



# GWU2X Instructions Guide

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# 1 Function

## 1.1 Overview

GWU2X is an ASSP chip in the GOWIN Gobridge family, which helps to communicate effectively with devices that use synchronous protocols (such as JTAG). The GWU2X series chip can be configured to USB TO JTAG/SPI/I<sup>2</sup>C protocol through host computer instructions, and the I/O status and levels(high and low) of all 16 GPIO ports can be modified through configuration instructions, making it very flexible and changeable. Therefore, you can configure the chip to the required transmission mode and state through configuration instructions. The chip will remain reset if not configured, and this will not have any impact on the rest of the chip. You can modify the function of the chip at any time through configuration instructions. This manual mainly describes the configuration instructions in detail.

## 1.2 Features

Features of the configuration instructions for the GWU2X series chip include:

- Supports USB to JTAG/SPI/I<sup>2</sup>C function;
- Configurable states of 16 GPIOs;
- Configurable protocol clock;
- Flexible instructions.

# 2 Pin Definitions

## 2.1 Configuration Pin Definitions

The definition of each configuration pin of GWU2X is showed in Table 2-1.

**Table 2-1 Pin Definitions**

Bit Number	Pin Name	Pin Number	I/O	Meaning
Bit0	TCK/SCL/SCK/GPIOL0	21	Output (can be configured as input)	Clock output
Bit1	TMS/CS/GPIOL1	22	Output (can be configured as input)	Select signal output
Bit2	TDI/SDA/MOSI/GPIOL2	26	Output (can be configured as input)	Data output
Bit3	TDO/MISO/GPIOL3	20	Input (can be configured as output)	Data input
Bit4	GPIOL4	29	Bidirectional	I/O
Bit5	GPIOL5	30	Bidirectional	I/O
Bit6	GPIOL6	32	Bidirectional	I/O
Bit7	GPIOL7	1	Bidirectional	I/O
Bit8	GPIOH0	4	Bidirectional	I/O
Bit9	GPIOH1	5	Bidirectional	I/O
Bit10	GPIOH2	10	Bidirectional	I/O
Bit11	GPIOH3	12	Bidirectional	I/O
Bit12	GPIOH4	13	Bidirectional	I/O
Bit13	GPIOH5	14	Bidirectional	I/O
Bit14	GPIOH6	15	Bidirectional	I/O
Bit15	GPIOH7	18	Bidirectional	I/O



# 3Notes

## 3.1 Notes about the clock

1. In SPI mode, when CPOL=0, data is transmitted on the falling edge of the clock. When CPOL=1, data is transmitted at the rising edge of the clock. Sampling can be performed at both the rising and falling edge. In JTAG and I<sup>2</sup>C modes, the default is that sampling is performed on the rising edge and data transmission is performed on the falling edge. .
2. If the default idle level of TCK/SCL/SCK port is low/high, the level will back to the default idle level at the end of sending any instruction that generates TCK/SCL/SCK regardless of which level is assigned by GPIO status configuration instruction..
3. When performing protocol transmission, make sure that the initial level of the TCK/SCL/SCK port is what you required, otherwise an error will occur.

Examples of configuring the clock port to low level: 0x20, 0x01, 0x00.

Please refer to 4.4.1 GPIO status configuration instruction (GPIO0~GPIO7) for the details of the above instructions.

## 3.2 Notes about data buffering

The GWU2X chip has a built-in buffer that can save the read data of the GPIO port and upload it to the host computer. It should be noted that only instructions with TDO/TDI port data retention function or GPIO read data instructions can be used to buffer data. The buffer size is 1 byte. Please refer to [4.3.2 Readback buffer - LSB/MSB configuration instruction](#) for the Big-endian/Little-endian mode setting. The buffer will be cleared after every 1 byte, and the data will be sent to the FIFO of the USB block.

There are two ways to send the buffered data to the FIFO of the USB block:

1. Send the buffered data to the FIFO of USB IP every time the buffer is full.
2. Send the buffered data to the FIFO of USB IP coercively through the TDO instruction (0X8B), see 4.3.1 Readback buffer -forced readback instruction for details.

# 4 Description of Instructions

## 4.1 Definition of Instructions

An instruction of the host computer is composed of three segments, namely the instruction segment, the length segment, and the data segment.

### 4.1.1 Instruction Segment

The instruction segment, composed of 1 byte, is the first byte segment sent to indicate the subsequent operation to be performed. The subsequent length segment and data segment have different definitions due to different instruction segments. Therefore, the instruction segment is particularly important. If the instruction segment is wrong, the subsequent data transmission will be abnormal.

### 4.1.2 Length Segment

The length segment, composed of 1 byte or 2 bytes, is the byte segment sent after the instruction segment and indicates the length of the following data segment. The length segment is used to separate the data segment from the instruction segment of the next sending instruction operation.

### 4.1.3 Data Segment

As the core field, the data segment is loaded with data to be transmitted. The final result of the data segment, the instruction segment, and the length segment is shown as the level changes of different ports to emulate various protocols. The length of the data segment is determined by the length segment, varying from 1 byte to 256 bytes.

## 4.2 Output Port Configuration Instructions

### 4.2.1 TMS port sending instruction (LSB) without saving TDO data

0x5B,  
Length,  
Byte1

The bit length of the TMS/CS port is between 1 bit and 7 bits according to the length segment, and the highest bit of the data segment is a fixed bit of TDI/SDA/MOSI. For example, if the length segment is 0x00, 1 bit of TMS/CS and 1 bit of TDI/SDA/MOSI will be output, and if the length segment is 0x03, 4 bits of TMS/CS and 1 bit of TDI/SDA/MOSI will be output. TDI/SDA/MOSI is fixed as the highest bit of the data segment, so the maximum value of the length segment for the number of TMS/CS bits is 0x06. The LSB of the data segment will be sent first, and the bit 0 of the data segment is placed on TMS/CS. The TCK/SCL/SCK pin provides the clock, and the data will be changed to the next bit on the falling edge of the TCK/SCL/SCK signal. The TDI bit and the last bit of TMS will be sent at the same time. The data on the TDO/MISO pin is ignored.

### 4.2.2 TDI port bits shifting instruction (LSB) without saving TDO data

0x6B,  
Length,  
Byte1

The TDI/SDA/MOSI port can output up to 8 bits according to the length segment. For example, if the length segment is 0x00, 1 bit of TDI/SDA/MOSI will be output, and if the length segment is 0x03, 4 bits of TDI/SDA/MOSI will be output. The maximum value of the length segment is 0x07. Byte[0] is the first TDI bit sent, and Byte[XX] is the last TDI bit sent. The lowest bit of the data segment is placed on TDI/SDA/MOSI, and the TCK/SCL/SCK pin provides the clock. The data will be changed to the next bit on the falling edge of the TCK/SCL/SCK signal, and the data on the TDO/MISO pin will be ignored.

### 4.2.3 TDI port bits shifting instruction (MSB) without saving TDO data

0x6D,  
Length,

**Byte1**

The TDI/SDA/MOSI port can output up to 8 bits according to the length segment. For example, if the length segment is 0x00, 1 bit of TDI/SDA/MOSI will be output, and if the length segment is 0x03, 4 bits of TDI/SDA/MOSI will be output. The maximum value of the length segment is 0x07. Byte[7] is the first TDI bit sent, and Byte[XX] is the last TDI bit sent. The highest bit of the data segment is placed on TDI/SDA/MOSI, and the TCK/SCL/SCK pin provides the clock. The data will be changed to the next bit on the falling edge of the TCK/SCL/SCK signal, and the data on the TDO/MISO pin will be ignored.

#### **4.2.4 TDI port bytes shifting instruction (LSB) without saving TDO data**

0x7B,  
Length,  
Byte1,  
...  
Byte 256(max)

The TDI/SDA/MOSI port can output up to 256 bytes according to the length segment. For example, if the length segment is 0x00, 1 byte of TDI/SDA/MOSI will be output, and if the length segment is 0x03, 4 bytes of TDI/SDA/MOSI will be output. The maximum value of the length segment is 0xff. Byte0[0] is the first TDI bit sent, and ByteXX[7] is the last TDI bit sent. The lowest bit of the first byte of the data segment is placed on TDI/SDA/MOSI, and the TCK/SCL/SCK pin provides the clock. The data will be changed to the next bit on the falling edge of the TCK/SCL/SCK signal, and the data on the TDO/MISO pin will be ignored.

#### **4.2.5 TDI port bytes shifting instruction (MSB) without saving TDO data**

0x7D,  
Length,  
Byte1,  
...  
Byte 256(max)

The TDI/SDA/MOSI port can output up to 256 bytes according to the length segment. For example, if the length segment is 0x00, 1 byte of

TDI/SDA/MOSI will be output, and if the length segment is 0x03, 4 bytes of TDI/SDA/MOSI will be output. The maximum value of the length segment is 0xff. Byte0[7] is the first TDI bit sent, and ByteXX[0] is the last TDI bit sent. The highest bit of the first byte of the data segment is placed on TDI/SDA/MOSI, and the TCK/SCL/SCK pin provides the clock. The data will be changed to the next bit on the falling edge of the TCK/SCL/SCK signal, and the data on the TDO/MISO pin will be ignored.

#### 4.2.6 TMS port sending instruction (LSB), TDO port data saved

0x5C,  
Length,  
Byte1

The bit length of the TMS/CS port is between 1 bit and 7 bits according to the length segment, and the highest bit of the data segment is a fixed bit of TDI/SDA/MOSI. For example, if the length segment is 0x00, 1 bit of TMS/CS and 1 bit of TDI/SDA/MOSI will be output, and if the length segment is 0x03, 4 bits of TMS/CS and 1 bit of TDI/SDA/MOSI will be output. TDI is fixed as the highest bit of the data segment, so the maximum value of the length segment for the number of TMS/CS bits is 0x06. The LSB of the data segment will be sent first. Bit 0 of the data segment is placed on TMS/CS, and the TCK/SCL/SCK pin provides the clock. The data will be changed to the next bit on the falling edge of the TCK/SCL/SCK signal, and the TDI bit and the last bit of TMS will be sent at the same time. The data on the TDO/MISO pin will be buffered into the device according to the clock generated by the instruction.

#### 4.2.7 TDI port bits shifting instruction (LSB), TDO port data saved

0x6C,  
Length,  
Byte1

The TDI/SDA/MOSI port can output up to 8 bits according to the length segment. For example, if the length segment is 0x00, 1 bit of TDI/SDA/MOSI will be output, and if the length segment is 0x03, 4 bits of TDI/SDA/MOSI will be output. The maximum value of the length segment is 0x07. Byte[0] is the first TDI bit sent, and Byte[XX] is the last TDI bit sent. The lowest bit of the data segment is placed on TDI/SDA/MOSI, and the TCK/SCL/SCK pin provides the clock. The data will be changed to the next bit on the falling edge of the TCK/SCL/SCK signal, and the data on the TDO/MISO pin will be buffered into the device according to the clock generated by the instruction.

### 4.2.8 TDI port bits shifting instruction (MSB), TDO port data saved

0x6E,  
Length,  
Byte1

The TDI/SDA/MOSI port can output up to 8 bits according to the length segment. For example, if the length segment is 0x00, 1 bit of TDI/SDA/MOSI will be output, and if the length segment is 0x03, 4 bits of TDI/SDA/MOSI will be output. The maximum value of the length segment is 0x07. Byte[7] is the first TDI bit sent, and Byte[XX] is the last TDI bit sent. The highest bit of the data segment is placed on TDI/SDA/MOSI, and the TCK/SCK pin provides the clock. The data will be changed to the next bit on the falling edge of the TCK/SCL/SCK signal, and the data on the TDO/MISO pin will be buffered into the device according to the clock generated by the instruction.

### 4.2.9 TDI port bytes shifting instruction (LSB), TDO port data saved

0x7C,  
Length,  
Byte1  
...  
Byte 256(max)

The TDI/SDA/MOSI port can output up to 256 bytes according to the length segment. For example, if the length segment is 0x00, 1 byte of TDI/SDA/MOSI will be output, and if the length segment is 0x03, 4 bytes of TDI/SDA/MOSI will be output. The maximum value of the length segment is 0xff. Byte0[0] is the first TDI bit sent, and ByteXX[7] is the last TDI bit sent. The lowest bit of the first byte of the data segment is placed on TDI/SDA/MOSI, and the TCK/SCL/SCK pin provides the clock. The data will be changed to the next bit on the falling edge of the TCK/SCL/SCK signal, and the data on the TDO/MISO pin will be buffered into the device according to the clock generated by the instruction.

### 4.2.10 TDI port bytes shifting instruction (MSB), TDO port data saved

0x7E,  
Length,  
Byte1,  
...

Byte 256(max)

The TDI/SDA/MOSI port can output up to 256 bytes according to the length segment. For example, if the length segment is 0x00, 1 byte of TDI/SDA/MOSI will be output, and if the length segment is 0x03, 4 bytes of TDI/SDA/MOSI will be output. The maximum value of the length segment is 0xff. Byte0[7] is the first TDI bit sent, and ByteXX[0] is the last TDI bit sent. The highest bit of the first byte of the data segment is placed on TDI/SDA/MOSI, and the TCK/SCL/SCK pin provides the clock. The data will be changed to the next bit on the falling edge of the TCK/SCL/SCK signal, and the data on the TDO/MISO pin will be buffered into the device according to the clock generated by the instruction.

#### 4.2.11 TCK port sending instruction, TDO/TDI port data not saved

0x9B,

LengthL, (Low eight bits of the length segment)

LengthH (High eight bits of the length segment)

The TCK/SCL/SCK port can output up to 65536 clocks according to the length segment. For example, if the length segment is 0x00 0x00, 1 byte of TCK/SCL/SCK will be output, and if the length segment is 0x03 0x01, 260bits of TCK/SCL/SCK will be output. The maximum value of the length segment is 0xff 0xff. Calculate the number of clocks generated through the value of the length segment, and then directly output the corresponding number of clocks on TCK/SCL/SCK pin. Data on TDO /MISO and TDI/SDA/MOSI pins is ignored.

#### 4.2.12 TCK port sending instruction, TDO port data saved

0x9C,

LengthL, (Low eight bits of the length segment)

LengthH (High eight bits of the length segment)

The TCK/SCL/SCK port can output up to 65536 clocks according to the length segment. For example, if the length segment is 0x00 0x00, 1 byte of TCK/SCL/SCK will be output, and if the length segment is 0x03 0x01, 260bits of TCK/SCL/SCK will be output. The maximum value of the length segment is 0xff 0xff. Calculate the number of clocks generated through the value of the length segment, and then directly output the corresponding number of clocks on TCK/SCL/SCK pin. Data on the TDO /MISO pin will be buffered into the device according to the clock generated by the instruction.



### 4.2.13 TCK port sending instruction, TDI port data saved

0x9D,

LengthL, (Low eight bits of the length segment)

LengthH (High eight bits of the length segment)

The TCK/SCL/SCK port can output up to 65536 clocks according to the length segment. For example, if the length segment is 0x00 0x00, 1 byte of TCK/SCL/SCK will be output, and if the length segment is 0x03 0x01, 260bits of TCK/SCL/SCK will be output. The maximum value of the length segment is 0xff 0xff. Calculate the number of clocks generated through the value of the length segment, and then directly output the corresponding number of clocks on TCK/SCL/SCK pin. Data on the TDI/SDA/MOSI pin will be buffered into the device according to the clock generated by the instruction.

## 4.3 Input Port Instructions

### 4.3.1 Readback buffer -forced readback instruction

0x8B

Through this instruction, the buffered TDO/MISO data, TDI/SDA/MOSI data, and GPIO data in the device will be read out. If the data in the device is less than 1 byte, the high bits will be padded with zeros. If the buffered TDO/MISO data is zero, this instruction will not take effect.

### 4.3.2 Readback buffer - LSB/MSB configuration instruction

0xDB,

Byte1

Through this instruction, the Big-endian/Little-endian mode can be configured. When the instruction is 0xDB 0x11, the read back cache will be set to LSB mode and the output will be sorted from low to high. When the instruction is 0xDB 0xff, the readback cache will be set to MSB mode and the output will be sorted from high to low. LSB is the default mode after power on.

## 4.4 Other Instructions

In addition to the 4 dedicated IO ports for the protocols configuration, the GWU2X bridge chip also provides 12 GPIO ports for user configuration. The GPIO configuration instructions can be used to set the status of the IO ports (input/output, high/low). These features make the GWU2X chip very

flexible to use. It should be noted that all GPIOs are output by default, so be sure to configure GPIOs when using.

#### 4.4.1 GPIO status configuration instruction (GPIO0~GPIO7)

0x20,

Byte1 (input/output configuration),

Byte2 (high/low configuration)

This instruction is used to configure the input/output status(1 for output, 0 for input) and high/low status (1 for high level, 0 for low level) of the lower eight-bit GPIO ports, according to the order of 1 byte from low to high in one-to-one correspondence with the GPIO ports. For example, 0x02 (input/output configuration) 0x01 (high/low configuration) is to set GPIO1 as output and the rest as input, and set GPIO0 as high level and the rest as low level.

#### 4.4.2 GPIO status configuration instruction (GPIO8~GPIO15)

0x21,

Byte1 (input/output configuration),

Byte2 (high/low configuration)

This instruction is used to configure the input/output status(1 for output, 0 for input) and high/low status (1 for high level, 0 for low level) of the higher eight-bit GPIO ports, according to the order of 1 byte from low to high in one-to-one correspondence with the GPIO ports. For example, 0x02 (input/output configuration) 0x01 (high/low configuration) is to set GPIO9 as output and the rest as input, and set GPIO8 as high level and the rest as low level.

#### 4.4.3 GPIO reading data instruction (GPIO0~GPIO7)

0x22

This instruction is used to read the lower eight bits of GPIO ports transmission data into the buffer. Only 1 bit of each port will be stored per instruction, 8 bits in total. It should be noted that the buffering location is the same as the TDO/MISO data location, and the data will be placed after the TDO/MISO data.

#### 4.4.4 GPIO reading data instruction (GPIO8~GPIO15)

0x23

This instruction is used to read the lower eight bits of GPIO ports

transmission data into the buffer. Only 1 bit of each port will be stored per instruction, 8 bits in total. It should be noted that the buffering location is the same as the TDO/MISO data location, and the data will be placed after the TDO/MISO data.

#### 4.4.5 CPOL setting instruction

0xCB,

Byte1

This instruction is used to set the default sck level in SPI mode. When the instruction is 0xCB 0x11, CPOL is set to 0, and SCK is low by default; When the instruction is 0xCB 0xFF, set CPOL=1 and SCK is high by default. CPOL is 0 by default after reset.

#### 4.4.6 Clock frequency configuration instruction

The clock frequency of the TCK/SCL/SCK port can be configured by inputting the frequency division value. The duty cycle of TCK/SCL/SCK is always 50%, and the default frequency is 2.5MHz. It should be noted that the clock frequency obtained by frequency division must be an integer.

The configuration formula is:

Clock frequency = 60 (MHz) / division value

1.  $240\text{KHz} \leq \text{Clock frequency} \leq 30\text{MHz}$

0xAB,

0xValue

Value = division value

2.  $120\text{KHz} \leq \text{Clock frequency} < 240\text{KHz}$

0xAC,

0xValue

Value = division value - 256

#### 4.4.7 Instructions table

Table 4-1 Instructions table

Instruction	Input data	Output data	BITS/BYTES	TDO/TDI readback	MSB	LSB
0x5B		√	BITS			√
0x5C		√	BITS	√		√
0x6B		√	BITS			√
0x6C		√	BITS	√		√
0x6D		√	BITS		√	

Instruction	Input data	Output data	BITS/BYTES	TDO/TDI readback	MSB	LSB
0x6E		√	BITS	√	√	
0x7B		√	BYTES			√
0x7C		√	BYTES	√		√
0x7D		√	BYTES		√	
0x7E		√	BYTES	√	√	
0x8B	√					
0x9B		√				√
0x9C		√		√		√
0x9D				√		
0xAB						√
0xAC						√
0x20						√
0x21						√
0x22				√		
0x23				√		
0xCB						
0XDB						

# Terminology and Abbreviations

The abbreviations and terminology used in this manual are as shown in Table A-1 below.

**Table A -1 Terminology and Abbreviations**

Terminology and Abbreviations	Full Name
JTAG	Joint Test Action Group
I <sup>2</sup> C	Inter-Integrated Circuit
SPI	Serial Peripheral Interface
ASSP	Application Specific Standard Product
GPIO	Gowin Programmable I/O

# Support and Feedback

Gowin Semiconductor provides customers with comprehensive technical support. If you have any questions, comments, or suggestions, please feel free to contact us directly by the following ways.

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E-mail: [support@gowinsemi.com](mailto:support@gowinsemi.com)

