

# **FEX02TB (Increase Data) 2.4GHz FH-SS RF-module Instruction Manual**



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## 1 Overview

- (1) 2.4 GHz band FH (frequency hopping) type wireless module.
- (2) This module has adopted a communication protocol that is intended to be used as a wireless controller.
- (3) Using the UART, it is set by the command input, and performs input and output operational data.



Table 1 : FEX02TB Appearance photo

## 2 General Specification

### 2.1 High-frequency portion

- Technical standards : ARIB STD-T66  
: FCC Part15.247  
: EN 300 328
- Antenna power : 20~75mW
- Communication method : Spread spectrum FH system
- Spread bandwidth : 60MHz
- Radio frequency band : 2407.5MHz~2467.5MHz
- Frequency control : frequency hopping (31 patterns, 31 waves)
- Data modulation rate : 128.143kbps
- Coverage area : outdoors 365m [TBD]  
(according to an external antenna, sight distance, and our measurement method)
- Antenna terminal : U.FL connector
- Antenna : diversity (Tx/Rx)
- Error detection function : CRC-CCITT (16bits)

### 2.2 External interface

- Physical interface : molex 53780-1490(14pin)  
Mating connector 51146-1400
- Interface : RS-232C (DCE-mode)  
input 3.3V CMOS-level (with hysteresis)  
output 3.3V CMOS-level
- Communication method : full duplex
- Synchronization method : start-stop synchronization method
- Baud rate : 115200bps
- Flow control : none
- Data length : 7 bit/8 bit

- Stop bit : 1 bit/2 bit
- Parity : even/odd/none

### 2.3 Power supply

- Source voltage : DC 3.8V~8.5V
- Consumption current : transmission 300mA or less  
reception 35mA or less  
average at communication 200 mA or less [TBD]

### 2.4 Environmental specifications

- Temperature conditions : Operating temperature limits  
ambient temperature ; -20 to +60°C  
Storage temperature range  
ambient temperature ; -30 to +70°C
- Operating humidity limits : 90%RH or less (no condensing)
- Storage humidity range : 90%RH or less (no condensing)
- Anti-vibration : 50m/s<sup>2</sup> (JIS-C-60068-2-6)
- Anti-shock : 500m/s<sup>2</sup> (JIS-C-60068-2-27)

### 2.5 Others

- External dimensions : 63(W) × 35(D) × 3(H) mm
- Weight : about 14g

**2.6** External Terminal

Table 1 : Terminal function

No.	Terminal name	I/O	Function	Internal terminal processing
1	NC	—		
2	RxD	OUT	UART RxD (Response Output)	
3	TxD	IN	UART TxD (Command Input)	
4	NC	—		
5	GND	—	signal ground	
6	CLK	IN	reserved	Pull-down
7	STE	IN	reserved	Pull-down
8	SDA	IN	reserved	Pull-down
9	SCL	IN	Reserved	Pull-down
10	VCC	—	Power DC 3.8~8.5 V	
11	RST	IN	CPU reset	
12	3.3V	OUT	Test	
13	Reserved	OUT	Reserved	Low
14	TEST	IN	Test	

**2.7** Reset terminal

Resetting with the Reset terminal provides the pulse below.

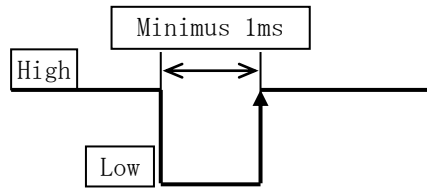


Figure 2 : Reset pulse

**2.8** Initialization time

- (1) The initialization time (after power up until accept command) is 90ms or less.
- (2) The initialization time by the RST command input is 1200ms.

**2.9** Appearance

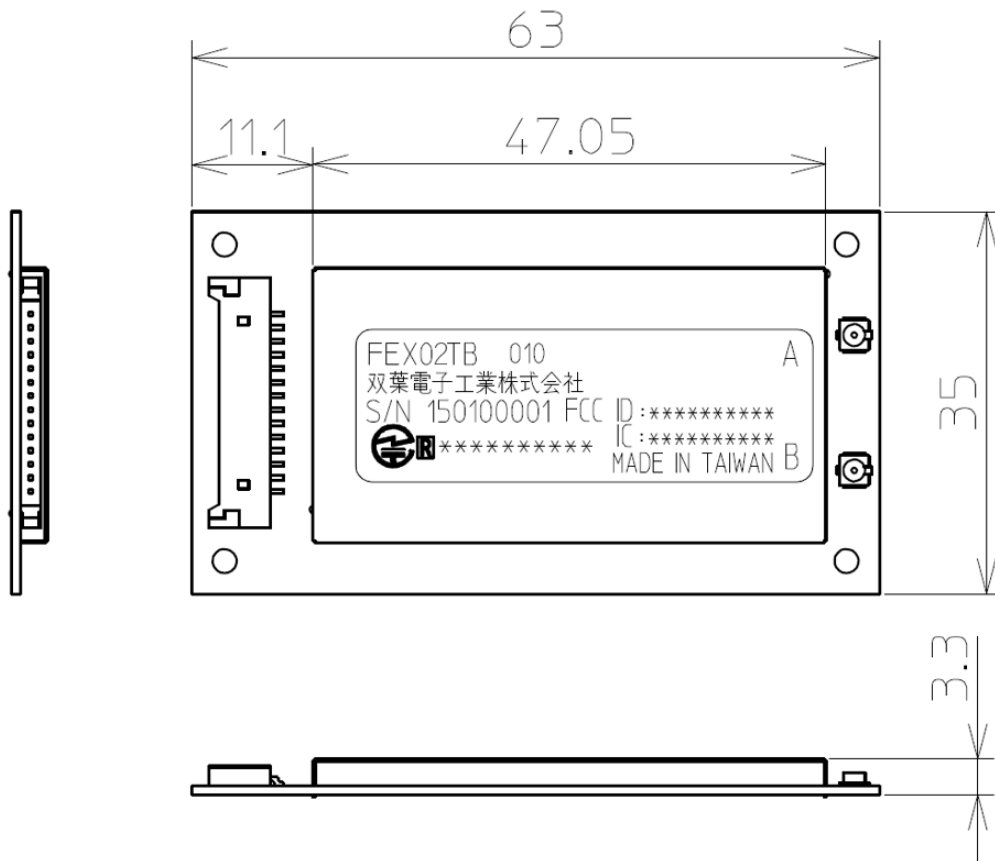


Figure 3 : FEX02TB External view

**2.10** Antennas

This radio transmitter (FCC ID: AZP-FEX02T1, IC: 2914D-FEX02T1) has been approved by Federal Communications Commission or 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, having a gain greater than the maximum gain indicated for any type listed are strictly prohibited for use with this device.

Table 2 : Specification of antennas

	Antenna type	Peak gain	Connector type	Obtained certification
ANT-2.4-CW-RH-SMA	Omni-directional (1/4 Wave Antenna)	-0.9dBi	SMA	CE
ANT-2.4-WRT-SMA	Omni-directional (1/2 Wave Antenna)	3.5dBi	SMA	CE
ANTB24-073A0	Omni-directional	2.14dBi	MHF (I-PEX)	FCC/IC, CE
TNHW 2450 RP	Omni-directional (1/2 Wave Antenna)	2.4dBi	TNC reverse	CE
RD2458-5-OTDR	Omni-directional	3.0dBi	N male	CE

### 3 Communication Method

#### 3.1 Frequency hopping

This wireless module employs an FH system as a diffusion method. In the FH system, diffusion signals with a wide bandwidth are produced by hopping the frequency according to a certain pattern. The pattern is called a frequency hopping pattern. This device has 31 types of frequency hopping patterns. The same hopping pattern is set for the wireless machines that are intended to mutually communicate.

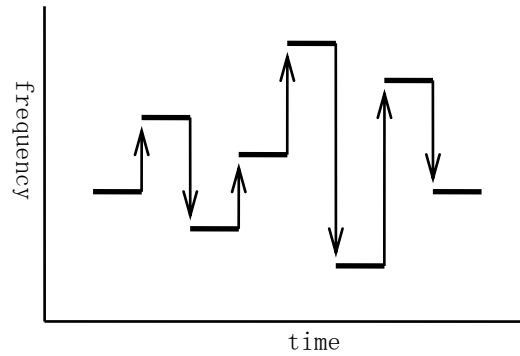


figure 4 : frequency hopping

Even when the hopping pattern is the same, mutual communication is impossible when a wireless module randomly hops the frequency. Therefore, in the frequency hopping system, one of the wireless machines works as a standard, while other wireless machines synchronize the frequency and hopping timing of each machine by receiving packets from the standard machine. This is called synchronization.

#### 3.2 Synchronization

The slave switches frequency while waiting for a wireless packet from the master. When a wireless packet is received, it switches to the next frequency and waits for a wireless packet again. When received, it is judged that the synchronization with the master was successful. After that, the slave matches the timing and sends wireless packets to the master.

No timeout is set, even for cases when synchronization is unsuccessful due to a poor communication environment. It continues receiving until synchronization succeeds. In the case when synchronization fails during communication for some reason, a maximum of 1000ms is required to re-synchronize.

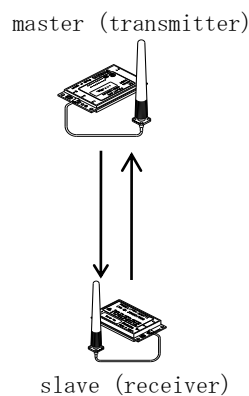


figure 5 : master and slave



## 4 Communication procedure

### 4.1 Overview

Communication is done in the following manner :

- (1) Right after the power is turned on, the master and slave does not have wireless communication and is in an invalid state.
- (2) For sending/receiving a wireless packet, start the FH operation by inputting the @FHS command (the master and the slave).  
The master initiates RF transmission and reception.  
The slave starts RF reception, wait for communication from the master.
- (3) If FH synchronization acquisition, slave start also sent. After that, the slave will continue in automatic synchronization.
- (4) By TLC command to set the data you want to send.
- (5) In FH synchronization acquisition, it will receive the data periodically from the communication partner.  
If the synchronization is out, it does not receive the data.
- (6) To stop sending/receiving a wireless packet, type the @FHE command and quit the FH operation.

### 4.2 Send command

The command header is "@TLC", the terminator is CR+LF (0x0D 0x0A). There is no response to the command.

Please send data as a binary data of 60-byte fixed.

Radio transmission will be run every 20ms. By @TLC command, it will update the transmitted data. If @TLC command is not inputted, the previous data is wirelessly transmitted. If you also send command has not been entered once, the data of all 0 is wireless transmitted.

**【Send (update) format】**

@TLC[Binary data 60 bytes][CRLF]

### 4.3 Received data

The received data is appended "RLC" of 3 bytes as a header.

The Received data is binary data of 60-byte fixed.

Radio reception will be run every 20ms. In a state that can't be wireless communication, it will not be output to the wired.

**【Reception format】** Repeat

RXT[Binary data 60 bytes]

**4.4 Master communication procedure**

- (1) After the power is turned on, the master does not perform the wireless communication.
- (2) If you want to transmit and receive wireless packet, enter FHS command.
- (3) As long as the FH synchronization acquisition, the data from the slave is output to the wired. The received data will be "RLC" header is added.
- (4) If you send the data to the slave, enter the @TLC command. By sending @TLC command regularly, the transmitted data is updated.
- (5) If you stop the wireless communication, enter the @ FHE command.

**4.5 Slave communication procedure**

- (1) After the power is turned on, the slave does not perform the wireless communication.
- (2) If you want to transmit and receive wireless packet, enter FHS command.
- (3) As long as the FH synchronization acquisition, data from the master is output to the wired. The received data will be "RLC" header is added.
- (4) If you send the data to the master, enter the @TLC command. By sending @TLC command regularly, the transmitted data is updated.
- (5) If you stop the wireless communication, enter the @ FHE command.

**4.6 Communication time**

Interval of the frequency hopping (switching frequency) is 20ms. This 20ms is one frame. The master wirelessly transmits (1 packet transmission) at the beginning of the frame. Communication time is about 5ms. The slave that is synchronized with the master wirelessly receives the packet at the beginning of the frame.

The figure below shows the timing.

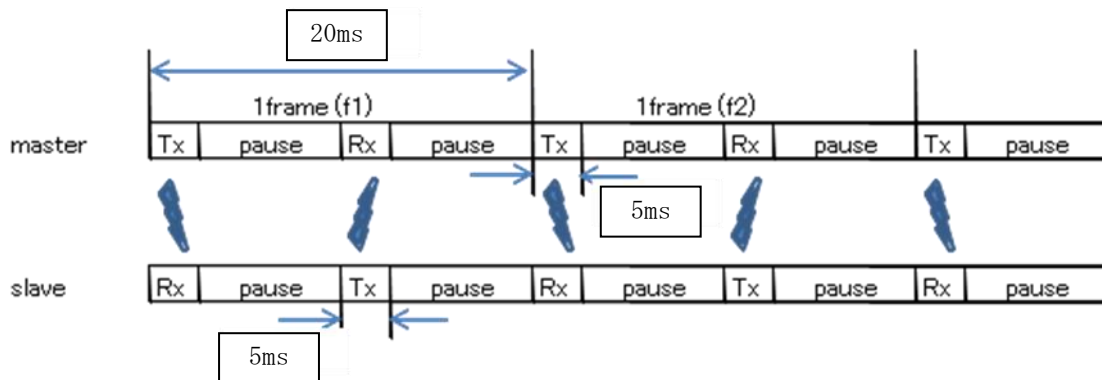


Figure 6 : FH communication timing

## 5 Other functions

### 5.1 ID Registration

In order to associate the master and the slave, an ID code is used. Each wireless module has a unique value.

For wireless communication, registration of the ID code of the communication partner is necessary. Wireless machines without ID code registration are unable to communicate. This prevents improper connections.

To make the pairing, in a state in which the closer to the master / slave, and then run the @IDS command to both the master / slave. In the case of slave, it is possible to register up to two. Please refer to the description of @IDS command for how the second unit of the specified.

If the pairing is successfully complete, "Pair" response is output, pairing ID code is written to the memory. In order to perform the normal communication, please do the once reset.

If the pairing is not completed, approximately becomes a time-out within 5 seconds, it is returned NO response.

The slave is possible to register the master up to two.

However, communication is carried out in a one-to-one, you will not be able to communicate from two masters. The slave keeps a connection with the master that initiated the first communication.

## 6 Commands

### 6.1 List of commands

Table 3: List of commands

No.	Command name	Function
1	ARG	Display all register values
2	DBM	Reference a reception intensity of received packet
3	ERR	Reference error status
4	FHE	End FH operation
5	FHS	Start FH operation
6	ID1	Reference and set pairing ID1
7	ID2	Reference and set pairing ID2
8	IDS	Start ID registration
9	INI	Initialize register values
10	ODA	Disable output
11	OEN	Enable output
12	REG	Reference and set register values
13	RST	Reset
14	TLC	Set wireless data
15	VER	Display version

### 6.2 How to use commands

- (1) When inputting a command to the wireless module, add 1 byte header for command recognition (command header) at the beginning of the command, in order to differentiate from regular data. The command header is "@" (40H).
- (2) Command is case-sensitive.
- (3) A 2-byte terminator is used to terminate a command. The terminator is [CRLF] (0DH: carriage return + 0AH: line feed).
- (4) The wireless module executes a command process after recognizing a command. For a command with a response, it returns the response to external devices after the process is completed.
- (5) Do not input subsequent commands or data before getting a response.
- (6) Command example

@ARG[CRLF]

### 6.3 Command responses

#### 6.3.1 Types of command responses

Command responses and their meanings are:

- P0: normal termination
- P1: running command
- N0: command error
- N6: memory register writing error

## 6.4 Details of the command functions

The symbols used in this section have the following meaning:

- [ ] : Required input parameter/s
- ( ) : Optional input parameter/s

ARG : Display all register values

---

**【Format】**

ARG

**【Response】**

Setting list display

NO : command error

**【Function】**

- Refers to all contents of memory register. Displays a two-digit hexadecimal number plus H at the end.

DBM : Reference the reception intensity of received packet

---

**【Format】**

DBM

**【Response】**

-XXXdBm : reception intensity

NO : command error

**【Function】**

- Reads the reception intensity of the most recent, correctly received packet, and displays it in decibels.
- When none has been received after resetting, “-134dBm” is displayed.
- The signal strength indication is not absolute. It can be used for accurate relative measurements but should not be considered an absolute value.

ERR : Reference error status

---

**【Format】**

ERR

**【Response】**

xxH : error status

NO : command error

**【Function】**

- This command display the error information of the internal this module. If 00H is no error.
- bit2=1: memory (settings area) error
- bit1=1: memory (user area) error
- bit0=1: RF error

**F H E** : End FH operation

---

**【Format】**

FHE

**【Response】**

P0 : normal termination  
N0 : command error

**【Function】**

- End FH operation. At this status, wireless transmission does not occur.
- Master/Slave stops radio transmission and reception. If state that FH synchronization acquisition, and then release it.
- Even when there is received data from a paired module, wired output does not occur.

**F H S** : Starts FH operation

---

**【Format】**

FHS

**【Response】**

P0 : normal termination  
N0 : command error

**【Function】**

- Starts FH operation.
- Master/Slave starts radio transmission and reception.
- When there is received data from a paired master, wired output starts.
- If there is data received from pairing the communication partner, to start the output to the wired.

**I D 1** : Reference and set pairing ID1

---

**【Format】**

ID2(:pairing ID code 1)

pairing ID code 1 : xxxxxxxx (9-digit)

**【Response】**

xxxxxxx : pairing ID code 1 (when when referencing)  
P0 : normal termination (when setting)  
N0 : command error

**【Function】**

- References and sets the pairing ID code 1.
- By inputting only the command, currently set values can be referenced.
- Specify the ID code (9-digit Serial Number) of the module that is the communication partner.
- Both master and slave are valid.
- The setting becomes effective after a reset.

**I D 2** : Reference and set pairing ID2

---

**【Format】**

ID2(:pairing ID code 2)

pairing ID code 2 : xxxxxxxx (9-digit)

**【Response】**

xxxxxxx : pairing ID code 2 (when when referencing)  
P0 : normal termination (when setting)  
N0 : command error

**【Function】**

- References and sets the pairing ID code 2.
- By inputting only the command, currently set values can be referenced.
- Specify the ID code (9-digit Serial Number) of the module that is the communication partner.
- Slave only is valid.
- The setting becomes effective after a reset.

**I D S** : Start ID registration

---

**【Format】**

IDS:[pairing area]

pairing area : x (1= pairing ID code 1, 2= pairing ID code 2)

**【Response】**

P0 : normal termination  
Pair : pairing is completed  
N0 : command error, or pairing is not completed  
N6 : memory register writing error

**【Function】**

- Starts pairing operation.
- In the case of master, please specify '1' to the pairing area.
- In the case of slave, please specify '1' or '2' to the pairing area.

**I N I** : Initialize register value

---

**【Format】**

INI

**【Response】**

P0 : normal termination  
N0 : command error

**【Function】**

- Resumes all contents of the memory register in the wireless module to the status at factory shipment.

**ODA** : Disable output

---

**【Format】**

ODA

**【Response】**P0 : normal termination  
N0 : command error**【Function】**

- Disable the radio transmission and wired output. Temporarily used when you want to stop FH communication. If this module already has FH synchronization acquisition, also it will continue to maintain FH synchronization after executing this command.
- Output in the initial state is enabled.
- Slave only.

**OEN** : Enable output

---

**【Format】**

OEN

**【Response】**P0 : normal termination  
N0 : command error**【Function】**

- Enable the radio transmission and wired output.
- Output in the initial state is enabled.
- Slave only.

**REG** : Reference and set register values

---

**【Format】**

REG[register number]( :set value)

Register number : 00~XX

Set value : input a two-digit hexadecimal number with H at the end,  
or a three-digit decimal number without any suffix.**【Response】**XXX : currently set value (when referencing)  
P0 : normal termination (when setting)  
N0 : command error  
N6 : memory register writing error**【Function】**

- References and sets the memory register.
- By inputting only a register number, currently set values can be referenced.
- The setting will be valid after reset.



## R S T : Reset

---

### 【Format】

RST

### 【Response】

P0 : normal termination  
N0 : command error

### 【Function】

- This module will be reset.

## T L C : Set wireless data

---

### 【Format】

TLC[binary data]

Binary data : 60-bytes fixed

### 【Response】

None

### 【Function】

- It specifies the data you want to send to the communication partner. It is 60-bytes fixed in binary data.
- In order to avoid the mixing of the received data, there is no response to this command.
- Input of this command, please as a 50ms interval at the shortest.

## V E R : Display version

---

### 【Format】

VER

### 【Response】

Program Version 1.000 : display version  
N0 : command error

### 【Function】

- Reads a program version of the wireless module.
- X. XXX
  - └─ Improvements and bug fixes within a range of specifications
  - └─ Minor specification change
  - └─ Major specification change

## 7 Memory register

The memory register is a register that sets and memorizes operation modes and communication parameters for the wireless module. These values are read when the power is turned ON, and the module starts operating according to the setting.

### 7.1 Memory register list

Table 4: Memory register list

Register number	Function	Default	Default function
REG00	Operation mode	00H	Master
REG01	Reserve	00H	
REG02	Frequency hopping pattern	00H	
REG03	Reserve	00H	
REG04	Wireless communication setting 1	08H	Antenna diversity
REG05	Wireless communication setting 2	00H	
REG06	Reserve	00H	
REG07	Reserve	00H	
REG08	Wired communication setting 1	01H	19200bps
REG09	Wired communication setting 2	00H	
REG10	FH synchronization determination setting 1	00H	
REG11	FH synchronization determination setting 2	00H	
REG12	Detailed setting	08H	
REG13	Reserve	00H	
REG14	Pairing ID code 1	00H	
REG15		00H	
REG16		00H	
REG17		00H	
REG18		00H	
REG19	Reserve	00H	
REG20	Pairing ID code 2	00H	
REG21		00H	
REG22		00H	
REG23		00H	
REG24		00H	
REG25	Reserve	00H	

**7.2** Memory register function detail

**REG 0 0** : Operation mode [default : 0 0 H]

\* Sets an operation mode (for the master or the slave).

Table 5 : Operation mode

00H	Master (default)
01H	Slave

**REG 0 1** : Reserved [default : 0 0 H]

\* Not used in this wireless module. Leave default setting.

**REG 0 2** : Frequency hopping pattern [default : 0 0 H]

\* Sets the frequency hopping pattern. It can be set to 00~1E (0~30).

\* Master only settings are valid. Slave sets the frequency hopping pattern automatically based on the information of the master.

\* In the initial state, a specific frequency hopping pattern is set. Because it is set to 00H if you initialize, please set again.

\* When using multiple systems within the same area, the frequency may periodically match and interfere with each other even when the frequency hopping patterns are different.

**REG 0 3** : Reserved [default : 0 0 H]

\* Not used in this wireless module. Leave default setting.

**REG 0 4** : Wireless communication setting 1 [default : 0 8 H]

Bit7~4 : Reserved

\* Not used in this machine. Make sure to set to 0.

Bit3 : Antenna diversity

Table 6 : Antenna diversity

0	Disable antenna diversity
1	Enable antenna diversity (default)

\* Enables/disables antenna diversity.

\* When used with two antennas, set to 1 in this bit.

Bit2 : Antenna selection

Table 7 : Antenna selection

0	Antenna is fixed to A (default)
1	Antenna is fixed to B

\* At the non-diversity reception, decide the antenna terminal.

Bit1~0 : Reserved

\* Not used in this machine. Make sure to set to 0.

REG 0 5 : Wireless communication setting 2 [default : 0 0 H]

\* Not used in this wireless module. Leave default setting.

REG 0 6 : Reserved [default : 0 0 H]

\* Not used in this wireless module. Leave default setting.

REG 0 7 : Reserved [default : 0 0 H]

\* Not used in this wireless module. Leave default setting.

REG 0 8 : Wired communication setting 1 [default : 0 1 H]

Bit 7: data length

Table 8: Data length

0	8 bit data (default)
1	7 bit data

Bit 6: parity bit

Table 9: Parity bit

0	Without parity (default)
1	With parity

Bit 5: Even/odd parity

Table 10: Parity

0	Even parity (default)
1	Odd parity

\* Invalid when “without parity” is set in bit 6.

Bit4: Stop bit

Table 11: Stop bit

0	1 stop bit (default)
1	2 stop bit

Bit3 : Reserved

\* Not used in this machine. Make sure to set to 0.

Bit2~0 : Baud rate setting

Table 12 : Baud rate

Bit2	Bit1	Bit0	Baud rate
0	0	0	19200bps
0	0	1	115200bps (default)
0	1	0	Reserved
0	1	1	Reserved
1	0	0	Reserved
1	0	1	Reserved
1	1	0	Reserved
1	1	1	Reserved

REG 09 : Wired communication setting 2 [default : 0 0 H]

Bit7~5 : Reserved

\* Not used in this machine. Make sure to set to 0.

Bit4 : Addition and deletion of CRLF

Table 13 : Addition and deletion of CRLF

0	Do not add the CR+LF code to the receive data. (default)
1	Add the CR+LF code to the receive data.

\* Sets whether adding the CRLF code or not to the received data.

Bit3~0 : Reserved

\* Not used in this machine. Make sure to set to 0.

REG 10 ~ 11 : Reserved [default : 0 0 H]

\* Not used in this wireless module. Leave default setting.

REG 12 : Detailed setting [default : 0 8 H]

Bit7 : Startup message output

Table 14 : Startup message output

0	Disable startup message output (default)
1	Enable startup message output

- \* When you want to output message at startup, set to 1 in this bit.
- \* At startup, "Input command" is output to the wired. By this message, you can recognize the activation timing.

Bit6~4 : Reserved

\* Not used in this machine. Make sure to set to 0.

\* No function assignment.

Bit3 : Receive level control

Table 15 : Receive level control

0	Disable receive level control
1	Enable receive level control (default)

- \* When used with “Receive level control”, set to 1 in this bit.
- \* “Receive level control” turns LNA Off and decreases the reception level when communication at the short distance.

Bit2~0 : Reserved

- \* Not used in this machine. Make sure to set to 0.
- \* No function assignment.

REG 1 3 : Reserved [default : 0 0 H]

- \* Not used in this wireless module. Leave default setting.

REG 1 4 ~ 1 8 : Pairing ID code 1 [default : 0 0 H]

- \* Sets an ID code for a pairing machine.
- \* Both the master and slave use this.

REG 1 9 : Reserved [default : 0 0 H]

- \* Not used in this wireless module. Leave default setting.

REG 2 0 ~ 2 4 : Pairing ID code 2 [default : 0 0 H]

- \* Sets an ID code for a pairing machine.
- \* Only the slave use this.

REG 2 5 : Reserved [default : 0 0 H]

- \* Not used in this wireless module. Leave default setting.

## 8 FCC Warning

The final end product must be labeled in a visible area with the following:

“Contains FCC ID: AZP-FEX02T1”, “contains IC: 2914D-FEX02T1”.

The grantee’s FCC ID can be used only when all FCC/ IC compliance requirements are met.

Manufacturers integrating the Radio Control Module into other devices should note the following:

The device is compliant with part 15.247 of Title 47 of the FCC rules.

If the Radio Control Module is integrated into a new host product, the final host product still requires Part 15 Subpart B compliance testing with the modular transmitter installed.

### 8.1 FCC Label Compliance 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.

### 8.2 To assure continued FCC compliance

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

### 8.3 Exposure to Radio Frequency Radiation

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment.

(1) When used as a master:

This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

(2) When used as a slave:

This equipment should be installed and operated with minimum distance 20cm between the radiator & your body.

## 9 IC Warning

(English)

### 9.1 IC Label Compliance Statement

This device complies with Industry Canada license-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.

### 9.2 Exposure to Radio Frequency Radiation

This equipment complies with IC radiation exposure limits set forth for an uncontrolled environment.

(1)When used as a master:

This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

(2)When used as a slave:

This equipment should be installed and operated with minimum distance 20cm between the radiator & your body.

(French)

### 9.3 Déclaration de conformité à l'étiquette IC

Cet appareil radio est conforme au CNR d' Industrie Canada.

L' utilisation de ce dispositif est autorisée seulement aux deux conditions suivantes : (1) il ne doit pas produire de brouillage, et (2) l' utilisateur du dispositif doit être prêt à accepter tout brouillage radioélectrique reçu, même si ce brouillage est susceptible de compromettre le fonctionnement du dispositif.

### 9.4 Exposition au rayonnement radiofréquence

Cet équipement est conforme aux limites d'exposition aux rayonnements IC définies pour un environnement non contrôlé.

(1)Lorsqu' il est utilisé comme maître:

Cet émetteur ne doit pas être co-situé ou fonctionner conjointement avec une autre antenne ou émetteur.

(2)Lorsqu' il est utilisé comme esclave:

Cet équipement doit être installé et utilisé avec un minimum de 20 cm de distance entre la source de rayonnement et votre corps.