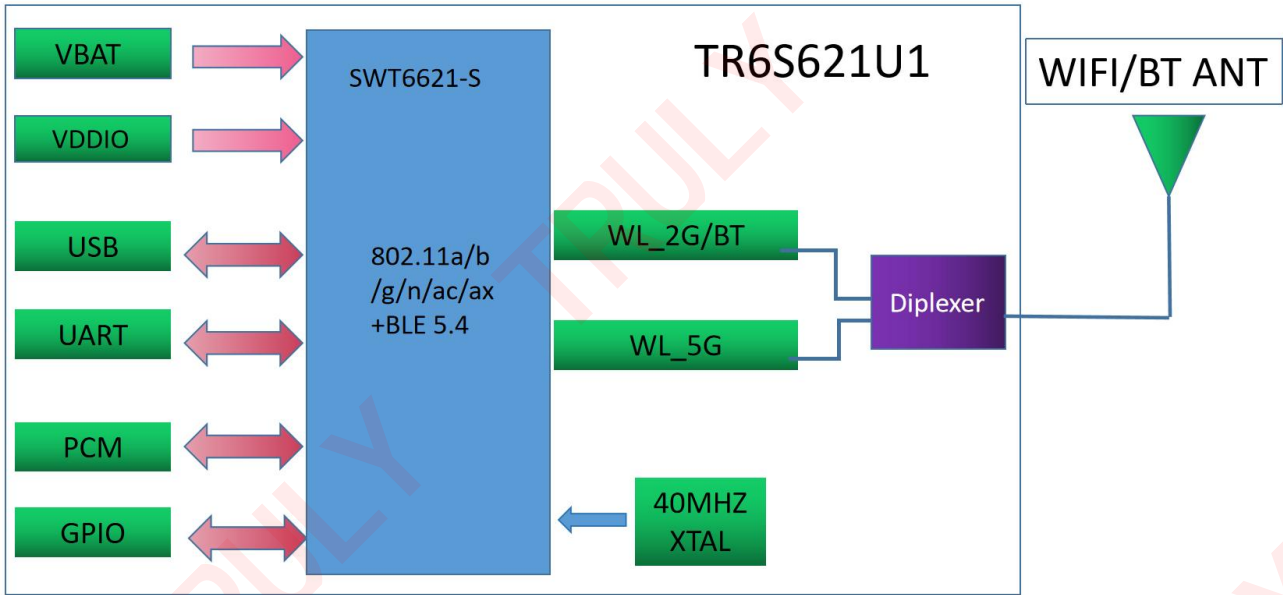


Figure 1. Block Diagram of TR6S621U1

2. Pin Configuration and Functions

2.1 Module Pin Diagram

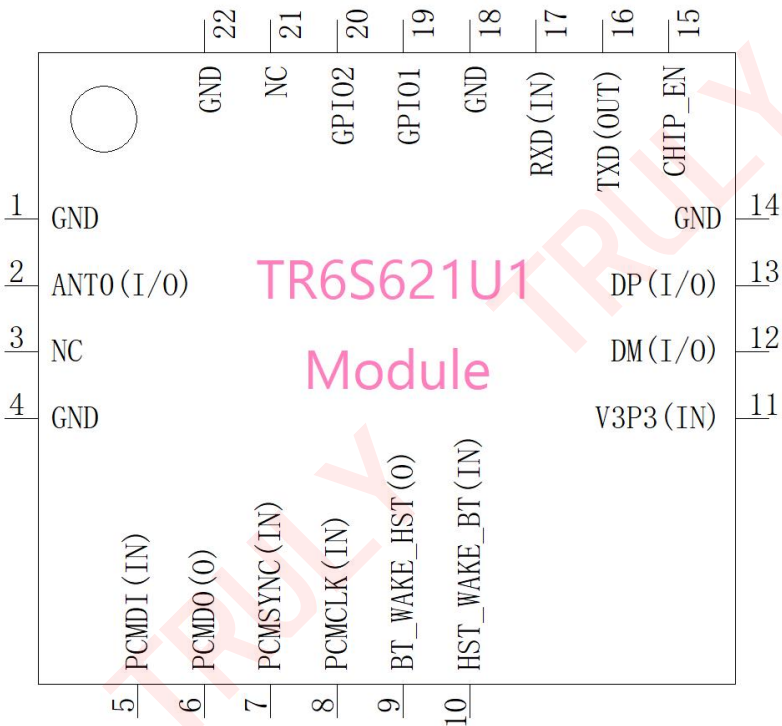


Figure 2. Pin Diagram of TR6S621U1

2.2 Pin Functions

Pin	Name	Description
1	GND	Ground
2	ANT	WLAN and BT RF input/output port
3	NC	No connect, keep floating
4	GND	Ground
5	PCM_IN	PCM data input
6	PCM_OUT	PCM data output
7	PCM_SYNC	PCM sync signal
8	PCM_CLK	PCM clock
9	BT_WAKE_HOST	BT wake up Host
10	HOST_WAKE_BT	Host wake up BT
11	VBAT	3.3V power supply
12	DM	USB Data Minus
13	DP	USB Data Positive
15	CHIP_EN	Chip Enable pin(high enable/ low disable)
16	TXD	High-Speed UART1 TX
17	RXD	High-Speed UART1 RX
18	GND	Ground
19	GPIO1	GPIO1
20	GPIO2	GPIO2
21	NC	No connect, keep floating
22	GND	Ground

3. Specifications

3.1 WIFI RF Specifications

Category	Descriptions
Dimension	L*W*H :13.0mm (±0.2mm)*12.2mm (±0.2mm)*2.0mm (±0.1mm)
Standard	IEEE 802.11a/b/g/n/ac/ax+BT 5.4
Frequency Band	2.4GHZ Band: 2412~2500MHZ
	5GHZ Band: 5150~5250MHZ@Band1
	5250~5350MHZ@Band2
	5470~5725MHZ@Band3
	5725~5850MHZ@Band4
Bandwidth	20/40/80MHz
Data Security	WEP,WPA/WPA2/WPA3

Data Rate	802.11b [11,5.5,2 and 1Mbps] 802.11g [54,48,36,24,18,12,9&6Mbps] 802.11n HT20:up to 72.2Mbps 802.11n HT40:up to 150Mbps 802.11ac VHT40:up to 200Mbps 802.11ax HE20:up to 143.4Mbps 802.11ax HE40:up to 286.8Mbps 802.11ax HE80:up to 600.5Mbps
Ambient Temperature	-30℃~70℃
Storage Temperature	-40℃~85℃
Antenna	External RF antenna
Operating System	Linux /Android
Operating Voltage	VBAT:3.3V;VDDIO:1.8V or 3.3V

3.2 Bluetooth RF Specifications

Parameter	Conditions	Minimum	Typical	Maximum	Unit
Frequency range		2402		2480	MHz
RX sensitivity	1 Mbps	-	-91	-	dBm
	2 Mbps	-	-89	-	dBm
	3 Mbps	-	-87	-	dBm
Initial carrier frequency offset		-24	5	24	KHz
Output power	BR	6	8	10	dBm
	EDR	4	6	8	dBm
	LE	4	6	8	dBm

4. Application and Implementation

4.1 Application Diagram

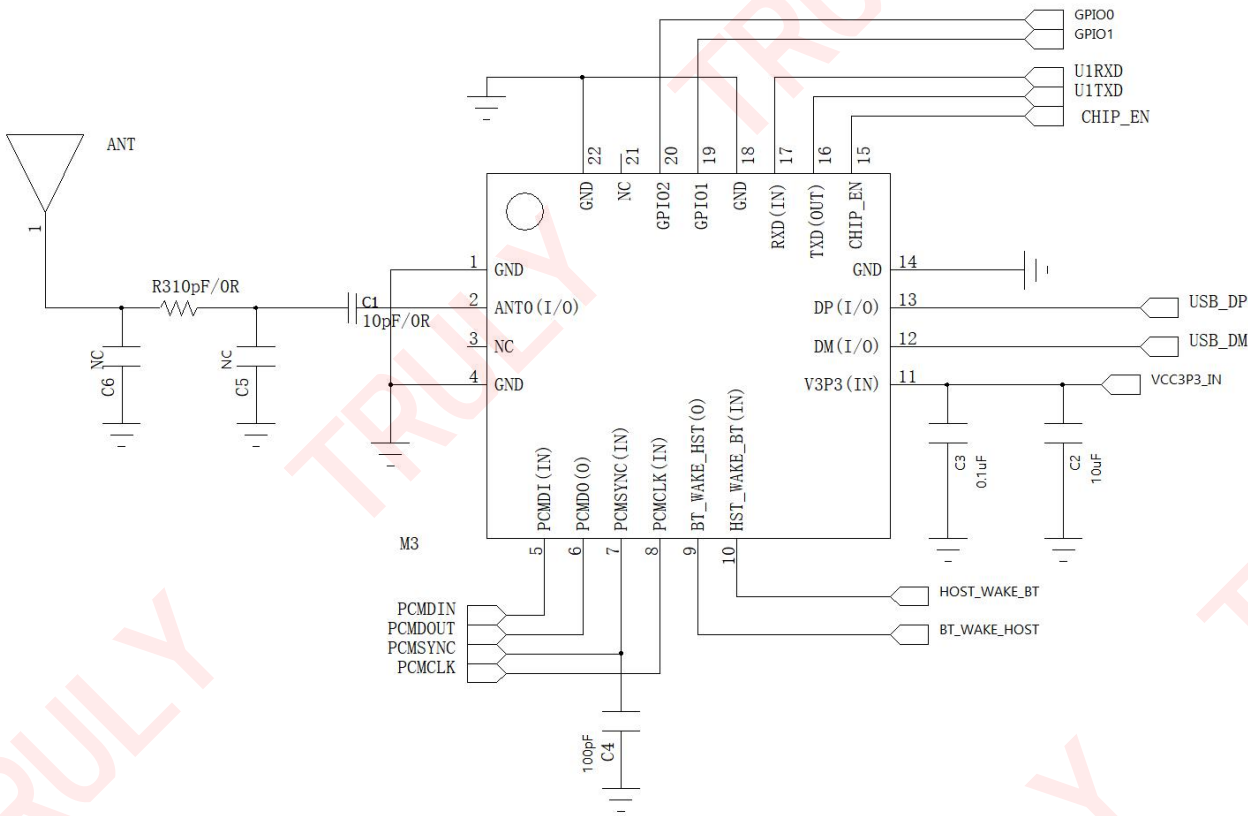
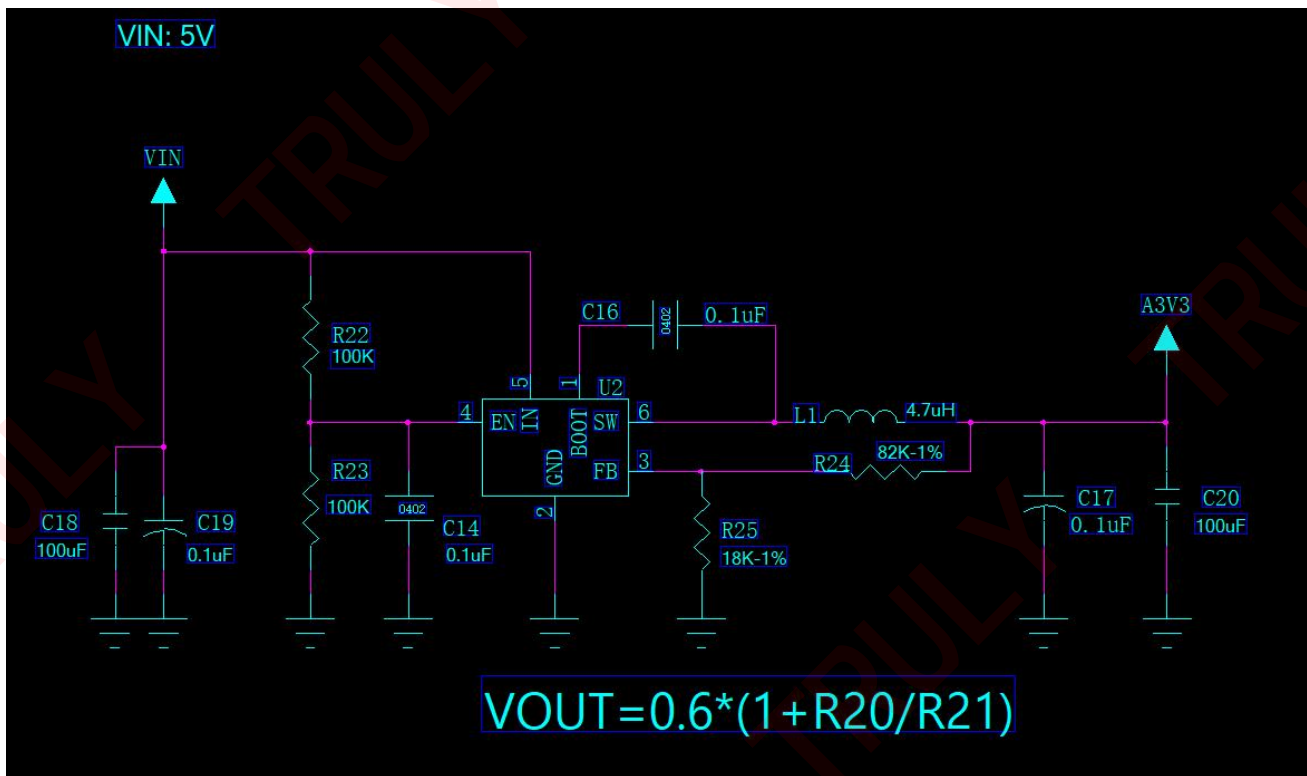


Figure 3. Application Schematic Diagram of TR6S621U1

4.2 Reference design

4.2.1 Power supply requirement

The module power supply voltage is DC+3.3V, and the maximum module current is 800mA. The power supply design needs to consider the output current and power interference. To avoid the +3.3V power supply from interfering with other circuits on the motherboard, it is recommended to supply to the module using the regulator circuit alone. the recommended DC-DC circuit structure shown in the figure below. A 4.7uF~10uF capacitor is connected in parallel at 3_3VD output to filter out the interference. A bead is connected in series at 3_3VD output. The bead and capacitor must be placed as close to the module as possible. If you need to share +3.3V with other circuits, consider whether the current of the shared power supply is sufficient.



4.2.2 USB Interface

Place the USB PHY as close as possible to the USB 2.0 connector. The signal swing during high-speed operation on the DP/DM lines is relatively small ($400\text{ mV} \pm 10\%$), so any differential noise picked up on the twisted pair can affect the received signal. When the DP/DM traces do not have any shielding, the traces tend to behave like an antenna and picks up noise generated by the surrounding components in the environment. To minimize the effect of this behavior:

-

DP/DM traces should always be matched lengths and must be no more than 4 inches in length; otherwise, the eye opening may be degraded

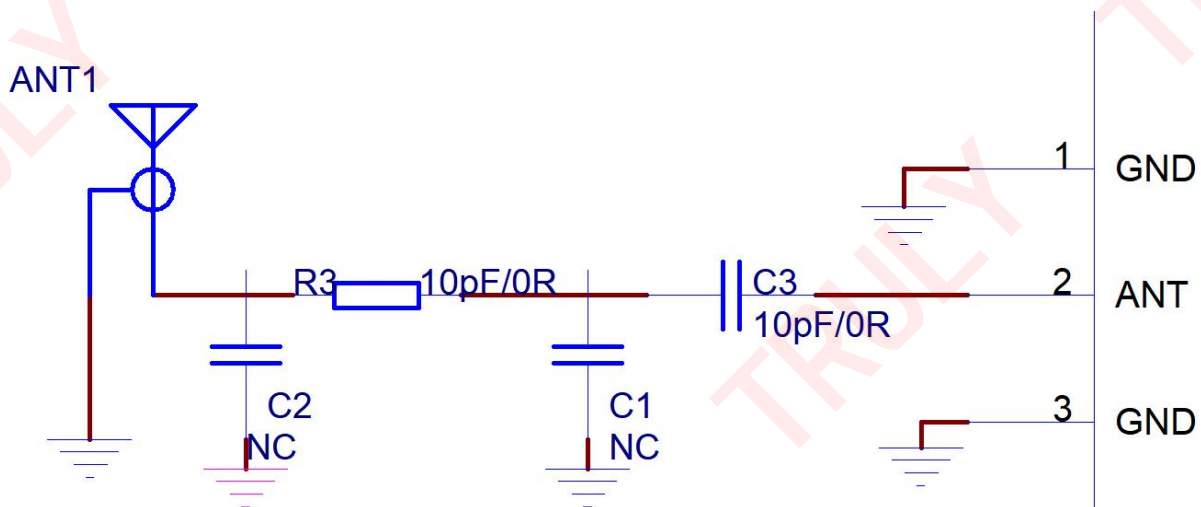
- Route DP/DM traces close together for noise rejection on differential signals, parallel to each other and within two mils in length of each other (start the measurement at the chip package boundary, not to the balls or pins).

- A high-speed USB connection is made through a shielded, twisted pair cable with a differential characteristic impedance of $90\ \Omega \pm 15\%$. In layout, the impedance of DP and DM should each be $45\ \Omega \pm 10\%$.

- DP/DM traces should not have any extra components to maintain signal integrity. For example, traces cannot be routed to two USB connectors.

4.2.3 RF circuit

Due to the SMD package, the RF port impedance must be offset after the module is soldered to the motherboard. In order to achieve the best performance,, it is recommended to add a PI-type matching network to the motherboard, as shown below (C2, R3,C1). The value of the PI type matching network needs to be debugged according to the actual motherboard to match RF port impedance to 50 Ohm.



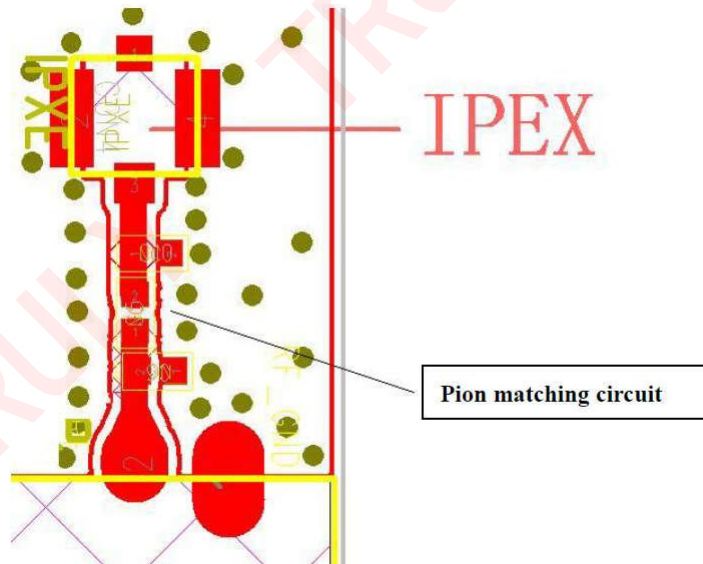
The antenna ANT1 in the figure above must be 50 Ohm. If the antenna is not matched, it is recommended to add a set of PI type matching network at the front of the antenna to match the antenna. Generally, the antenna manufacturers will give Suggestions on matching parameters. The RF line layout should be matched according to 50ohm. The line impedance is related to the plate, plate thickness, line width and copper spacing. Professional software can be used to alculate the line width. Note: for multilayer plates, the plate thickness should calculate thedistance from RF routing layer to GND of the next layer. There are RF lines Layout principles :

a. RF line layout needs to match 50 ohms. The line width can be calculated by professional

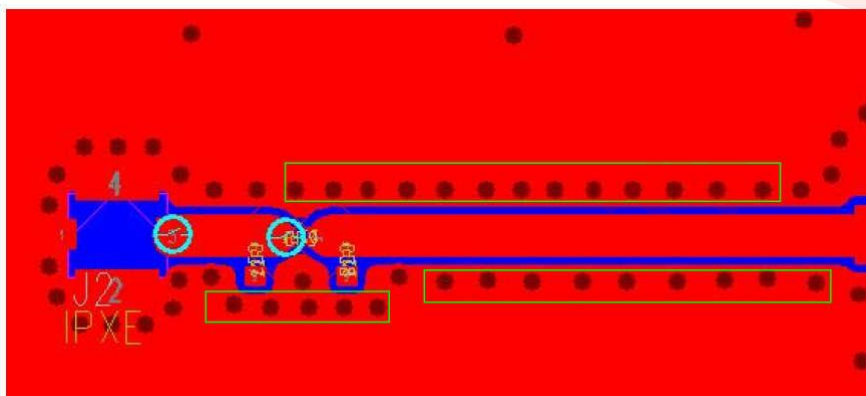
software. (Note: If it is a multi-layer board, The board thickness should calculate the distance from the RF trace layer to the next ground layer.)

b. The RF line must be surrounded by ground copper and ground holes.

c. The PI-type matching circuit for adjusting the impedance of the module is placed close to the module. The PI type matching circuit for matching the antenna is placed close to the antenna.

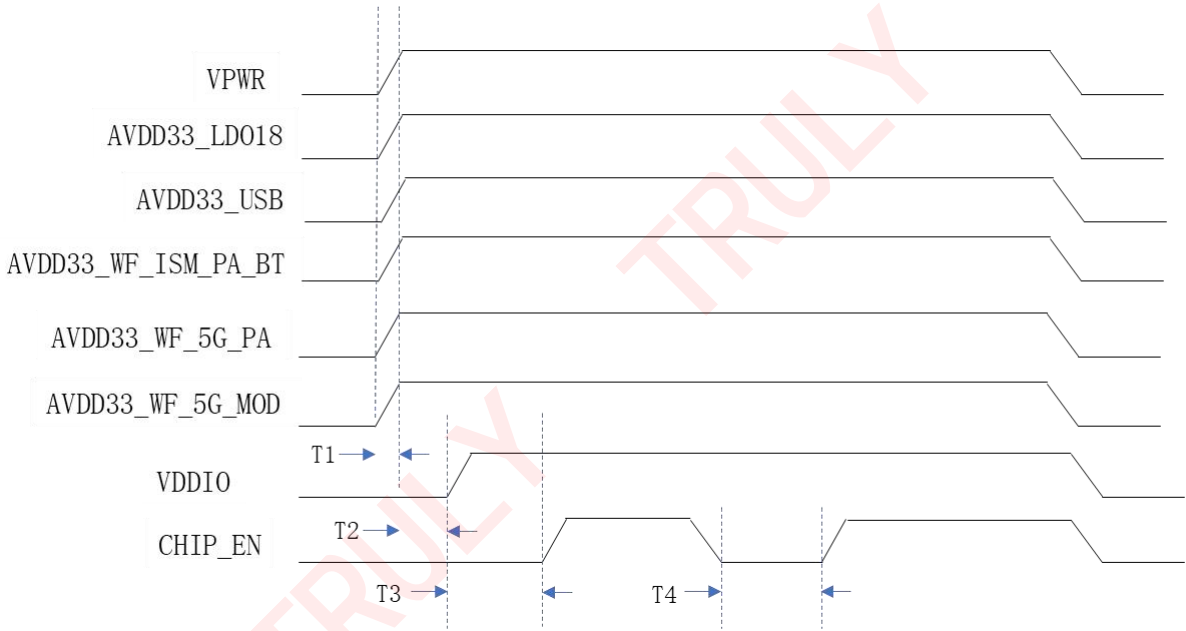


The PI type matching circuit Layout



The RF line Layout

4.3 Power on/off Timing

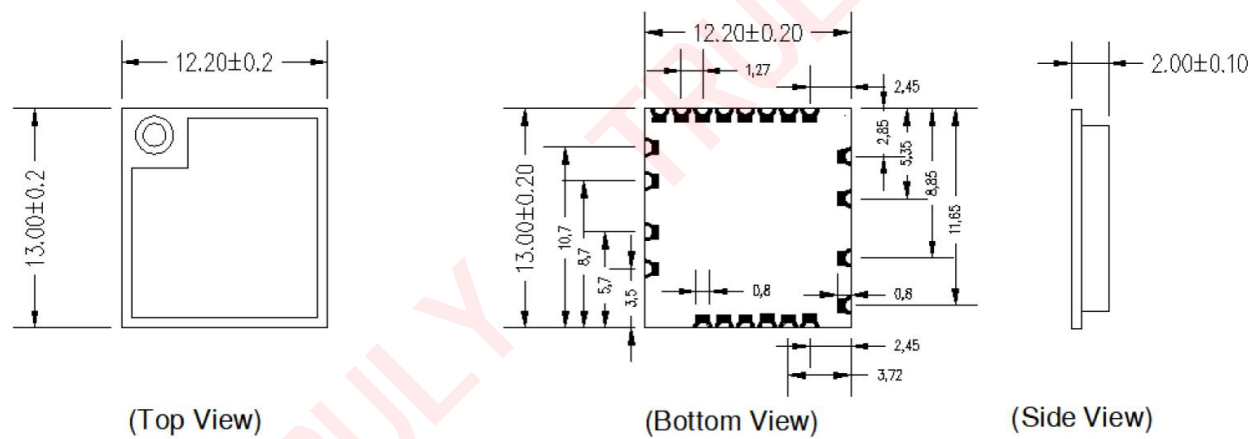


The figure below shows the chip power on sequence.

	Description	Min.	Typ.	Max.	Unit
T1	3.3V Ramp up time	200	500	-	μs
T2	VDDIO should be powered on after 3.3V is powered on	0	-	-	μs
T3	CHIP_EN should be powered on after VDDIO/VDDIO is powered on	0	-	-	μs
T4	CHIP_EN reset time	50	-	-	ms

5. Mechanical and Package

5.1 Mechanical Size



Note:L*W*H: 13.0mm (±0.2mm)*12.2mm (±0.2mm)*2.2mm (±0.1mm)

Figure 4. Mechanical Size of TR6S621U1

5.2 Recommended Land Pattern

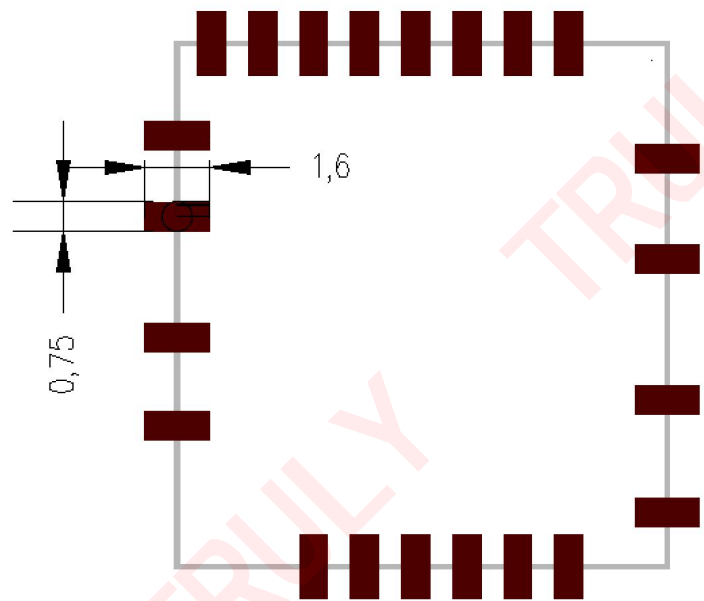


Figure 5. On Board Pad Suggest: (Unit: mm)

5.3 Package Information

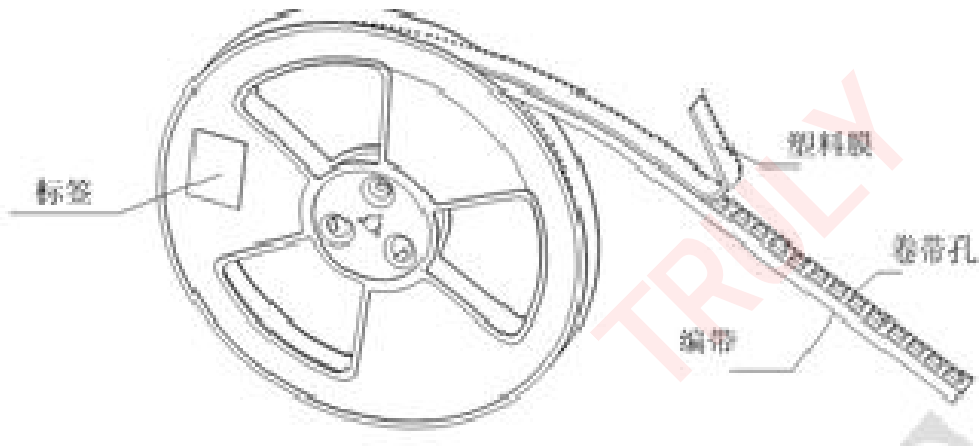
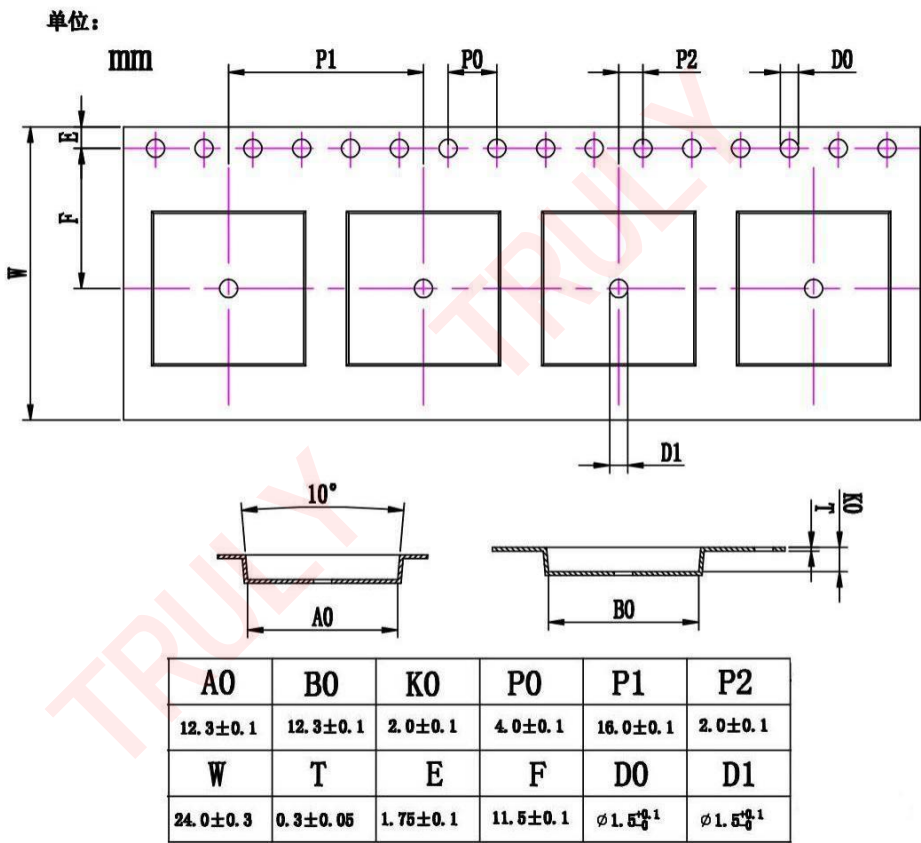


Figure 6. Brief Packaging Process of TR6S621U1 Modules

6. Thermal Reflow

The number of reflux shall not exceed 2 times, and the tin feeding height of the half hole of the module shall be no less than 1/4.

Stage	Note	Pb-free assembly
Average ramp-up rate	T_L to T_p	3 °C/ second max.
Preheat	Temperature min (T_{smin})	150°C
	Temperature max (T_{smax})	200°C
	Time (t_{smin} to t_{smax})	60 – 120 seconds
Time maintained above	Temperature(T_L)	217°C
	Time (t_L)	60 – 150 seconds
Peak package body temperature (T_p)	T_p must not exceed the specified classification temp($T_c=245$ °C).	
Time(t_p) within 5°C of the specified classification temperature (T_c)	30 seconds	
Ramp-down rate (T_p to T_L)	6 °C / seconds max.	
Time 25°C to peak temperature	8 minutes max.	

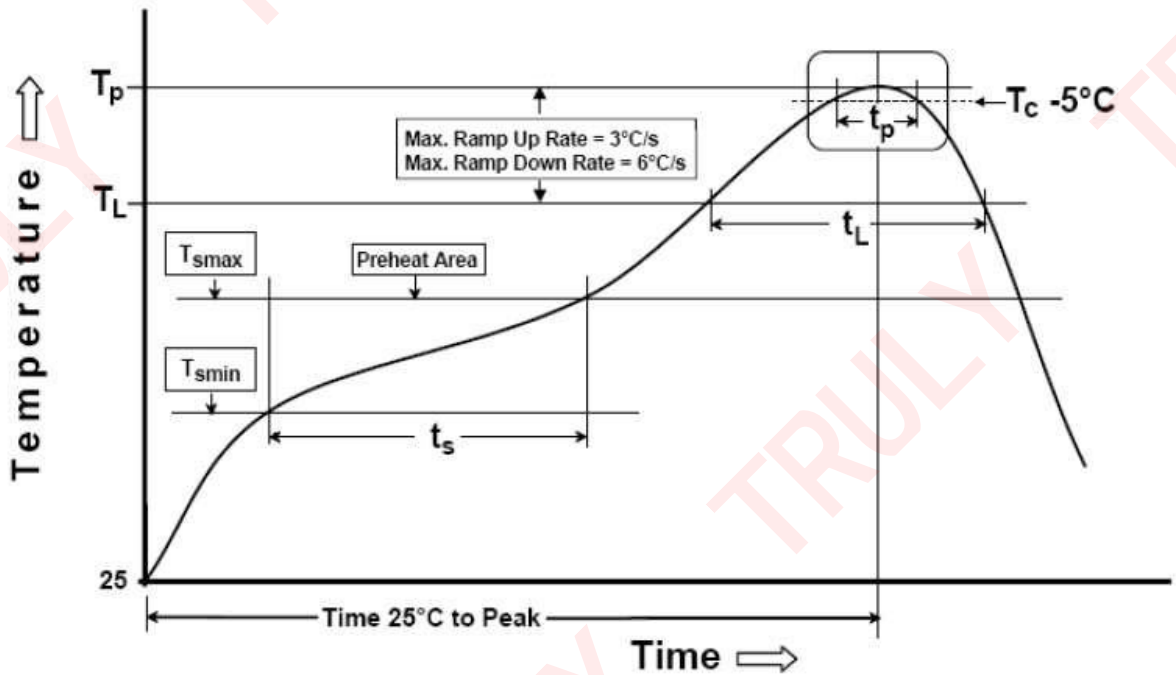


Figure 7. Recommended Reflow for Lead Free Solder

Note: The module is recommended not to go through reflow oven twice.

7. Ordering Information

Part NO.	Working Voltage	ANT	Shielding Cover	Remark
TR6S621U1	3.3V	1 antennas	Included	USB

8. Revision History

Version	Change Content	Reviser	Date
V0.1	Draft Version	Grant	2024.06.08
V0.2	Change Application Diagram	Grant	2025.03.08

FCC Statement

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.

Any Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

The modular can be installed or integrated in mobile or fix devices only. This modular cannot be installed in any portable device.

Any company of the host which install this modular with Single modular approval should perform the test of radiated emission and spurious emission according to FCC part 15C : 15.247 and 15.209 requirement, Only if the test result comply with FCC part 15C : 15.247 and 15.209 requirement, then the host can be sold legally.

FCC Radiation Exposure Statement

This modular complies with FCC RF 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. This modular must be installed and operated with a minimum distance of 20 cm between the radiator and user body.

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.

OEM INTEGRATION INSTRUCTIONS:

This device is intended only for OEM integrators under the following conditions:

The module must be installed in the host equipment such that 20 cm is maintained between the antenna and users, and the transmitter module may not be co-located with any other transmitter or antenna. The module shall be only used with the internal on-board antenna that has been originally tested and certified with this module. External antennas are not supported. As long as these 3 conditions above are met, further transmitter test will not be required.

However, the OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this module installed (for example, digital device emissions, PC peripheral requirements, etc.). The end-product may need Verification testing, Declaration of Conformity testing, a Permissive Class II Change or new Certification. Please involve a FCC certification specialist in order to determine what will be exactly applicable for the end-product.

Validity of using the module certification:

In the event that these conditions cannot be met (for example certain laptop configurations or co-location with another transmitter), then the FCC/IC authorization for this module in combination with the host equipment is no longer considered valid and the FCC ID/IC of the module cannot be used on the final product. In these circumstances, the OEM integrator will be responsible for re-evaluating the end product (including the transmitter) and obtaining a separate FCC authorization. In such cases, please involve a FCC/IC certification specialist in order to determine if a Permissive Class II Change or new Certification is required.

Upgrade Firmware:

The software provided for firmware upgrade will not be capable to affect any RF parameters as certified for the FCC/IC for this module, in order to prevent compliance issues.

End product labeling:

This transmitter module is authorized only for use in device where the antenna may be installed such that 20 cm may be maintained between the antenna and users. The final end product must be labeled in a visible area with the following: "Contains FCC ID: 2BOHY-621U1".

Information that must be placed in the end user manual:

The OEM integrator has to be aware not to provide information to the end user regarding how to install or remove this RF module in the user's manual of the end product which integrates this module. The end user manual shall include all required regulatory information/warning as show in this manual.

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/ICES-003) 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.

Explanation: This module meets the requirements of FCC part 15C(15.247), FCC part 15E(15.407).

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 EUT antenna is dipole antenna.

2.4 Limited module procedures

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

A limited module 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 limited module 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 not a limited 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.

Explanation: Yes, The module with trace antenna designs, and This manual has been shown the layout of trace design, antenna, connectors, and isolation requirements.

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/IC (new application).

Explanation: This module complies with FCC RF radiation exposure limits set forth for an uncontrolled environment, This equipment should be installed and operated with a minimum distance of 20 centimeters between the radiator and your body." This module is designed to comply with the FCC statement, " Contains Transmitter Module FCC ID: 2BOHY-621U1 Or Contains FCC ID: 2BOHY-621U1".

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 EUT has a Dipole antenna, and the antenna utilizes an RA-SMA connector, making it difficult to replace.

Brand	Model Name	Antenna Type	Connector	Gain (dBi)	Note
TRULY	A25458101	Dipole	RA-SMA	2.4G:2.5	2400-2500MHz
				5G:2.50	5150-5900MHz

2.8 Label and compliance information

Grantees are responsible for the continued compliance of their modules to the FCC/IC 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 Transmitter Module FCC ID: 2BOHY-621U1 Or Contains FCC ID: 2BOHY-621U1”.

2.9 Information on test modes and additional testing requirements⁵

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/IC requirements.

Explanation: Top band 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/ICES-003 disclaimer

The grantee should include a statement that the modular transmitter is only FCC authorized for the specific rule parts (i.e., FCC/IC transmitter rules) listed on the grant, and that the host product manufacturer is responsible for compliance to any other FCC/IC 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/ICES-003 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/ICES-003 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.