DE4001 USER MANUAL

DEICO ONYX
USB - I²C/SPI CONVERTER

DEICO

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Contents

PREFACE

This manual describes the usage of Onyx USB I²C/SPI Converter and graphical user interface (GUI). Onyx I²C/SPI Adapter can be controlled using the provided graphical user interface (GUI).

Figure 1: Onyx USB-I²C/SPI Converter

Introduction to I²C

Inter-Integrated Circuit (I²C) is a synchronous serial communication protocol. All devices are connected via 2-wires that are Serial Data (SDA) and Serial Clock (SCL). I²C has a master/slave protocol and it supports multi master and multi slave operations. Every slave device has its own unique address.

Operation of I²C

In I²C, data is transferred by message. Messages are broken up into frames. Each message has an address frame and one or more data frame. Messages have also start bit, stop bit, read/write bit and ack/nack bits. Message frame is shown in *Figure 2* and sample bitstream is shown in *Figure 3*.

Figure 2: Message frame of I²C

- ⇨ **Start Condition:** SDA line switches from high to low before SCL line switches from high to low.
- ⇨ **Address Frame:** The address frame is always first in any new communication sequence. Each slave has a 7 or 10 bit unique address.

- ⇨ **ACK/NACK BIT:** Each frame is followed by an ACK/NACK bit. If a frame was successfully received, an ACK (0) bit is returned to sender from receiving device.
- ⇨ **Read/Write Bit:** Read/Write bit indicates the read (1) or write (0) operation.
- ⇨ **Data Frames:** Data frame is always 8 bits and sends the MSB first. After all data frames are sent, master sends a stop condition to slave.
- ⇨ **Stop Condition:** SDA line switches from low to high after SCL line switches from low to high.

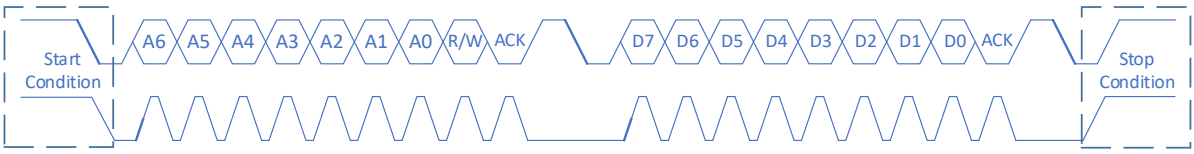

Figure 3: Sample bitstream of I²C

Table 1: Specs of I²C

Specification	Value
Wires Used	2
Maximum Speed	3.4Mbps
Max Master	Unlimited
Max Slave	1008

Introduction to SPI

Serial Peripheral Interface (SPI) is a synchronous serial communication. SPI devices are connected via 4-wires that Master Output/Slave Input (MOSI), Master Input/Slave Output (MISO), Slave Select (SS) and Clock (SCLK). SPI has a master/slave protocol and it support multi slave operations.

Operation of SPI

SCLK, MOSI and MISO are shared by all devices on SPI Bus. Each slave device has its own SS line. Master device generates the clock. When data is sent from master to a slave, it is sent via MOSI. When data is sent from slave to master, it is sent via MISO. The master chooses which slave it wants to talk to by setting the slave's SS line to low. In idle state, the SS line is kept at high.

Table 2: Specs of SPI

Specification	Value
Wires Used	4
Maximum Speed	10Mbps
Max Master	1
Max Slave	Unlimited*

**In practice, the number of slaves is limited by the load capacitance of the system, which reduces the ability of the master to accurately switch between voltage levels.*

Modes of SPI

In SPI, the main can select clock polarity (CPOL) and clock phase (CPHA). Both parameters have two states which results in four possible modes. These combinations are shown in *Figure 4*.

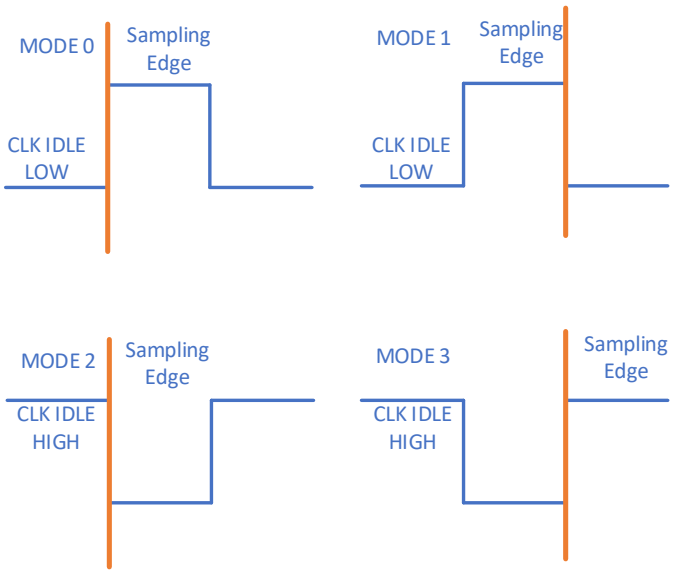

Figure 4: Modes of SPI

Functional Description

Onyx USB-I²C/SPI Converter connects a PC to an embedded or a generic device which uses the I²C/SPI protocol via USB. Onyx USB-I²C/SPI Converter can be used as master or slave for I²C and SPI. I²C and SPI pins can also be used as GPIO or combined with I²C or SPI functionality. Onyx USB-I²C/SPI Converter is powered directly from the PC's USB port.

Features

- ⇨ Plug and play with DEICO Serial Center
- ⇨ USB powered
- ⇨ Master or slave mode
- ⇨ I²C interface speeds up to 3.4MHz
- ⇨ I²C interface multi-master mode support
- ⇨ I²C interface internal pull-up resistors
- ⇨ SPI interface speeds up to 25MHz
- ⇨ Full duplex SPI interface
- ⇨ SPI interface software configurable slave select polarity
- ⇨ Configurable I²C and SPI pins as GPIO or combined with I²C or SPI

Scope of Delivery

DEICO Onyx USB I²C/SPI Converter supplied with the following components.

- ⇨ DEICO Onyx USB I²C/SPI Converter (*Figure 5*)
- ⇨ USB type-A to type-C cable (*Figure 6)*
- ⇨ 225mm 10 position socket to female pin cable (*Figure 7*)
- ⇨ 152.4mm 10 position female socket to socket cable (*Figure 8*)

Figure 5: DEICO Onyx USB-I²C/SPI Converter

Figure 6: USB type-A to type-C cable

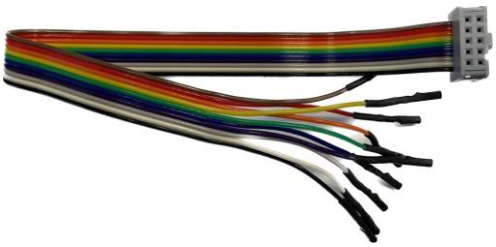

Figure 7: Female socket to pin cable

Figure 8: Female socket to socket cable

GETTING STARTED

Initial Installation

Onyx target connector (*Figure 37*) connections must be connected to target device. USB cable type-C side (*Figure 6*) must be connected to Onyx type-C connector (*Figure 38*). USB-A side must be connected to a PC. After all these connections is done, Onyx will be ready to use.

OPERATING BASICS

Required Software

Following software must be installed to use Onyx Control Center:

- .NET Desktop Runtime 6.0 (https://dotnet.microsoft.com/en-us/download/dotnet/thank-you/runtime-desktop-6.0.25-windows-x64-installer)
- FTDI's D2XX Driver (https://ftdichip.com/wp-content/uploads/2021/08/CDM212364_Setup.zip)

Installation of these software are included in the Onyx Control Center setup.

Obtaining and Installing the Onyx Control Center

Setup file for the Onyx Control Center can be obtained from DEICO's GitHub page (https://github.com/deicogithub/Onyx-USB-I2C-SPI-Converter/releases/tag/v2.0.1). Following steps shows the installation process by using the setup file.

Selecting Additional Tasks

At first step, user is prompted to select additional tasks such as creating a shortcut, installing D2XX drivers and installing .NET 6.0 Runtime. Users can select any of these tasks according to their needs.

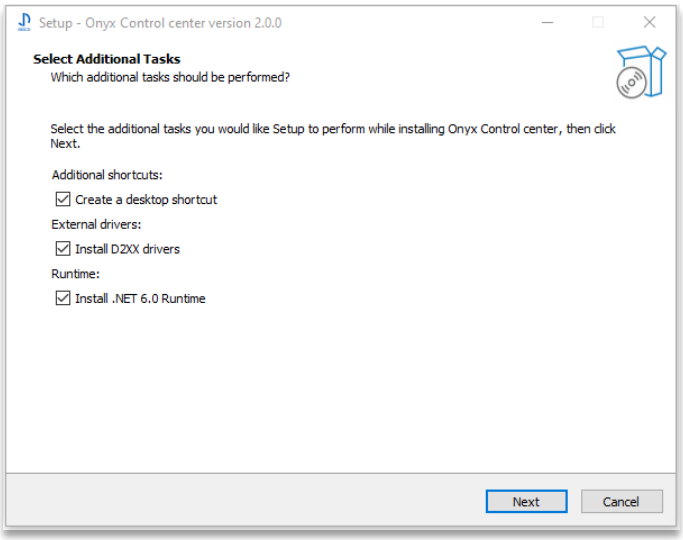

Figure 9: Setup - Selecting additional tasks

Installing .NET 6.0 Runtime

.NET 6.0 Runtime is required for Onyx Control Center to run. Install steps of .NET 6.0 Runtime installation should be followed.

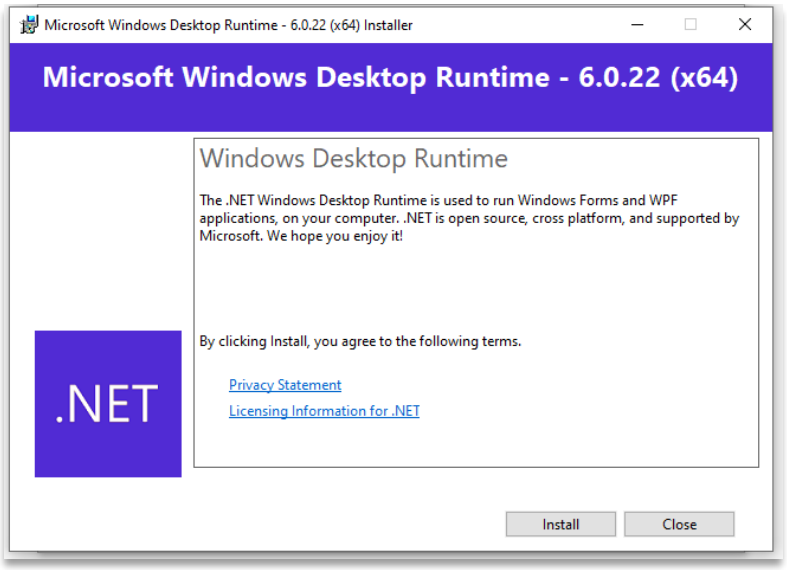

Figure 10: Setup - Installing .NET 6.0 Runtime

User should wait for runtime installation to complete and when the installation is completed, the window can be closed.

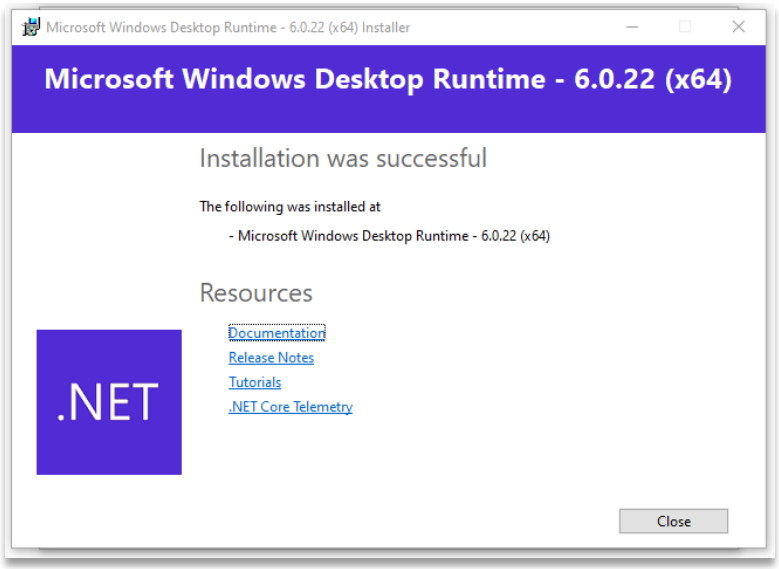

Figure 11: Setup - Installing .NET 6.0 Runtime

Installing D2XX Drivers

After following the next steps, installation starts. If user selects the option “Install D2XX Drivers”, another installation window automatically appears to install the drivers.

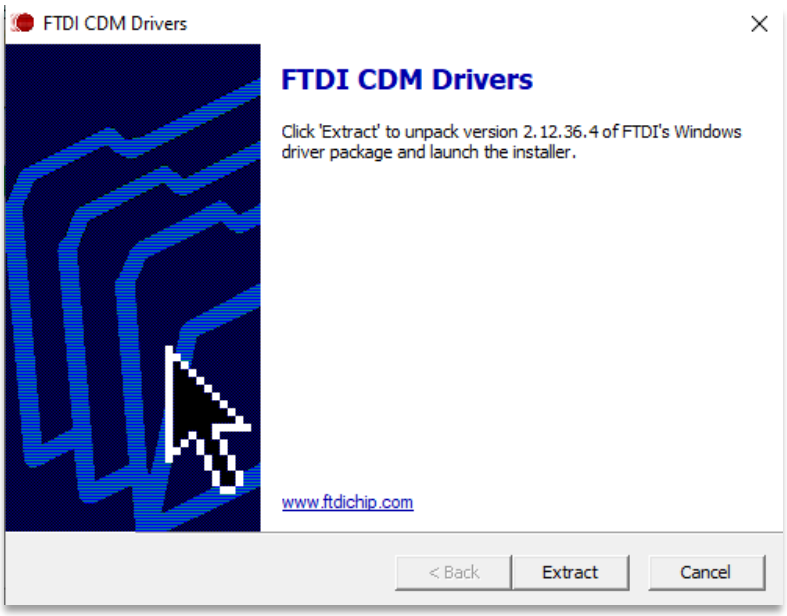

Figure 12: Setup - Installing drivers

To complete driver installation, user should click to extract and proceed to installation. Driver installation wizard asks user to agree to license agreement. After this step, driver installation is completed.

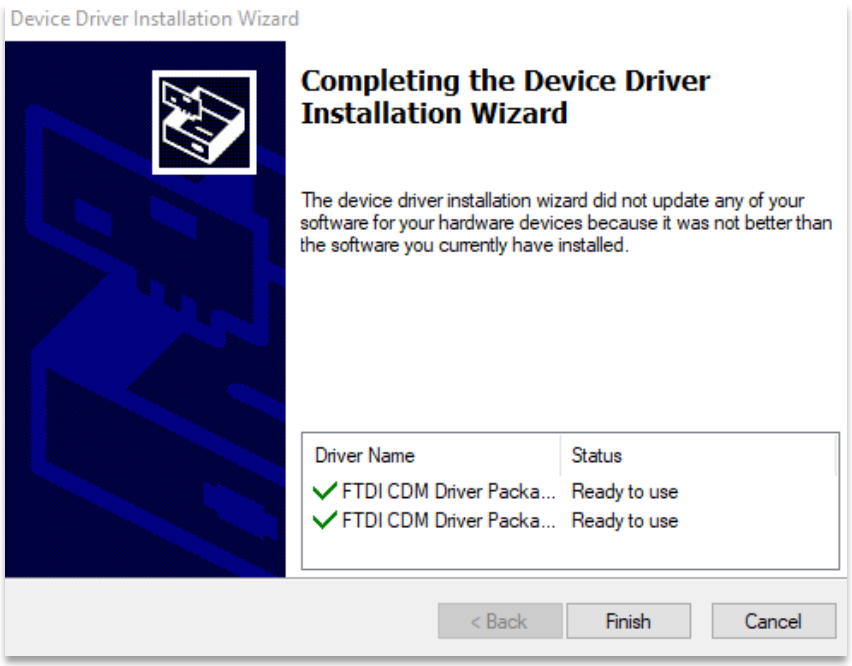

Figure 13: Setup - Completing driver installation

Completing Onyx Controller Installation

User completes the installation by clicking “Finish”.

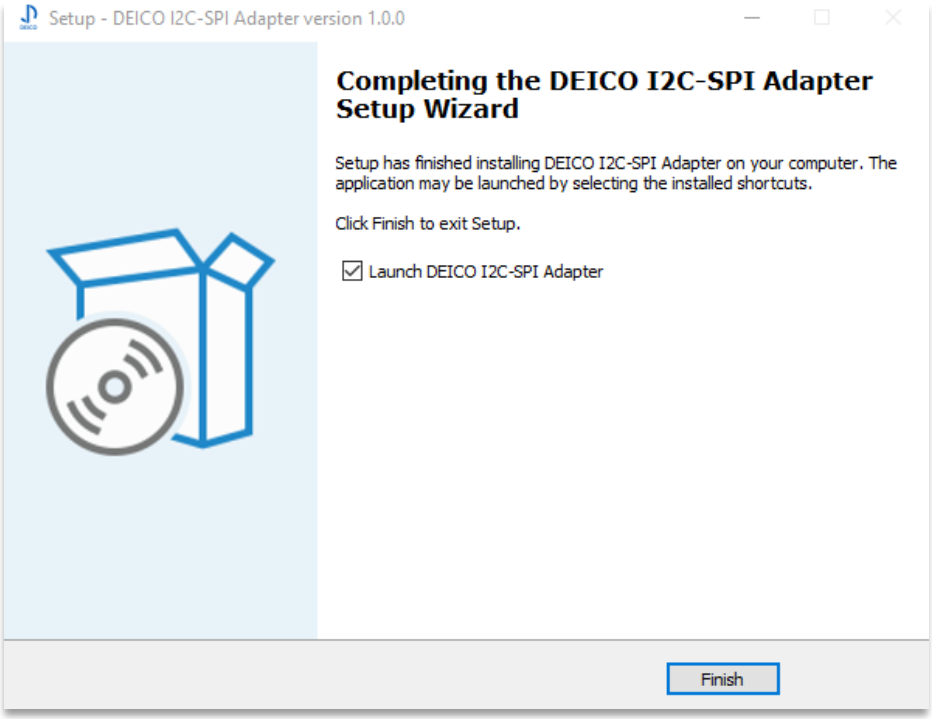

Figure 14: Completing installation

Installation Path

Default installation path for 64-bit application is “C:\Program Files\Onyx Control Center”. Currently users cannot change the installation path.

Connection Window

When the application is started, connection window will appear. Onyx devices connected to the user’s computer will be shown in this window.

User should use the “Refresh” button to update the list if a new device is connected to the computer because device list is not updated automatically.

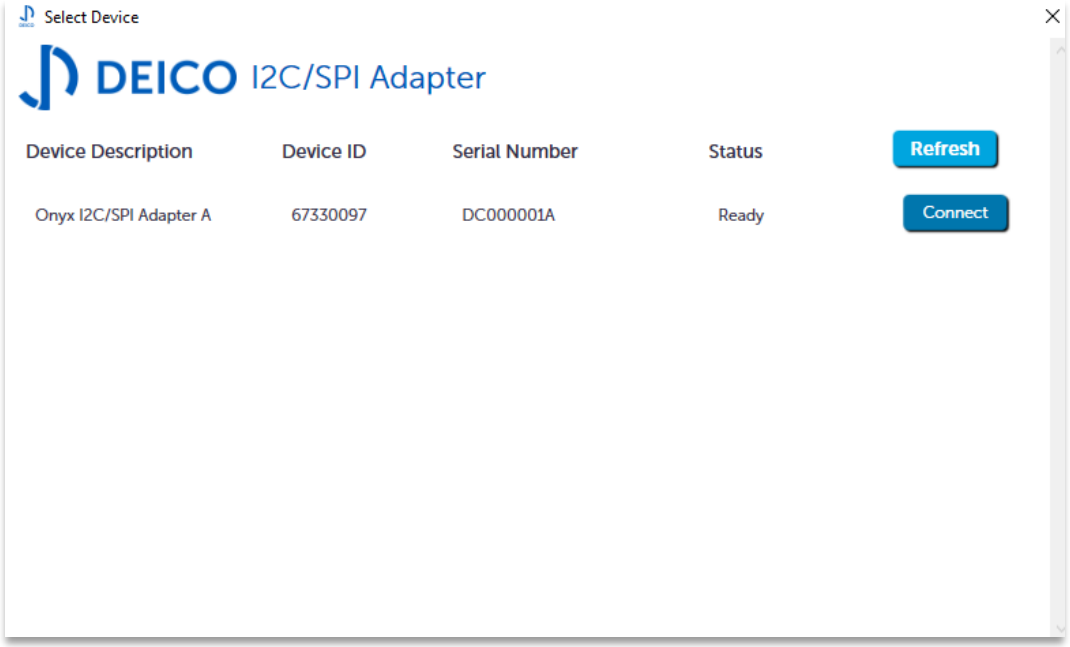

Figure 15: Connection window

Device description, ID number, serial number and device status are displayed in the device list. User can use the “Connect” button to open the device.

Control Window

Control window appears when user opens a device. This window contains all the functionality to control the Onyx I²C/SPI Adapter.

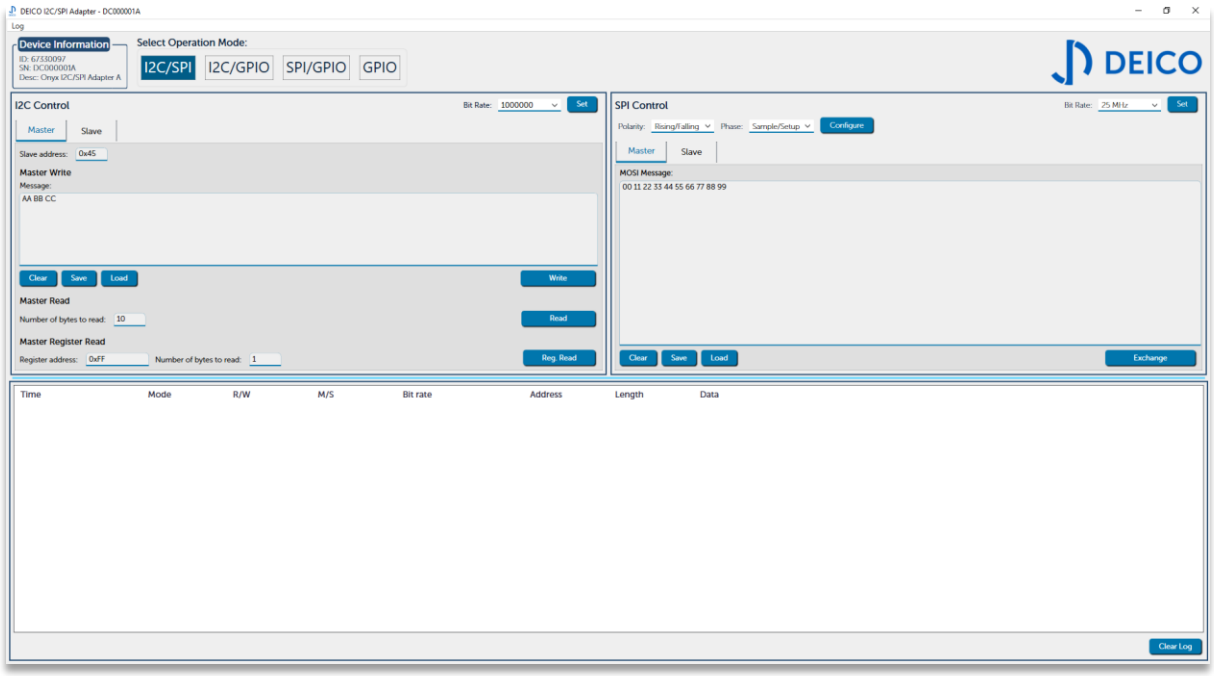

Figure 16: Control window

Device Information

Device information is shown in the upper left corner of the control window. User can check the connected device's description, ID and serial number.

Selecting Operation Mode

Right next to the device information there is a control for selecting the operation mode. There are four operation modes of Onyx I²C/SPI Adapter, which are I²C/SPI, I²C/GPIO, SPI/GPIO and GPIO modes.

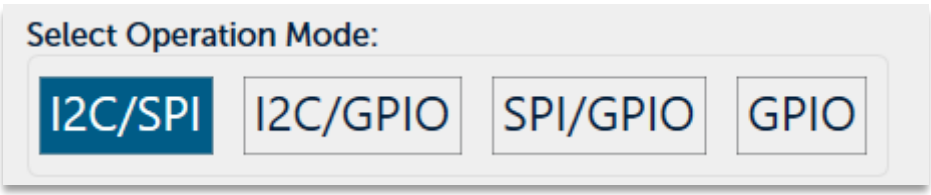

Figure 17: Selecting operation mode

Controls displayed on the UI are changed automatically whenever the operation mode is changed. Users can select the operation mode according to their needs. For example, if user needs both I²C and SPI controls, I²C/SPI mode should be selected, if GPIO pins are needed along with SPI, SPI/GPIO mode should be selected.

Note There are six operational pins on the Onyx device, two for I²C and four for SPI. GPIO pins are configured according to the operation mode. Pins of communication protocol that is not selected are configured as GPIO for I²C/GPIO and SPI/GPIO pins. For example, in I²C/GPIO mode, SPI pins are configured as GPIO pins. In the GPIO mode, all pins are configured as GPIO pins.

I²C Control Panel

When user selects any operation mode with I²C enabled, I²C Control panel is displayed.

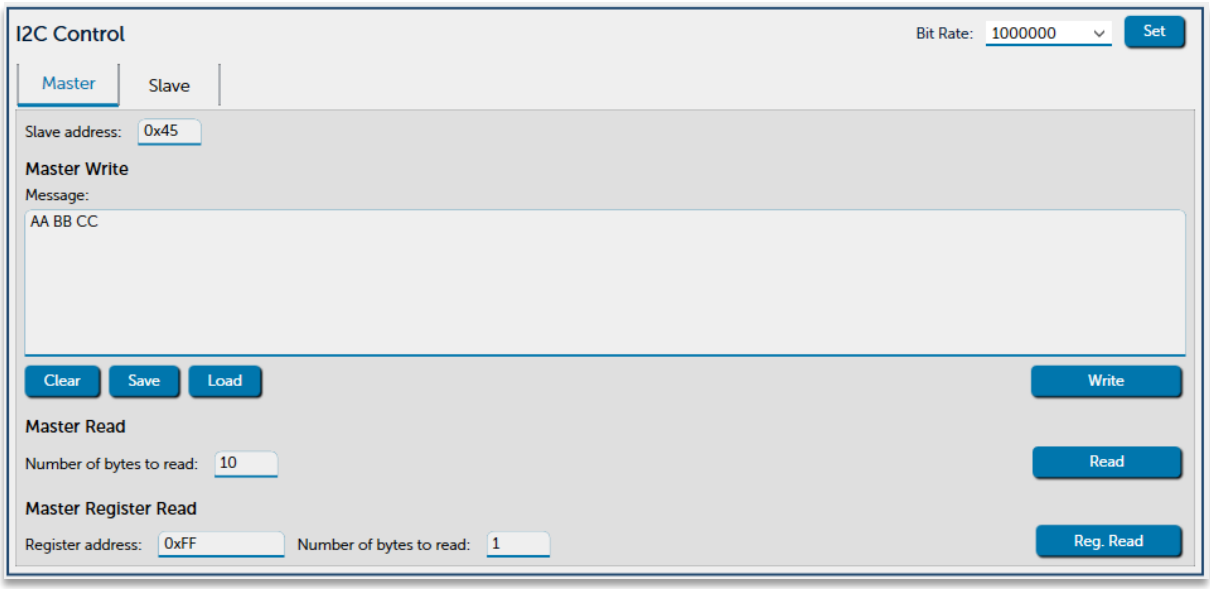

Figure 18: I²C control panel

There are two tabs to control the I²C, one is for master operations and the other is for the slave operations.

I²C Master Operations

In the I²C master mode, user can:

- ⇨ Set bit rate,
- ⇨ Write to a slave device,
- ⇨ Read from a slave device,
- ⇨ Read a register value from a slave device.

Set Bit Rate

To set the bit rate, user can select the desired bit rate and click on the “Set” button.

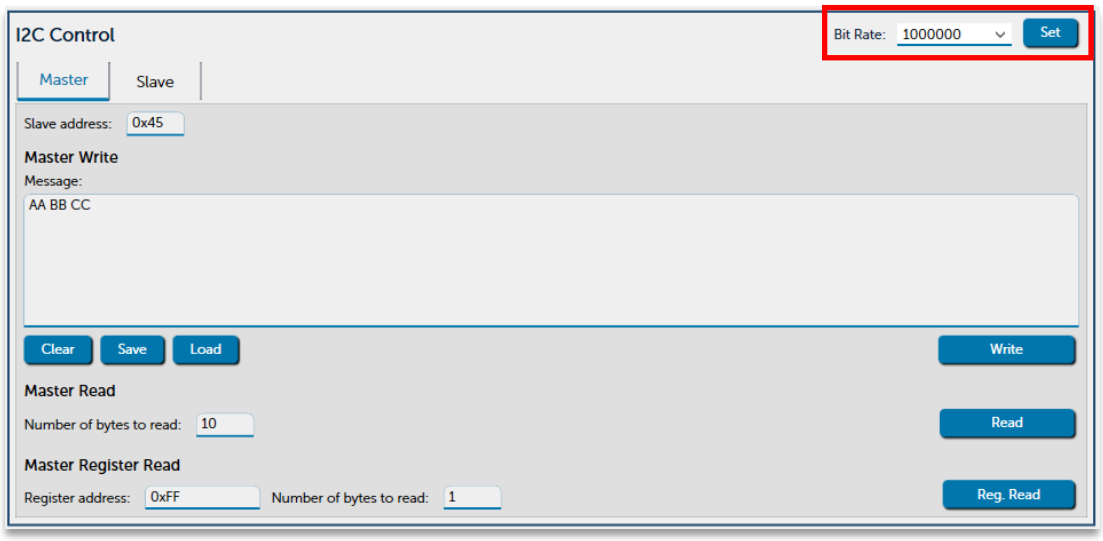

Figure 19: I²C master - Set bit rate

Operational bit rates are currently 100kHz, 400kHz and 1MHz.

Note Application saves the set bit rate to a settings file, see “*Saved Settings*” for settings. However, these settings are saved to file only, if user resets the device or powers off, bit rate must be set again to operate at the desired speed.

Note Set bit rate works for master operations only.

Master Write Operation

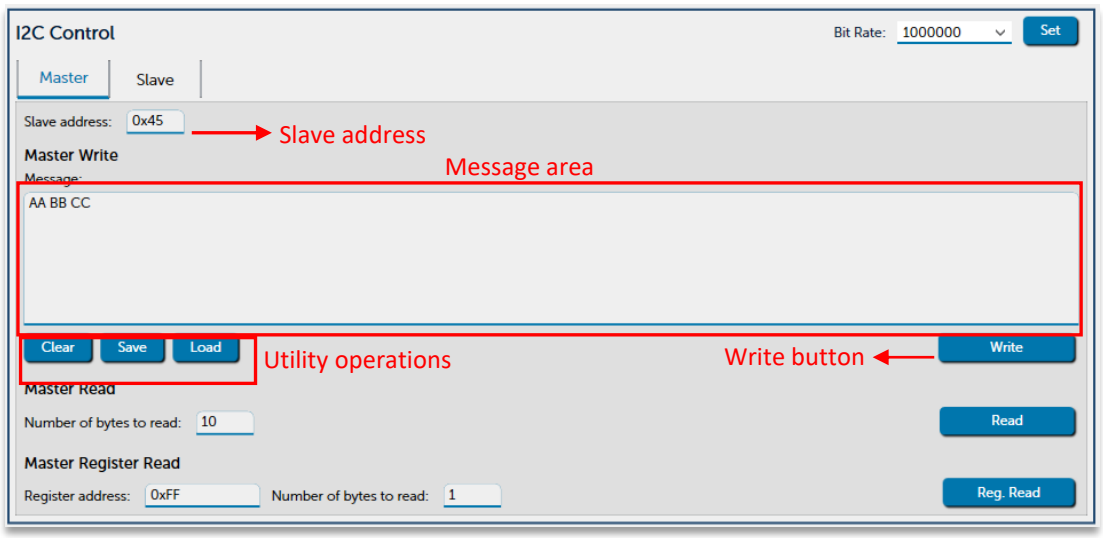

Figure 20: I²C master - Write operation

Slave address can be set in the slave address field. This address can be written either in the decimal format or in the hexadecimal format. In the example above slave address is set to 0x45 (69 in decimal).

Message field contains the data that will be transmitted to the slave device. This area accepts only hexadecimal characters. Each byte is separated by a space automatically. Below this field, there are three utility buttons that can be used to clear the data, save it to a file and load from a file.

To transmit the data, user must click on the “Write” button.

Master Read and Register Read Operations

Slave address can be as explained in the master write operation. User must provide the number of bytes to read and then click on the read button. Read data will be displayed on the transaction information panel, see “*Transaction Information Panel*”.

Register read operation is similar to read operation. The only difference is that user must provide a register address to read from. Then, read data will be displayed on the transaction information panel.

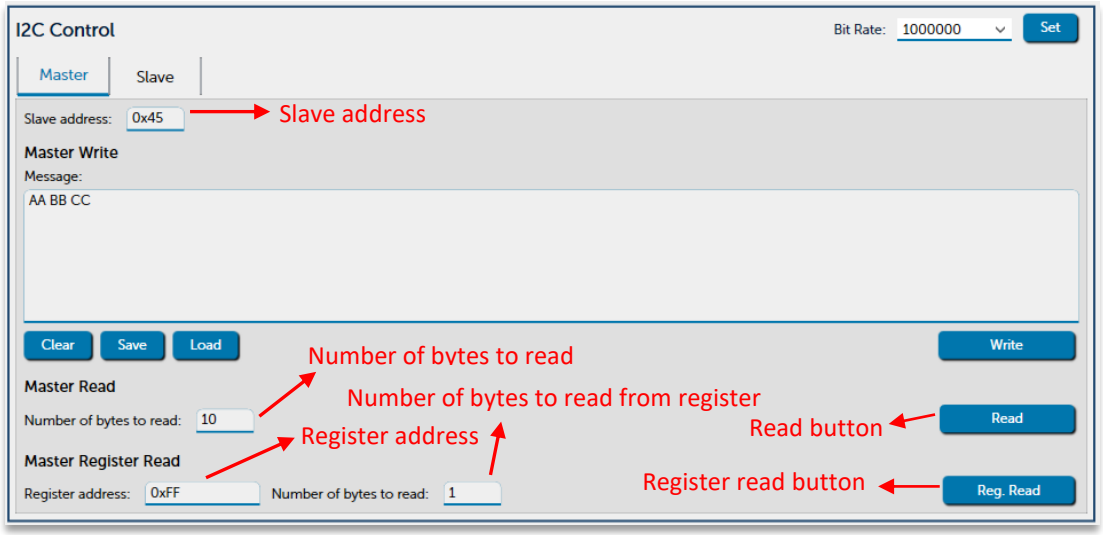

Figure 21: I²C master - Read & register read operations

I²C Slave Operations

By selecting the “Slave” tab, I²C can be configured as a slave device. Slave address of the Onyx I²C slave device can be entered into the slave address field.

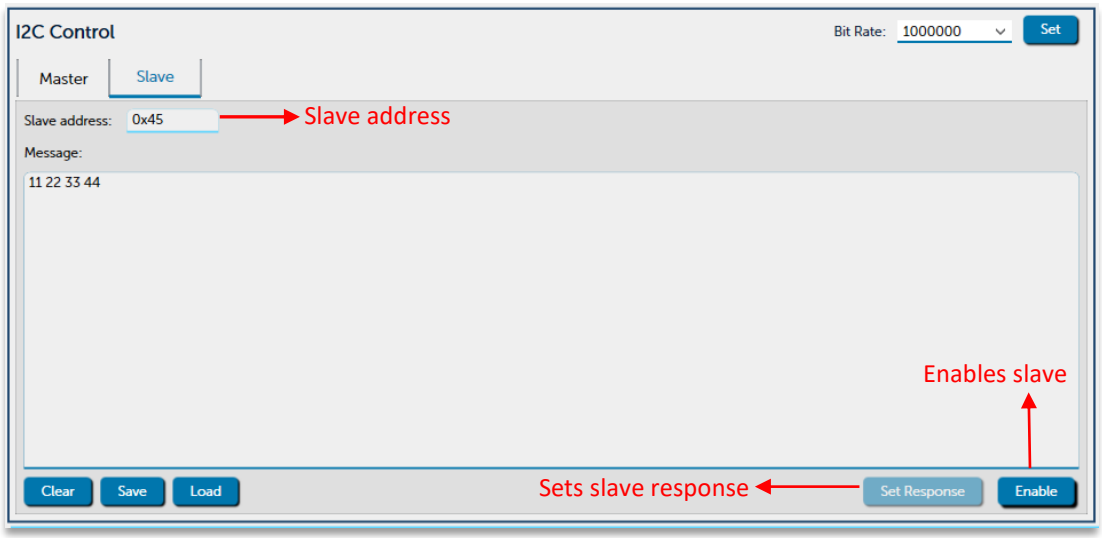

Figure 22: I²C slave control panel

To enable the slave device, enable button must be clicked. Response of the slave device can be set **after** enabling the slave device. Message area is the same as the master panel’s message field.

While the I²C slave is enabled, any incoming data to the device will be written into the transaction information panel.

SPI Control Panel

If user selects a mode that enables the SPI, SPI control panel will be displayed. Similar to I²C there are two tabs for master and slave operations.

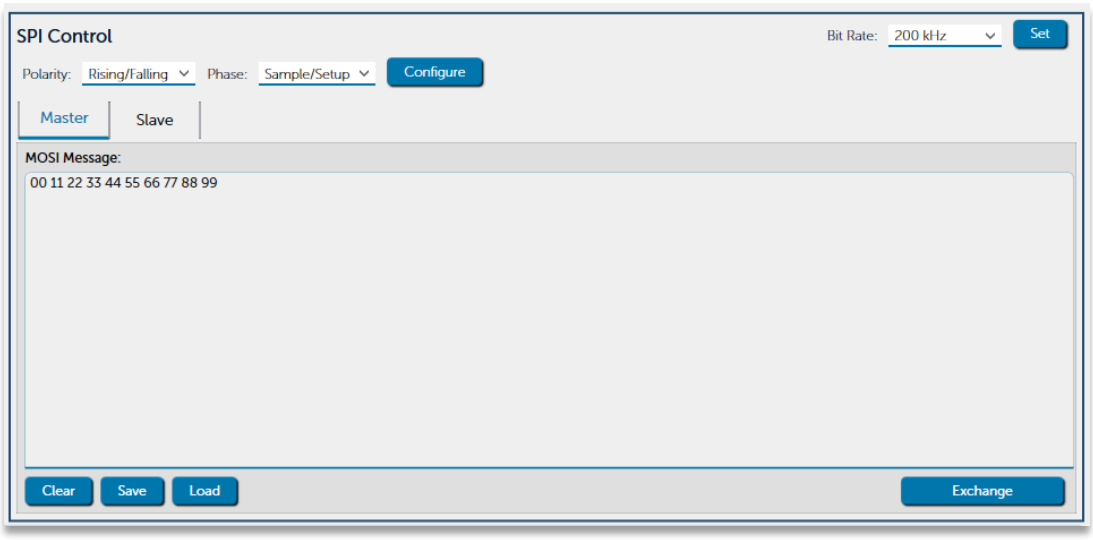

Figure 23: SPI control panel

SPI Master Operations

In the SPI master mode, user can:

- Set bit rate,
- Configure SPI mode,
- Exchange data with a slave device.

Set Bit Rate

Available bit rate values for SPI are:

- 200kHz
- 400kHz
- 800kHz
- 1.6MHz
- 3MHz
- 6MHz
- 12MHz
- 25MHz

To set the bit rate, user can select the desired bit rate and click on the “Set” button.

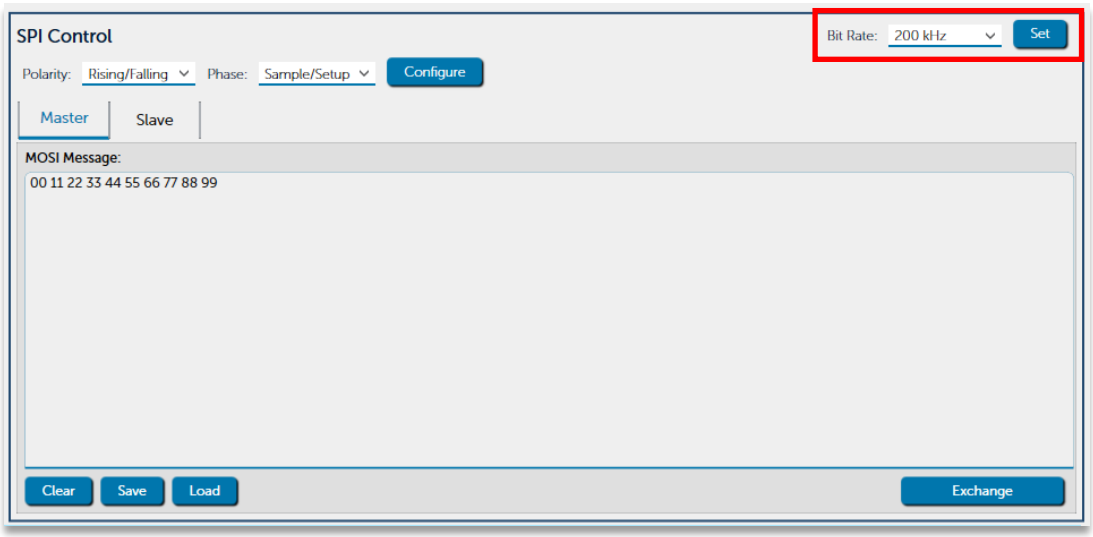

Figure 24: SPI master - Set bit rate

Note Application saves the set bit rate to a settings file, see “*Saved Settings*” for settings. However, these settings are saved to file only, if user resets the device or powers off, bit rate must be set again to operate at the desired speed.

Note Set bit rate works for master operations only.

Set SPI Mode

SPI has 4 different modes. These modes can be set by setting the polarity and phase. There are separate fields for setting the polarity and the phase.

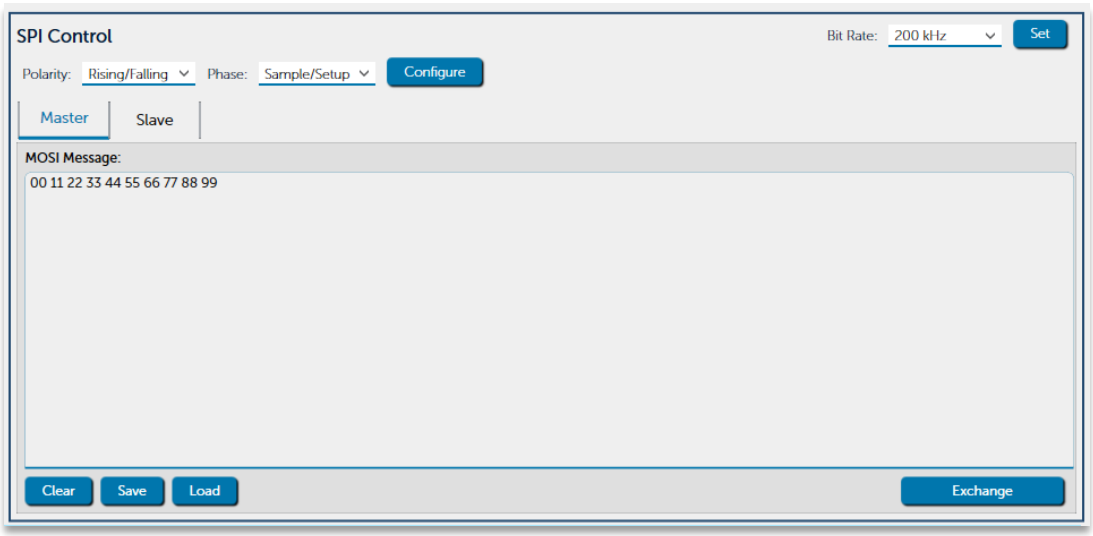

Figure 25: SPI master - Configure modes

User can select the polarity and phase from the combo boxes. After setting the polarity and phase, by clicking the “Configure” button, SPI configuration is sent to the device.

Note Application saves the configuration to a settings file, see “*Saved Settings*” for settings. However, these settings are saved to file only, if user resets the device or powers off, configuration must be set again to operate at the desired speed.

Note Set configuration works for master operations only.

SPI Master Exchange

SPI master does not have separate controls for write and read operations. Instead, a single exchange command exists. Similar to I²C operations, message field accepts only hexadecimal characters. After entering data to the message field, data can be exchanged by clicking exchange button.

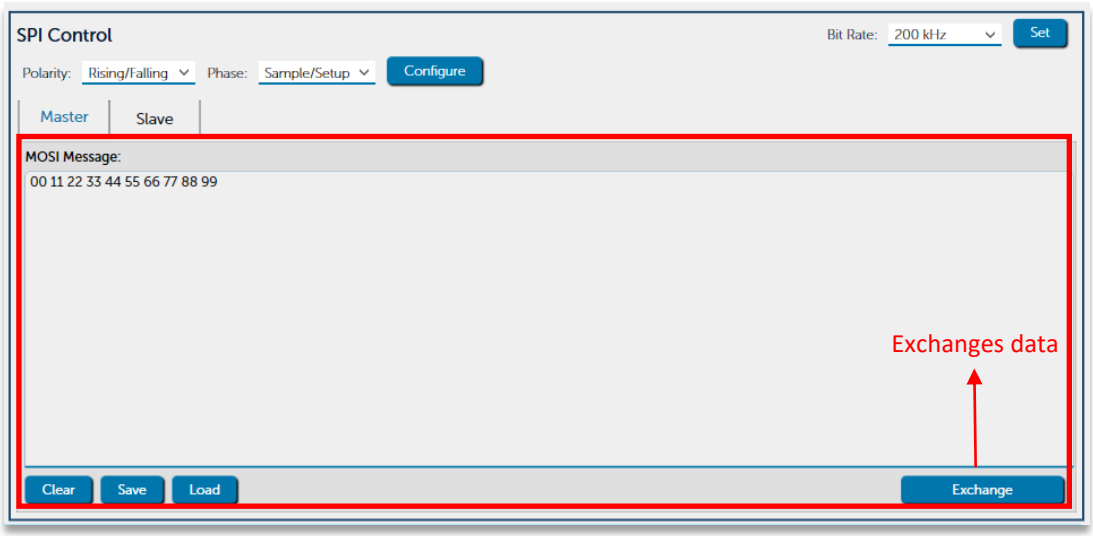

Figure 26: SPI master - Exchange operation

Received data by the SPI master is shown in the transaction information panel. If user wants to read data only, “00” bytes can be entered into the message field.

SPI Slave Operations

To enable the slave device, enable button must be clicked. Response of the slave device can be set **after** enabling the slave device. Message area is the same as the master panel’s message field.

While the SPI slave is enabled, any received or transmitted data will be written into the transaction information panel.

Figure 27: SPI slave control panel

GPIO Control Panel

When user selects an operation mode that configures pins as GPIO, GPIO display will appear. Pins configured as GPIO are dependent on the selected mode. For example, if I²C/GPIO mode is active, SPI pins (Pin #9, #8, #7 and #5) are configured as GPIO.

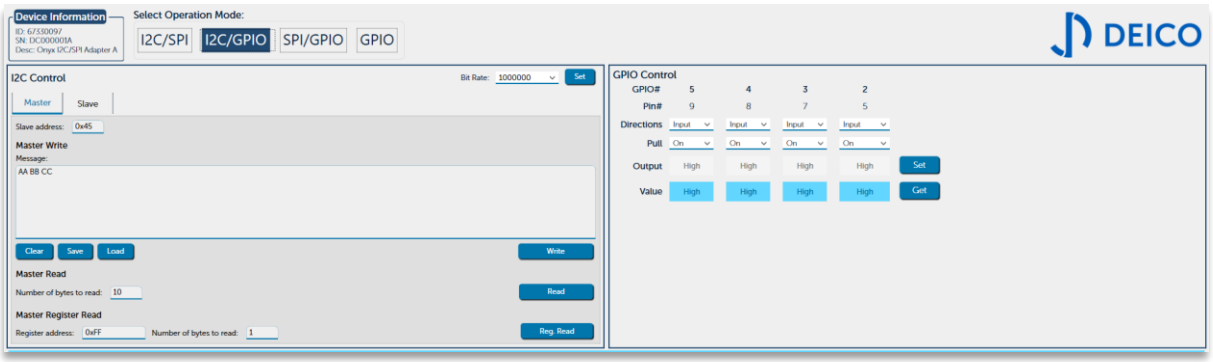

Figure 28: I²C/GPIO mode

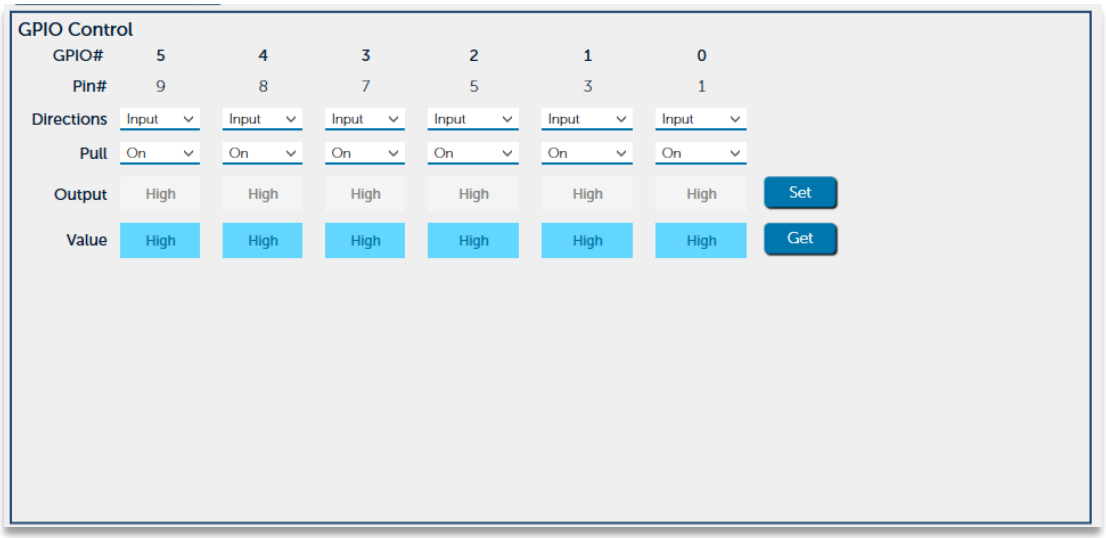

Figure 29: GPIO control panel

When GPIO mode is selected, all pins are configured as GPIO pins. *Figure 29* shows the configured GPIO pins in this mode.

In the GPIO control panel, there are two information fields, GPIO numbers and pin numbers. Pin numbers specify the position of the physical pin on the target bus connector.

Four fields are editable in the GPIO control panel, which are directions, pull-up mode, output value and the read value. Each field can be set exclusively for a pin.

Set Directions and Pull-up Mode

Direction specifies the pins' direction, input or output. If a pin is configured as input, Output field is disabled and pull field is enabled for that pin. Pull field enables or disables the pull-up for that pin. After setting the configuration, user must click on the "Set" button to configure pins.

Example below shows the both configurations. GPIO#5 is configured as "Input" and "Pull" value is on. Output is disabled for this pin. GPIO#4 is configured as "Output" and pull mode is disabled for that pin.

Figure 30: GPIO control panel

Set Output Values and Read Values

Output pins' values can be configured using the output toggles. After configuring pins, "Set" button must be clicked to set the values. "Set" button also automatically reads the values of pins and updates the value indicators.

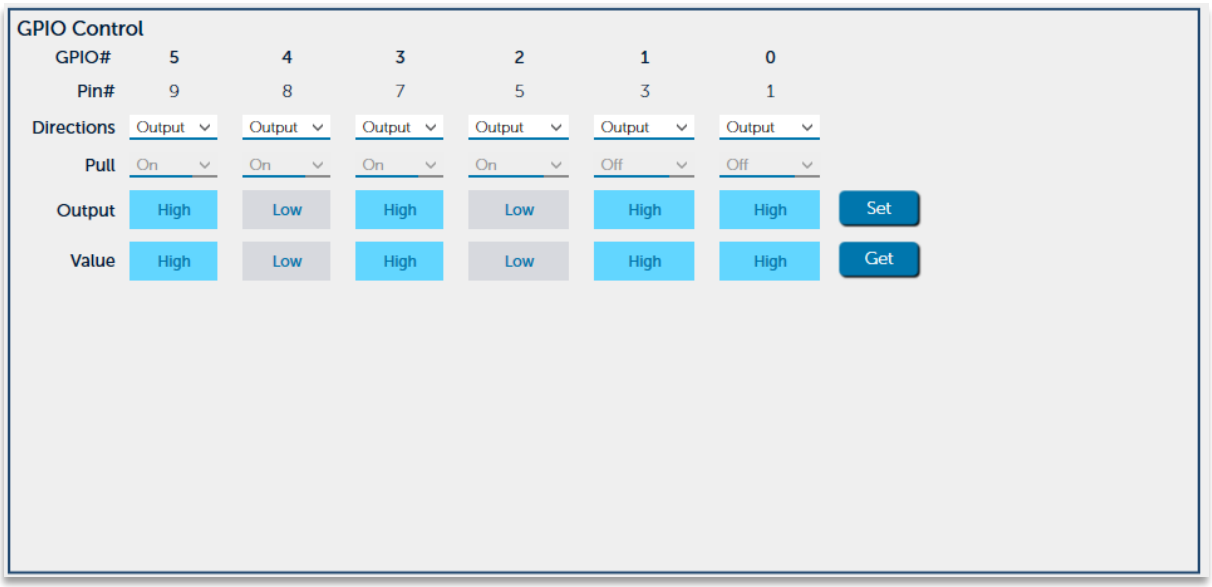

Figure 31: GPIO control - Output pins

"Get" button reads the values of pins either input or output and updates the value indicators.

Note Values and configuration of pins are also displayed on the transaction information panel.

Note Due to various communication delays or other issues, pin values may not be updated immediately. User must click to "Get" button to update read values.

Transaction Information Panel

In the transaction information area, information about the performed actions is displayed. Transmitted data, read data, configurations and errors are displayed in this panel.

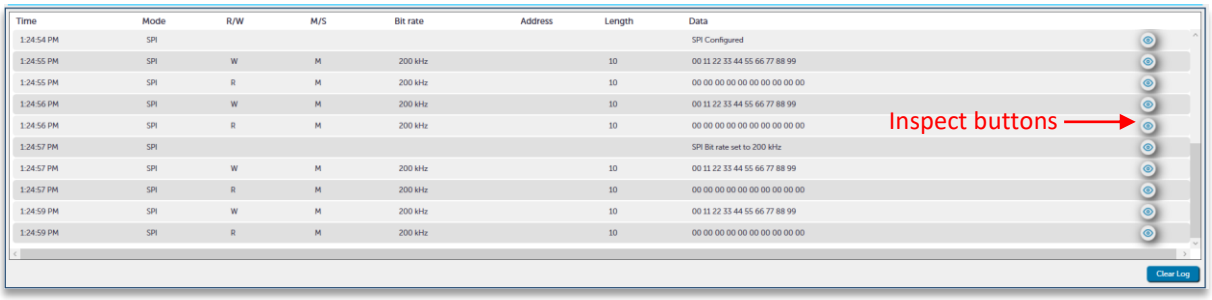

Figure 32: Transaction information panel

As shown in *Figure 32*, all messages have fields time, mode, read or write information, master or slave information, bit rate, address if exists, length and data. Fields are filled according to the action.

This panel can be cleared using the “Clear Log” button. Also, if user wants to examine the message in more detail, there is an inspect button on the right of each message.

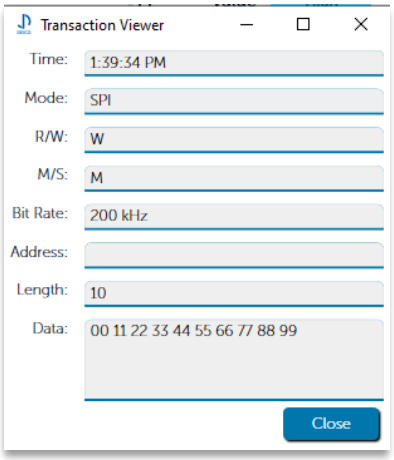

Figure 33: Transaction viewer

Saved Settings

It was previously discussed that settings are saved into files. Saved files are located at the user's %AppData% path, which is something like:

"C:\Users\user.name\AppData\Roaming\Onyx I²C-SPI Adapter"

In the settings directory:

- Operation mode
- I²C configurations and message data
- SPI configurations and message data
- GPIO configurations of last session

are saved as ".xml" files

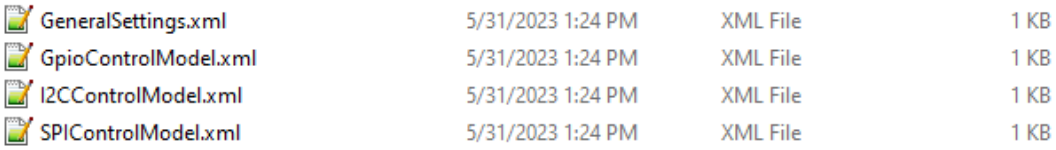

Figure 34: Settings files

COMPATIBILITY

Windows

Currently, Onyx Controller can run on 64-bit version of Windows. 32-bit version compatibility will be provided in the future.

Linux

Linux compatibility will be available in the future.

HARDWARE OVERVIEW

Block Diagram of Onyx

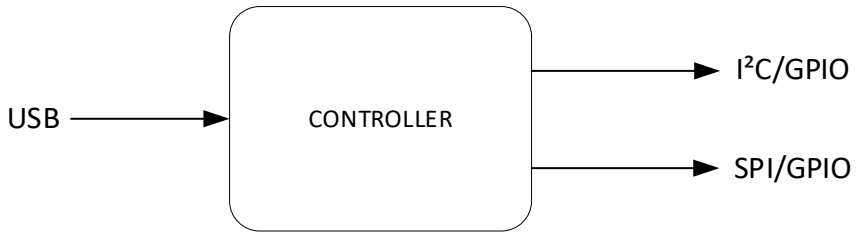

Figure 35: Block diagram of Onyx

Interfaces and Connections of Onyx

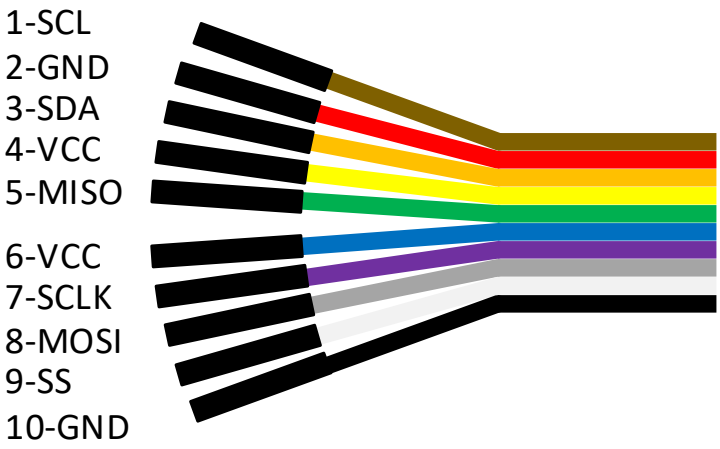

Figure 36: Cable pinout

Figure 37: Target connector

Table 3: Target connector pin description

Pin	Pin Name	Description
1	I²C SCL	I²C interface clock signal. There is an internal 4.7KOHM pull-up resistor. This pin can be used as GPIO.
2	GND	Ground connection.
3	I²C SDA	I²C interface data signal. There is an internal 4.7KOHM pull-up resistor. This pin can be used as GPIO.
4	VCC 3V3	3.3V output.
5	SPI MISO	SPI interface master in slave out signal. This pin can be used as GPIO.
6	VCC 3V3	3.3V output.
7	SPI CLK	SPI interface clock signal. This pin can be used as GPIO.
8	SPI MOSI	SPI interface master out slave in signal. This pin can be used as GPIO.
9	SPI SS	SPI interface slave select signal. This pin can be used as GPIO.
10	GND	Ground connection.

Figure 38: USB connector and LEDs

Table 4: Descriptions of USB connector and LEDs

No	Name	Description
1	Power LED	Power LED lights up constantly green, when the power is stable.
2	Type-C Connector	Via the USB Type-C connector Onyx is connected to a PC. Onyx gets its power via USB connector.
3	ACT LED	ACT LED lights up yellow while the I²C or SPI communication is active.

Firmware Upgrade

If your Onyx operates on older versions, the firmware can be upgraded using Onyx-Programmer tool. This tool can be downloaded from our website.

Firmware Upgrade Steps

To realize the upgrade, user should:

- ⇨ Connect Onyx to the computer,
- ⇨ Run “onyx-programmer.exe”,
- ⇨ Select the device whose firmware is wanted to be upgraded you want to upgrade its firmware,

```
Welcome to Onyx Programmer Version 2.0.1

Connected ONYX devices:
1. SN: DC000078A - Description: Onyx I2C/SPI Adapter v2.0.1 A
Select a device to upgrade firmware:
```

Figure 39: Firmware upgrade – Available devices

- ⇨ Press any key to continue,

```
Welcome to Onyx Programmer Version 2.0.1

Connected ONYX devices:
1. SN: DC000078A - Description: Onyx I2C/SPI Adapter v2.0.1 A
Select a device to upgrade firmware:
1
Selected device: SN: DC000078A - Description: Onyx I2C/SPI Adapter v2.0.1 A
DO NOT UNPLUG ONYX DURING FIRMWARE UPGRADE IT MAY CAUSE THE DEVICE TO BE NON-FUNCTIONAL
Press any key to start firmware upgrade...
```

Figure 40: Firmware upgrade – Available devices

⇨ Wait for download to complete.

If firmware upgrade is successful, the message “Firmware upgrade completed successfully” should be seen.

```
Download        [=====================   ]  80%       209152 bytes
Download        [=====================   ]  84%       217088 bytes
Download        [======================  ]  86%       222976 bytes
Download        [======================  ]  88%       227328 bytes
Download        [======================= ]  91%       236800 bytes
Download        [======================= ]  92%       237824 bytes
Download        [========================]  96%       248064 bytes
Download        [========================]  96%       250368 bytes
Download        [========================] 100%       258048 bytes
Download done.
state(6) = dfuMANIFEST-SYNC, status(0) = No error condition is present
Resetting USB to switch back to runtime mode
Firmware upgrade completed successfully!
Press any key to exit...
```

Figure 41: Firmware upgrade completion

Note When updating the firmware, Onyx should never be unplugged. Onyx can malfunction as a result of this. The user should contact DEICO’s support in case of any malfunction.

Note If firmware upgrade fails due to any reason, the user should wait for a failure message “Failed uploading: uploading error” or a similar one. Then, user should unplug the device and start over to upgrade firmware.

TROUBLESHOOTING

Operation Information

Transaction Message Limit

Maximum transaction message hold in the panel is limited to 5000.

Simultaneous Master/Slave Operations

Simultaneous master and slave operation is not supported.

I²C Pins as GPIO

I²C pins, pin#1 and pin#3 are internally pulled up. Which means that when they are configured as GPIO inputs, their values are always high.

Known Issues and Limitations

I²C Master Bit Rate Limitation

I²C master is currently not operational when the set bit rate is faster than 1MHz. High speed I²C requires additional logic for operation. This feature is currently not implemented.

Data Size Limitation

Largest data that can be sent in one command is limited to 2KB. Any data larger than 2KB is divided into packets of 2KB data, and API processes each packet until all the data is transmitted.

SAFETY GUIDELINES

Caution Do not operate the Onyx USB-I²C/SPI Converter in a manner not specified in this document. Product misuse can result in a hazard. You can compromise the safety protection built into the product if the product is damaged in any way. If the product is damaged, return it for repair.

WARRANTY

This warranty is applicable to the DEICO ONYX manufactured by DEICO. The warranty covers all components of the product. The warranty period offered for this product is 2 years starting from the date of purchase.

The DEICO ONYX should be used under normal operating conditions and in accordance with the manufacturer's specified instructions. The warranty is non-transferable and applies only to the original purchaser or end-user. Unauthorized repairs or modifications may void the warranty. The warranty does not cover damages resulting from normal wear and tear.
Authorized service centers designated by DEICO will provide free repair services during the warranty period. If repair is not feasible, DEICO will replace the product with the same model or an equivalent one.

To avail warranty service, purchase receipt should be retained. The product should be in its original packaging and accompanied by the original accessories.

The warranty does not cover, but is not limited to, the following:

- ⇨ Damages resulting from user error or improper use.
- ⇨ Damages caused by natural disasters, floods, fires, etc.
- ⇨ Damages resulting from unauthorized repairs or modifications.

For warranty service or any warranty-related inquiries, please contact DEICO's customer service department via support@deico.com.tr.

DEICO

Contact

DEICO Head Office

Teknopark Ankara, Serhat Mah.,
2224 Cad., No:1 F Blok, Z-12,
Yenimahalle, Ankara, Türkiye

support@deico.com.tr

+90 312 395 68 44

www.deico.com.tr


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