DBM050 Datasheet

Specifications

Version v0.1

DePIN Labs

Overview

✧ Descriptions

The development of IoT and smart hardware has spanned several decades, leading to an increasingly urgent need for data security, identity authentication, and hardware encryption. In recent years, the rise of Web3.0 has provided new solutions for data security-based rights confirmation and transactions in traditional smart hardware and IoT application scenarios. Leveraging decentralized methods, DePIN effectively addresses the security and privacy issues in AIOT networks, clarifying data ownership and data value ownership.

DePIN Labs, based on BLE5.3 and BLE Mesh communication technologies, and integrating asymmetric hardware encryption algorithms widely used in blockchain, has developed and designed a foundational hardware encryption module that can be widely applied to DePIN projects. This module supports the Zephyr open-source IoT operating system, making it particularly suitable for integration and development in open-source ecosystem projects. Currently, this module has been applied in numerous Web3.0 DePIN projects such as Helium, DIMO, Metablox, Caldance, and React.

Ordering infor：

Part Number	Descriptions	Output Power
DBM050	BLE5.3, BLE Mesh, ECC	8dBm

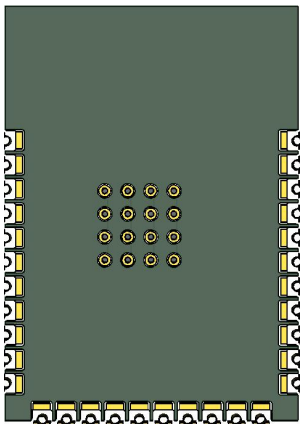
✧ Features

- MCU and on-chip storage
  - ARM® Cortex-M4 processor，64MHz
  - Up to 512kB/1MB flash & 64 kB RAM
- Bluetooth
  - BLE5.3 data rate：1Mbps，2Mbps，500Kbps，125Kbps
  - Tx power：-45dBm ~ 8dBm
  - Rx sensitivity：
    - -100dBm@125Kbps
    - -99dBm@500Kbps
    - -96dBm@1Mbps
    - -93dBm@2Mbps
  - BLE Mesh
  - Support BLE HCI device driver
- Supports SOC as the main control device for secondary development, adaptable to a wide range of IoT application scenarios
- Rich peripherals, including GPIOx/USB/UART/SPI/I2C/PWM/ADC, can meet most IoT application needs
- Supports various symmetric and asymmetric hardware encryption algorithms such as RSA & ECC
  - CC EAL6+ (HW+JCOP), FIPS 140-2 L3
  - Support SHA-1, SHA-224, SHA-256, SHA-384, SHA-512 and so on
  - Support AES128, 192, 256
  - RSA cipher for de-/encryption (up to 4096 bit)
  - ECDSA, ECDH, ECDHE, EdDSA
    - ECC NIST (192 to 521 bit)
    - Brainpool (160 to 512 bit)
    - Twisted Edwards Ed25519 /Montgomery Curve25519
    - Koblitz (192 to 256 bit)
    - Montgomery (Curve448) [Goldilocks]
- 2uA sleep current
- PCB Antenna

- Ultra small size 15.24*21.59*2.5mm
- Operating conditions:
  - Operating voltage range: 1.8V to 3.6V
  - Operating temperature range: -40 to +85℃

✧ Applications

- IoT Devices
- IoT Gateway
- Wearable devices
- Smart home
- Tracking
- Wireless sensor
- Industrial control
- AMR
- Smart agriculture



目录

1 Hardware Blcok

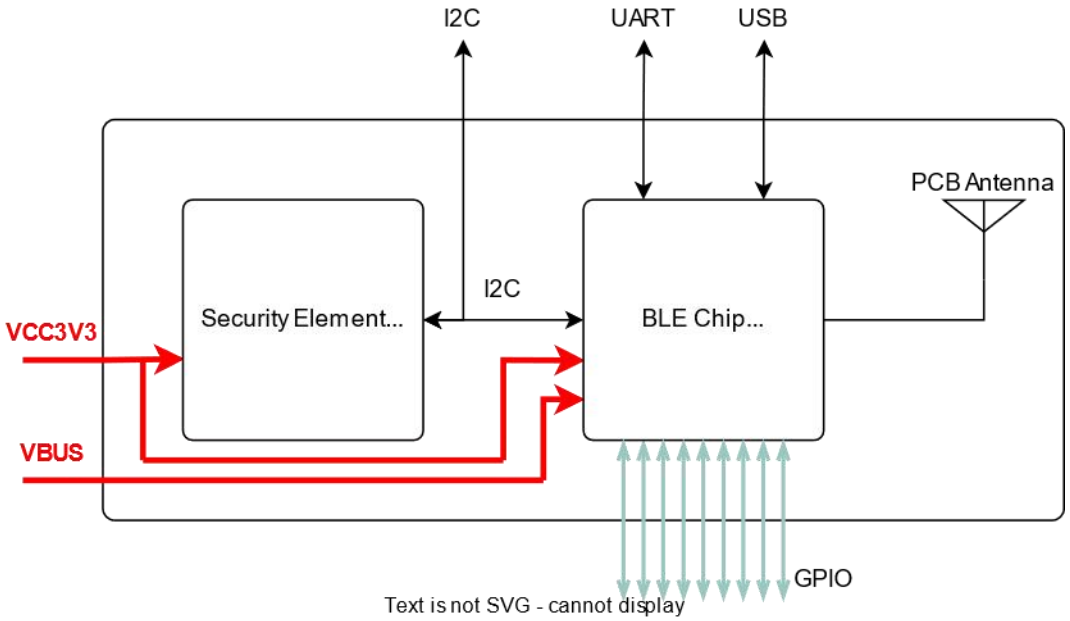


Figure 1 ***DBM050 hardware block***

2 Pin definitions

2.1 Pin layout

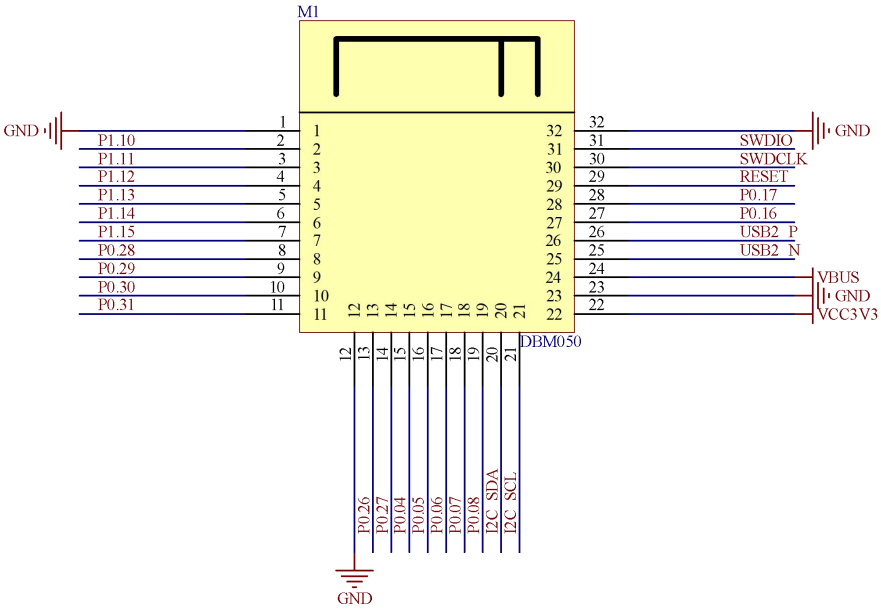


Figure 2 Pin layout (Top view)

2.2 Pin definitions

The DBM050 module has a total of 32 pins. The detailed pin definitions are shown in the table below.

Table 1 Pin descriptions

No.	Name	Type	Function
1	GND	P	Ground
2	P1.10	I/O/T	MCU GPIO
3	P1.11	I/O/T	MCU GPIO
4	P1.12	I/O/T	MCU GPIO
5	P1.13	I/O/T	MCU GPIO
6	P1.14	I/O/T	MCU GPIO

7	P1.15	I/O/T	MCU GPIO
8	P0.28	I/O/T	MCU GPIO
9	P0.29	I/O/T	MCU GPIO
10	P0.30	I/O/T	MCU GPIO
11	P0.31	I/O/T	MCU GPIO
12	**GND**	**P**	**Ground**
13	P0.27	I/O/T	MCU GPIO
14	P0.27	I/O/T	MCU GPIO
15	P0.04	I/O/T	MCU GPIO
16	P0.05	I/O/T	UART_TX from MCU
17	P0.06	I/O/T	UART_RX from MCU
18	P0.07	I/O/T	UART_CTS from MCU
19	P0.08	I/O/T	UART_RTS from MCU
20	I2C_SDA	I/O/T	I2C_SDA for SE
21	I2C_SCL	I/O/T	I2C_SCL for SE
22	**VCC3V3**	**P**	**System Power supply**
23	**GND**	**P**	**Ground**
24	**VBUS**	**P**	**VBUS Power supply**
25	**USB_N**	**I/O/T**	**USB_DM signal**
26	**USB_P**	**I/O/T**	**USB_DP signal**
27	P0.16	I/O/T	MCU GPIO
28	P0.17	I/O/T	MCU GPIO
29	RESET	I	BLE Reset Input
30	SWDCLK	O	SWDIO of SWD for program download
31	SWDIO	I/O/T	SWDIO of SWD for program download
32	**GND**	**P**	**Ground**

P: power supply; I: input; O: output; T: high impedance; ANT: antenna port.

3 Electric specificiations

3.1 Extreme Operating Conditions

Stress beyond the absolute maximum ratings listed in Table 2 may cause permanent damage to the module. Prolonged exposure to absolute maximum rated conditions may affect the device's reliability.

Table 2 Extreme Operating Conditions

Symbol	Parameter	Min	Max	Unit
VDD	Power supply voltage	-0.3	3.6	V
VIN	I/O pin voltage	-0.3	3.6	V
Pin_LoRa	RF input level@ANT_LoRa	-	0	dBm
T_A	Operating Temperature	-40	85	℃
T_{Store}	Storage Temperature	-65	150	℃

3.2 Recommended Operating Conditions

Table 3 Recommended Operating Conditions

Symbol	Parameter	Min	Type	Max	Unit
VDD	Power supply voltage	1.8	3.3	3.6	V
VIN	I/O input voltage	-0.3	3.3	3.6	V
T_A	Operating Temperature	-40	25	85	℃

3.3 Specifications

Table 4 DBM050 module specificaitons

Model	DBM050
Platform Configurations	
MCU	ARM® Cortex®-M4 32-bit processor with FPU, 64 MHz internal clock
MCU Flash	512kB/1MB
RAM	256kB
System	
MCU OS	Zephyr RTOS
Wireless	
Bluetooth	Bluetooth 5.4 + Bluetooth Low Energy (BLE)
RF Characteristic@BLE&2.4GHz	
TXOP	8dBm Maximum
	-45 to +8 dBm TX power
Sensitivity	-95dBm@1Mbps, BLE
	-92dBm@2Mbps, BLE
	-103dBm@125kbps, BLE
Data rates	Bluetooth® 5 – 2 Mbps, 1 Mbps, 500 kbps, and 125 kbps
	IEEE 802.15.4-2006 – 250 kbps
	Proprietary 2.4 GHz – 2 Mbps, 1 Mbps
Power Consumption	
Power Supply	3.3V
Current@sleep mode	2.35uA
Current@Standby mode	3.0mA
Current@BLE Transmitting	16.5mA@8dBm
Current@BLE Receiving	6.3mA@1Mbps
Current@LoRa Transmitting	BLB200LBHP: 105mA@22dBm BLB200HBHP: 120mA@22dBm
Current@LoRa Receiving	5.3mA
Interface	
	GPIO x23
	USB x1
	UART x2
	I2C x2
	SPI x4
	QSPI x1
	ADC x8
	PWM x4
Security	
	CC EAL6+ (HW+JCOP), FIPS 140-2 L3
	支持 SHA-1, SHA-224, SHA-256, SHA-384, SHA-512 等哈希算法
	支持 AES128, 192, 256 等对称硬件加密
	RSA cipher for de-/encryption (up to 4096 bit)
	ECDSA, ECDH, ECDHE, EdDSA 等 ECC 算法，支持的 ECC 曲线： ● ECC NIST (192 to 521 bit) ● Brainpool (160 to 512 bit) ● Twisted Edwards Ed25519 /Montgomery Curve25519 ● Koblitz (192 to 256 bit) ● Montgomery (Curve448) [Goldilocks]
Environment	

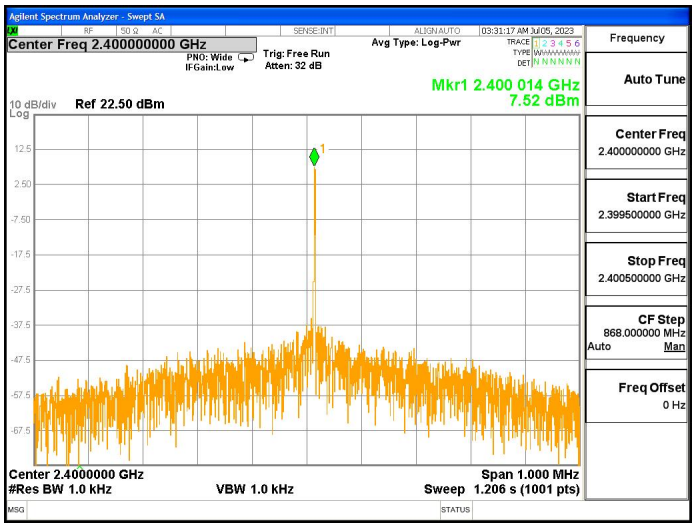
Operating Temperature	-40~85℃
Humidity	5%~ 95% RH
Mechnaical	
Size	15.24*21.59*2.5mm
Weight	1g

4 RF performance

4.1 RF performance test

Test contditions，VDD=3.3V，Ta=25℃。

4.1.1 Transmit power test



BLE TXOP@8dBm/2400MHz

5 Reference design

5.1 HCI device

This is a typical application reference circuit for connecting the module to peripheral components, such as the power supply, antenna, reset button, JTAG interface, and UART interface.

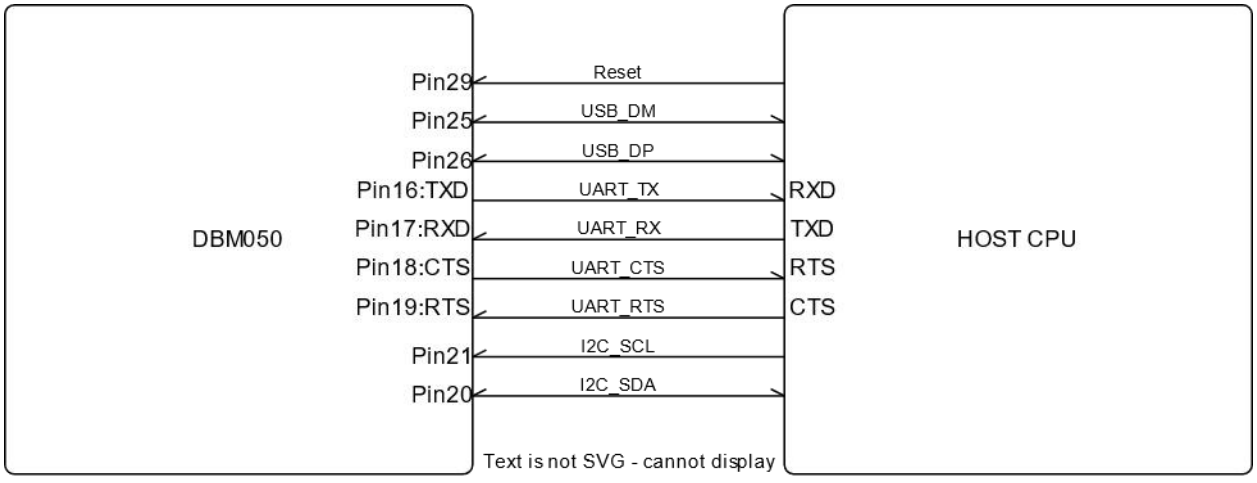


Figure 27 DBM050 reference design

5.2 Secondary Development Based on the Module for Sensor Terminal Product Design

6 Mechanical

6.1 Mechanical size

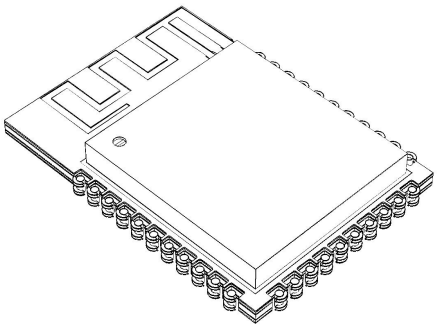


Figure 28 DBM050 apperance

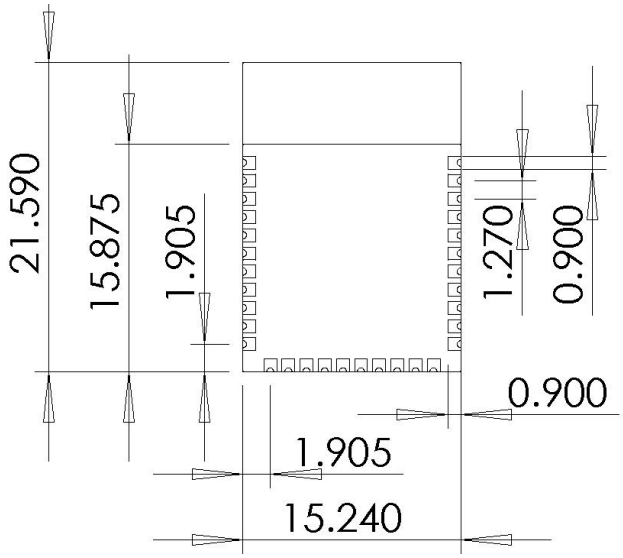


Figure 29 DBM050 top view

Figure 30 DBM050 side view thickness=2.5mm

6.2 Recommended PCB footprint

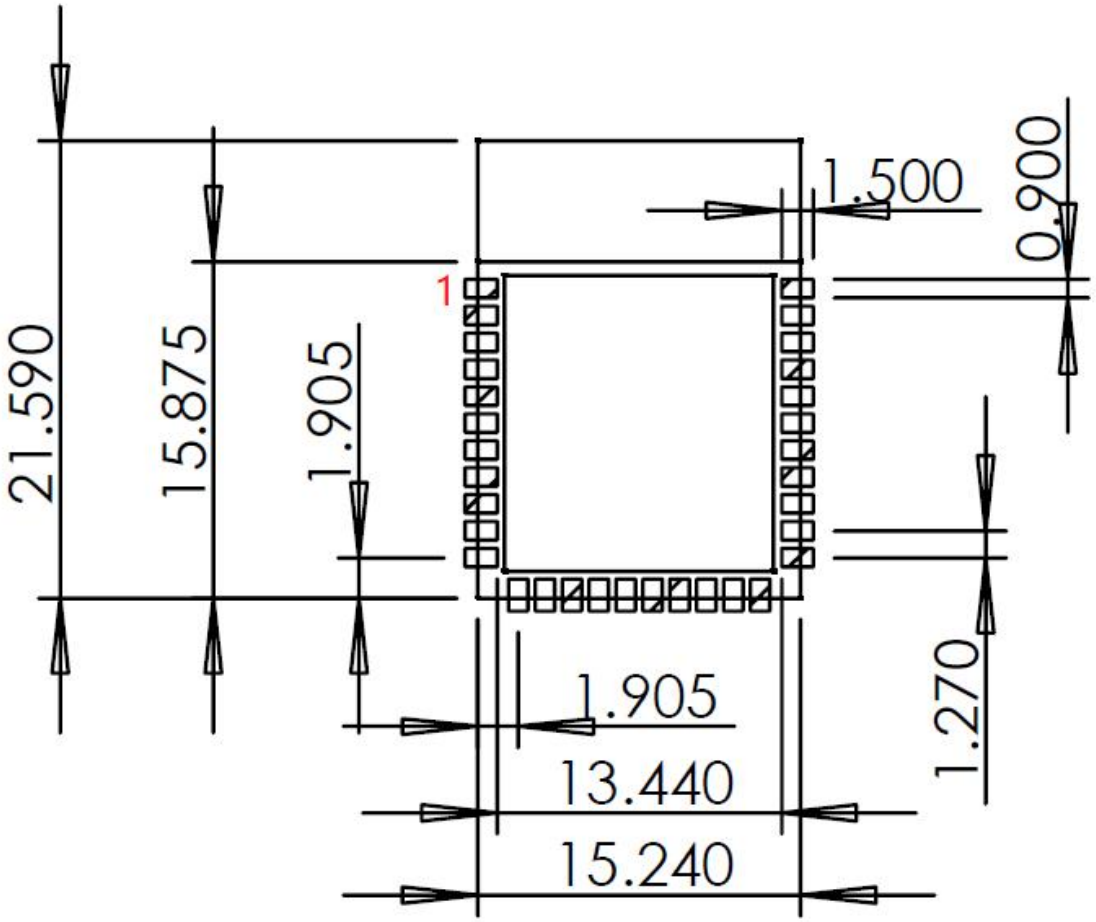


Figure 31 DBM050 建议 PCB layout 封装

7 Storage and Assembly

7.1 Storage

The module should be stored long-term in a sealed moisture barrier bag (MBB) and placed in a non-condensing atmospheric environment, maintaining conditions of <40°C and 90% relative humidity (RH). The module has a Moisture Sensitivity Level (MSL) of 3.

Upon removal from the package, the module must be placed in an environment with factory conditions of 25±5°C and 60% relative humidity (RH). If these conditions cannot be met, the module needs to undergo baking.

7.2 ESD

- Human body model (HBM): ±2000 V
- Charged-device model (CDM): ±500 V

7.3 Reflow Soldering

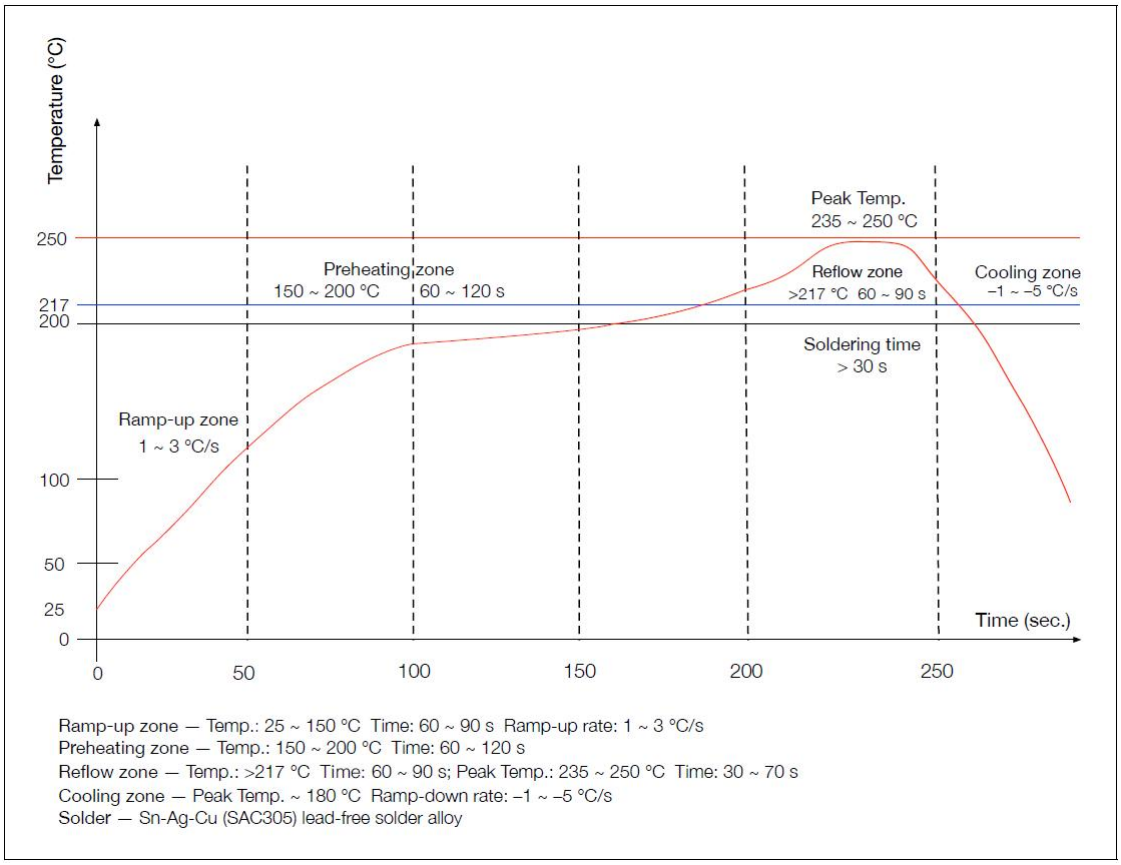


Figure 32 DBM050 Reflow Soldering

8 Requirement per KDB996369 D03

8.1 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(15.247).

8.2 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.

8.3 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.

8.4 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.

8.5 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:2BGP8-DBM050

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

8.7 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: 2BGP8-DBM050, Contains IC: 32572-DBM050"

8.8 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.

8.9 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.

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.

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

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.

FCC Radiation Exposure Statement:

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 & your body.

ISED Statement

This device complies with Industry Canada licence-exempt RSS standard(s). Operation is subject to the following two conditions:

(1) this device may not cause interference, and

(2) this device must accept any interference, including interference that

may cause undesired operation of the device."

This equipment should be installed and operated with a minumum distance of 20 cm between the radiator and your body.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes :

(1) l'appareil nedoit pas produire de brouillage, et

(2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique

subi, même si le brouillage est susceptible d'en compromettre le

fonctionnement."

Cet équipement doit être installé et utilisé avec une distance minimale de 20 cm entre le radiateur et votre corps.

MODIFICATION: Any changes or modifications not expressly approved by the grantee of this device could void the user's authority to operate the device.

Toute modification non approuvé explicitement par le fournisseur de licence de l’appareil peut entraîner l’annulation du droit de l’utilisateur à utiliser l’appareil.

This Class B digital apparatus complies with Canadian ICES-003.

Cet appareil numérique de la classe B est conforme à la norme NMB-003 du Canada

IC labeling requirement for the final end product:

The final end product must be labeled in a visible area with the following "Contains IC: 32572-DBM050"

The Host Marketing Name (HMN) must be indicated at any location on the exterior of the host product or product packaging or product literature, which shall be available with the host product or online.

This radio transmitter [lC:32572-DBM050] has been approved by Innovation, Science and Economic Development Canada to operate with the antenna types listed below, with the maximum permissible gain indicated. Antenna types not included in this list that have a gain greater than the maximum gain indicated for any type listed are strictly prohibited for use with this device.

Frequency range	Manufacturer	Peak gain	Impedance	Antenna type
2402~2480MHz	Depin Labs Limited	2.18dBi	50 Ω	PCB Antenna

The OEM must certify the final end product to comply with unintentional radiators (FCC Sections 15.107 and 15.109) before declaring compliance of the final product to Part 15 of the FCC rules and regulations. Integration into devices that are directly or indirectly connected to AC lines must add with Class II Permissive Change.

The OEM must comply with the FCC labeling requirements. If the module's label is not visible when installed,then an additional permanent label must be applied on the outside of the finished product which states: " Contains transmitter module FCC ID: 2BGP8-DBM050". Additionally, the following statement should be included on the label and in the final product's user manual: " 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 interferences, and

(2) this device must accept any interference received, including interference that may cause undesired operation."

The module is limited to installation in mobile or fixed applications. Separate approval is required for all other operating configurations, including portable configuration with respect to Part 2.1093 and different antenna configurations.

A module or modules can only be used without additional authorizations if they have been tested and granted under the same intended end - use operational conditions, including simultaneous transmission operations.

When they have not been tested and granted in this manner, additional testing and/or FCC application filing may be required. The most straightforward approach to address additional testing conditions is to have the grantee responsible for the certification of at least one of the modules submit a permissive change application.

When having a module grantee file a permissive change is not practical or feasible, the following guidance provides some additional options for host manufacturers. Integrations using modules where additional testing and/or FCC application filing(s) may be required are: (A) a module used in devices requiring additional RF exposure compliance information (e.g., MPE evaluation or SAR testing); (B) limited and/or split modules not meeting all of the module requirements; and (C) simultaneous transmissions for independent collocated transmitters not previously granted together.

This Module is full modular approval, it is limited to OEM installation ONLY.

Integration into devices that are directly or indirectly connected to AC lines must add with Class II Permissive Change. (OEM) Integrator has to assure compliance of the entire end product include the integrated Module. Additional measurements (15B) and/or equipment authorizations (e.g. Verification) may need to be addressed depending on co-location or simultaneous transmission issues if applicable. (OEM) Integrator is reminded to assure that these installation instructions will not be made available to the end user