Horti Lighting Protocol

Version 1.0

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Change Management			
Version	**Date**	**Author(s)**	**Changes**
0.9	5 April 2023	Hoogendoorn, Priva, Ridder	Draft version for comments lamp suppliers
1.0	1 May 2023	Hoogendoorn, Priva, Ridder	Final version based on feedback lamp suppliers

Glossary

Definition	
Automation system	Horticulture process control automation system
Channels	Via Channels information can be transmitted over serial lines.
Control area	A defined area controlled as a whole by the Automation system.
General Settings	General settings to read information of the Lighting system or set certain setting of the Lighting system.
Horticulture process control automation system	The system to automatically control a wide range of processes in the greenhouse.
Horticulture Lighting Protocol (HLP)	Description of a Modbus based interface to connect Horticulture lighting systems to Horticulture process control automation systems.
Horticulture lighting system	The gateway and network of the lighting system in the greenhouse.
Lighting system	Horticulture lighting system
Modbus register	The Modbus registers contain process values used to control the Control areas.
Module	The Protocol is set up modular to meet the needs of all kinds of Lighting system technologies. The modules are defined in article 3.2.
Protocol	Horticulture Lighting Protocol (HLP)
Verification register	Via these registers a light recipe can be verified.

Table of Contents

1. Horticulture Lighting Protocol (HLP)

1.1. The Horticulture Lighting Protocol (HLP), hereafter named 'Protocol', describes a Modbus based interface to connect Horticulture lighting systems, hereafter named 'Lighting systems', to Horticulture process control automation systems, hereafter named 'Automation systems'.

2. System architecture

2.1. The Protocol describes how the Lighting system and the Automation system communicate. The Protocol assumes the Lighting system functions as Modbus slave and the Automation system as Modbus master.

2.2. Automation system → Ethernet/RS-485 → Lighting system Gateway → Lighting system network.

3. Modules

3.1. The Protocol is set up modular to meet the needs of all kinds of Lighting system technologies. The most basic way to use the Protocol is to only support the base functionality of communicating setpoints per Control area per channel.

3.2. There are four modules to expand on that functionality:

i) Module System status – Provide feedback to the Automation system about the status of the Lighting system.

ii) Module Power – Provide feedback about the actual power usage of the luminaires.

iii) Module Exact Light Control – Makes it possible to control the exact output, per spectrum of a Control area in µmol.

iv) Module Universal Measurements – Makes up to ten free to use measurements per Control area available.

3.3. When a specific Module is supported, all parameters within this Module must be properly supported.

4. Options

4.1. The Protocol assumes Control areas (groups of lamps) with the same settings. There are 100 Control areas available in the Protocol design. Each control area can have up to eight Channels. Not all channels have to be used.

4.2. All individual Channels can be controlled by percentage or by µmol/s/m² (or µmol/s[1]). Control using a percentage is the easiest solution, this gives control over each physical Channel of the lamps. The percentage is assumed to be linear to the light output of the lamps.

[1] *µmol/s/m² in case the exact output of the luminaires at plant level is available, or µmol/s in case only the output of the individual luminaires is known, µmol/s is the output per luminaire.*

4.3. In case precise control over the light spectrum is preferred, the lamps should be controlled using µmol/s/m² (or µmol/s). In this case verification of the light recipe is necessary, the Protocol provides this option via Verification registers.

4.4. The verification process works in steps.

i) The Automation system sends one or more values to the Verification registers.

ii) The Lighting systems checks these values against the lamp's capabilities.

iii) The Automation system reads back the minimum and maximum values for each Channel in use.

iv) The Automation system sets the desired setpoints.

4.5. A gateway of the Lighting system that supports Module IV must calculate the Verification registers of a Control area within 800ms of the last change of any Verification setpoint of a Control area.

5. Modbus

5.1. The Protocol makes use of standard Modbus, either Modbus TCP or Modbus RTU via RS-485 half-duplex wiring. Parameters to control the Lighting systems are exchanged via 16-bit integer holding registers.

5.2. Keeping the large numbers of parameters in mind, Modbus TCP is preferred, especially for Lighting systems with a significant number of Control areas.

5.3. The Protocol uses big-endian byte order.

5.4. When using Modbus TCP, the gateway of the Lighting system uses a static IP address.

5.5. For the Modbus TCP interface port 502 is used.

5.6. The gateway of the Lighting system needs to support a well-documented and always available method to reset the Modbus and IP settings back to default.

6. Modbus registers

6.1. There are two tables attached which describe the available Modbus registers. The first table with General settings provides the option to read information of the Lighting system or set certain settings of the Lighting system.

6.2. Modbus registers 50 to 99 can be implemented freely by the Lighting system manufacturer.

6.3. The second table describes the Modbus registers containing process values, used to control the Control areas.

6.4. Modbus registers 0..99 and “Power on setpoint Control Area n Channel x” should be non-volatile and be kept during power interruptions and reboots. Repeated writes to these Modbus registers should not lead to excessive wear.

6.5. When a value is written to one of the General Settings registers it is required to apply the setting(s) manually. This can be achieved by writing a value to “Apply settings”. Al

values written to Modbus registers from the General settings table will be applied at once.

6.6. As there are two options for physical connection with the gateway, Modbus RTU and Modbus TCP, the relevant parameters should be used, 20..24 or 30..43. If both interfaces are available both parameter ranges are active.

6.7. The Modbus registers 0..31999 are used or reserved for future expansions of the Protocol. Modbus registers 32000..60000 available manufacture specific expansions.

7. Modbus timing

7.1. To be able to control large amounts of Control areas a decent Modbus response time should be achieved, less than 50ms.

7.2. No specific order of read or writes or 'blocks of writes' should be required.

7.3. A write action should not directly result in traffic over the network of the Lighting system. The gateway is responsible for regulating the timing and the amount of traffic over the (wireless) network of the Lighting system.

7.4. When using the module Exact Light Control only, it is expected that the setpoints of the channels have interdependencies. To make sure that a valid combination of setpoints has been communicated, the lighting system should assume that when the setpoint of the last channel in use of a control area has been written, all setpoint changes within the control area have been communicated and should apply the setpoints of the control area. For example, if a control area uses four channels, when a setpoint to channel four is written all setpoints for that control area must be applied. The same mechanism is used for the verification setpoint option.

8. Modbus functions

8.1. Modbus Function Code 3 is used for reads, and Function Code 16 for writes.

8.2. The "Status Control Area n" register can be used to provide information about the status of the Lighting system. 0 indicates that everything is fine for that specific Control area. Bit 0..7 are reserved for specific use, bits 8..15 may be used by the Lighting system to indicate manufacturer-specific errors. Unresponsive luminaires should not be included in these Modus registers.

8.3. Non-consecutive Modbus registers must be readable and writable. Modbus registers associated with unused control areas must be readable and writable too.

8.4. Modbus has the option to respond to requests with exception responses, exceptions 1 to 4 should be implemented. As described at: modbus.org

9. Lighting system

9.1. When using percentages to control a Control area, a setpoint greater than 0 and lower than the minimum setpoint of a luminaire, the luminaire assumes the minimum setpoint.

9.2. When a setpoint is received at the gateway, the setpoint must be realized within 20 seconds.

9.3. After power on, the gateway must be responsive within 120 seconds.

9.4. After power on of a luminaire, it must be responsive within 180 seconds.

9.5. After power on of a luminaire and doesn't get a setpoint of the gateway the luminaire should fall back to the predefined power on setting setpoint.

9.6. The protocol describes the use up to 100 Control areas and maximum 8 Channels per Control area, these are the limits of the Protocol, the Lighting system can have lower limits.

9.7. The Automation system is expected to support controlling multiple Lighting systems gateways at the same time independently.

10. Modbus registers

10.1. There are multiple Modbus registers per Control area. Al Modbus registers must be implemented and interpreted as described below.

10.2. Status Control Area n: Via these Modbus registers issues with a Control area can be communicated. A 0 means everything is okay, any other value means a fault which could result in the luminaires in the whole Control area to be turned off. Luminaires being unresponsive should not be reflected in this Modbus register.

Bit 0	General issue
Bit 1	Gateway configuration issue
Bit 2	Lighting system (wireless) network issue
Bit 3	Reserved
Bit 4	Reserved
Bit 5	Reserved
Bit 6	Reserved
Bit 7	Reserved

Bit 8..15 can be used to indicate additional issues.

10.3. Number of luminaires Control Area n: The number of luminaires that are configured for the given Control area and should be available if the Lighting system is working properly.

10.4. Luminaires Unresponsive Control Area n: The number of luminaires that are not responding to new setpoints or otherwise not functioning as desired, either measured or calculated.
10.5. Current Power Control Area n: The actual power usage of the Control area, either measured or calculated.
10.6. Max Power Control Area n: The maximum power the Control area could draw if all Channels are at maximum and all luminaires are functioning properly.
10.7. Minimum setting Control Area n Channel x: The technical minimum setpoint of this Channel of this Control area in percentage. This function is not required for Module Exact Light Control.
10.8. Power on setting Control Area n Channel x: The setpoint for this Channel of this Control area when the luminaire is powered on and no setpoint is communicated to the Lighting system or has reached the luminaires after 180 seconds, in percentage. To set power on setting to follow the last setpoint set this value to 6553.5.
10.9. Setpoint Control Area n Channel x: The setpoint for a Channel of a Control area in percentage.
10.10. Realized Control Area n Channel x: The value of the current realized setpoint of the Lighting system of Channel of a Control area in percentage.
10.11. Setpoint in micromole Control Area n Channel x: The setpoint for a Channel of a Control area in micromole.
10.12. Realized in micromole Control Area n Channel x: Value of the current setpoint of the Lighting system of Channel of a Control area in micromole.
10.13. Verification Control Area n Channel x: A hypothetical setpoint for a Channel of a Control area in micromole. Writing to these Modbus registers results in the relevant “Verification minimum Control Area n Channel x” and “Verification minimum Control Area n Channel x” being calculated by the Lighting system. When there is a dependency between the Channels within a Control area which results in changed maximum and minimum values for the other Channels this Modbus register can be used to have the Lighting system calculate the maximum and minimum setpoints of the other Channels. Keep in mind that the maximum and minimum setpoint are only valid if just one parameter is changed. If more parameters must be changed a new verification has to be performed.
10.14. Verification minimum Control Area n Channel x: The minimum value a luminaire can output for the given setpoints in “Verification Control Area n Channel x” for this Channel in this Control area.
10.15. Verification maximum Control Area n Channel x: The maximum value a luminaire can output for the given setpoints in “Verification Control Area n Channel x” for this Channel in this Control area.

10.16. Universal Measurement x Control Area n: With these Modbus registers additional measurements can be made available. Implementation of these Modbus registers is not mandatory.