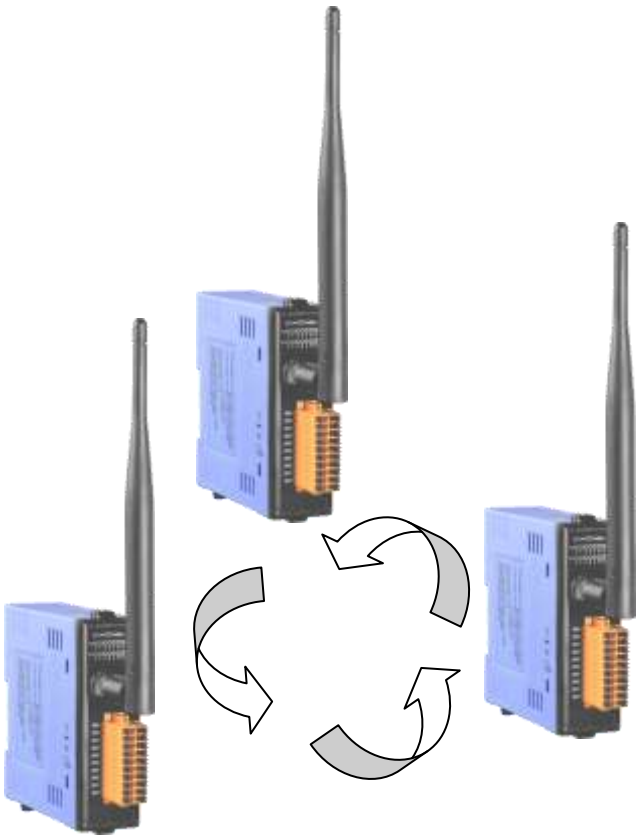


ZigBee I/O (Pair Connection) Group

ZT-20xx-IOG

User Manual

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ZT-20xx-IOG SERIES

User Manual

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1 Introduction

1.1 Introduction to ZT-20xx-IOG

ZT-20xx-IOG series (referred to as ZT-IOG) is a series of ZigBee wireless communication module with Digital Input and Digital Output channels. The “IOG” in the ZT-IOG is the abbreviation for the “I/O Group” and means this series is the multi-to-multi I/O Pair-connection Group module.

The ZT-IOG has two main functions: "I/O Pair-connection" and "I/O Group".

I/O Pair-connection Function

I/O Pair-connection means the same number of DI and DO channels will automatically be bound together as a pair, e.g. DI0 and DO0 be bound as a pair, DI1 and DO1 as a pair, DI2 and DO2 as a pair, and so on.

The actions of the paired DI and DO can be as follows. For instance:

(A) When the DI channel state is high, the paired DO channel will automatically output the state of high.

(B) When the DI channel state is low, the paired DO channel will automatically output the state to low.

I/O Group Function

In the ZT-IOG series, the module that its address (or Node ID) been adjusted to "0" will automatically be the ZigBee Coordinator (Host), those modules that address are "not 0" will be as the ZigBee Router (Slave). These two ZigBee types co-organize a ZigBee network, and form a multi-DI to multi-DO Group with the I/O Pair-connection function. When any one ZT-IOG module changing its DI channel state will automatically update all ZT-IOG modules' DO states of the

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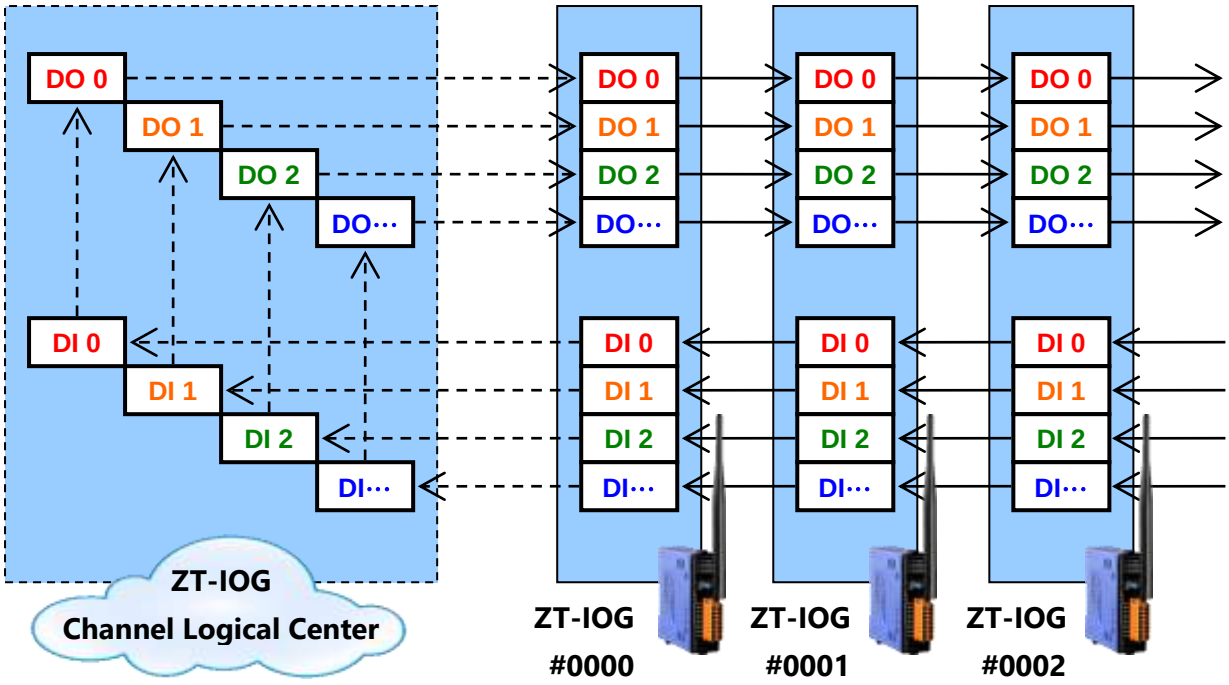
same channel number within the group.

Based on the above two function features, the ZigBee Coordinator will serve as a message processing and distribution center in the ZigBee network. As long as any DI of any ZT-IOG module changes its channel state, it will immediately trigger an event and upload it to the ZigBee Coordinator for I/O Updating Logic calculations to determine the DO output states of the ZT-IOG Group. Then, the ZigBee Coordinator will broadcast a message periodically to all ZT-IOG modules for synchronizing all DO channel states to achieve the multi-to-multi I/O Pair-connection Group functions. (Support up to 280 Pair-connection channels)

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1.2 Product Features

ZT-IOG series module has the following features: users **do not need** to use a controller and write additional programs; it **can** automatically link the Digital I/O channel states in two or more locations through the wireless communication, and transfer the Digital Input state to remote Digital Output automatically. Not only can easily meet customer's application needs, but also can save the costs of the hardware configuration and the staff development.



1.3 I/O Updating Logic For the ZT-IOG Modules

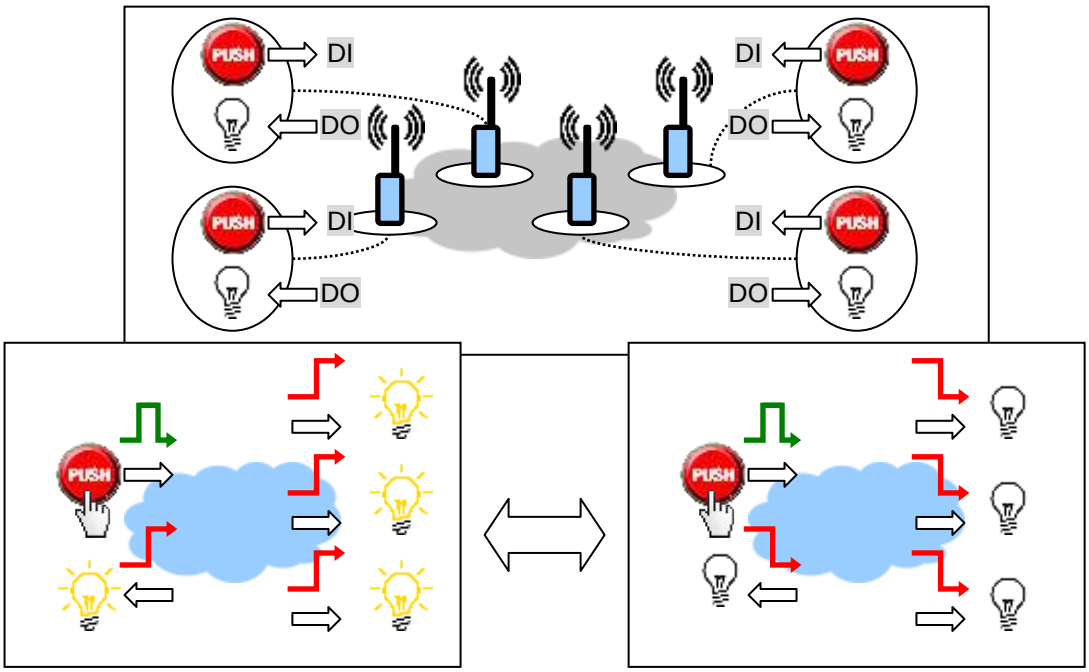
The ZigBee Coordinator (Host) is the Channel Logical Center of the ZT-IOG modules in the IOG system. There are two modes for the I/O Updating Logic:

(1) Pulse Mode

Rule: When **【any】** DI channel of the ZT-IOG module is triggered to rising edge, the IOG system will generate an event that will make the states of **【all】** ZT-IOG modules' DO channels in the network change to the reverse edge.

EX: Suppose the initial state of the DO2 channel in the ZT-IOG group is low, as long as the DI2 channel of **【any one】** ZT-IOG module in the network is triggered to rising edge, the DO2 output channel states of **【all】** ZT-IOG modules in the IOG network will be updated to the high state.

1. The DI2 channel of **【any ZT-IOG】** was the first time triggered to rising edge, it will make the DO2 channel states of **【all ZT-IOG】** change from low to high (0 → 1). (And also the 3rd, 5th, 7th... times)
2. The DI2 channel of **【any ZT-IOG】** was the second time triggered to rising edge, it will make the DO2 channel states of **【all ZT-IOG】** change from high to low (1 → 0). (And also the 4th, 6th, 8th... times)



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(2) Level Mode

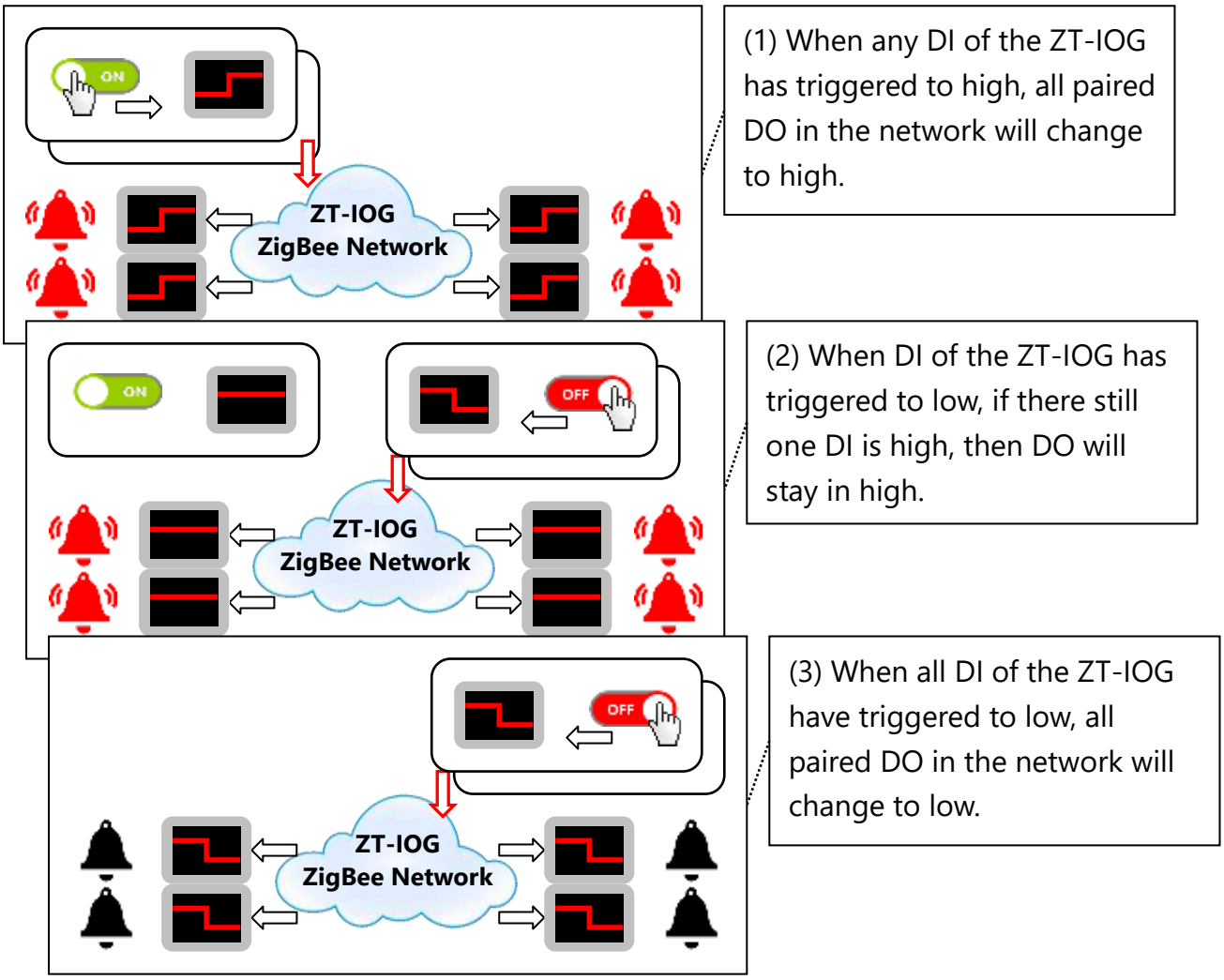
Rule 1: **【OR Logic】**

【Any one】 DI channel of the ZT-IOG module in the network triggered to the high state will generate a rising event, and then **【all】** ZT-IOG modules' DO channels in the network will change to high state automatically.

Rule 2: **【AND Logic】**

【All】 DI channel of the ZT-IOG module in the network triggered to the low state will generate a falling event, and then **【all】** ZT-IOG modules' DO channels in the network will change to low state automatically.

EX:



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2 Hardware Information

2.1 Specifications

➢ Digital I/O Specifications

Model Name		ZT-2043-IOG	ZT-2053-IOG	ZT-2055-IOG	ZT-2060-IOG
Digital Input					
Channels		0	14	8	6
Dry Contact	Type	X	Sink	Source	N/A
	ON Voltage Level	X	Close to GND	Close to GND	N/A
	OFF Voltage Level	X	Open	Open	N/A
	Effective Distance	X	500 m (Max.)	500 m (Max.)	N/A
Wet Contact	Type	X	Sink/Source	Sink/Source	Sink/Source
	ON Voltage Level	X	+3.5 V_{DC} ~ +30 V_{DC}	+10 V_{DC} ~ +50 V_{DC}	+3.5 V_{DC} ~ +30 V_{DC}
	OFF Voltage Level	X	+1 V_{DC} Max.	+4 V_{DC} Max.	+1 V_{DC} Max.
Input Impedance		X	3 kΩ, 0.33 W	10 kΩ	3 kΩ, 0.33 W
Digital Output					
Channels		14 (Sink)	0	8 (Sink)	4
Type		Isolated Open Collector	X	Open Collector	Power Relay, Form A
Current	Max. Load / Contact Rating	700 mA/channel	X	650 mA/channel	5 A @ (250 V_{AC}/30 V_{DC})
	Overload Protection	1.1 A (with short-circuit protection)	X	1.4 A (with short-circuit protection)	------
Voltage	Max. Contact Voltage	------	X	------	270 V_{AC} 125 V_{DC}
	Load Range	+5 ~ +50 V_{DC}	X	+3.5~+50 V_{DC}	------
	Overvoltage Protection	------	X	60 V_{DC}	------
Release Time		X	X	X	Max. 5 ms (at Rated Voltage)
Mechanical Endurance (at no load)		X	X	X	2 x 10^7 ops (300 ops/minute)
Electrical Endurance (Resistive Load)		X	X	X	10^5 ops (10 ops/minute)
Insulation Resistance		X	X	X	Min. 1000M Ω (at 500 VDC)
Surge Strength		X	X	X	5,080 V (1.2/50us)
Model Name		ZT-2043-IOG	ZT-2053-IOG	ZT-2055-IOG	ZT-2060-IOG

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➢ Other Specifications

Model Name	ZT-2043-IOG	ZT-2053-IOG	ZT-2055-IOG	ZT-2060-IOG
LED				
PWR	1 Red LED, ZigBee Device Power Indicator			
ZigBee	1 Green LED, ZigBee Connection Indicator			
DI	Green LED, Status of Digital Input Channel			
	N/A	DI0 ~ DI13	DI0 ~ DI7	DI0 ~ DI5
DO/Relay	Red LED, Status of Digital Output Channel			
	DO0 ~ DO13	N/A	DO0 ~ DO7	RL0 ~ RL3
Power				
Input Voltage Range	+10 V_{DC} ~ +30 V_{DC}			
Power consumption	0.84W (Max.)	0.72 W (Max.)	2.5 W (Max.)	1.4 W (Max.)
Intra-module Isolated, Field-to-Logic	3750 V_{DC}	3750 V_{DC}	2500 V_{DC}	2500 V_{DC}
Mechanical				
Dimensions (L x W x H)	87 mm x 33 mm x 110 mm	87 mm x 33 mm x 110 mm	96 mm x 33 mm x 110 mm	94 mm x 33 mm x 110 mm

➢ Common Specifications for ZT-20xx Series Modules

EMS Protection	
ESD (IEC 61000-4-2)	±4 kV Contact for Power Line, Communication Line and each Channel ±8 kV Air for Random Point
EFT (IEC 61000-4-4)	±4 kV for Power Line
Surge (IEC 61000-4-5)	±3 kV for Power Line
Mechanical	
Flammability	Fire Retardant Materials (UL 94V-0 Level)
Dimensions (W x L x H)	33 mm x 87 mm x 110 mm
Installation	DIN-Rail
Environment	
Operating Temperature	-25 to 75 °C
Storage Temperature	-30 to 80 °C
Relative Humidity	10 ~ 90% RH, Non-condensing

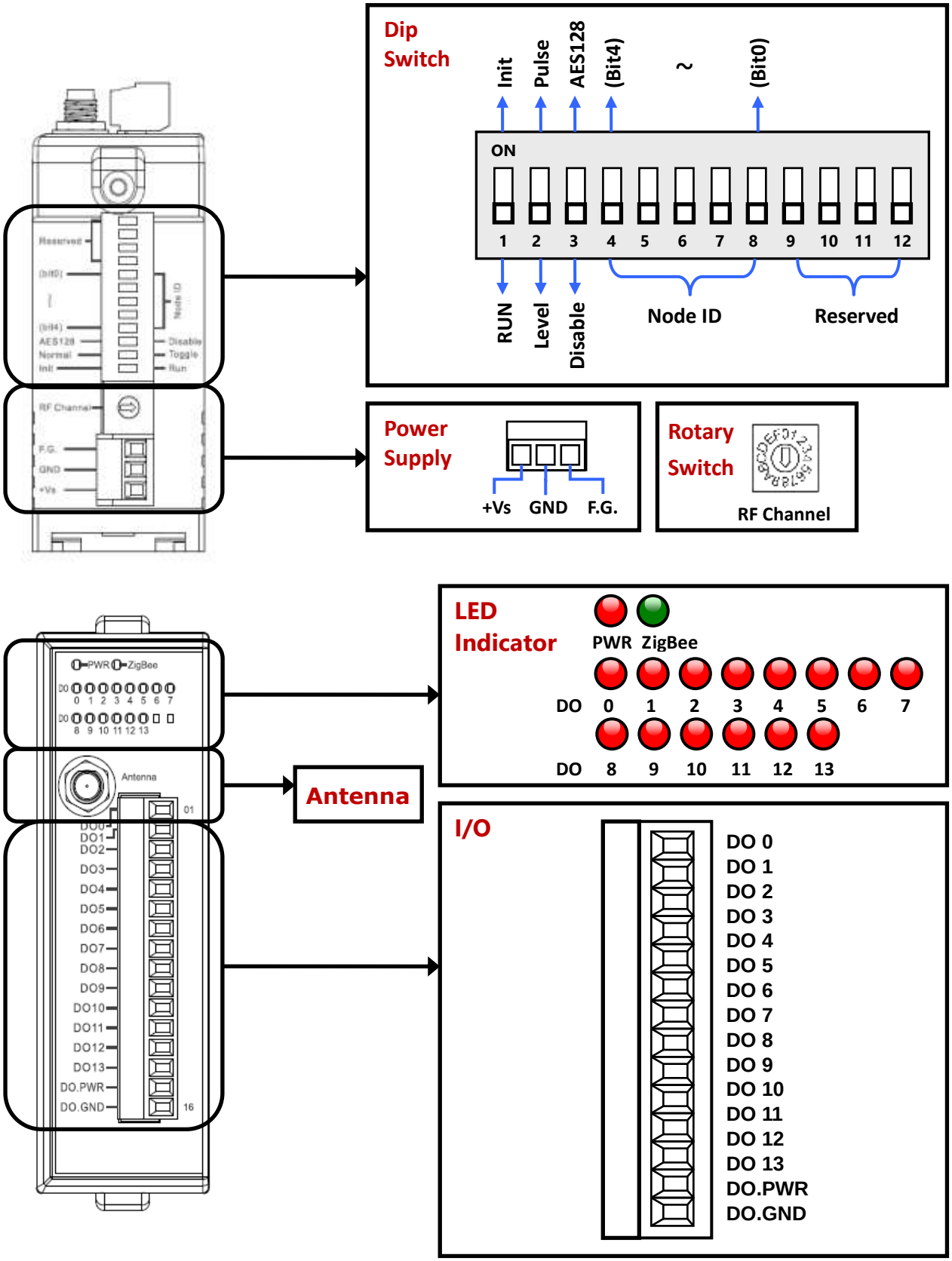
➢ ZigBee Wireless Specifications

Wireless	
RF Channels	16
RF Transmit Power	11 dBm
Antenna	2.4 GHz - 5 dBi Omni-directional Antenna
Transmit Range (LOS)	700 m (Typical)
Max. Slaves Supported	255
EMI Certification	CE/FCC, FCC ID

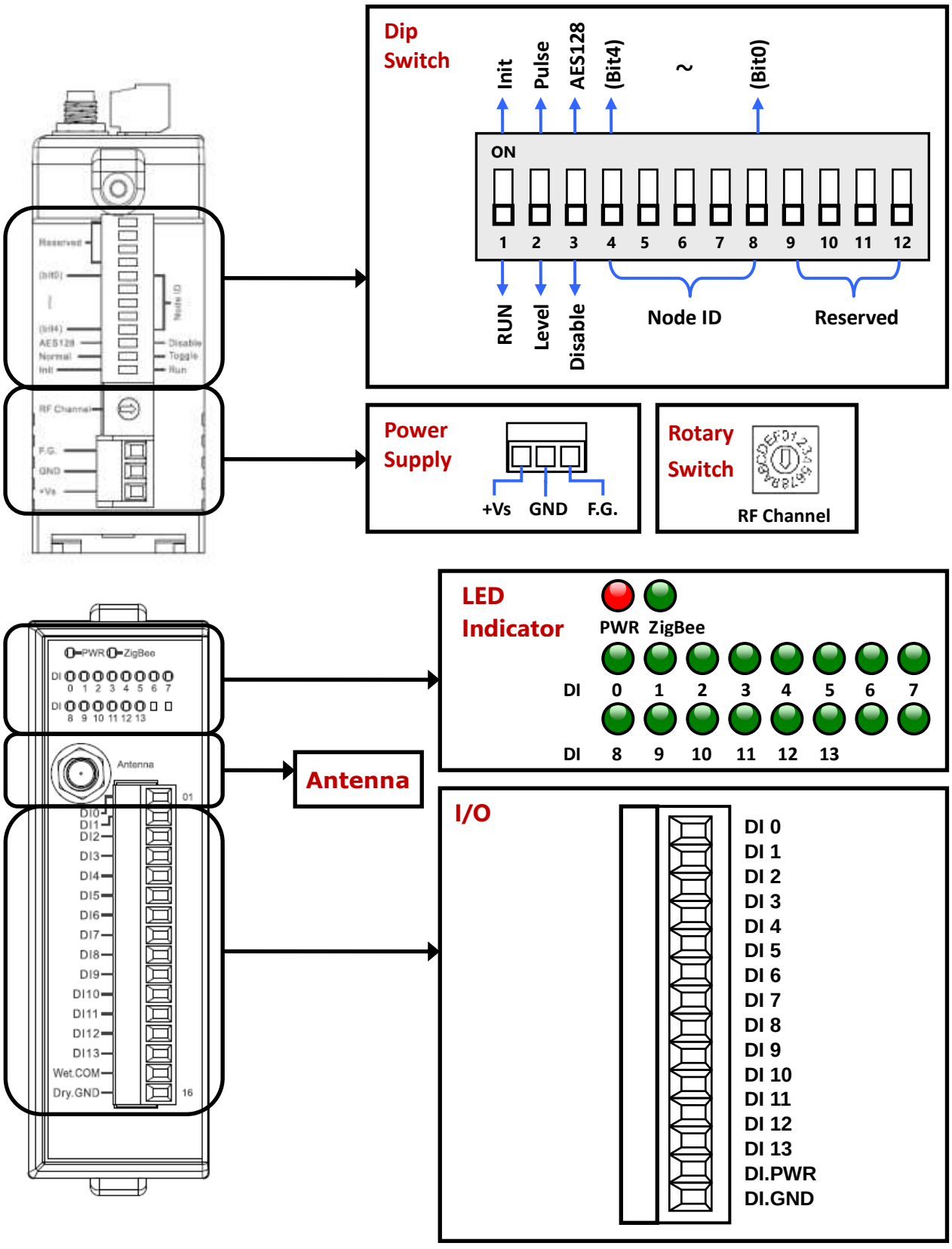
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2.2 Pin Assignments

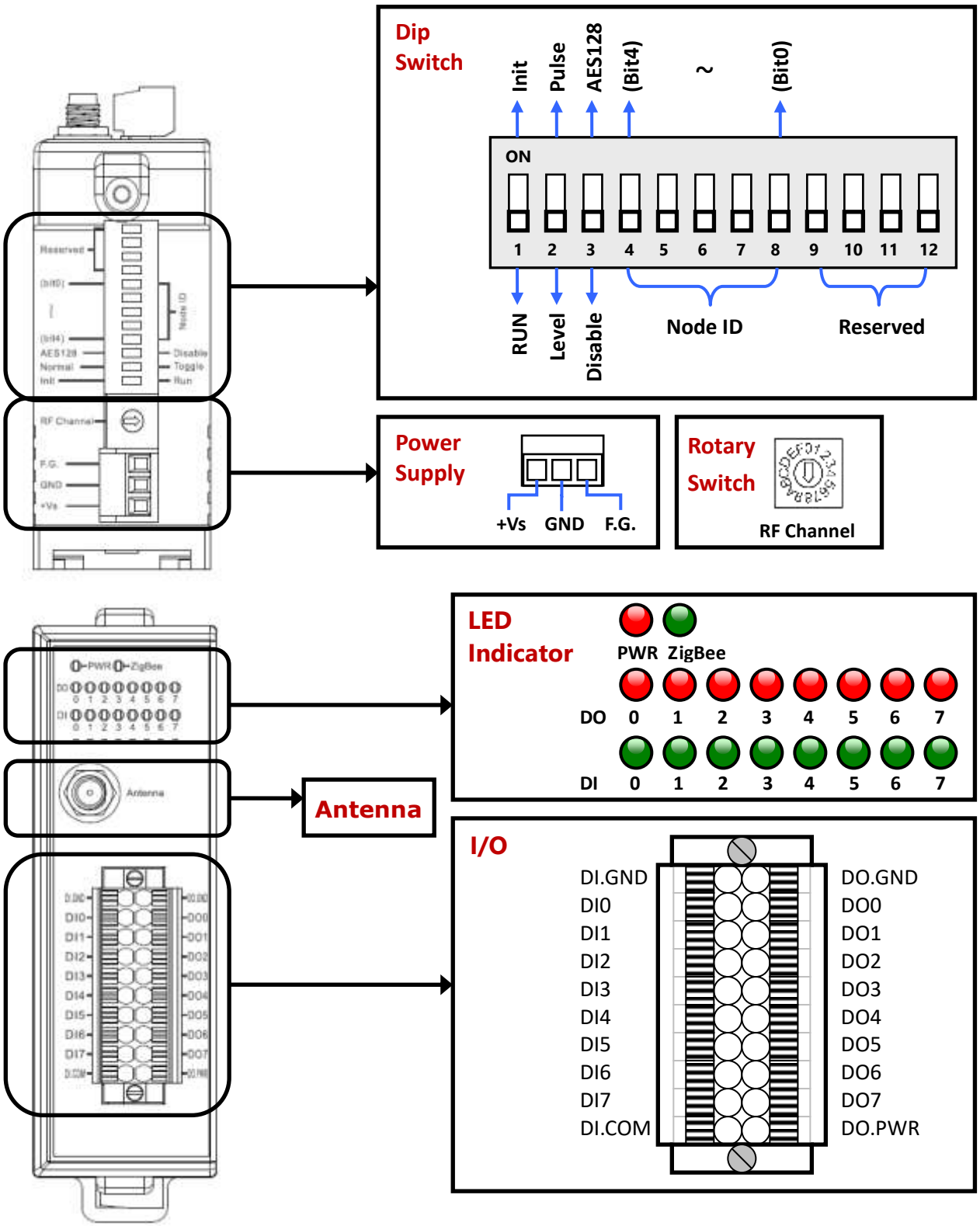
➢ ZT-2043-IOG Pin Assignments



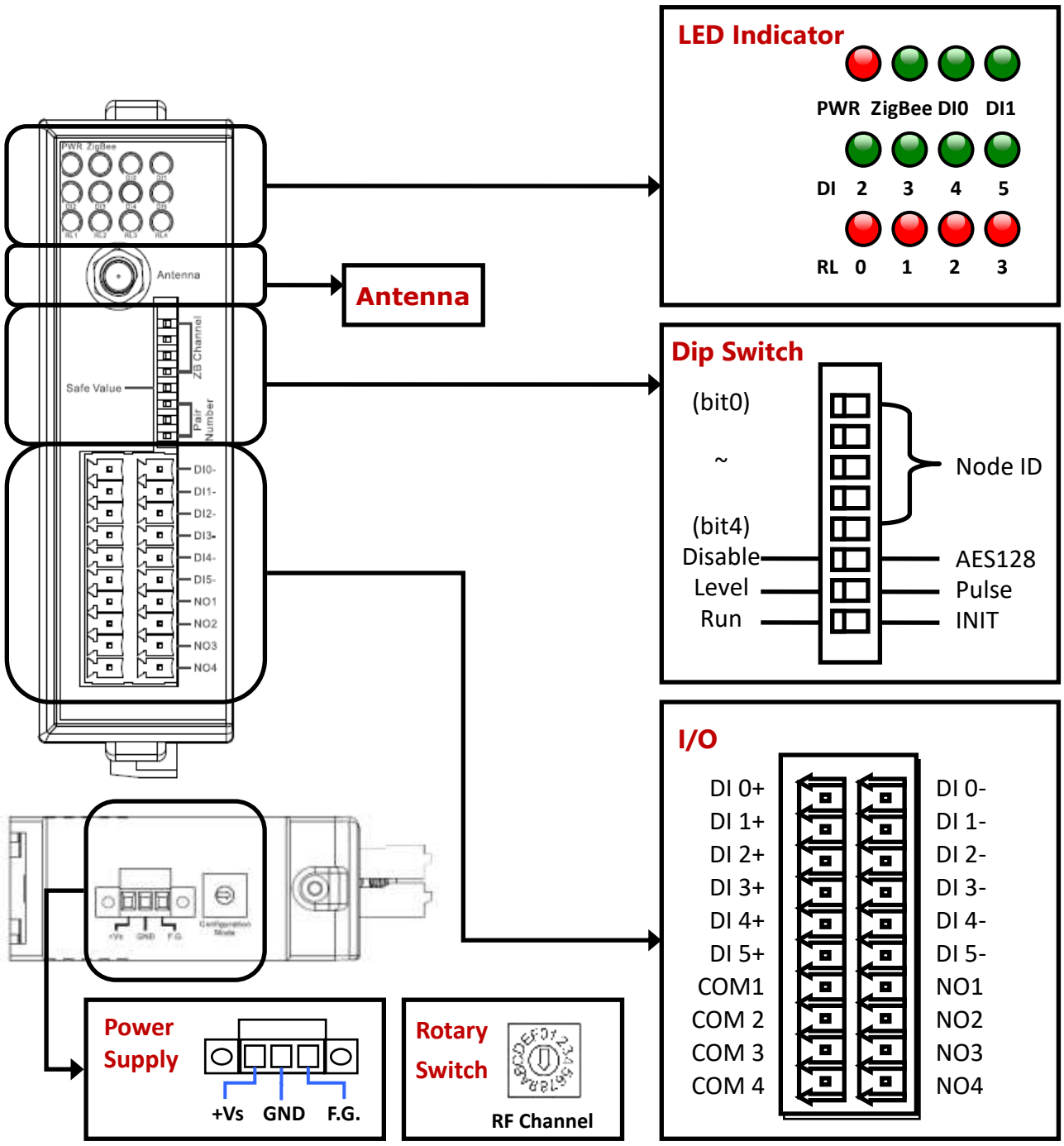
➢ ZT-2053-IOG Pin Assignments



➢ ZT-2055-IOG Pin Assignments

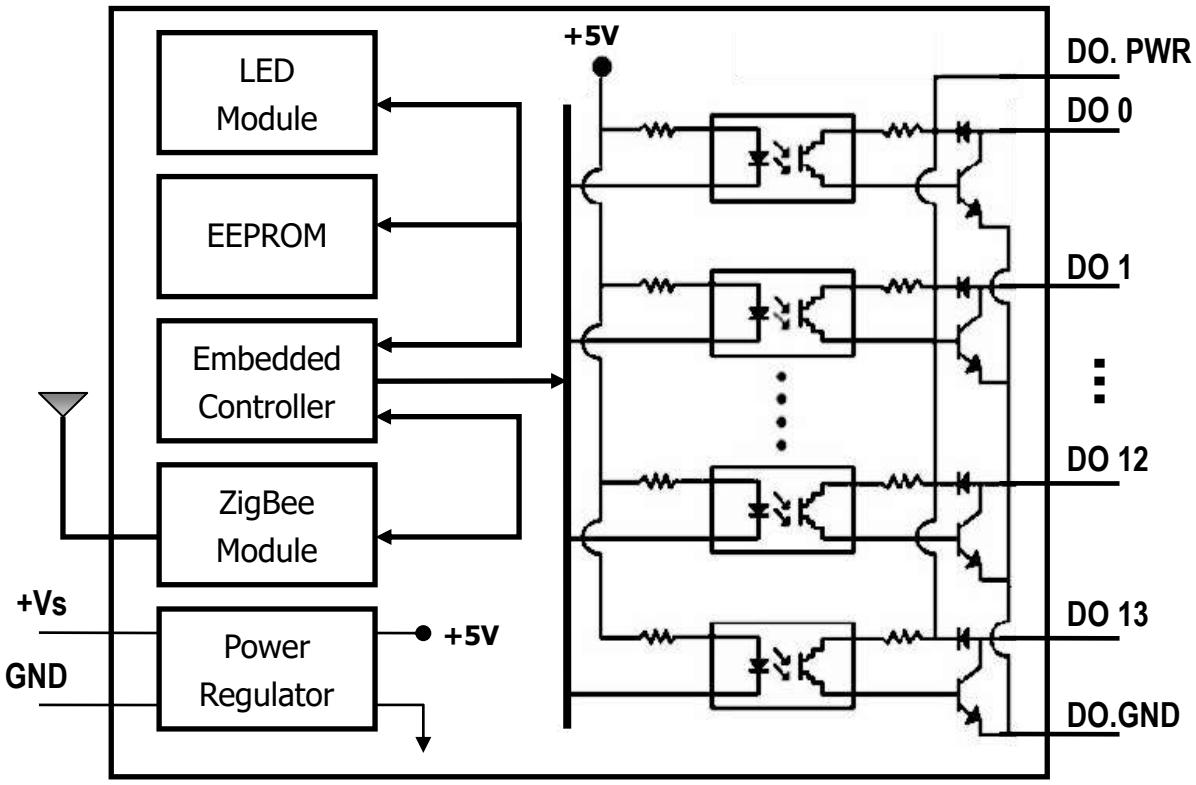


➢ ZT-2060-IOG Pin Assignments

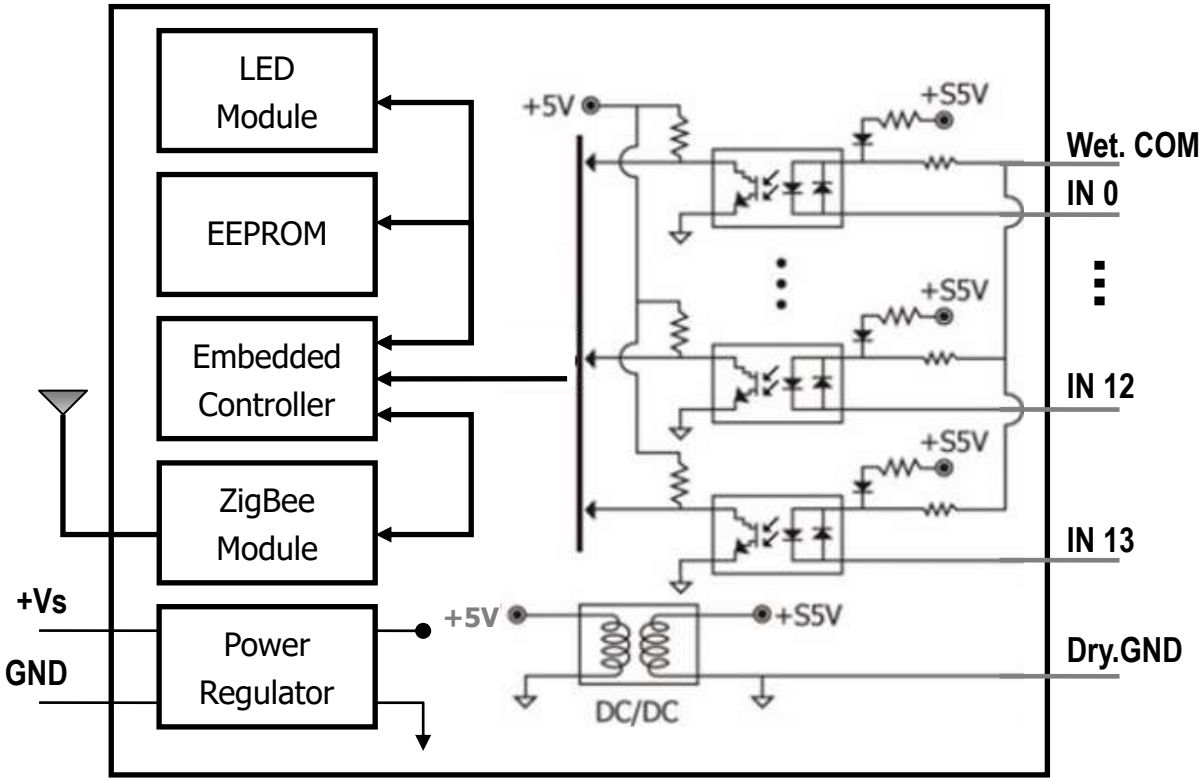


2.3 Block Diagrams

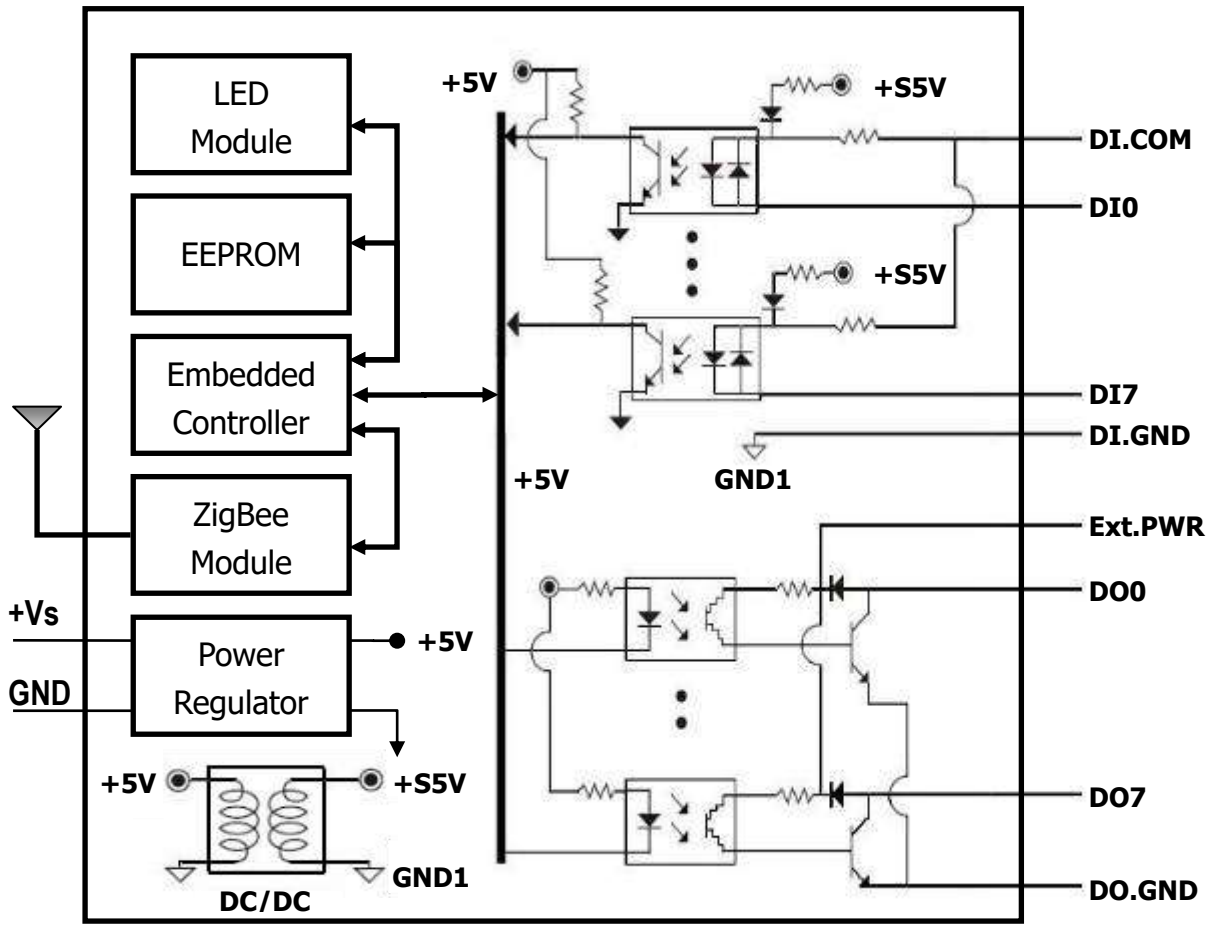
➢ ZT-2043-IOG Block Diagram



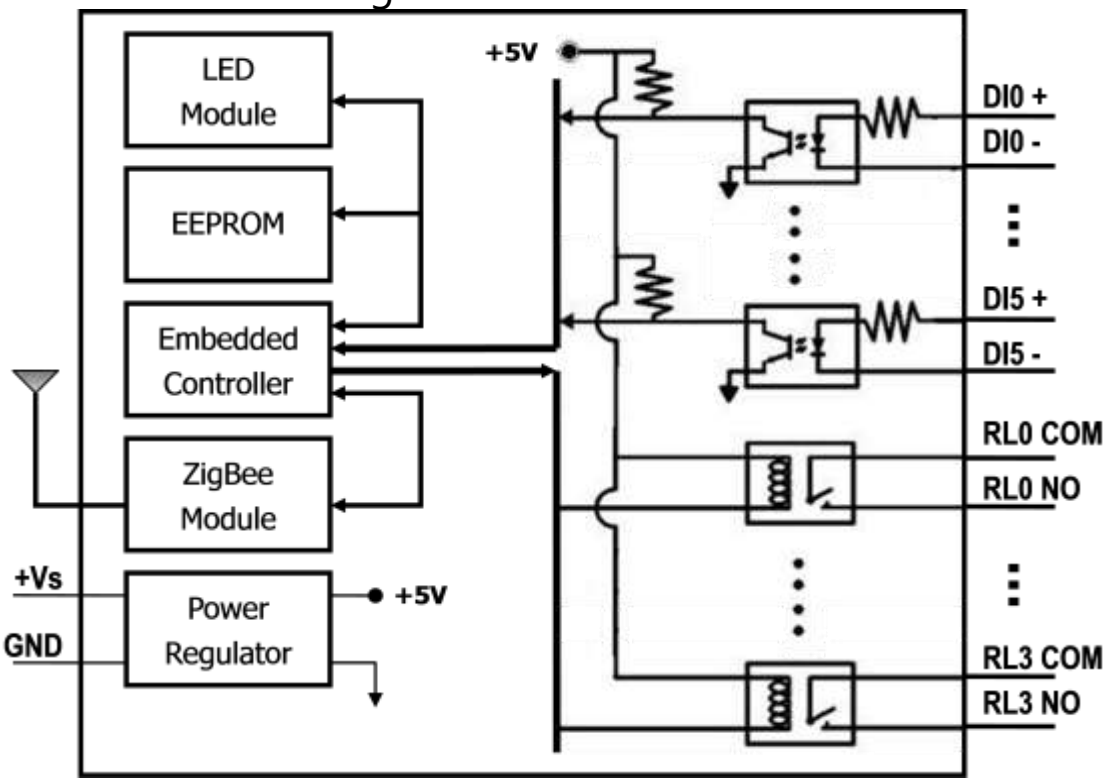
➢ ZT-2053-IOG Block Diagram



➢ ZT-2055-IOG Block Diagram

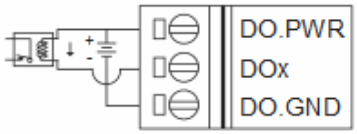
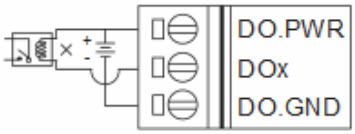
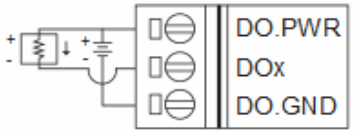
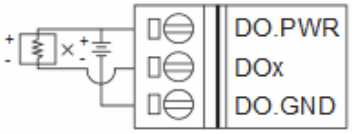


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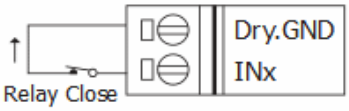
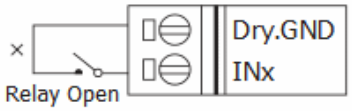
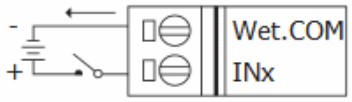
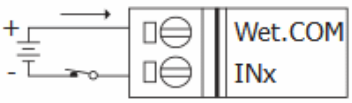


2.4 Wire Connections

➢ ZT-2043-IOG Wire Connection

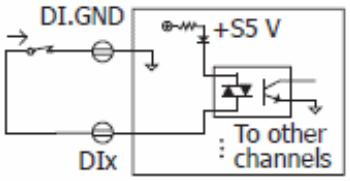
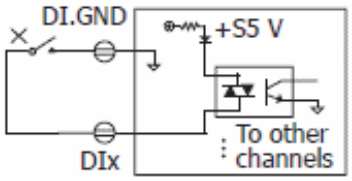
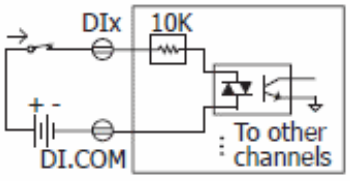
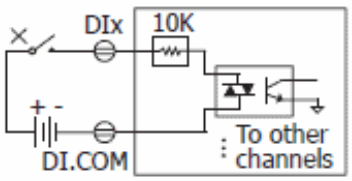
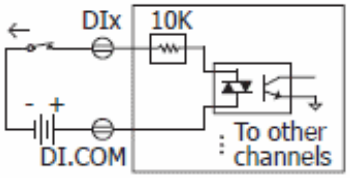
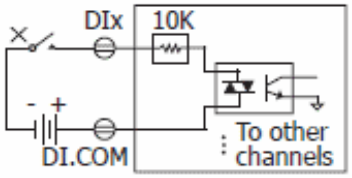
Digital Output	ON State LED ON Readback as 1	OFF State LED OFF Readback as 0
Drive Relay	Relay ON	Relay OFF
		
Resistance Load	Relay ON	Relay OFF
		

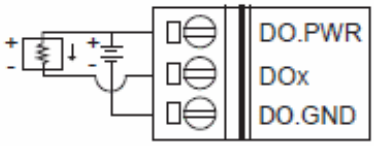
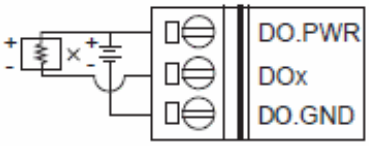
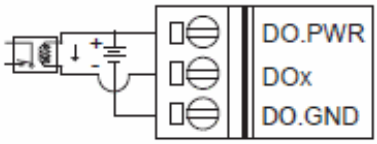
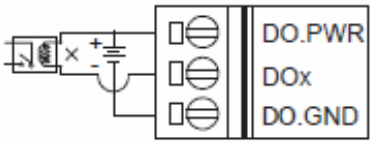
➢ ZT-2053-IOG Wire Connection

Input Type	**ON State LED ON Readback as 1**	**OFF State LED OFF Readback as 0**
Dry Contact	Relay ON	Relay OFF
		
Wet Contact (Source)	Voltage > 3.5V	Voltage < 1V
		
Wet Contact (Sink)	Open Collector ON	Open Collector OFF
		

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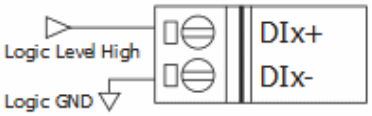
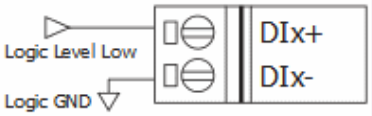
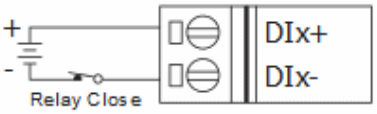
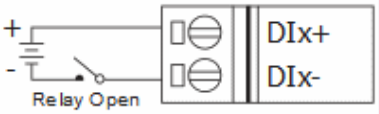
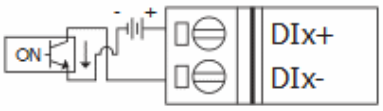
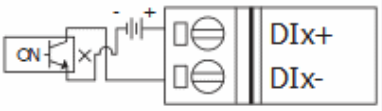
➢ ZT-2055-IOG Wire Connection

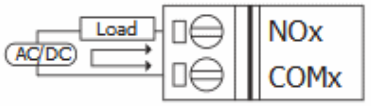
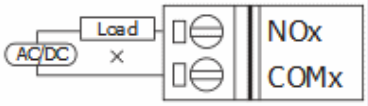
Input Type	ON State Readback as 1	OFF State Readback as 0
Dry Contact	Close to GND	Open
		
Wet Contact (Sink)	+10 ~ +50 VDC	+4 VDC Max.
		
Wet Contact (Source)	+10 ~ +50 VDC	+4 VDC Max.
		

Output Type	ON State Readback as 1	OFF State Readback as 0
Digital Output (Resistance Load)		
Digital Output (Inductive Load)		

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➢ ZT-2060-IOG Wire Connection

Input Type	ON State LED ON Readback as 1	OFF State LED OFF Readback as 0
TTL/ CMOS Logic	Voltage > 3.5V	Voltage < 1V
		
Relay Contact	Relay ON	Relay OFF
		
Open Collector	Open Collector ON	Open Collector OFF
		

Output Type	ON State LED ON Readback as 1	OFF State LED OFF Readback as 0
Relay Contact	Relay ON	Relay OFF
		

3 Setting up the ZT-20xx-IOG Modules

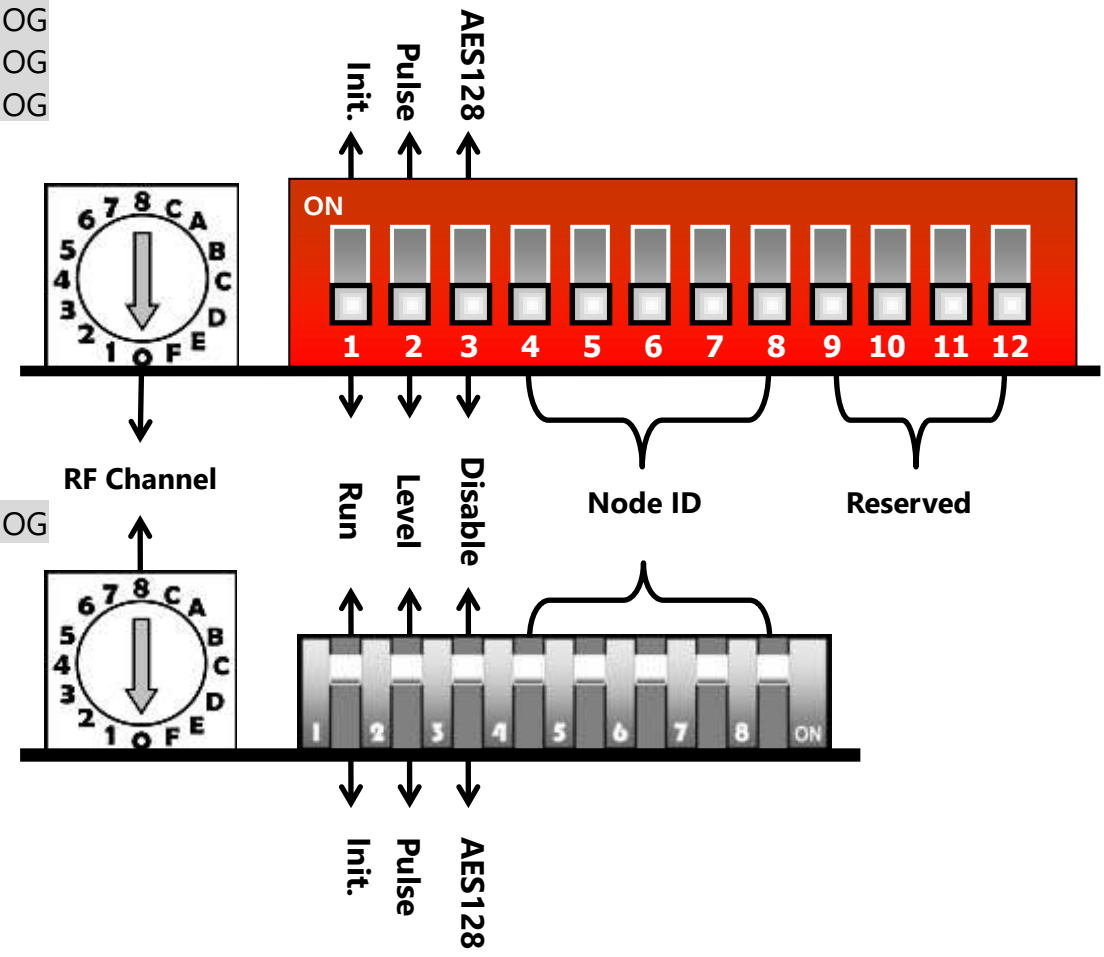
The settings for the ZT-20xx-IOG modules include "Hardware Basic Setting" and "Software Advanced Setting" two parts. Users can set up the basic settings via the hardware DIP and Rotary switches on the module. Some advanced settings, like adjusting the wireless output power, setting the safe value for disconnection, changing the I/O updating frequency of the IOG network..., users can remotely set up via the software. The following will introduce these settings.

3.1 Hardware Basic Setting

3.1.1 Hardware Setting Interface

The hardware has two types depending on the different model numbers. The definitions of the Rotary/DIP switches are as the following diagrams:

- ✓ ZT-2043-IOG
- ✓ ZT-2053-IOG
- ✓ ZT-2055-IOG



- ✓ ZT-2060-IOG

3.1.2 Basic Setting Parameters for Hardware

This section introduces the hardware settings of the Rotary/DIP switches.

(A) DIP_1 : DIP Switch 1; Module Initial Mode

There are two module initial modes: “RUN” and “INIT”.

- ✓ For normal operation, set the DIP_1 to the RUN position.
- ✓ For advanced setting, set the DIP_1 to the INIT position, then can do the setting by software. Refers to 【3.2.1: Software Setting Steps】.

Trigger mode	DIP_1	Descriptions
RUN	OFF	Communicating mode Pan ID = according to the software setting (Default: 0x0000) RF Channel = set by the rotary switch Node ID = set by the rotary switch
INIT	ON	Software setting, via ZT-2550/ZT-2570/ZT-USBC remotely Pan ID = 0x3FFF RF Channel = set by the rotary switch

(B) DIP_2 : DIP Switch 2; Event trigger mode or way

The event trigger modes of the ZT-IOG system, the same are the trigger ways for the DI channel of the ZT-IOG module, have two: Level and Pulse. Users choose the suitable mode according to the "I/O updating logic" of the application needs, refer 【Ch.1.3 I/O Updating Logic...】for detail descriptions.

Trigger mode	DIP_2	Descriptions
Level Mode	OFF	If any DI channel state is high, all DO channel states are high. If all DI channel states are low, all DO channel states are low.
Pulse Mode	ON	If any DI channel is triggered to rising edge, all DO channels will change to the reverse edge once.

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(C) DIP_3 : DIP Switch 3; Encryption

In wireless communication, it provides data encryption that supports AES-128 bit encryption algorithm.

The encryption setting is based on the ZigBee Coordinator (Node ID is 0x0000), other ZT-IOG modules within the same group are synchronized passively.

- ✓ Set the encryption directly through this DIP Switch.

Encryption	DIP_3	Descriptions
Disable	OFF	Not using encryption
Enable	ON	Using AES-128 bit encryption for wireless communications

(D) DIP_4~DIP_8 : DIP Switch 4~8; Node ID

The Node ID is the ZigBee device ID, or known as the node addresses.

- ✓ The settable range is 0x0000 ~ 0x001F, up to 32 groups.
- ✓ A ZT-IOG network must specify a device to 0x0000 (ZigBee Coordinator)
- ✓ The ZigBee Coordinator must be supplied power permanently, or the IOG system cannot work properly.
- ✓ The Node ID of ZT-IOG module cannot duplicate in the same group, please set the DIP Switch directly.

Node ID	DIP_4	DIP_5	DIP_6	DIP_7	DIP_8	Node ID	DIP_4	DIP_5	DIP_6	DIP_7	DIP_8
0x0000	off	off	off	off	off	0x0010	**ON**	off	off	off	off
0x0001	off	off	off	off	**ON**	0x0011	**ON**	off	off	off	**ON**
0x0002	off	off	off	**ON**	off	0x0012	**ON**	off	off	**ON**	off
0x0003	off	off	off	**ON**	**ON**	0x0013	**ON**	off	off	**ON**	**ON**
0x0004	off	off	**ON**	off	off	0x0014	**ON**	off	**ON**	off	off
0x0005	off	off	**ON**	off	**ON**	0x0015	**ON**	off	**ON**	off	**ON**
0x0006	off	off	**ON**	**ON**	off	0x0016	**ON**	off	**ON**	**ON**	off
0x0007	off	off	**ON**	**ON**	**ON**	0x0017	**ON**	off	**ON**	**ON**	**ON**
0x0008	off	**ON**	off	off	off	0x0018	**ON**	**ON**	off	off	off
0x0009	off	**ON**	off	off	**ON**	0x0019	**ON**	**ON**	off	off	**ON**
0x000A	off	**ON**	off	**ON**	off	0x001A	**ON**	**ON**	off	**ON**	off
0x000B	off	**ON**	off	**ON**	**ON**	0x001B	**ON**	**ON**	off	**ON**	**ON**
0x000C	off	**ON**	**ON**	off	off	0x001C	**ON**	**ON**	**ON**	off	off
0x000D	off	**ON**	**ON**	off	**ON**	0x001D	**ON**	**ON**	**ON**	off	**ON**
0x000E	off	**ON**	**ON**	**ON**	off	0x001E	**ON**	**ON**	**ON**	**ON**	off
0x000F	off	**ON**	**ON**	**ON**	**ON**	0x001F	**ON**	**ON**	**ON**	**ON**	**ON**

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(E) Rotary Switch：RF Channel

"RF Channel" indicates the radio frequency channel, following the IEEE 802.15.4 standard and using the ISM 2.4G radio band.

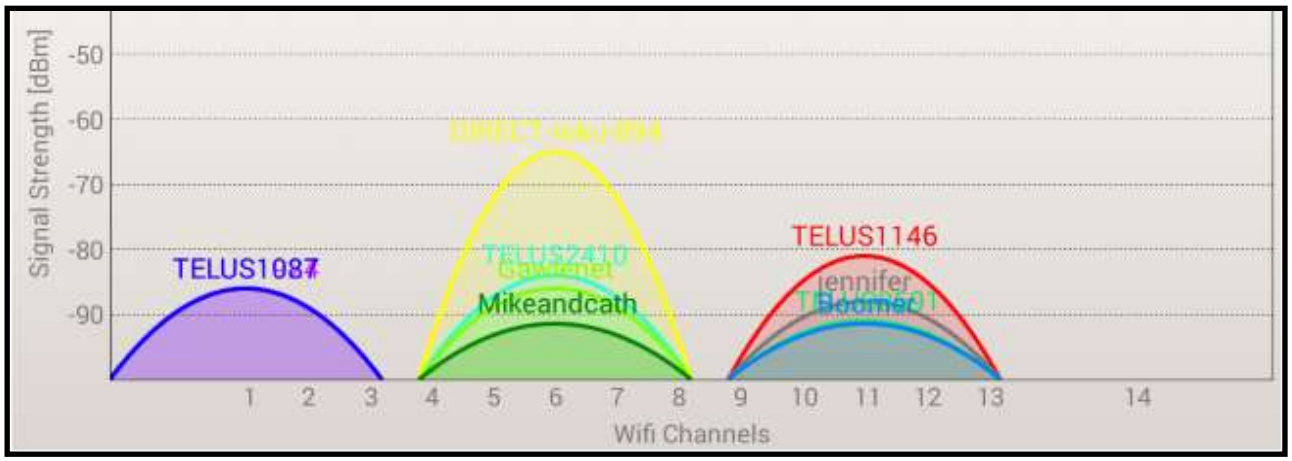
Rotary Switch	Switch Range	Description
	0 ~ F	2405 MHz ~ 2480 MHz

a. The ZigBee wireless communication, the same as Wi-Fi, uses a single fixed channel and need to pre-set the radio frequency band.
b. The RF Channel must be set to the same value as other modules on the same ZigBee network.
c. For different ZigBee networks, first priority is to adjust the RF Channel, please directly switch the Rotary Switch.

The 2.4GHz is a universal free-of-use band, such as wireless LAN (IEEE 802.11b / IEEE 802.11g), Bluetooth, ZigBee, etc., all can work in the 2.4GHz, so the user must select the channel for the ZigBee network very carefully, and had better avoid to use the same wireless frequency with other devices in the same place to ensure the communication effectiveness.

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EX: User can download the 【Wifi Analyzer】 by the smart phone to analyze the using channels in the environment, for example of the diagram below, the channel 1, 6 and 11 are occupied by several Wi-Fi networks.



Then, from the following【Figure (a) Wi-Fi and ZigBee Channel Diagram】, the frequencies of the using Wi-Fi channel 1, 6 and 11 are 2412±11 (MHz), 2437± 11 (MHz) and 2462±11 (MHz). These 3 channel ranges are the radio interference source for the ZigBee network in the same band; So, the better ZigBee options that recommended in this case are 2423 ~ 2426 (MHz), 2448 ~ 2451 (MHz) and 2473 ~ 2480 (MHz).

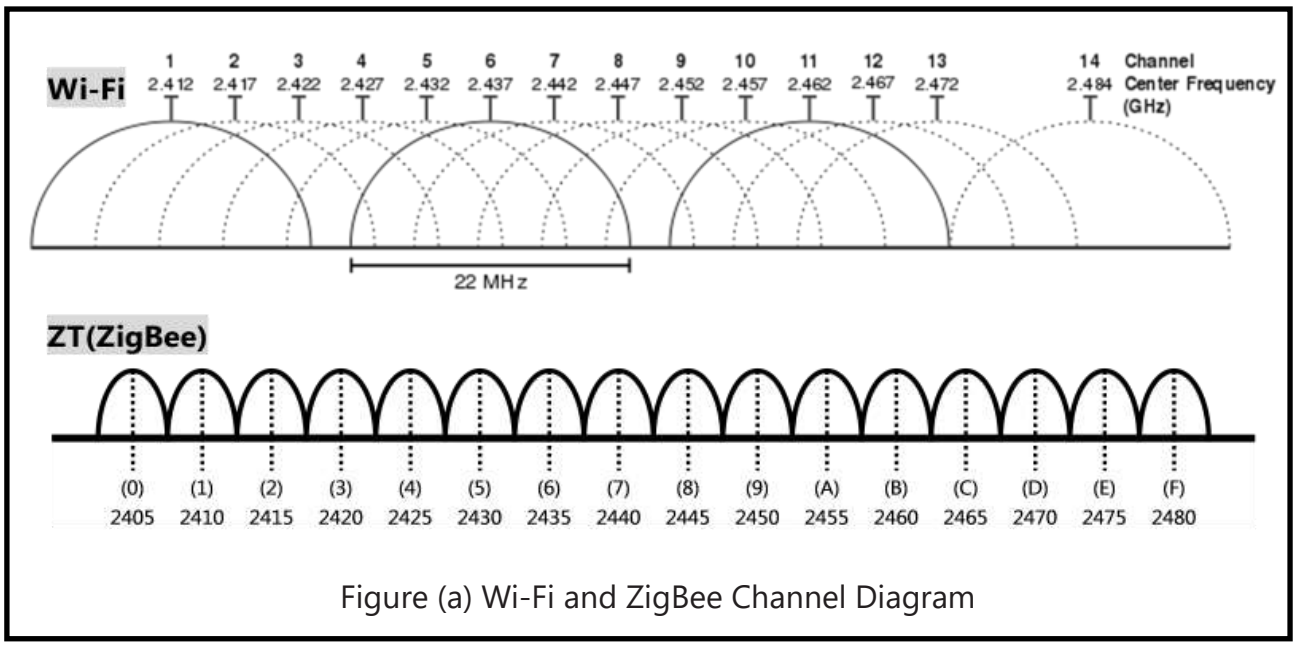


Figure (a) Wi-Fi and ZigBee Channel Diagram

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Then, from the 【Figure (b) Wi-Fi and ZigBee Channel Table】, we know the three ranges 2423 ~ 2426 (MHz), 2448 ~ 2451 (MHz) and 2473 ~ 2480 (MHz) are the ZigBee channels 4, 9, E and F, so these four ZigBee channels may be preferred selecting to avoid overlap with the WLAN.

According to the above method, the user can set the ZT devices to the best wireless channel for different environments.

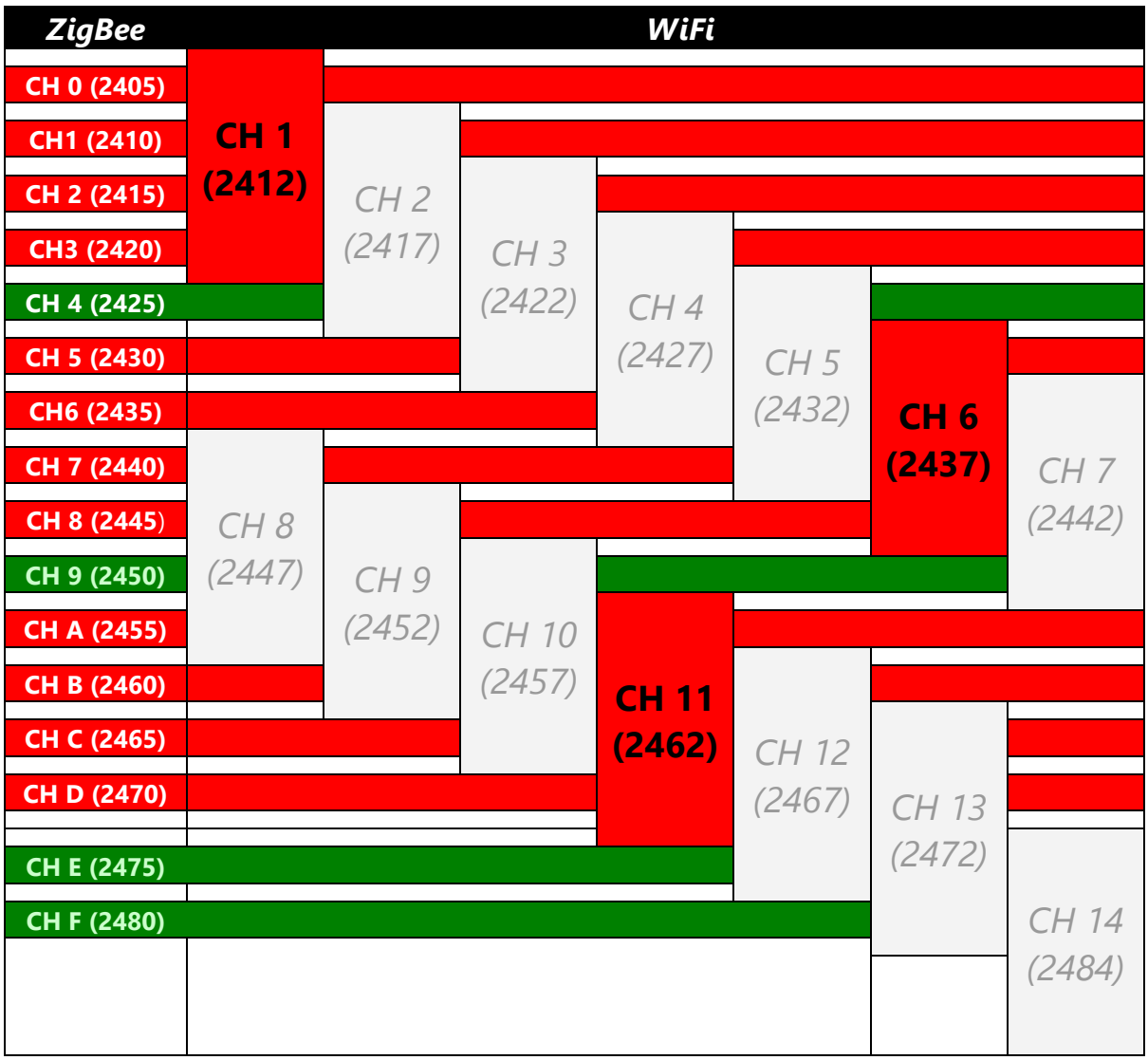


Figure (b) Wi-Fi and ZigBee Channel Table

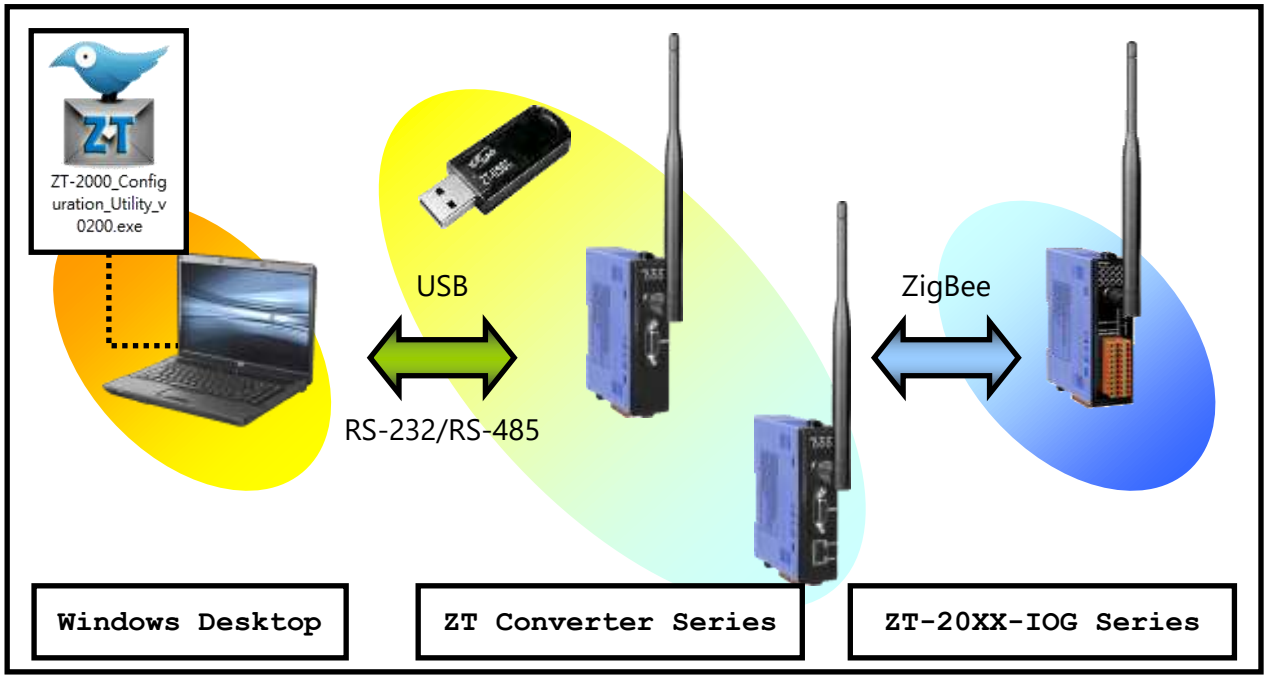
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3.2 Software Advanced Setting

3.2.1 Software Setting Steps

If the IOG system needs advanced settings, such as adjusting the wireless output power, setting the safe value for disconnection, changing the I/O updating frequency..., please follow the software setting steps below.

(1) As the ZT-20xx-IOG device does not include a COM port, the user must prepare a ZigBee converter, e.g. ZT-USBC, ZT-2550 or ZT-2570, to convert the signal to wireless signal via the USB, RS-232 or RS-485 interface for remote setting the ZT-20xx-IOG module.



(2) For building the wireless communication of the ZT-20xx-IOG and the ZigBee converter, first, set up the following parameters of the ZigBee converter via the "ZT-2000 Configuration Utility", so it can wirelessly communicate with the ZT-20xx-IOG that in the INIT mode.

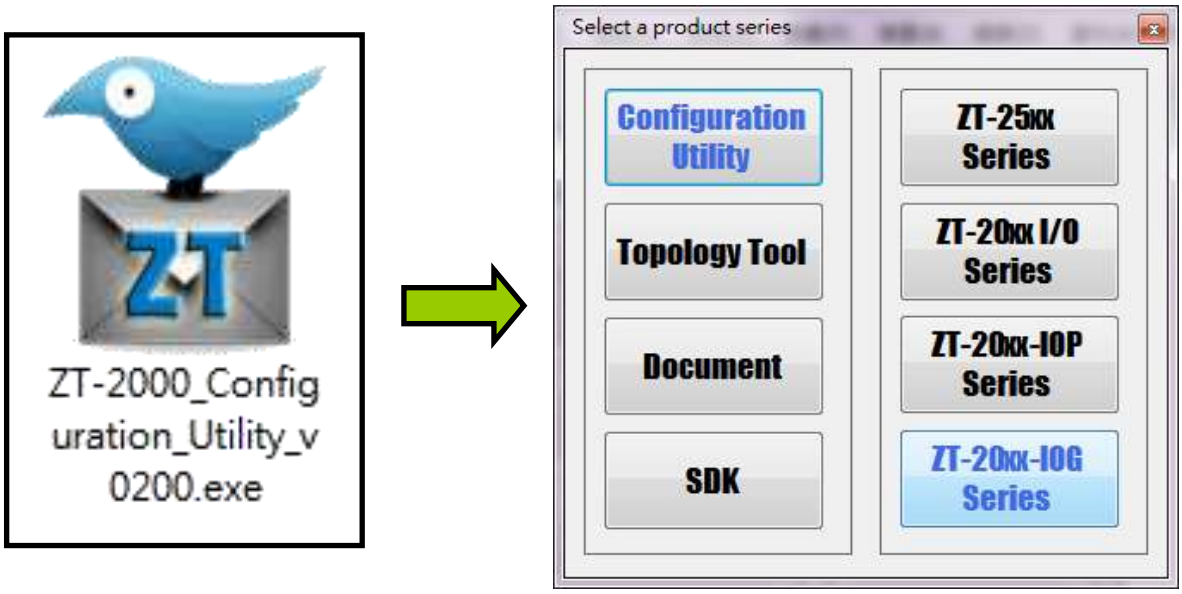
Model	ZT-20xx-IOG	ZT-USBC	ZT-2550, ZT-2570
Application Mode	N/A	N/A	Transparent Mode
Pan ID	INIT default to 0x3FFF	Set to 0x3FFF by software	
Node ID	INIT default to 0x0020	Fixed to 0x0000 as a ZigBee Coordinator	
RF Channel	Set by Rotary switch	Same with the Rotary switch of the ZT-IOG.	

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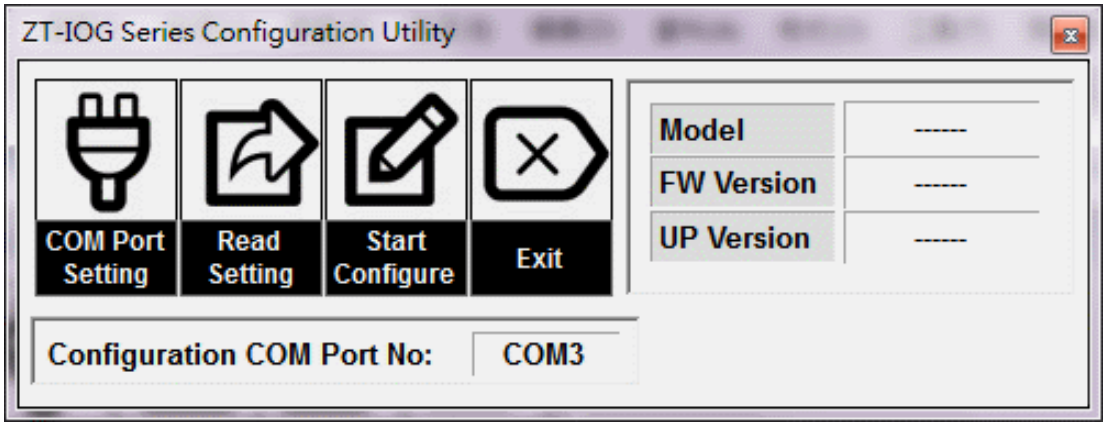
(3) Switch the Dip Switch 1(DIP_1) of the ZT-20xx-IOG module to INIT mode. Refer the 【DIP_1】 of 3.1 Hardware Basic Setting.

(4) Restart the power of the ZigBee Converter and the ZT-20xx-IOG module, wait for the green LED (ZigBee) of the ZT-20xx-IOG module changing to steady lit, that means the wireless communication established, and then can call the software utility.

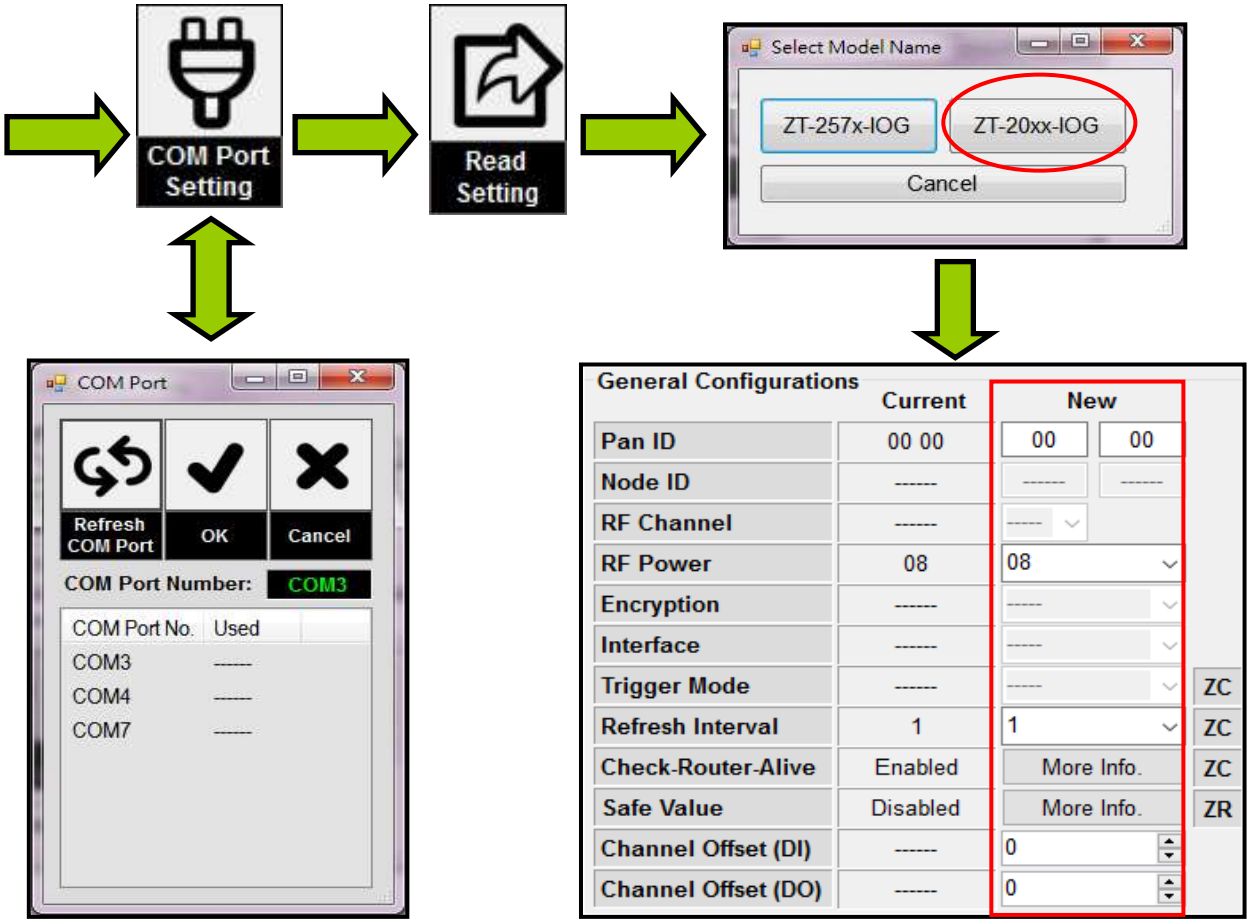
(5) Execute the ZT-20xx-IOG Configuration Utility (Windows Based):
http://ftp.icpdas.com.tw/pub/cd/usbcd/napdos/zigbee/zt_series/utility/



(6) Use "ZT-IOG Series Configuration Utility" to connect the ZT-20xx-IOG.



1. Click【COM Port Setting】to select the COM port of the ZigBee converter.
2. Click【Read Setting】to read the current settings of the ZT-20xx-IOG module.



(7) After reading the settings, directly set the parameters in "New" column. The next section will describe the parameters of the advanced setting.

(8) After setting the parameters, click【Start Configure】to complete the software setting.

3.2.2 Advanced Setting Parameters for Software

The advanced parameters are set by software via the wireless communication remotely. This section focuses on the parameter descriptions; for setting method, please refer to the previous section【3.2.1. Software Setting Steps】.

(1) Pan ID (Personal Area Network identification)

"PAN ID" is the group identity for a ZigBee network, to distinguish the different ZigBee networks of the same frequency band.

- ✓ Default: 0x0000; use the default value, or the devices in the same ZigBee network use the same value.

(2) RF Power (Radio Frequency Transmission Power)

"RF Power" denotes the wireless transmit power value.

- ✓ Usually do not need to adjust; if the wireless signal is weak and unstable, users may increase the RF power to debug and test.

Hexadecimal	Output Power(dBm)	Descriptions
0x0F	19	Typical Maximum
…	…	…
0x08	11	Fit the CE/FCC certification

The parameter adjustment purely personal behavior, ICP DAS can not guarantee to pass CE/FCC certification if adjusting this parameter, nor assume any liability because of the adjustment parameters derived from the RF Power.

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(3) Refresh Interval

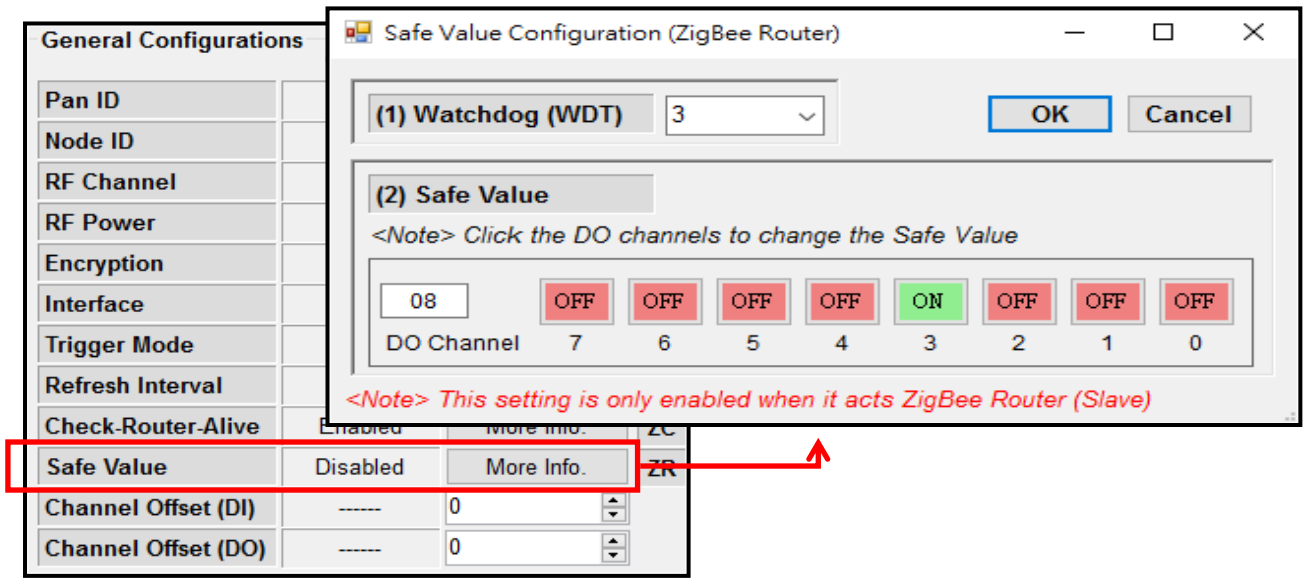
It denotes the interval time to update the I/O channel, in the unit "second". According to 【Functions】in 1.1 Introduction, the ZigBee Coordinator serves as a message processing and distribution center. It will broadcast a message "periodically" to all ZT-IOG modules for synchronizing all DO channel states. This parameter is about the interval to broadcast the message periodically.

- ✓ The ZigBee Coordinator broadcasts default once per second. If the ZT-IOG module of the ZigBee Router updates DI channel frequently to trigger a large number of events, we recommend user to increase the refresh interval, to prevent the ZigBee network congestion and low updating performance.

(4) Watchdog (WDT) & Safe Value (ZigBee Router)

The settings list below, details refer 【3.3 Check Alive for Disconnection】.

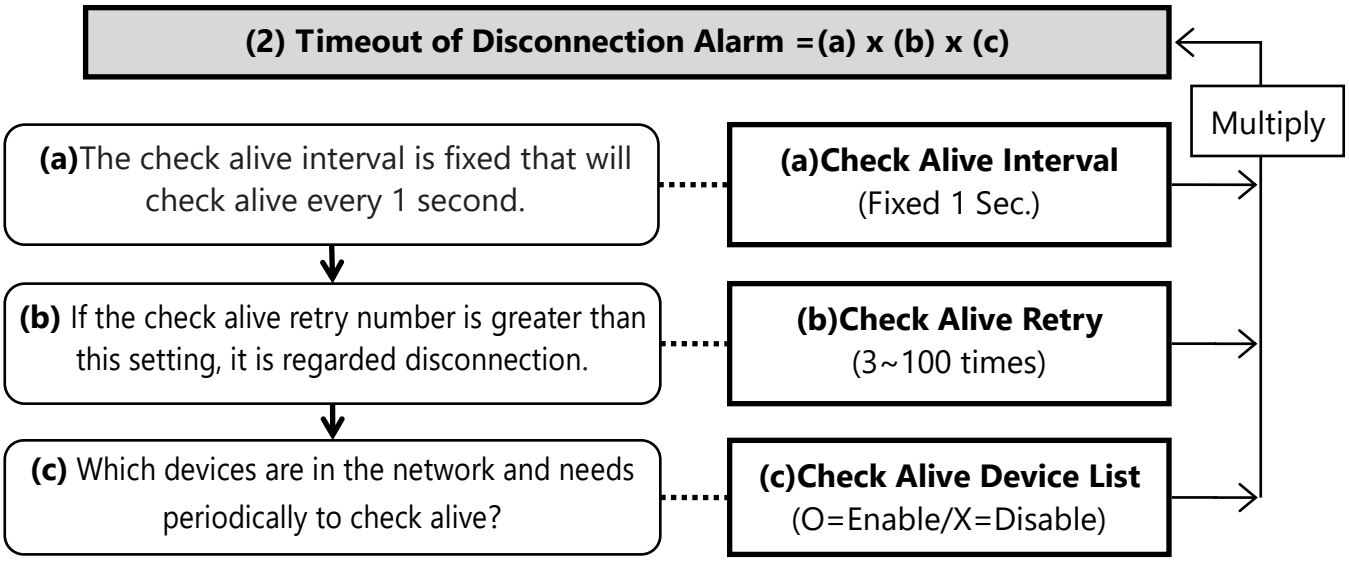
Configurations	Status		Explain
WDT (Watchdog Time)	Disabled		Set the timeout of disconnection; It is regarded disconnection if does not receive the updating broadcast within this time.
	3 ~ 25s	Enabled	
Safe Value	OFF	low	Set the safe value of the DO; be triggered if the module is disconnection.
	ON	high	

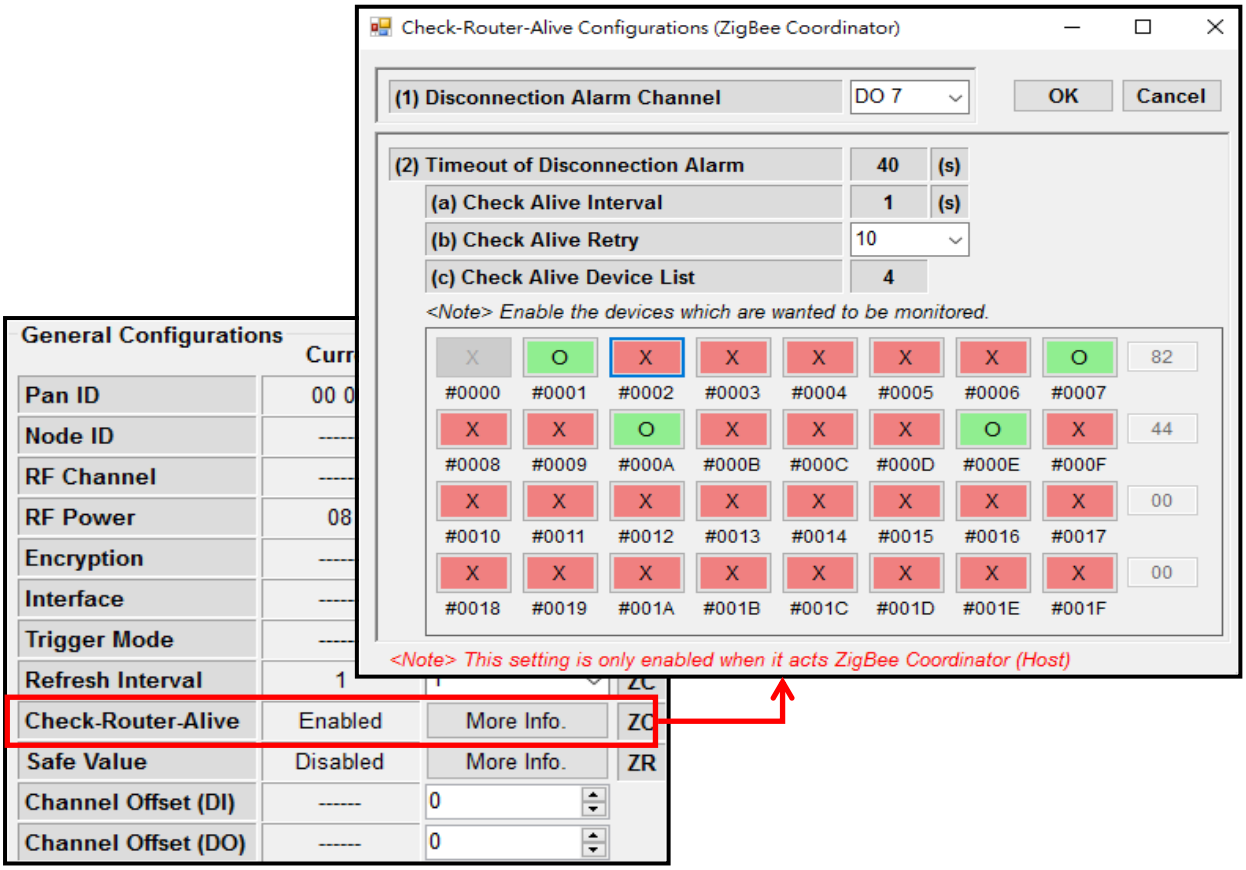


(5) Check-Router-Alive (ZigBee Coordinator)

The settings list below, details refer 【3.3 Check Alive for Disconnection】.

Configurations	Explain
(1)Disconnection Alarm Channel	Specify one DO channel as the disconnection Alarm
(2)Timeout of Disconnection Alarm	The timeout to trigger alarm = (a) x (b) x (c)
(a) Check Alive Interval	The interval is fixed that will check alive per second.
(b) Check Alive Retry	Set the number to retry. It is regarded disconnection if the check alive occupied greater than this setting.
(c) Check Alive Device List	The devices want to check periodically in the ZT-IOG group.



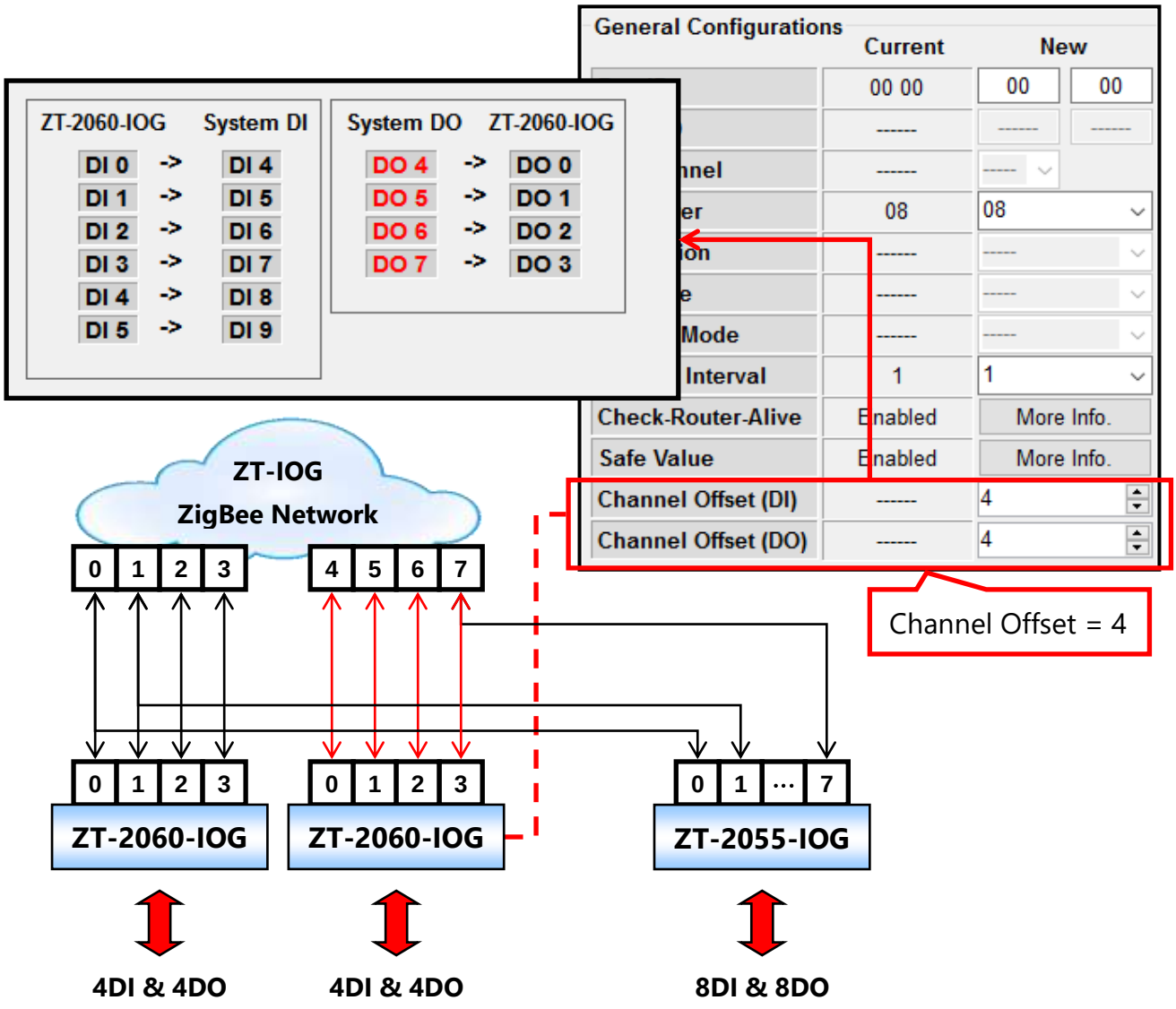


(6) Channel Offset (DI/DO)

The settings list below, details refer【3.4 I/O Tags Expansion】.

Configurations	Explain
Channel Offset (DI)	The DI offset value, to map the virtual channel of ZT-IOG.
Channel Offset (DO)	The DO offset value, to map the virtual channel of ZT-IOG.

For example, the ZT-2055-IOG module provides 8 DI and 8 DO channels, while the ZT-2060-IOG module provides 4 Relay and 6 DI channels. When the ZT-2055-IOG (8 DI) makes pair-connection with two ZT-2060-IOG (4 Relay), user can set the channel offset (DO) of one ZT-2060-IOG module to 4, then can reach the above needs; the channel Offset (DI) can be set by the same way.



3.3 Check Alive for Disconnection

In the I/O logic of the ZT-IOG system, the ZigBee Coordinator receives the I/O events, calculates the logic and publishes the broadcast like a control center, so the ZT-IOG system can automatically synchronize the I/O status without any additional controller. Nevertheless, if the ZigBee wireless communication occurs the disconnection, it cannot actively send warning messages by the controller like the traditional architecture.

Thus, user can use the DO safe value of the ZT-IOG module. Set a specific DO channel to output "high" state when the wireless communication is disconnected, and connect an alarm device (e.g. a buzzer, alarm light...) on that DO to trigger the alarm and warn the officer in case of unexpected hazards.

The following will introduce the mechanisms of the ZigBee Coordinator and the ZigBee Router for the disconnection.

i. ZigBee Router：Watchdog (WDT) & Safe Value (DO)

When the ZigBee Router does not receive the updating broadcast from the ZigBee Coordinator within a period, it regards disconnection. Then the ZT-IOG module will load the preset safe value of DO and output the user-defined DO state to avoid unexpected system hazards. Until receiving the updating broadcast from the ZigBee Coordinator that means the communication has recovered, the module will lift the DO safe value and accept the system updating again.

The parameters of the ZigBee Router are as below: (To setting parameters)

- ✓ **Watchdog(WDT)**：Watchdog Enabled Time. It is regarded disconnection if does not receive the updating broadcast within this time.
- ✓ **Safe Value**：The safe value of DO channel for disconnection; can be set to "high" or "low".

ii. ZigBee Coordinator：Check-Router-Alive

According to 【Functions】in 1.1 Introduction, the ZigBee Coordinator serves as a message processing and distribution center. It activity broadcasts messages to all ZT-IOG modules to synchronize all DO channel states. Since the way of the broadcast, we do not know if the message is successfully delivered to the ZigBee Router on the receiving end.

Therefore, setting Check-Router-Alive is intended to allow the ZigBee Coordinator actively detect the device connection status. Detect one module per second to confirm the connection status of each ZigBee Router module, so the host can control the operating status of the ZT-IOG system.

The parameters of the ZigBee Coordinator are as below: (To setting parameters)

- ✓ **Disconnection Alarm Channel**：When the disconnection occurs, this channel will output “high” state. The user can install an alarm on it for notifying the officer to check the system.
- ✓ **Timeout of Disconnection Alarm**：The timeout value, unit: second, is the multiply product of the "Check Alive Interval (Fixed 1 sec.)" and the "Check Alive Retry" and the "Check Alive Device List". When the timeout greater than this value, it is regarded the module disconnection and will trigger the alarm channel to be High state.
- ✓ **Check Alive Retry**：Set the number to check alive. The module is regarded disconnection if timeout occupied greater than this setting.
- ✓ **Check Alive Device List**：The devices want to check periodically in the ZT-IOG group. When set the slave modules to "ON", it means to enable the devices the function of check alive for disconnection.

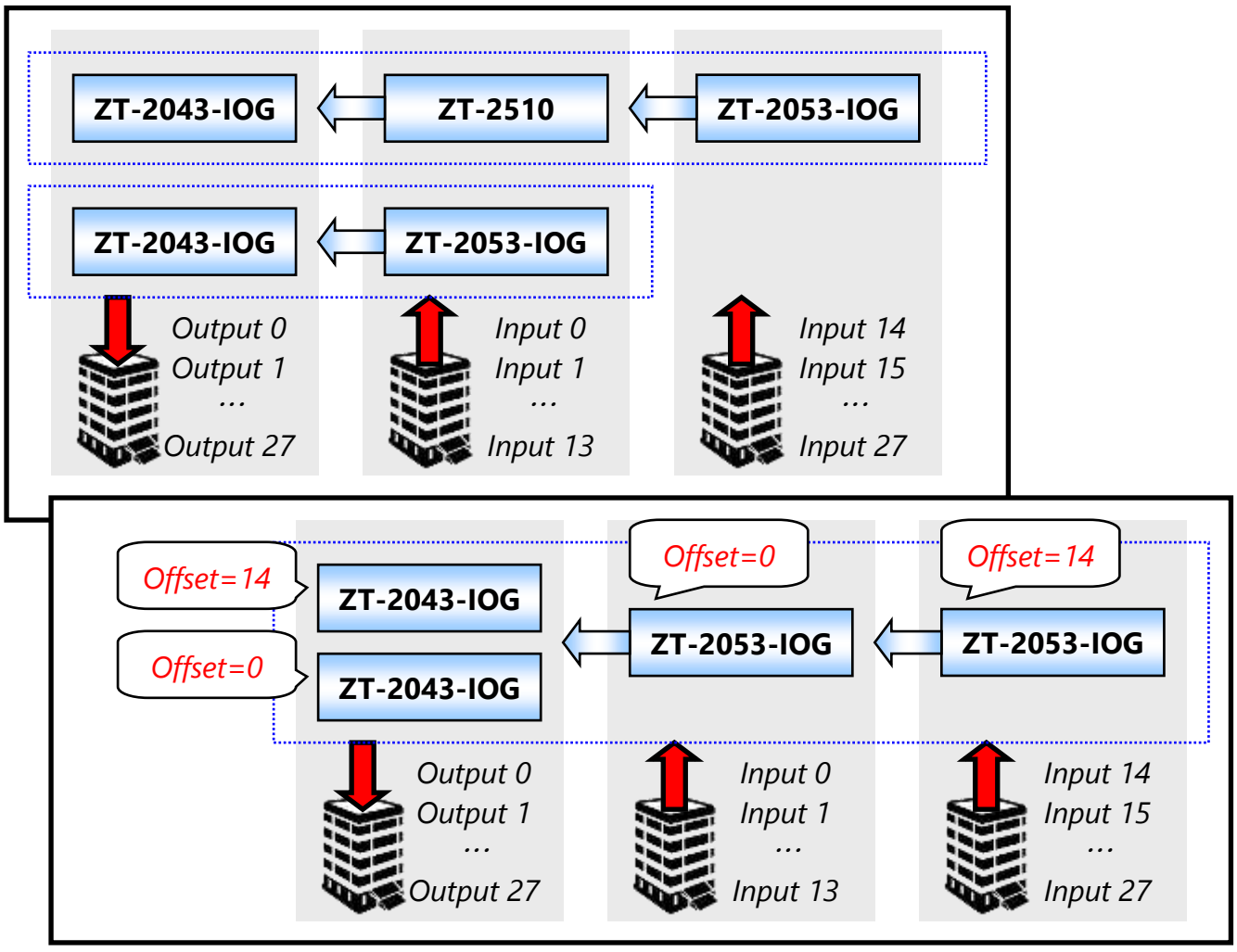
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3.4 I/O Channel Expansion

The physical channel number of a ZT-IOG module is limited, sometimes the I/O channels is not enough for the application needs, so the ZT-IOG module provides a Channel Offset function to logically offset the physical I/O channels that function supports maximum 280 I/O channels in a ZigBee network.

For example, an application needs to support 28 I/O Pair-connection channels, using the module default setting will need to divide the ZT-IOG modules into two ZigBee networks, but using the Channel Offset function can expand a network to 28 I/O Pair-connection channels and merge two networks into one single network. The advantages of merging the ZigBee networks:

1. To reduce the number of ZT-IOG networks can set up more ZT-IOG systems in the limited band of wireless environment.
2. Reduce the use of ZigBee Repeater, as below.



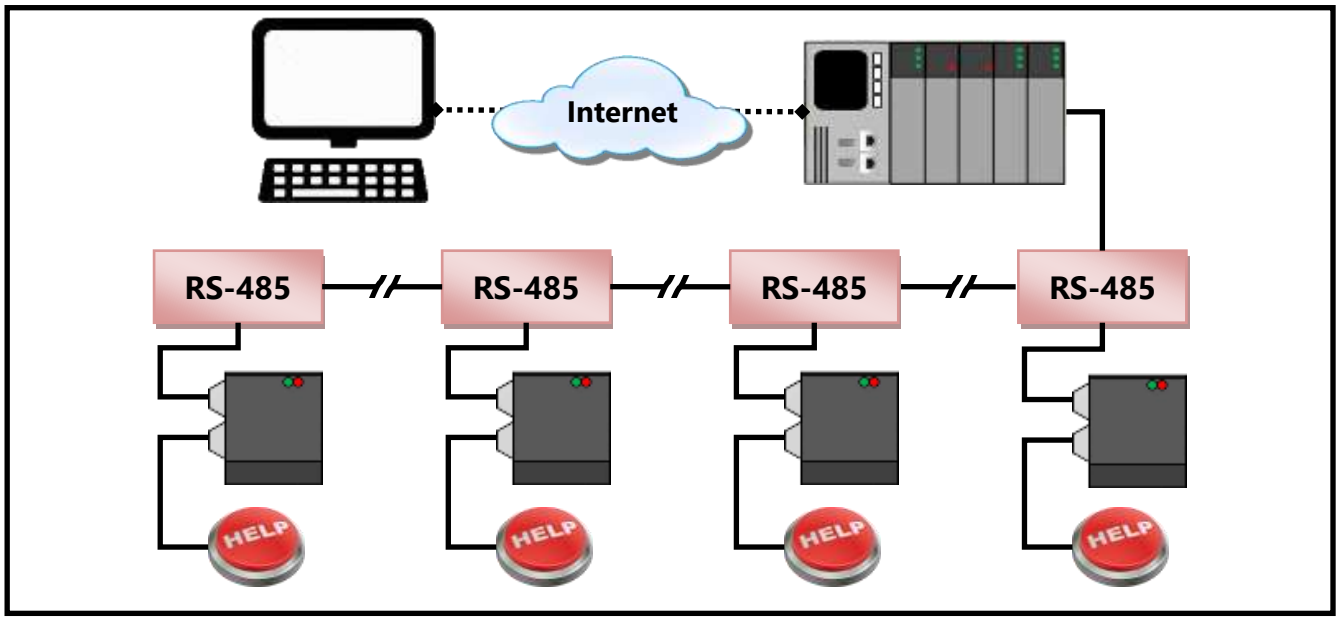
4 Applications

4.1 Emergency Bell Alarm System

Emergency bell alarm system is often used in MRT, buildings, schools, hospitals and other public places for security management. When an accident occurs, one can press the alarm bell to immediately notify the related personnel, at the same time, the security control center will be informed the event's location and send the staff to take immediate actions right away.

Description

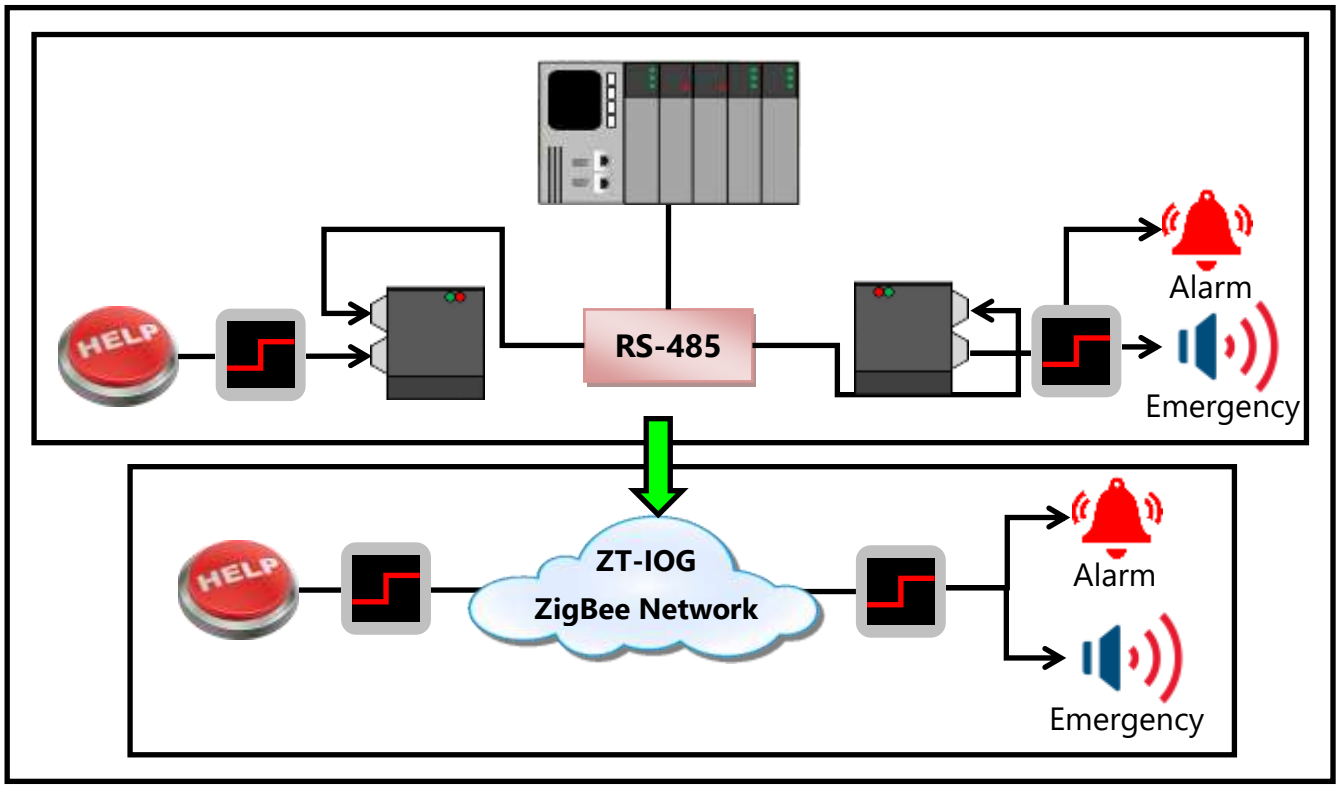
Using the campus security management as an example, in a traditional alarm bell system, the alarm bell is installed in a restroom entrance and is only linked to a buzzer bell for regional alarm notification. But in such way, when encounters an emergency, the staffs of the security center can not be notified immediately and efficiently. To reply the emergency state to the host of the security control center, users must pay higher costs in wiring deployment to transmit the messages from multiple locations to the security control center; if these locations are widespread or across different buildings, the costs are often quite expensive.



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ZT-IOG System is Perfect for Emergency Bell Alarm System

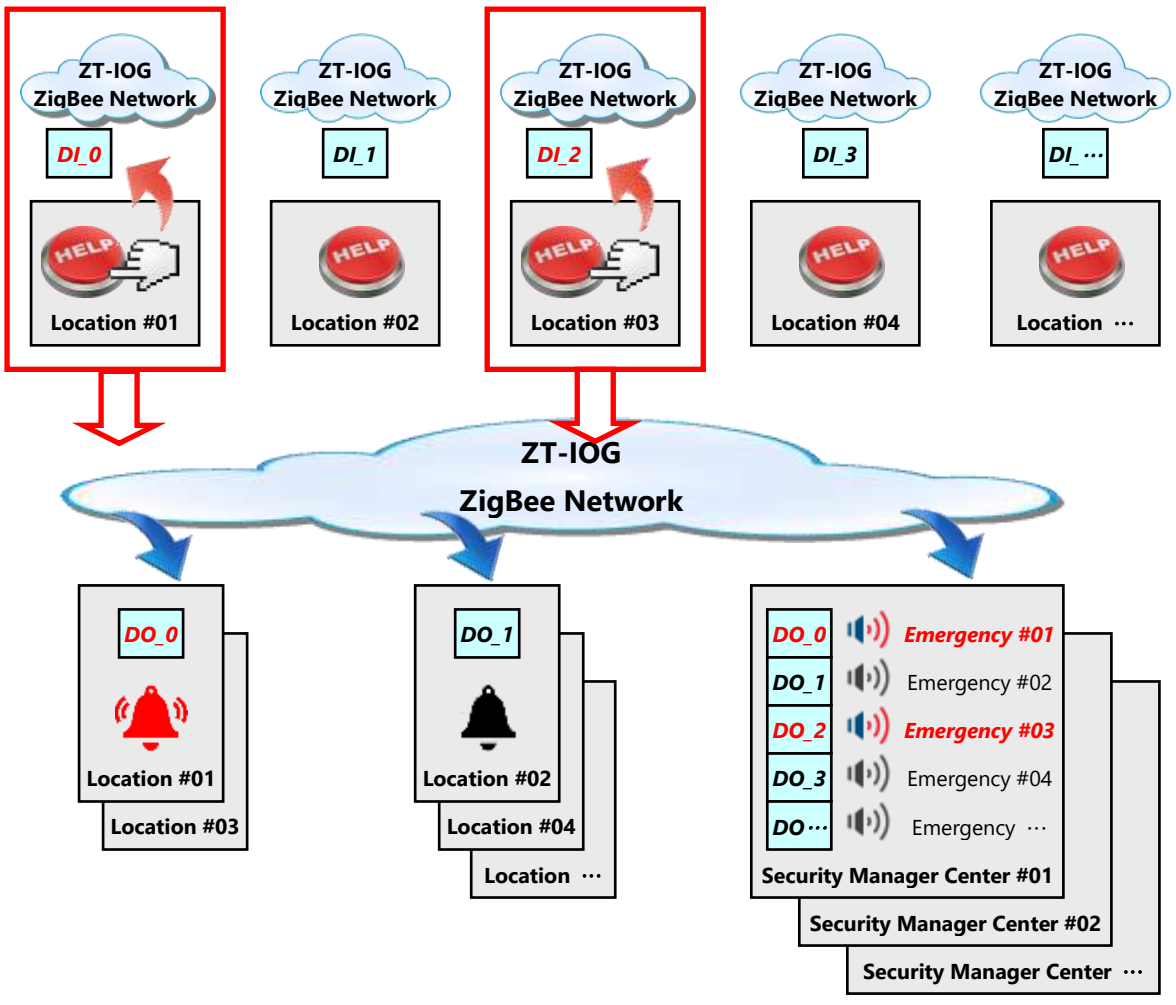
According to above application statement, in order to solve the difficulty and high cost problems of wiring deployment, ICP DAS provides the ZigBee wireless solution. The ZT-IOG system can automatically update the DIO channel status to the message center (ZigBee Coordinator) via the wireless communication, and then the message center will synchronize all DO channel status of the ZT-IOG network. This synchronization of changing DO states may function as the "emergency alert" to trigger the alarm bell.



Application Architecture Description

The emergency alarm bells may be installed in many places, every alarm bell should be able to actively upload events to the security center. The ZigBee network of the ZT-IOG modules is multi-to-multi I/O Pair-connection architecture, so the triggered event of any alarm bell will be updated to the message center.

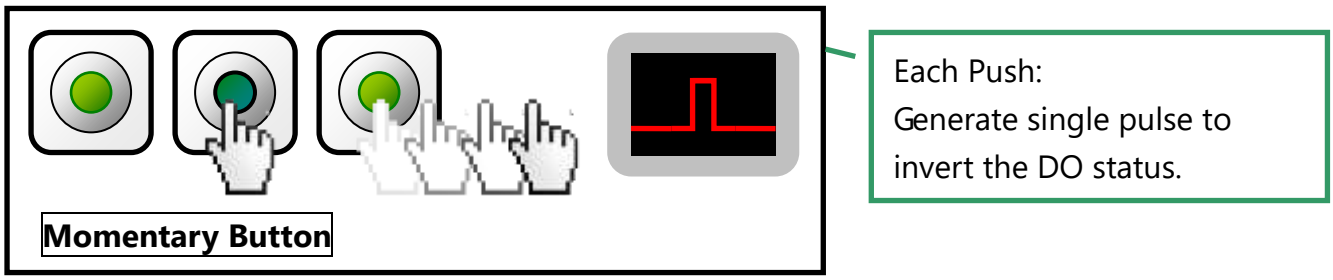
The ZT-IOG network is a multi-to-multi I/O Pair-connection architecture, so when any alarm bell is triggered, it will link all ZT-IOG modules' mapping DO channel in the network. By applying "Pulse Mode" control logic, the user can install the alarm bells in many locations and link the warning devices of these locations, for example, link the alarm buzzers or video devices in multiple locations to multiple security control centers.



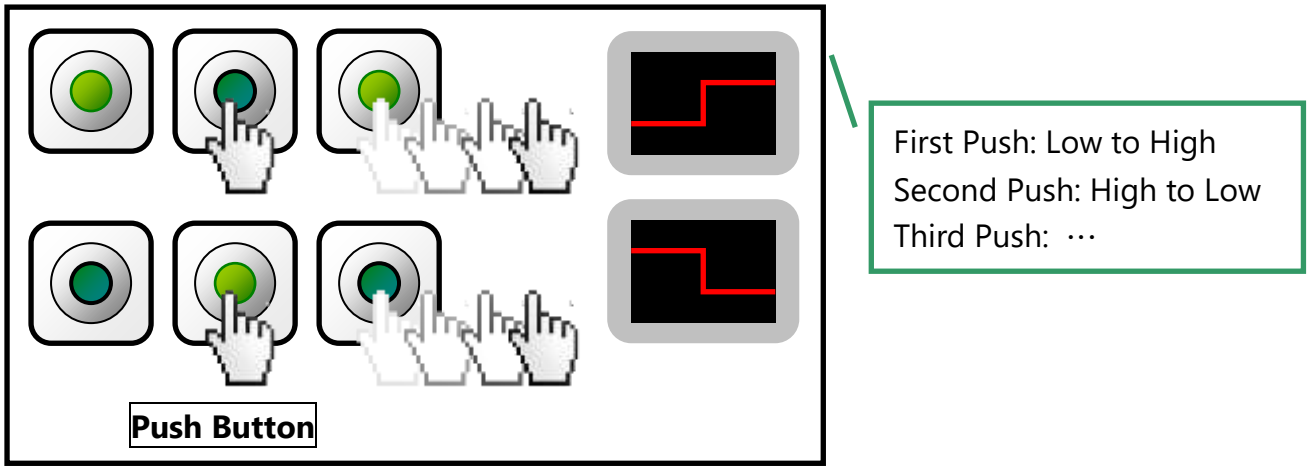
Event Triggering Modes

When applying ZT-IOG modules in different applications, the user can install different triggering devices according to the event mode of the application case.

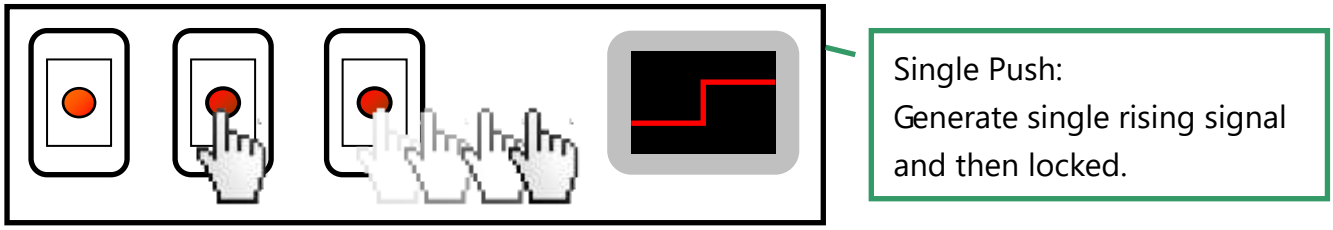
(1) The lighting control system can apply the "Edge Mode" to "Momentary Button", so that multiple lights can be turned on or off simultaneously.



(2) The emergency bell alarm system for fire safety can apply the "Level Mode" to "Push Button", so that the emergency alarm can be triggered and released at the same location.



(3) When installing the emergency bell alarm system for campus restroom, to avoid the emergency alerts being disabled intentionally; the "Emergency Button" cannot be restored easily; therefore it can be used as an alarm trigger when an emergency occurs.

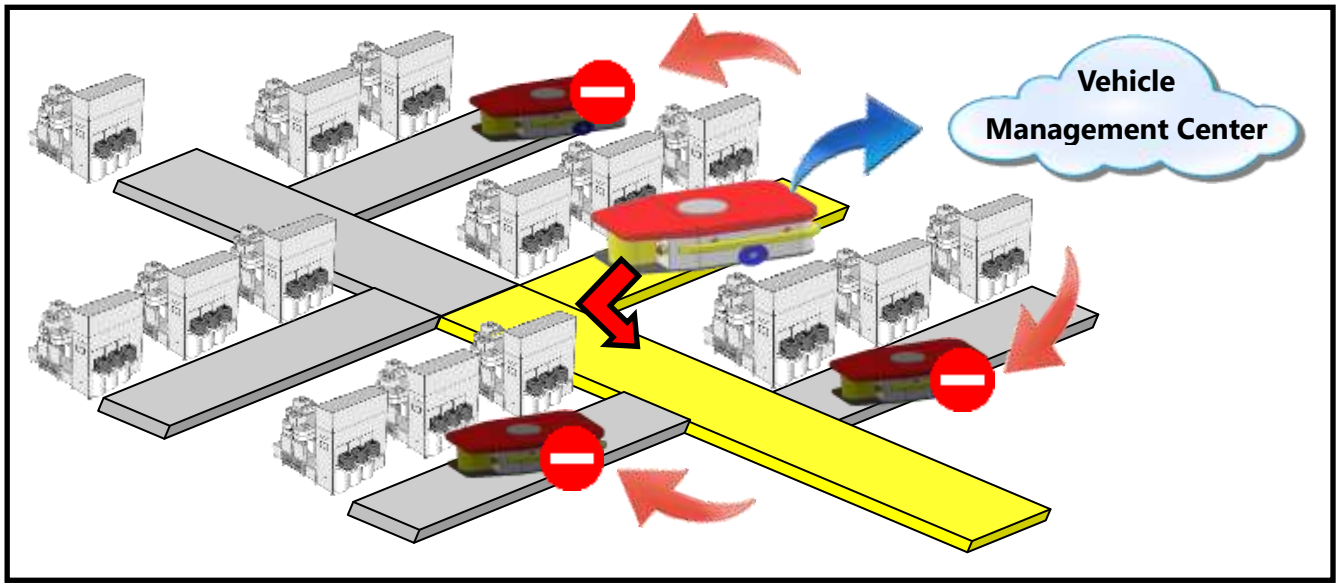


4.2 Route Management System for AGV

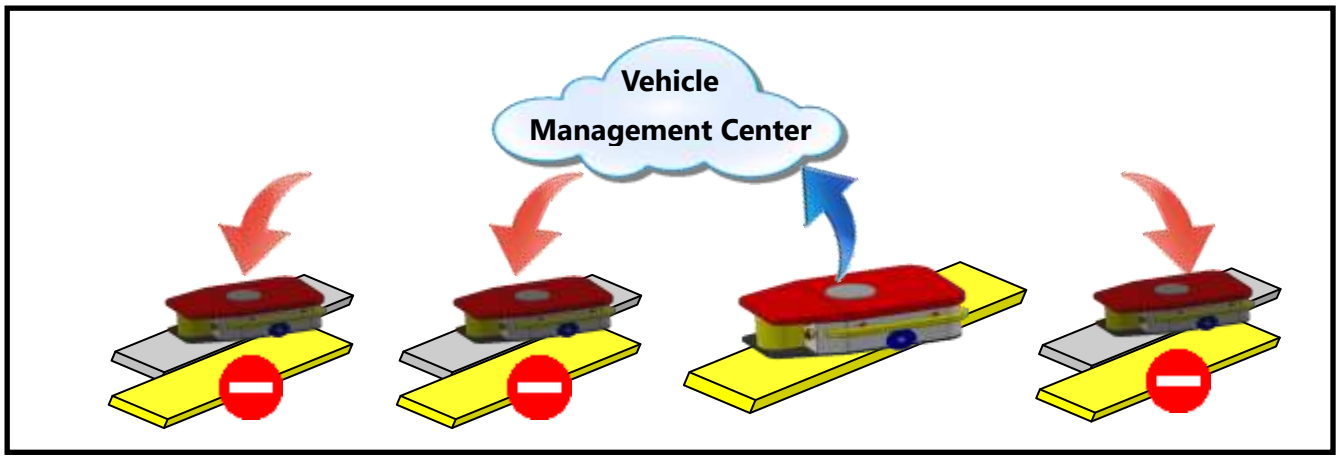
In recent years, the system of unmanned factory or warehouse automation becomes popular, the Automatic Guided Vehicles (AGV) are used to transport goods in the product lines, storage systems, transfer stations, etc. When there are several AGV in one location, the vehicle driving routes may overlap, therefore to prevent the routes conflict is an important issue.

Application Statement

When an AGV is going to enter a restricted area, such as the main road, track or elevator..., the AGV needs to request the vehicle management center for entering permission. When the center accepts the request, the other AGV will no longer be able to enter that area until the AGV depart and the management center release the control, and then other AGV can apply to enter that restricted area.



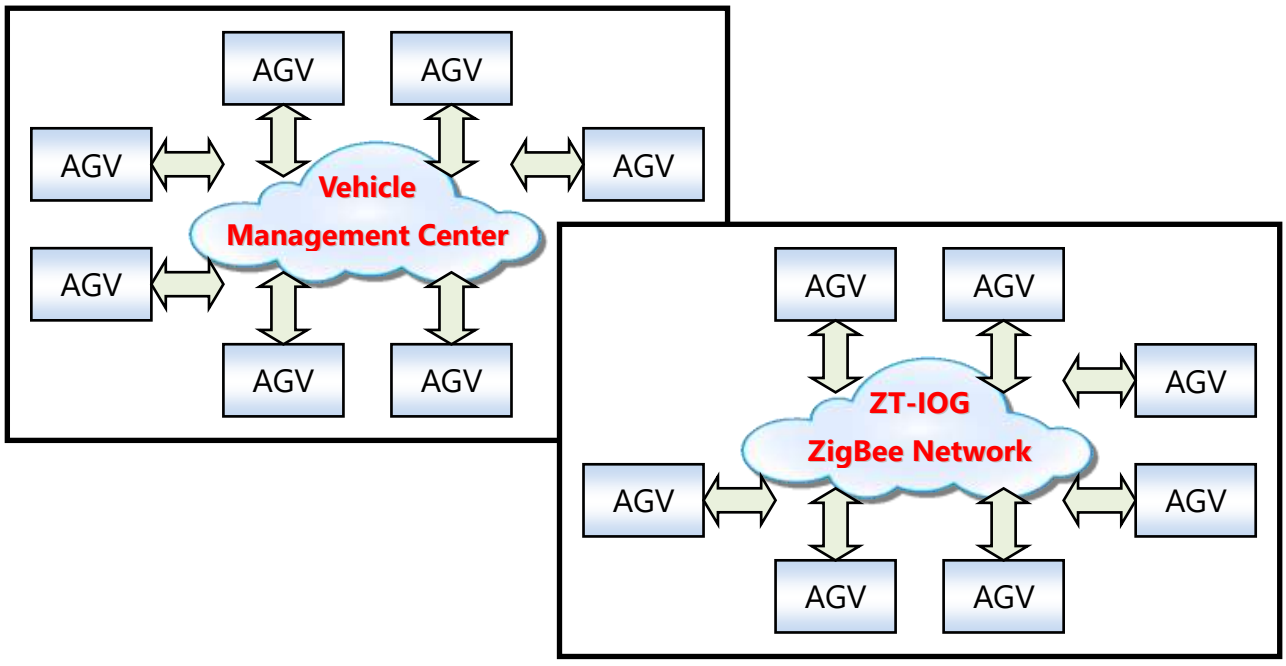
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The ZT-IOG System is Suitable for the AGV Route Management System

According to the above application statement, each AGV can send messages to the vehicle management center, and can send an area disable message to other AGV in the region. The vehicle management center can be seen as a virtual cloud, it is a M2M (Machine to Machine) architecture. The AGV is a mobile device, so it needs a wireless device with the M2M architecture to do the message exchange.

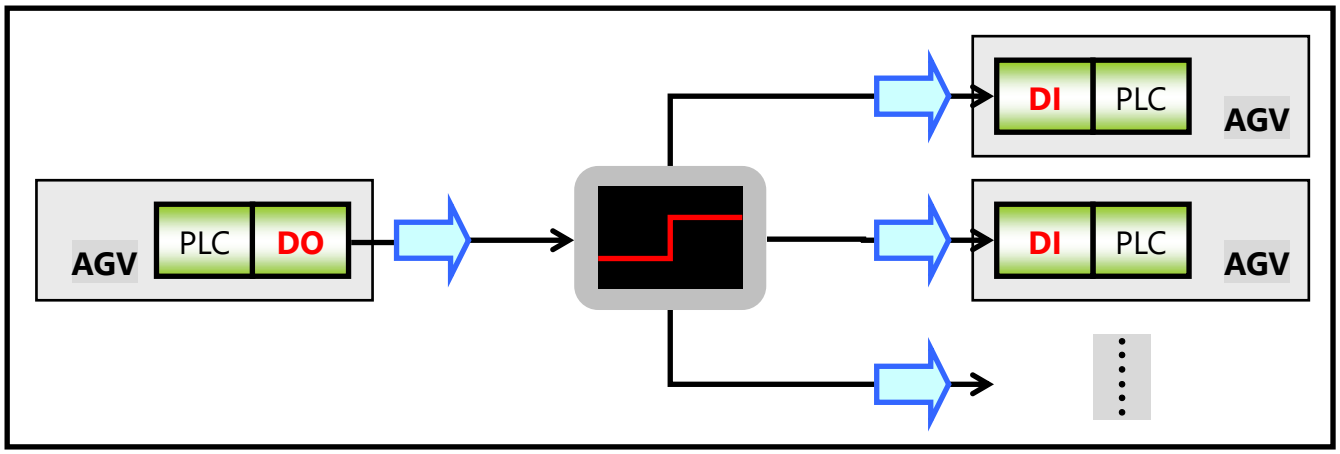
The ZT-IOG network is a multi-to-multi I/O Pair-connection architecture, so any ZT-IOG module in the ZigBee network can change the I/O channel state of the other ZT-IOG modules. This feature meets the requirement of this application, and thus achieves the purpose of the message exchange.



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Message Exchange

When an AGV is going to enter the restricted area, it must get the current status of the area, and update the status. In this case, the "On/Off" states of the DI/DO channels can be used to simulate the message of "occupied/idle" status and notify other AGV via the status of I/O channels to reach the route management goal.



Application Architecture (i)

The architecture of the AGV route management system includes two levels:

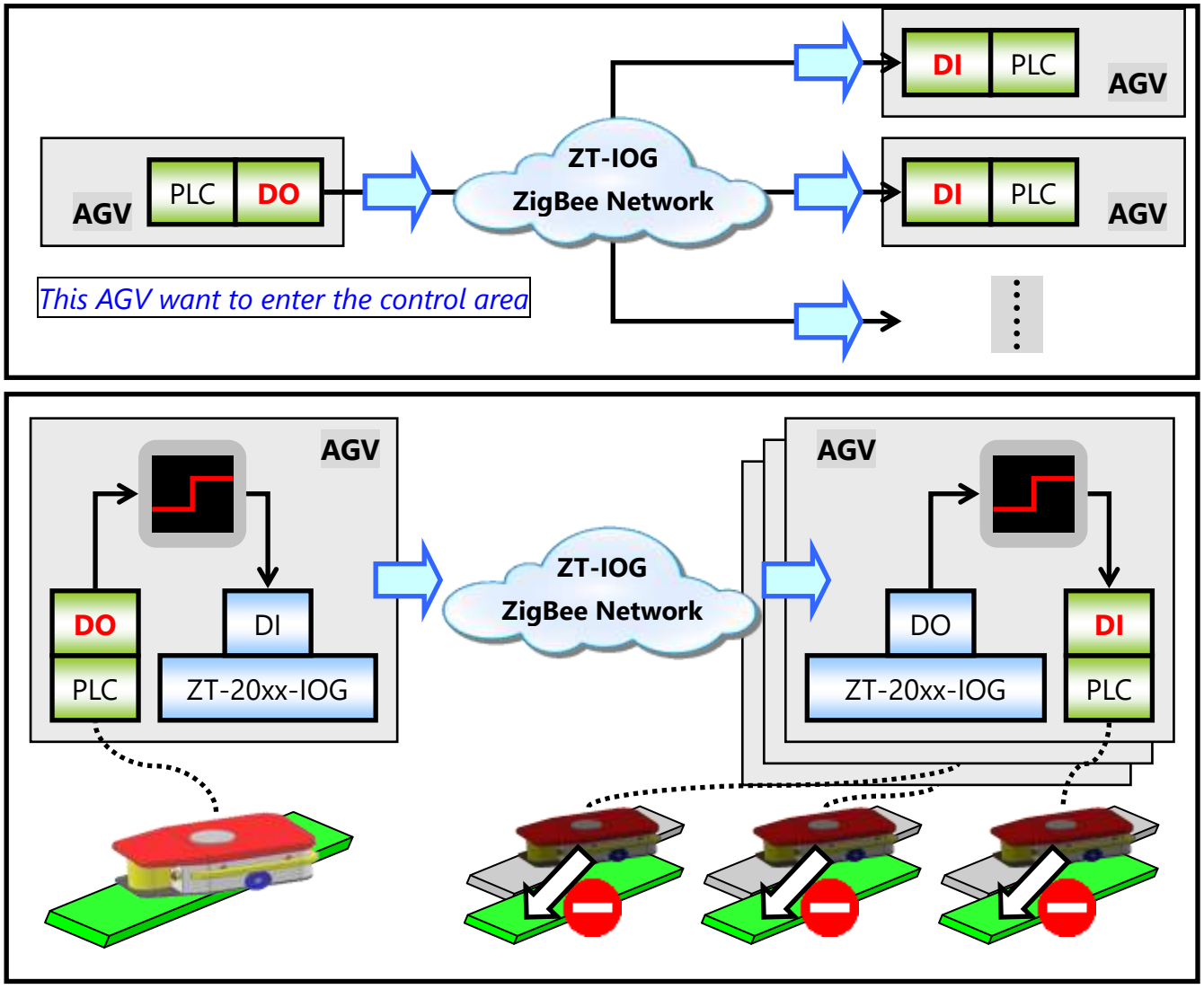
(1) **Control level**: the AGV is equipped with PLC, PAC or IPC controller, etc. In addition to controlling the goods moving and the vehicle driving, it also manages the message exchange among vehicles in order to obtain the current route status and calculate the timing to enter the restricted area.

(2) **Message exchange level**: The ZT-IOG network can function as a medium of exchange messages. Not only simulate the "occupied/idle" status via the I/O "On/Off" status of the ZT-IOG module, but also automatically update the I/O states via the ZigBee wireless network to break the geographical limitation.

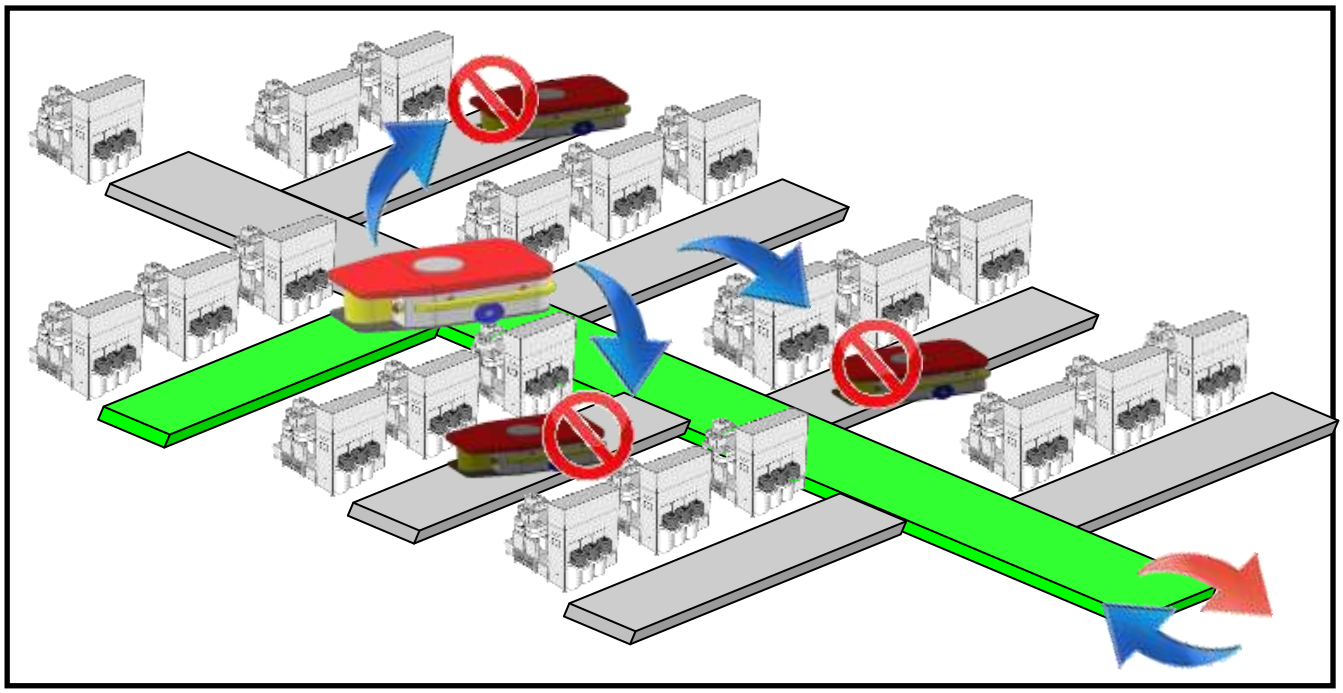
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The Actual Operation

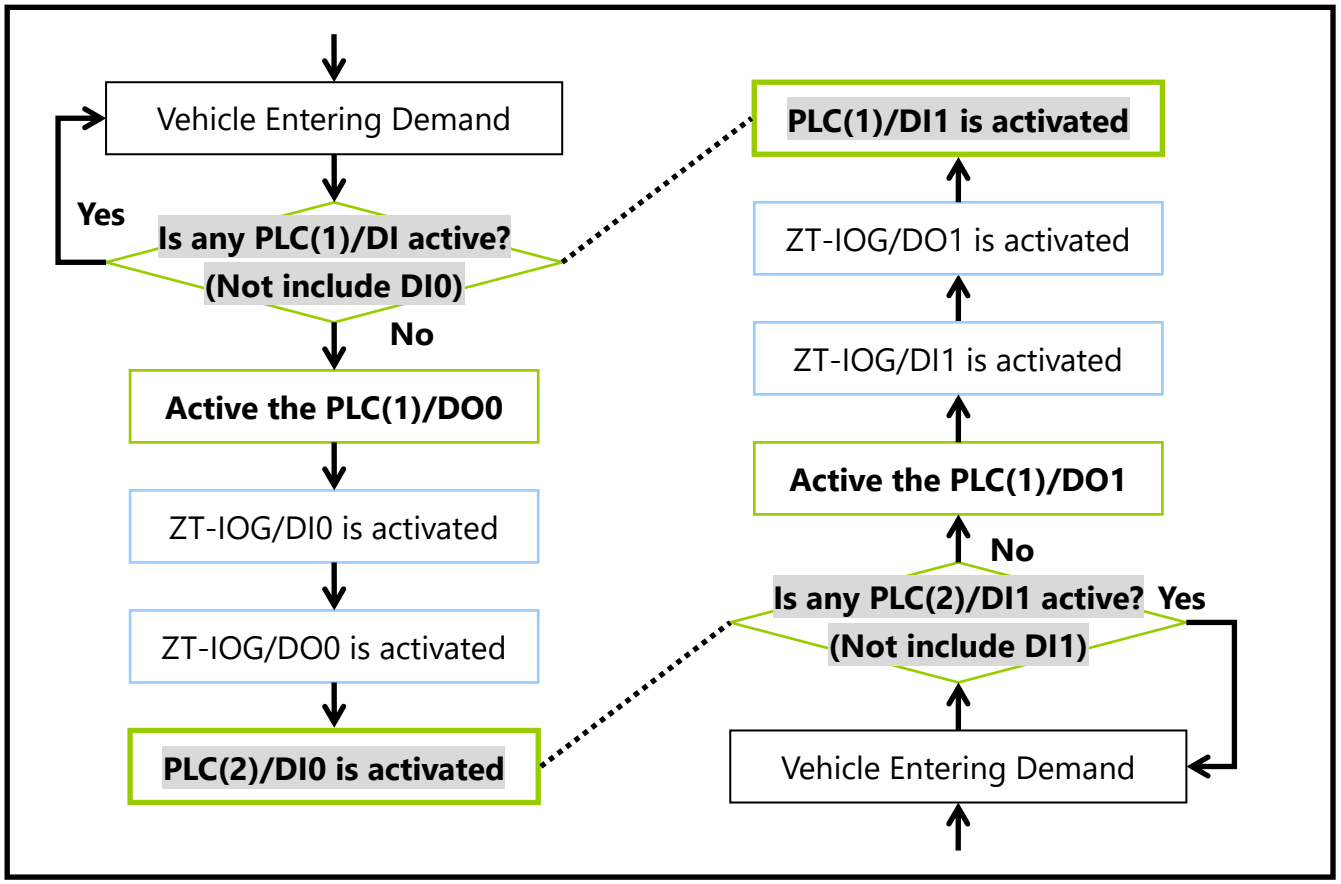
When an AGV wants to enter the restricted area, its PLC of the control level will output a "high" state to trigger the DI of the ZT-IOG module, meanwhile the DO of the ZT-IOG modules in the network will change to "high" based on the "Level Mode" Updating Logic, then will trigger the DI of the PLC on all vehicles to "high", and then they get the using status is "occupied", so that other vehicles will not enter this area for the safety reason. When this AGV leaves the restricted area, its PLC will cancel the "high" level state of the ZT-IOG, and then other AGV can send the requirement to enter this area again.



Overall Architecture Diagram



Applications Logic Flow Chart

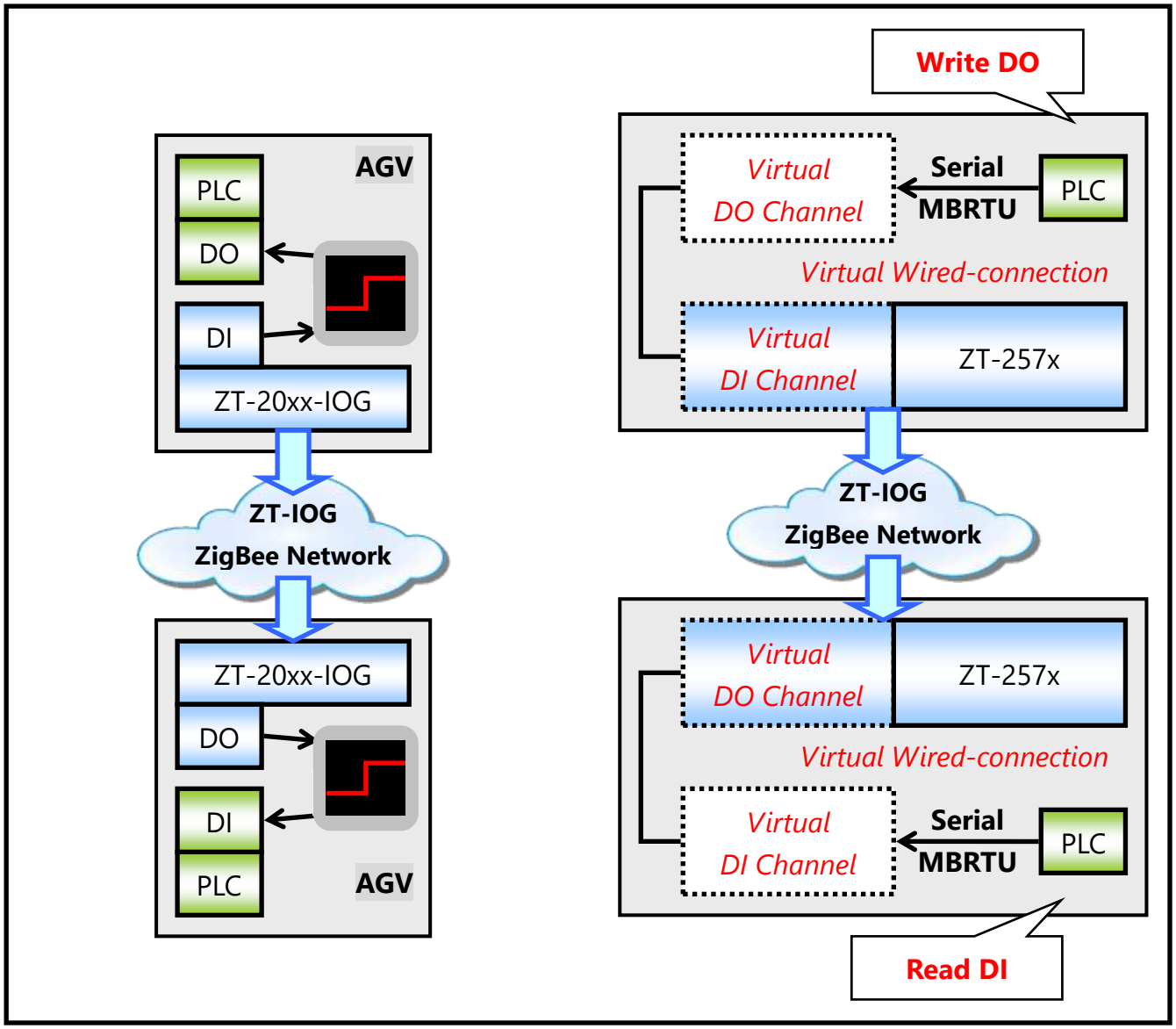


Application Architecture (ii)

Based on the above application and architecture, in addition to use the "physical I/O" of the ZT-20xx-IOG modules to simulate "occupied/idle" status via the "On/Off" state, you can also use the serial port communication (RS-232/RS-485) on the PLC to achieve the message exchange function.

The ZT-257x module provides 280 pairs of virtual digital input/output channels that can access the virtual I/O channel by the Modbus RTU protocol, and the virtual I/O channel states still can Pair-connection with the physical I/O channel states. Its DI/DO works the same way, for more detailed description, please refer to the ZT-2570 and ZT-2571 module IOG mode at the below link.

http://ftp.icpdas.com.tw/pub/cd/usbcd/napdos/zigbee/zt_series/document/zt-257x/



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5 Appendixes

5.1 LED Indicator Status

LED Indicator	Status	Introduction
ZigBee Net (Green LED)	***ZigBee Coordinator (Host)***	
	Steady Lit	ZigBee network is establish
	Blink to Steady Lit	Rejoin ZigBee network or the network is occupied
	ZigBee Router (Slave)	
	Steady Lit	The signal is strong
	Blinking (500 ms)	The signal is available
	Blinking (1s)	The signal is weak
	Blinking (2s)	The signal is unstable or there is not available
	Irregular lit/blinking	Module address (Node ID) is repeated
ZigBee PWR (Red LED)	***The status of module board***	
	Steady Lit	Power ON
	Blinking (200 ms)	Module initialization failure
	Blinking (500 ms)	Watchdog enabled
	Steady Unlit	Power OFF
	Irregular lit/blinking	Power cord is in poor contact

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