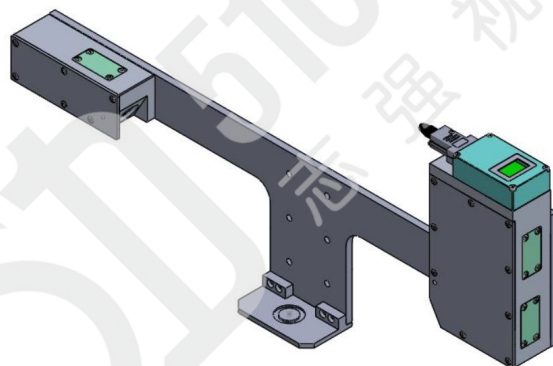


iP-AF

User Manual

iP-AF1 Model



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Revision History

Revision	Date	Descriptions
001	2021/02/02	Initial Release

Contents

1. Safety standard -----	4
1.1. Electrical Precautions -----	4
2. Product Specification -----	5
2.1. Overview -----	5
Specifications -----	6
2.2. Connector and LED Display -----	7
2.2.1. LCD Display -----	8
2.3. Configurator Program -----	9
2.4. Operation Mode(Address : 0x0300) -----	10
2.5. Parameter View -----	11
2.6. Device Status Display Window -----	13
2.7. Firmware Update -----	13
3. Serial Communication -----	14
3.1. Communication protocol -----	14
3.1.1. Communication specification -----	14
3.1.2. Modbus Communication FRAME -----	14
3.2. Command Parameter Address -----	15
Operation Parameter -----	16
3.2.1. Read Only Parameter -----	16
3.2.2. System Parameter -----	17
3.2.3. User Parameter -----	17
3.2.4. Error Code -----	19

1. Safety standard

This product is an electronic device that requires safety precautions. Please read the following symbols in the manual carefully.



Warning

1.1. Electrical Precautions

In case of power supply, in order to be concerned about the electric damage of Laser and internal circuit, power should be applied when the communication line and Laser Device wirings are connected.

It is recommended to use the model recommended by the manufacturer for the power supply unit. If you choose the product, it is recommended to use the product which satisfies the electrical safety standard.

Cables used in the power supply must use cables that meet the electrical insulation and output current specifications.

2. Product Specification

2.1. Overview

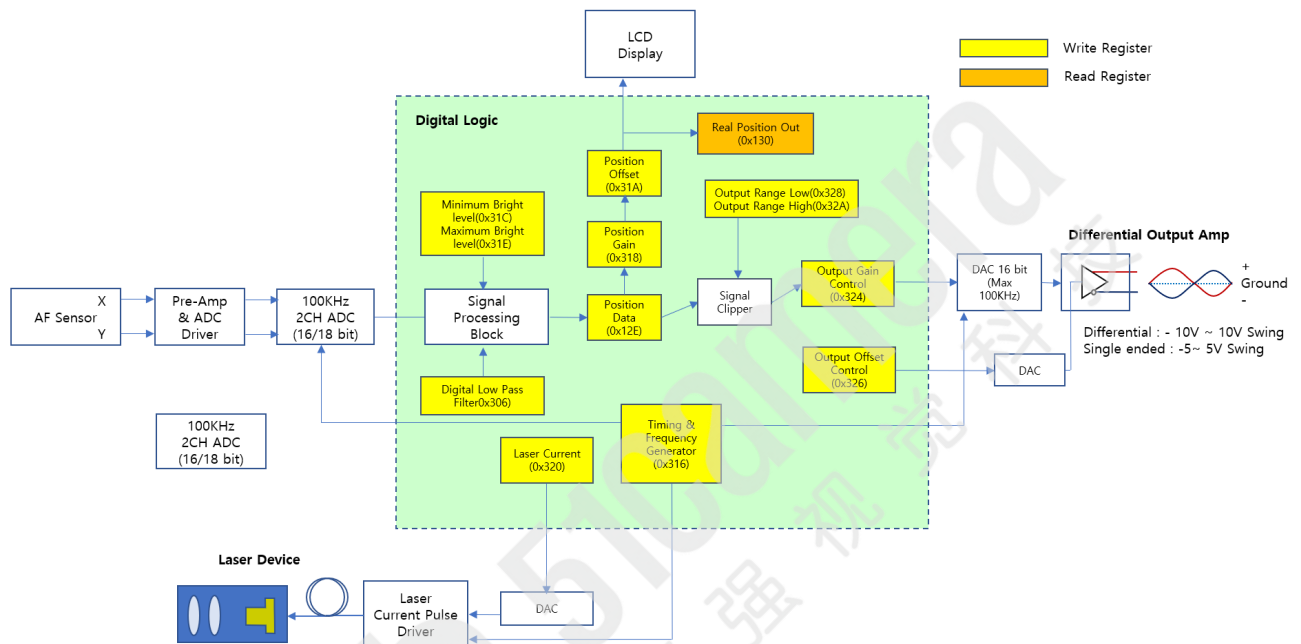


Image 2.1 System Block Diagram

Specifications

Contents	iP-AF1
Sensor Active Area	6 mm (Length) X 1 mm (width)
Max Sampling Speed	Input -. 100KHz 16/18 bit ADC -. Analog Input BW : 100KHz Output -. Output Signal : -10 ~ 10 V (Differential) -. Output Signal : -5 ~ 5 V (Single ended) -. Output impedance : 50 ohm -. Analog Output BW : 50KHz
Position Resolution	< 0.15 μ m (at Single Sampling)
Linearity Error	< 0.4 %
Digital Interface	RS-485(Modbus)
Operation	Off, Continuous, Pulse
Display	Position, Brightness, Error Code
Power Input	Normal Operation : 24 V / 0.1A Power Input Range : 8 ~ 48 V
Power Consumption	< 0.5W
Function	Ambient Light Cancelling Function Laser Current Control Low Pass Filter Setting Output Gain / Offset Control Position Range Setting

Table 2.1 Specifications of iP-AF1

2.2. Connector and LED Display

Connector



Name	Pin	Description
Power Input	6 1	Power Input + Ground(Power)
Laser Output	3 8	Laser + Laser -
RS485 Line	7 2	RS485_A RS485_B
Analog Output	5 9 4	Analog Output + Analog Output - Ground(Analog)
Housing		Ground

Image 2.2 Input/Output Connector

2.2.1. LCD Display



Image 2.3 LCD Display

Name	Description
Position Value	The center of sensor is marked as 0 um. The effective measuring range is ± 2250 um **1) @ optical magnification 1x. The optical magnification of current configuration is 1.60x. Therefore, the maximum measuring range is ± 1400 um **1) The effective measuring range of PSD sensor is calculated as about 3/4 of the total length of the sensor. Ex) $3000 \times 0.7 = 2250$ um
Brightness	Brightness is a value representing the brightness received from sensor. The best range is 60% to 100%. By adjusting the laser current value, the best condition can be set. If the value is too low, the measurement accuracy become low, and if the value is higher than 150%, an incorrect value is output.
Error Status	Displays the Error status.

2.3. Configurator Program

The Configurator automatically detects device by searching the serial port for connection. Double click the model of recognized device to display its device setting window as shown below.

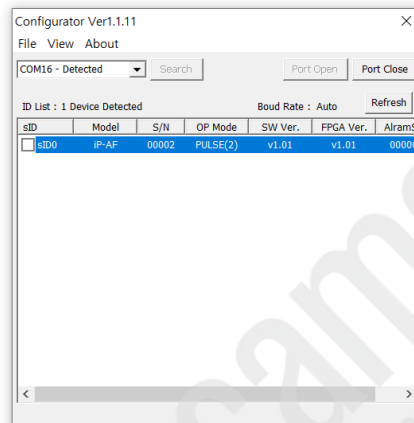


Image 2.4 Configurator Program for iP-AF

Detailed parameters can be set in the Device setting window as below.

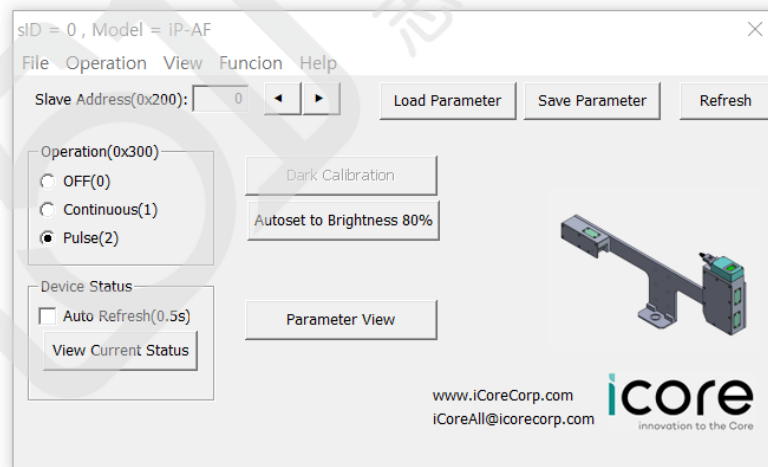
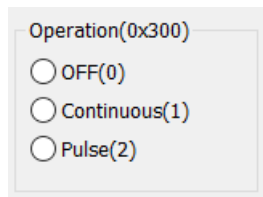


Image 2.5 Device Setting Window

2.4. Operation Mode(Address : 0x0300)

Operation mode is a function to set three operation options: OFF, Continuous, and Pulse.



- **OFF (0):** Turn off the Output Channel.
- **Continuous (1):** Continuous capture mode
- **Pulse (2):** Pulse capture mode (Ambient Light removal function is included)

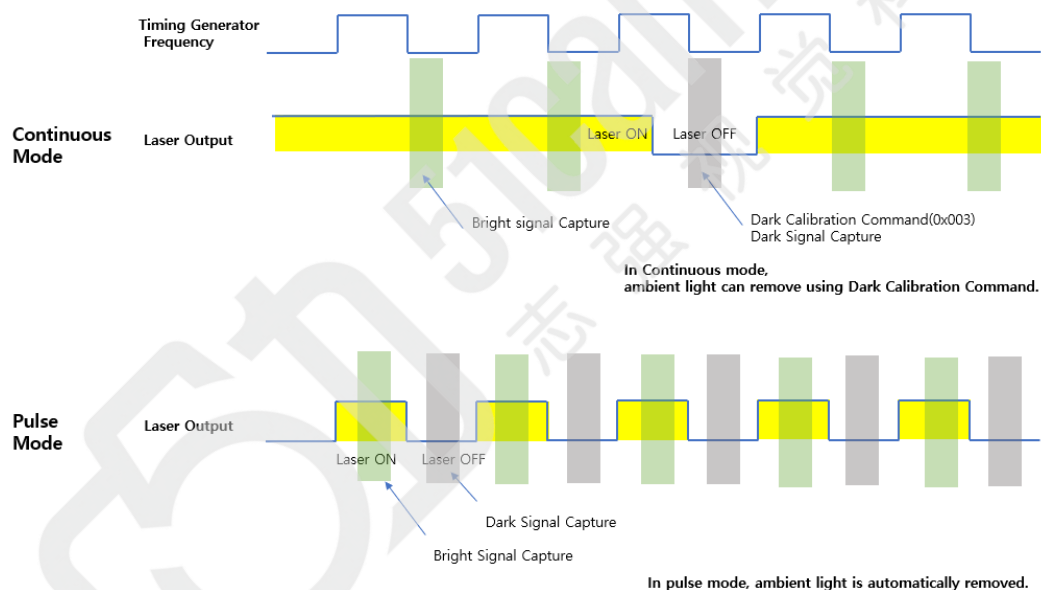


Image 2.6 Data Capture Timing

2.5. Parameter View

Parameter View

EDIT RELOAD REFRESH

0x0007 AutoBrightness Target

0x0300 OP Mode

0x0306 Digital Filter 0~3

0x0307 Laser ON

0x0316 Frequency Hz

0x0310 Duration us

0x0312 Period us

0x0314 Delay us

0x0318 Position Gain

0x031A Position Offset

0x031C Bright level Low %

0x0320 Laser Current mA

0x0324 Output Gain

0x0326 Output Offset V

0x0328 Output RangeH um

0x032A Output RangeL um

0x010E PCB_Temp °C

0x0106 ErrorStatus

0x0128 ADC_DarkX DN

0x012A ADC_DarkY DN

0x012C PositionOut DN

0x012E PositionDAC DN

0x0130 RealPosition um

0x0132 Brightness %

Refresh

Image 2.7 Device Parameter Setting Window

Description of registers

Name	Description
Auto Brightness	The Auto Brightness command is a function that automatically adjusts the brightness to input target value. When adjustment is complete, it is returned as 0. If Brightness is lower than 1%, it can not be started.
Bright Level Low	Bright Level Low Register set the minimum brightness for outputting the position value. If the brightness value is lower than the setting, the position value is not updated. (Analog output retains its previous value)

Bright Level High	Bright Level High Register set the maximum brightness for outputting the position value. If the brightness value is higher than the setting, the position value is not updated. (Analog output retains its previous value) This value is fixed at 160%.
Position Gain	Position Gain value set the gain value for display output. In the current PSD optical system configuration, the calibrated value is 0.6244. This value does not affect the analog output.
Position Offset	Position Offset Register set the offset value for display output. This value does not affect the analog output.
Output Gain	This value set the gain of analog output. Output Voltage[mV] = Position Output [um]* 3.3333 *Output Gain /Position Gain In the current optical configuration, the Position Gain is 0.6244 and the Output Gain is 2.000. The output resolution per 1um is as follows. = 1um * 3.3333 * 2.000 / 0.6244 = 10.6768 mV (at differential Output)
Output Offset	This value is the analog output offset value. It can be set in the range of -5.0 ~ 5.0V, the single end output is applied at half of the set value.

2.6. Device Status Display Window

Displays the current device status. If 0.5 second refresh button is activated, the current status is updated every 0.5 second automatically.

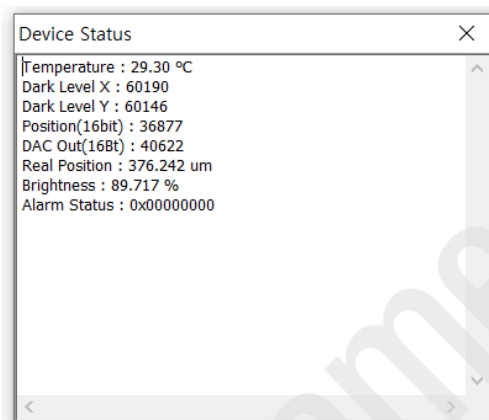


Image 2.8 Device Status Display Window

2.7. Firmware Update

The configurator provides function to upgrade boot loader, MCU and FGPA logic via the Serial interface. For detailed field upgrade information, please refer to the field upgrade document provided by the manufacturer.

3. Serial Communication

3.1. Communication protocol

All command parameters of the *IP-AF* use the RTU Modbus Protocol and are implemented via RS-485 interface. If you want to control directly from user application, you can control with the following communication setting. The configuration command uses the Modbus protocol, which is an asynchronous half duplex. The command is sent first from the master device (PC or controller) and the device returns a response to the command.

 Caution	When Windows enters standby and power saving mode, serial communication may be disconnected by default. After recovering from this mode, serial communication must be reconnected.
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3.1.1. Communication specification

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

3.1.2. Modbus Communication FRAME

- **Request Packet**

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(Wrtie)	~	Write Value	
255(for Broad Cast)	0x10(Multi Write)	0x004FF		

3.2. Command Parameter Address

The command parameters are configured in four address areas, depending on the properties used as shown below. System and user parameters can be saved in Flash memory so that they can be maintained even when the power is turned off.

The operation parameter is a register area that initializes the counter or stores or loads the memory. Read Only Parameter is a parameter area that indicates the status of the device. It is used to read the status value of the internal device.

System parameter area contains device factory shipment information and version information. Read operation is available but write operation is limited. User parameter can be read or written to the user's setting area. When the setting value is saved in Flash memory, it is automatically loaded when rebooting.

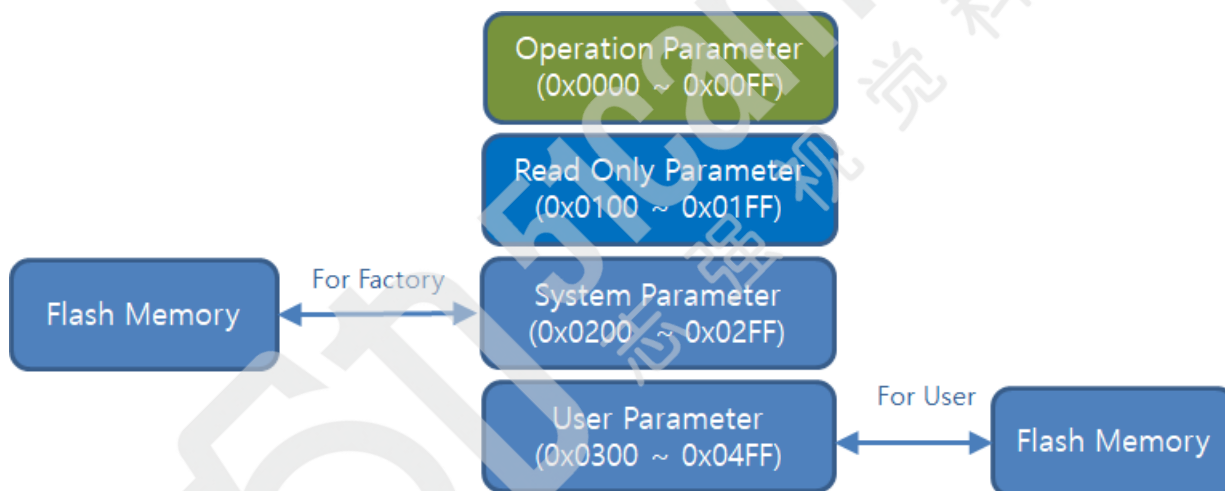


Image 3.1 Parameter Areas

- **Data format Definition**

U16(=unsigned integer 16 bit)	: 2 Byte
U32(=unsigned integer 32 bit)	: 4 Byte
float	: 4 Byte

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 Activation (For write enable of 0x0201, 0x020C register)
Dark Calibration	0x0006	R/W	U16	1: Start Dark Calibration 0: Completed
Auto Brightness	0x0007	R/W	U16	1: Start Auto Brightness Control 0: Completed

3.2.1. Read Only Parameter

Parameter	Register Address	Attribute	Data Format	Description
Error Status	0x0106	R	U32	Return Error Code**1)
PCB Temperature	0x010E	R	float	Return PCB Temperature [°C]
ADC Dark X	0x0128	R	U32	Return Dark level ADC Value X
ADC Dark Y	0x012A	R	U32	Return Dark level ADC Value Y
Position Out	0x012C	R	U32	Return Position After calculation
Position DAC	0x012E	R	U32	Return DAC Output Value
Real Position Output	0x0130	R	float	Return Real Position Output
Brightness	0x0132	R	float	Return Brightness value [%]

** 1) For details of Error Code, refer to Error Code in the manual.

3.2.2. 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 128 : iP-AF-01
Baud rate Setting	0x020A	R/W	U16	Return Baud rate Setting- 0 : 115200 1 : 38400 2 : 9600

3.2.3. 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(Default) 1 : External Digital Input Port(Not Support)
Control Mode	0x0305	R/W	U16	0 : Laser Current Control Mode(Default) 1 : Laser Brightness Control(not Support)
Digital Low Pass Filter	0x0306	R/W	U16	Digital Low Pass Filter Setting 0 : bypass 1 : Moving Average 2 2 : Moving Average 4 4 : Moving Average 16
Laser On/OFF	0x0307	R/W	U16	Laser On/Off Setting 0 : Laser Output Enable 1 : Laser Output Disable
Sample Count	0x0308	R/W	U16	Data Sample Count per capture period

				1 : This value is fixed 1
Data Sampling Frequency	0x0316	R/W	Float	Data Sampling Frequency(Hz) 200 ~ 50,000 : Continuous Mode 200 ~ 10,000 : Pulse Mode
Position Gain	0x0318	R/W	Float	Position Gain Value f : 0.010 ~ 100.000
Position Offset	0x031A	R/W	Float	Position offset Value f : -500.000 ~ 500.000 um
Minimum Bright Level	0x031C	R/W	Float	brightness minimum value 0.0 ~ 50.0% (recommend value : 1.0%)
Maximum Bright Level	0x031E	R/W	Float	brightness maximum value f : 160 % (This value is fixed 160%)
Laser Current	0x0320	R/W	Float	Laser Current Adjustment Value f : 0 ~ 100.0 mA
Laser Voltage	0x322	R	Float	Maximum Laser Voltage f : 5.0 (This value is fixed 5.0V)
Output Signal Gain	0x324	R/W	Float	Analog Output Gain f : 1.000 ~ 16.000
Output Signal Offset	0x326	R/W	Float	Analog Output Offset f : -5.000 ~ 5.000
Output Range Low	0x328	R	Float	Display Output Range Low[um]
Output Range High	0x32A	R	Float	Display Output Range High[um]

3.2.4. Error Code

Error Code	Description	Remark
0x0001	Laser Connection Error	-. Laser device is not connected.
0x0002	PCB Temperature over 50℃	-. If the environmental temperatures is higher than 50℃
0x0008	FPGA Register Check Error	-. As a symptom of FPGA communication error, if the symptom occurs after the FPGA upgrade, perform the FPGA upgrade again
0x0010	Flash Memory Check Error	-. Contact the manufacturer if the symptom occurs.
0x0020	Brightness level to low	-. If the laser output is lower than the minimum Bright Level, an alarm is triggered.
0x0040	Brightness level to High	-. If the laser output is Higher than the maximum Bright Level, an alarm is triggered.
0x0100	Measure Range Over	

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