

MMBT-S Interface Box

Manual



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Contents

1	Disclaimer	4
2	System Overview	5
2.1	MMBT-S Components	5
2.2	MMBT-S Sockets and Hardware Features.....	5
2.3	Runtime Modes	6
2.3.1	Runtime Mode: Simple Mode	6
2.3.2	Runtime Mode: Pulse Mode	6
2.3.3	Runtime Mode selection	7
3	Technical Information	8
3.1	Technical Specifications	8
3.2	Pinout of the D-Sub 25 output socket.....	8
3.3	Warnings.....	9
3.4	Delay Testing.....	10

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3.5	Compatibility.....	11
3.5.1	Operating Systems.....	11
3.5.2	Stimulus Presentation Software.....	11
3.5.3	Hardware Systems.....	11
4	System Setup & Installation.....	12
4.1	Driver Installation for Microsoft Windows	12
4.2	Driver Installation for Unix and macOS operating systems	12
4.3	Setup: Presentation®, NeuroBehavioral Systems (NBS).....	13
4.3.1	Presentation® Settings of the MMBT-S.....	13
4.3.2	Testing Presentation® with the MMBT-S in Simple Mode	15
4.4	Setup: E-Prime, Psychology Software Tools, Inc.....	16
4.4.1	Sending Trigger Markers via Task Events	18
4.4.2	Sending Trigger Markers using User Script.....	19
4.4.3	Example User Script for Sending Trigger Markers in E-Prime.....	20
4.5	Setup: MATLAB.....	21
4.6	Setup: PsychoPy, Psychology software in Python, Peirce JW	22

Table of Figures

Figure 1: MMBT-S with USB cable	5
Figure 2: MMBT-S D-SUB 25 Socket and LED	5
Figure 5: MMBT-S Runtime Mode Switch	7
Figure 3: D-Sub 25 Pinout of the MMBT-S	8
Figure 4: Delay Measurement Results of the MMBT-S compared to an LPT port.....	10
Figure 6: Presentation® Settings Tab	13
Figure 7: Presentation® Port Settings Window	14
Figure 8: Presentation® Settings for MMBT-S Simple Mode	15
Figure 9: E-Prime Add Device Window	16
Figure 10: E-Prime Device List.....	17
Figure 11: E-Prime MMBT-S Connection Settings.....	17
Figure 12: E-Prime Task Event Settings Window	18
Figure 13: E-Prime User Script Example for Sending Trigger Markers.....	19

Table of Tables

Table 1: MMBT-S Technical Specifications.....	8
Table 2: D-Sub 25 Pinout Description of the MMBT-S	9

1 Disclaimer

The following documentation and step-by-step guide show the various steps after receiving the MMBT-S Interface Box from NEUROSPEC AG.

NEUROSPEC AG's MMBT-S system is a USB interface system designed for use in scientific and engineering research environments. It is not an LPT port. It appears as a virtual COM port (i.e. serial port) and connects through a USB cable to a stimulus presentation computer. It outputs 8 bits of trigger information through a female D-Sub 25 connection (i.e. parallel port) to any given trigger receiving system (e.g. an EEG system). Thus, when connecting make sure to locate and address the MMBT-S as a Serial Port using the appropriate COM port address and not as a Parallel Port using a hexadecimal address.

The MMBT-S system is not a CE or FDA approved medical device for use in medical diagnostic or therapeutic applications. Its sole purpose is to interface with biosignal recording systems. Any other information gathered from this device, either implied or otherwise, is not the intent purpose of this instrument and is therefore not the responsibility of NEUROSPEC AG or its subsidiaries.

Any usage of this instrument except for the specific purpose outlined above is strictly prohibited and voids all NEUROSPEC AG assurances of the system's durability or functionality except those strictly expressed in the accompanying manual.

The specifications, information and performance of the MMBT-S system, may be changed without notice. Since the use of this information and the conditions in which the system is used are beyond the control of NEUROSPEC AG and its subsidiaries, it is the obligation of the customer and/or the equipment operator to determine the correct and safe selection and settings and conditions of use of the device.

2 System Overview

The following chapter gives an overview of the system components and their use.

2.1 MMBT-S Components

The MMBT-S package contains the following:

- 1 x MMBT-S Interface Box
- 1 x USB memory stick with manual and drivers
- 1 x USB Cable



Figure 1: MMBT-S with USB cable

2.2 MMBT-S Sockets and Hardware Features

The MMBT-S contains two connection sockets, a USB Micro and D-SUB 25 female socket. A green LED (Figure 2) to the left of the D-SUB 25 socket indicates incoming trigger markers on line 1. As trigger markers are sent in parallel fashion to the biosignal acquisition system, the output follows a binary sequence. Hence, the LED of the MMBT-S illuminates when the trigger marker equals an odd value (i.e. 1, 3, 5, 7..... 255).



Figure 2: MMBT-S D-SUB 25 Socket and LED

2.3 Runtime Modes

The MMBT-S can operate in two different modes, "Pulse Mode" and "Simple Mode", depending on the hardware switch setting next to the USB Micro connection. Before changing modes, make sure that the MMBT-S is disconnected from any computer.

2.3.1 Runtime Mode: Simple Mode

In Simple Mode, the MMBT-S sends data bytes (1-255) to the output port (D-Sub 25) the same way as they are received from the trigger marker sending computer connected to the MMBT-S. The output frequency is limited by how long it takes for the firmware to check the USB interface, so it should be in the range of 5 kHz. The output port (D-Sub 25) remains HIGH until the software sends a 0 to pull it LOW, or another trigger marker is sent. The Simple Mode is useful, especially where programmers who develop their own software want to control the ON/HIGH time of the output port. Furthermore, this mode is useful for trigger marker receiving systems (e.g. the biosignal amplifier) with a sampling rate of <250Hz. In such a case, the pulse width of the trigger marker must be calculated accordingly.

2.3.2 Runtime Mode: Pulse Mode

In Pulse Mode, which is the factory setting, the MMBT-S sends data bytes (1-255) to the output port the same way as they are received from the trigger marker sending computer connected to the MMBT-S. Additionally, after 8 ms the MMBT-S automatically sends a trigger marker '0' to pull all pins LOW.

Running the MMBT-S in Pulse Mode greatly simplifies the way the stimulus presentation software sends trigger markers, as the stimulus presentation software does not need to handle the resetting of the trigger lines. The stimulus presentation software could still attempt to reset the lines explicitly, but this will be ignored by the MMBT-S as it will still reset the port after 8 ms. Note that the MMBT-S has a small receive buffer size (64 bytes), so if a few trigger markers were sent in too rapid succession, they will not get lost but will be delayed by 8 ms each.

After booting the computer or after reconnecting the USB cable to the MMBT-S, the trigger output port remains inactive, which is as if they were not connected. The output port will become active and initialized to zero once the stimulus presentation software opens the MMBT-S port.

2.3.3 Runtime Mode selection

The Runtime Mode that the MMBT-S operates in (i.e. either Pulse Mode or Simple Mode) is defined by the hardware switch setting next to the USB Micro connection port (Figure 3). The letter "P" on top of the switch symbolises the Runtime Mode Pulse Mode, whereas the letter "S" stands for Simple Mode. The factory setting is Pulse Mode. This switch setting is checked by the MMBT-S when it is reset or reconnected to the USB port of the computer.



Figure 3: MMBT-S Runtime Mode Switch

3 Technical Information

The following chapter outlines technical information, specifications and conducted delay measurements.

3.1 Technical Specifications

The following table (Table 1) lists the technical specifications of the MMBT-S.

Table 1: MMBT-S Technical Specifications

Default Runtime mode	Pulse Mode
Connection Interface	USB Micro and D-SUB 25
Operating Voltage	5 V
Input Voltage (recommended)	7-9 V
Input Voltage (limit)	6-9 V
Digital Output Bits	8
Digital Output Pins	Pins 2 – 9 (standard LPT)
Ground Pins	Pins 20 – 25 (standard LPT)
Baud rate	9600
Operating Temperature	5°C (40°F) - 40°C (104°F)
Length	92 mm
Width	92 mm
Height	32 mm
Weight	125 g

3.2 Pinout of the D-Sub 25 output socket

The D-Sub 25 output socket of the MMBT-S supplies the receiving device with 8-bit digital logic levels. Output of the logic levels is TTL (transistor-transistor logic), meaning 5 V for High and 0 V for Low. Figure 4 depicts the pinout of the D-Sub 25 output socket of the MMBT-S.

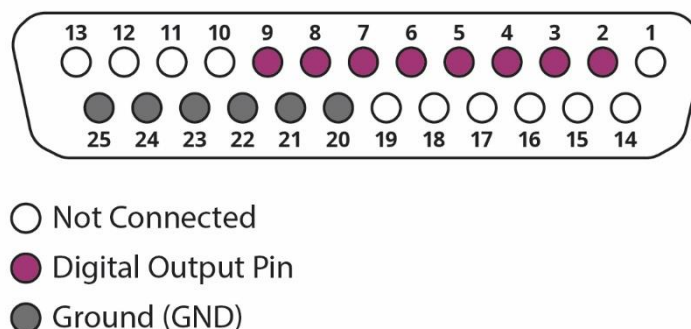


Figure 4: D-Sub 25 Pinout of the MMBT-S

Table 2: D-Sub 25 Pinout Description of the MMBT-S

Pin	Function
1	N/C
2	Bit 1 (5 V High, 0 V Low)
3	Bit 2 (5 V High, 0 V Low)
4	Bit 3 (5 V High, 0 V Low)
5	Bit 4 (5 V High, 0 V Low)
6	Bit 5 (5 V High, 0 V Low)
7	Bit 6 (5 V High, 0 V Low)
8	Bit 7 (5 V High, 0 V Low)
9	Bit 8 (5 V High, 0 V Low)
10 - 19	N/C
20 - 25	Ground (GND)

3.3 Warnings

- Running stimulus delivery and experiment control software via RDP (Remote Desktop Protocol) or in a virtual environment is not recommended.
- The MMBT-S has a resettable polyfuse that protects your computer's USB ports from shorts and overcurrent. Although most computers provide their own internal protection, the fuse provides an extra layer of protection. If more than 500 mA is applied to the USB port, the fuse will automatically break the connection until the short or overload is removed.
- Setting the baud rate incorrectly (i.e. to 1200) will reset the MMBT-S. The reset will affect the processor and disconnect the MMBT-S from the computer (meaning that the MMBT-S will disappear from the device manager). NEUROSPEC AG cannot be made liable for any reset MMBT-S.

3.4 Delay Testing

Measurements on the accuracy of the MMBT-S were conducted and compared with an on-board LPT Port of a computer. The results: the MMBT-S from NEUROSPEC AG has latencies in the sub-millisecond range. The delay measurements were made using a Desktop Computer running on Windows 7, 64-Bit. An average delay of 120 μ s was measured. See also the graph below (Figure 5).

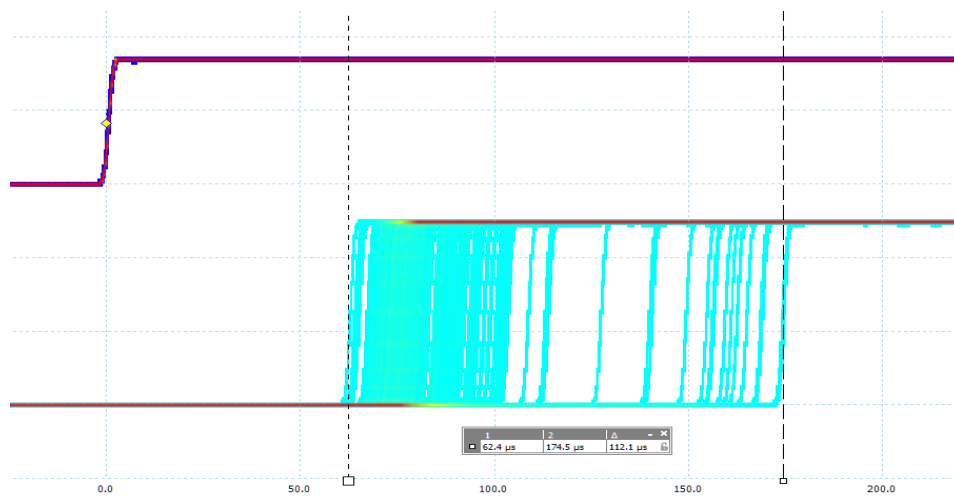


Figure 5: Delay Measurement Results of the MMBT-S compared to an LPT port

3.5 Compatibility

3.5.1 Operating Systems

The MMBT-S has been tested using the following operating systems:

- Windows 7 / 8 / 8.1 / 10
- macOS 10.12 / 10.13 / 10.14
- Ubuntu 18.04

Other operating systems (OS) or other versions of operating systems should work equally fine as virtual COM ports are common (serial) ports for most computer systems.

3.5.2 Stimulus Presentation Software

The MMBT-S and driver have been tested and runs with the following neuroscience stimulus delivery and experiment control software:

- Presentation®, NeuroBehavioral Systems (NBS)
- E-Prime, Psychology Software Tools, Inc.
- PsychoPy, Psychology software in Python, Peirce JW
- OpenSesame, COGSCI dotNL cognitive science
- Inquisit, Millisecond Software

Other software (such as SuperLab, Cedrus or Stim2, NeuroScan Compumedics etc.) have not been tested, however, the implementation and compatibility should work equally fine. When establishing a connection from such a software, make sure to set up the MMBT-S as a serial type connection and not parallel/LPT type connection! A guide on how to set up the MMBT-S with the above-mentioned software is given below.

3.5.3 Hardware Systems

The MMBT-S has been tested and can send trigger markers (TTL) to the following biosignal amplifiers:

- ActiveTwo, Biosemi
- ActiChamp / BrainAmp, Brainproducts
- DSI-4 / DSI-7 / DSI-24 / DSI-VR300 / DSI-Hybrid, Wearable Sensing
- fNIR Imaging System, BIOPAC Systems, Inc.
- LABNIRS / LIGHTNIRS, Shimadzu
- All MP-systems (incl. BSL, MP36, MP160 etc.), BIOPAC Systems, Inc.
- neuvo, NeuroScan Compumedics
- SynAmps RT, NeuroScan Compumedics

Other not listed biosignal amplifiers with a standard TTL (transistor-transistor logic) trigger input should work equally fine.

4 System Setup & Installation

4.1 Driver Installation for Microsoft Windows

Connect the USB memory stick to your computer and follow these steps:

- 1) Extract the .ZIP Archive File (with an unzip software, e.g. 7-Zip or WinZip).
- 2) Navigate into the extracted folder and run the appropriate installation file: **dpinst-amd64** for 64-Bit / **dpinst-x86** for 32-Bit Operating Systems.
- 3) Connect USB cable to the MMBT-S and to the computer running the stimulus presentation software.
- 4) Connect the trigger cable (with D-Sub 25 connector on the one side) to the MMBT-S and the trigger receiving device (i.e. the biosignal recording device).
- 5) Open the Windows Device Manager and under Ports (COM & LPT) check whether the MMBT-S Box is available.
- 6) Take note of the COM port (e.g. COM4).

If the driver has been successfully installed, the MMBT-S should appear in the Windows Device Manager and can be used with the listed compatible soft- and hardware (Chapter 3.5).

The driver is also available from www.neurospec.com/Support and under the "Downloads" section. The download requires a login. Use the following credentials to download the MMBT-S driver: Username: neuro // Password: showme

4.2 Driver Installation for Unix and macOS operating systems

On most common Unix operating systems, the driver comes preinstalled and does not need to be installed. To determine the connection port, follow these steps:

- 1) Connect the USB cable to the MMBT-S and to the computer running the stimulus presentation software.
- 2) Connect the trigger cable (with D-Sub 25 connector on the one side) to the MMBT-S and the trigger receiving device (i.e. the biosignal recording device).
- 3) Open a shell/terminal window of your selected Unix system and check the connection port using the following command:
`ls /dev/tty.*`
or the following command for Debian systems:
`dmesg | grep tty`
- 4) A list of connected serial devices will appear. The name of the MMBT-S will start with `/dev/tty.usbmodemxxxx` (x being numbers) or `ttyACMx` (x being numbers for Debian systems).

4.3 Setup: Presentation®, NeuroBehavioral Systems (NBS)

Presentation® from NeuroBehavioral Systems (NBS) allows for addressing the MMBT-S in both the Simple and Pulse Mode. These Runtime Modes are described in chapter 2.3.

4.3.1 Presentation® Settings of the MMBT-S

First, open Presentation®, NeuroBehavioral Systems (NBS) and follow these guided steps to implement and test the connection to the MMBT-S (please note: a valid Presentation® license is required).

- 1) Go to the **Settings** tab of your experiment.
- 2) Choose **Port** from the selection on the left side.
- 3) Under **Output Port**, click **Add** to add a new output port (Figure 6).

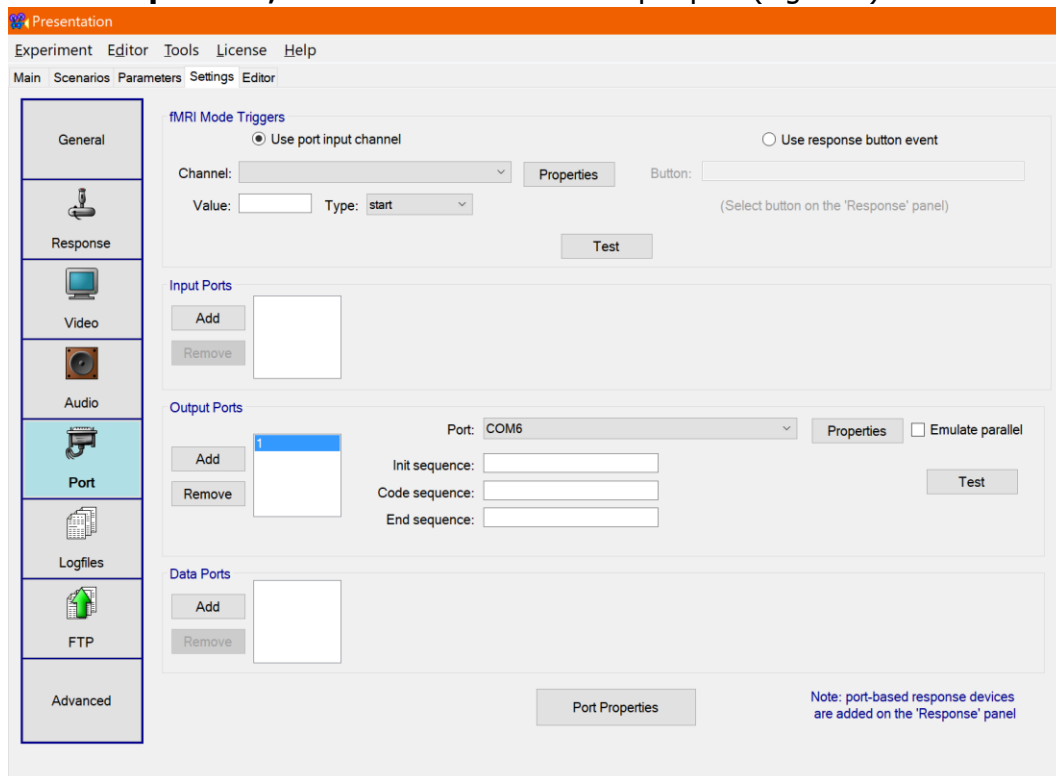


Figure 6: Presentation® Settings Tab

- 4) Then open the **Properties** of that newly added port and navigate to **Options > Device Enumeration > Enumerate COM Ports**.
- 5) Click on the **Re-enumerate**-button.
- 6) After re-enumerating all ports, a new port should appear (verify the COM Port number, see chapter 4.2).
- 7) Close the window again.
- 8) Now, under Port choose the newly enumerated COM Port and select **Properties**.
- 9) Set the Serial Port properties as follows (Figure 7):
 - a. Rate: 9600
 - b. Parity: none

- c. Data Bits: 8
- d. Stop Bits: 1
- e. CTS control: off
- f. DSR out control: off
- g. DSR in control: off
- h. DTR control: enable
- i. RTS control: disable
- j. Set FIFO interrupt: disable

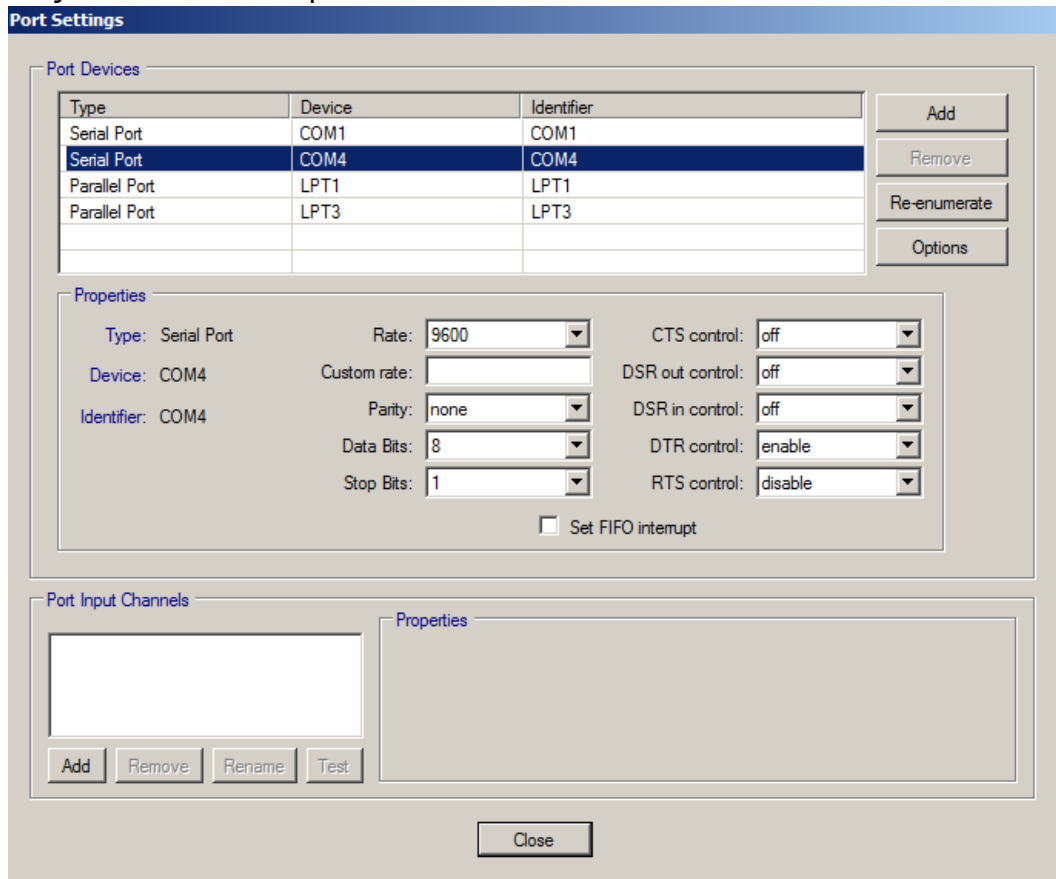


Figure 7: Presentation® Port Settings Window

- 10) The (BAUD) Rate must be set to **9600**. Do not attempt to set other Baud Rates!
- 11) Further, make sure to uncheck the setting **Set FIFO interrupt**.
- 12) Close the window and save the settings as well as your experiment.
- 13) Then test whether you can send trigger markers via the MMBT-S, by sending trigger markers via the: **Test** feature in the **Settings** tab under **Output Ports** settings.

4.3.2 Testing Presentation® with the MMBT-S in Simple Mode

Presentation® allows for dynamically adjusting the pulse width of the trigger markers. For a desired Pulse other than 8 msec, unplug the MMBT-S and set the Runtime Mode to Simple Mode. In Simple Mode, the MMBT-S forwards the 8 bits of data to the output port without automatically pulling these data lines LOW. The output frequency is limited by the time it takes the firmware to check the USB interface (normally around 5 kHz). The Runtime Modes of the MMBT-S are described in chapter 2.3.

In the **Output Ports** section under the **Settings** tab, enable the setting **Emulate parallel** (Figure 8). Set the desired Default Pulse Width in milliseconds and click on the **Test** button to send test trigger markers.

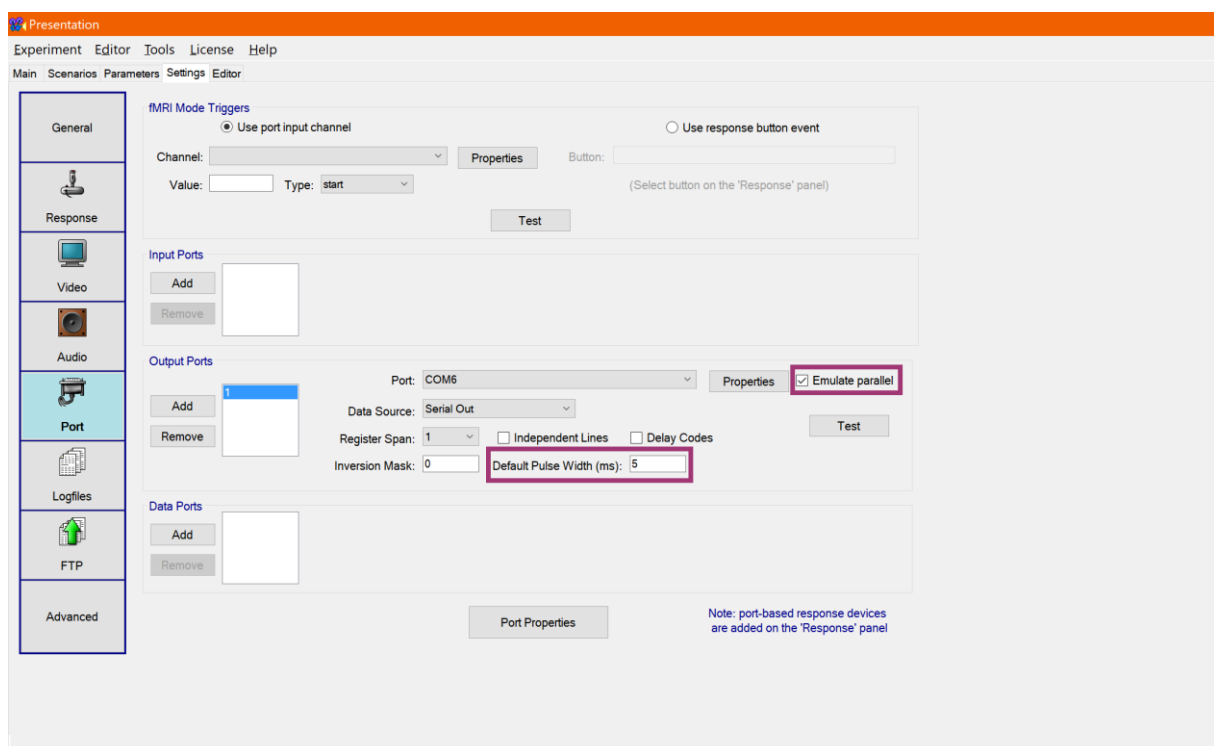


Figure 8: Presentation® Settings for MMBT-S Simple Mode

4.4 Setup: E-Prime, Psychology Software Tools, Inc.

E-Prime versions 2 and 3 have been tested and can communicate with the MMBT-S.

In order to add the MMBT-S as a Serial Device to your E-Prime experiment, follow these steps:

- 1) Open E-Prime.
- 2) Go to **Edit > Experiment...** and open the **Devices** tab.
- 3) Add a new Device by clicking the **Add** button on the bottom left.
- 4) Choose the Serial device and OK (Figure 9).

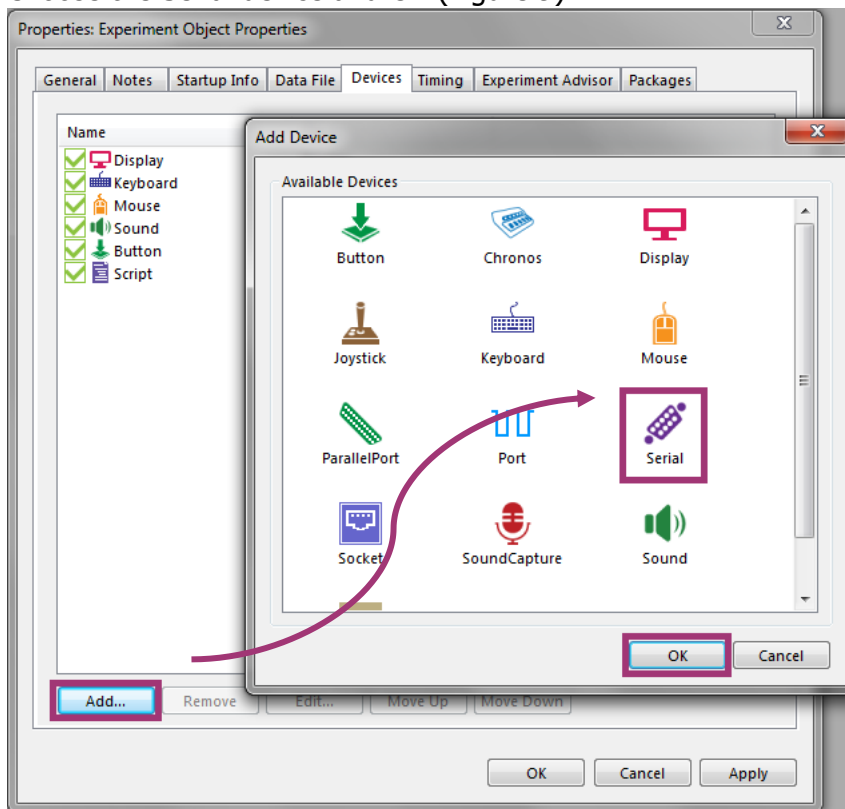


Figure 9: E-Prime Add Device Window

- 5) Back in the Devices tab, select the newly added serial device and click **Edit...** (Figure 10).

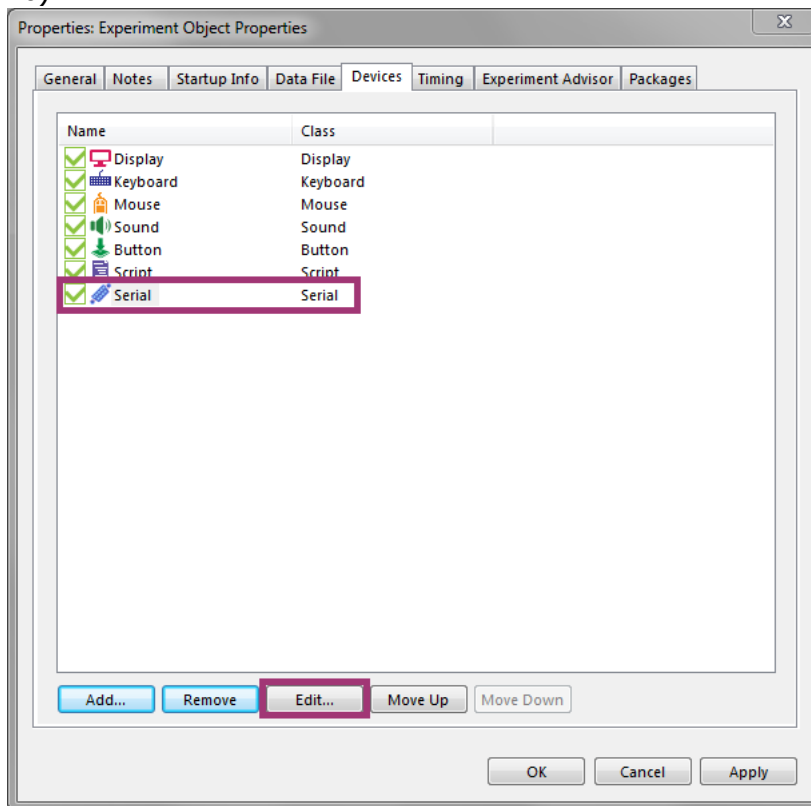


Figure 10: E-Prime Device List

- 6) Set the settings of the serial device accordingly (Figure 11):
- Name: { insert name of your choice }
 - COM Port: COM Port of the MMBT-S (see chapter 4.2)
 - Bits per second: 9600
 - Data Bits: 8
 - Parity: None
 - Stop Bits: 1

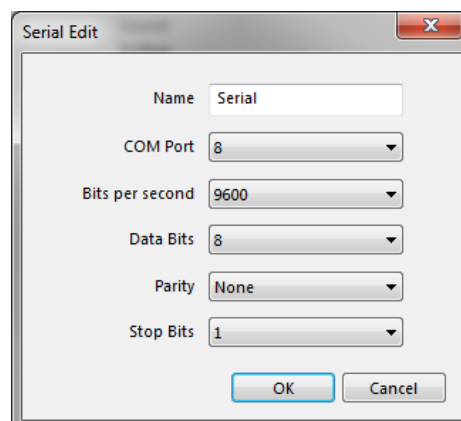


Figure 11: E-Prime MMBT-S Connection Settings

4.4.1 Sending Trigger Markers via Task Events

When working with any E-Objects in E-Prime, sending trigger markers is set in the settings window of the corresponding E-Object. The settings for each E-Object in E-Prime is accessible via the orange button on the top left of the block (Figure 12). Make sure that the MMBT-S is connected to your computer via the USB cable and the appropriate device settings under **Edit > Experiment... > Devices > Serial (add device if needed)** are set. In the sample experiment below (Figure 12), two events were added when the mouse of the computer is clicked. Both events send a trigger marker "1" (trigger pin 1 goes HIGH).

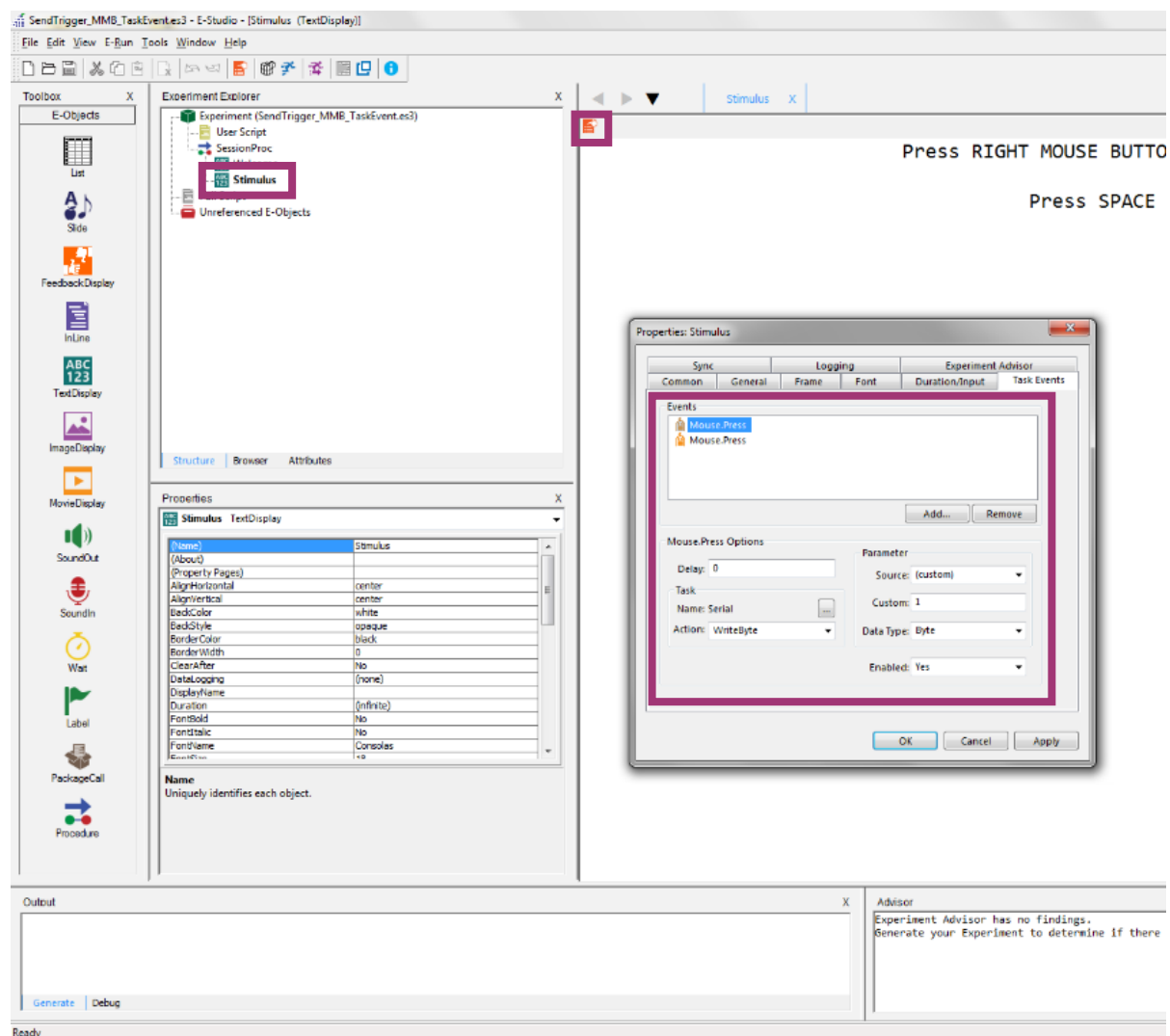


Figure 12: E-Prime Task Event Settings Window

Please note: if the MMBT-S is set to Simple Mode, make sure to use two Events. The first Event sets the according pin to HIGH (i.e. "sends a trigger") and the second event to brings all pins to LOW again (i.e. "stops the trigger"), as in the example above (Figure 12). Read chapter 2.3 for more information on the different Runtime Modes.

4.4.2 Sending Trigger Markers using User Script

Trigger markers can also be sent to the MMBT-S using a User Script. Add a User Script block to your Experiment. Next, within the User Script block, write your E-Prime code. Example code for sending trigger markers is listed below (chapter 4.4.3). Make sure the MMBT-S is connected to your computer and the appropriate device settings under **Edit > Experiment... > Devices > Serial (add device if needed)** are set. Access the MMBT-S in your code using the appropriate serial port "<Name>".

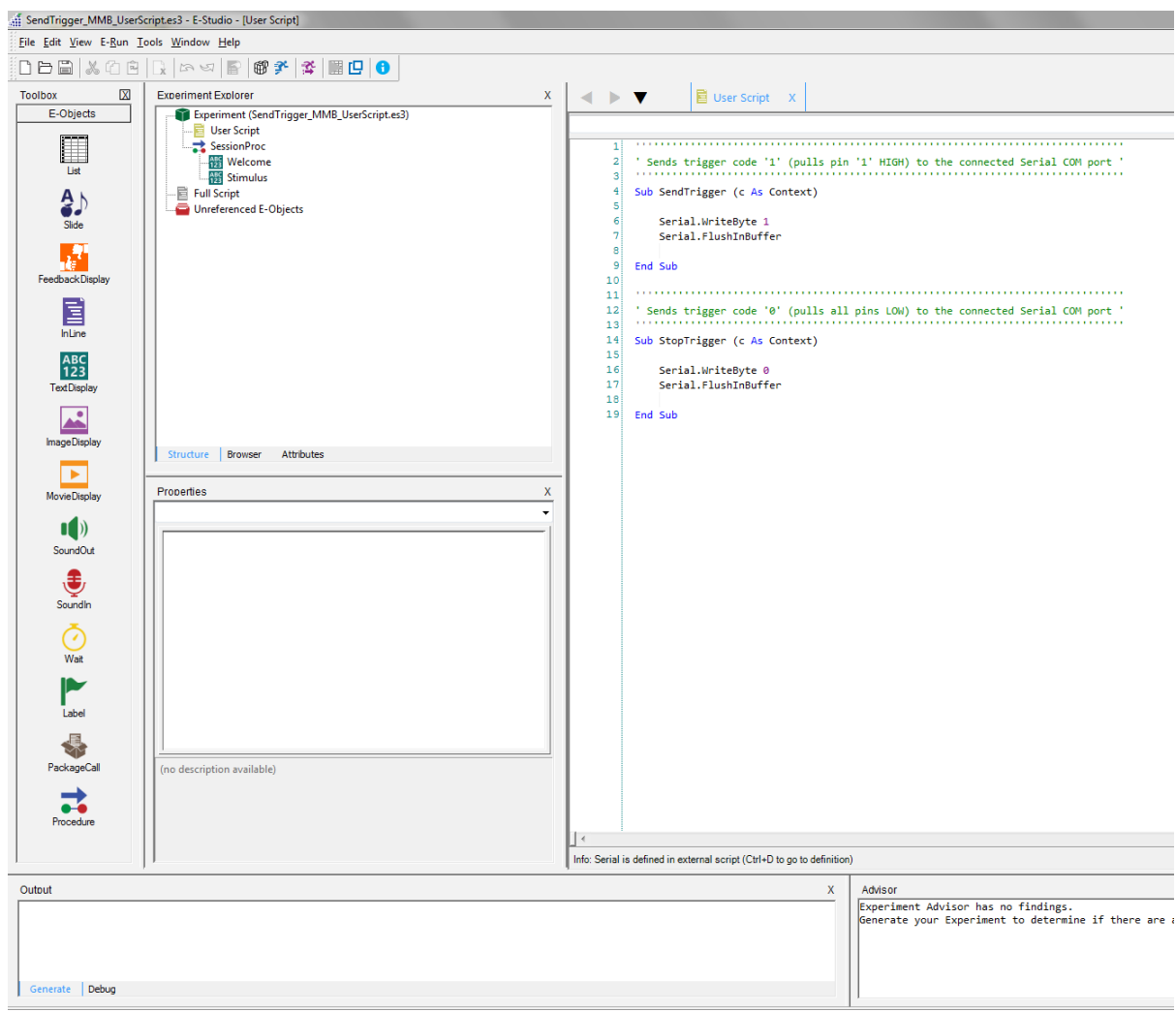


Figure 13: E-Prime User Script Example for Sending Trigger Markers

Please note: if the MMBT-S is set to Simple Mode, make sure to use two functions. The first function sets the according pin to HIGH (i.e. "sends a trigger") and the second function to bring all pins to LOW (i.e. "stops the trigger"), as in the example above (Figure 13). Read chapter 2.3 for more information on the different Runtime Modes.

4.4.3 Example User Script for Sending Trigger Markers in E-Prime

Find below example code for sending trigger markers. If the MMBT-S is set to Pulse Mode, only the function "SendTrigger" is required; if the MMBT-S is set to Simple Mode, both the "SendTrigger" and "StopTrigger" functions are required. See chapter 2.3 for more information on the Runtime Modes.

```
.....  
'   Sends trigger code '1'           '  
.....
```

```
Sub SendTrigger (c As Context)
```

```
    Serial.WriteByte 1  
    Serial.FlushInBuffer
```

```
End Sub
```

```
.....  
'   Sends trigger code '0'           '  
.....
```

```
Sub StopTrigger (c As Context)
```

```
    Serial.WriteByte 0  
    Serial.FlushInBuffer
```

```
End Sub
```

4.5 Setup: MATLAB

The compatibility of the MMBT-S has been tested in MATLAB running under macOS Mojave (10.14). Use the below sample code to connect and send trigger markers to a connected MMBT-S in MATLAB. Make sure to replace and use the appropriate port name of the connected MMBT-S (see chapter 4.2).

```
myPort = serial('/dev/tty.usbmodem1421');  
set(myPort, 'BaudRate', 9600);  
fwrite(port_handle, trigger_val); % trigger_val = any arbitrary trigger  
code (0-255)
```

Check out the GitHub repository from Dr. Niko Busch, for an easy integration and access to the MMBT-S using MATLAB functions:

<https://github.com/nabusch/NeurospecTriggerBox>

4.6 Setup: PsychoPy, Psychology software in Python, Peirce JW

The compatibility of the MMBT-S has been tested in Python and PsychoPy running under Windows 10. Use the following sample code to connect and send triggers from PsychoPy or within your Python 3 script. Make sure to replace and use the appropriate port name of the connected MMBT-S (see chapter 4.2).

Note: this sample script requires the open source library “pyserial” to be installed.

```
Import serial

Ser = serial.Serial()

Ser.port = 'COMx' # replace COMx with the actual COM port name
Ser.open()

# Send trial trigger code
Trigger = 5 # trigger code must be between 1-255
Ser.write(bytes(chr(Trigger)), 'UTF-8')

# End of script
Ser.close() # important before ending code!
```