
User's Guide

RIGOL

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Logic Signal Output Module

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Safety Notices

Review the following safety precautions carefully before operating the instrument to avoid any personal injury or damage to the instrument or products connected to it.

To avoid potential hazards, use the instrument in a manner only as specified by this user manual.

The instrument should be serviced by qualified personnel only.

To avoid fire or personal injury

***Use proper power cord.**

Only the dedicated power cord of the products approved by the State should be used.

Connect and disconnect accessories properly.

Do not connect or disconnect probes or test leads while they are connected to a voltage source.

***Ground the instrument.**

This generator is grounded through the protective earthing conductor of the power cord. To avoid electric shock, the grounding conductor must be connected to earth ground. Make sure the instrument is properly grounded before connecting the input or output terminals.

Observe all terminal ratings.

To avoid fire or shock, observe all ratings and marks on the instrument. Follow the user manual for further rating information before making connections to the instrument.

Do not operate without covers.

Do not operate your generator with covers or panels removed.

***Use proper fuse.**

Only use the fuse type and rating specified for this product.

Avoid circuit or wire exposure.

Do not touch exposed connections or components when they are on.

Do not operate with suspected failures.

If you suspect damage with this product, have it inspected by qualified service personnel before further operations.

Provide proper ventilation.

Do not operate in wet/damp conditions

Do not operate in an explosive atmosphere

Keep product surfaces clean and dry

NOTE: Items with * are for the host machine of DG3000 Series Function/Arbitrary Waveform Generator.

Safety Terms and Symbols

Terms in this manual. These terms may appear in this manual:



WARNING: Warning statements identify conditions or practices that could result in injury or loss of life.



CAUTION: Caution statements identify conditions or practices that could result in damage to this product or other property.

Terms on the product: These terms may appear on the product:

DANGER indicates an injury hazard that may be immediately accessible.

WARNING indicates an injury hazard that may be not immediately accessible.

CAUTION indicates that a potential damage to the instrument or other property might occur.

Symbols on the product: These symbols may appear on the Instrument:



**Hazardous
Voltage**



**Refer to
Instructions**



**Protective
Earth Terminal**



**Grounding
Terminal
of Chassis**



**Test
Grounding
Terminal**

Logic Signal Output Module at a Glance

RIGOL company's Logic Signal Output Module which has 16-channel data outputs and 2-channel clock outputs, making DG3000 series practical and meaningful Mixed Signal Generator (MSG). The logic outputs can be configured according to user's needs for specific timing of digital signals. The outputs can be used as logic circuit signal sources, for testing and analysis of the logic circuit designs. General digital signal protocols can be constructed easily; in conjunction with the analog channels, real life mixed signals can be produced.

The Logic Signal Output Module has the following function features:

- Module operation can be turned "ON" or "OFF";
- Two operation modes: "Depend" and "Independ";
- Two trigger modes: Auto, Burst;
- Four protocols: RS232、I²C、SPI、PO;
- User-defined protocol output based on PO protocol;
- A variety of code pattern outputs: All '0', All '1', '01' turn, IEEE standard pseudorandom sequence;
- Online data editing of protocols;
- Arbitrary output rate in the "Depend" work mode;
- User-defined channels output, including data and clock lines (choose from 16+2);
- Digital channel and analog channel outputs and respectively setting of channels output or not;
- Provide TTL, LVTTTL, CMOS, LVCMOS and user-defined output voltage;
- Remote configuration;
- Embedded help.

Expressions in this manual:

The expressions of buttons in this manual are the same as those on the front panel. The operation buttons are surrounded by a textbox, such as the , and texts with shadow, such as **Edit Digital W**, indicate the operation menu of editing digital waveform in function. The five menu keys at the right side of the LCD are labeled as F1, F2, F3, F4 and F5 from top to bottom.

NOTE:

The DG3000 models which are interoperable with the Logic Signal Output Module are: DG3121A、DG3101A and DG3061A.

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Chapter 1 Quick Start

This chapter introduces the connections and user interfaces of the module, and leads users to get familiar how to use the module.

This chapter is divided into the following sections:

- Ports of the module
- To connect the module
- User interface

Ports of the Module

When you get a new DG3000 Logic Signal Output Module, first be familiar with the ports and markings on it. There are three main ports: port connected to DG3000, a digital logic output and an analog logic output, as shown in Figure 1-1.

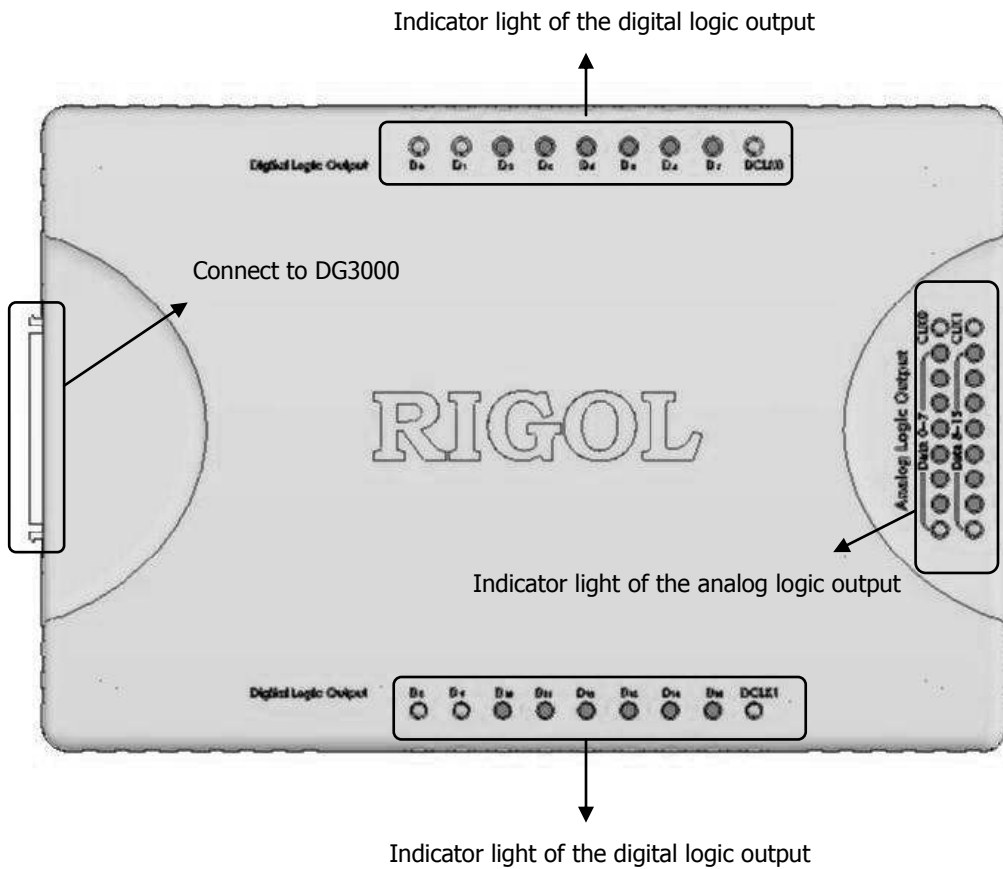


Figure 1-1 Port instruction of the module

As shown in Figure 1-2, to use the module, please connect this port to the "DIGITAL OUTPUT" connector at the rear panel of DG3000 with the provided cable as described in "Appendix A".

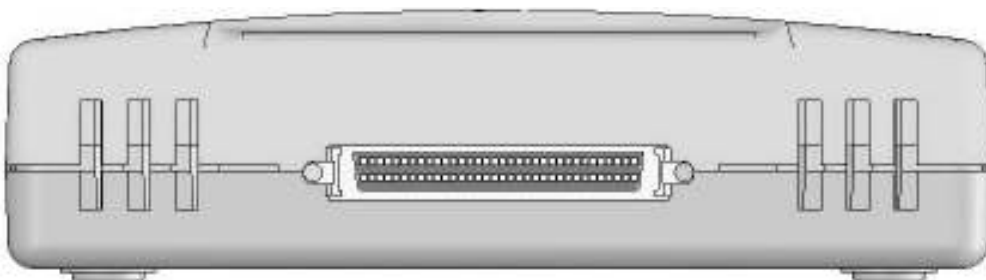


Figure 1-2 Port used for connecting to DG3000

The analog logic output port and the pin definitions are shown in Figure 1-3. To use it, please connect the provided logic analyzer testing wires to this port; connect the other ends of the testing wires to the input of a logic analyzer which will verify the output signal of the module. The logic analyzer testing wires can also be used to transform the analog logic output.

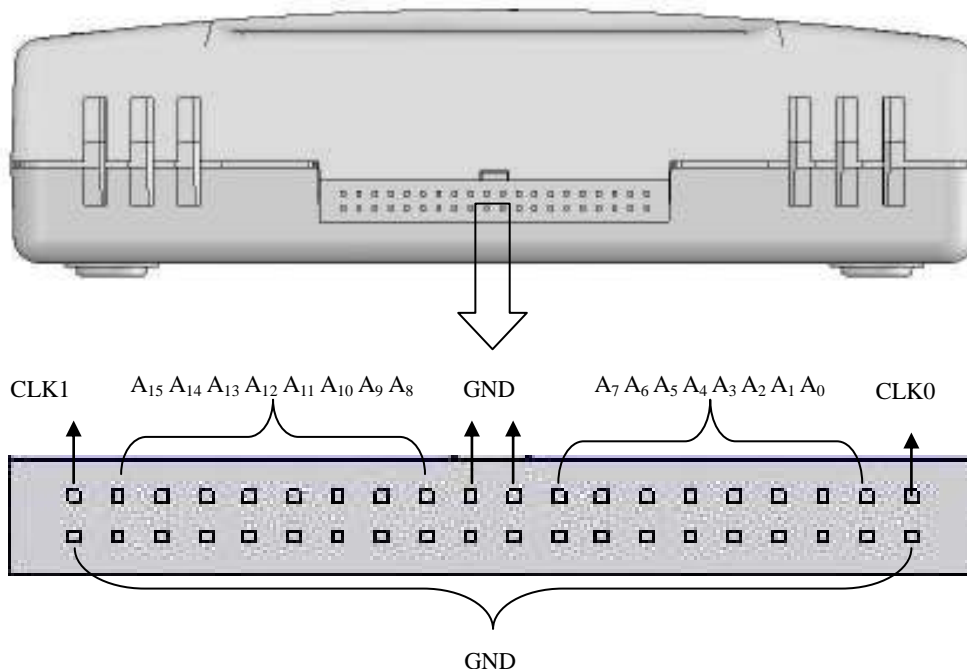


Figure 1-3 Port instruction of the analog logic output

The digital logic output port is shown below in Figure 1-4. The outputs are located at the two sides of the module. The module provides 16 digital channels ($D_0 \sim D_{15}$) + 2 clock output channels (DCLK0, DCLK1).

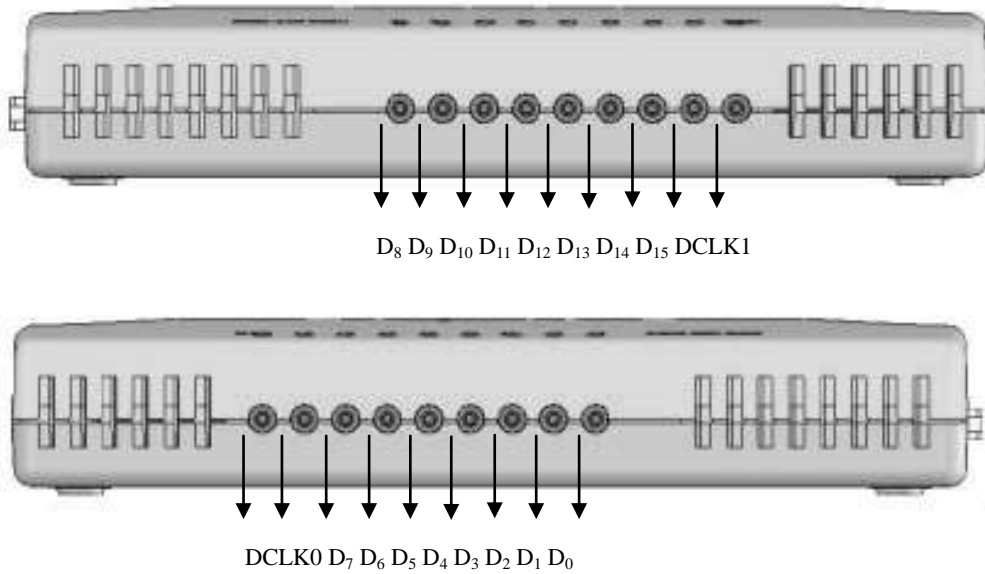


Figure 1-4 Ports instruction of the digital logic output

To Connect the Module

The Logic Signal Output Module is an optional accessory of the DG3000 Series Function/Arbitrary Waveform Generator. Connect the module to a DG3000 as shown in Figure 1-5. Make sure that the power is off before and during the connection. Power up the instrument, the DG3000 will confirm if the module has been successfully installed by displaying the message: "Digital module is installed". Otherwise, repeat the above setup process until the screen shows the success message.



Figure 1-5 Connect the module to DG3000



WARNING When connecting the module to a DG3000, the power must be turned off.

DG3000 provides a switch function to control the power modes of the module. Press **Utility** → **Output Setup** → **Digit-Modu**, as shown in Figure 1-6, there are two power states: "Power-On" and "Power-Off".

The module supports two work modes: "Depend" and "Independ".

At the "Depend" mode, all the analog waveforms output are disabled, the output rate and phase of digital output will have not limit.

At the "Independ" mode, both the module and DG3000 can works normally. However, the output rate and phase of module will have "some limit" (See the following prompt message).

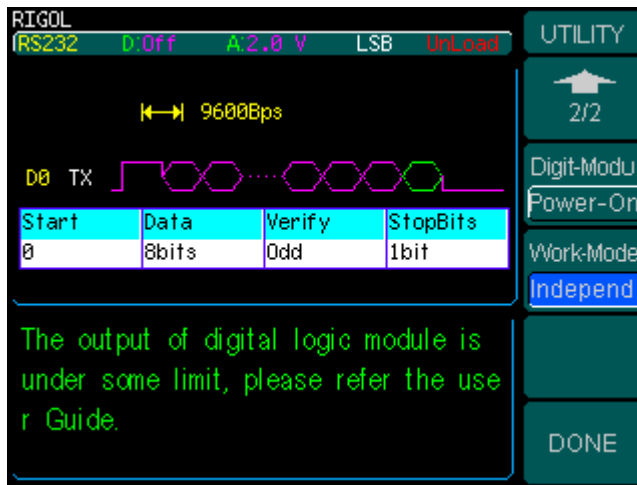


Figure 1-6 Choose "Independ" mode

Examples in this manual use the "Independ" mode to introduce the functions and operation methods of the module, as shown in Figure 1-6 Choose "Independ" mode, the **Arb** button will blink indicating that the modified settings have not been activated, Press **Arb** again to execute.

Limit of the output rate

In "Independ" work mode, the output rate has the following limit:

- RS232: $(100\text{MBps}/120\text{MBps}) / (2 \times N)$, $(N=1, 2, 3, \dots)$
- SPI: $(100\text{Mbps}/120\text{Mbps}) / (2 \times N)$, $(N=1, 2, 3, \dots)$
- IIC: $(100\text{Mbps}/120\text{Mbps}) / (8 \times N)$, $(N=1, 2, 3, \dots)$
- PO: $(100\text{Mbps}/60\text{Mbps}) / N$, $(N=1, 2, 3, \dots)$

User Interface

DG3000 Series Function/Arbitrary Waveform Generators provide users clear and easy-to-use graphical displays for: Communication Protocol Interface, and Data Editing Interface.

Communication protocol interface allows users to configure the system:

- Select digital communication protocols
- Select multifarious code patterns or user-defined patterns
- Set the data output length
- Select data transmission rate or user-defined rate output
- Set trigger mode and trigger level
- Configure output channels with various signal line.

Data Editing Interface allows users to:

- Edit data in hexadecimal or binary form
- Store the waveform data in non-volatile memory,
- Recall and edit stored data.

Communication Protocol Interface

Press **Arb** → **Edit Digital W**, to enter the communication protocol interface as shown in Figure 1-7. The upper-left is Status bar, from left to right are: current protocol, digital voltage, analog voltage, data transmission manner and configuration state. Below the Status bar is a Figure shape of the protocol; consists of data transmission rate, configuration of data-line and clock-line; then the Protocol format. Below the Protocol format is the basic Parameter settings. The right side of the screen is the Operation Menus.

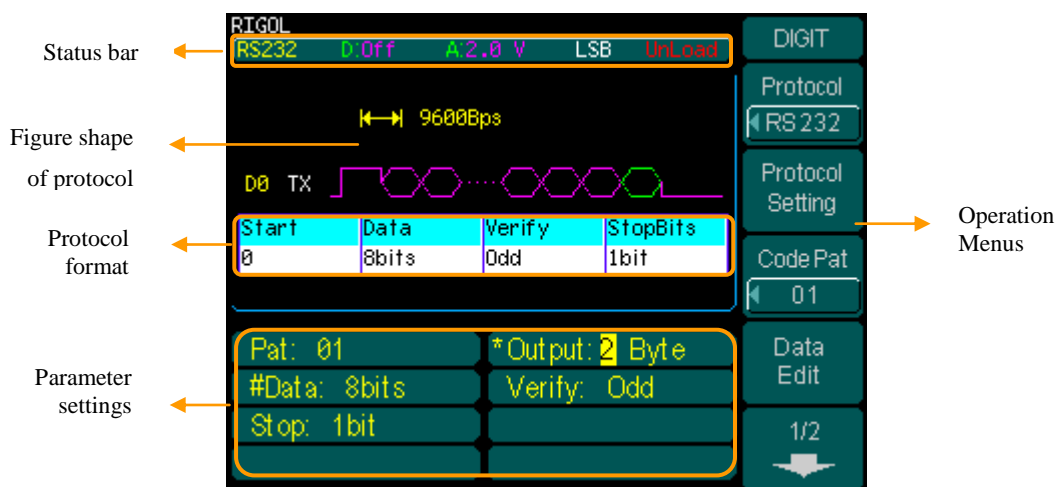


Figure 1-7 Communication protocol interface

PROMPT

- "Loaded" indicates that the current output is the current configuration, while "Unload" indicates that the current output is the last configuration.
- Parameters marked with "*" indicate that they have been modified.
- The blinking **Arb** button indicates that the modified setting has not been implemented, press **Arb** again to execute.
- Press **Arb** to complete change of the configuration, or switch to arbitrary wave mode if no parameter is changed.

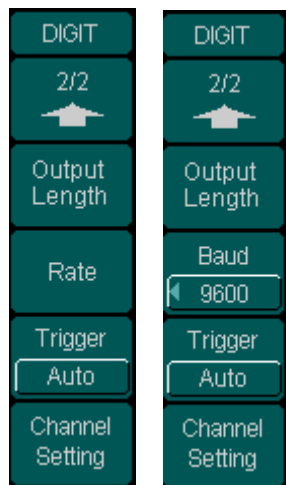
The operation menus and description are shown in the following figures and tables. Figure 1-8(2) is for SPI、IIC、PO protocol, and Figure 1-8(3) is for RS232 protocol.

Figure 1-8(1) Table 1-1(1) Operation menu description



Menu	Setting	Description
Protocol	RS232 SPI IIC PO	To set protocol type, use the knob to choose the protocol and press F1 again.
Protocol Setting		To set the parameters for the protocol.
Code Pat	ALL0 ALL1 01 8PRBS 16PRBS 32PRBS User	To set common code pattern To set user-defined pattern
Data Edit		A shortcut of editing the output data.

Figure 1-8(2) Figure 1-8(3) Table 1-1(2) Operation menu description



Menu	Setting	Description
Output Length		To set the data output length.
#Rate/ Baud		To set the data transmission rate. To set the Baud rate. (In RS232 protocol)
Trigger		To display the trigger mode.
Channel Setting		To configure the output channel.

Data Edit Interface

User data editor provides abundant data outputs. A DG3000 has a 256k (1k=1024) Bytes of data space. Arbitrary digital waveforms can be generated by editing the data.

Press **Arb** → **Edit Digital W** → **Data Edit**, to enter the "DATAEDIT" interface as shown in Figure 1-9. The interface is divided into three parts: the upper-left side is the Data space, below the Data space is the Input area. The right side of the screen is the Operation Menu.



Figure 1-9 User data editing interface

The DATAEDIT operation menus and description are shown in the following figures and tables.

Figure 1-10(1)



Table 1-2(1) Operation menu description

Menu	Setting	Description
Address/ Data	Address Data	To edit the address or data.
Input Type	HEX BIN	To choose hexadecimal or binary form to input user data.
SELECT		Press this menu to confirm the selecting.
DataSource	Volatile ArbWave1 ArbWave2 ArbWave3 ArbWave4	Data stored in volatile space. Data stored in non-volatile space.

Figure 1-10(2)



Table 1-2(2) Operation menu description

Menu	Setting	Description
DataPage UpCross		Turn to the last page.
DataPage DnCross		Turn to the next page.
Save Recall		Store user data in non-volatile memory or U disk. Recall data from non-volatile memory or U disk to edit.
DONE		Store all the changes and return the previous level menu.

Chapter 2 To Edit Digital Waveform

This chapter shows how to edit digital waveforms with respect to the protocol settings. It is divided into the following sections:

- Protocol setting
- To set the code pattern
- To set the data output length
- To set the data transmission rate
- To set the trigger mode
- Channel setting
- Digital waveform calibration

Protocol Setting

Protocol Setting is to configure the format and parameters of the protocol. At present, the DG3000 Logic Signal Output Module supports 4 communication protocols: RS232 (Recommended Standard-232), SPI (Serial Peripheral Interface), IIC (Inter-Integrated Circuit) and PO (Parallel Port). The PO is a parallel communication protocol and the other three are serial communication protocols.

To Set RS232 Protocol

Press **Arb** → **Edit Digital W** → **Protocol**. Use the knob to choose "RS232". Press F1 again to select "RS232" as shown in Figure 2-1.

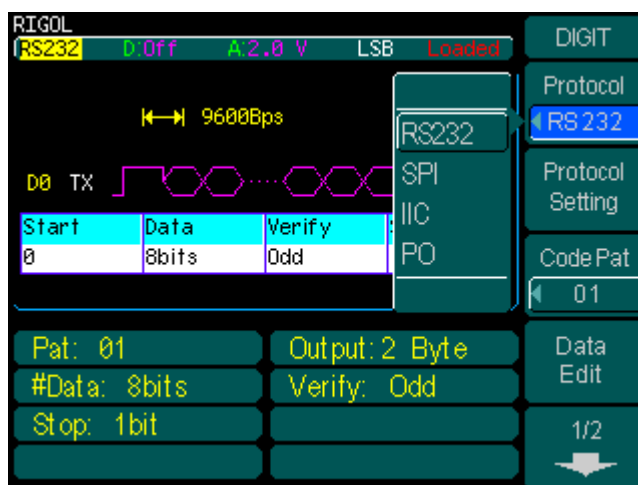


Figure 2-1 Choose RS232 protocol

Press **Protocol Setting**, to enter the protocol setting menu as shown in Figure 2-2.

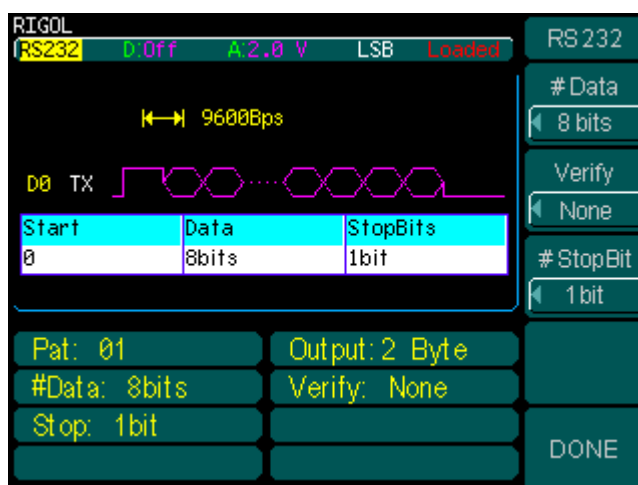


Figure 2-2 RS232 protocol setting interface

The RS232 protocol setting menu and operation description are shown in the following figure and table.

Figure 2-3



Table 2-1 Operation menu description

Menu	Setting	Description
#Data	5bits 6bits 7bits 8bits	To set transmission data length per frame.
Verify	None Odd Even Fixed0 Fixed1	None Odd Even Fixed0 Fixed1
#StopBit	1bit 1.5bits 2bits	To set the stop bit of the character frame.
DONE		Store all the changes and return the previous level menu.

Terms Explanation

To make the setting of "Verify" more flexible for users, two "verify" types: "Fixed0" and "Fixed1" are included.

- **Fixed0:** Always set the "verify" bit to "0".
- **Fixed1:** Always set the "verify" bit to "1".

To Set SPI Protocol

Press **Arb** → **Edit Digital W** → **Protocol**. Use the knob to choose "SPI". Press F1 again to select "SPI" as shown in Figure 2-4.

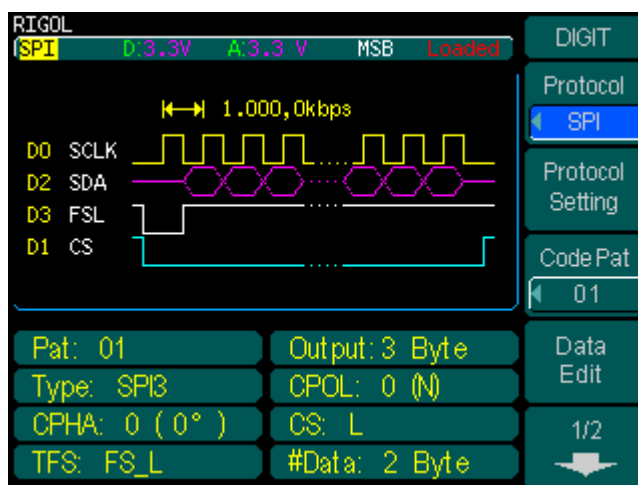


Figure 2-4 Choose SPI protocol

Press **Protocol Setting**, to enter the protocol setting menu as shown in Figure 2-5.

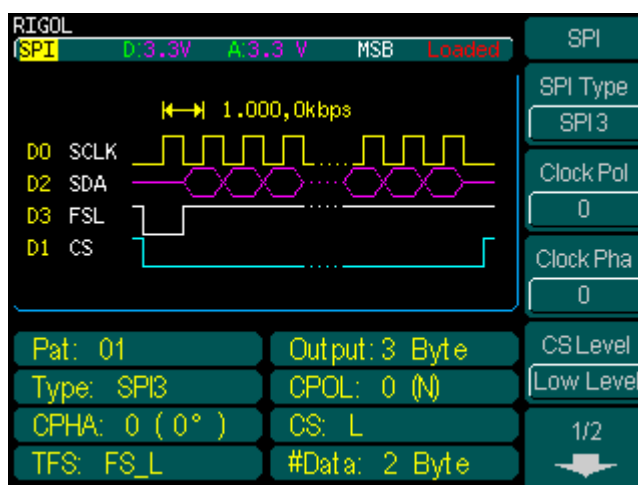


Figure 2-5 SPI protocol setting interface

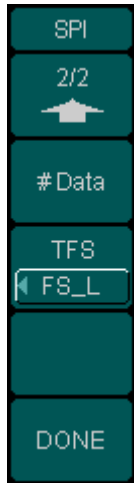
The SPI protocol setting menu and operation description are shown in the following figures and tables.

Figure 2-6(1) Table 2-2(1) Operation menu description



Menu	Setting	Description
SPI Type	SPI3 SPI2	To set the SPI type, use F1 or the knob to switch the options.
Clock Pol	0 1	To set the clock polarity, use F2 or the knob to switch the options.
Clock Pha	0 1	To set the clock phase, use F3 or the knob to switch the options.
CS Level	High Level Low Level	To set the CS level, use F4 or the knob to switch the options.

Figure 2-6(2) Table 2-2(2) Operation menu description



Menu	Setting	Description
#Data	1Byte 2Byte 3Byte	To set transmission length of each data frame, use the knob to switch the options.
TFS	FS_L FS_H LD_L LD_H NONE	To set the TFS type: Front Sync, Low level effective Front Sync, High level effective Last Sync, Low level effective Last Sync, High level effective Do not the TFS type
DONE		Store all the changes and return the previous level menu.

Terms Explanation

- **SPI Type:** The difference between SPI3 and SPI2 is to set the CS level or not. Users do not want to choose the CS line could select SPI2.
- **TFS:** Transmit Frame synchronization Signal. The frame synchronization signal is used for data synchronization. It indicates the start of the data block.

To Set IIC Protocol

Press **Arb** → **Edit Digital W** → **Protocol**. Use the knob to choose "IIC". Press F1 again to select "IIC" as shown in Figure 2-7.

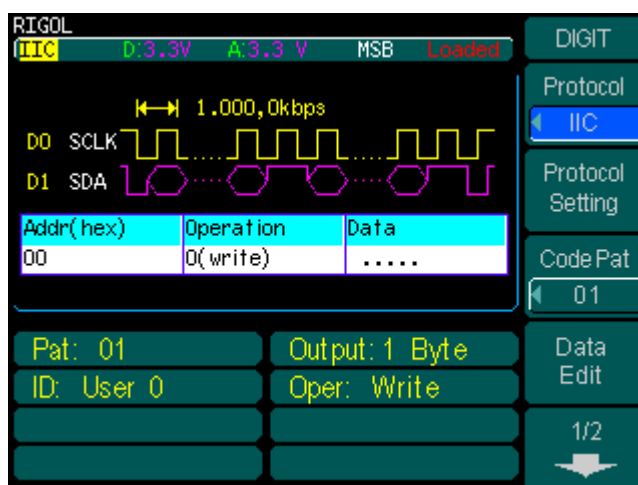


Figure 2-7 Choose IIC protocol

Press **Protocol Setting** to enter the protocol setting menu as shown in Figure 2-8.

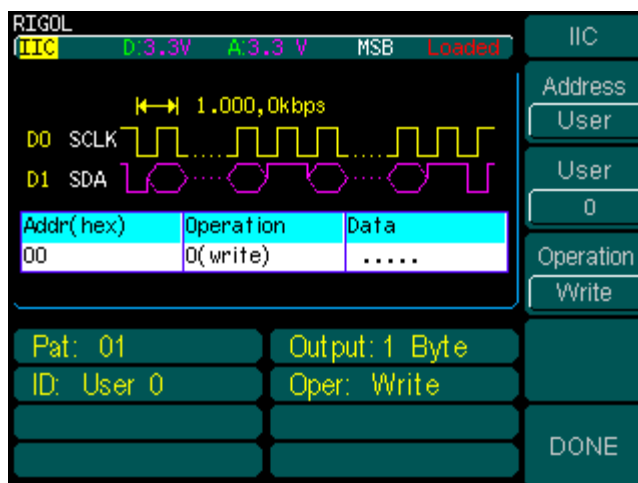


Figure 2-8 IIC protocol setting interface

The operation menu and description of User-defined IIC address are shown in the following figure and table.

Figure 2-9



Table 2-3 Operation menu description

Menu	Setting	Description
Address	User None	Enable or disable the Address of the slave or host chip.
User	0~127	Set the Address of the slave or host chip.
Operation	Write Read	To set the operation mode.
DONE		Store all the changes and return the previous level menu.

To Set PO Protocol

Press **Arb** → **Edit Digital W** → **Protocol**. Use the knob to choose "PO". Press F1 again to select "PO" as shown in Figure 2-10.

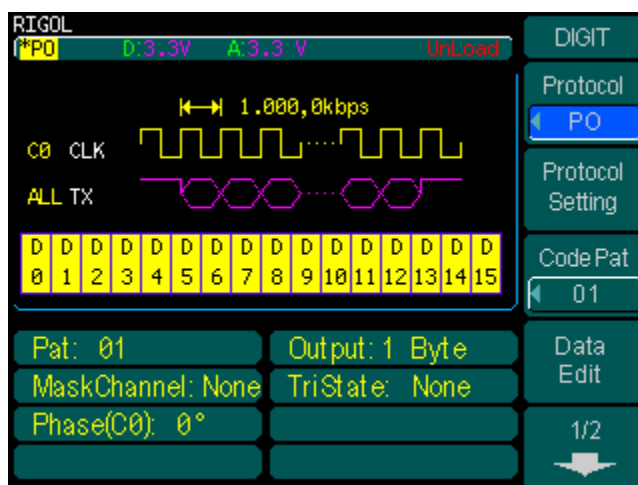


Figure 2-10 Choose PO protocol

Press **Protocol Setting**, to enter the protocol setting menu as shown in Figure 2-11.

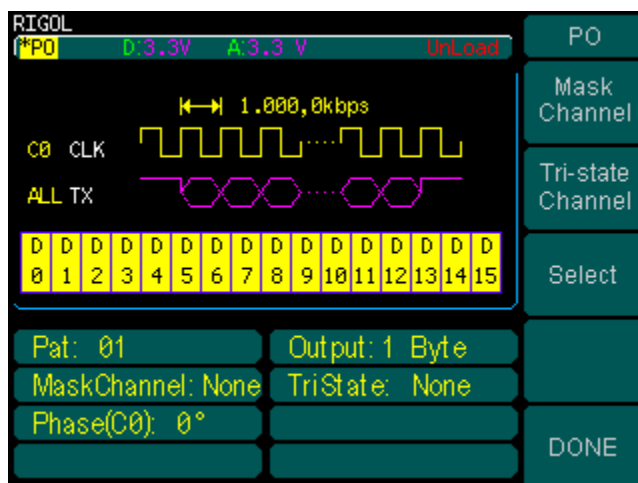


Figure 2-11 PO protocol setting interface

The PO protocol setting menu and operation description are shown in the following figure and table.

Figure 2-12



Table 2-4 Operation menu description

Menu	Setting	Description
Mask Channel	None D0 : D15	None: No Mask Channel. D0~D15: Select the appointed channel as the Mask Channel.
Tri-state Channel	None D0 : D15	None: No Tri-state Channel. D0~D15: Select the appointed channels as the Tri-state Channels.
Select	Select CANCEL	Select or Deselect Mask Channel or Tri-state Channel.
DONE		Store all the changes and return the previous level menu.

Keypoints:

- Mask Channel
Data in the Mask Channel can be edited in the user space. "0" in the Mask Channel, indicates the corresponding Tri-state Channel output is not high Z (normal output), while "1" indicates the corresponding Tri-state Channel output is high Z.
- Tri-state Channel
Tri-state Channel is the channel to be "masked". The Tri-state Channel output depends on the corresponding data "1" and "0" in Mask Channel, high Z, and not high Z respectively.

Example:

Suppose D0 is the Mask Channel, D1 and D5 are Tri-state Channels. Set data in the three channels as shown below:

D0: 1 0 0 1 1 0 0 1 0 1 0 1 0 1 0 0 0 0 1 0 0 1 0 0 ...
 D1: 0 1 0 1 0 1 0 1 0 1 0 1 0 1 0 1 0 1 0 1 0 1 0 1 ...
 D5: 1 0 1 0 1 0 1 0 1 0 1 0 1 0 1 0 1 0 1 0 1 0 1 0 ...

Then the output would be: (“Z” indicates high Z)

D0: 1 0 0 1 1 0 0 1 0 1 0 1 0 1 0 0 0 0 1 0 0 1 0 0 ...

D1: Z 1 0 Z Z 1 0 Z 0 Z 0 Z 0 Z 0 1 0 1 Z 1 0 Z 0 1 ...

D5: Z 0 1 Z Z 0 1 Z 1 Z 1 Z 1 Z 1 0 1 0 Z 0 1 Z 1 0 ...

NOTE

- Only one of the channels (D0~D15) can be chosen as the Mask Channel. The selected channel turns azury on the screen (See page 2-41, Figure 2-45 Channel marks).
- Users can choose one or more channel as the Tri-state Channel. The selected channels turn bolarious on the screen (See page 2-41, Figure 2-45 Channel marks).
- Both the opening (yellow on the screen) and the closed (white on the screen) channels can be chosen as the Mask Channel or the Tri-state Channel. The difference is that the opening channel can output but not the closed channel. To know how to open or close the channel, see page 2-42, Table 2-12(1) Operation menu description.

To Set the Code Pattern

Code Pattern setting generates the output code patterns. It includes common patterns such as "All0", "All1", "01", PRBS (Pseudo Random Binary Sequence) and user-defined codes.

Common Code Pattern

Press **Arb** → **Edit Digital W** → **Code Pat**. Choose common code pattern such as: All0, All1, 01, 8PRBS, 16PRBS, 32PRBS. Use the knob to choose the required code pattern and then press F3, as shown in the Figure 2-13.

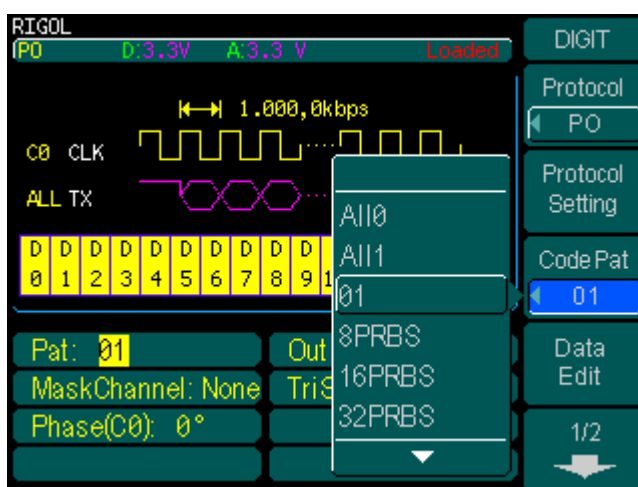


Figure 2-13 Choose the common code patterns

Table 2-5 Description of the Common Code Pattern

Code Pattern	Description
All0	All "0" sequence
All1	All "1" sequence
01	"0", "1" alternate sequence
8PRBS	PRBS generated by an 8 bits linear shift register
16PRBS	PRBS generated by a 16 bits linear shift register
32PRBS	PRBS generated by a 32 bits linear shift register

User Define Code Pattern

Press **Arb** → **Edit Digital W** → **Code Pat** → **User**. Scroll until “User” appears in the menu bar as shown in Figure 2-14. Users can set the data output offset as needed.

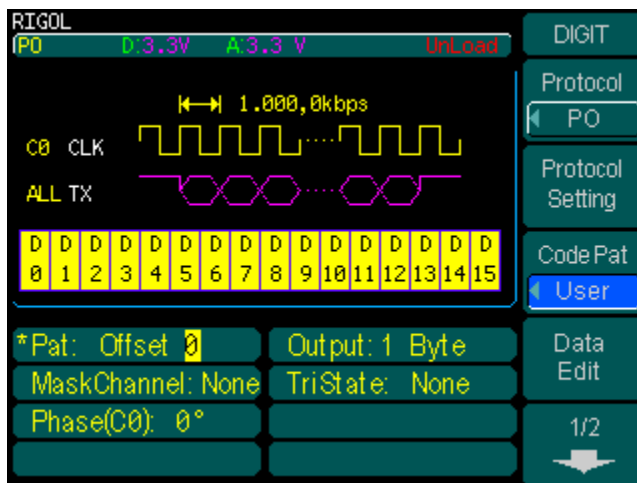


Figure 2-14 Set the output offset

When “User” is selected, the outputs of the generator will be the user edited data (See the next section “User data editor”). The “Offset” setting is convenient for users to choose the starting position of output data.

User Data Editor

Edit Address and Data

1. Edit address

Select **Address** or **Data** to edit; press F1 to toggle the two options. Select **Address** as shown in Figure 2-15.

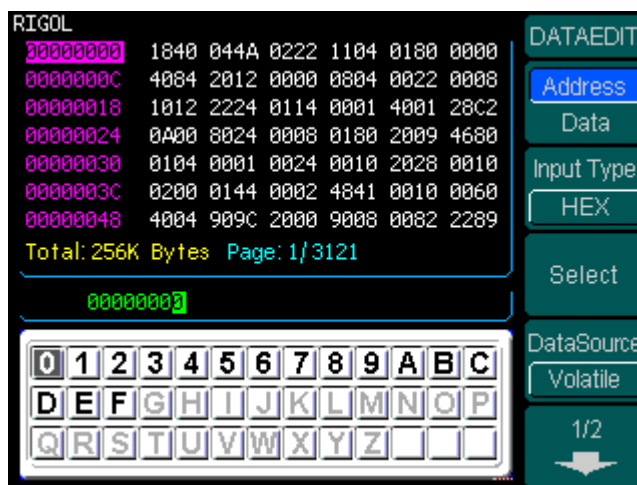


Figure 2-15 Select "Address" to edit

When editing address, use the left or right direction key to select the address bit. Use the knob to choose the numeric or letter on the displayed keyboard. Press **Select** to confirm the selection.

PROMPT

- Address can only be set to an even number, or an error will appear.

2. Edit data

Press F1 and select **Data**, and then modify the data on current highlighted position. There are two kinds of input types: Hexadecimal and Binary. Use the left or right direction key to select the data bit for editing. Use the knob to choose the numeric or letter on the displayed keyboard. Press **SELECT** to confirm the selection. The input format of Hexadecimal and Binary are shown in Figure 2-16.



Figure 2-16(a) Edit data (Hexadecimal)



Figure 2-16(b) Edit data (Binary)

Edit Stored Digital Waveform

The currently editing data is in the volatile memory, and the stored data in the non-volatile memory can be imported as shown in Figure 2-17.



Figure 2-17 Select data source

Press **DataSource**. Repeat pressing this key or use the knob to select the storage location of digital waveform: Volatile、ArbWave1、ArbWave2、ArbWave3 or ArbWave4.

PROMPT

- Only the location which has stored digital waveform will appear in the **DataSource** option.
- The currently editing data is always located in the volatile memory. When choosing data from the non-volatile memories: ArbWave1、ArbWave2、ArbWave3 or ArbWave4; data will be copied to volatile memory for editing, and those stored in non-volatile will not be changed.

Data Browse, Store and Recall

1. Data browse

Press F5 and switch to the second page as shown in Figure 2-18. Press **DataPage UpCross** to display data in the previous page, press **DataPage DnCross** you will see data in the next page.

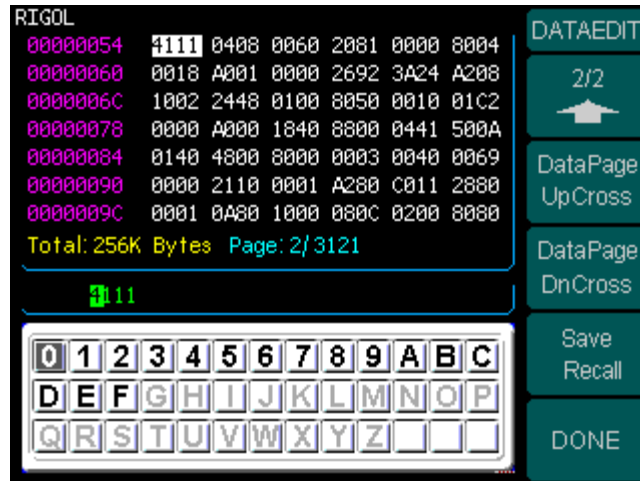


Figure 2-18 Switch the data page

Below the Data Space, it shows the total data length and the current page. If users want to edit data on any page; switch to that page by pressing **DataPage UpCross** or **DataPage DnCross**. Press F1 to return the upper level menu, and then edit data as introduced before.

2. Save and Recall

Users can store data in the non-volatile memory or a U disk, and recall them into the volatile space for editing.

Press **Save Recall** to enter the save and recall interface as shown in Figure 2-19.

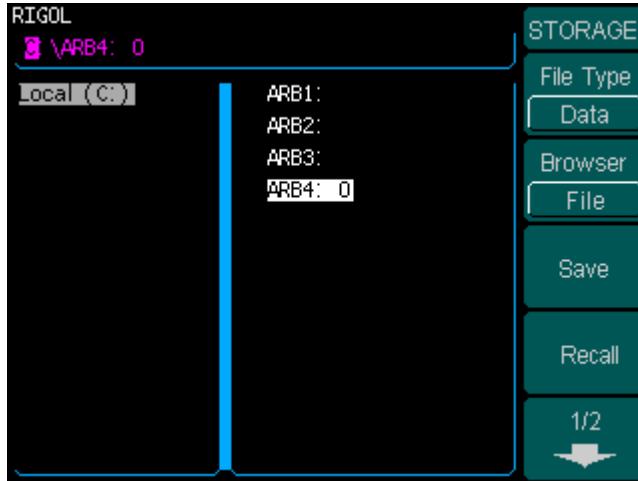


Figure 2-19 Save and recall interface

The Save/Recall menu and operation description are shown in the following figures and tables.

Figure 2-20(1)

Table 2-6(1) Operation menu description



Menu	Setting	Description
File Type	Data All File State	Arbitrary Waveform files All kinds of files The Setting of the generator
Browser	Directory Path File	Shift between Directory, Path and file
Save		Save digital waveform data to the appointed place
Recall		Recall the waveform or Setting information in the specific position in the memory.

Figure 2-20(2)



Table 2-6(2) Operation menu description

Menu	Setting	Description
Delete		Delete the selected waveform file.
CANCEL		Cancel the current operation and return the previous level menu.

File type selection

Press F1 repeatedly to toggle between the file types.

To use the Browser

Press F2 repeatedly to toggle between "Directory", "Path" and "file".

(1) Save

Press **Save**, to enter the data saving interface. Enter a filename by using the displayed keyboard. The instrument supports both Chinese and English inputs.

● Chinese input

Example: To enter the filename “数字波”.

Press F1 to select **Chn_S**.

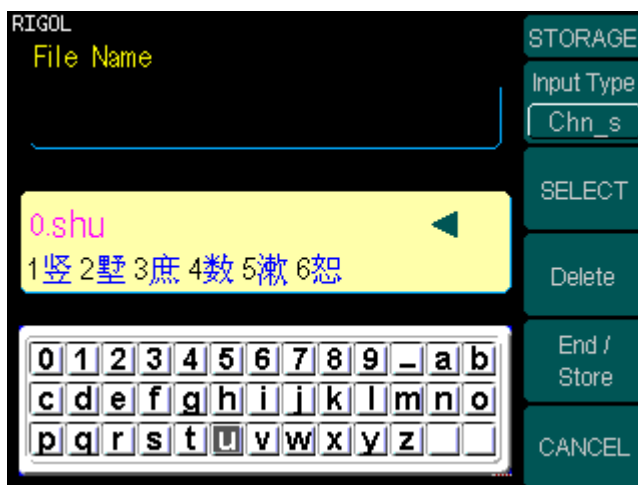


Figure 2-21 Input Chinese filename

Use the knob to choose “s”; press **SELECT** to confirm the selection. Repeat with “h” and “u”; the input field will display a series of matching Chinese characters. Use the direction key to look for the characters “数” as shown in Figure 2-21. Press “4” in the keypad on the front panel of the DG3000. Repeat the above process to input “字” and “波”. To delete a character, use the direction key to select it and then press **Delete**. When finished, press **End/Store** to end the storage.

- **English input**

Example: To enter the filename "digital" as shown in Figure 2-22.
Press F1 to select **En**.



Figure 2-22 Input English filename

Use the knob to choose "d"; press **SELECT** to confirm the selection. Repeat until "digital" completed. To delete a character, use the direction key to select it and then press **Delete**. When finished, press **End/Store** to end the storage.

The final results after the examples above are as shown in Figure 2-23.



Figure 2-23 Save and recall interface

(2) Recall

As shown in Figure 2-24, there is a file named "digital" in the non-volatile location ARB2.

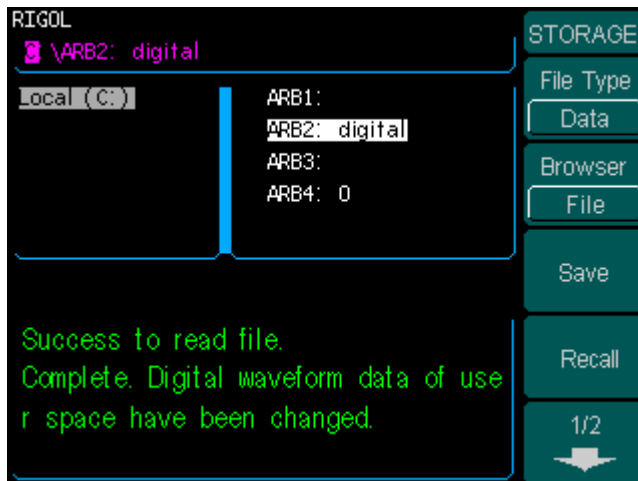


Figure 2-24 Recall a stored digital waveform

Press F2 to switch the browser and select "File". Use the up and down direction key to select "ARB2: digital". Press **Recall** to recall the file. The screen will display a prompt as shown in figure 2-24.

NOTE

- **There will be an error when trying to read analog waveform to digital storage space.**

When you enter the STORAGE menu from "user data editor", only digital waveform can be read. If try to read an analog waveform, an error message will be given (See the "Error Message" section).

- **There will be an error when trying to read digital waveform to analog storage space.**

When you enter the STORAGE menu by pressing **STORAGE** on the front panel of DG3000, only analog waveform can be read, if try to read a digital waveform, an error message will be given (See the "Error Message" section).

(3) Delete

Enter the second page of the STORAGE menu as shown in Figure 2-25; use the knob and direction key to select the file you want to delete, and then press **Delete**.

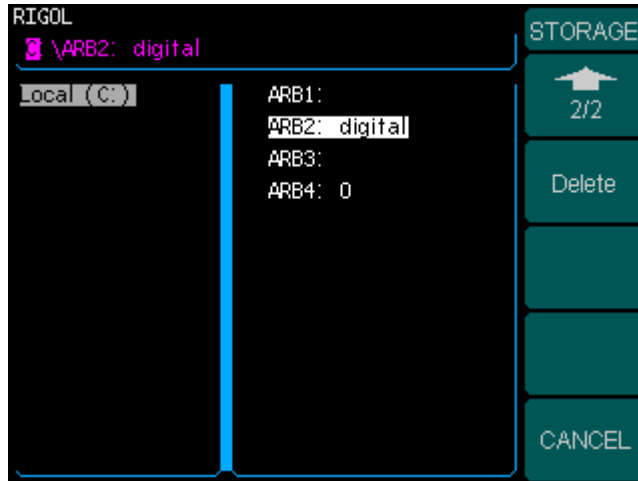


Figure 2-25 File delete

Output User Data

When **Code Pat** is set to "User", the protocol will output the user-defined data, and users can set the value of "Offset" to select the start data location.

The communication protocols have specified transmission sequence of data. For example, RS232 uses "LSB"; SPI and IIC use "MSB", but for PO, both "LSB" and "MSB" can be used. Therefore, the output sequence of user data depends on the chosen protocol.

LSB:

Least Significant Bit, for binary sequence 00001111, LSB is the most right bit "1".

MSB:

Most Significant Bit, for binary sequence 00001111, MSB is the most left bit "0".

In the following **Example 1** and **Example 2** we will introduce how to output user-defined data.



Figure 2-26 Output user data

Example 1:

Use RS232 protocol, output data length=1 Byte, data line=D1, Offset=1, the other parameters use default value, output user data as shown in Figure 2-26.

Explanation:

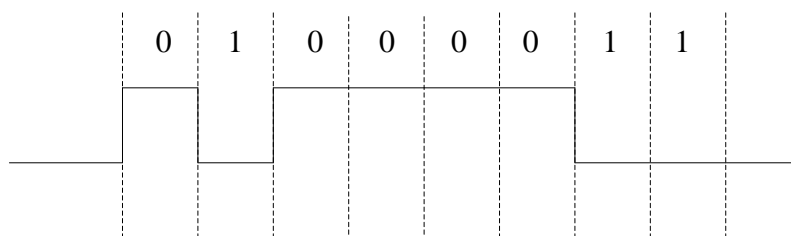
Offset=1 indicates the first data "1840" would not be output. As data transmitting through line D1, it will output 8 bits (1 Byte) in the 8 data start from "044A". The data storage is shown in the following table.

Table 2-7 Data Storage

Address	Data (D15~D0)
00000002	044A(0000010001001010)
00000004	0222(0000001000100010)
00000006	1104(0001000100000100)
00000008	0180(0000000110000000)
0000000A	0000(0000000000000000)
0000000C	4084(0100000010000100)
0000000E	2012(0010000000010010)
00000010	0000(0000000000000000)

Output:

1. According to the above table, the output data would be: 1 1 0 0 0 1 0;
2. For RS232 protocol, the output sequence is "LSB", then the output should be: 0 1 0 0 0 1 1;
3. For RS232 protocol is negative logic output, in the output figure, "0" is represented by high level and "1" is represented by low level as shown in the figure below:



Note: For RS232 protocol, -15V~-5V is logic "1" and +5V~+15V is logic "0".

Example 2:

Use PO protocol, output data length=4Bytes, data line=All, Offset=0, the other parameters use default value, output user data as shown in Figure 2-26.

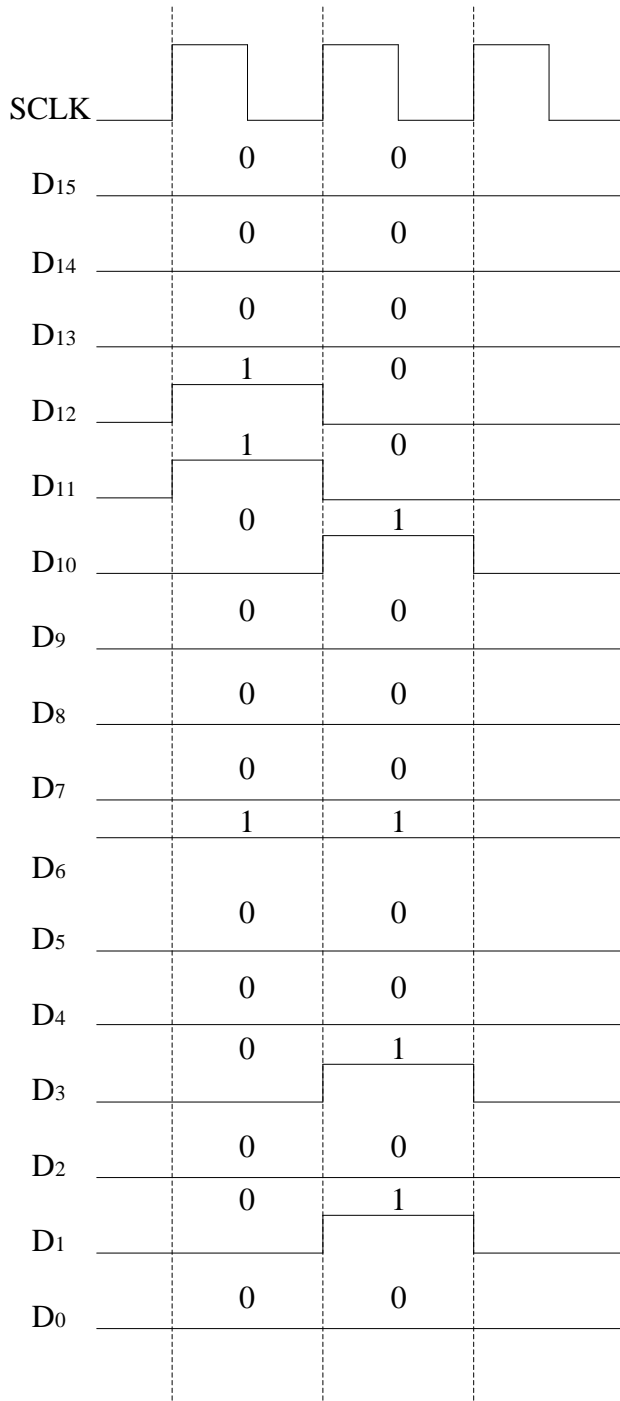
Explanation:

Offset=0 indicates the first data "1840" would be output. As data transmitting parallel from the 16 channels, each channel will output 2 bits (total is 32 bits=4 Bytes). The data storage is shown in the following table.

Table 2-8 Data Storage (4Bytes)

Address	Data (D15~D0)
00000000	1840(0001100001000000)
00000002	044A(0000010001001010)

The output is shown in the following figure:



To Set the Output Data Length

Press **Arb** → **Edit Digital W** → F5, to enter the second page of "DIGIT". Press **Output Length** to set the output data length as shown in Figure 2-27.

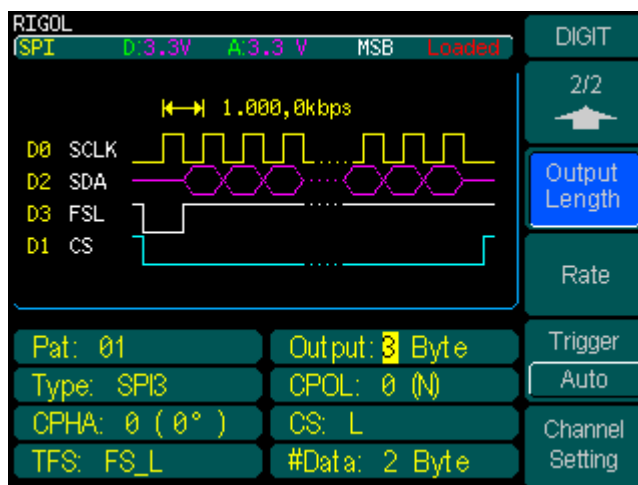


Figure 2-27 Set the output data length

PROMPT

- **Output Length:** To define the output data length (Byte). Different protocols have different upper limit.
- If current the current output code is User code, then User code plus User offset can not exceed User space and the upper limit of protocol output, in addition, not to exceed 256k Bytes.
- RS232 output upper limit: 35k Bytes; SPI output upper limit: 40k Bytes; IIC output upper limit: 10k Bytes; PO output upper limit: 128k (1k=1024) Byte.

To Set the Data Transmission Rate

Different protocols have different data transmission rate settings. RS232 refers to "Baud per second", while SPI, IIC, PO refer to set "bits per second (bps)".

1. Baud rate Setting

Press **Arb** → **Edit Digital W** → **F1** → **RS232** → **F5**, to enter the second page of "DIGIT" menu. Press **Baud**, it would display as shown in Figure 2-28.

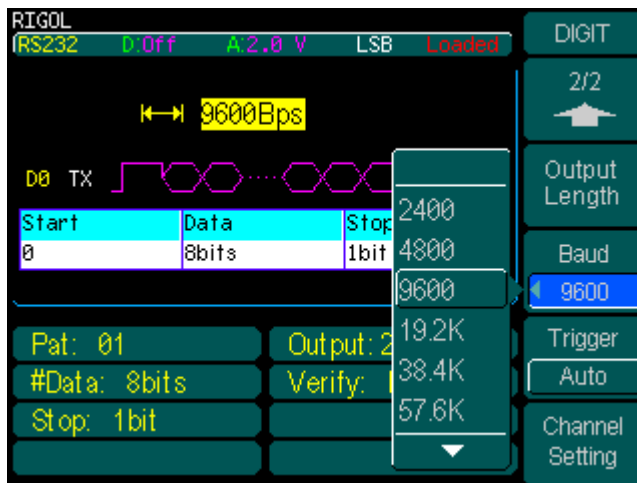


Figure 2-28 Set the Baud rate

Baud setting provides transmission rate options: 2400, 4800, 9600, 19.2k, 38.4k, 57.6k, 115k, and the default is 9600.

Besides the above options, the RS232 also provides user-defined output rate as shown in Figure 2-29.

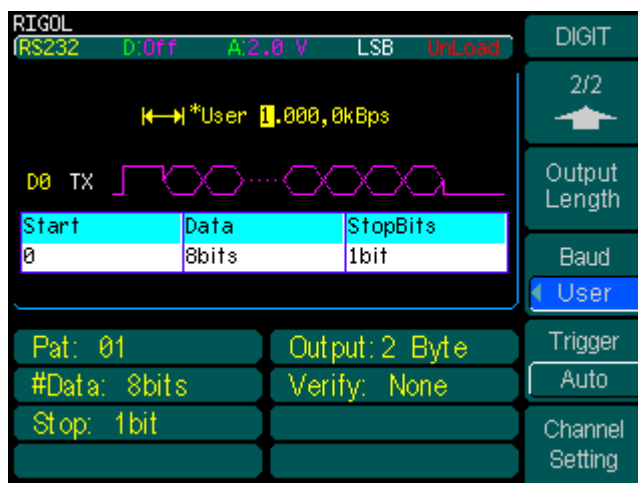


Figure 2-29(a) Choose user-defined output rate

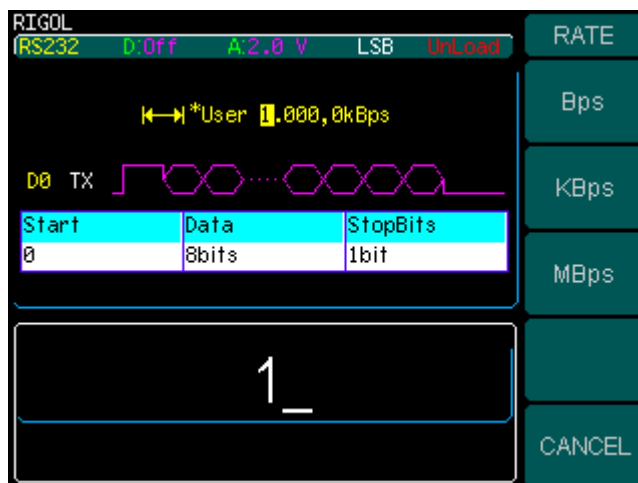


Figure 2-31(b) Input user-defined output rate

Terms Explanation

- **Baud rate:** Code elements transmission per second. The unit is Bps (Bauds per second).
- **Bit rate:** Binary bits transmission per second. The unit is bps (bits per second). Bit rate is an important specification of digital communication system. When the channel is fixed, the higher the information transmission rate is, the better the effectiveness will be.

2. Rate Setting

Press **Arb** → **Edit Digital W** → F1 → **SPI** → F5, to enter the second page of "DIGIT". Press **Rate**, it would display as shown in Figure 2-30.

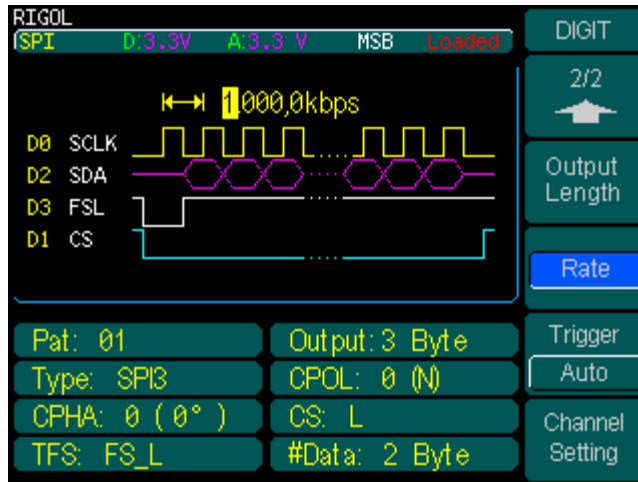


Figure 2-30 Transmission rate setting

To Set the Trigger Mode

The module provides 2 trigger modes: Auto and Burst, the default is Auto mode.

1. Auto trigger

Press **Arb** → **Edit Digital W** → **F5** → **Trigger**, to enter the interface as shown in Figure 2-31. To change the trigger mode; turn to **Burst** mode.

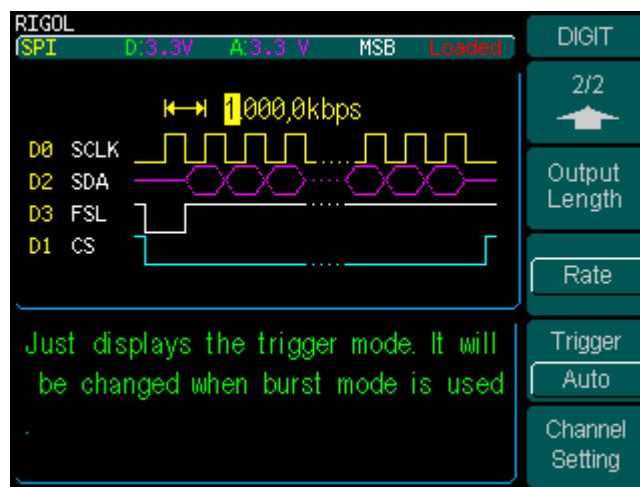


Figure 2-31 Set Auto trigger mode

2. Burst mode trigger

Burst trigger includes 3 modes with respect to different trigger sources: Internal, External and Manual. In Burst mode, the screen will also display the current protocol in use and the related parameters.

1) Internal trigger

Press **Burst** → **Source** → **Internal**, to enter the interface as shown in Figure 2-32.

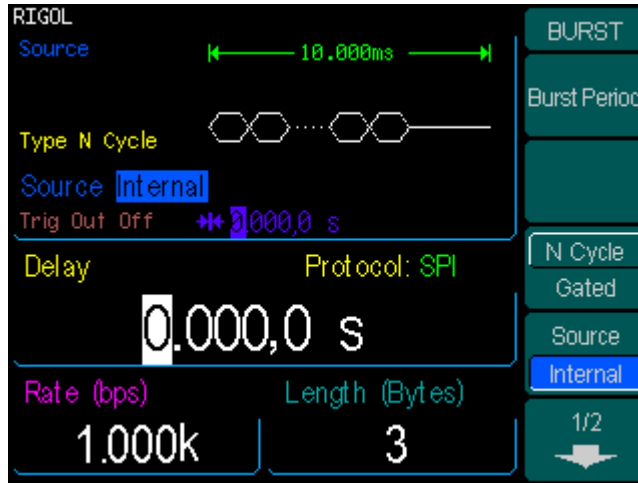


Figure 2-32 Choose internal source

Press F5, to enter the second page of "BURST" as shown in Figure 2-33. Select a rising or a falling edge through the **Trig Out** option, or you can choose "Off" to disable the trigger output.

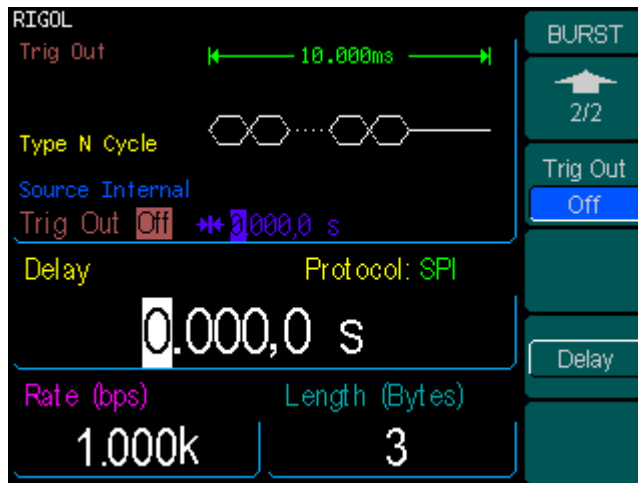


Figure 2-33 Set the "trig out" signal

2) External trigger

Press **Burst** → **Source** → **External**, to enter the following interface as shown in Figure 2-34.

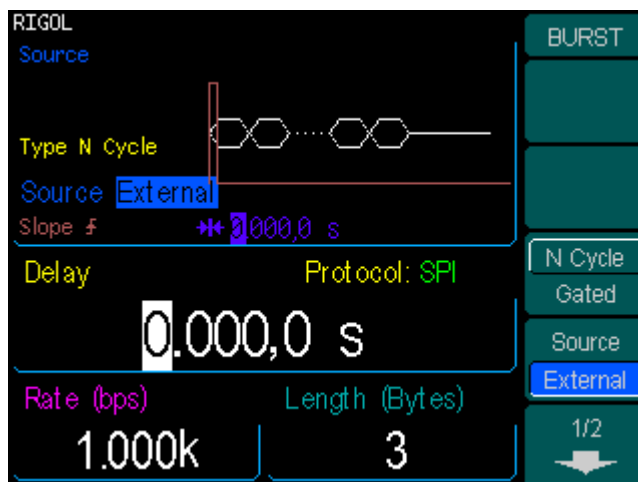


Figure 2-34 choose external source

Press F5, to enter the second page of "BURST" as shown in Figure 2-35, and select a rising or a falling edge through the **Slope** option.

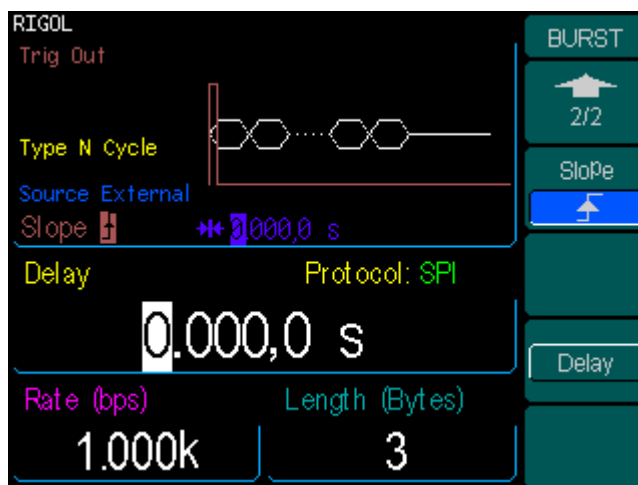


Figure 2-35 Set the "trig out" signal

3) Manual trigger

Press **Burst** → **Source** → **Manual**, to enter the interface as shown in Figure 2-36. The function key **Trigger** on the front panel will turn bright when **Manual** is selected.

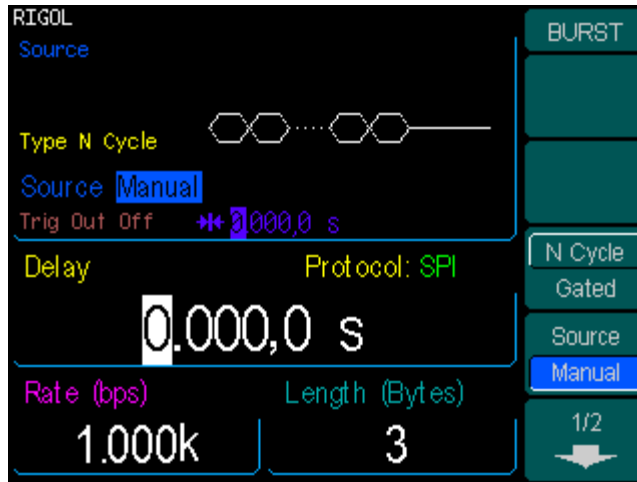


Figure 2-36 Choose manual trigger

Press F5, to enter the second page of "BURST" as shown in Figure 2-37. Select a rising or a falling edge through the **Trig Out** option, or you can choose "Off" to disable the trigger output.

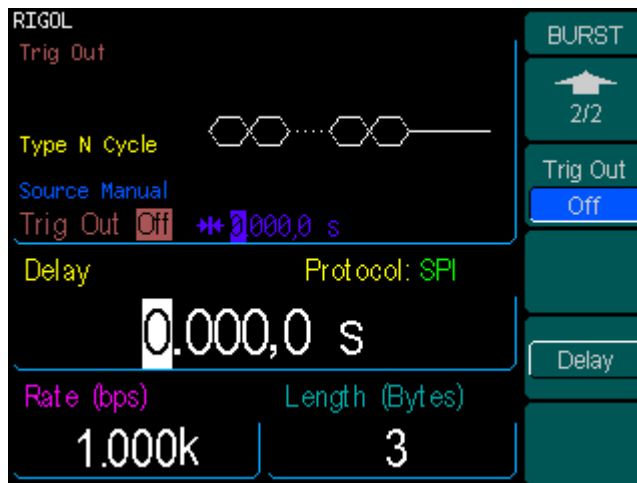


Figure 2-37 Set the "trig out" signal

When finishing the trigger mode setting, press **Burst** to return the "DIGIT" interface.

Channel Setting

The module provides 16 data output lines and 2 clock lines. Users can select any of them as in need, and set the channel output voltage. This section introduces the channel settings of each protocol.

Channel Setting for RS232 Protocol

Press **Arb** → **Edit Digital W** → **RS232** → **Channel Setting**, to enter the interface as shown in Figure 2-38.

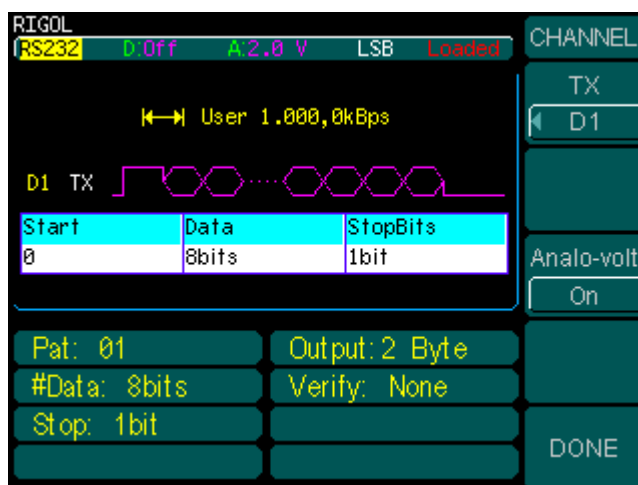


Figure 2-38 Channel setting of RS232

The Channel setting menu of RS232 protocol and operation description are shown in the following figure and table.

Figure 2-39



Table 2-9 Operation menu description

Menu	Setting	Description
TX	D0 D1 ⋮ ⋮ D14 D15	Select data line of RS232.
Analo-volt	On Off	Set analog channels voltage.
DONE		Store all the changes and return the previous level menu.

PROMPT

Since RS232 voltage is negative logic and has negative voltage. While digital channel cannot output negative voltage, just enable analog voltage and always close digital channel.

Channel Setting for SPI Protocol

Press **Arb** → **Edit Digital W** → **SPI** → **Channel Setting**, to enter the interface as shown in Figure 2-40.

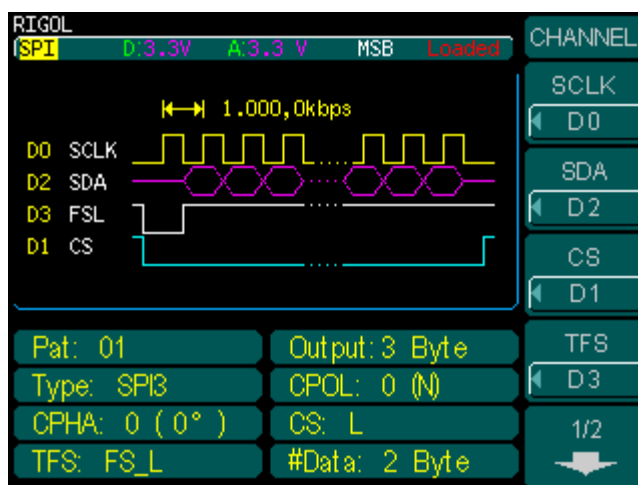


Figure 2-40 Channel setting of SPI

The Channel setting menu of SPI protocol and operation description are shown in the following figures and tables.

Figure 2-41(1)

Table 2-10(1) Operation menu description



Menu	Setting	Description
SCLK	D0 : D15	Select clock line of SPI.
SDA	D0 : D15	Select data line of SPI.
CS	D0 : D15	Select CS line of SPI.
TFS	D0 : D15	Select TFS line of SPI.

Figure 2-41(2) Table 2-10(2) Operation menu description



Menu	Setting	Description
Digit-Volt	1.8V 2.5V 3.3V 4.0V User Off	Set digital channels voltage. The default is 3.3V. User-defined mode (1.4V~4.2V) Turn off digital voltage output.
Analo-Volt	On Off	Set analog channels voltage.
DONE		Store all the changes and return the previous level menu.

NOTE

- When setting SCLK, SDA, CS and TFS, selected D0~D15 cannot be double set. For example, SCLK has set to be D0; SDA cannot be assigned to D0, unless SCLK being set to another line.
- SPI, IIC, PO protocols provide both analog and digital channel voltage output. Users can configure them individually.
- When analog voltage is higher than 4.2V, digital voltage will automatically adjust to be 3/8 of analog voltage.

Channel Setting for IIC Protocol

Press **Arb** → **Edit Digital W** → **IIC** → **Channel Setting**, to enter the interface as shown in Figure 2-42.

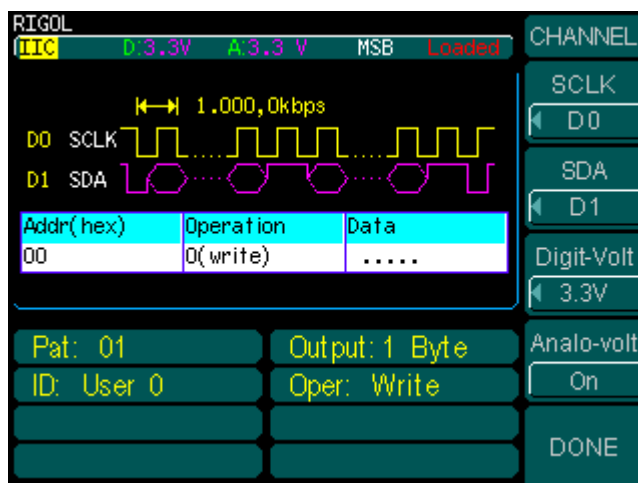


Figure 2-42 Channel setting of IIC

The Channel setting menu of IIC protocol and operation description are shown in the following figure and table.

Figure 2-43



Table 2-11 Operation menu description

Menu	Setting	Description
SCLK	D0 : D15	Select clock line of IIC.
SDA	D0 : D15	Select data line of IIC.
Digit-Volt	1.8V 2.5V 3.3V 4.0V User Off	Set digital channels voltage. The default is 3.3V. User-defined mode(1.4V~4.2V) Turn off digital voltage output.
Analo-Volt	On Off	Set analog channels voltage.
DONE		Store all the changes and return the previous level menu.

NOTE

When setting SCLK, SDA, CS and TFS, selected D0~D15 cannot be double set. For example, SCLK has set to be D0; SDA cannot be assigned to D0, unless SCLK is being set to another line.

Channel Setting for PO Protocol

Press **Arb** → **Edit Digital W** → **PO** → **Channel Setting**, to enter the interface as shown in Figure 2-44.

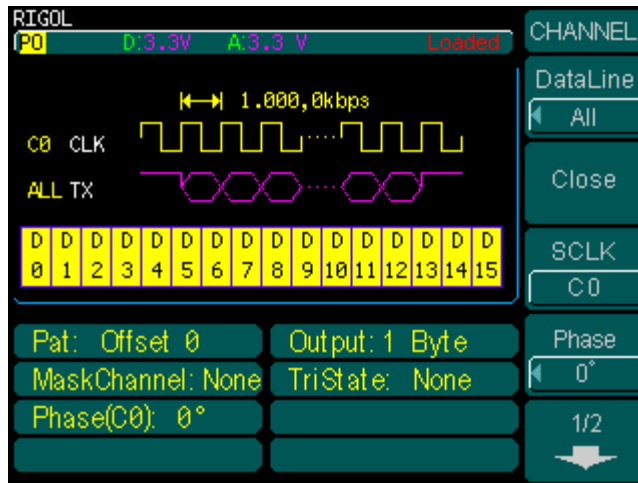


Figure 2-44 Channel setting of PO

PO is a parallel protocol. Users can choose multiple channels and set their output status (ON or OFF). As introduced in page 2-9 "To Set PO Protocol", the protocol can set Mask channel and Tri-State channel. These channels can be identified with different colors as the following figure shows.

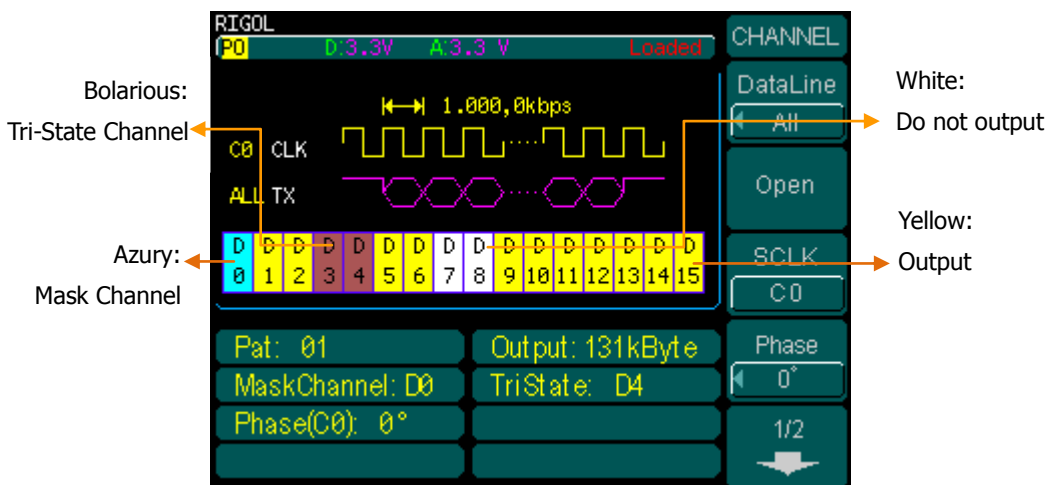


Figure 2-45 Channel marks

The Channel setting menu of PO protocol and operation description are shown in the following figures and tables.

Figure 2-46(1) Table 2-12(1) Operation menu description



Menu	Setting	Description
DataLine	D0 : D15 ALL	Select data line of PO.
Open Close		To confirm whether output the selected channel or not. Open denotes output. Close denotes do not output.
SCLK	C0 C1	Select clock line of PO.
Phase	0 90 180 270	Select the clock phase.

Figure 2-46(2) Table 2-12(2) Operation menu description



Menu	Setting	Description
Digit-Volt	1.8V 2.5V 3.3V 4.0V User Off	Set digital channels voltage. The default is 3.3V. User-defined mode (1.4V~4.2V) Turn off digital voltage output.
Analo-Volt	On Off	Set analog channels voltage.
DONE		Store all the changes and return the previous level menu.

Digital Waveform Calibration

Digital Waveform Calibration is used to calibrate the output voltage of the module. When users connect the digital module with different DG3000s or connect a DG3000 with different modules, the calibration should be performed.

Press **Arb** → **Cal Digital W**, to enter the interface as shown in Figure 2-47.

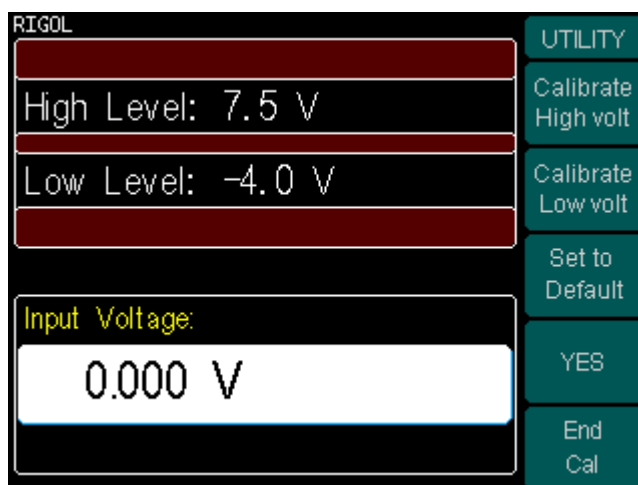


Figure 2-47 Digital waveform calibration interface

Figure 2-48

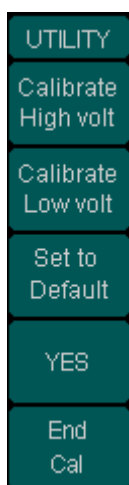


Table 2-13 Operation menu description

Menu	Setting	Description
Calibrate High volt		Select the High Level to be calibrated.
Calibrate Low volt		Select the Low Level to be calibrated.
Set to Default		Restore to default calibration.
YES		Press the button to complete the selected calibration item.
End Cal		Finish the calibration.

1. Calibration method

Turn on the digital waveform calibration function, use the logic analyzer testing line or probe of the oscilloscope and connect the output signal of the analog channel to an oscilloscope or a multimeter.

2. Calibration step

(1) High level calibration

Press **Calibration High volt** and read the DC voltage level from the oscilloscope or the multimeter when the output is high level of 7.5V, input the value to DG3000 and press **YES** to finish the calibration.

(2) Low level calibration

Press **Calibration Low volt**, and read the DC voltage level from the oscilloscope or the multimeter when the output is low level of -4V, input the value to DG3000 and press **YES** to finish the calibration.

If there are input errors or other cause and results in error of the output voltage after the calibration, press **Set to Default** to restore the level to factory default.

Chapter 3 Examples

This chapter provides users application examples of digital waveform generation. They are:

- Example 1: To generator a RS232 digital waveform
- Example 2: To generator a SPI digital waveform
- Example 3: To generator an IIC digital waveform
- Example 4: To generator a PO digital waveform
- Example 5: To generate an IIC digital waveform using the PO protocol

Example 1: To Generate a RS232 Digital Waveform

To generate a RS232 protocol digital waveform: 8 bits per frame of data transmission, Odd verification, 1 Stopbit, "01" code pattern, 1 Byte of output data length, 9600Bps of baud rate, Auto trigger mode, data lines D0, analog voltage output of 2.0V.

Operation steps:

1. Press **Arb** → **Edit Digital W**, to initiate the digital waveform editing interface.
2. Press **Protocol**, and use the knob to choose "RS232". Press the softkey again to select "RS232".
3. Press **Protocol Setting**, for the menu of RS232 protocol settings.
 - 1) Press **#Data**; use the knob to choose "8bits". Press the softkey again to select "8bits".
 - 2) Press **Verify**; use the knob to choose "Odd". Press the softkey again to select "Odd".
 - 3) Press **#StopBit**; use the knob to choose "1bit". Press the softkey again to select "1bit".
 - 4) Press **DONE** to complete the RS232 protocol settings.
4. Press **Code Pat**, and use the knob to choose "01". Press the softkey again to select "01" code.
5. Press F5 to go to the next page.
6. Press **Output Lenth**, and use the keyboard input 1. Press **Enter**, (or use the direction key and the knob to input the value) the output of data length is set to be 1 Byte.
7. Press **Baud**, and use the knob to choose "9600". Press the softkey again to select 9600Bps.
8. Press **Trigger**, the default is "Auto". (You cannot set the trigger mode through this menu. To understand the other trigger mode, please refer to the section of "To Set the Trigger Mode" in chapter 2.)
9. Press **Channel Setting**, for the menu of channel settings.
 - 1) Press **TX**; use the knob to choose "D0" from optional D0~D15. Press the

- softkey again to select "D0".
- 2) Press **Analo-volt**; use the keyboard to input "2" and choose the unit of "V", then the output analog voltage is set to be "2.0V".
 - 3) Press **DONE** to complete the channel settings.
10. Press the blinking button **Arb**. All modified parameters (denoted with "**") will be implemented. The "*" sign will disappear, and the configuration status will change from "UnLoad" to "Loaded".

After all the above steps are finished, the screen display will be shown as in Figure 3-1.

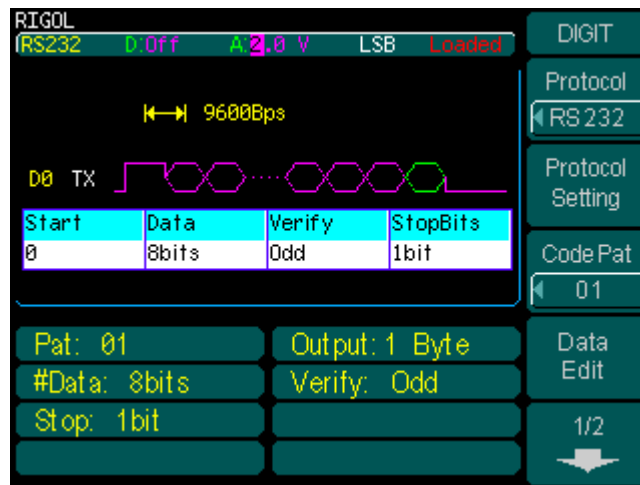


Figure 3-1 RS232 protocol output

Example 2: To Generate a SPI Digital Waveform

To generate a SPI protocol digital waveform: SPI3 type, 0 clock polarity, 0 clock phase, low CS lene D0, dvel, 2 Bytes per frame of data transmission, TFS type FS_L, "01" code pattern, 2 Bytes of output data length, 1 kbps of data transmission rate, Auto trigger mode, clock liata line D2, CS line D1, Start-stop mark line D3, digital voltage output of 3.3V.

Operation steps:

1. Press **Arb** → **Edit Digital W**, to initiate the digital waveform editing interface.
2. Press **Protocol**, and use the knob to choose "SPI". Press the softkey again to select "SPI".
3. Press **Protocol Setting**, for the menu of SPI protocol settings.
 - 1) Press **SPI Type**; use the softkey or the knob to select "SPI3".
 - 2) Press **Clock Pol**; use the softkey or the knob to select "0".
 - 3) Press **Clock Pha**; use the softkey or the knob to select "0".
 - 4) Press **CS Level**; use the softkey or the knob to select "Low Level".
 - 5) Press F5 to enter the next page.
 - 6) Press **#Data**; use the keyboard to input "2".
 - 7) Press **TFS**; use the knob to choose "FS_L". Press the softkey again to select "FS_L".
 - 8) Press **DONE** to complete the SPI protocol setting.
4. Press **Code Pat**; use the knob to choose "01". Press the softkey again to select "01" code.
5. Press F5 to go to the next page.
6. Press **Output Lenth**, and use the keyboard input 2. Press **Enter**, (or use the direction key and the knob to input the value.) the output of data length is set to be 2 Bytes.
7. Press **Rate**, and use the keyboard to input "1". Choose the unit of "kbps". The data transmission rate is set to be 1 kbps.
8. Press **Trigger**, the default is "Auto". (You cannot set the trigger mode through this menu. To understand the other trigger mode, please refer to the section of "To Set the Trigger Mode" in chapter 2.)

9. Press **Channel Setting**, for the menu of channel settings.
 - 1) Press **SCLK**; use the knob to choose "D0". Press the softkey again to select "D0".
 - 2) Press **SDA**; use the knob to choose "D2". Press the softkey again to select "D2".
 - 3) Press **CS**; use the knob to choose "D1". Press the softkey again to select "D1".
 - 4) Press **TFS**; use the knob to choose "D3". Press the softkey again to select "D3".
 - 5) Press F5 to go to the next page.
 - 6) Press **Digit-Volt**; use the knob to choose "3.3V". Press the softkey again to select "3.3V". Please observe that the softkey **Analo-volt** is "ON" and has been automatically set to be 3.3V.
 - 7) Press **DONE** to complete the channel settings.
10. Press the blinking button **Arb**. All modified parameters (denoted with "**") will be implemented. The "*" sign will disappear, and the configuration status will change from "UnLoad" to "Loaded".

After all the above steps are finished, the screen display will be shown as in Figure 3-2.

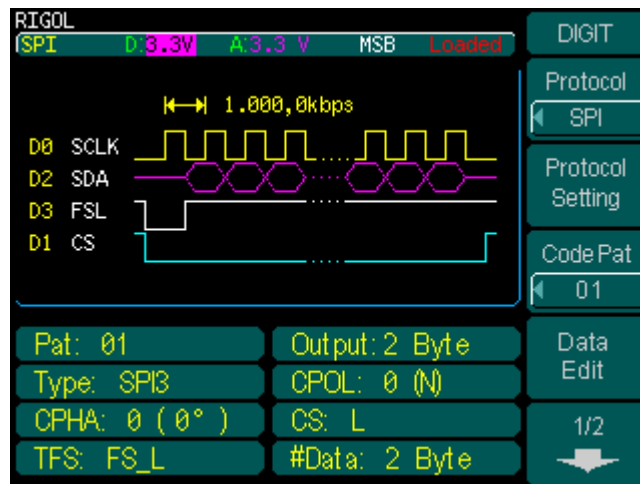


Figure 3-2 SPI protocol output

Example 3: To Generate an IIC Digital Waveform

To generate an IIC protocol digital waveform: User address 10, Write operation mode, "All0" code pattern, 2Bytes of output data length, 1kbps of data transmission rate, Auto trigger mode, clock line D0, data line D1, digital voltage output of 3.3V.

Operation steps:

1. Press **Arb** → **Edit Digital W**, to initiate the digital waveform editing interface.
2. Press **Protocol**, and use the knob to choose "IIC". Press the softkey again to select "IIC".
3. Press **Protocol Setting**, for the menu of IIC protocol settings.
 - 1) Press **Address**; use the softkey or the knob to choose "User".
 - 2) Press **User**; use the knob to change the address to be "10". Press the softkey again to finish the setting.
 - 3) Press **Operation**; choose "Write". Press the softkey again to finish the operation mode setting.
 - 4) Press **DONE** to complete the IIC protocol settings.
4. Press **Code Pat**, and use the knob to choose "All0". Press the softkey again to select "All0" code.
5. Press F5 to go to the next page.
6. Press **Output Lenth**, and use the keyboard input 2. Press **Enter**, (or use the direction key and the knob to input the value.) the output of data length is set to be 2 Bytes.
7. Press **Rate**, and use the keyboard to input "1". Choose the unit of "kbps". The data transmission rate is set to be 1kbps.
8. Press **Trigger**, the default is "Auto". (You cannot set the trigger mode through this menu. To understand the other trigger mode, please refer to the section of "To Set the Trigger Mode" in chapter 2.)
9. Press **Channel Setting**, for the menu of channel settings.
 - 1) Press **SCLK**, and use the knob to choose "D0". Press the softkey again to select "D0".

- 2) Press **SDA**, and use the knob to choose "D1". Press the softkey again to select "D1".
 - 3) Press **Digit-Volt**, and use the knob to choose "3.3V". Press the softkey again to select "3.3V". Please observe the moment you will see the softkey **Analo-volt** is "ON" and has been automatically set to be 3.3V.
 - 4) Press **DONE** to complete the channel settings.
10. Press the blinking button **Arb**. All modified parameters (denoted with "**") will be implemented. The "*" sign will disappear, and the configuration status will change from "UnLoad" to "Loaded".

After all the above steps are finished, the screen display will be shown as in Figure 3-3.

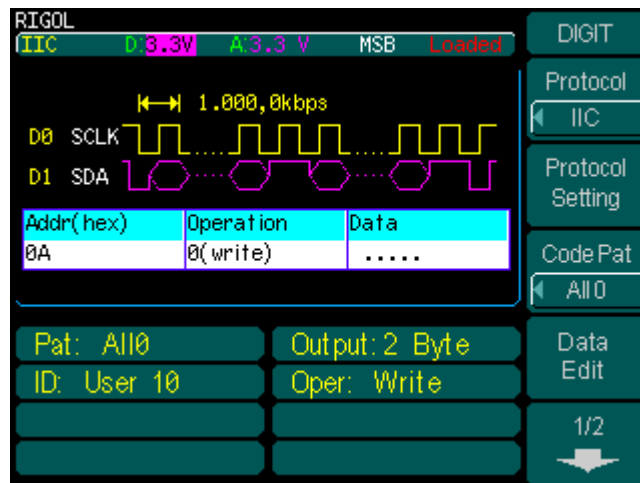


Figure 3-3 IIC protocol output

Example 4: To Generate a PO Digital Waveform

To generate a PO protocol digital waveform: Mask Channel of D0, Tri-State Channel of D3 and D4, "8 PRBS" code pattern, 2 Bytes of output data length, 1k bps of data transmission rate, Auto trigger mode, "All" data line, clock line C1, 90 phase, turn off digital voltage output and output analog voltage of 1.8V.

Operation steps:

1. Press **Arb** → **Edit Digital W**, to initiate the digital waveform editing interface.
2. Press **Protocol**, and use the knob to choose "PO". Press the softkey again to select "PO".
3. Press **Protocol Setting**, for the menu of PO protocol settings.
 - 1) Press **Mask Channel**; use the knob to choose "D0". Press F3 to select it.
 - 2) Press **Tri-state Channel**; use the knob to choose "D3". Press F3 to select it, use the same way to select D4.
 - 3) Press **DONE** to complete the PO protocol settings.
4. Press **Code Pat**, and use the knob to choose "8PRBS". Press the softkey again to select "8PRBS" code.
5. Press F5 to go to the next page.
6. Press **Output Length**, and use the keyboard input 2. Press **Enter**, (or use the direction key and the knob to input the value.) the output of data length is set to be 2 Bytes.
7. Press **Rate**, and use the keyboard to input "1". Choose the unit of "kbps". The data transmission rate is set to be 1 kbps.
8. Press **Trigger**, the default is "Auto". (You cannot set the trigger mode through this menu. To understand the other trigger mode, please refer to the section of "To Set the Trigger Mode" in chapter 2.)
9. Press **Channel Setting**, for the menu of channel settings.
 - 1) Press **DataLine**, and use the knob to choose "All". Press the softkey again to select "All".
 - 2) Press F2 and choose "Open" to select the channel. (Line in yellow denotes that it is selected, line in white is not.)

- 3) Press **SCLK**, and use the softkey or the knob to select "C1".
 - 4) Press **Phase**, and use the knob to choose "90°". Press the softkey again to set the phase to be 90 degree.
 - 5) Press F5 to go to the next page.
 - 6) Press **Digit-Volt**, and use the knob to choose "Off". Press the softkey again to select "Off".
 - 7) Press **Analo-volt**, and use the keyboard to input and "1.8" and choose the unit of "V" to set the analog voltage to 1.8V.
 - 8) Press **DONE** to complete the channel settings.
10. Press the blinking button **Arb**. All modified parameters (denoted with "**") will be implemented. The "*" sign will disappear, and the configuration status will change from "UnLoad" to "Loaded".

After all the above steps are finished, the screen display will be shown as inin Figure 3-4.

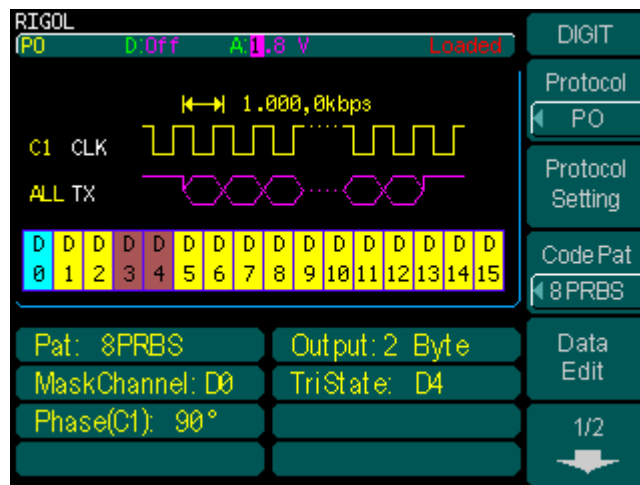


Figure 3-4 PO protocol output

Example 5: To Generate an IIC Digital Waveform Using the PO Protocol

Operation steps:

1. Refer to Example 3 above, and use the default setup to output the IIC protocol timing sequence as shown in the diagram below:

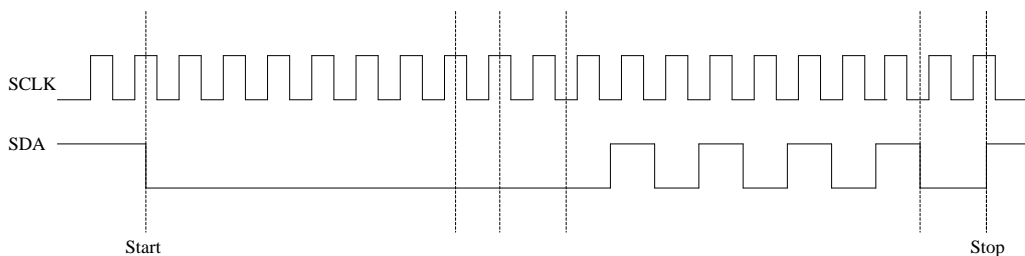


Figure 3-5 Time sequence of IIC protocol

From the above Figure 3-5, where SDA jumps from high to low when SCLK=1 indicates the "start" of the data output, and then; Address (0x00), Write operation (0), response bit (High Z), 1 Byte data (01 code pattern), response bit (High Z). The data output stops when SDA jumps from low to high when SCLK=1.

2. In PO protocol, set "D0" as SCLK, "D1" as SDA and the code pattern as "User". Through editing the data in the user space, it can generate an IIC protocol digital waveform.
 - 1) First the SCLK data, because SDA jumps when SCLK transits from high or low, SCLK data should not be set as 010101..., and it should be 001100110011...;
 - 2) Since the IIC protocol has "high Z" output, the Mask Channel and the Tri-state Channel should be set; D1 is the Tri-state Channel for data output, and D2 is the Mask Channel.
 - 3) Data in D0 and D1 can be edited with reference to Figure 3-5. While D2 is the Mask Channel, setting the corresponding bits of D1 (Tri-state

Channel) to "1" will produce a High Z output; and the rest "0". Therefore, the binary data in the three channels should be shown as below:

```
D0: 11 00 11 00 11 00 11 00 11 00 11 00 11 00 11 00 11 00 11 00 11
    00 11 00 11 00 11 00 11 00 11 00 11 00 11 00 11 00
D1: 11 11 10 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
    01 11 10 00 01 11 10 00 01 11 10 00 01 11 10 00 00 01 11
D2: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 01 11 10 00
    00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 01 11 10 00
```

In the user space, each data has 16 bits (D15~D0). The first data bits of D2, D1, D0 are: 0, 1, 1, so the first data should be "0003", and the other data are shown below:

00000000	0003	0003	0002	0002	0003	0001
0000000C	0000	0000	0001	0001	0000	0000
00000018	0001	0001	0000	0000	0001	0001
00000024	0004	0004	0005	0005	0000	0000
00000030	0001	0001	0000	0000	0001	0001
0000003C	0000	0000	0001	0001	0000	0000
00000048	0001	0001	0000	0000	0001	0001
00000054	0000	0000	0001	0001	0000	0002
00000060	0003	0003	0002	0000	0001	0001
0000006C	0000	0002	0003	0003	0002	0000
00000078	0001	0001	0000	0002	0003	0003
00000084	0002	0000	0001	0001	0000	0002
00000090	0003	0003	0002	0000	0001	0005
0000009C	0004	0004	0005	0003	0002	0002

Judging from above, the total data length is 168 Bytes. The Generator will output the edited data the same way as the default configuration of IIC protocol. Users can adjust the output rate as needed.

Chapter 4 Prompt Message & Troubleshooting

Prompt Message

Common Prompt Message

1. **Digital module is installed, Please wait, press help key to reset.**

Power-on prompting message 1. It prompts users that digital module has been connected.

2. **Need Help? Press and hold down any key. Selected interface is USB. Mobile disk is moved. Not detect a digital module. Digital output will be closed.**

Power-on prompting message 2. It prompts users that the setting has been restored; users can operate the instrument normally. When power-on, the system detects the current setting and USB interface has chosen; prompts not USB device is detected; and prompt that digital module has not connected.

3. **Need Help? Press and hold down any key. Selected interface is USB. Mobile disk is moved. Detected a digital module.**

Power-on prompting message 2. It prompts users that the setting has been restored; users can operate the instrument normally. When power-on, the system detects the current setting and USB interface has chosen; prompts not USB device is detected; and prompt that digital module has been connected.

4. **The function is optional. Please connecting digital module to fulfill the performance. Getting more help, please visit www.rigol.com.**

If digital module has not been connected, press **Utility** → **Output Setup** → **Digit-Modu**, when trying to choose "Power-On", this message will appear to prompt users digital module should be connected first.

5. **Press "Arb" to complete change of configuration. Or switch to arbitrary wave mode if not change any parameter.**

Connect digital module, press **Arb** → **Edit Digital W**, this message will appear,

It prompts users to use **Arb** to finish the output.

6. Restore all instrument settings to factory defaults?

Press **Utility** → **System** → **Set to Default**; this message will appear.

7. All settings are restored to factory defaults.

Press **Utility** → **System** → **Set to Default**, all the data and settings will restore to default.

8. Success to save file.

When succeeded to store the digital waveform; this message will appear.

9. Success to read file. Complete. Digital waveform data of user space have been changed.

When succeeded to recall the stored digital waveform; this message will appear.

10. The output of digital logic module is under some limit; please refer to the user Guide.

When choose "Independ" mode; this message will appear.

11. The output function of analog wave is disabled. The digital logic output range of speed and phase is extended. Please refer to the user Guide.

When choose "Depend" mode; this message will appear.

12. Wave file will cover!**

When store a digital waveform in a location where a waveform file already exist, press **Save**; this message will appear.

13. Cover the file?

When store a digital waveform in a location where a waveform file already exist, press **End/Store**; this message will appear.

14. Delete the file?

Choose a file you want to delete, press **Delete**; this message will appear.

15. Just displays the trigger mode. It will be changed when burst mode is used.

Press **Arb** → **Edit Digital W** → **F5** → **Trigger**; this message will appear.

16. Digital logic module is triggered.

Press **Burst** → **Source** → "Manual", and press the button **Trigger** on the front panel of the instrument; this message will appear.

17. Trigger Source of Digital Logic Signal has been changed to Manual.

Press **Burst** → **Source** → "Internal", press **Trigger** on the front panel of the instrument; this message will appear.

18. Set the rate by bit per second (bps).

Press **Arb** → **Edit Digital W** → **RS232** → **Baud**, choose the "User" option; this message will appear.

19. High level has been calibrated.

Press **Arb** → **Cal Digital W** → **Calibration High volt**, input the measured value, and press **YES**; this message will appear.

20. Low level has been calibrated.

Press **Arb** → **Cal Digital W** → **Calibration Low volt**, input the measured value, and press **YES**; this message will appear.

21. Please measure A0 channel, then input the value.

Press **Arb** → **Cal Digital W** → **Calibration High volt**, (**Calibration Low volt**); this message will appear.

22. Voltage calibration coefficients are restored to factory defaults.

Press **Arb** → **Cal Digital W** → **Set to Default**; this message will appear.

23. Please choose calibration item.

Press **Arb** → **Cal Digital W** → **Set to Default** → **YES**; this message will appear.

24. No changes.

When you are changing certain parameter, and press **CANCEL**; this message will appear to prompt users that there is not changed.

(denotes the content will vary according to the setting)**

Error Message

1. Please select a valid File. You are trying reading analog wave into digital space; please confirm you are working under analog space.

When users recall analog waveform at digital waveform editor interface; this message will appear.

2. Please select a valid File. You are trying reading digital wave into analog storage space, or please confirm you are working under the analog waveform edit it.

Press , enter the STORAGE menu, and choose a stored digital waveform to recall; this message will appear.

3. Invalid operation. Digital logic output module is under co-operation working with DG series.

If the current work mode is "Depend", analog waveform is disabled. Press any function key of analog wave; this message will appear.

4. Invalid operation. Digital logic output module is power off.

If the digital module is power-off, pressing → → F5 → F3 (Work- mode); this message will appear.

5. Please power on the digital logic module

If the digital module is power-off, press , choose and press again; this message will appear.

6. The address of 16 bits data must be even.

When edit the address, you can not select an odd address.

Data Overflow

1. **Data length upper limit** Bytes=**k Bytes**

RS232: Data length upper limit 35840 Bytes=35k Bytes

SPI: Data length upper limit 40960 Bytes=40k Bytes

IIC: Data length upper limit 10240 Bytes=10k Bytes

PO: Data length upper limit 131072 Bytes=128k Bytes

When user's setting exceeds limit, the system will automatically adjust it to the corresponding upper limit.

2. **Data length lower limit 1 Byte**

The data length lower limit is 1 Byte for all the protocols. When user's setting is lower than 1 Byte, the system will automatically adjust it to be 1 Byte.

3. **** Mbps**

It denotes the transmission rate upper limit.

RS232: 60 Mbps

SPI: 60 Mbps

IIC: 30 Mbps

PO: 100Mbps

When user's setting exceeds limit, the system will automatically adjust it to the corresponding upper limit.

4. **1bps**

It denotes the transmission rate lower limit.

The transmission rate lower limit is 1 bps for all the protocols. When user's setting is lower than 1 bps, the system will automatically adjust it to be 1 bps.

5. **Offset Upper limit output overflow user space!**

When the code pattern is "User", and the sum of "Offset" and the output length exceeds the upper limit of current protocol output length; this message will appear.

6. **Offset Lower limit 0**

When the code pattern is "User" and the offset set by users is lower than 0; this message will appear.

7. **Voltage upper limit **V**

Analog voltage:

RS232: 4.5V or -2.0V according to the type of the instrument.

SPI、IIC、PO: 9.4V

Digital voltage:

RS232: Off

SPI、IIC、PO: 4.2V

When the set voltage exceeds the upper limit, the system will automatically adjust it to the corresponding upper limit.

8. Voltage lower limit **V

Analog voltage:

RS232: 2.0V or -4.5V according to the instrument type.

SPI、IIC、PO: 1.4V

Digital voltage:

RS232: Off

SPI、IIC、PO: 1.4V.

When the set voltage exceeds the lower limit, the system will automatically adjust it to the corresponding lower limit.

9. Data Number per frame Upper limit 3 Byte

In SPI protocol setting, the upper limit of transmission data per frame is 3 Byte, if the specified value is higher than 3 Byte, the system will automatically adjust it to be 3 Byte.

10. Data Number per frame Lower limit 1 Byte

In SPI protocol setting, the lower limit of transmission data per frame is 1 Byte, if the specified value is lower than 1 Byte, the system will automatically adjust it to be 1 Byte.

11. IIC Address upper limit 127

In IIC protocol setting, when the user-defined address exceeds 127; this message will appear.

12. IIC Address lower limit 0

In IIC protocol setting, when the user-defined address is lower than 0; this message will appear.

(denotes the content will vary according to the setting)**

Troubleshooting

1. If digital module does not work after DG3000 powering up, please follow the steps below:

- (1) Turn off the instrument, check if the connection cable is correctly connected.
- (2) Turn on the instrument, check if the **Digit-Modu** option has set to be "Power-On".
- (3) If it does not work correctly, contact **RIGOL** for our service.

2. If all the settings are correct, but no waveforms output, please follow the steps below:

- (1) Check if the SMB-to-SMA RF coaxial line or logic analyzer testing lines you are using are correctly connected.
- (2) Set the **Power On** option to be **Last** when all the above steps have been finished.
- (3) Restart the instrument.

Chapter 5 Specifications

All these specifications apply to the logic signal output module of DG3000 Series Function/Arbitrary Waveform Generator unless otherwise specified. To reach these specifications, two conditions must be met first:

- The instrument must have been operating continuously for more than 30 minutes within the specified operating temperature.
- Must perform the Test/Cal (Calibrate) operation if the operating temperature changes by more than 5 °C.

Specifications

Public Specification	
Digital voltage range	1.4~4.2V (Typical and user-defined) (except RS232)
Trigger mode	Auto, Burst mode trigger
Code pattern	All"0", All"1", "01", Pseudo-random code, User data
User space	256k bytes online-edit, 2M bytes output (UltraWave)
PO	
Analog voltage range	1.4~9.4V
CLK	C0、C1
Clock phase	0 ⁰ 、90 ⁰ 、180 ⁰ 、270 ⁰
Data line	D0~D15
Transmission rate	1bps~100Mbps
Data output range	1Byte~128k Bytes
Mask Channel	None, D0~D15
Tri-state Channel	None, D0~D15
IIC	
Analog voltage range	1.4~9.4V
Bit sequence	MSB
CLK	D0~D15
Data line	D0~D15
Transmission rate	1bps~15Mbps
Data output range	1Byte~10k Bytes
Optional output address	None、7bits address
Operation	Write, Read
SPI	
Analog voltage range	1.4~9.4V
Bit sequence	MSB
CLK	D0~D15
Data line (SDA)	D0~D15
TFS	D0~D15
CS	D0~D15
Transmission rate	1bps~60Mbps
Data output range	1byte~40k bytes
SPI type	SPI2, SPI3
Clock polarity	0、1
Clock phase	0、1
CS level	High level、Low level
#Data	1~3Bytes
TFS	FS_H、FS_L、LD_H、LD_L or NONE
RS232	
Analog voltage range	2.0V~4.5V -4.5V~-2.0V
Bit sequence	LSB

Data line (TX)	D0~D15
Transmission rate	1Bps~60MBps
Data output range	1Byte~35k Bytes
#Data	5~8bits
verification mode	Supports None、Odd、Even、Fixed0 and Fixed1.
#StopBit	Supports 1bit、1.5bit and 2bits

Chapter 6 Appendix

Appendix A: Accessories

DG3000 Logic signal Output Module provides the following standard accessories:

- A connection cable between DG3000 and the logic signal output module
- 9 SMB-to-SMA RF coaxial lines
- 20 logic analyzer testing lines
- 20 logic analyzer testing clips
- A User's Guide

Appendix B: Warranty

RIGOL Technologies, Inc. warrants its products' mainframe and accessories in materials and workmanship within the warranty period. Within the warranty period, **RIGOL** guarantees free replacement or repair of products which are proven defective.

To get repair service or obtain a copy of the whole warranty statement, please contact with your nearest **RIGOL** sales and service office.

RIGOL does not provide any other warranty items except the one being provided by this summary and the warranty statement. The warranty items include but not being subjected to the hint guarantee items related to tradable characteristic and any particular purpose.

RIGOL will not take any responsibility for cases of indirect damages, improper use and ensuing damages.

Appendix C: Maintenance

General Care

Do not store or leave the instrument in the place where the LCD display will be exposed to direct sunlight for long periods of time.



CAUTION: To avoid damage to the instrument, do not expose them to sprays, liquids, or solvents.

Cleaning

Check the Instrument frequently according to the operation conditions; follow the steps below to clean the exterior surface of the instrument:

- Remove loose dust on the outside of the instrument with a lint- free cloth. Take care to avoid scratching the clear plastic display filter.
- Please disconnect the power. Use a soft cloth dampened with water to clean the instrument. To avoid damage to the surface of the instrument, do not use any abrasive or chemical cleaning agent.



WARNING: Before restarting the instrument, make sure that the instrument is dry to avoid any short-circuit or body damage because of the moisture.

Appendix D: Contact RIGOL

If you have any problem or requirement occurs when using our products, please contact **RIGOL** Technologies, Inc. or the local distributors.

Domestic: Please call

Tel: (86-10) 8070 6688

Fax: (86-10) 8070 5070

Service & Support Hotline: **800 810 0002**

9:00 am –5: 00 pm from Monday to Friday

Or by e-mail:

service@rigol.com

Or mail to:

RIGOL Technologies, Inc.

156# CaiHe Village, ShaHe Town, ChangPing District, Beijing, China

Post Code: 102206

Overseas: Contact the local **RIGOL** distributors or sales office.

For the latest product information and service, visit our website: www.rigolna.com

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