

USER MANUAL

RBF-DBW40

*ELECTRONIC CONTROL UNIT*

 **robeff**

**REVISION HISTORY**

<b>Revision</b>	<b>Release Notes</b>	<b>Release Date</b>
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# 1 Connectors

## 1.1 Low Signal Connector

Low signal connector on RBF-DBW40 is 0367831201. Mate connector is Molex 0367921201.



**Figure 1** RBF-DBW40 Connector 036783120

**Figure 2** Mate Connector 0367921201

**Table 1** RBF-DBW40 Connector 036783120 Pinouts

Pin #	Name	I/O	Description
1	GND	Input	Ground return signal
2	USB DM	-	USB DM Line
3	USB DP	-	USB DP Line
4	CAN L	-	CAN Low Line
5	CAN H	-	CAN High Line
6	Torque Sensor-A	Input	Torque Sensor-A Input
7	V Supply	Input	V Supply input
8	GND	Input	Ground return signal
9	GND	Input	Ground return signal
10	GND	Input	Ground return signal
11	5V	Output	5V output for Torque Sensor
12	Torque Sensor-B	Input	Torque Sensor-B Input

## 1.2 High Power Connector

Power Supply connector is DEUTSCH DTP04-2P. Mate connector is DEUTSCH DTP06-2S.



**Figure 3** High Power Supply Connector DTP04-2P



**Figure 4** Mate Connector DTP06-2S

**Table 2** High Power Supply Connector DTP04-2P Pinouts

Pin #	Name	I/O	Description
1	Power Supply	Input	V supply voltage up to 40V
2	GND	Input	Ground return signal

DC Motor output connector is DEUTSCH DTP06-2S. Mate connector is DEUTSCH DTP04-2P.



**Figure 5** DC Motor output Connector DTP06-2S



**Figure 6** Mate Connector DTP04-2P

**Table 3** DC Motor Output Connector DTP06-2S

Pin #	Name	I/O	Description
1	DC Motor (+)	Output	DC Motor positive pole line
2	DC Motor (-)	Output	DC Motor negative pole line

## 2 RBF-DBW40 Overview

### 2.1 Overview

RBF-DBW40 is a single-phase, bidirectional DC motor driver-based steer-by-wire and brake-by-wire control unit. It provides a simple CAN-Bus and serial interface for users to integrate as a drive-by-wire solution into their vehicles. With its user-friendly GUI, application-specific configurations like CAN message IDs, feedback sensor interface, limitations, etc. can be made. RBF-DBW40 has been designed to handle 40 A currents.

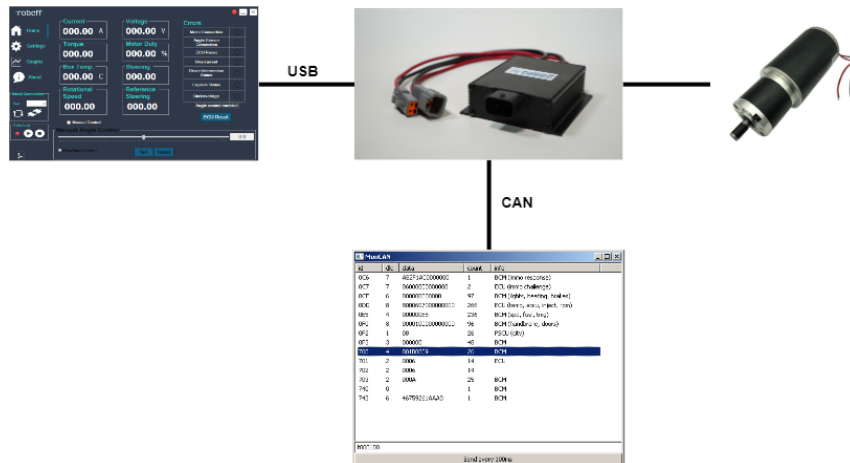


Figure 7 Overview of the DBW40

### 2.2 User Interface

RBF-DBW40 has a user-friendly interface. Users can change settings with this interface. Interface connect DBW40 with USB.

### 2.3 Can Communication

RBF-DBW40 supports CAN-Bus communication. User can change CAN-Bus baud rate 250, 500 or 1000 Kbps. Also, user can change message ids.



## 3 Control

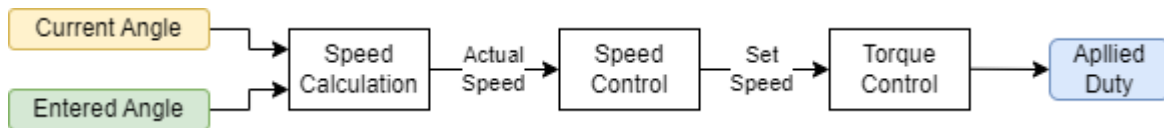
### 3.1 Control Overview

DBW40 contains 3 different modes for motor control as angle control, duty control, intervention mode. In angle control mode, the controller moves to entered angle value. In duty control mode, the controller applies entered duty value to the motor.

In intervention mode, the controller doesn't apply any power to the motor. In this mode, the motor is disabled and all decisions are made by the user.

### 3.2 Angle Control Mode

The DBW40 control layer consists of two parts. These are speed and torque control. When the user enters the angle value, the difference between the current angle value and entered angle is sent to the speed control. After this process, the torque value determined according to the determined speed value is applied to the motor.



**Figure 8** Overview of Angle Control

### 3.3 Speed Controller

The DBW40 determines the angular velocity according to the angle change. The determined angular velocity value enters the speed controller. The output value of the speed controller is limited to the maximum speed value determined by the user. By default, this value is limited to 360.

### 3.4 Torque Controller

The torque value required to apply the speed value determined in the speed control mode to the motor is determined by the torque controller.

#### 3.4.1 Duty Control Mode

In duty control mode, the angle control mode is disabled. The torque value entered by the user is applied directly to the motor. This mode can only be controlled via CAN-Bus. Duty value is limited to -100 between 100.

#### 3.4.2 Intervention Mode

In Intervention mode, the DBW40 does not interfere with the motor. All control is left to the user.

## 4 CAN-Bus

The DBW40 uses a CAN interface to provide sensor and status information (e.g. motor duty, rotation angle, etc.) to external systems and to use the controller. The message IDs and baud rate of the CAN interface are changeable. While sensor and status information is sent with 3 IDs, 1 ID is used for control operations. All message IDs data formats are Intel(Little Endian). The default baud rate is 500 kbps.

### 4.1 Feedback1(Tx)

**Default ID :** 0x290H

**Frequency :** 100 Hz

**Data Format :** Intel(Little Endian)

**DLC :** 8

**Table 4** FeedBack1 Message

Message	Data Type	Length	Description	Start Bit
ReferenceAngle	IEEE float32	32 bit	Received reference angle to the DBW	0
ActualAngle	IEEE float32	32 bit	Actual angle in the DBW	32

### 4.2 Feedback2(Tx)

**Default ID :** 0x292H

**Frequency :** 10 Hz

**Data Format :** Intel(Little Endian)

**DLC :** 8

**Table 5** FeedBack2 Message

Message	Data Type	Length	Description	Start Bit
Motor Duty	Signed	8 bit	Instant duty cycle applied to the motor	0
Motor Current	Unsigned	8 bit	The current of the motor	8
Motor Voltage	Unsigned	8 bit	The voltage of the motor	16
Box Temperature	Signed	8 bit	The box temperature of the DBW	24
RawTorqueA	Unsigned	16 bit	The raw vaule of the torque sensor A	32
RawTorqueB	Unsigned	16 bit	The raw vaule of the torque sensor B	48

### 4.3 Feedback3(Tx)

**Default ID :** 0x294H

**Frequency :** 10 Hz

**Data Format :** Intel(Little Endian)

**DLC :** 8

**Table 6** Feedback3 Message

Message	Data Type	Length	Description	Start Bit
Motor Connection	Unsigned	1 bit	Instant duty cycle applied to the motor	0
Overcurrent	Unsigned	1 bit	The current of the motor	1
AngleSensorConnection	Unsigned	1 bit	The voltage of the motor	2
Driver Intervention	Unsigned	1 bit	The box temperature of the DBW	3
EcuReset	Unsigned	1 bit	The raw vaule of the torque sensor A	4
Undervoltage	Unsigned	1 bit	The raw vaule of the torque sensor B	5
Reserved		58 bit	Reserved	6

### 4.4 ReceiveCommand(Rx)

**Default ID :** 0x298H

**Data Format :** Intel(Little Endian)

**DLC :** 8

**Table 7** ReceiveCommand Message

Message	Data Type	Length	Description	Start Bit
ControlMode	Unsigned	8 bit	Control mode of the DBW <b>0:angle control</b> <b>1:duty control</b> <b>2:intervention mode</b>	0
ReferenceDutyCycle	Signed	8 bit	Applied duty cycle to the motor in the duty cycle mode	8
SetAngle	IEEE Float32	32 bit	Reference angle in the angle control mode	16
ResetCommand	Unsigned	8 bit	DBW reset command. This command should first get value 1 then 0 for reset	48
Reserved		8 bit	Reserved	56

## 5 Errors

### 5.1 Motor Connection

The DBW40 constantly checks the motor connection. If the DBW40 is started when the motor is not connected to the system, the motor connection error will be active. The motor connection error is a permanent. If the DBW40 is to be started again, the DBWReset command must be applied. Motor connection errors can be monitored both via the user interface and CAN-Bus.

### 5.2 Angle Sensor Connection

In angle control mode, the DBW40 continuously checks the duration of the data from the angle sensor. If the duration of the angle sensor data is above the threshold value set by the user, an angle sensor error occurs and the angle control mode is reset. Angle sensor error is a temporary error. If the sensor data time returns to normal, the error clears. Angle sensor error can be monitored both via the user interface and CAN-Bus.

### 5.3 Overcurrent

A motor current error occurs when the motor current reaches the maximum current value set by the user. The motor current fault is permanent. If the DBW40 is to be started again, the DBWReset command must be applied. Motor current errors can be monitored both via the user interface and CAN-Bus.

### 5.4 Driver Intervention

If there is a torque sensor of the motor connected to DBW40, driver intervention can be used. If the motor torque sensor has 2 output ADC, pin A is connected to pin A of DBW40, and pin B is connected to pin B of DBW40. Raw values of both pins can be displayed via CAN-Bus and the user interface.

A torque value is obtained by subtracting the raw analog values of the A and B pins. If this value is greater than the user-specified driver intervention threshold, it is detected as a driver intervention and the controller is disabled. Driver intervention is permanent. If the DBW40 is to be started again, the DBWReset command must be applied. Driver intervention can be monitored both via the user interface and CAN-Bus.

### 5.5 DBW Reset

DBW reset is a necessary procedure for error clearing. The DBW Reset procedure is required if a permanent error has occurred in the system and these errors have been cleared. DBW Reset can be performed via both the user interface and the CAN-Bus interface. To perform via the CAN-Bus interface, the ResetCommand byte in the ReceiveCommand message must first be set to 1 and then set to 0.

### 5.6 EEPROM

DBW40 uses EEPROM to save settings. An EEPROM error occurs if an error occurs during the EEPROM write and read operations. This error does not prevent the controller from working. If an error is detected during reading, the factory settings are assigned to the DBW40 settings.

## 6 User Interface

The user interface has 3 different forms. These are Home, Settings, and Graphs forms. The Home form contains the DBW40 data and the manual control part. The Settings form is the part where the DBW40's settings are performed. The Graphic form is the part that allows the DBW40 data to be plotted.

### 6.1 Installation

Follow these steps to install the software

- Go to <https://www.robef.com/project/rbf-dbw40>
- Click on User Interface.
- Follow the on screen instructions.
- The installation process places shortcuts to RBF DBW on the computer's desktop and Start menu.

### 6.2 Connection

The DBW40 includes its own internal FTDI USB module. When the DBW is connected to the computer, the driver of the FTDI module must be checked first from Device Manager. If it is not installed, it can be downloaded from <https://ftdichip.com/drivers/vcp-drivers/>.

After the driver is installed, it will appear as USB Serial Port in Ports in Device Manager.

The available ports in the "Serial Connection" section on the left will be displayed. After selecting the port belonging to the DBW40, the connection can be established by pressing the "Connect" button. If user wants to refresh ports, can click on the "Refresh" button.



**Figure 9** Serial connection section

## 6.3 Data Log

Data from DBW40 can be logged via the interface. Logged data are shown below.

- Current
- Duty
- Torque
- Act. Steering Ang.
- Ref. Steering Ang.
- Temperature
- Voltage

Log data format is fully compatible with .csv format. Users can import the data to Excel.

For data logging, press the start button in the Data Log section. Then, choose the path to install the .txt file. After choosing path, start button convert to pause button. After choosing the path, the start button is converted to the pause button. User wants to pause logging, press pause button. When stop recording, press stop button.



**Figure 10** Data log section

## 6.4 Home

The Home form shows the DBW40 data and errors. The refresh time of these data is 50 Hz. When an error occurs in the DBW40, the box opposite the error turns red. When the error is cleared, the button color returns to its original state.

The DBW40's mode is indicated below the error field. It reads "Angle control enabled" in angle control mode, "Duty control enabled" in duty control mode, and "Driver Intervention mode enabled" in Intervention mode.

To activate the manual control, it is necessary to press the Manual Control checkbox first. There are two different control methods when Manual Control is active. First, the progressbar is brought to the desired degree value and the set button is pressed. Press the Real-time control checkbox to switch to real-time control mode. In real-time control mode, each time the progressbar value changes, the changed value is transferred directly to the DBW40.

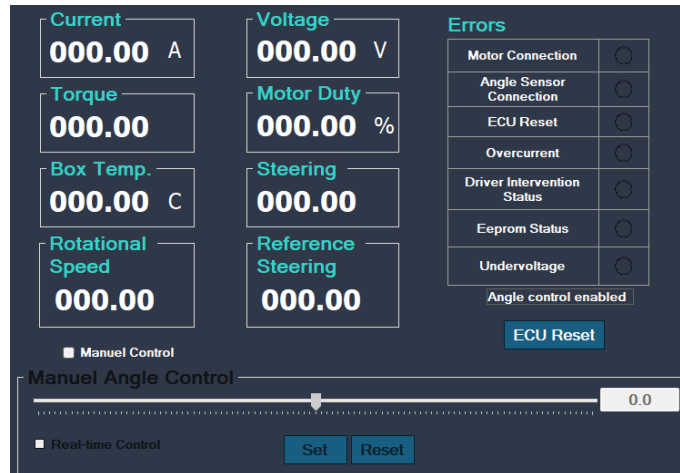


Figure 11 Home section

## 6.5 Settings

Settings form is the form in which the DBW40's settings are displayed. In addition, settings can be entered in this form.

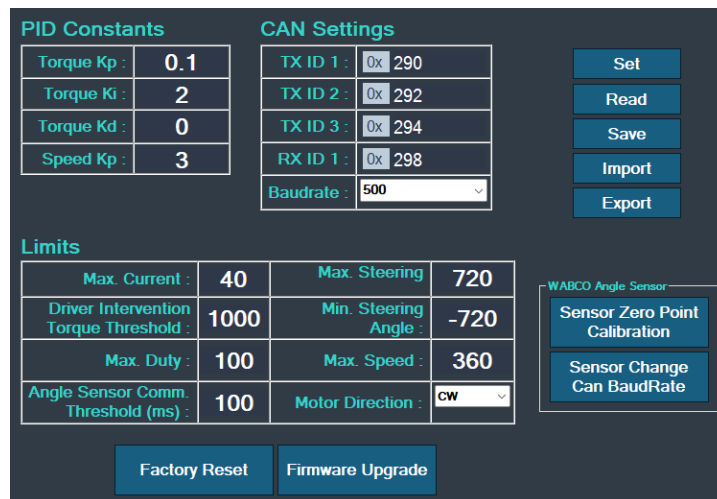


Figure 12 Settings section

### 6.5.1 PID Constants

These coefficients are used in torque and speed control. The user has to determine these coefficients according to the characteristics of the system. Default values are as shown in figure.

**Table 8** PID Constants Value

PID Constants	Value
Speed Kp	3
Torque Kp	0.1
Torque Ki	2
Torque Kd	0

### 6.5.2 CAN Settings

DBW40 Can settings can be changed. User can change baud rate and message ids. Message ids can be entered as the standard id in the range 0x0 - 0x7FF, and the extended id after 0x800. Default values are as shown in figure.

**Table 9** Can Settings Default Values

CAN Settings	Value
TX ID 1	0x290H
TX ID 2	0x292H
TX ID 3	0x294H
RX ID 1	0x298H
BAUD RATE	500 kbps



### 6.5.3 Limits

#### 6.5.3.1 Max. Current

Current protection works according to "Max current" value. The DBW40 works up to a maximum of 40A. Values above 40A may damage the DBW40. This value works between 0-40. By default max. Current limit is set to 40.

#### 6.5.3.2 Driver Intervention Torque Threshold

This value determines the maximum value required for driver intervention to occur. By default driver intervention torque threshold is set to 1000.

#### 6.5.3.3 Max. Duty

It determines the maximum duty value that can be applied to the motor. This value must be in the range of 0-100. By default max. Duty is set to 100.

#### 6.5.3.4 Angle Sensor Comm. Threshold

It determines the maximum time required for the communication error in the connected angle sensor. By default angle sensor comm. threshold is set to 100.

#### 6.5.3.5 Max. Angle

It determines the maximum angle value in degrees that can be reached in the angle control mode. By default max. angle is set to 720.

#### 6.5.3.6 Min. Angle

It determines the minimum angle value in degrees that can be reached in angle control mode. By default min. angle is set to -720.

#### 6.5.3.7 Max. Speed

It determines the maximum speed value that can be reached in speed control mode.

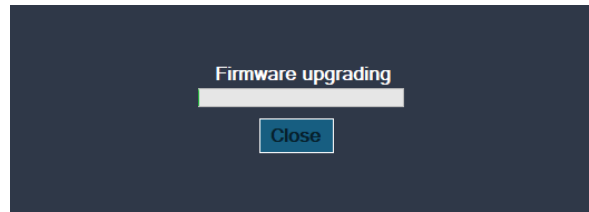
By default max. speed is set to 360.

#### 6.5.3.8 Motor Direction

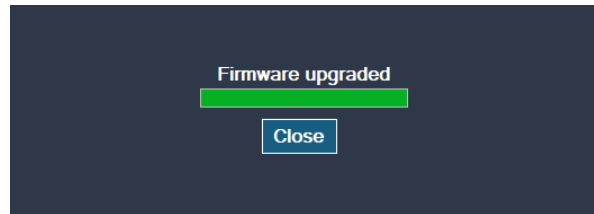
In cases where the motor direction is not known, the controller can be used by changing the motor direction. By default motor direction is set to CW.

#### 6.5.4 Firmware Upgrade

New firmware can be installed whenever any changes are made to the DBW40 software. For firmware upgrades, first, click on the firmware upgrade button. Then the correct .hex file is selected from the window that opens and the installation process is started. **During the installation process, the interface must not be closed in any way.** After the installation process is complete, you can continue to use the interface.



**Figure 13** Firmware upgrading status



**Figure 14** Firmware upgraded status

**ATTENTION: Before firmware upgrade, please export your settings.**

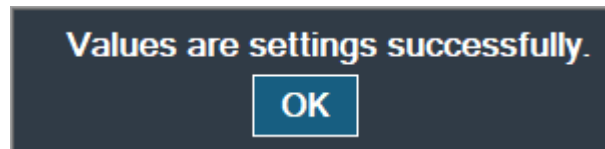
#### 6.5.5 Factory Reset

When the "factory Reset" button is pressed, all settings return to their default values.

#### 6.5.6 Settings Set-Read

Press the "Read" button to read the DBW40 settings. When the "Set" button is pressed, the values specified in the interface are loaded into the RAM of the DBW40. A box shown in the Figure 15 is displayed when the settings are loaded properly.

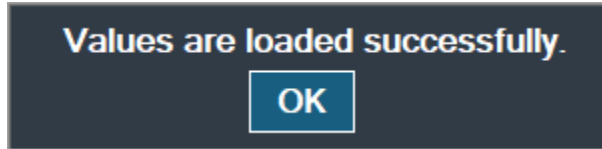
**Settings saved in RAM are not saved in the DBW40's EEPROM.**



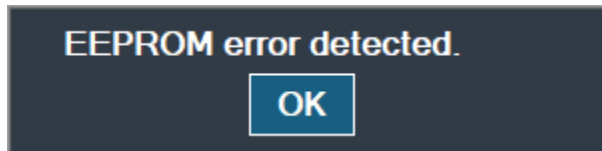
**Figure 15** Settings properly load box

### 6.5.7 Settings Set

Press the "SAVE" button to load the settings saved in the DBW40 RAM to the EEPROM. The box shown in the figure is displayed when the settings have been successfully saved to the EEPROM. If the recording to the EEPROM fails, the box shown in the Figure is displayed.



**Figure 16** EEPROM Save properly load box



**Figure 17** EEPROM error detected box

### 6.5.8 Settings Import&Export

All settings entered in the interface can be exported as an .xml file. For exporting data, "Export" button should be pressed.

The "Import" button must be pressed to import the exposed settings. It is recommended to perform "Export" after each setting change.

### 6.5.9 WABCO Angle Sensor

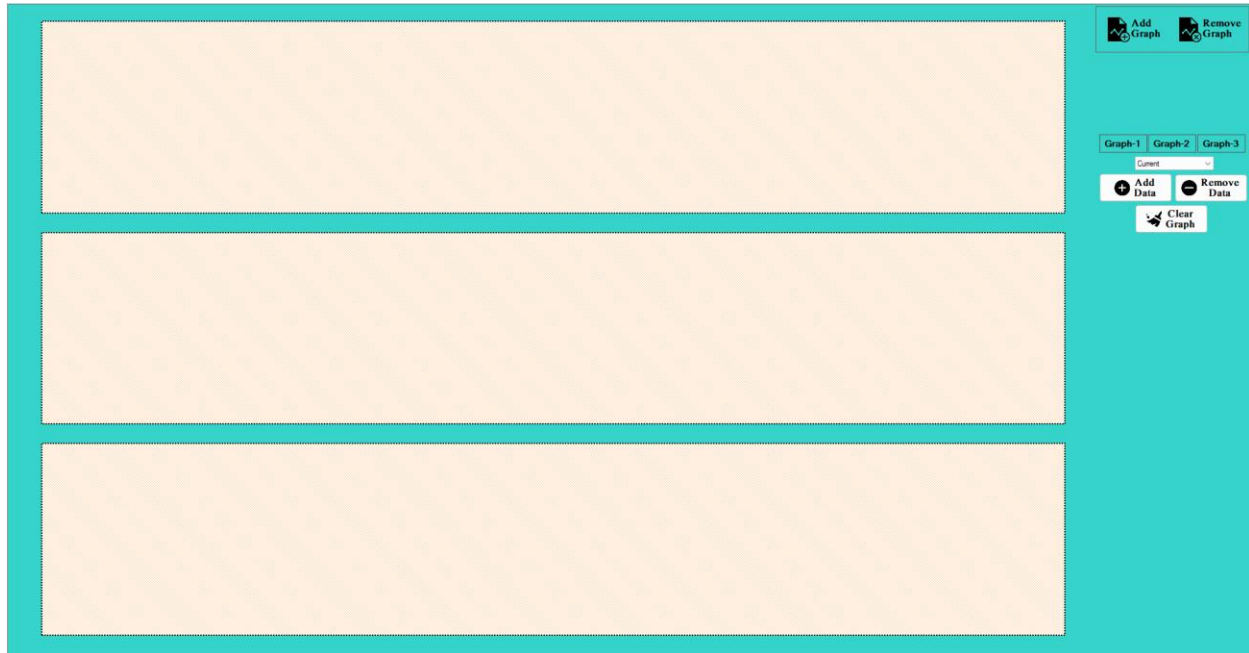
The DBW40 is fully compatible with the WABCO angle sensor. For more information about WABCO angle sensor, please visit <https://www.wabco-customercentre.com/catalog/en/4411200100>.

Zero degree adjustment of WABCO angle sensor and can baudrate change can be done via the interface.

WABCO has 2 different CAN baudrate 250 and 500 kbps.

## 6.6 Graphics

The Graphic form has 3 charts. Desired data can be plotted in all 3 charts. By default, a single graphic can be used.



**Figure 18** Graphics Form

### 6.6.1 Add & Remove Graph

When user want to add a graph, click the "Add Graph" button. Maximum 3 charts can be added to the "Graphic Form".

Click the "Remove Graphic" button to remove the graphic.

### 6.6.2 Add & Remove Data

To add data to the chart, first select which chart to add. Select the data to add later. Finally, click the "Add Data" button.

To remove data from the chart, first, select which chart to add. Then select the data removed. Finally, click the "Remove Data" button.

### 6.6.3 Clear Graph

Click the "Clear Graph" button to clear all data in the selected graph.