



# HYBRID Light System User Manual

## Revision History

Revision	Date	Descriptions
1.1	Jan/10/2023	Initial release
1.2	Jul/03/2023	Safety instruction added



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## 1. Safety

Please use this manual before using the product. This is an electronic device that requires safety precautions for safe use. Please pay close attention to the symbol and its description below:

	Warning Symbol
	Class 3B Laser Safety

### 1.1. Instructions on electric factors

- In consideration of the risk of electrical damage to the LED and internal circuits upon power input, it is recommended to the greatest extent possible to supply power in a state where the digital IO, communication channel, and LED wires are connected.
- Since high voltage remains in the LED and output pins even after the power is turned off, it is recommended to disconnect the LED connector or disconnect the power supply for at least 30 seconds while handling the cable.
- While the digital IO input terminal is disconnected electrically by the photo coupled element, the digital output terminal includes its output pin connected to the internal ground. Therefore, when an external device is to be connected, it is recommended to connect to an input terminal that is electrically disconnected. For connection to a device that is not disconnected, it is advisable to connect the (-) negative pole wire and then the (+) positive pole wire.
- The product can be categorized into 'category 1' in OVERVOLTAGE CATEGORIES defined by the IEC since the products is powered by external PSU. As for the PSU, it is advisable to use a model recommended by the manufacturer. If the user has to select a product at his/her discretion, a product that meets electrical safety standards should be used. It is recommended to use a product with short circuit protection and current limit functions.
- Cables used for the PSU need to satisfy the specifications of electrical insulation and output current.

- As for the LED output cables, cable specifications may be determined based on the continued current output. However, the voltage fluctuation upon high current pulse output as stated in Section 2.3 Cable Selection must be taken into consideration.

## 1.2. Instructions on environmental conditions

- The product is designed to be used indoors where the temperature ranging from 0 °C to 50°C and the humidity does not exceed 80%.
- Place the product where personnel cannot accidentally touch it and ensure there is a free flow of air around it.
- Place the product where POLLUTION DEGREE is less than 2 to avoid any damage on it. Altitude 2000m or below is allowed.

## 1.3. Instructions on laser

- Class 3B laser is equipped so avoid all eye exposure to beams from laser. Be careful to keep the beam away from eyes and faces
- protective eyewear is suggested or recommended.

## 2. Product standard

### 2.1. Overview

**Hybrid light system** is composed of a high power light controller and a hybrid light specifically designed for machine vision applications. It is capable of high-speed control and high-efficiency operation. Regardless of the LED voltage and type, it can control the light accurately under optimal conditions. The products include high-efficiency power circuits sufficient enough to operate high power light. It can respond quite quickly, generating a current pulse at least as much as  $0.5\mu\text{s}$ . It contains an over-driving function to operate the light instantly at high current. Upon over-driving, it initiates the duration limit and duty limit functions in order to protect LED elements.

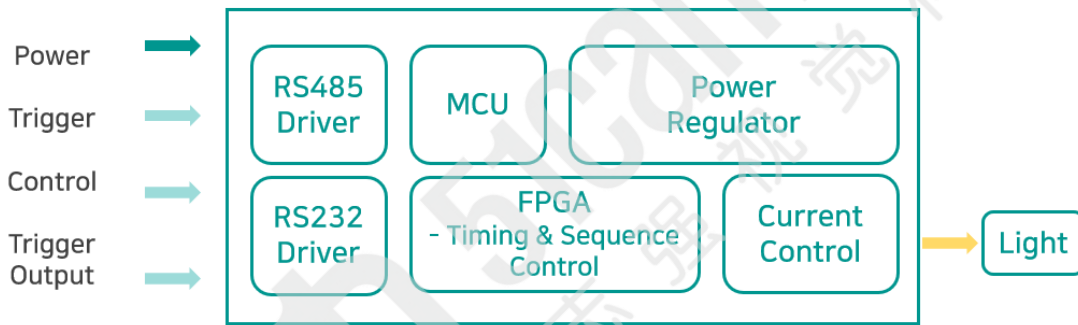


Figure 1 System block diagram

## 2.2. System components

- ILS-HWS1600W-D46 1EA
- IP-HYBRID-M1 1EA
  - iPulse LED Lighting controller
  - Light connector
  - 4 Pin Digital IO connector
  - 2 Pin Power connector
- CA-H4-500-A1 (M8 cable for light)



*Figure 2* ILS-HWS1600W-D46 (Left) and IP-HYBRID-M1 (Right)

### Separate components

- Power Supply Unit
- RS-485 communication device.
- RS-232 cable
- Power / IO cable



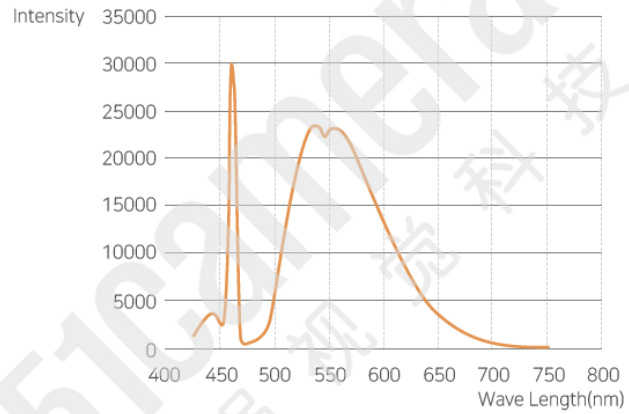
*Figure 3* RS-485 communication module

\*\*This product includes no separate components, but if required by the user, they may be provided.

### 2.3. Specifications

MODEL	ILS-HWS1600W-D46
Color	White
Wavelength	5500K
Power	DC: 10W Pulse: 1600W

Spectrum



**Table 1** Specifications of ILS-HWS1600W-D46

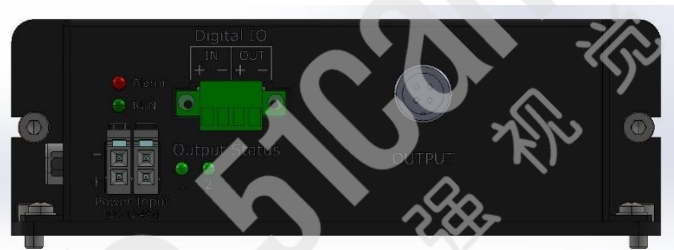
MODEL	IP-HYBRID-M1
channel	1
Intensity Resolution	Continuous/ Pulse minimum Step: 1%
Max. Output Per Channel	Continuous : 100% Pulse: : 1000%
Trigger Source	External IO / RJ45 Port / Soft Trigger Input
Duration Setting	0.1 ~ 5,000 us (step 0.1us)
Internal Period	1.0 - 1,000,000 us (Step : 0.1us)
Trigger Delay	0.0 - 5,000 us (Step : 0.1us)
Control Interface	RS-485 (for Multiple Device Control) / RS-232(for Single Device Control)
Control Protocol	Modbus
Digital IO Input	Opto-coupled Input (3 ~ 24 V, 4 ~ 50 mA)
Digital IO Output	TTL Output (5V, 330 ohm Output)
Mechanical Spec. (W×H×L), weight	145 x 90 x 48(mm), 500g
Power Requirements	12 - 48V 50 W @ 24 V
Operation Temperature	Case temperature : 0 °C ~ 50°C
Connectors	Control : RJ45 8Pin Connector Power : Molex 26013114(5569-02A3) Digital IO : 3.5 mm pitch 4pin Terminal Light Output : GX 12mm 4Pin

**Table 2** Specifications of IP-HYBRID-M1

## 2.5. Connector and LED display

As shown in the figure below, three types of connectors and the status LED are located on the front side of the product, and their functions are as follows:

- 2 Pin power input connectors
- 4 Pin digital IO connectors: External trigger input and trigger output
- Light output connector
- Alarm LED : Alarm status indication
- Run LED : Motion status indication
- Output status LED : LED channel enable status indication



*Figure 4* Front connectors and LED for the controller

As shown in the figure below, two types of connectors and the DIP switch are located in the lateral part of the product, and their functions are as follows:

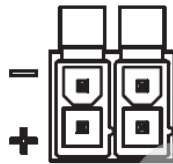
- 8 Pin RJ45 connector: RS-485 communication and trigger signal input
- 9 Pin RS-232 connector: RS-232 communication
- DIP switch: Device address setting




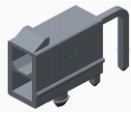
*Figure 5* Side connectors and switch

### 2.5.1. Power input / Output connector

The power input connector uses Molex 2-pin connectors. Two connectors of the same specifications are arranged on the front side. These two connectors, with the same poles directly connected to each other, can be utilized as a power output when multiple devices are connected in parallel by using one PSU. Image 2.7 below shows an example of connecting in parallel one power output, through which multiple devices can be supplied with power. As for the power plug, Molex 5557-02R bundled in the product package or a compatible plug may be used. As for the power supplier, the applicable power range is 12V to 48V. It is recommended to use an SMPS of 24V voltage output and 2A current output.



*Figure 6* Power input connector

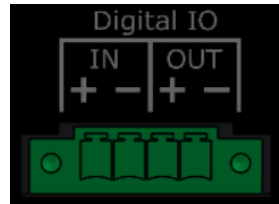
IO Cable	Plug	Receptacle
Power connector	 Molex 39012020 (5557-02R)	 Molex 26013114 (5569-02A2)

*Table 3* Power connector



*Figure 7* Power parallel connection

### 2.5.2. Digital IO connector



*Figure 8* Digital IO connector

As shown in the figure above, the digital IO connector for the trigger input/output is arranged on the front side of the product. A 3.5mm pitch terminal connector is used. The trigger input part is insulated internally by means of a photo coupler. It can receive 3.3-24V trigger signals. When the voltage input is as high as 24V, resistance needs to be added in series in order to protect the photo coupler from damage. Digital IO output signals are of 5V TTL, and the output impedance is 330 ohm. A plug compatible with the digital IO connector is delivered in the same product package.

### 2.5.3. LED Output connector



*Figure 9* Light output connector

As shown in the figure above, the connector for the Light output is arranged on the front side of the product. Cable may be provided from iCore.

### 2.5.4. LED Display

LEDs are used to indicate the status of the front and lateral sides of the product. Indications of the display status are as below

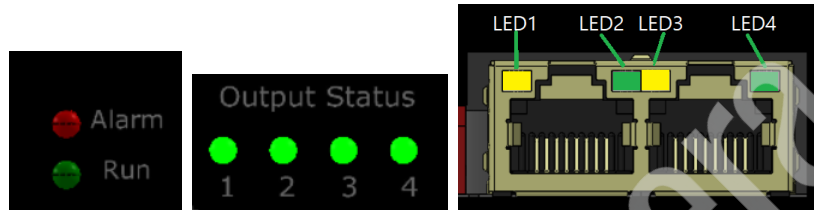


Figure 10 LED Display

LED	Color	Description
Alarm LED	RED	<b>Alarm status indication</b> -. Blinking 1s: Alarm status indication The alarm status register indicates symptoms. To release the alarm, execute the [Alarm Reset] command. -. Single Pulse 10ms : When there is an undefined parameter access or a trigger input error
Run LED	GREEN	<b>Operation status indication</b> -. Blinking 50 Hz : Normal operation status -. Blinking 1 Hz: Boot loader status -. Blinking 10 Hz: Firmware Download status
Output Status LED	GREEN	<b>LED channel enable status indication</b> -. The 'LED Enable' status of each channel
RJ45 LED1	YELLOW	<b>The trigger input status of the digital IO port</b>
RJ45 LED2	GREEN	<b>The trigger input status of RJ45</b>
RJ45 LED3	YELLOW	<b>Serial communication receive operation status</b>
RJ45 LED4	GREEN	<b>Serial communication transmit operation status</b>

Table 4 LED Display Description

### 2.5.5. DIP-Switch setting

The DIP switch at the lateral part of the case is for setting up the Device ID. An address may be allotted in the following way: IDs available for the DIP setting are No. 0 to No. 14. If there are more devices to be connected, set all of the DIP switches to ON (No. 15) and set up the Device ID by using the Slave Address (0x0200) parameter. The valid range is from 0 to 249. An address can be allotted to a max. of 250 devices. The 'Slave Address 0x0200' parameter is 'Write-protected.' It may be modified once '1' is entered into the 'Write Enable (0x300)' register.



Figure 11 DIP switch

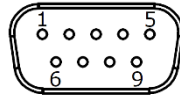
DIP-switch				Slave
Switch 1	Switch 2	Switch 3	Switch 4	Address
0	0	0	0	sID0
1	0	0	0	sID1
...				...
1	0	1	1	sID13
0	1	1	1	sID14
1	1	1	1	Programable sID0 ~ sID249

Table 5 DIP-Switch setting

\*\*.) Switch OFF is 0, Switch ON is 1

### 2.5.6. Device communication interface

As for communication interfaces, RS-232 and RS-485 Ports are available. RS-232 is for one-on-one communication between a PC and a device while RS-485 is for 1 on N communication. Max. of 250 devices can be controlled. The section below is about pin placements and descriptions of each interface.



RS-232

Figure 12 RS-232 connector

Pin number	Name	Description
2	RXD	Receive Data (Data is received through this pin)
3	TXD	Transmit Data (Data is transmitted through this pin)
5	GND	Ground(Used as reference for all pin voltage pulses)
1,4,6,7,8,9	NC	Not Connected.

Table 6 RS-232 Port Pin Configuration

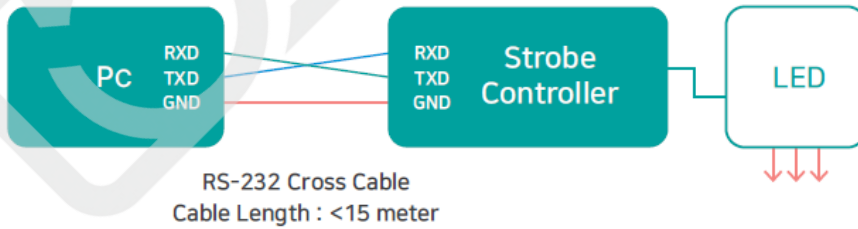


Figure 13 RS-232 connection

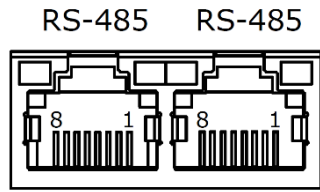


Figure 14 RS-485 connector

Pin number	Name	Description
1,2	N.C	Not Connected.
3	RS485 Data(A)+	Non-inverting receiver input and non-inverting driver output
6	RS485 Data(B)-	Inverting receiver input and inverting driver output
4	Trigger Input RJ45 -	Trigger Input RJ45 Port -
5	Trigger Input RJ45 +	Trigger Input RJ45 Port +
7,8	GND	Ground(Used as reference for all pin voltage pulses)
1,2	NC	Not Connected.

Table 7 RS-485 port pin configuration

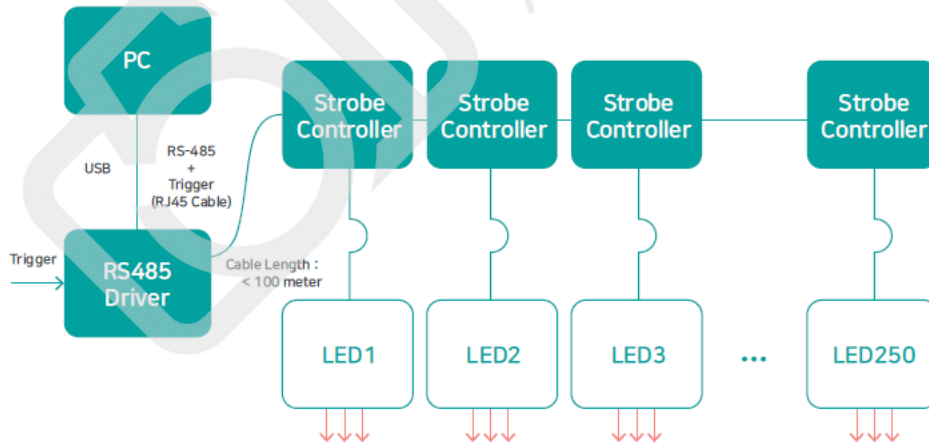
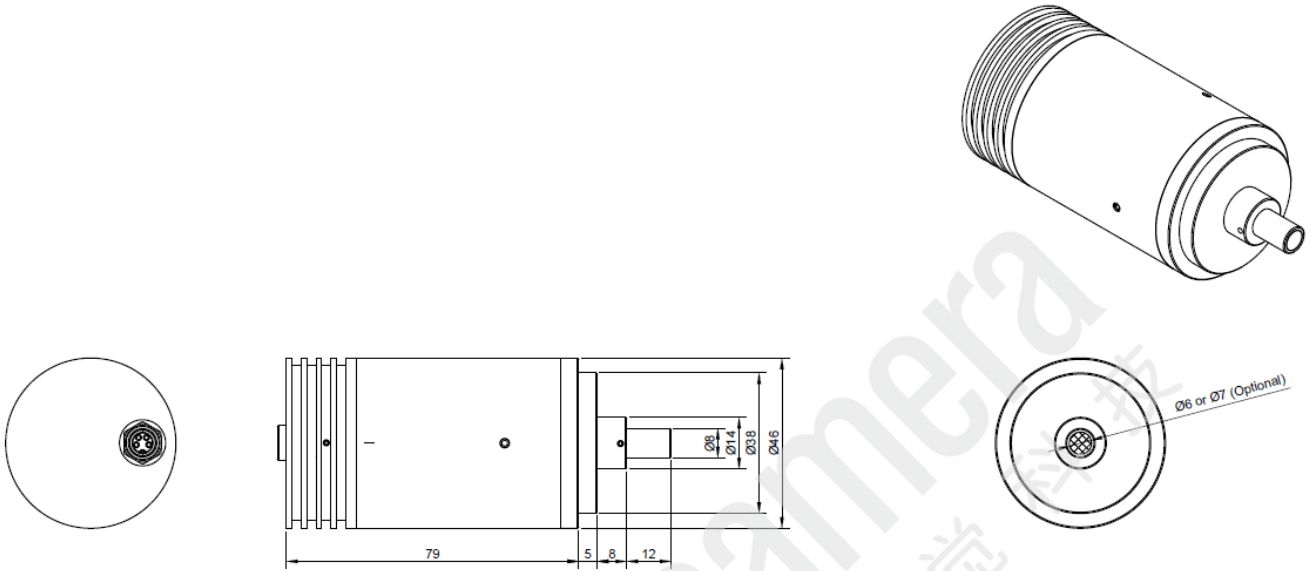
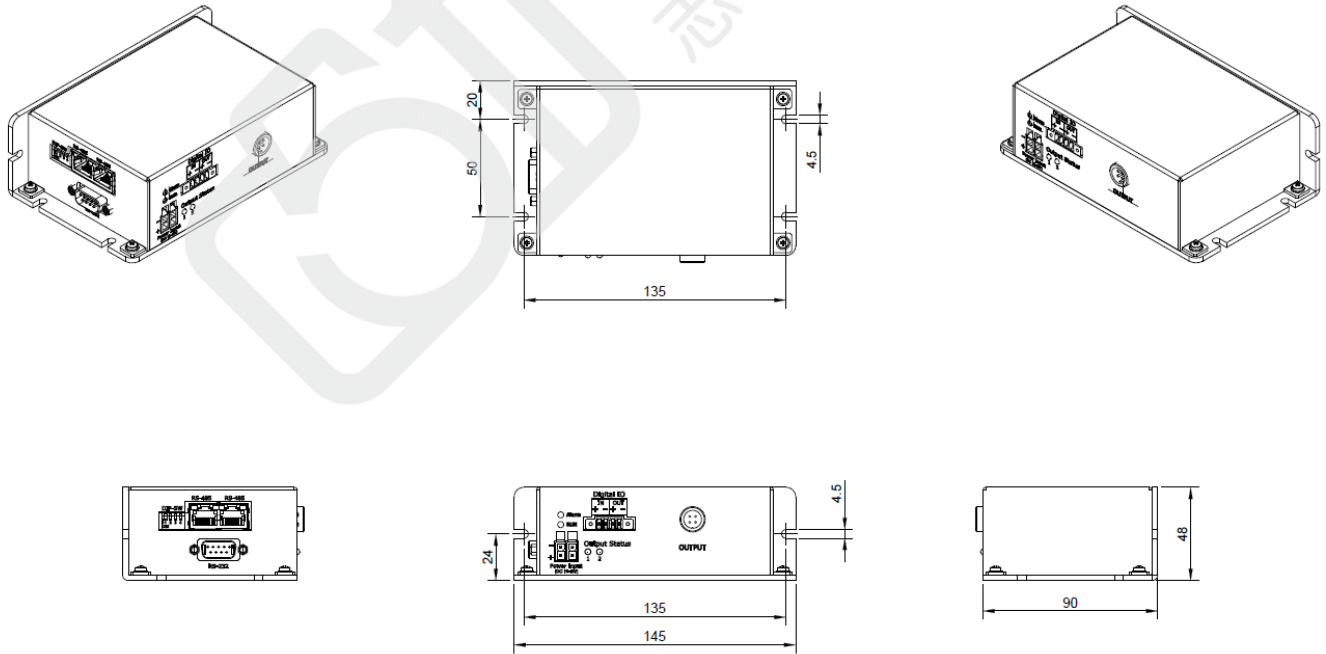


Figure 15 RS-485 connection

## 2.6. Mechanical specification



*Figure 16* Mechanical Dimensions for ILS-HWS1600W-D46



*Figure 17* Mechanical Dimensions for IP-HYBRID-M1

### 3. Main Features

#### 3.1. iPulse configurator

iPulse Configurator is a program to control the controller. This program searches connectable serial ports and detects connected devices automatically. Double-clicking a detected device leads to the device setting window below:

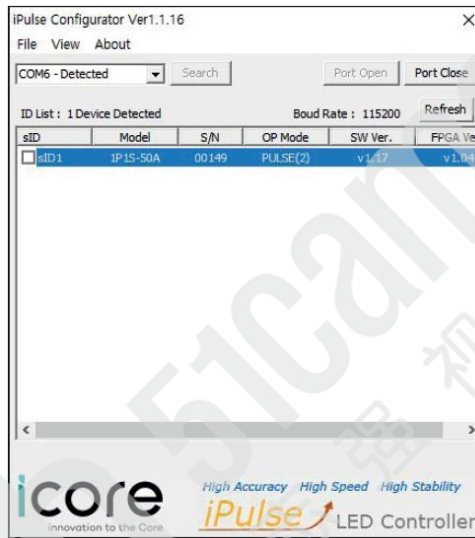


Figure 18 iPulse configurator program

In the device setting window, there are specific parameters that can be set up.

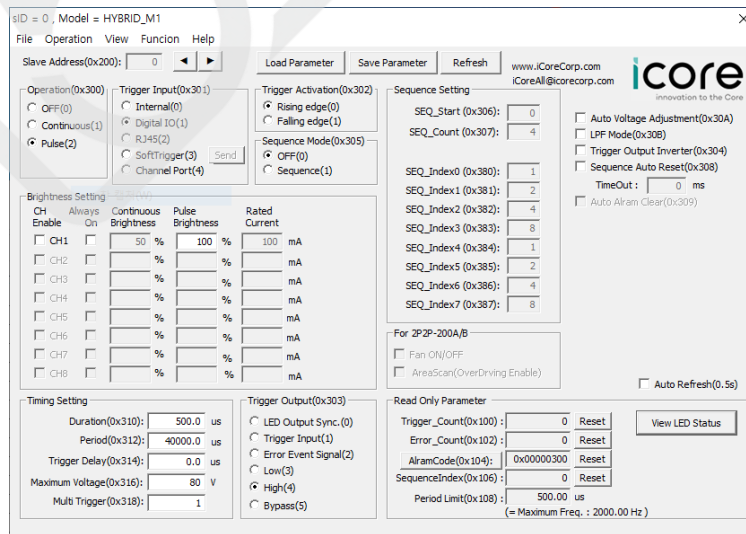


Figure 19 Device setting window

### 3.2. Operation Mode(Address : 0x0300)

The 'Operation Mode' is used to set up 3 motions: OFF, Continuous, and Pulse.

- **OFF(0)** : To turn off LEDs of every channel.
- **Continuous(1)** : To operate LEDs continually.
- **Pulse(2)** : To operate with the pulse in the set duration.

### 3.3. Trigger Input Source (Address : 0x0301)

This is to set up the Trigger Input Source. There are 4 input settings.

- **Internal(0)** : To generate periodic trigger signals by setting the internal period.
- **Digital IO(1)** : To receive trigger signals through an external digital IO port.
- **RJ45 Port(2)** : To receive signals through RJ45 Port's trigger inputs.
- **Soft Trigger(3)** : To receive trigger inputs through the [Soft Trigger] command.

### 3.4. Trigger Input Activation (Address : 0x0302)

This is to set up 'Activation' of Trigger Input signals. There are 2 settings.

- **Rising edge(0)** : To execute 'Activation' of trigger signals at the rising edge.
- **Falling edge(1)** : To execute 'Activation' of trigger signals at the falling edge.

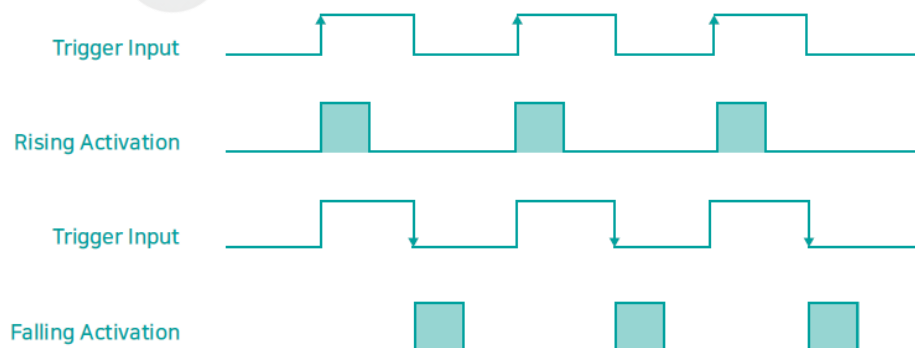


Figure 20 Trigger activation

### 3.5. Trigger Output Source (Address : 0x0303)

This is to set up types of trigger output. There are 5 settings.

- **LED Output Sync(0)** : LED output that is synchronized with LED output signals to which 'Duration' and 'Delay' are applied.
- **Trigger Input(1)** : To output trigger 10us of duration.
- **Trigger Error Signal(2)** : To output trigger error event signals.
- **Low(3)** : To output digital '0' signals.
- **High(4)** : To output digital '1' signals.
- **Bypass(5)** : To bypass and output the input signals.

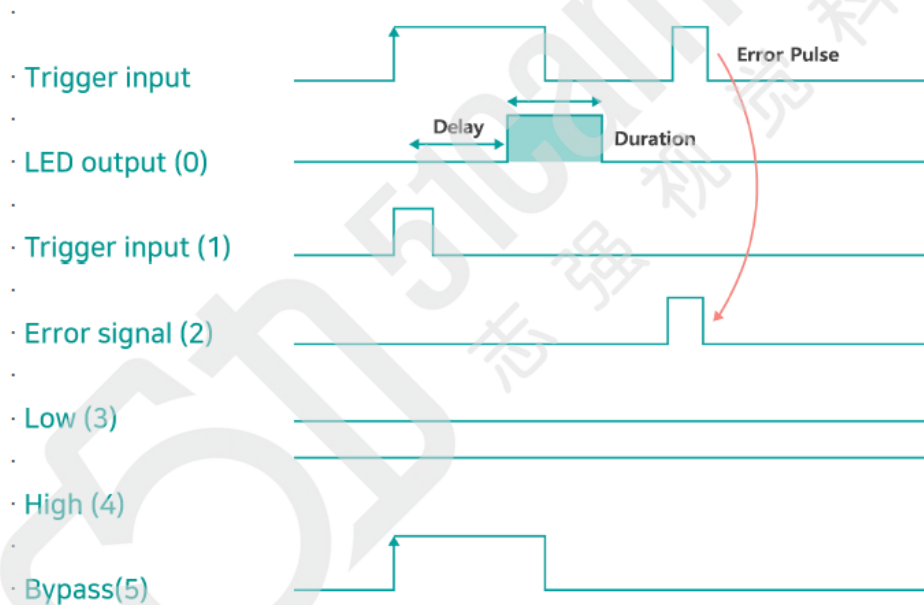


Figure 21 Trigger output source

### 3.6. Trigger Output Inverter (Address : 0x0304)

To invert and output trigger output signals.

### 3.7. Brightness Setting

Brightness setting items include channel ON/OFF, brightness and rated current settings in 'Continuous' and 'Pulse' modes, etc.

- **CH Enable** : CH Enable is a driving control signal that blocks the current into LEDs when it is off.
- **Continuous Brightness** : This is to set up the brightness in the 'Continuous' mode. The setting range is between 0 and 100%.
- **Pulse Brightness** : This is to set up the brightness in the 'Pulse' mode between 0 and 1000%. Between 101% and 1000%, the current value is larger than the rated value of LEDs. Thus, this may be viewed as an over-driving condition, in which 'Duty' and 'Duration' are limited in order to protect LED elements.

### 3.8. Timing Setting

For the timing setting, the following items may be configured

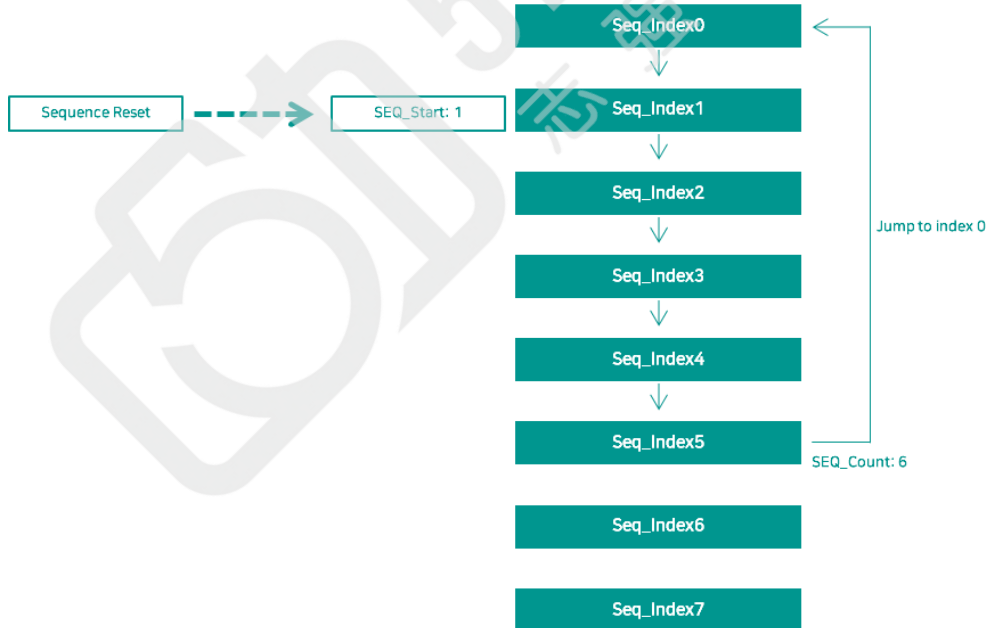
- **Duration(0x310)**: This is a parameter to set up the pulse width for LED operation between 1.0 and 5000.0us.
- **Period(0x312)**: When the 'Trigger Input Source' is set to 'Internal,' it is possible to set up the operation cycle of the LED internally by means of this function between 3.0 and 1000000.0 us.
- **Delay(0x314)**: This parameter is to generate a pulse after a certain period of delay following an external trigger signal input. The unit is 'us' and the valid range is 0.0 to 5,000.0 us.
- **Multi Trigger(0x318)** : Controller is able to generate pulses as many as this parameter when there is trigger input. If you input '10' at this parameters, the controller generates signals and drive LED 10 times right after getting input trigger.

### 3.9. Sequence Setting

The 'Sequence' function is to turn on the LEDs of each channel sequentially upon the 'Trigger' input or to change the combination of each channel. There are two modes available: Sequence Mode and Multi Sequence Mode. This function can be configured by using the parameter items below:

- **Sequence Mode (0x305)** : Set the sequence mode on/off. When activated, the output of the LED channel given as the Sequence Index may be sequentially changed in synchronization with the Trigger signal.
- **SEQ\_Start (0x306)** : Setting the index that starts the sequence after the sequence reset
- **SEQ\_Count (0x307)** : Set Sequence Count

When the [Sequence Reset] command is sent, it is initialized to the sequence index specified by the 'Seq\_Start' parameter. The 'SEQ\_Count' parameter is to set up the number of sequence to be run. The sequence index is adjusted according to the designated number and then reloaded back to 'Index 0.' Table 13 Shows how to set up the 'Sequence Index' value. The ON/OFF status of each LED channel is designated in the bit unit. The bit value may be converted into a decimal value.



*Figure 22* Sequence mode operation

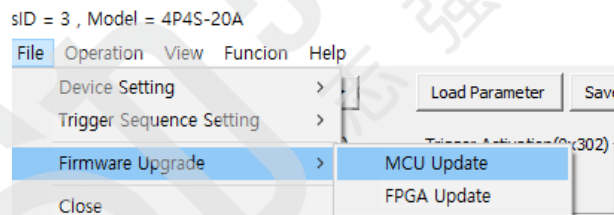
LED Output				Sequence index
CH4	CH3	CH2	CH1	
0	0	0	0	0
0	0	0	1	1
0	0	1	0	2
0	1	0	0	4
1	0	0	0	8
1	1	1	1	15

**Table 8** Sequence index value

\*\* LED OFF is 0, LED ON is 1

### 3.10. Firmware update

upgrade Bootloader, MCU, and FPGA logic through the Serial interface.



## 4. Serial communication

### 4.1. Setting command

Every setting command of iPulse uses the RTU Modbus Protocol and is executed through the serial interface of RS-485 or RS-232. If a user intends to control it directly, the following communication setting may be used. Setting commands use the Modbus protocol, which is an asynchronous half duplex communication method. Once a command is transmitted from a master device (PC or controller), the receiving device returns a response to that command.



When Windows is in the stand-by mode or sleep mode, basically, the serial communication may be disconnected. After restoration from this mode, the serial communication needs to be reconnected.

#### 4.1.1. Communication specifications

- baud Rate : 115200 bps(Selectable 9600, 38400)
- Data Bit : 8 bit
- Parity Bit : No Parity
- Stop bit : 1 stop bit
- Flow control : None
- CRC Check : Yes
- Cable Length : < 100 meter (@baud rate 115200)

#### 4.1.2. Modbus communication frame

Slave Address 1Byte	Function 1Byte	Start register 2Byte	# of Register 2Byte	CRC Checksum 2Byte
0 ~ 249 (For user)	0x03(Read)	0x0000	Read Count	CRC Value
254 (For bust read)	0x06(Write)	~	Write Value	
255 (For broad cast)	0x10(Multi Write)	0x004FF		

*Table 9* Request packet

## 4.2. Parameter Address area

Parameters may be divided into 4 address areas depending on the attributes as shown in the figure below. System parameters and user parameters are stored in flash memory so that their status can remain even while the power is off.

Operation parameters are in the register area where the counter is initialized or such actions as saving in or loading from the memory are executed. The 'Read Only' parameter is to report the internal status of a device. This is used to read the value of a device's internal status.

The system parameter area includes information on a device's factory default and version. Reading is possible but writing is restricted. User parameters for user settings. Both reading and writing are possible. Once settings are saved in flash memory, they are loaded automatically upon rebooting.

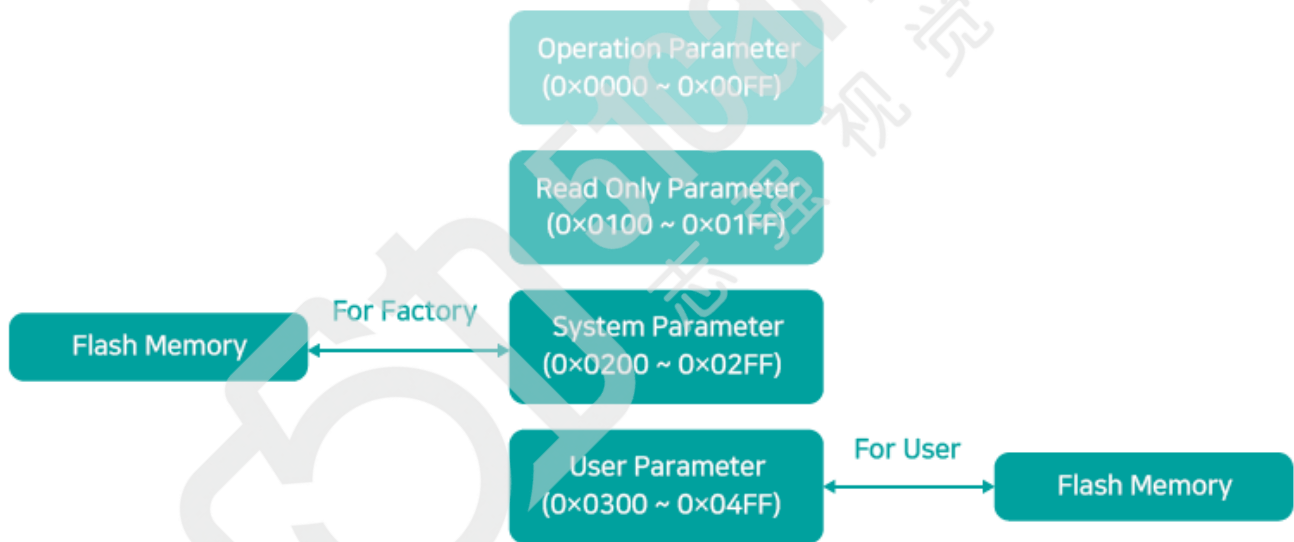


Figure 23 Parameter area

- Data format definition

U16(=unsigned integer 16 bit) : 2 Byte

U32(=unsigned integer 32 bit) : 4 Byte

float : 4 Byte

#### 4.2.1. Operation parameter

Parameter	Register Address	Attribute	Data format	Description
Reboot device	0x0000	R/W	U16	0 : Default 1 : Run reboot device
Save parameter	0x0001	R/W	U16	0 : completed or Default 1 : Save to User Setting
Load parameter	0x0002	R/W	U16	0 : completed or Default 1 : Load from User Setting
Write enable	0x0003	R/W	U16	0 : Default 1 : Write Enable Status
Alarm reset	0x0004	R/W	U16	1 : Run Alarm Reset
Soft trigger	0x0005	R/W	U16	1: Send Soft Trigger Single Pulse
Trigger counter reset	0x0006	W	U16	1: Reset Trigger Counter
Error counter reset	0x0007	R/W	U16	1: Reset Error Counter
Sequence index reset	0x0008	R/W	U16	1: Reset Sequence Index Reset

#### 4.2.2. Read Only parameter

Parameter	Register Address	Attribute	Data format	Description
Trigger Count	0x0100	R	U32	Return Trigger Counter value
Error Count	0x0102	R	U32	Return Error Counter value
Alarm Code	0x0104	R	U32	Return Alarm Code (**1)
Sequence Index Number	0x0106	R	U32	Return Sequence Index Number
Period Limit	0x0108	R	float	Return Period Limit. [us]
LED+ Voltage	0x010C	R	float	Return LED+ Voltage [V]
PCB Temperature	0x010E	R	float	Return PCB Temperature [°C]
LED-Voltage	0x0110	R	float	Return LED- Voltage [V]

\*\*1) For more details on alarm codes, refer to the 'Alarm Code' section below.

#### 4.2.3. System parameter

Parameter	Register Address	Attribute	Data Format	Description
Device Address	0x0200	R/W	U16	Return Device Slave Address
Boot Loader Version	0x0202	R	U16	Return Boot Loader Version
SW Version	0x0204	R	U16	Return SW Version
FPGA Version	0x0206	R	U16	Return FPGA Version
Serial Number	0x0208	R	U16	Return Serial Number
Model Code	0x020A	R	U16	Return Model Code

#### 4.2.4. User parameter

Parameter	Register Address	Attribute	Data Format	Description
Operation Mode	0x0300	R/W	U16	0 : OFF 1 : Continuous Mode 2 : Pulse Mode
Trigger Input Source	0x0301	R/W	U16	0 : Internal 1 : Digital Input Port 2 : RJ45 Input Port 3 : Soft Trigger
Trigger Input Activation	0x0302	R/W	U16	0 : Active High 1 : Active Low
Trigger Output Source	0x0303	R/W	U16	0 : LED Output Sync. 1 : Trigger Input Signal(Bypass) 2 : Error Event Signal 3 : Low 4 : High 5: Bypass
Trigger Output Inverter	0x0304	R/W	U16	0 : Normal 1: Inverter
Sequence Mode	0x0305	R/W	U16	0 : OFF 1 : Sequence Mode Enable
Sequence Initial Index	0x0306	R/W	U16	Set Sequence Initial Index n (0 ~ 7)

Sequence Number	0x0307	R/W	U16	Set Sequence Number n (1 ~ 8)
Auto Sequence Reset	0x0308	R/W	U16	Auto Sequence Reset 0 : OFF / 1 : Enable (**Supported from MCU Ver 1.04)
Auto Sequence Reset Time Out	0x0308	R/W	U16	Auto Sequence Reset Time Out [ms] n : (1 ~ 65535) (**Supported from MCU Ver 1.04)
Auto Voltage	0x030A	R/W	U16	0 : OFF 1 : Auto Voltage Enable
LPF Mode	0x030B	R/W	U16	0 : Default 1 : Low Pass Filter Enable
Power Down	0x030C	R/W	U16	0 : Default 1 : Power Down
Duration	0x0310	R/W	float	Duration Setting [us] 0.1~ 5000.0 us
Period	0x0312	R/W	float	Internal Period Setting [us] 1.0 ~ 1,000,000 us
Trigger Delay	0x0314	R/W	float	Trigger Delay Setting [us] 0.0 ~ 1,000,000.0 us
Voltage	0x0316	R/W	U16	Set Maximum LED Voltage n : (0 ~ 80V)
LED1 Enable	0x0320	R/W	U16	0 : OFF 1 : LED1 Enable
LED1 Current Rate Continuous	0x0330	R/W	U16	Set LED1 Current Rate for Continuous [%] n : (0 ~ 100)
LED1 Current Rate Pulse	0x0340	R/W	U16	Set LED1 Current Rate for Pulse [%] n : (0 ~ 1000)
Sequence Data[8]	0x0380 ~ 0x387	R/W	U16	Set Sequence Data, 8 Array n : (0 ~ 15)  ** Refer to Sequence Mode section

#### 4.2.5. Alarm code

Alarm mask	Description	Action to do
0X0002	PCB Temperature over 70°C	- . When it is used at high temperature or generates heat out of overloading, the PCB temperature may increase. It is recommended to attach the case on a structure that radiates heat well.
0X0008	FPGA Register Check Error	- . In the event that FPGA communication errors occur after FPGA upgrading, the upgrading process needs to be retried.
0X0010	Flash Memory Check Error	- . When this symptom occurs, consult with the manufacturer.
0X0020	Power Range Over	- . An alarm is issued when the LED output exceeds the output setting.
0X0040	LED Short Circuit	- . An alarm is issued when there is a short in the LED wire or when the LED + operation voltage is lower than 2V. Remove the LED wire and check the symptoms.
0X0100 0X0200 0X0300	Light Not Connected	- . An alarm is issued when there is no load on the light. - . When the LED voltage exceeds the rated operation voltage, the LED does not work with the operation voltage increasing to the peak.