



EZBee™

2.4GHz Zigbee Serial Module

User Manual: Zigbee Module

Version 1.2

EZ way to go wireless with Zig**Bee**

Revision History: User Manual of EZBee™

<i>Version</i>	<i>Document Number</i>	<i>Changed Contents</i>	<i>Date</i>
1.2	EZB_manual_0123	Commands Update by Firmware Upgrade	01/23/2006
1.1	EZB_manual_1201	Commands Addition by Firmware Updates	12/01/2005
Pre	EZB_manual_0927	Preliminary Version	09/26/2005

Module Version History

Part no.	Description	Version	Release Date
EZB-001	2.4GHz Zigbee Module Short Range	EZBEE.FI.0.9.5 EZBEE.RI.0.9.5	Jan. 2006
EZB-100	2.4GHz Zigbee Module Long Range	EZBEE.FI.0.9.5 EZBEE.RI.0.9.5	Jan. 2006
EZB-001EK	EZB-001 Evaluation Kit	EZBEE.FI.0.9.5	Jan. 2006



<EZB-EK: EZBee™ Evaluation Kit>

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1. About EZBee™

EZBee™ is a compact Zigbee single-board module which is compliant to the 2.45GHz Zigbee specification v1.0 of IEEE 802.15.4. With EZBee™, users may enable Zigbee wireless network easily without a professional knowledge on Zigbee protocol. EZBee™ is designed to be used as a serial RF module to a Host system.



<Fig. 1.1: EZB-001(left) & EZB-100(right)>

Using AT commands provided, users may communicate with EZBee™. Full AT commands available can be found [from page 8](#).

EZBee modem provides two ways of transmitting messages between modules, **Connectionless mode and Connection mode**.

Connectionless Mode: In this mode, users may send data (point-to-point or broadcast) to the other nodes in the connected Zigbee network by AT commands.

Connection Mode: In this mode, users may send data WITHOUT AT commands to other nodes in connected network.

Each modules has extended address, short address and unique ID. The unique ID is used in both connectionless & connection mode.

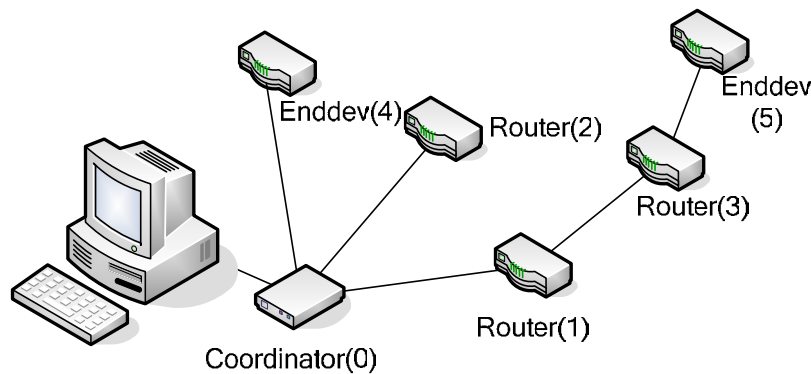


Figure 1.2 ZigBee Network With EZBee™

Key Features

- IEEE 802.15.4 compliant PHY and MAC
- Full Function Device (FFD)
- 128KB Flash memory, 4KB SRAM, 4KB EEPROM
- UART, SPI and JTAG interface
- 16 Channels in the 2.45GHz ISM band
- 2.7 ~ 3.6V supply voltage
- -30°C to 85°C operating temperature
- Conforms with ETSI EN 300 440 (Europe), FCC CFR-47 part 15.247 and 15.249 (USA), ARIB STD-T66 (Japan)

Applications

- Wireless remote control
- Building automation
- Personal area network
- Industrial control
- OEM equipment
- PC peripherals

2. Specification

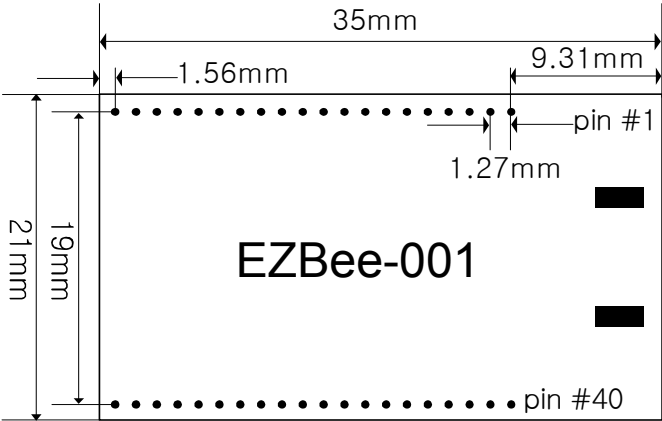
Parameters	EZBee-001	EZBee-100	
TX Power	0dBm (1mW)	10dBm(10mW)	17dBm (EIRP 100mW)
Range (Urban, Outdoor)	30m	350m	600m
Range (LOS)	100m	650m	1200m
Dimensions	35 x 21 x 3 mm	38 x 26 x 3 mm	
RX Sensitivity	-94dBm (1% PER)	-102dBm (1% PER)	
TX Current(Typical)	27mA	95mA	140mA
RX Current(Typical)	30mA	55mA	55mA
RF Data Rate	250 Kbps		
Frequency, Channel	2400MHz ~ 2483.5MHz, 16ch		
Operating Temp.	-30 ~ 85°C		
ANT	Internal	External	
Supply voltage	2.7 ~ 3.6V		

Networking	
Supported Network Topologies	Mesh, Tree, Star
Certifications	
FCC/CE/ETSI	Pending

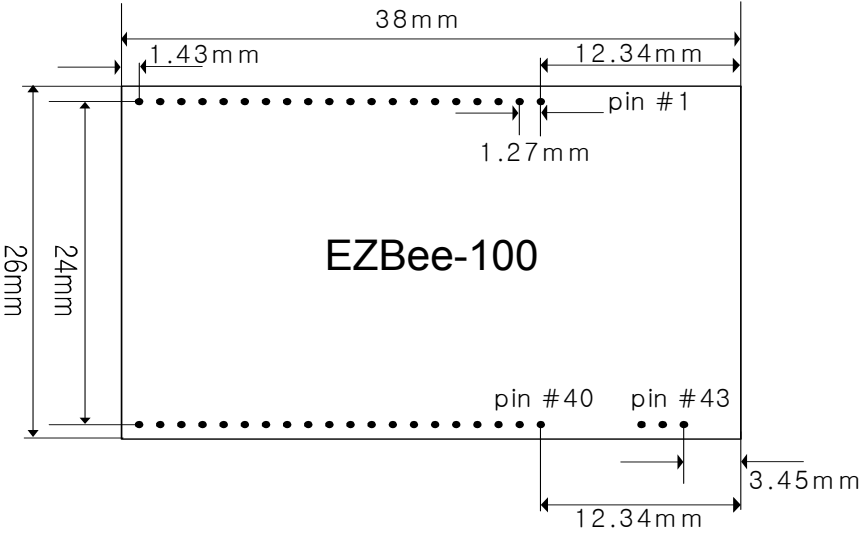
3. Hardware Structure

3.1 Mechanical Drawing

- PCB Connector Hole: 0.6 Ø (Recommend)



< EZBee-001 >



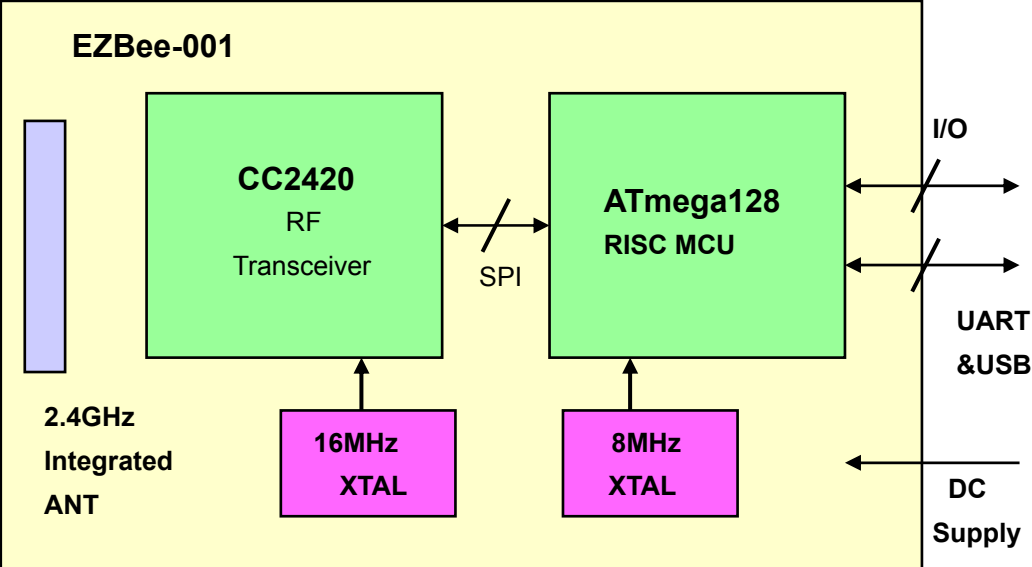
< EZBee-100 >

3.2 Pin Assignment

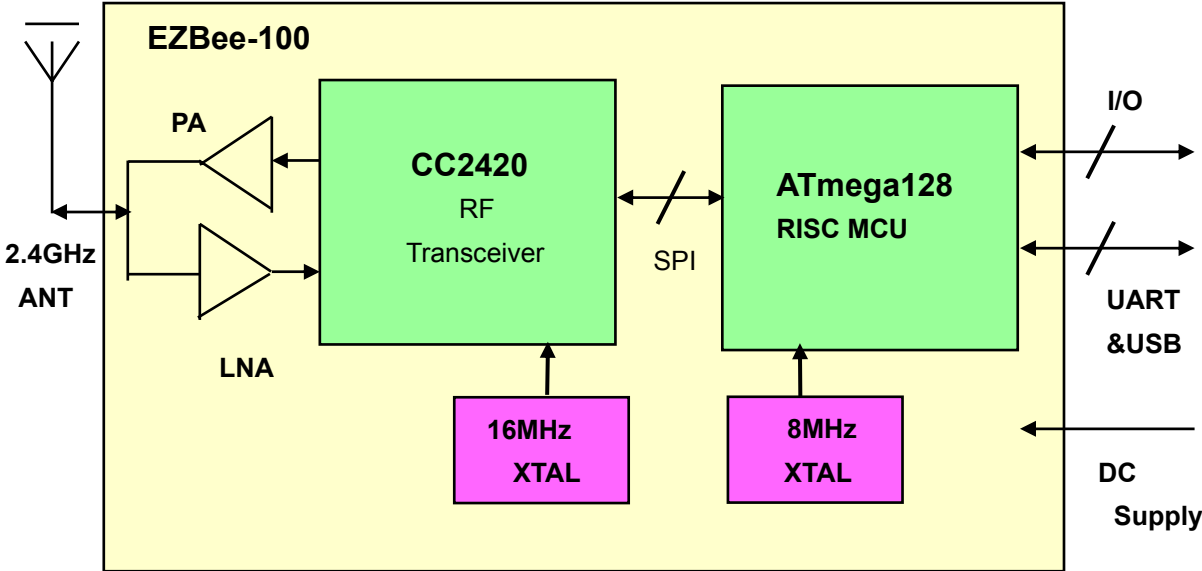
Pin Number		Description	Pin Number		Description
EZBee-001	EZBee-100		EZBee-001	EZBee-100	
1	1	GND	40	40	PB7(OC2)
2	2	VCC	39	39	PB4(OC0)
3	3	RXD	38	38	PE5(OC3C)
4	4	TXD	37	37	PE4(OC3B)
5	5	RTS	36	36	PE3(OC3A)
6	6	CTS	35	35	AREF
7	7	RESET	34	34	PF0(ADC0)
8	8	PG0(WR)	33	33	PF1(ADC1)
9	9	PG1(RD)	32	32	PF2(ADC2)
10	10	PC0(A8)	31	31	PF3(ADC3)
11	11	PC1(A9)	30	30	PF4(TCK)
12	12	PC2(A10)	29	29	PF5(TMS)
13	13	PC3(A11)	28	28	PF6(TDO)
14	14	PC4(A12)	27	27	PF7(TDI)
15	15	PC5(A13)	26	26	PA0(AD0)
16	16	PC6(A14)	25	25	PA1(AD1)
17	17	PC7(A15)	24	24	PA2(AD2)
18	18	PG2(ALE)	23	23	PA3(AD3)
19	19	PA7(AD7)	22	22	PA4(AD4)
20	20	PA6(AD6)	21	21	PA5(AD5)

41	GND
42	RF
43	GND

3.3 Block Diagram



< EZBee-001 >



< EZBee-100 >

4. Module Configuration

Users may configure EZBee™ series with simple and easy AT commands. Following AT commands set can be used with your module. If you will need any further technical support, please contact to support@widecastint.com

4.1 AT Commands

AT commands interface can be divided into network commands and system commands.

Default serial setting of EZBee™:

38,400bps / 8 Data bit / 1 Stop bit / Non Parity / No hardware flow control

AT commands Set

Category	AT command	Parameter	Description	Default
Network	D	None	Try connection to previously connected module	
		< Module ID / Module saddr>	Try connection with module ID or module short address	
	H	None	Disconnect	
	SP	None	Start/Join PAN	
	DP	None	Disjoin from PAN	
	RJ	None	Restart / Rejoin PAN	
		@<Module ID/Module saddr>	Remote module rejoin request	
	&ANS	None	Connection request accept	
	&MSG	=<Module ID/Module saddr>, <message>	Send message	
	&RJT	None	Connection request reject	
	Z	None	Module reset	
		@<Module ID / Module saddr>	Remote module reset request	
	NZ	None	Reset network layer	
V	None	Show module version		
S	None	Show module status		

System	+AS	?	Get auto network start mode	1
		=<0/1>	Set auto network start mode	
	+ATAN	?	Get connection auto answer mode	1
		=<0/1>	Set connection auto answer mode	
	+BM	?	Get beacon mode	15
		=<0~15>	Set beacon mode	
	+BR	?	Get serial baud rate	38400
		=<baud rate>	Set serial baud rate	
	+CH	?	Get channel	19
		=<11~26>	Set channel	
	+DST	?	Get destination ID	0
		=<Destination node ID>	Set destination ID	
	+E	<0/ 1>	Serial echo off/ echo on	1
	+EA	?	Get extended address	Factory set
		@<Module ID>?	Get extended address of remote module	
		=<extended address>	Set 64-bit extended address	
	+ID	?	Get node ID	
		@<Module saddr>?	Get node ID of remote module	
		=<Module ID>	Set node ID	
	+NWK	?	Get network configuration	
=<net mode>,<max child>,<max router>,<max node depth>		Set network configuration		
+PID	?	Get PAN ID	FFFF	
	=<0~3FFF/ FFFF>	Set PAN ID		
+SA	?	Get short address		
	@<Module ID>?	Get short address of remote module		

Notification message

message	Parameter	Description	
\$CONFLT_ID	none	My ID conflict	
	<Conflict ID>	Confliction with the module with ID <Conflict ID>	
\$INIT	None	Network stack init	
\$IDCHG	=<Previous ID>,<Changed ID>	Shows ID of remote module	
\$JOIN	<Module ID>,<Module saddr>,<Module eaddr>	For Coordinator, shows the status of joining of other modules.	
	FAIL	For Router or Enddev, Join FAIL message	
\$LEAVE	<extended address>	Network disjoin indication or confirmation	
\$LOST	None	Network lost indication	
\$MSG	<Node ID>, <Message>,<Link-quality>	Notify incoming message	
	Parameter description	<Node ID>	Source ID(0~0xFFFF)
		<Message>	Variable even size message length
		<Link-quality>	0~0xFF
\$PNS	COORD/ROUTER	PAN Start mode	
\$REQC	<Request node ID>	Connection request indication	
\$RESET	None	Module reset	
\$FACTORY_RESET	None	Reset to Factory Default Configuration	
\$SADDR	<short address>	Network join confirm	

Result message

Result messages show the result after the command process.

Message	Description
ALREADY START	Network already started
BUSY	Peer is busy
CANCEL	Connection cancelled
CONNECT	Connection success
CONN RESET	Peer reset connection
DISCONNECT	Disconnection success

ERROR	Invalid command or parameter
INVALID_MAC	Invalid 64-bit extended address
NET STOP	Network did not start
NO CARRIER	Can't send message to destination
NO RESPONSE	Peer does not response
NOMEM	Exhaust memory
NOEXIST ID	There is not such ID
OK	Command recognition success
REJECT	Peer reject connection request
SELF ID	Destination is myself

4.2 Description of AT Commands

Users may communicate with EZBee modules via RS232 interface.

Default serial port setup	
Baud rate	38400
Data	8-bit
Parity	None
Stop bit	1-bit
Flow control	None

Serial interface of EZBee modules can be configured by AT commands.

Command	Parameter	Result	Description
AT+BR?	none	<baud rate>	Show current serial baud rate
AT+BR=	2400	OK	Set baud rate
	4800		
	9600		
	19200		
	38400		
	57600		

The end of AT command will be distinguished by '\r' or '\n'.

Setup echo mode

Users may configure echo options of serial communication.

Command	Parameter	Result	Description
AT+E0	None	OK	Serial echo off
AT+E1	None	OK	Serial echo on

PAN Start / Join

After start-up of module operation, for data communications, one module should start PAN network or join the existing PAN. Following commands may be used to join or disjoin PAN.

To start PAN or join the existing PAN:

Command	Parameter	Result	Description
ATSP	None	\$PNS=COORD	PAN coordinator start
		\$PNS=ROUTER	PAN router start
		\$SADDR=<shortaddr>	PAN join (router/enddev)
		ALREADY START	PAN has been started already or already have joined to PAN.
		INVALID MAC	Extended address has Not been configured.

After successful joining, the Coordinator gets following message:

Command	Parameter	Description
\$JOIN=	<Module ID>, <Module short address>, <Module extended address>	Shows ID, short address, and extended address of the newly joined module.

When failed to join, the Router or the Enddev gets following message:

Command	Parameter	Description
\$JOIN=	FAIL	Join Failure

PAN auto start / join

When start the module, users may configure the PAN starts, or join the PAN automatically

Command	Parameter	Result	Description
AT+AS?	None	0	Automatic Start mode OFF
		1	Automatic Start mode ON
AT+AS=	0	OK	Configures Automatic Start mode OFF
	1		Configures Automatic Start mode ON

PAN Restart / Rejoin

When Restart or Rejoin the PAN with local or remote modules.

To restart or rejoin the PAN, network information stored in flash memory will be removed.

Command	Parameter	Result	Description	Remarks
ATRJ	None	Same Result by ATSP command (PAN start/join).	Restart/Rejoin the PAN	Only works for Coordinator
	@<Remote ID>		Request Rejoining of the remote module with ID <Remote ID>.	
	@S<Remote saddr>		Request Rejoining of the remote module with Short address <Remote saddr>.	

PAN disjoin*

To disjoin from the joined PAN:

Command	Parameter	Result	Description
ATDP	None	\$LEAVE=OK	Disjoin request success
		\$LEAVE=FAIL	Disjoin request failed
		\$LEAVE=<extaddr>	Disjoin indication from <extaddr>
		FAIL	Not joined

Network Layer Reset*

Reset the Network layer.

Once the Network is reset, users should use ATSP command to start the PAN for communication.

Any network data stored in Flash memory will be removed.

Command	Parameter	Result	Description	Remarks
ATNZ	None	\$INIT	Request network layer reset	

Configuration of PAN ID

Users may assign PAN ID to distinguish each PAN nearby, or to prohibit joining of unauthorized modules, in the range 0x0~0x3FFF or 0xFFFF. If PAN ID is configured in the range between 0x0~0x3FFF, only modules with such a PAN ID may joined the PAN network.

Command	Parameter	Result	Description
AT+PID?	None	<PAN ID>	Shows current PAN ID in ASCII hexadecimal
AT+PID=	0~3FFF or FFFF	OK ERROR	Configures PAN ID

After setting of PAN ID, the module will reset itself to activate new PAN ID.

Configuration of Module ID

Users may assign unique ID for each EZBee module for data communication between the modules. Each ID of the modules should be unique in a PAN.

FFD may have the module ID, '0' or 'COORD', to work as Coordinator in a PAN, and other cases, modules will act as either Router or End-device depending on the firmware. \

Command	Parameter	Result	Description
AT+ID?	None	0000	This module works as Coordinator.
AT+ID@<saddr>?		<Module ID>	Shows current Module ID.
AT+ID=	0~FFFE	OK	Configures module ID

If the module ID is 'FFFF' or 'BROAD', this means "Broadcast". In this case, the module ID cannot be used to transmit messages. Only AT commands can be used for Broadcast.

If the modified ID is being used by other module, following message will be shown to both local and remote modules.

Message	Parameter	Description
\$CONFLT_ID	None	The modified ID is being used by other module in the PAN.
	=<Conflict ID>	ID <Conflict ID> is being used by other module in the PAN.

If already joined PAN, and the modification of ID is successful, following message will be shown (on Remote Module).

Message	Parameter	Description
\$IDCHG	=<previous ID>,<changed ID>	Change ID of remote module

Message Transmission without connection

EZBee™ may send/receive data in Not-connected status by AT commands.

Command	Parameter	Result	Description
AT&MSG=	<Module ID>, <Message> or S<Module saddr>,<Message>	OK	Success of message transmission
		FAIL	Failure of message transmission
		NOEXIST ID	No destination with such ID was not found in the PAN

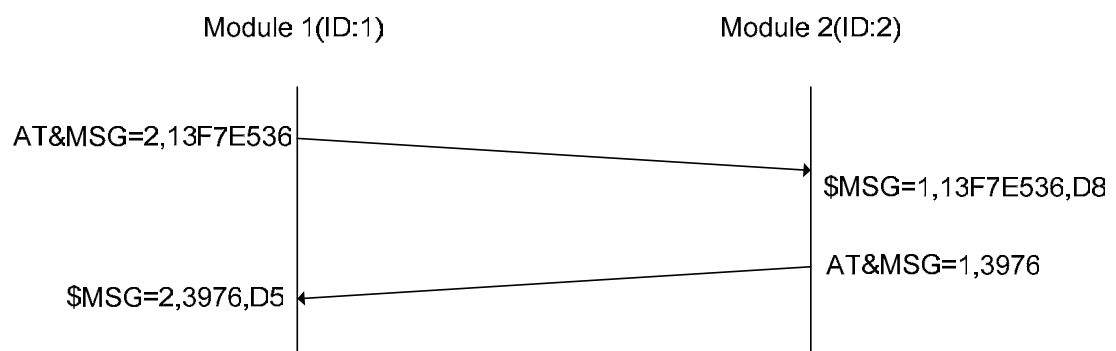
		SELF ID	Destination is myself
--	--	----------------	-----------------------

The module who received the message from sender by 'AT&MSG=' command will show following messages:

Command	Parameter	Description
\$MSG=	<src ID>, <message>, <link quality>	Message received from the module with <src ID>

Message should be transmitted in ASCII hexadecimal format, and should not exceed 62 characters length including AT commands.

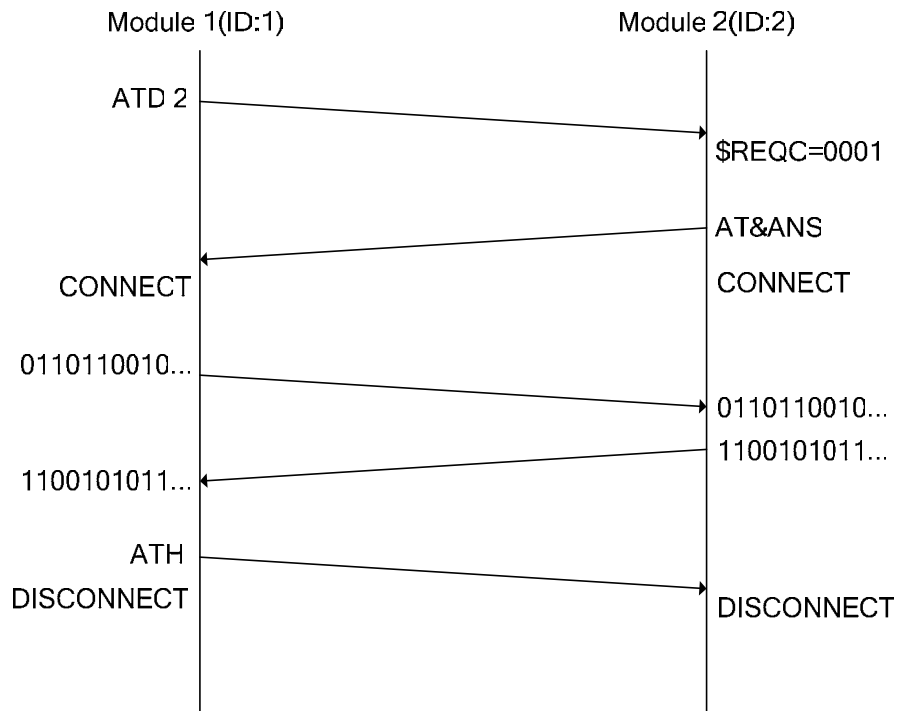
Following shows example of message transmission:



In above drawing, module 1 is sending '0x13f7e536' to module 2, and when module 2 receives this message, link quality is '0xd8'. When module 2 is sending '0x3976' to module 1, the link quality when received by module 1 is '0xd5'.

Message Transmission after connection

EZBee™ provides connection mechanism between the connected modules via message pipes. So it is possible to send/receive serial data WITHOUT AT commands between the modules. Max. length of each message is 64bytes, and should have 5msec of time gap between each message. Following drawing shows the procedure from connection to disconnection:



1) Connection Command

Command	Parameter	Result	Description
ATD	<space> <Node ID> or <space>S<M odule saddr> or None	SELF ID	Destination module to connection is myself
		NOEXIST ID	No module with such ID
		NO RESPONSE	No response from the peer during connection transaction
		CANCEL	connection transaction was cancelled by the Peer
		BUSY	The Peer was already connected or trying to connect to the other module
		REJECT	The Peer rejected connection request.
		CONNECT	The Peer accepted connection request

The Peer module which received Connection request from the sender may have following messages.

Command	Parameter	Description
\$REQC=	<Source ID>	Connection request message received from the module of <Source ID>

If parameter after ATD command is not specified, the module will try to connection to destination module configured by “AT+DST” command.

2) Disconnection command

Users may disconnect with currently connected module:

Command	Parameter	Result	Description
ATH	None	DISCONNECT	Finish current connection
+++		NO RESPONSE	No response from the Peer during Disconnect transaction

Configuration of Default Destination ID

Users may omit the parameter of ATD command, by configuring default destination ID.

Command	Parameter	Result	Description
AT+DST?	None	<Dest ID>	Shows currently configured destination module ID
AT+DST=	<Node ID>	OK	Configures Default ID of destination module

Connection Request Accept

When received Connection request message, receiver module may accept the request of connection:

Command	Parameter	Result	Description
AT&ANS	None	CONNECT	Connection request was accepted
		ERROR	No connection request has been arrived.
		NO RESPONSE	No response from the Peer
		CONN RESET	Connection transaction has been RESET by the Peer

Connection Request Reject

When received Connection request message, receiver module may reject the request of connection:

Command	Parameter	Result	Description
AT&RJT	None	OK	Connection request was rejected
		ERROR	No connection request has been arrived.

Automatic Answering Configuration on Connection Request

By following commands, users may accept connection request automatically.

Command	Parameter	Result	Description
AT+ATAN?	None	0	Currently this auto-answer mode is OFF.
		1	Currently this auto-answer mode is ON.
AT+ATAN=	0	OK	Configures Auto-answer mode to be OFF
	1		Configures Auto-answer mode to be ON

Reading Network Configuration

Reads current configuration of Network

Command	Parameter	Result	Description
AT+NWK?	None	<NETMODE>, <MAXCHILD> <MAXROUTER>, <MAXDEPTH>	Shows current network configuration
AT+NWK	=<NETMODE>, <MAXCHILD>, <MAXROUTER>, <MAXDEPTH>	OK / ERROR	Configure/Change network configuration.

Each parameters of result message by 'AT+NWK?' command means:

Field	Parameter	Description
<NETMODE>	MESH	Current Network Mode
	STAR	
	TREE	
<MAXCHILD>	Decimal number	The number of max. child nodes which may join to one node.
<MAXROUTER>	Decimal number	The number of max. router nodes which may join to one node. The number of max. routers should be same or smaller than the number of max. childs.
<MAXDEPTH>	Decimal number	Max. depth of network from the Coordinator

Once the Network parameter is configured, module will reset itself to apply new configuration, and restart or rejoin the PAN.

Configuration of Beacon Mode

Users may use Beacon mode to synchronize the modules in ZigBee Network:

Command	Parameter	Result	Description
AT+BM?	None	<beacon mode>	Shows current value of beacon mode
AT+BM=	0~15	OK	Configures Beacon mode

Beacon mode available:

Mode	Description	Mode	Description
15	No beacons	7	2 seconds
14	4 minutes	6	1 seconds
13	2 minutes	5	480 milliseconds
12	1 minutes	4	240 milliseconds
11	31 seconds	3	120 milliseconds
10	15 seconds	2	60 milliseconds
9	7.5 seconds	1	30 milliseconds
8	4 seconds	0	15 milliseconds

Configuration of Default Channel

Using following commands, users may read/configure the default channel to scan, start or join the Zigbee network.

Command	Parameter	Result	Description
AT+CH?	None	<default channel>	Reads current default channel
AT+CH=	11~26	OK	Configures Default channel

Default channels available:

Channel	Description	Channel	Description
11	2405 MHz	19	2445 MHz
12	2410 MHz	20	2450 MHz
13	2415 MHz	21	2455 MHz
14	2420 MHz	22	2460 MHz
15	2425 MHz	23	2465 MHz
16	2430 MHz	24	2470 MHz
17	2435 MHz	25	2475 MHz
18	2440 MHz	26	2480 MHz

Once the Network parameter is configured, module will reset itself to apply new configuration

Reading of Short Address

Users may read the 16-bit short address assigned by the Coordinator or the Router.

Command	Parameter	Result	Description
AT+SA	?	<short address>	Reads currently assigned Short address
	@<module ID>?	<short address>	Reads the short address of the remote module with <module ID>
		NOEXIST ID	No module found with such ID in the PAN

If the short address is 'FFFF', this means short address has not been assigned.

Reading of Extended Address

Reads/Configures current IEEE 64-bit extended address assigned to the Coordinator or the Router by following command:

Command	Parameter	Result	Description
AT+EA	?	<extended address>	Reads currently assigned extended address
	@<Module ID>?	<extended address>	Reads the extended address of the module with <Module ID>
		NOEXIST ID	There is no module with the module ID in the PAN
	=<eaddr>	\$RESET	Configures the extended address as <eaddr>
		ERROR	This extended address is out of format so cannot be assigned or this address has been assigned already.
*E	\$RESET	RESET of the Extended address	

Before to configure new Extended address, extended address should be RESET (extended address of 0xFFFFFFFFFFFFFFF). After configuration of the new extended address, module will RESET itself to apply new values.

Module Reset

Software Reset by following command:

Command	Parameter	Result	Description
ATZ	None	\$RESET	S/W reset of the module
	@<Module ID>	OK	Reset of the module with <Module ID>
		FAIL	No response from the module
		NOEXIST ID	No module found with such ID in the PAN
	@<Module saddr>	OK	Reset of the module with Short address <Module saddr>
		FAIL	No response from the module

RESET command for Remote module can be operated by only the Coordinator.

Reading Module Version

Reads version of the module

Command	Parameter	Result	Description
ATV	None	EZBEE.FI.0.9.5	FFD with normal memory version 0.9.5
		EZBEE.FX.0.9.5	FFD with external memory version 0.9.5
		EZBEE.RI.0.9.5	RFD with normal memory version 0.9.5
		EZBEE.RX.0.9.5	RFD with external memory version 0.9.5

Reading Module Status

Reads current status of module

Command	Parameter	Result	Description
ATS	None	<Module type>.<Net start>. <Total mem>.<Current used mem>. <highly used mem>	Reads current status of the module

Each parameters of Result by ATS command means:

Field	Value	Description
<Module type>	C	Coordinator
	R	Router
	E	Enddev
<Net start>	S	Network start
	T	Network stop

5. Legal Notice & Contact

About this Document

This document provides introductory instructions on how to set up and manage EZBee™-DK001 within your networking environment. Should you require more information, please refer to website at www.widecastint.com.

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EZBee™

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COMPANIES' TOTAL LIABILITY IS LIMITED TO THE PRICE/LICENSE FEE ACTUALLY PAID BY PURCHASER TO COMPANIES FOR THE PRODUCT WITH RESPECT TO WHICH LOSSES OR DAMAGES ARE CLAIMED.

IN NO EVENT SHALL COMPANIES OR ITS LICENSOR AND SUPPLIERS BE LIABLE FOR ANY INDIRECT, INCIDENTAL OR CONSEQUENTIAL LOSSES OR DAMAGES OF ANY NATURE WHATSOEVER, INCLUDING, BUT NOT LIMITED TO, LOSS OF DATA OR DATA BEING RENDERED INACCURATE, LOSSES SUSTAINED BY YOU OR THIRD PARTIES SUCH AS LOSS OF BUSINESS, LOSS OF PROFITS, BUSINESS INTERRUPTION OR PERSONAL INJURY, EVEN IF COMPANIES OR ITS LICENSORS OR SUPPLIERS HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES.

This warranty does not cover replacement of products damaged by abuse, accident, misuse, neglect, alteration, repair, disaster, improper installation or improper testing.

CONTACT: