Respiratory heart rate detection radar module HLK-LD6002

User Manual

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CONTENT

1.Product Introduction

HLK-LD6002 is a radar induction module developed based on ADT6101P chip, with a single-chip integrated 57-64GHz RF transceiver system, 2T2R PCB microstrip antenna, 1MB flash, radar signal processing unit, ARM ® Cortex ®- M3 kernel. This module is based on the FMCW radar mechanism, detecting radar echoes reflected from the surface of the human body. Combined with radar signal processing algorithms, it achieves real-time measurement of individual respiratory heart rate frequency.

2.Product characteristics

- Radar detection based on FMCW frequency modulated continuous wave signal
- Realize non-contact perception of human respiration and heart rate
- The maximum detection distance of human respiratory heart rate is 1.5m
- Universal UART interface, providing communication protocol
- Reserve multiple sets of IO ports and communication interfaces to support customer secondary development, suitable for multiple scenario applications
- Compact in size, only 25 * 31.5mm, supports two methods of pin insertion and patch connection
- Not affected by temperature, humidity, noise, airflow, dust, light and other environmental factors

3. Application Area

- Smart home applications
  Implementing home empowerment based on respiratory heart rate measurement
- Health management
  Real time monitoring of respiratory heart rate data
- Smart Health Care
  Elderly respiratory and heart rate monitoring, reporting any abnormalities immediately

4. Electrical characteristics and parameters

4.1 Function parameters

Parameters	Min	Typical	Max	Unit
Respiratory and heartbeat detection distance (chest)	0.4		1.5	m
Respiratory measurement accuracy		90		%
Respiratory measurement frequency range	9		48	bpm
Heartbeat measurement accuracy		90		%
Heartbeat measurement frequency range	60		150	bpm
Refresh time		50		ms
Setting test time		1		Min
Max testing No.		1		per

4.2 Electrical characteristics

Operation parameters	Min	Typical	Max	Unit

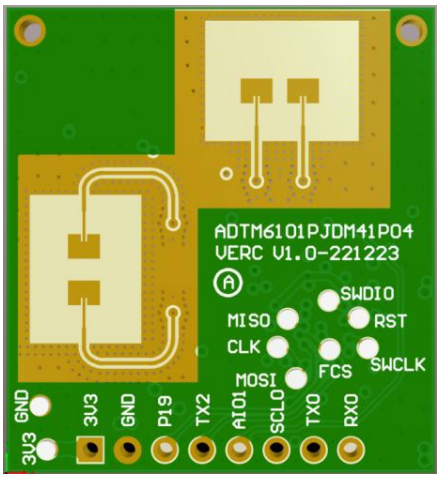
Operation voltage（VCC）	3.1	3.3	3.5	V
Operation current（ICC）			600	mA
Operation temperature （TOP）	-20		85	℃
Storage temperature（TST）	-40		85	℃

4.3 RF characteristics

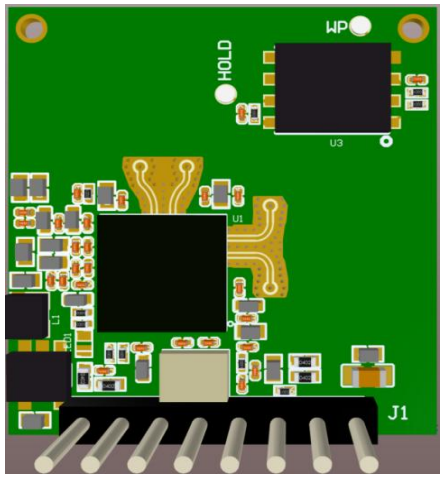
Operation parameters	Min	Typical	Max	Unit
Operating Frequency	58		62	GHZ
Transmission power（Pout）		12		dBm
Antenna gain		4		dBi
Horizontal beam（-3dB）	-60		+60	°
vertical beam（-3dB）	-60		+60	°

5. Hardware Description

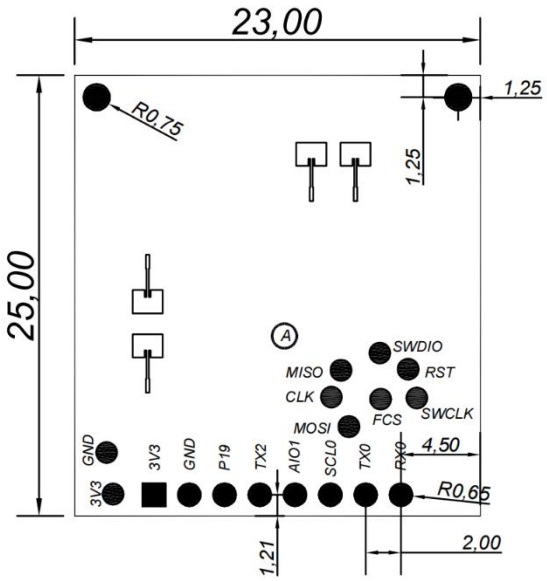
5.1External dimensions

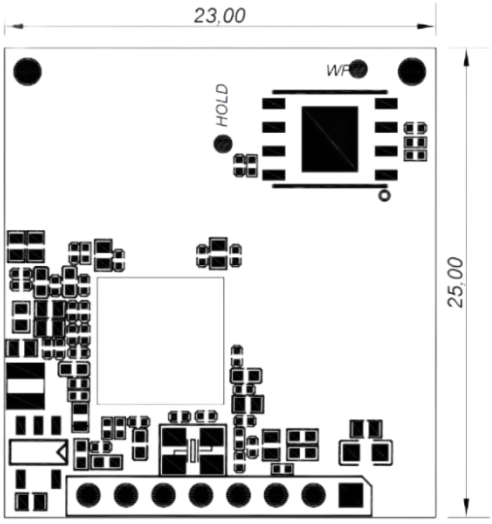


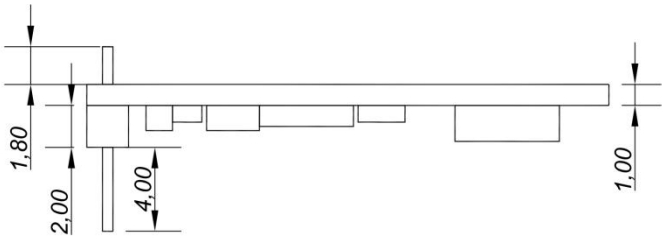
Front view of the module



Back view of the module



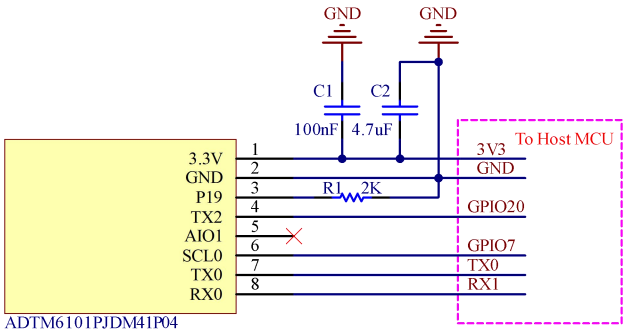




5.2 Pin Definition

Pin No.	Pin Name	Description	Note
1	3V3	POWER_INPUT 3.3V	
2	GND	GND	
3	P19	GPIO19	Boot1
4	TX2	GPIO20	
5	AIO1	Analog IO	
6	SCL0	GPIO07	
7	TX0	Connected to external serial port TX	
8	RX0	Connected to external serial port RX	

5.3 Module peripheral reference design



5.4 Boot Configuration

	BOOT1	BOOT0	Note
Configure level	0	1	Flash startup within the module
Pin number	Pin8	Pin12	

* Both BOOT1 and BOOT0 modules are internally pull-up. Before starting the module, BOOT1 must be connected to a low level

6.Usage and Configuration

6.1 Typical application circuit

The typical application circuit LD6002 module can directly use UART0 to output detection results according to the specified protocol. The serial port data includes total phase, respiratory phase, heartbeat phase results, respiratory rate, and heartbeat rate results. Users can flexibly use it according to specific application scenarios.

The module is powered by 3.3V, and the input power supply capacity is required to be greater than 1A.

The output voltage of the module IO port is 3.3V. The default baud rate for the serial port is 1382400, with no parity check.

6.2 GUI visualization tool application

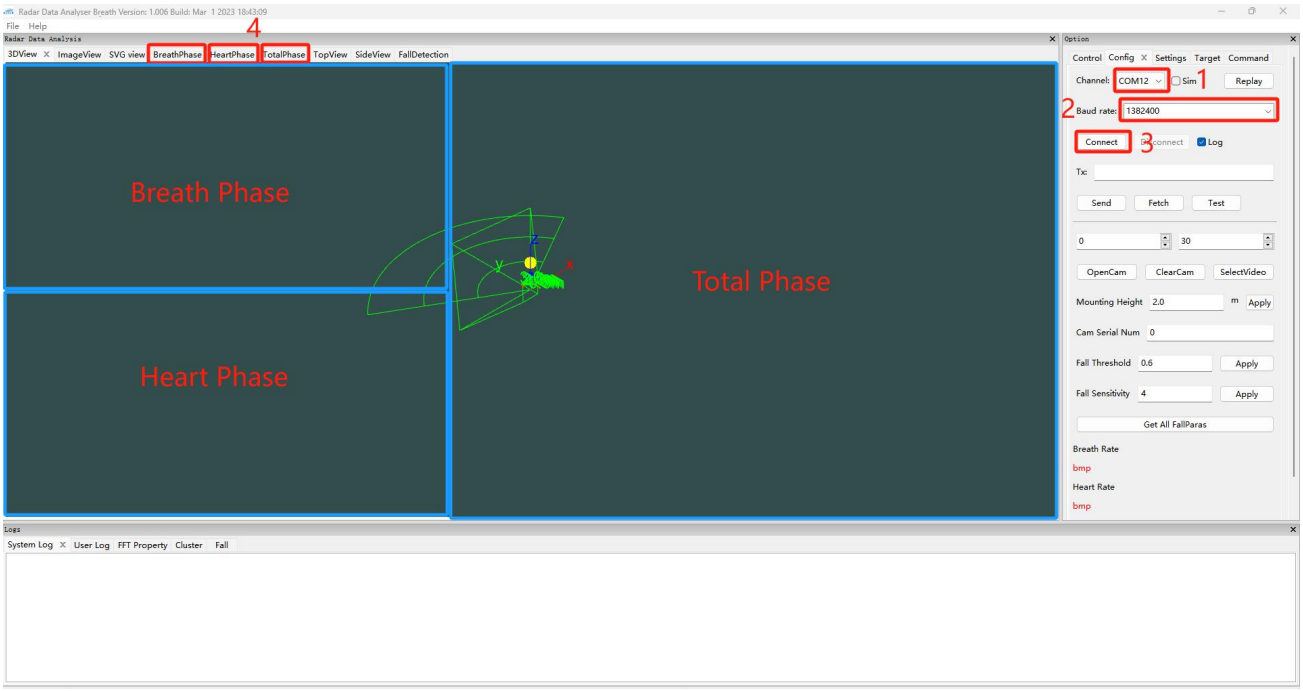
1) Equipment connection

2) Select the serial port to connect to in the Configuration interface of the Option bar in the upper right corner

3) Set the baud rate to 1382400

4) Click the 【 Connect 】 button to start measuring

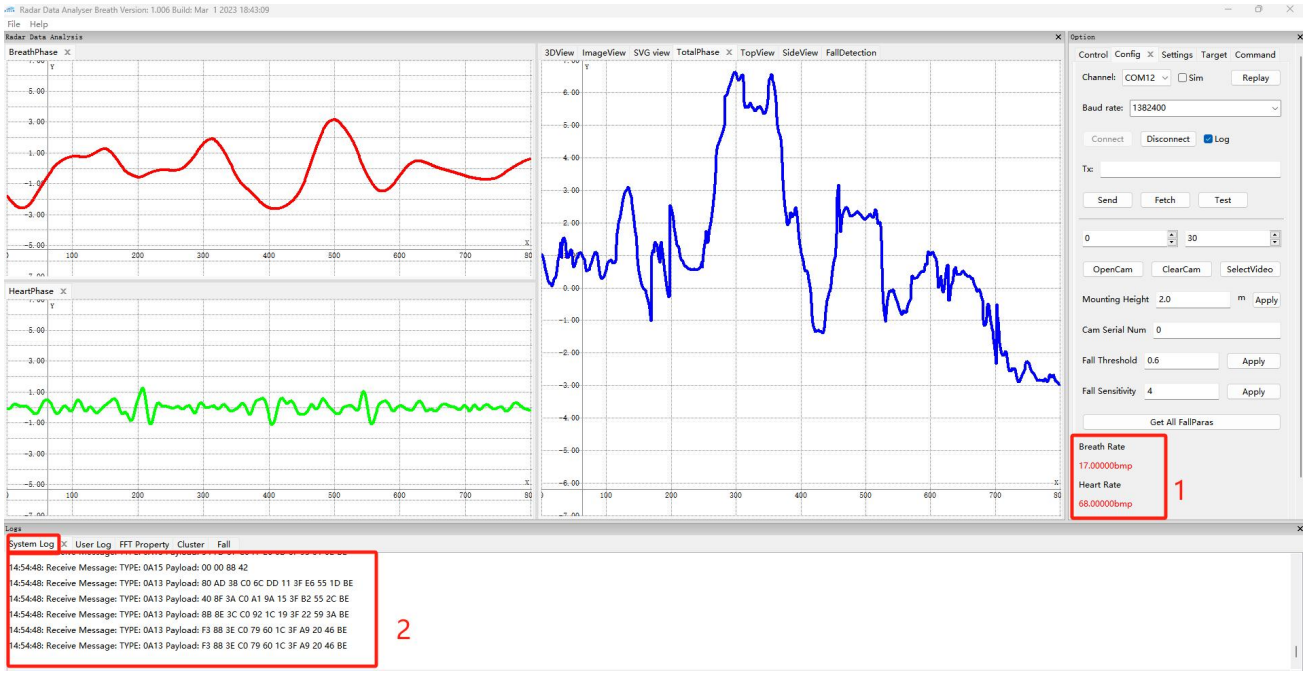
5) For the convenience of viewing data, the Breath Phase, Heart Phase, and Total Phase windows can be dragged and arranged in the following format



1. Data viewing

1) The lower right corner displays information on breathing and heart rate.

2) The System Log window in the bottom left corner displays message information, which includes total phase data, heartbeat phase, respiratory phase, respiratory rate, and heartbeat rate information.

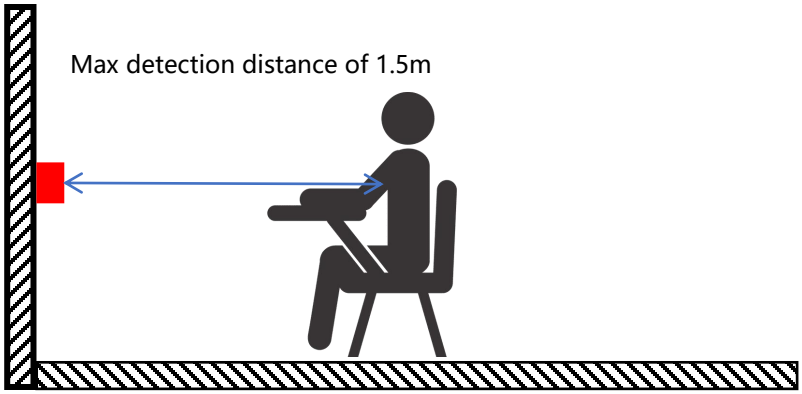


6.3 OTA Upgrade

Please refer to the document "OTA Upgrade Tool User Manual V1.0"

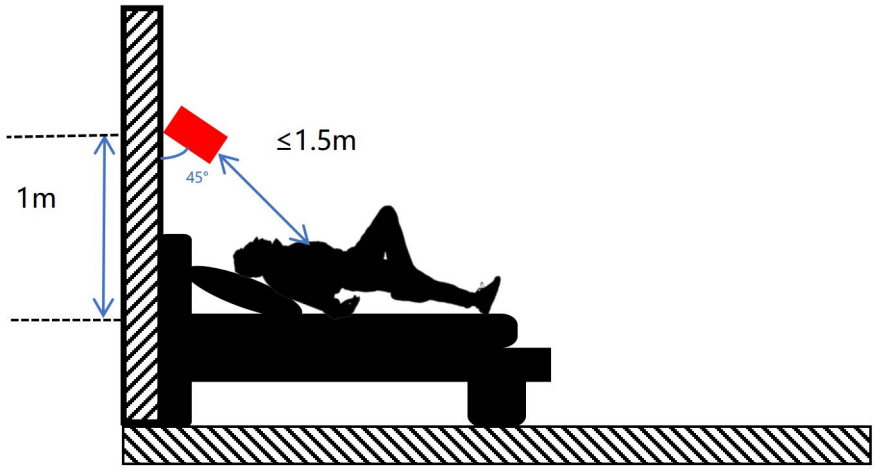
6.4 Installation method and sensing range

1. Slide mounted, it is recommended that the radar installation height be consistent with the height of the tested person's chest cavity, and the module position should be ≤ 1.5m from the chest cavity position



Slide installation diagram

2. Oblique installation: For the needs of sleep breathing and heart rate detection, a tilted installation method can be used. The radar is required to be installed at a height of 1m directly above the head of the bed, with a downward tilt of 45 ° towards the middle of the bed. The distance between the radar and the chest cavity is controlled within a range of 1.5m, and the normal direction of the radar is aligned with the main detection position to ensure that the radar can detect breathing and heart rate data.



Oblique installation diagram

7. Notes

1. The detection distance of the radar module is closely related to the target RCS and environmental factors, and the effective detection distance may vary with changes in the environment and target. Therefore, it is normal for the effective detection distance to fluctuate within a certain range.

2. The radar module has extremely high power requirements, requiring an input voltage of 3.2-3.4V, power ripple ≤ 50mV, and current ≥ 1A. If using a DCDC power supply, the switching frequency is required to be no less than 2MHz.

3. Due to the fact that respiratory heart rate is a weak reflex signal, radar signal processing requires a period of time for data accumulation. During the accumulation process, there are many factors that affect the radar processing results. Therefore, occasional detection failures are a normal phenomenon.

4. Currently, respiratory heart rate measurement only supports single individuals. Please ensure that there is only one person in the detection area.

5. It is required to measure in a resting state, and if a large movement is detected, the measurement will stop.

8.Design of radar antenna cover

The radar antenna cover is used to protect the radar antenna from external environmental influences such as rain, sunlight, and wind. But it has the following effects on radar antennas: the dielectric loss and reflection loss caused by the antenna cover will reduce the effective power of the radar; Causing distortion of antenna beams, resulting in changes in the radar's operating area; The reflection of electromagnetic waves by the shell reduces the isolation of the radar transmitting and receiving antenna, and may lead to receiver saturation; The phase of electromagnetic waves passing through radar radomes changes, affecting the measurement of angles. Therefore, it is necessary to design radar radomes to reduce the impact of the casing and improve radar performance.

Design requirements::

1. When selecting materials for radar radomes, while ensuring durability and low cost, materials with smaller dielectric constant and loss tangent should be selected to reduce the impact of radar radomes on radar performance.

The dielectric constant and dissipation factor of commonly used materials are shown in the table below:

Materials	Dielectric constant（ε_r）	Dissipation factor（tan δ）
polycarbonate	2.9	0.012
ABS	2.0-3.5	0.0050-0.019
PEEK	3.2	0.0048
PTFE（Teflon®）	2	<0.0002
Plexiglass®	2.6	0.009
Glass	5.75	0.003
Ceramics	9.8	0.0005
PE	2.3	0.0003
PBT	2.9-4.0	0.002

2. It is required that the surface of the radar antenna cover is smooth and the thickness is uniform and consistent

3. Design requirements for thickness of radar antenna cover

$$T = N \bullet \frac{c}{2f\sqrt{\varepsilon_r}}，N=1，2，3\ldots$$

T：thickness of radar antenna cover

c：speed light，3×10^8 m/s；

f：Center frequency

ε_r：Material dielectric constant，DK

4. Design requirements for the height of radar antenna from the inner surface of the shell

$$d = N \bullet \frac{c}{2f}\quad N=1，2，3\ldots$$

c：speed light，3×10^8 m/s；

f：Center frequency

f=60GHz

c/2f=2.5mm

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.3

Explanation: This module meets the requirements of FCC part 15C(15.255)

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 has a PCB Antenna, and the antenna use a permanently attached antenna which is not replaceable.

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 (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, FCC ID is: 2AD56HLK-LD6002.

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 p in 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 PCB Antenna, and the antenna use a permanently attached antenna which is unique.

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: 2AD56HLK-LD6002, Contains IC: 30529-HLKLD6002"

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 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 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 circuity), 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 circuity, so the module does not require an evaluation by FCC Part 15 Subpart B. The host shoule be evaluated by the FCC Subpart B.

2.11 Manual Information to The End User

The OEM integrator has to be aware not to provide information to the end user regardinghow to inst all or remove this RF module in the user's manual of the end product whichintegrates this module.

The host integrator must follow the integration instructions provided in this document andensure that the c omposite system end product complies with the requirements by atechnical assessment or evaluation to th e rules and to KDB Publication 996369The host integrator installing this module into their product must ens ure that the finalcomposite product complies with the requirements by a technical assessment or evaluatio nto the rules, including the transmitter operation and should refer to quidance in KDBPublication 996369.

OEM/Host Manufacturer Responsibilities

OEM/Host manufacturers are ultimately responsible for the compliance of the Host andModule. The final product must be reassessed against all the essential requirements of theFCC rule such as FCC Part 15 Subpart B before it can be placed on the US market. Thisincludes reassessing the transmitter module for compliance w ith the Radio and RF Exposureessential requirements of the FCC rules

2.12 How to Make Changes -Important Note

In the event that these conditions cannot be met (for example certain laptop configurationsor co-location with another transmitter), then the FCC authorization is no longer considerecvalid and the FCC iD cannot be used on the final product. In these circumstances, the OEMintegrator will be responsible for re-evaluating the end prod uct (including the transmitterand obtaining a separate FCC authorization.

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