Introduction

Modbus is a commonly used protocol used for communicating between industrial devices.

A Modbus Master can communicate with up to 247 Slaves, each with a unique Slave Id from 1 to 247. The Master is responsible for sending commands to the Slaves, which act on the command and reply.

In the RAPIX Lighting Control System, a Zone Controller can act as a Modbus Slave.

A full description of Modbus is beyond the scope of this document. Refer to the official Modbus specification at http://www.modbus.org/.

This document describes of controlling and monitoring a RAPIX Lighting Control System using Modbus.

RAPIX Support for Modbus

Modbus Options

Modbus has four object types, two of which are supported by the RAPIX Zone Controller:

Object type	Access	Size	Supported?
Coil	Read-write	1 bit	YES
Holding register	Read-write	16 bits	YES
Discrete input	Read-only	1 bit	NO
Input register	Read-only	16 bits	NO

The following Modbus functions related to reading and writing the values of Coils and Holding Registers are supported:

Function Code	Function
1	Read Multiple Coils
3	Read Multiple Holding Registers
5	Write Single Coil
6	Write Single Holding Register
15	Write Multiple Coils
16	Write Multiple Holding Registers

The following options are supported:

Transport	TCP/IP
Holding Register	16 bit, unsigned integer Big-endian (most significant byte first)
Number of connections to a Modbus Master	1

Addresses

The RAPIX Lighting Control System uses a one-to-one mapping between a Modbus object number and the RAPIX Zone Id. Therefore, for example, a Modbus object number 7 will map to RAPIX Zone id 7.

Modbus has various conventions for numbering Modbus objects so that, for example, Coil 7 will not be confused with Holding Register 7. The most common number convention is:

- Coil *numbers* start with 0 and span from 00001 to 09999
- Holding Register *numbers* start with 4 and span from 40001 to 49999
- The *number* ranges listed above map to *addresses* 0 to 9998.
- For this convention:
  the *address* of a coil is the coil *number* minus 1
  the *address* of a Holding Register is the *number* minus 40001

Some examples of using this convention are shown below:

Modbus Object	Modbus Address	RAPIX Zone Id
Coil number 00005	4	5
Coil number 01234	1233	1234
Holding Register number 40005	4	5
Holding Register number 41234	1233	1234

The Modbus *address* is the value used in the Modbus data frames. This value is not visible to the user, and is not generally of interest.

The setup of RAPIX Zone Controllers allows the selection of the address offsets to suit any numbering convention. The mapping shown in the table above corresponds to the default offset of 0.

The effect of changing the offset value is shown in the table below:

Coil Offset	Coil Number	Modbus Address	RAPIX Zone Id
0	5	4	5
1	6	5	5
100	105	104	5
1000	1005	1004	5

Note that some systems do not follow the convention of subtracting 1 from the *number* to get the *address*. For these systems, use offset values of 1.

If needed, you can calculate the behaviour as follows:

Zone Id = Modbus Address + 1 – offset

Zone Levels

When a Modbus Coil is used to control or monitor a RAPIX Zone, the Coil state (on/off) maps to the Zone state (on/off).

When a Modbus Holding Register is used to control or monitor a RAPIX Zone, the Holding Register value (0 - 65535) maps to the Zone level (0 - 254).

The RAPIX Lighting Control System provides several options for how the Holding Register level mapping can be done to suit the requirements of the Modbus Master.

Modbus Scale	Purpose	Scaling
0 – 1	On/off control	0 = off 1 = on
0 – 100	Percentage control	0 = off 1 – 100 = 1% – 100%
0 – 254	DALI Level control	0 = off 1 – 254 = DALI Level 1 to 254
0 – 255	8-bit control	0 = off 1 – 255 = 0.4% to 100%
0 – 65535	16-bit control	0 = off 1 – 65535 = 0.4% to 100%

When the zone levels are read from a Holding Register, there are two options for the value returned:

- Target Level: the level requested for the Zone
- Current Level: the current average level of all the members of the zone.

Is it recommended that the Target Level be used, because reading the Holding Register will return the same value that was written to it. When using the Current Level, the value read from a Holding Register will often be different from the value written to it. This will occur if:

a. The Zone is fading to the new level (see below)
b. The target level is outside of the range of some of the Zone devices. For example, the Zone may be set to 100%, but some devices may be restricted to a maximum of 90%. The Zone average will then be something in between 90% and 100%.

Fade Times

When a RAPIX Zone is set to a new level, a fade time can be used. This is the time taken for the level to transition from the current level to the new level. Fade times of 0 (instant) and 1 to 65535 seconds (18 hours) can be selected.

To set the fade time, the value (in seconds) is written to a special Holding Register (the address is selectable). Following this, all Zone level changes will use this fade time. The fade time defaults to 0 (instant) on start-up.

Zone Error Status

RAPIX Zone Controllers can report the error status of Zones through Modbus Holding Registers. The error status value is a bitfield as shown in the table below:

Bit-field Value*	Name	Meaning
0x00	OK	Everything in the Zone is OK
0x01	LEVEL UNKNOWN	The level of some or all devices in the zone is unknown. This is not necessarily an error.
0x02	LAMP FAILURE	One or more devices has a lamp failure
0x04	DEVICE_FAILURE	One or more devices has an internal failure
0x08	DEVICE MISSING	One or more devices in the Zone are not responding (but the DALI Line is OK)
0x10	DALI LINE FAILURE	One or more DALI Lines (which are part of the Zone) have a communication failure
0x20	ZONE CONTROLLER COMMS FAILURE	One or more Zone Controllers (which are part of the Zone) is not communicating
0x40	EM FAILURE	One or more Emergency Devices has a failure
Others	undefined	Do not use

**** Note: 0x indicates a hexadecimal value***

The simplest way to use the Error Status value is:

1. If the value is 0, all is OK
2. If the least significant bit is set, then the Zone Level is unknown / uncertain (this is not necessarily an error)
3. If any of the other bits are set, there is a failure

Examples:

Error Status = 17 = 0x11 = 0x10 + 0x01 (DALI Line Failure and Level Unknown)

Error Status = 70 = 0x46 = 0x40 + 0x04 + 0x02 (EM Failure, Device Failure and Lamp Failure)

An address offset must be configured when reading the error status of a zone.

For example: if the offset is 1000, then reading register 1023 will give the error state of Zone 23.

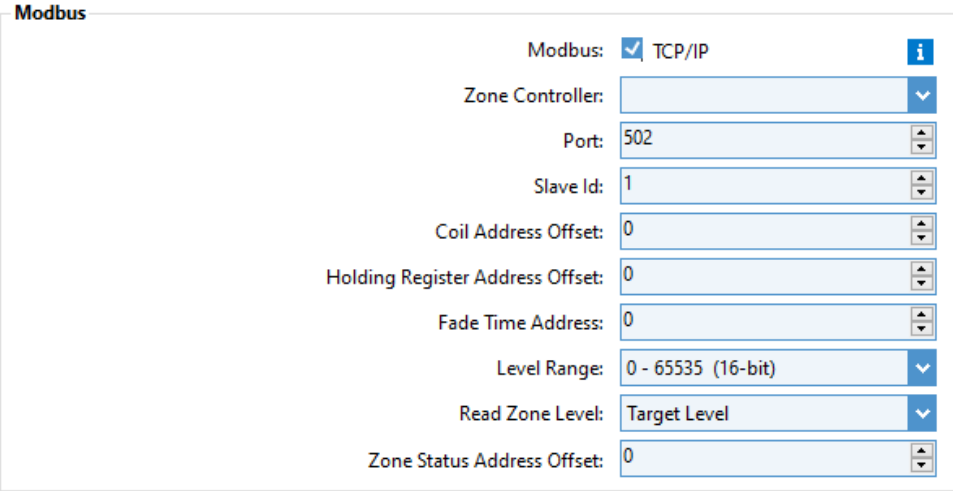
Reading 1000 (i.e. "Zone 0") will give the error state of the whole system.

If the Zone Status Address Offset is set to 0, reading of the Zone Error Status is disabled.

Configuring the Modbus interface using RAPIX Integrator

To configure the Modbus interface to the RAPIX Lighting Control System:

- Use RAPIX Integrator Software
- Select the Site tab:



The Modbus settings are described in the table below:

Setting	Purpose	Default Value
Modbus TCP/IP	Enables the Modbus interface on the selected Zone Controller	Disabled
Zone Controller	The Zone Controller that will have the Modbus interface enabled. **Ozuno recommends the Zone Controller with the lowest IP address is not used, as this will be the Master Zone Controller and will therefore be busier than the others.**	-
Port	The TCP/IP Port	502
Slave Id	The Modbus Slave Id	1
Coil Address Offset	The address offset for Modbus coils	0
Holding Register Address Offset	The address offset for Modbus holding registers	0
Fade Time Address	The address of the Holding Register used for setting the Zone fade time	0
Level Range	The range that the Modbus master will use for the Zone Level	65535
Read Zone Level	Whether to read the Zone target level or current level	Target Level
Zone Status Address Offset	The offset added to the Zone Id for reading error status	0

Run-time Execution

After the configuration has been set using RAPIX Integrator software, it is saved to the Zone Controllers.

After the configuration has been transferred, the Zone Controller that was configured as the Modbus slave will accept Modbus over TCP requests.

After that transfer, there is no need for RAPIX Integrator to remain open, connected to Zone Controllers, remain on site, and so on.

Use with Third-Party systems

Configuration

To interface a Modbus system to the RAPIX Lighting Control System, use this configuration:

1. Use the Zone Controller IP Address and Port as set in RAPIX Integrator
2. Use 16-bit unsigned, big-endian format for Holding Registers
3. Configure the Modbus system and/or the Modbus settings in RAPIX Integrator so that the following are compatible:
    a. Numbering scheme (i.e. Address Offset values);
    b. Level range; and
    c. Slave Id.

Polling

Modbus Masters poll Modbus Slave devices to read the values of coils and registers.

The number of Modbus objects being read, and the rate of the polling should be minimised to reduce the processing load on a RAPIX Zone Controller.

The RAPIX Zone Controller display can be used to show the CPU usage.

Reduce the Modus Master polling rate if the RAPIX Zone Controller CPU load increases by more than 20%.

Change History

Rev	Date	Updated By	Comment
1	7 Nov 2019	DS	First Release
2	11 Nov 2019	DS	Added new features
3	15 Jan 2020	DS	Added Zone Error Status
4	23 Sep 2020	DS	Corrected description of offsets

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