

## **Holley Middle TX Power ZigBee Module**

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### **HT-MDL-Z-EM-2400-101-X**

#### **Holley Group Co., Ltd.**

No.18, Xidoumen Rd, Hangzhou, China

Tel: 86-571-88471721

Fax: 86-571-88471690

[www.holley.cn](http://www.holley.cn)

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## **1. Introduction**

The Holley ZigBee module is a ZigBee/IEEE 802.15.4 compliant solution that satisfies the needs of low-cost, low-power wireless sensor networks. The module is easy-to-use, saves board space and provides reliable delivery of data between devices.

The Holley ZigBee module operates within the ISM 2.4 GHz frequency band. No configuration is necessary for out-of-box RF communications. The module's default configuration supports a wide range of data system applications. The module uses Ember's EM250 wireless microcontroller to provide a comprehensive solution.

### **1.1 Product Features**

- State-of-art EM250 chip adopted
- Stable and reliable Ember protocol stack embedded
- Universal 28-pin socket interface design
- Easy to implement ZigBee technology integration for hardware equipment manufacturers
- Wider communication range and higher network reliability

## 2. Specifications

Table 2-01: Specifications of the HT-MDL-Z-EM-2400-101-X (PRELIMINARY)

Performance	
Typical Transmit Range	2km (line of sight)
Maximum Transmit Power Output	$19 \pm 0.5\text{dBm}$
Programmable output power range	25dB
RF Data Rate	250kbps
Serial Interface Data Rate (software selectable)	1200-115200 bps
Receiver Sensitivity	-103dBm(1% packet error rate)
Power Requirements	
Supply Voltage	3.3V
Operating Current(Transmit)	186mA
Operating Current(Receive)	42mA
Power-down Current	$0.82 \mu\text{A}$
General	
Operating Frequency Band	ISM 2.4GHz
Dimensions	46mm*28mm*5mm
Operating Temperature	-40 to 85°C
Antenna Interface	MMCX jack (connected to the MMCX plug of antenna cable)
Networking & Security	
Supported Network Topologies	Point-to-point, Point-to-multipoint, Peer-to-peer & Mesh
Number of Channels (software selectable)	15 Direct Sequence Channels
Interface Features	
Compatible with Ember modules	
17 GPIO ports	
4 interrupt ports	
2 serial ports, UART/SPI/I2C supported	
4*12 bits A/D conversion	

### 3. Pin Configurations

#### 3.1 Pin Signals

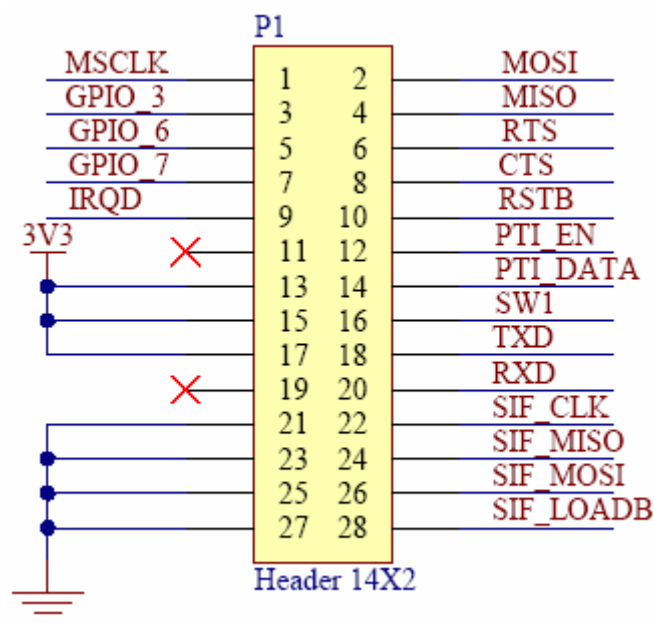


Figure 3-01: Pin Signals

#### 3.2 Pin Assignment

Table 3-01: Pin Assignment

Module Pin	Signal	Corresponding EM250 Pin	Pin Description
1	MCLK	24	GPIO2; SPI Clock of SC2; I <sup>2</sup> C Clock of SC2
2	MOSI	21	GPIO0; SPI Master output slave input of SC2
3	GPIO_3	25	GPIO3; SPI slave select of SC2
4	MISO	22	GPIO1; SPI Master input slave output of SC2 I <sup>2</sup> C data of SC2
5	GPIO_6	29	GPIO6; ADC input 2
6	RTS	20	GPIO12; UART RTS handshake of SC1
7	GPIO_7	30	GPIO7; ADC input 3
8	CTS	19	GPIO11; UART CTS handshake of SC1; SPI Clock of SC1

Module Pin	Signal	Corresponding EM250 Pin	Pin Description
9	IRQD	40	GPIO16; External interrupt source D
10	RSTB	13	Active low chip reset (internal pull-up)
11	NC	-	-
12	PTI_EN	26	GPIO4; ADC input 0; Frame signal of Packet Trace Interface
13	VDD	-	DC3.3V supply
14	PTI_DATA	27	GPIO5; ADC input 1; Data signal of Packet Trace Interface PTI
15	VDD	-	DC3.3V supply
16	GPIO_8	31	GPIO8; ADC reference output; External interrupt source A
17	VDD	-	DC3.3V supply
18	TXD	32	GPIO9; UART TXD of SC1; SPI Master output of SC1; I <sup>2</sup> C data of SC1
19	NC	-	-
20	RXD	33	GPIO10; UART RXD of SC1; SPI Master input of SC1; I <sup>2</sup> C Clock of SC1
21	GND	-	Ground
22	SIF_CLK	34	Serial interface, clock (internal pull-down)
23	GND	-	Ground
24	SIF_MISO	35	Serial interface, master in/slave out
25	GND	-	Ground
26	SIF_MOSI	36	Serial interface, master out/slave in
27	GND	-	Ground
28	SIF_LOADB	37	Serial interface, load strobe (open-collector with internal pull-up)

### 3.3 Mounting Considerations

The Holley ZigBee module is designed to mount into a 28-pin receptacle and therefore does not require any soldering when mounting it to a board. The development kits contain the RS232 interface board which uses one 28-pin receptacle to receive module.

## 4. AT Command

### 4.1 Definitions

- COO    -A coord module.
- Coord   -This is the module within the ZigBee network that forms the network.
- FFD    -A fully functional node within the ZigBee network which can route messages, and store them for its RFD children.
- Host    -This is the host processor which will communicate with the ZigBee module.
- MED    -A mobile RFD.
- Mesh    -This is the mesh network that is implemented by the ZigBee protocol.
- RFD    -A network node that is sleepy, mobile or both.
- Rxer    -The module that receives a message from the Txer.
- SED    -A sleepy RFD.
- Sink    -The node within the network which is designated as the main message source/sink.
- Target   -The ZigBee processor is described as the target in this communication protocol.
- Txer    -The module that sends a message to the Rxer.

### 4.2 Command Summary

Table 4-01: Command Summary

ATI	Software revision info
ATGPnn	Get parameter value nn
ATSPnn=<data>	Get parameter value nn
AT+BCAST	Broadcast a message to all nodes of the network.
AT+BLOAD	Forces the node into standalone boot mode.
AT+FM	Form a network
AT+JN	Join a network
AT+PANSCAN	Scan for available networks
AT+JPAN:CC;PPPP	Join the pan with channel CC and panID PPPP
AT+LEAVE	Leave the current network
AT+INFO	Get info about the current device in the network
AT+LIST	List all the nodes that are known in the network and their type
AT+UCAST	Send a message to the specified EUI64
AT+UCASTB	Send a binary message to the specified EUI64
AT+SCAST	Send a message to the sink
AT+SCASTB	Send a binary message to the sink
AT+SSINK	Search for the sink

### 4.3 Error Codes

When a message cannot complete as expected, it will return an error code. The code that is reported is a 2 byte ASCII representation. The valid codes are listed in the table below.

Table 4-02: Error Codes

Code	Description
01	Unknown command
02	Unknown parameter
03	Unicast could not be sent
04	No sink known
05	Cannot form a network
06	Cannot join a network
07	No network located
08	Not possible while in a network
09	Not possible while not in a network
10	No sink found



#### 4.4 Parameters

The target shall contain several parameters in memory as tokens, which will affect the operation of the device.

Table 4-03: Encryption Key

Encryption Key	
Parameter	P01
Size	128 bits (32 characters)
Mode	Write only
Description	The Encryption key is the 128 bit AES key that is specified in the ZigBee protocol.
Default	"00000000000000000000000000000000"
Example	"ATSP01=0123456789ABCDEF0123456789ABCDEF\r"

Table 4-04: Network Setup

Network Setup																																			
Parameter	P02																																		
Size	2 bytes (4 characters)																																		
Mode	Read/Write																																		
Description	This parameter sets up the basic functionality of the network, including the type of device and joining features.																																		
Default	"000C"																																		
Bit Definition	<p>The following table defines the bits for the network setup parameter.</p> <table> <tr> <th>Bit</th><th>Operation</th></tr> <tr> <td>0x8000</td><td>Reserved (set to 0)</td></tr> <tr> <td>0x4000</td><td>Reserved (set to 0)</td></tr> <tr> <td>0x2000</td><td>Reserved (set to 0)</td></tr> <tr> <td>0x1000</td><td>Reserved (set to 0)</td></tr> <tr> <td>0x0800</td><td>Set: Allow joining (overrides bits 0x000f)</td></tr> <tr> <td>0x0400</td><td>Set: Device is MED; Unset: Device is SED</td></tr> <tr> <td>0x0200</td><td>Device is RFD</td></tr> <tr> <td>0x0100</td><td>Device is sink</td></tr> <tr> <td>0x0080</td><td>Reserved (set to 0)</td></tr> <tr> <td>0x0040</td><td>Reserved (set to 0)</td></tr> <tr> <td>0x0020</td><td>Reserved (set to 0)</td></tr> <tr> <td>0x0010</td><td>Set: When joining a network, use the network key</td></tr> <tr> <td>0x0008</td><td>Set: Allow unsecured joining via local node</td></tr> <tr> <td>0x0004</td><td>Set: Allow secured joining via local node</td></tr> <tr> <td>0x0002</td><td>Set: Allow unsecured joining via Trust Centre</td></tr> <tr> <td>0x0001</td><td>Set: Allow secured joining via Trust Centre</td></tr> </table>	Bit	Operation	0x8000	Reserved (set to 0)	0x4000	Reserved (set to 0)	0x2000	Reserved (set to 0)	0x1000	Reserved (set to 0)	0x0800	Set: Allow joining (overrides bits 0x000f)	0x0400	Set: Device is MED; Unset: Device is SED	0x0200	Device is RFD	0x0100	Device is sink	0x0080	Reserved (set to 0)	0x0040	Reserved (set to 0)	0x0020	Reserved (set to 0)	0x0010	Set: When joining a network, use the network key	0x0008	Set: Allow unsecured joining via local node	0x0004	Set: Allow secured joining via local node	0x0002	Set: Allow unsecured joining via Trust Centre	0x0001	Set: Allow secured joining via Trust Centre
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Example	"ATGP02\r"																																		

## Appendix A: Mechanical Outline Drawing

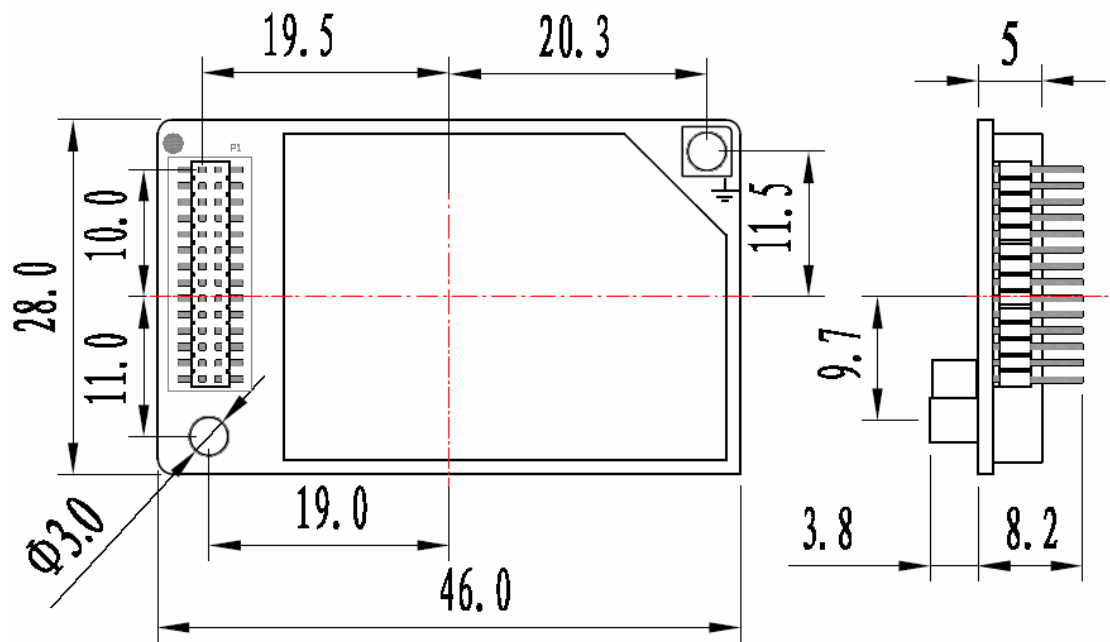


Figure A-01: HT-MDL-Z-EM-2400-101-X Outline Drawing

## Appendix B: Accessories

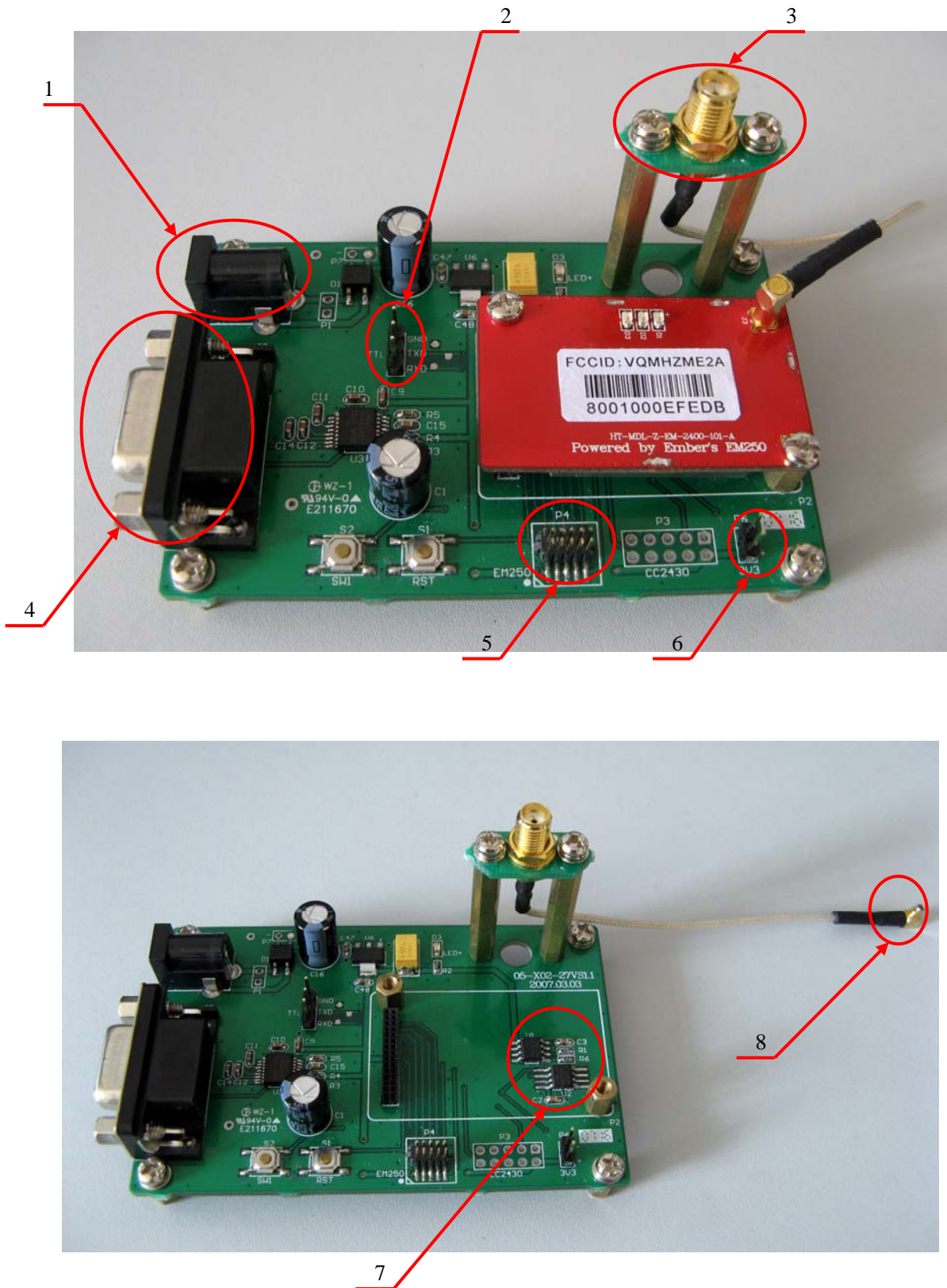


Figure B-01(a) (b): Holley ZigBee Module Carry Board

1. Power supply, require DC9.0V.
2. UART TTL interface, connected to EM250's SC1 UART mode.
3. SMA antenna connector.
4. RS232 connect, DB9 female mode. This interface is derived from item 2 above, through a MAX3221 chip.
5. EM250's system SIF interface. This interface is necessary in downloading program and debugging (with Ember's Insight Adaptor).
6. DC3.3V power output/input port. If the board is powered by item 1, then this port provides a DC3.3V output. Or, the board could be powered by DC3.3V directly via this port.
7. Two 64Kbytes EPROM chips make up a total space of 128Kbytes, for sake of module's remote upgrade. The E<sup>2</sup>PROM are connected to EM250's SC2 I<sup>2</sup>C mode.
8. MMCX connector to the module.

## Appendix C: Agency Certifications

### FCC Certification

This equipment complies with Part 15 of the FCC rules and regulations.

To fulfill FCC Certification requirements, an OEM manufacturer must comply with the following regulations:

1. The modular transmitter must be labeled with its own FCC ID number, and, if the FCC ID is not visible when the module is installed inside another device, then the outside of the device into which the module is installed must also display a label referring to the enclosed module. This exterior label can use wording such as the following:

#### **Example of label required for OEM product containing HT-MDL-Z-EM-2400-101-X module**

**Contains FCC ID: VQMHZME2A**

The enclosed 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 similar wording that expresses the same meaning may be used.

2. To be used with the HT-MDL-Z-EM-2400-101-X module, the external antennas have been tested and approved which are specified in *Approved Antenna List*. The HT-MDL-Z-EM-2400-101-X module may be integrated with other custom design antennas which OEM installer must authorize following the FCC 15.21 requirements.

**WARNING:** The Original Equipment Manufacturer (OEM) must ensure that the OEM modular transmitter must be labeled with its own FCC ID number. This includes a clearly visible label on the outside of the final product enclosure that displays the contents shown below. If the FCC ID is not visible when the equipment is installed inside another device, then the outside of the device into which the equipment is installed must also display a label referring to the enclosed equipment.

**IMPORTANT:** This equipment 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 (FCC 15.19).

The internal/external antenna(s) used for this mobile transmitter must provide a separation distance of at least 20 cm from all persons and must not be co-located or operating in conjunction with any other antenna or transmitter.

**IMPORTANT:** Modifications not expressly approved by this company could void the user's authority to operate this equipment (FCC section 15.21).

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.

### Approved Antenna List

HT-MDL-Z-EM-2400-101-X module has been tested and approved for use with the antennas listed in the table below.

Table B-01: Approved Antenna List

Part Number	Manufacturer	Description	Gain (dBi)	Min. Separation (cm)
ANT-FW-2400-1.3-B	Fuweicom Electronics Technology Co.,Ltd.	Omni, with SMA-J connector,* frequency range 2.4-2.5 GHz	2.1	20

\* Two kinds of antenna cables are used: one is 9cm long, and the other is 15cm long. Both cables have two connectors: one is MMCX plug connected to the module, and the other is SMA jack connected to the antenna.

## Appendix D: Ordering Information

Table C-01: Part Numbers

HT	-MDL	-Z	-EM	-2400	-101	-X
Company name	Module Product	ZigBee Compatible	RF Chip Provider (Ember)	Radio Frequency (2400MHz)	Output Power (19±0.5 dBm)	Antenna Interface*

- \* -A: with MMCX straight jack  
-B: with MMCX right angle jack

## Appendix E: Version Control

Date	Version	Notes
2007.10.07	1.0	1st Issue of Preliminary Manual

\* Holley reserves the right to make changes to the product specification at anytime without notice.

## Appendix F: Contact Details

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