

# **Modular Behavioral System**

## General Overview & Parts of the System

User Manual

**SUPERTECH** Instruments

## **General Description**

Supertech Instruments provides high quality instrumentation for neuroscience and physiological research applications. Behavioral physiology is one of our featured fields. Research of learning and memory requires special data acquisition and control systems with unique peripheral interfaces to interact with the behaving lab animals.

Modular Behavioral System is a complete, integrated hardware/software system to study the learning, memory and behavioral activity of the experimental animals. In this description both of the words "module" and "unit" are used as synonyms, because their meaning is the same in this context: a detachable part of the Modular Behavioral System. Modular Behavioral System consists of a power supply module, a microcontroller-based system controller unit, different peripheral control units and a Windows-based behavioral control program.

Behavioral physiology requires great versatility and variability of the measuring equipments, because the experimental paradigms are changed frequently. The most important aspect was the flexibility in the development process of the Modular Behavioral System. Its base feature is the modularity. The hardware configuration can be rearranged in minutes by the researcher. On the hardware side the system controller unit can process up to 12 event control signals simultaneously. In the hardware the number of the input and output signals is not restricted, only their total number is limited to 12.

"Automated Stimulus Control" program offers a simple but powerful graphical interface to design any interactive behavioral task and provides the sampling, collection and recording of the experimental data. The individual setup configurations can be saved and loaded. "Automated Stimulus Control" program is a subject of continuous development. You can find its actual features on the product description page of the Modular Behavioral System.

The peripheral units of the Modular Behavioral System send or receive the event control signals from/to the experimental environment. On the one hand the peripheral control units communicate with the system controller via an internal system bus. On the other hand the peripheral control modules communicate with the external peripheral devices on standard TTL level. This way (using TTL level at the inputs and outputs) any third-party peripheral circuit and any newly developed peripheral equipment can be connected to the Modular Behavioral System any time.

## **Security Rules**

The general security rules of the mains-supplied electronic devices must be kept as always. In the Modular Behavioral System in most of the cases there is one of the shockers (DC Shocker or AC Shocker) installed. The shockers are constant current generators, operating on very high compliance voltages. Furthermore the shocking grids are big, free and can be touched by hand. The maximal output current of the DC Shocker or the AC Shocker is more than enough to force the human heart to stop. Be extremely careful if you use these equipments.

Please read through the Security Rules section in the User Manual of the DC Shocker, too.

## **Parts of the System**

The number and type of the peripheral units in the Modular Behavioral System is flexible. They can be ordered independently of each other, according to the actual requirements of the experimental paradigm. There are three base components, which should always be involved in every system. They are the Power Supply Module MBPS-3, the 12-bit USB System Controller and the control program.

Currently the following hardware components of the Modular Behavioral System are available:

- Power Supply Module MBPS-3
- 12-bit USB System Controller
- 4-channel TTL Input Control Module
- 4-channel TTL Output Control Module
- Sound Generator End-stage
- DC Shocker Controller PDC-2
- DC Shocker DCS-4 (1-channel, floating, isolated)

## **Further development**

Until now we have developed the above listed modules for the Modular Behavioral System. Since the research of learning and memory raises new challenges for the scientists day by day, you may not find the appropriate peripheral module for your special task in our actual choice. If the desired unit of yours seems to be interesting for other researchers as well, Supertech Instruments will develop that equipment especially for you. It is our method, how we improve the features of our system. We collect all the notices and feedbacks of our customers, and we implement their (may be your) knowledge into the features of the Modular Behavioral System.

## **Power Supply Module MBPS-3**

Power Supply Module provides the supply voltages for the components of the Modular Behavioral System. This unit establishes very accurate supply voltages with precise load and noise regulation. On the front plates of the peripheral components of the system there are indicator LEDs to show the presence of the supply voltages of the modules.

Power Supply Module MBPS-3 is available in 115 VAC or in 230 VAC mains voltage version.

## **12-bit USB System Controller**

This equipment is an intelligent unit based on a high-end AVR microcontroller operated by a built-in firmware. This unit is an interface between the control program running on the PC and the peripheral modules of the Modular Behavioral System.

On the left side of its front plate there is the USB connector to the PC. This USB port is the communication channel between the PC and the firmware in the 12-bit USB System Controller.

Next to the USB connector there is a green LED. It shows if the USB cable is correctly connected to the PC.

On the right side of the front plate of the 12-bit USB System Controller there is a green LED showing the presence of the 13.5 V supply voltage.

12-bit USB System Controller is the origin, the master of the digital input/output lines of the system bus. The system bus consists of 12 digital input/output lines. They are numbered from 2 to 13. You can find detailed information about the usage of the digital input/output lines in the Controls on the Bottom Sides of the Peripheral Units section.

## **4-channel TTL Input Control Module**

The four pieces of BNC connectors are the digital inputs of the TTL Input Control Module. They have identifier letters A to D instead of numbers. The reason is that the digital input/output lines of the system bus are numbered. This way they cannot be mixed up during the assignment process of the input/output lines of the 12-bit USB System Controller to the channels of the TTL Input Control Module.

Inputs: TTL / 3.3 V compatible, 0.5 unit-loads

The TTL standard describes the voltage and load specifications of the inputs and outputs of a digital logic system, what is supplied from 5V. Nowadays most of the microcontrollers and digital systems use 3.3V of supply voltage internally. The inputs of the TTL Input Control Module are universal. They are fully compatible with the standard TTL specification. Furthermore they accept the logic levels of the non-standard-TTL 3.3V systems correctly, with optimal noise margins, too.

Above the BNC input connectors there are indicator LEDs for every channel, respectively. They lit when high logic level signal is coming in to the given input. If no signal is connected to the inputs, weak pull-down resistors provide the accurate low logic levels as default.

On the right side of the front plate of the TTL Input Control Module there is a green LED showing the presence of the 5 V supply voltage.

## 4-channel TTL Output Control Module

The four pieces of BNC connectors are the digital outputs of the TTL Output Control Module. They have identifier letters A to D instead of numbers. The reason is that the digital input/output lines of the system bus are numbered. This way they cannot be mixed up during the assignment process of the input/output lines of the 12-bit USB System Controller to the channels of the TTL Output Control Module.

Outputs: TTL compatible, 10 unit-loads capability

**Warning!** The digital outputs produce standard TTL voltage levels. They must not be connected to the inputs of a 3.3 V digital system directly, because the 3.3 V inputs would be destroyed! There are special voltage translator circuits to solve this incompatibility.

Above the BNC output connectors there are indicator LEDs for every channel, respectively. They lit when TTL high level signal is coming out on the given output.

On the right side of the front plate of the TTL Output Control Module there is a green LED showing the presence of the 5 V supply voltage.

## Sound Generator End-stage

Audio Input of the Sound Generator End-stage is a stereo 3.5 mm jack. This input receives stereo signal from the sound output of the PC. The control program can use the advantage of the stereo sound capability of the PC. On the left and on the right channel two independent sound samples can be generated. After receiving the stereo signal from the PC, they are mixed together in the Sound Generator End-stage and amplified together as a mono signal.

Audio Output of the Sound Generator End-stage is a mono 6.3 mm jack.

Maximum output power (THD = 10%): 500 mW

Impedance range of the loudspeaker: 8 – 32 Ohm

Volume control: 10-turn helical potentiometer with scale accuracy of 0.001

The volume control of the Sound Generator End-stage is not usual. The reason, why it was designed such an expensive way was the repeatability. You can calibrate the sound level of the whole system once and you can reproduce the calibrated situation with the extremely precise scale of the volume control potentiometer any time.

On the right side of the front plate of the Sound Generator End-stage there is a green LED showing the presence of the 13.5 V supply voltage.

For the Sound Generator End-stage we provide a suitable wideband loudspeaker as an accessory.

## **Connectors on the Back Sides of the System Components**

On the back side of every component of the Modular Behavioral System there are two pieces of 40-pin Berg sockets. These two sockets are internally connected parallel. Physically it is the system bus. In the Modular Behavioral System the 40-wire cables are used to connect the functional units (in other word modules) of the system together. Every equipment in the system must be interconnected on the system bus. The sequence of the interconnections is not important; the cabling should be done on the least messy way with the 40-pin cables.

The 40-wire cables provide the supply voltages and the bidirectional control signals for the operation of the units. Since the 40-pin cables form a system bus, there are three basic rules for the interconnection of the system. These rules assure that every module gets supply voltages and has access to the control signals:

- 1) Power Supply MBPS-x and the 12-bit USB System Controller units should be connected together by a 40-wire cable.
- 2) The system bus (formed by the 40-cables) should start from either the Power Supply MBPS-x or the 12-bit USB System Controller module.
- 3) Every unit of the system should be connected to at least one more module.

## **Controls on the Bottom Sides of the Peripheral Units**

On the bottom side of every peripheral module you can find a small window on the enclosure covered with a small plastic plate. If you open the screws of the cover you can find the selector matrix. By the selector matrix you can assign the input/output lines of the 12-bit USB System Controller to the channels of the given peripheral unit.

There are two figures in the end of this User Manual. They show and explain the details of the selector matrices of the single-channel and the 4-channel peripheral units, respectively.

Putting a jumper cap onto a cross point of the matrix means a short circuit between the row and column wires. The jumper cap connects the row and column wires.

The selector matrices have 12 columns. They are the digital input/output lines of the 12-bit USB System Controller. They are numbered from 2 to 13.

### **Single-channel Peripheral Modules**

In every single-channel peripheral module the selector matrix has got only one row. Its name is SEL. Electrically the SEL wire is the input or the output of the given unit.

In every single-channel peripheral module only one jumper cap should be used. If you do not put any jumper cap on any cross point of the selector matrix, it is logically equals to that situation if the peripheral unit would have been removed from the system.

In a single-channel peripheral module it is prohibited to assign more than one input/output lines to the actual unit. In other words it is prohibited to put on more than one jumper caps on the selector matrix.

#### **4-channel Peripheral Modules**

In every 4-channel peripheral module the selector matrix has got four rows. Their names (from A to D) represent the channels of the module. The wires from A to D are the inputs or the outputs of the respective channels of the given peripheral unit.

In every 4-channel peripheral module a maximum number of four jumper caps should be used, only one jumper cap in any row and only one jumper cap in any column of the selector matrix. If you do not put any jumper cap on a row of the selector matrix, it is logically equals to that situation if the respective channel of the peripheral unit is removed from the system (that channel is inactive).

In a 4-channel peripheral module it is prohibited:

- 1) To assign more than one input/output lines to one given channel.
- 2) To assign more than one channels to one given input/output line.

The above paragraph can be expressed easier in other words: it is prohibited to put on more than one jumper caps either in one column or in one row of the selector matrix.

#### **Warning about the System Bus**

On the top of the above listed restrictions for the individual peripheral units you have to take care of the same I/O line assignment aspects for the whole Modular Behavioral System. It is prohibited to assign any of the input/output lines of the 12-bit USB System Controller to more than one peripheral channel even in the whole system! When you put the jumper caps on the selector matrices you should compare the settings of all the peripheral modules against each other to assure the "one I/O line – one channel" aspect.

A faulty (redundant) I/O line assignment can even destroy the involved I/O lines of the 12-bit USB System Controller or the internal circuits of the peripheral modules, because electrically a redundant (doubled) I/O line assignment means a shortcut of the output driver circuits!

#### **First Time Installation and Setup**

Before connecting the components of the Modular Behavioral System together with the 40-wire bus cables the correct setup of the selector matrices should be done (see the Controls on the Bottom Sides of the Peripheral Units section).

Please connect all the cables:

Mains cable of the MBPS-x Power Supply unit

40-wire bus cables of the Modular Behavioral System

USB cable between the PC and the 12-bit USB System Controller

TTL input and output cables between the peripheral control units of the system and the external peripheral units (e.g. Touch Detector, LED Driver Unit, Spout Controller, etc.)

Loudspeaker cable to the output of the Sound Generator End-stage

Sound cable between the PC and the input of the Sound Generator End-stage

TTL control cable from an output of a peripheral control unit to the Start Input of the DC Shocker Controller

TTL control cable from the output of the DC Shocker Controller to the Shocker

Output cables of the DC Shocker to the shocking grid

After finishing the cabling switch on the Power Supply MBPS-x and the system is ready to use.

Install the control program on the PC.

Start the control program on the PC.

## **Warranty**

Supertech Instruments gives you 5 years of full warranty for electronic products and 3 years of full warranty for mechanical products by default. Longer warranty periods can also be defined and agreed (the actual conditions should be discussed before placing the order).

Supertech Instruments gives you full warranty for its products against defects in materials or workmanship as long as the equipment has been subjected to normal and proper use. During the warranty period, faulty products will be repaired or replaced free of charge provided they are returned to our workshop. Postage of the warranty repair actions is paid by the Customer. The exceptions are the Vibration Isolation Tables. There are special conditions introduced for repairing of Vibration Isolation Tables (see the appropriate User Manual). Supertech Instruments will undertake the servicing and calibration after the expiration of the warranty period for a nominal fee.

The warranty does not cover the faults made by the user.

The measuring equipments manufactured by Supertech Instruments are for experimental and/or lab animal purposes only and are not intended for human use.

Electrical safety measurements of proper operation of the 115 / 230 V AC mains electric system (from the equipments have been supplied) is the sole responsibility of the user.

You can find the general commercial and warranty conditions in the beginning of the Price List page of our website.

For every component of the Modular Behavioral System an additional warranty limitation is introduced. These equipments require very accurate supply voltages with precise load and noise regulation. MBPS-x Power Supply unit of the Modular Behavioral System is able to meet these requirements. Supertech Instruments provides 5 years of warranty for the components of the Modular Behavioral System (e.g. for the DC Shocker Controller) only in that case if they are supplied from a MBPS-x Power Supply unit.

## **Further Information Sources**

As the first step for further technical information please visit our website(s). On the website of Supertech Instruments you can find related products and further information.

On the Download page of our website you can find many more useful documents to support our products. Please check the list of the available documents.

Technical hotline via email (all of them work):

[office@superte.ch](mailto:office@superte.ch)

[office@supertechinstruments.co.uk](mailto:office@supertechinstruments.co.uk)

[office@super-tech.eu](mailto:office@super-tech.eu)

International technical hotline on the phone: + 36 20 9234 386

Supertech Instruments continuously uses several domain names (websites) with the same content. Please use that one, which is the easiest for you to remember:

[www.superte.ch](http://www.superte.ch)

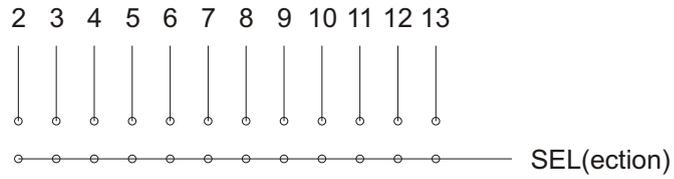
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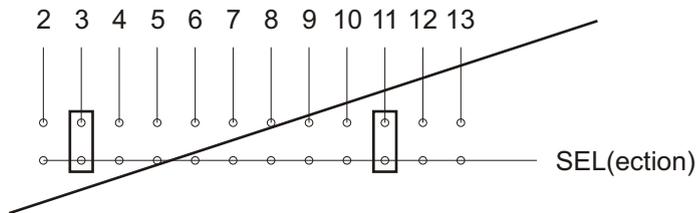
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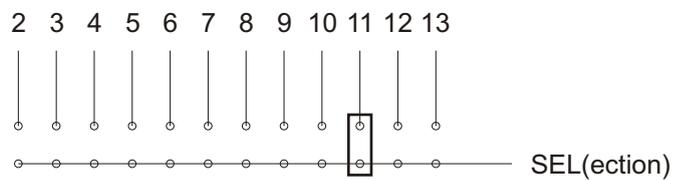
Digital Input / Output Lines of the  
12-bit USB System Controller



**Wiring Topology of the Selector Matrix**



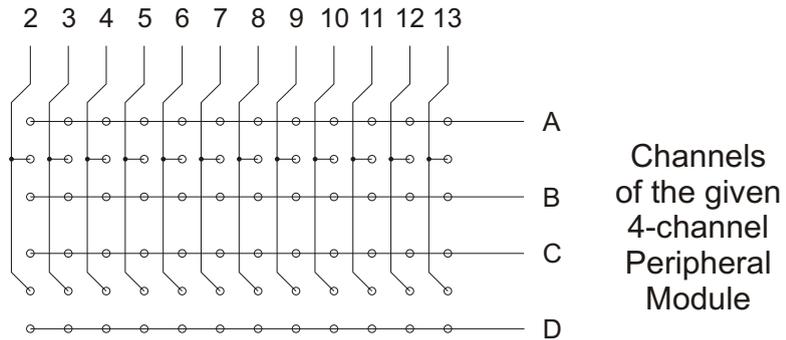
**FAULTY Setup! Two I/O Lines  
Are Assigned to This Module**



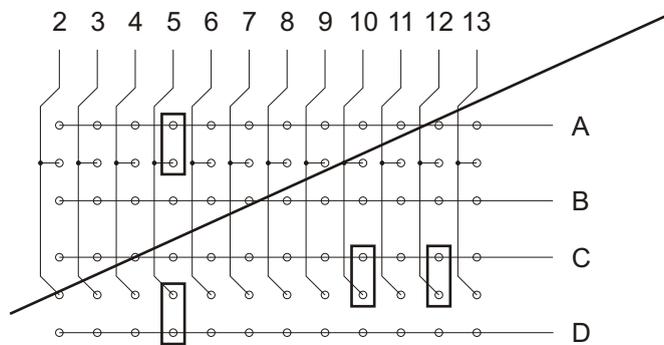
**GOOD Setup. I/O Line 11 Has  
Been Assigned to This Module**

**Assignment of the Input / Output Line to the Single-Channel  
Peripheral Unit of the Modular Behavioral System**

Digital Input / Output Lines of the  
12-bit USB System Controller

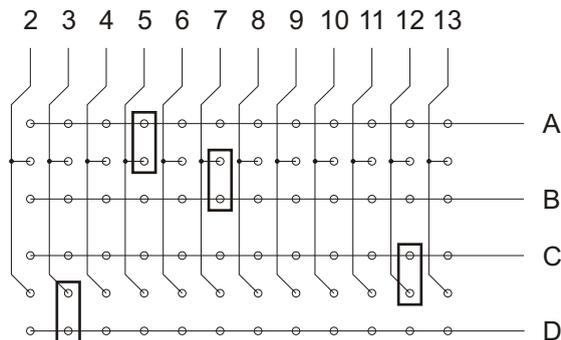


Wiring Topology of the Selector Matrix



**TWO FAULTS!**

- 1) I/O Line 5 is Assigned to Two Channels (A and D)
- 2) Two I/O Lines (10 and 12) are Assigned to Channel C



**GOOD Setup. I/O Line Assignments to  
Channels: 3 to D, 5 to A, 7 to B, 12 to C**

**Assignment of the Input / Output Lines to the Channels in a  
4-Channel Peripheral Unit of the Modular Behavioral System**