PlugTech

PRECISION SYSTEMS

TFLN IQ Modulator Bias Controller

(TFLN-IQ-01×-×××)

Operation Manual

Version: Rev1.0.1

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Plugtech Precision Systems Limited

Content

Model Description

TFLN-IQ-01×-×××

Function Version

A: Standard Version
S: Customized Version

Output Voltage Range

040: 0-4V
080: 0-8V
100: 0-10V

Caution

1. **Electrical safety**
   - Please use a power supply that complies with the regulations.
   - When using this product, take electrostatic (ESD) precautions to prevent damage to the product.
   - Do not disassemble or replace the electronic components of the product at will.

2. **Environmental requirements**
   - Operating temperature: -20°C to +80°C, humidity <80% RH.
   - Keep away from strong magnetic fields, vibration sources, and corrosive gases.

3. **Optical safety**
   - When operating the optical fiber, please take protective measures and avoid looking directly at the fiber.

Interface Description

No.	Name	Description
1	Power Switch	Turn on/off bias controller.
2	Power Input1	+5V DC adaptor input channel.
3	Power Select	Switch power input channel.
4	Power Input2	+5V DC source input channel, XH-2 connector.
5	MPD Input	Modulator built-in PD input.
6	Photodiode	External optical feedback input, FC/APC.
7	Bias Output	Controller's bias output port.
8	LED	Green light constantly on: Working under tracking state
		Green light blinking every 0.2s: Processing data and searching for controlling point
		Green light blinking every 1s: Feedback input is too weak
		Red light blinking every 3s: Feedback input is too strong
		Red light constantly on: Working under PauseControl mode or Manual mode
9	UART	UART interface for communication
10	Polar	Operation for polar selection
11	Reset	Operation for resetting controller
12	Earth	Ground pin of bias controller
13	M2 Hole	Controller's mounting hole

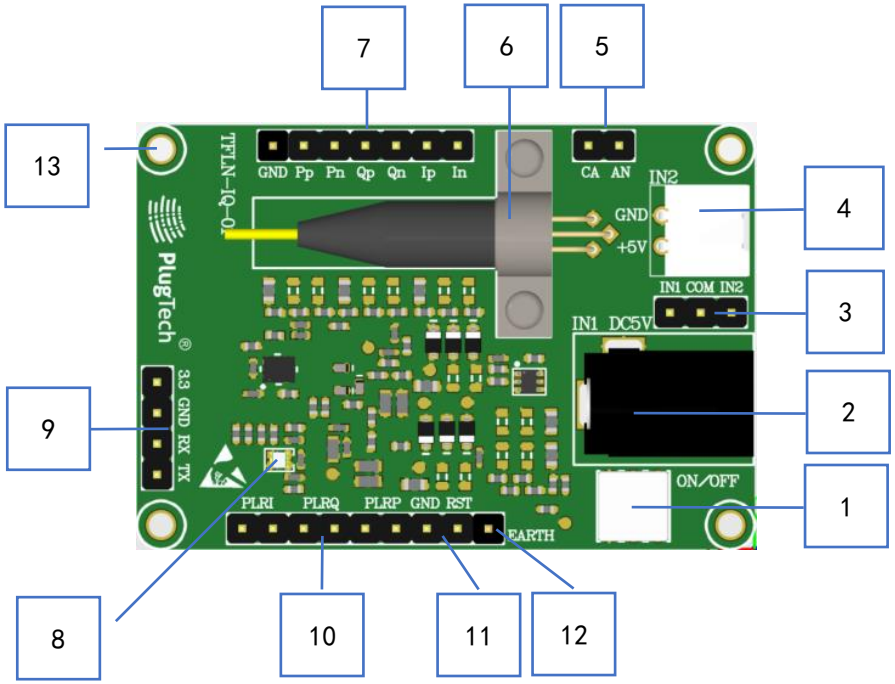

Figure 1. Interface Annotation

Specifications

Parameters	Min	Typ	Max	Unit	Note
Electrical Parameters					
Supply voltage	+4.5	+5	+5.5	V	
Operating current	70	~	700	mA	
Output voltage range	0	~	4	V	TFLN-IQ-01×-040
	0	~	8	V	TFLN-IQ-01×-080
	0	~	10	V	TFLN-IQ-01×-100
Feedback input current [1]	0.001	~	0.316	mA	
Optical Parameters					
Input optical power[1]	-30	~	-5	dBm	
Optical wavelength	1100	~	1650	nm	
Control Parameters					
I, Q arms are controlled on Null (Minimum) point.					
P arm is controlled on Q+ (right quadrature) or Q- (left quadrature) point[2].					

Note:

1. Please be noted that the input optical power does not correspond to the optical power at the selected bias point. It refers to the maximum optical power that the modulator can export to the controller within the output range of controller.
2. When the controller fails to complete the initialization or keeps indicating that the feedback light is too weak, it might be because the controller cannot find the appropriate Q+ (Q-) point. In this case, you can try to switch the working point of the P arm to the Q- (Q+) point by adjusting the Polar settings.

System Setup

Step 1: Choose power input channel

There are two power input channels for the controller, which are IN1 (power input1) and IN2 (power input2). Users can choose either IN1 or IN2 as power input by inserting the jumper to Power Select port and operating as follows:

Condition	Operation
Use +5V DC power adaptor as power supply	Use jumper to connect IN1 and COM pins of Power Select port.
Use other +5V DC source as power supply	Use jumper to connect IN2 and COM pins of Power Select port.

Note: It is preset to use IN1 as input channel and connects IN1 and COM together by factory default.

Step 2: Calibrate heater resistance

To ensure that the controller can work properly, we recommend to calibrate the heater resistance value of modulator to the controller through UART. The specific operation is as follows:

Step 1: Measure the resistance value of the modulator's each heater

Use multimeter to measure the actual heater resistance value of modulator (unit: ohm).

Step 2: Send the heater resistance value to controller

Send the measured resistance value to controller via UART command.

Please refer to the UART Operation chapter below for instructions on how to operate the UART.

Note:

(1) The default heater resistance value is 100 ohm.

(2) The value will be stored in Flash memory and automatically loaded when the controller is turned on or reset.

(3) Only first deployment of the controller is it necessary to calibrate the resistance. If the matching modulator is replaced, the resistance values need to be recalibrated.

Step 3: Feedback input selection

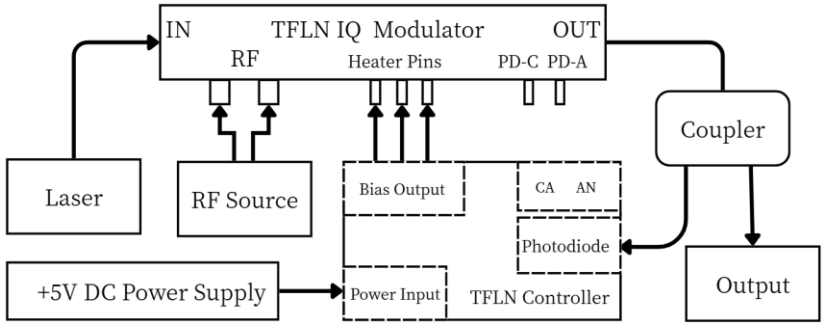

Figure 2 System diagram with the controller's onboard PD

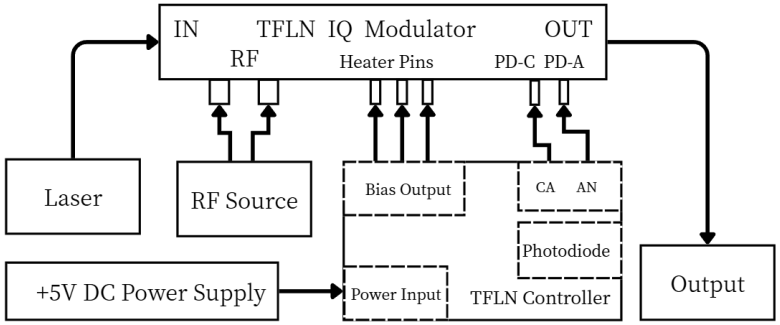

Figure 3 System diagram with the modulator's MPD

Please choose the appropriate feedback method according to the system conditions. User can choose either controller's onboard PD or modulator's MPD (if applicable) as feedback input.

Use controller's onboard PD as feedback input

Choose the appropriate optical coupler to ensure that the feedback optical power is within the specifications of the product. For example, if the laser output power is 10 dBm and the modulator has an insertion loss of 5 dB, the modulator's maximum optical output is about 5 dBm. In this case, the user can choose a 1:99 optical coupler with a 1% port output power of approximately -15 dBm, which is within the controller's feedback optical input range. In this case, the 1% port of coupler can be connected to the controller's photodiode as a feedback input, while the 99% port serves as the output of the system. When the controller uses onboard photodiode as feedback input, make sure the controller's CA and AN pins are unconnected.

Use modulator's MPD as feedback input

Make sure the maximum current output of modulator's built-in photodiode (PD) is within the controller's feedback input current range. See Figure 3 for Complete connection. Connect controller's AN and CA pins to modulator's MPD-A and MPD-C respectively. The controller's photodiode should remain unconnected.

Step 4: Controller's bias output connection

Here are the connection instructions.

Controller's Bias Output	Operation	Modulator's Heater Pins
Ip	Connect	Heater+ of I arm
In	Connect	Heater- of I arm
Qp	Connect	Heater+ of Q arm
Qn	Connect	Heater- of Q arm
Pp	Connect	Heater+ of P arm
Pn	Connect	Heater- of P arm

Step 5: Turn on the controller

1. Connect the Earth pin of controller to the ground and apply +5V power supply to controller.
2. Turn on the controller after the RF source (if applicable) and laser source is stabilized.
3. When the controller is turned on, if the controller's LED start blinking (green), it means that the controller start automatically initialization and calculation.

Operating Manual

(1) Set polar state operation

Set polar state to Positive

(1) Keep PLRx pins on the controller disconnected.
(2) Turn on or reset the controller.

Set polar state to Negative

(1) Use jumper to connect PLRx pins.
(2) Turn on or reset the controller.

Note:

(1) PLRx can be PLRI/PLRQ/PLRP.
(2) Polar depends on system RF signal. When there is no RF signal in the system, the polar should be positive. When RF signal has amplitude greater than a certain level, the polar will change from positive into negative. At this time, Null point and Peak point will switch with each other. Q+ point and Q- point will switch with each other as well. Polar switch enables user to change the polar directly without changing operation points.
(3) When the controller fails to complete the initialization or keeps indicating that the feedback light is too weak, it might be because the controller cannot find the appropriate Q+ (Q-) point. In this case, you can try to switch the working point of the P arm to the Q- (Q+) point by adjusting the Polar settings.

(2) Reset operation

Use the jumper to connect RST and GND pins for 1 second, then remove the jumper.

UART Operation

Step1: USB-UART adaptor board driver installation

If your computer does not have proper driver for the FT232 USB-UART converter module installed, complete the driver installation first:
Driver download link (32-bit Windows):
http://www.waveshare.net/w/upload/1/1f/FT232_Driver.7z
Driver download link (64-bit Windows):
http://www.waveshare.net/w/upload/4/49/CDM_v2.12.06_WHQL_Certified.zip
Additional information:
http://www.waveshare.net/w/upload/d/d0/FT232-USB-UART-Board-UserManual.pdf

Step2: Connection

The blue board below is the FT232 USB-UART module that will convert USB data to UART format.

Figure 4. USB-UART Converter

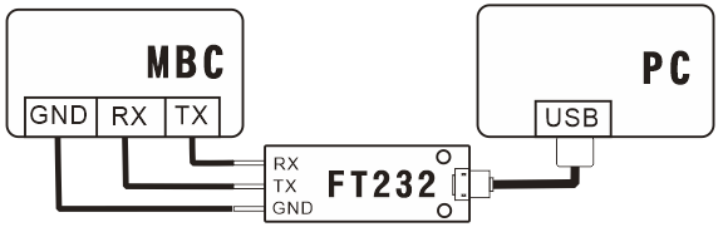

Figure 5. USB-UART Converter Connection

The TXD of USB-UART module should be connected to RX pin of bias controller.
The RXD of USB-UART module should be connected to TX pin of bias controller.
Refer to Figure 5 to complete the connection between controller and the computer.

Step3: Command execution

Execute commands through Matlab

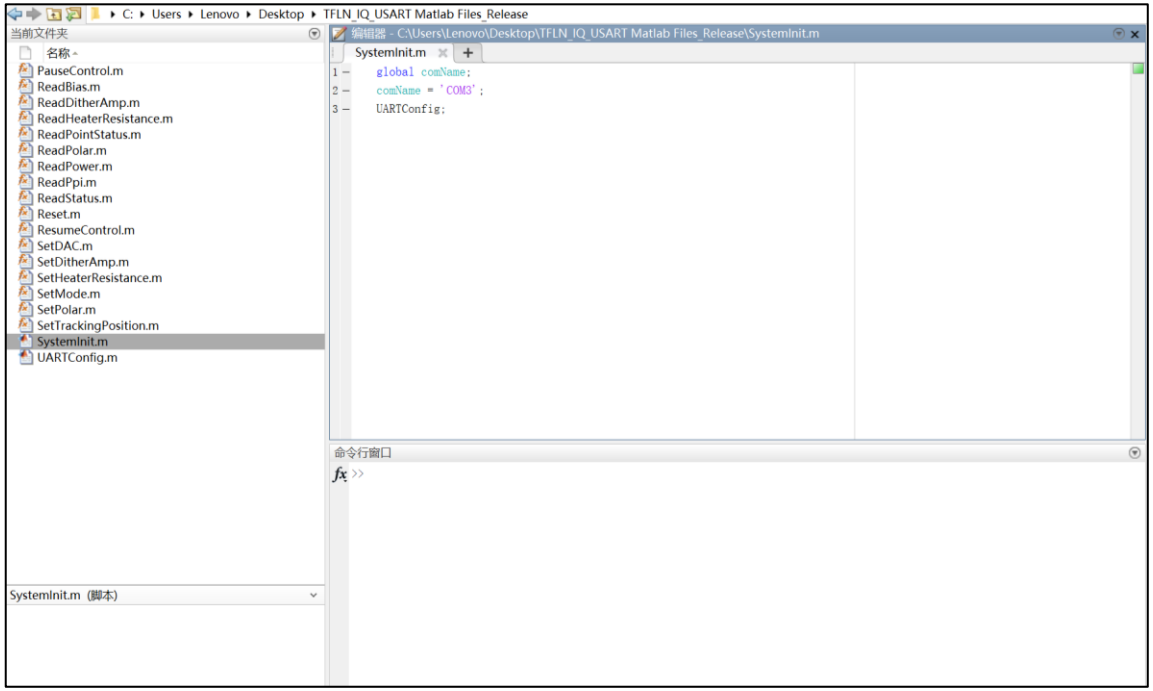

Figure 6. Matlab Interface

Step 1: Run SystemInt

1. Change the Matlab working directory to current directory of command script,and then you will find the available UART commands in the left navigation bar.
2. Open the SystemInit.m file and change the comName to the com port name where the USB-UART converter is installed on your computer. If you are using Windows system, you can check the COM port number in Device Manager. In this case, we use COM3.
3. Run SystemInit and if it returns "COM3 opened succeed", proceed to the next step, otherwise check whether the COM settings are correct.

Step 2: Run the function command (Run SetMode as an example)

Write "SetMode(2)" in the command window and run it. If the return value is a decimal value of 17, it means that the bias controller successfully switches to manual control mode.

Note: SetMode(1): auto-tracking mode; SetMode(2): manual control mode.

Matlab script function description

- **SetHeaterResistance(arm, res)**
  Description: To ensure that the controller is compatible with the modulator, the modulator's heater actual resistance value should be sent to controller. Even if the controller is turned off or reset, the heater resistance value data will not lose.
  Input data: Arm (1: arm I; 2: arm Q; 3: arm P) + Modulator's heater resistance value.
  Result: 17 for success and 136 for failure.
  Note: (1) Unit: ohm (Ω). (2) If the matching modulator is replaced, the resistance values need to be recalibrated.

- **ReadHeaterResistance(arm)**
  Description: Read current heater resistance data stored in the controller.
  Input data: Arm (1: arm I; 2: arm Q; 3: arm P).
  Result: Resistance value

- **ReadStatus**
  Description: Read current working status of controller.
  Input data: N/A
  Result: Current working status.

- **Reset**
  Description: Reset the controller.
  Input data: N/A
  Result: N/A

- **SetMode(mode)**
  Description: Set controller's working mode.
  Input data: Mode data (1: Auto mode; 2: Manual mode)
  Result: 17 for success and 136 for failure.
  Example: Send SetMode(1): switch to auto mode.
  Example: Send SetMode(2): switch to manual mode.

- **SetPolar(polar_I, polar_Q, polar_P,)**
  Description: This command can be used to set polar parameter between the positive and the negative.
  Input data: Polar_I (1: positive; 2: negative). Polar_Q (1: positive; 2: negative). Polar_P (1: positive; 2: negative).
  Result: 17 for success and 136 for failure.
  Example: SetPolar(1,1,2): The polar parameter of I arm is positive; The polar parameter of Q arm is positive; The polar parameter of P arm is negative.

- **ReadPolar**
  Description: Read current polar state of controller.
  Input data: N/A
  Result: The current polar state of the controller.

- **PauseContorl**
  Description: Pause the controller's automatic tracking program.
  Input data: N/A
  Result: 17 for success and 136 for failure.

- **ResumeContorl**
  Description: Resume controller's automatic tracking program.
  Input data: N/A
  Result: 17 for success and 136 for failure.

- **ReadPpi(arm)**
  Description: Read modulator's Pπ calculated by controller.
  Input data: Arm (1: arm I; 2: arm Q; 3: arm P).
  Result: Pπ value of modulator(mW).
  Note: This data is for reference only.

- **ReadBias(arm)**
  Description: Read the controller's current output bias voltage.
  Input data: Arm (1: arm I; 2: arm Q; 3: arm P).
  Result: Current output bias voltage value(V).

- **SetDAC(arm, voltage)**
  Description: In manual mode, manually set the output bias voltage.
  Input data: Arm (1: arm I; 2: arm Q; 3: arm P) + Target voltage value.
  Result: 17 for success and 136 for failure.
  Example: SetDAC(1,3) sets output bias for I arm voltage to 3V.

- **SetDitherAmp(multiple_I , multiple_Q)**
  Description: Set the amplitude of the dither signal, which must be a multiple of 1% of Pπ. Multiples can be set to one decimal place. Data will store in Flash and load automatically, even if the controller is turned off or reset, data will not lose.
  Input data: Dither signal amplitude multiple of arm_I + Dither signal amplitude multiple of arm_Q.
  Result: N/A
  Example: SetDitherAmp(3,3) sets I arm and Q arm's dither signal amplitude to 3% of Pπ.

- **ReadDitherAmp**
  Description: Read the amplitude multiple of a dither signal.
  Result: N/A
  Result: Current dither amplitude multiple.

- **ReadPower**
  Description: Read current optical power of controller's feedback input.
  Input data: N/A
  Result: Current optical power(mW).

- **ReadPointStatus(arm)**
  Description: Read the number of working points found by controller, the position of current working point, and result of working point initialization.
  Input data: Arm (1: arm I; 2: arm Q; 3: arm P).
  Result: Number of working points, the current working point position, and the initialization result.

- **SetTrackingPosition(I_position, Q_position, P_position)**
  Description: Switch working point position. For example, if there are two null points within bias output voltage range, user can specify which working point should be locked with this command.
  The data is not lost even if the controller is turned off or reset.
  The factory default position is the working point close to half of controller’s maximum output power. To switch to the default position, set position to 99.
  Input data: Target working point position value of I arm + Target working point position value of Q arm + Target working point position value of P arm. (99: Bias output half-power position; 1: the first point close to 0V; 2: the second point close to 0V…）
  Result: 17 for success and 136 for failure.
  Example: SetTrackingPosition(1,1,1): Three arms all switch to the first working point found from 0V to maximum output.
  Example: SetTrackingPosition(99,99,99): Three arms all switch to working point close to half of controller’s maximum output power.
  Note: The value of the input parameter (position) must not exceed the number of bias points within the bias range, otherwise the working point position cannot be successfully switched, and the controller’s LED will turn to yellow.

Execute commands through the GUI

Condition

The GUI software is developed for Windows OS.
Microsoft .NET Framework 3.5 is required for GUI software. It can be downloaded from the following links:
https://www.microsoft.com/en-us/download/details.aspx?id=21

Run the GUI software

Step 1: After completing the connection operation between the bias controller and the computer, turn on the bias controller.

Step 2: Run the software PlugTech TFLN Control Unit.exe.

Step 3: Select the com port where the USB-UART converter is installed on your computer, and click the Connect button to enter the control platform.

If the USB-UART driver is installed correctly, the COM port can be detected automatically. The COM port number can be found in Windows Device Manager.

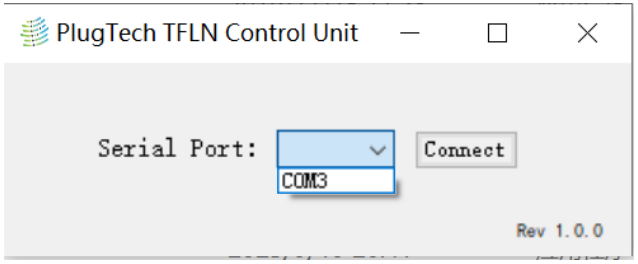

Figure 7. COM Connection Interface

Introduction to the functions of the GUI control platform

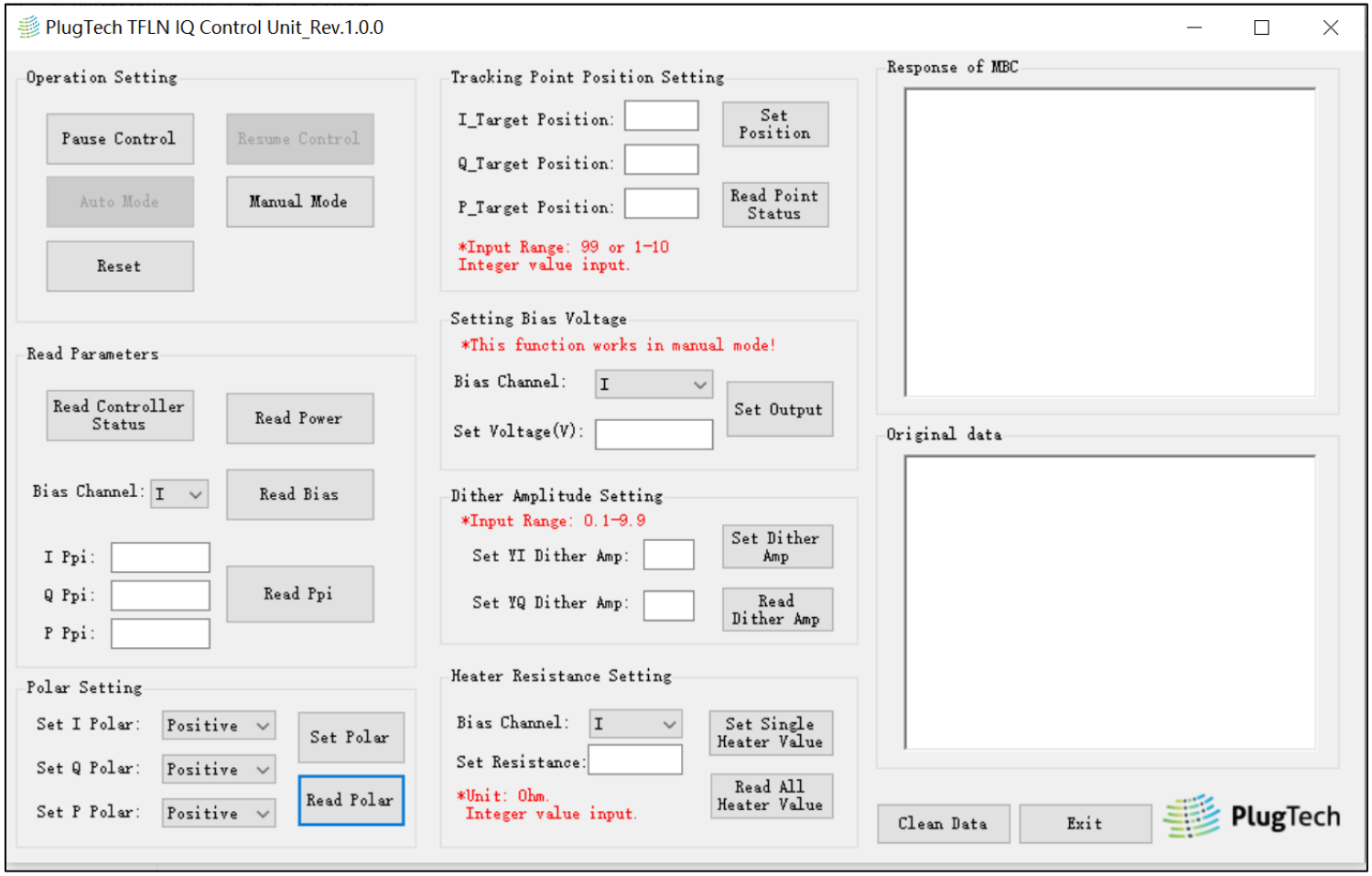

Figure 8. GUI Operation Interface

In this operation interface, users can debug or operate the bias controller directly, and each function button is described as follows:

- **Pause Control:**
  This function will pause the bias controller's auto-tracking program. Dither will be stopped and bias voltage output of bias controller will remain at the value when the Pause Control command is executed.

- **Resume Control:**
  When pause control is executed and the auto-tracking program is needed, execute this command will resume auto-tracking program.

- **Auto Mode:**
  When Manual Mode is executed and the auto-tracking mode is needed, execute this command will recalculate the control parameters and start auto-tracking.

- **Manual mode:**
  This function will stop the auto-tracking program. Dither will be stopped and bias voltage output of bias controller will remain at the value when the Manual Mode command is executed. User can manually change the bias voltage.

- **Reset:**
  Controller software reset.

- **Read Controller Status:**
  Read the current controller working status.

- **Read Power:**
  Read the optical power of the controller's current feedback input.

- **Read Bias:**
  Read current output voltage of controller.

- **Read Ppi:**
  Read the Pπ value of the modulator calculated by the controller.

- **Set Polar:**
  Set polar parameter of controller.

- **Read Polar:**
  Read current working polar parameters of controller.

- **Set Position:**
  Set a specific position of the working point.

- **Read Point Status:**
  Read the number of work points found within the output range, the current work point position, and the working point initialization result.

- **Set Output:**
  Manually set the output bias value of the controller.

- **Set Dither Amp:**
  Set the amplitude of the controller's dither signal, the input range is 0.1~9.9, corresponding to the dither signal amplitude of 0.1%~9.9% Pπ.

- **Read Dither Amp:**
  Read the amplitude of the current controller's dither signal.

- **Set Single Heater Value:**
  Set the heater resistance value of the modulator.

- **Read All Heater Value:**
  Read current heater values stored in the controller.

- **Clean Data:**
- Clear data in the GUI software display area.

- **Exit:**
  Exit the GUI software.

Execute commands through the master device

Configuration

The UART of the bias controller works at TTL (3.3V) level with following parameters: 57600 baud rate; 8 data bits, no parity bit, 1 stop bit.

Send command to bias controller

All command send to controller should follow a pattern of command ID + data. Command ID is one byte long which represents the function to be called by controller while data is six bytes long. For data bytes, it should be filled from the first byte and all unused bytes should be filled with zero. For example, to call command ID 0x64 with input data 2000 in hexadecimal format, [0x64,0x07,0xD0,0x00,0x00,0x00,0x00] should be sent to controller. Where 0x64 is the function ID and [0x07,0xD0] is 2000 in hexadecimal format.

Receive data from bias controller

After executing command from master device, controller will return data (except for reset command). Received data also follow a pattern of command ID + data. Command ID is one byte long representing the previous ID sent to controller and data is eight bytes long representing returned data from controller. Returned data is filled from the first byte and unused bytes are filled with zero. For example, if [0x64,0x11,0x00,0x00,0x00,0x00,0x00,0x00,0x00] is received by master device, command ID is 0x64, data is 0x11.

UART command list

Pause Control[1]			
Command ID	0x73		
Description	Pause the bias controller’s auto-tracking program.		
Data Send	N/A.		
Data Received	Operation result.		
	Data byte length:1.		
Example	Send content (Hexadecimal):	73 00 00 00 00 00 00	
	Received content (Hexadecimal):	73 11 00 00 00 00 00 00 00	Setting Status: Succeed.
		73 88 00 00 00 00 00 00 00	Setting Status: Failed.

Resume Control[1]			
Command ID	0x74		
Description	Resume the bias controller’s auto-tracking program.		
Data Send	N/A.		
Data Received	Operation result.		
	Data byte length:1.		
Example	Sent content (Hexadecimal):	74 00 00 00 00 00 00	
	Received content (Hexadecimal):	74 11 00 00 00 00 00 00 00	Setting Status: Succeed.
		74 88 00 00 00 00 00 00 00	Setting Status: Failed.

Reset	
Command ID	0x6D
Description	Reset the bias controller.
Data Send	N/A.
Data Received	N/A.
Example	Send content (Hexadecimal): 6D 00 00 00 00 00 00
	Received content (Hexadecimal): N/A.

Note: 1: This command can only be used when bias controller’s LED constantly ON.

Set Mode[1]			
Command ID	0x6A		
Description	Set control mode of the bias controller to be auto-tracking mode or manual control mode.		
Data Send	Control Mode. (0x01: Auto-tracking mode; 0x02: Manual control mode)		
	Data byte length:1.		
Data Received	Operation result.		
	Data byte length:1.		
Example	Set the controller to manual mode.		
	Send content (Hexadecimal):	6A 02 00 00 00 00 00	
	Received content (Hexadecimal):	6A 11 00 00 00 00 00 00 00	Setting Status: Succeed
		6A 88 00 00 00 00 00 00 00	Setting Status: Failed

Read Status		
Command ID	0x69	
Description	Get current operating status of bias controller.	
Data Send	N/A.	
Data Received	Operating Status. (0x01: Stabilizing; 0x02: Tracking; 0x03: Feedback input too weak; 0x04: Feedback input too strong; 0x05: Manual control mode; 0x06: PauseControl mode).	
	Data byte length:1.	
Example	Send content (Hexadecimal): 69 00 00 00 00 00 00	
	Received content (Hexadecimal): 69 01 00 00 00 00 00 00 00	Bias controller is currently in Stabilizing status.

Read Bias[1]		
Command ID	0x66	
Description	Read current bias voltage of controller. Unit: V.	
Data Send	The channel of the bias voltage output (0x01: I channel, 0x02: Q channel, 0x03: P channel)	
	Data byte length: 1.	
Data Received	4-byte floating-point data (little-endian).	
	Data byte length: 4.	
Example	Send content (Hexadecimal): 66 01 00 00 00 00 00	
	Received content (Hexadecimal): 66 5C 98 85 C0 00 00 00 00	The output bias voltage of channel I is -4.174829V.

Note: 1: This command can only be used when bias controller's LED constantly ON.

Read Power		
Command ID	0x65	
Description	Read the current optical power received by bias controller. Unit: uW.	
Data Send	N/A	
Data Received	4 bytes floating point number (Little Endian).	
	Data byte length:4.	
Example	Send content (Hexadecimal): 65 00 00 00 00 00 00	
	Received content (Hexadecimal): 65 22 F5 1F 41 00 00 00 00	The optical power input to the controller is 10uW.

Read Polar[1]		
Command ID	0x68	
Description	Read the polar parameter of the controller.	
Data Send	N/A.	
Data Received	Polar of I arm. (0x00: Positive; 0x01: Negative)	Byte one
	Polar of Q arm. (0x00: Positive; 0x01: Negative)	Byte two
	Polar of P arm (0x00: Positive; 0x01: Negative)	Byte three
	Data byte length:3.	
Example	Send content (Hexadecimal): 68 00 00 00 00 00 00	
	Received content (Hexadecimal): 68 01 01 01 00 00 00 00 00	Current polar of all arm is negative.

Read Ppi[1]		
Command ID	0x7C	
Description	Read the Pπ value of the modulator. Unit: mW.	
Data Send	Arm of the modulator (0x01: I arm, 0x02: Q arm, 0x03: P arm).	
	Data byte length: 1.	
Data Received	4 bytes floating-point value (little-endian).	
	Data byte length:4.	
Example	Send content (Hexadecimal): 7C 01 00 00 00 00 00	
	Received content (Hexadecimal): 7C A2 8F 8D 40 00 00 00 00	The Pπ value of the modulator's arm I is 4.423783 mW.

Note: 1: This command can only be used when bias controller's LED constantly ON.

Set Tracking Position[1]			
Command ID	0x77		
Description	Switch working point position. For example, if there are three null points within bias output voltage range, user can specify which working point should be locked with this command. The data will not lose even if the controller is turned off or reset. The factory default position is the working point close to half of controller's maximum output power. To switch to the default position, set position to 99.		
Data Send	Target working point position value of I arm.	(0x63: Bias output half-power position; 0x01: the first point close to 0V; 0x02: the second point close to 0V…)	Byte one
	Target working point position value of Q arm.		Byte two
	Target working point position value of P arm.		Byte three
	Data byte length:3.		
Data Received	Operation result.		
	Data byte length:1.		
Example 1	Switch to the default position.		
	Send content (Hexadecimal): 77 63 00 00 00 00 00		
Example 2	Switch to the first position of the working point for I arm, Q arm and P arm.		
	Send content (Hexadecimal): 77 01 01 01 00 00 00		
Example 1 & Example 2	Received content (hexadecimal):	77 11 00 00 00 00 00 00 00	Setting Status: Succeed.
		77 88 00 00 00 00 00 00 00	Setting Status: Failed.

Read Point Status[1]			
Command ID	0x76		
Description	Read the number of working points, the current working point location, and the initialization result information.		
Data Send	Arm of the modulator (0x01: I arm, 0x02: Q arm, 0x03: P arm).		
	Data byte length:1.		
Data Received	Number of working points.		Byte one
	Working point position. (0x63: Bias output half-power position; 0x01: First position; 0x02: Second position…)		Byte two
	Initialization result of the working point. (0x01: succeed; 0x02: failed)		Byte three
	Data byte length:3.		
Example	Send content (Hexadecimal): 76 01 00 00 00 00 00		
	Received content (Hexadecimal): 76 02 01 01 00 00 00 00 00	The number of working points on the I arm is 2; The current working point on the I arm is in the first position; Initialization of I arm succeed.	

Note: 1: This command can only be used when bias controller's LED constantly ON.

Set Polar			
Command ID	0x6C		
Description	Set polar parameter of the controller.		
Data Send	Polar of I arm (0x01: positive; 0x02: negative)	Byte one	
	Polar of Q arm (0x01: positive; 0x02: negative)	Byte two	
	Polar of P arm (0x01: positive; 0x02: negative)	Byte three	
	Data byte length:3.		
Data Received	Operation result.		
	Data byte length:1.		
Example	Set polar parameter to negative for I arm, Q arm and P arm.		
	Send content (Hexadecimal):	6C 02 02 02 00 00 00	
	Received content (Hexadecimal):	6C 11 00 00 00 00 00 00 00	Setting Status: Succeed
		6C 88 00 00 00 00 00 00 00	Setting Status: Failed

Set Bias Voltage Output[1]			
Command ID	0x6B		
Description	Set the controller output voltage. Unit: V. Note: This function can only be used in manual mode.		
Data Send	Bias voltage output channel. (0x01: I channel, 0x02: Q channel, 0x03: P channel)		Byte one
	Voltage data. (For example, if 3.215V is required for output, the voltage should be multiplied by 1000 to convert the value to integer, i.e. 3215. Then convert 3215 to hex format. Hex format of 3215 is 0x0C8F. Byte one is invalid. Byte two is upper of the final hex result, i.e. 0x0C. Byte three is the lower half, i.e. 0x8F.)		Byte two + byte three
	Sign of the voltage. (0x00: positive, 0x01: negative)		Byte four
	Data byte length:4.		
Data Received	Operation result.		
	Data byte length:1.		
Example	Set the output voltage of the bias controller's I output channel to -4.5V.		
	Send content (Hexadecimal):	6B 01 11 94 01 00 00	
	Received content (Hexadecimal):	6B 11 00 00 00 00 00 00 00	Setting Status: Succeed.
		6B 88 00 00 00 00 00 00 00	Setting Status: Failed.

Note: 1: This command can only be used when bias controller's LED constantly ON.

Set Dither Amp[1]			
Command ID	0x6F		
Description	Set the dither amplitude, which can only be set to a multiplier of 1%Pπ. Note: The factory default value is 1. Data will store in Flash and load automatically, even if the controller is turned off or reset, data will not lose. The write range is 0.1~9.9.		
Data Send	Dither amplitude multiplier data of Arm I.	Dither amplitude multiplier data = dither amplitude multiplier value × 10	Byte one
	Dither amplitude multiplier data of Arm Q.		Byte two
	Data byte length:2.		
Data Received	Operation result.		
	Data byte length:1.		
Example	Set the dither amplitude of I output channel I and output channel Q to 1.5% Pπ.		
	Send content (Hexadecimal): 6F 0F 0F 00 00 00 00		
	Received content (Hexadecimal):	6F 11 00 00 00 00 00 00 00	Setting Status: Succeed.
		6F 88 00 00 00 00 00 00 00	Setting Status: Failed.

Read Dither Amp[1]			
Command ID	0x99		
Description	Read the dither amplitude multiplier value in the controller.		
Data Send	N/A.		
Data Received	Dither amplitude multiplier data of Arm I.	Dither amplitude multiplier value = Dither amplitude multiplier data ×0.1	Byte one
	Dither amplitude multiplier data of Arm Q.		Byte two
	Data byte length:2.		
Example	Send content (Hexadecimal): 99 00 00 00 00 00 00		
	Received content (Hexadecimal): 99 0F 0F 00 00 00 00 00 00	The reading dither amplitude multiple value of output channel I and output channel Q is 0x0F(15)×0.1=1.5.	

Note: 1: This command can only be used when bias controller's LED constantly ON.

Set Heater Resistance			
Command ID	0x79		
Description	To ensure that the controller is compatible with the modulator, the modulator's heater actual resistance value should be sent to controller. This value will store in Flash memory, even if the controller is turned off or reset, the heater resistance value data will not lose. Only first deployment of the controller is it necessary to calibrate the resistance. If the matching modulator is replaced, the resistance values need to be recalibrated.		
Data Send	Arm of the modulator (0x01: I arm, 0x02: Q arm, 0x03: P arm).		Byte one
	Heater resistance value. (The value of the first byte is the first half (0xAB) of the heater resistance value converted to hexadecimal (e.g. 0xABCD), and the value of the second byte is the second half (0xCD) of the heater resistance (Hexadecimal)).		Byte two + byte three
	Data byte length:3.		
Data Received	Operation result.		
	Data byte length:1.		
Example	Set the heater resistance value of I arm to 100 ohm.		
	Send content (hexadecimal): 79 01 00 64 00 00 00		
	Receiving content (hexadecimal):	79 11 00 00 00 00 00 00 00	Setting Status: Succeed.
		79 88 00 00 00 00 00 00 00	Setting Status: Failed.

Read Heater Resistance		
Command ID	0x78	
Description	Read heater resistance data stored in the controller. Unit: ohm.	
Data Send	Arm of the modulator (0x01: I arm, 0x02: Q arm, 0x03: P arm)	
	Data byte length:1.	
Data Received	Heater resistance. (The value of the first byte is the first half (0xAB of the heater resistance value converted to hexadecimal (e.g. 0xABCD), and the value of the second byte is the second half (0xCD) of the heater resistance(hexadecimal))	
	Data byte length:2.	
Example	Read the heater value of the I arm stored in the controller.	
	Send content (hexadecimal): 78 01 00 00 00 00 00	
	Received content (hexadecimal): 78 00 64 11 00 00 00 00 00	The heater resistance value is 100 ohm.

Revision History

Version	Content	Date
1.0.0	First Release	2025/10/22
1.0.1	Added setup comment	2025/10/24