Instruction manual

UniTrain-I System
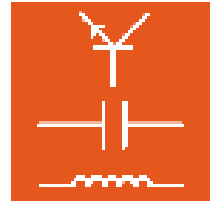
SO4203-2A Interface
SO4203-2B Experimenter

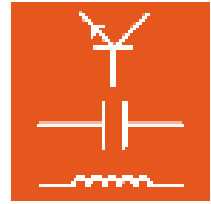4th Edition

www.lucas-nuelle.com   www.unitrain-i.com

UniTrain-I System

Contents

UniTrain-I System

Preface

This instruction manual is written to be read, understood and complied with in every respect by persons intending to use the training system.

It contains basic tips and instructions to be observed during assembly, operation, maintenance, disassembly and disposal involving the training system.

For that reason, this manual must be read through carefully before assembly by any teaching staff, students or other users. Only the information in this manual can prevent errors and ensure faultless operation.

Name and Address of manufacturer

Manufacturer and servicing address

LUCAS-NÜLLE GmbH
Siemensstr. 2
D-50170 Kerpen

Tel.: +49 (0) 22 73 5 67-0
Fax: +49 (0) 22 73 5 67-30

www.lucas-nuelle.com
www.unitrain-i.com

Legal information

Liability limitations

LUCAS-NÜLLE GmbH accepts no liability for any damage occurring due to the following:
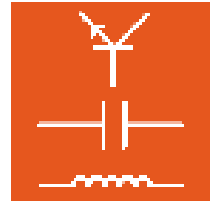
- Inappropriate or incompetent use
- Irresponsible or incorrect assembly and/or commissioning by operators or third parties
- Subsequent modifications by operators or third parties
- Natural wear and tear
- Negligent or incorrect handling, servicing or maintenance
- Actions not in keeping with the instruction manual
- Use of inappropriate materials

Copyright/authorisation

This instruction manual is authorised for the use of teaching staff and students.

The instruction manual contains specifications and drawings of a technical nature. These may not be reproduced distributed, utilised without permission for competitive advantage or passed on to others either in part or in full.

The making of copies, including extracts, is expressly permitted to users of the training system, but only for internal use in connection with the operation of the equipment.

UniTrain-I System

1. Correct usage

The UniTrain-I system is a computer-based training and experimentation system for vocational and further training and education in the areas of basic and advanced electrical engineering and electronics.

Its multimedia courses combine cognitive and hands-on (haptic) training units into a comprehensive unified concept, specifically enabling students to acquire skills in the handling of equipment. Starting with basic courses and advancing to cover a huge variety of electrical engineering and electronics topics, a wide range of multimedia courses is available for study in school or in professional and advanced training courses.

With the fixed voltages, the adjustable AC and DC voltages, the variable three-phase system along with countless virtual instruments, all the power resources and measuring equipment needed to perform experiments are available. These short circuit-proof sources use safe extra-low voltage and therefore provide the electronics novice with a secure learning and experimenting environment.

All devices are intended for indoor use only.

2. Safety instructions

Interface and Experimenter are designed in accordance with Protection Class III and are intended exclusively for low-voltage operation:

- **Only use the included power supply unit SO4203-2A and, where appropriate, the extended power supply unit SO4203-2D. Other power supply units are potentially hazardous and may cause destruction of the Interface.**

- **Opening power supply units is life threatening**

- **Defective or damaged power supply units should immediately be disconnected from the mains and sent away for repair**

- **Never supply the devices with voltages other than those from the power supply units SO4203-2A or SO4203-2D.**

- **Never measure voltages in excess of 25V RMS or 60V DC at the analog inputs**

- **Observe the limiting values of all inputs and outputs**

- **Make sure that the Interface and Experimenters are placed on a firm, level surface (e.g. a table) when connecting them together. Ensure that the Interface and Experimenters are not tilted when they are joined together to avoid bending the pins of the 96-pin terminal strip.**

- **When extracting experiment cards from the Experimenter, grip the cards underneath on the left-hand side only to avoid trapping fingers on the IrDa interface housing.**
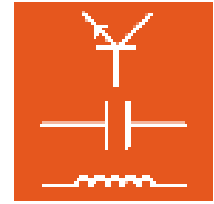
3. Overview

The *UniTrain-I Interface* is the central unit of the UniTrain-I system and provides the inputs, outputs, relays and measuring equipment necessary for experiments. It contains its own microprocessor and a memory chip for measured data. The USB interface is for connecting the experimenting hardware to the computer and transferring measured data to the computer and adjustment data to the interface. It is also possible to update the firmware (interface operating system) at any time via the USB port.

Operation and adjustment of the hardware and real-time measurements in actual experiments are performed using *virtual instruments (VI)* displayed on a computer monitor. The "virtual" controls on realistic laboratory equipment make it possible to implement "classic" laboratory procedures. The virtual instruments (VIs) are provided with the VI-starter package or the optional *LabSoft* software.

The *LabSoft* software is included with the courses that accompany the experiment cards. It augments the system, making it into a powerful experimenting platform for autonomous or guided experiments.

UniTrain-I Interface is designed for connection to one or more *UniTrain-I Experimenters*. The UniTrain-I Experimenters supply more fixed or variable experiment voltages and contain an infrared interface. The UniTrain-I Interface, the UniTrain-I Experimenters and the experiment cards are connected to each other via a bus (96-pin connector). The Experimenters serve three different functions

- A holder for Eurocard-sized experiment cards. Unitrain courses are available with experiment cards for a variety of different experiments, from Ohm's law, electrical engineering/electronics and digital technology to power electronics, automatic control technology and communications engineering using the Eurocard format.

- Breadboard experiment system (with an optional supplement: SO4203-2C); an infinite number of different experiments on all topics of electrical engineering and electronics is possible with wired components and ICs.

- Docking station for multimeters (e.g.: MetraHit One Plus or LN Multi 13S) for communication between the real and virtual multimeter.

Includes

UniTrain-I Interface **SO4203-2A**	UniTrain-I Interface, standard power supply unit, mains cable, USB cable, CD-ROM with the basic virtual instruments and VI starter
UniTrain-I Experimenter **SO4203-2B**	UniTrain-I Experimenter
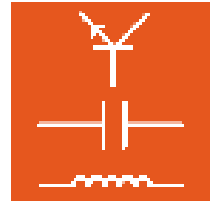
4. Initial installation of software

The CD included with the Interface contains the basic VIs (virtual instruments) with which most measurements and experiments can be performed.
The *VI Starter* program is also available for launching the instruments separately.

Requirements

To use the software you need:

- A personal computer with a running version of Microsoft® Windows Vista, 7, 8 or 8.1
- CD-ROM drive for installing software
- Unused USB port for the Interface
- At least 500MB of hard disc space for installing LabSoft. VI Starter needs about 50 MB.

Installation

> **Note:** If a LabSoft course is included, use the CD provided with the course to install the software. The CD supplied with the Interface is only needed if VI Starter is to be installed as well.

- Place the CD in the CD-ROM drive.
  If your computer is configured to run CDs automatically, the window with the installation wizard will appear automatically. If this is the case, you can go straight to the next step.
- Select **"Run"** from the Start menu. Enter the following command into the box that appears *d:\cdstart.exe* (the letter "**d**" at the beginning of this command may need to be replaced by the actual drive letter for your CD drive).
- Click on the text "Install software" to start the installation.

> **Important:** To install the software, it is necessary to have the Windows Installer set up on your system. If this is not available, it will be installed from the CD before the actual software is set up.

- Follow the instructions given by the Setup wizard.

The installation program copies the necessary files to your hard disk and adds a program group to the Start menu.

> **Important:** The first time you connect the Interface to the USB port, your computer will recognise the new hardware and activate a wizard. You will be asked to enter a source path for a suitable driver. You should enter the path to the CD ROM drive since the driver is located in the root folder of the CD provided.
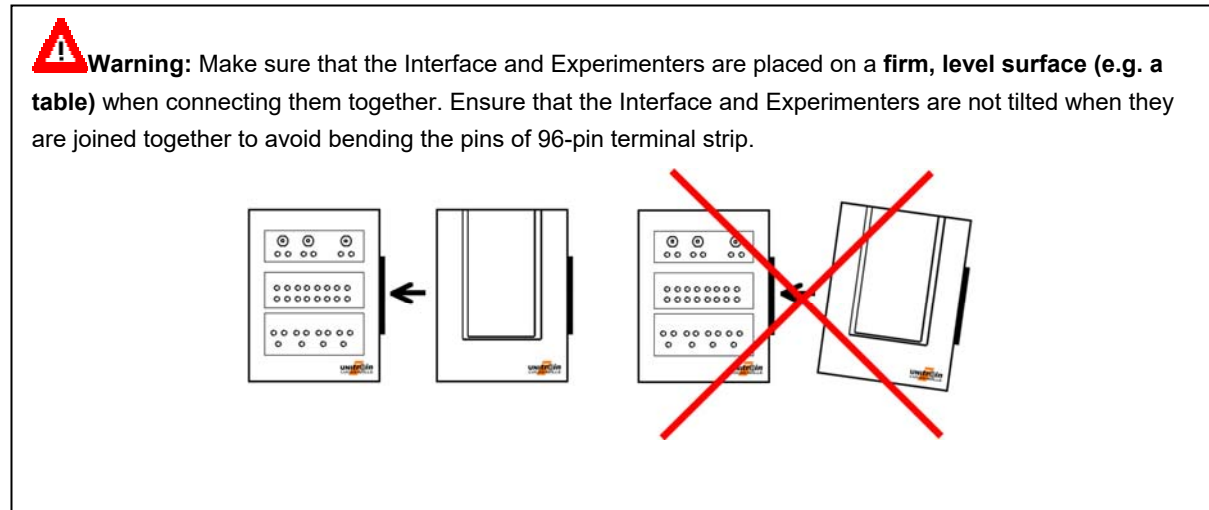> When installing under Windows Vista warnings from the operating system may appear during configuration of the driver. Ignore these warnings and continue with the installation.

A detailed description of how to install the software is provided in the section entitled "Instructions for installing LabSoft".
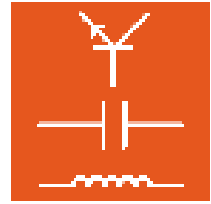
5. Handling

Connect the interface to one or more Experimenters. The number of Experimenters which can be connected is not limited and depends on the experiment. However, in most cases it does not exceed four.

⚠️**Warning:** Make sure that the Interface and Experimenters are placed on a **firm, level surface (e.g. a table)** when connecting them together. Ensure that the Interface and Experimenters are not tilted when they are joined together to avoid bending the pins of 96-pin terminal strip.


Equip the experimenter with the necessary experiment cards or with the breadboard and/or multimeter.

Set up the experiment and connections in accordance with the experiment instructions.

Connect the standard power supply to the socket at the rear of the Interface (see Chapter 6 Interface connection no. 10). Both power supply sockets are protected against polarity reversal.

If you require the variable voltage outputs V1, V2 and V3, then connect the additional power supply unit to the appropriate socket on the rear of the interface (see Chapter 6 Interface connection no. 9).
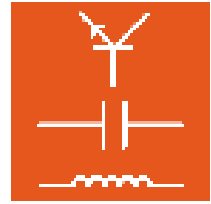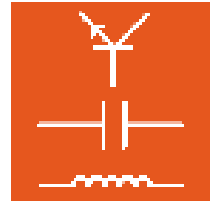
Connect one or both power supplies to the mains. Thanks to the power supplies' wide input range, they can be used worldwide without any changes to the operation of the equipment.

Connect the Interface to an unused USB port of the computer

Run the VI Starter or LabSoft software. All the virtual instruments are now at your disposal and you can start working.
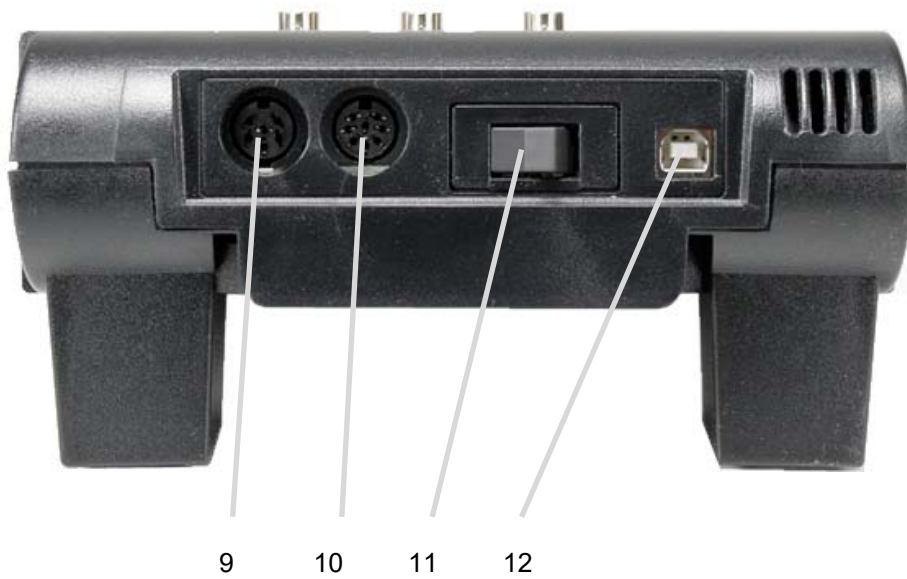
TIP: When using an Experimenter as a docking station for multimeters it is best if you use the Experimenter connected as far as possible to the right-hand side.
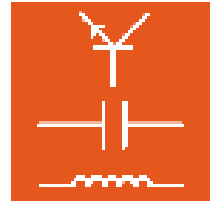
6. Interface control elements and connections

1   2   3   4   5   6   7   8

9   10   11   12

1. Relay field
   Relays can be used for general switching tasks, e.g. for discharging a capacitor. Of the total 8 relays, the first 4 are also connected to 2-mm sockets for experiments to be wired manually.

   Warning: For Eurocards with fault simulation capabilities, feeding voltage to the relays can result in malfunctions.

2. Digital outputs D0 to D7
   Of the total of 16 digital outputs, the first 8 are also connected to 2-mm sockets for experiments to be wired manually. The common earth for the digital outputs is available on the Experimenter (section E7) or analog output field (section I7).
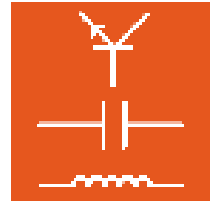
3. Digital inputs D0 to D7
   Of the total of 16 digital inputs, the first 8 are also connected to 2-mm sockets for experiments to be wired manually. The common earth for the digital inputs is available on the Experimenter (section E7) or analog output (section I7).
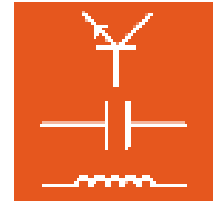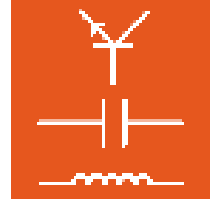
4. 96-pin terminal strip

Pin	Description of 96-pin terminal strip		
	Row A	Row B	Row C
1	Internal interface RxD	Digital input bit 0	GND
2	Internal interface TxD	Digital input bit 1	GND
3	NC	Digital input bit 2	Data bus1 bit 0
4	NC	Digital input bit 3	Data bus1 bit 1
5	NC	Digital input bit 4	Data bus1 bit 2
6	NC	Digital input bit 5	Data bus1 bit 3
7	Fault switch 8 NO contact	Digital input bit 6	Data bus1 bit 4
8	Fault switch 8 changeover contacts	Digital input bit 7	Data bus1 bit 5
9	Fault switch 8 NC contact	Digital input bit 8	Data bus1 bit 6
10	Fault switch 7 NO contact	Digital input bit 9	Data bus1 bit 7
11	Fault switch 7 changeover contacts	Digital input bit 10	Data bus1 bit 8
12	Fault switch 7 NC contact	Digital input bit 11	Data bus1 bit 9
13	Fault switch 6 NO contact	Digital input bit 12	Data bus2 bit 0
14	Fault switch 6 changeover contacts	Digital input bit 13	Data bus2 bit 1
15	Fault switch 6 NC contact	Digital input bit 14	Data bus2 bit 2
16	Fault switch 5 NO contact	Digital input bit 15	Data bus2 bit 3
17	Fault switch 5 changeover contacts	Digital output bit 0	Data bus2 bit 4
18	Fault switch 5 NC contact	Digital output bit 1	Data bus2 bit 5
19	Fault switch 4 NO contact	Digital output bit 2	Data bus2 bit 6
20	Fault switch 4 changeover contacts	Digital output bit 3	Data bus2 bit 7
21	Fault switch 4 NC contact	Digital output bit 4	Data bus2 bit 8
22	Fault switch 3 NO contact	Digital output bit 5	Data bus2 bit 9
23	Fault switch 3 changeover contacts	Digital output bit 6	COM variable voltages
24	Fault switch 3 NC contact	Digital output bit 7	Variable voltage V3
25	Fault switch 2 NO contact	Digital output bit 8	Variable voltage V2
26	Fault switch 2 changeover contacts	Digital output bit 9	Variable voltage V1
27	Fault switch 2 NC contact	Digital output bit 10	Reserved IRDA TX
28	Fault switch 1 NO contact	Digital output bit 11	Reserved IRDA RX
29	Fault switch 1 changeover contacts	Digital output bit 12	-15V
30	Fault switch 1 NC contact	Digital output bit 13	-15V
31	+5V	Digital output bit 14	GND
32	+5V	Digital output bit 15	+15V

5. Analog differential amplifier input - BNC socket and simultaneously 2-mm sockets A+ and A-.

6. Analog differential amplifier input - BNC socket and simultaneously 2-mm sockets B+ and B-.

7. High-speed analog output - BNC socket and simultaneously 2-mm sockets S and GND. The analog output is normally used for the function generator.

8. Status display,
   LED lights when power is being provided by the power supply.

9. Connection to extended power supply SO4203-2D
   The extended power supply is only necessary for experiments using the outputs V1, V2 and V3. See Experimenter, section 5

10. Connection of main power supply SO4203-2A
    The main power supply must be connected to the Interface here and provides isolated voltages for the Interface's own electronics as well as for the experiments. Voltage outputs for experiments are also available from the Experimenter.

11. On/off switch
    An on/off switch disconnects the Interface from the supply of power from the SO4203-2A and SO4203-2D power supplies.

12. Connection to USB port
    To operate VIs on the computer, a USB port is needed. Connect the Interface to the computer using the USB cable provided.

7. Experimenter control elements and connections

1   2   3   4   5   6   7   8   9   10   11

12
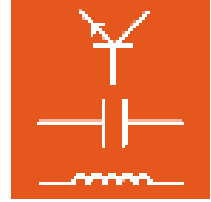
1. Button for ejecting experiment cards.

2. 96-pin terminal strip for connecting experiment cards
   For pin assignment see Chapter 6, Interface, section I 4

3. 96-pin terminal strip for connecting Experimenter to Interface or other intervening Experimenter
   For pin assignment see Chapter 6, Interface, section I 4 (pins 27c and 28c are not connected, though)

4. Breadboard seating (SO4203-2C)
   Hold the breadboard (SO4203-2C) in your hand such that the lugs are on the right-hand side. Insert the breadboard into the Experimenter such that the lugs are pressed into the appropriate openings in the Experimenter and such that the entire breadboard is supported.

5. Track for UniTrain-I experiment cards
   Insert the UniTrain-I experiment cards into the track from above until you hear and feel the connectors snapping into place.
   Warning: When removing the cards, only reach in under the left-hand side of the cards as otherwise you could injure your finger(s) on the IrDa interface.

6. Three variable voltage outputs V1, V2 and V3 with common earth COM. These power outputs are intended as an adjustable DC, AC and 3-phase supply unit. In contrast to conventional supply units for alternating or 3-phase current, which use fixed-ratio or variable transformers, here it is possible to finely adjust both the amplitude and the frequency. To ensure maximum latitude when performing experiments, this power supply is absolutely electrically isolated from the rest of the UniTrain-I system.
   To optimize the efficiency, the output voltages are reached using a switched-mode power supply unit. To achieve this, the output voltages are operated in the switching mode at high frequency and pulse width modulated in accordance with the desired waveform and frequency. The three-phase LC filter reconstructs the desired low-frequency output voltage and suppresses the high-frequency modulation or clock frequency.

7. 96-pin terminal strip for connecting to other Experimenters
   For pin assignment see Interface, section I 4

8. Fixed voltage outputs

9. Recess for multimeter

10. Infrared interface with transmitter and receiver diode

11. Status display

12. Connection for standard power supply unit: The Experimenters can also be operated without the Interface. To supply fixed voltages for the experiments, the standard power supply unit may be connected to socket E 11 on the side. Then the three fixed voltages +15V, +5V and –15V are available via the terminal strips and 2-mm sockets. If the Experimenter is to be connected to an Interface, this connection is not available because then the standard power supply unit must be connected to the Interface.
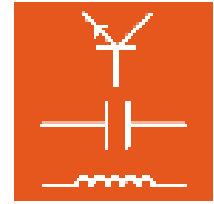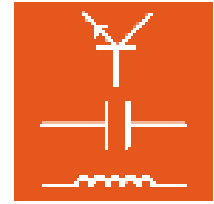
8. Technical data

Standard power supply unit

Supply voltage	100-250 V; 1.0-0.5 A; 50-60 Hz
Interface outputs	5V, 1A; 15 V 0.4 A; -15 V / 0.4 A via 1.5m cable and 8-pin DIN connector
Experimenter outputs	5V, 1A; 15 V 0.4 A; -15 V / 0.4 A via 1.5m cable and 8-pin DIN connector
Mains connection	via supplied mains cable for non-heating appliances 1.5m

Interface

Housing	Material ABS, dimensions: 28cm x 18cm x 9cm Weight 1.2 kg
Processor	32-bit processor, clock frequency 20 MHz 256 KB RAM 256 KB FLASH
Inputs/outputs	34 2-mm sockets Analog signals also via 3 BNC sockets Standard power supply unit via 8-pin DIN socket Additional power supply unit via 6-pin DIN socket USB interface 96-pin terminal strip, female, for connecting Experimenter
High-speed analog output/ Function generator	High-speed analog output for periodic or single output of freely programmable voltages Waveforms: square with adjustable pulse-duty factor, triangular, sinusoidal, freely programmable (arbitrary) Output voltage: ±10 V Output current: max. ±200 mA Frequency range: 0...1 MHz
Analog power supply unit outputs	Three analog power outputs for periodic or single output of freely programmable voltages. Intended primarily as adjustable DC, AC or 3-phase power supply unit. Waveform: sinusoidal, freely programmable (arbitrary) Output voltage: $\pm$ 20 V DC or 14 V RMS Output current: max. 1 A DC or 2 A AC (total current) Frequency range: 0...150 Hz Clock frequency: 10 kHz ... 35 kHz Tapped from 96-pin terminal strip or 2-mm sockets on Experimenter
Analog inputs	Two high-speed differential measurement inputs Input sockets: A and B to BNC and 2-mm sockets Input impedance: diff.1 MΩ || 30pF Maximum voltage: diff. 100 V 2 x AD converters: sampling frequency up to 2 x 40 MS; resolution 10 bit Measurement ranges: 10V/div, 5V/div, 1V/div, 500mV/div, 200mV/div, 100mV/div, 50mV/div, 20mV/div (sampling oscilloscope) $\pm$50V, $\pm$20V, $\pm$10V, $\pm$5V, $\pm$2V, $\pm$1V, $\pm$500mV, $\pm$200mV,

		±100mV (voltmeter)
	Memory:	2 x 16K x 10 Bit
	Triggering	from A or B, rising or falling edge.
		Adjustable pre- or post-trigger
Digital outputs/digital signal generator	16 digital outputs for controls or as programmable digital signal source for testing digital circuits	
	Outputs:	16 outputs, 8 of which to 2-mm sockets
	Output voltage:	TTL / CMOS protected with 240 Ω
	Output current:	max. 3 mA with respect to GND
	Maximum voltage:	-15 V...15 V
	Clock frequency	0...100 kHz
Digital inputs/digital analyzer	16 digital inputs for detecting binary states and for use as a digital analyzer	
	Inputs:	16 inputs, 8 of which to 2-mm sockets
	Input voltage:	TTL- / CMOS-compatible, open = 0
	Maximum voltage:	±15 V
	Sampling frequency:	up to 100 kHz
	Triggering:	arbitrary combinations of input state (low, high, don't care)
	Memory:	2K x 16-bit
Relays	8 available (changeover) relays for use as a keyboard-operated switch or fault simulator, 4 of which to 12 2-mm sockets	
	Contact rating: 1 A / 24V DC	
Interfaces	USB 1.1	

Experimenter

Housing	Material ABS, dimensions: 28cm x 18cm x 9cm
	Weight 0.6 kg
Inputs and outputs	8 each to 2-mm sockets
	1 DIN socket, 8-pin for connecting the standard power supply unit
	96-pin VG terminal, male, for connection to the interface
	96-pin VG terminal, female, for connecting the experiment card
	96-pin VG terminal, female, for connecting other Experimenters Infrared interface (RxD and TxD)
Functions	Holder and connection for UniTrain-I experiment cards
	Holder for breadboards
	Docking station for multimeters

9. Manufacturer's note

The electronic compatibility (EMC) of the UniTrain-I system was tested in conjunction with the standard and extended, power supply unit. In this configuration, the system meets the following protection requirements specified by European law concerning the electromagnetic compatibility of appliances. The interference emitted by the UniTrain-I system remains below the permitted maximum value. The interference emitted by other devices will not infringe upon the minimum guaranteed performance level of the UniTrain-I system. Exposure to strong RF fields in the immediate vicinity (e.g. from mobile phones) may cause malfunctions.

.

Test range	European standard	German standard
Emitted interference	EN 55011 Class A, Group 1	VDE 0875-11 Class A, Group 1
Immunity to interference	EN 50082-1	VDE 0839-82-1