



pidb electricity



Plug-in board module system “demo” (PIBD) for electricity and electronics

A laboratory system featuring vertical experiment set-ups; this facilitates clear and easy-to-understand demonstrations of the principles of electrical and electronic circuits at an introductory and advanced level. Max. operating voltage allowed: 42 V (protected extra-low voltage)

- Clear overview of circuits
- Easy to set up
- Reliable electrical connections
- Modules stick to the board well

135 electricity experiments along with 115 electronics experiments

DE920-1A Plug-in panel, “demo”

Assembly panel for mounting and electrically connecting “demo” plug-in components (PIBDs); A total of 63 socket clusters, each consisting of four 4-mm sockets arranged 40 mm apart, which are not connected to each other, while adjacent socket clusters are connected electrically in every direction;

Back of the plug-in panel: metal panel, painted matt white; used as a magnetic panel especially for mechanics, thermodynamics and optics experiments with magnets; dimensions: approx. 800x632x34 mm

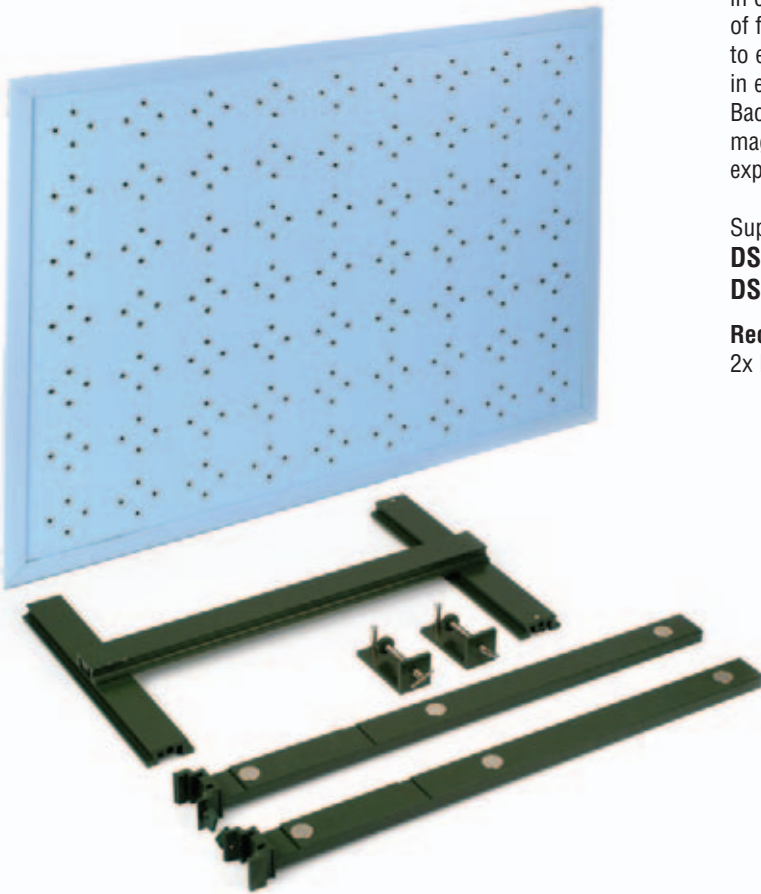
Support material for firmly mounting “demo” plug-in panel DE920-1A:

DS101-1G Support base, large, L=500 mm

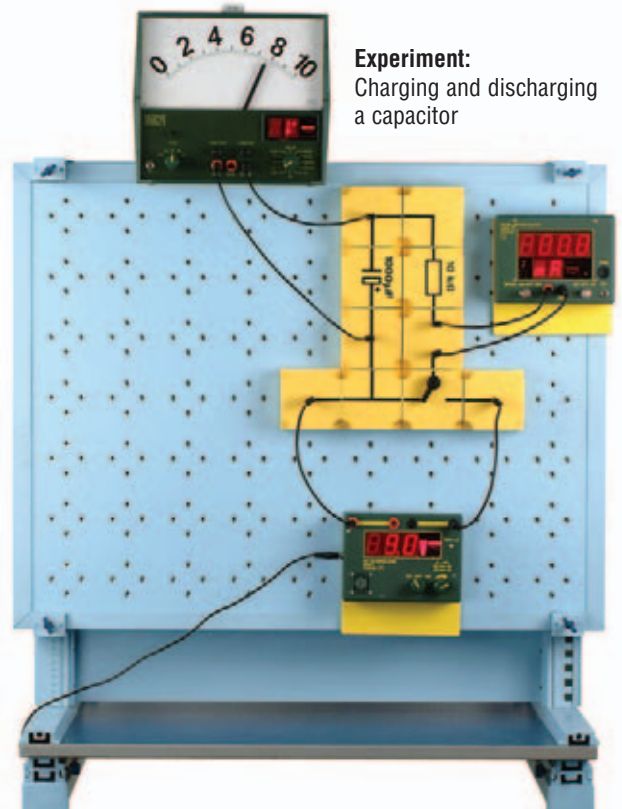
DS600-6G Board holders, pair, magnetic

Recommended accessory:

2x DS500-1G screw clamps, jaw width approx. 50 mm



If the NTL assembly panel (DS602-2A) or the NTL laboratory bench (DS602-2K) is available, the demo plug-in panel DE920-1A can be mounted vertically on either of them using a pair of DS503-1P panel holders

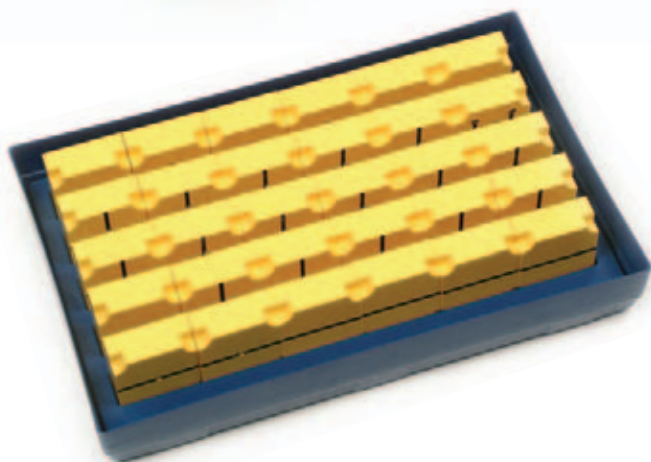
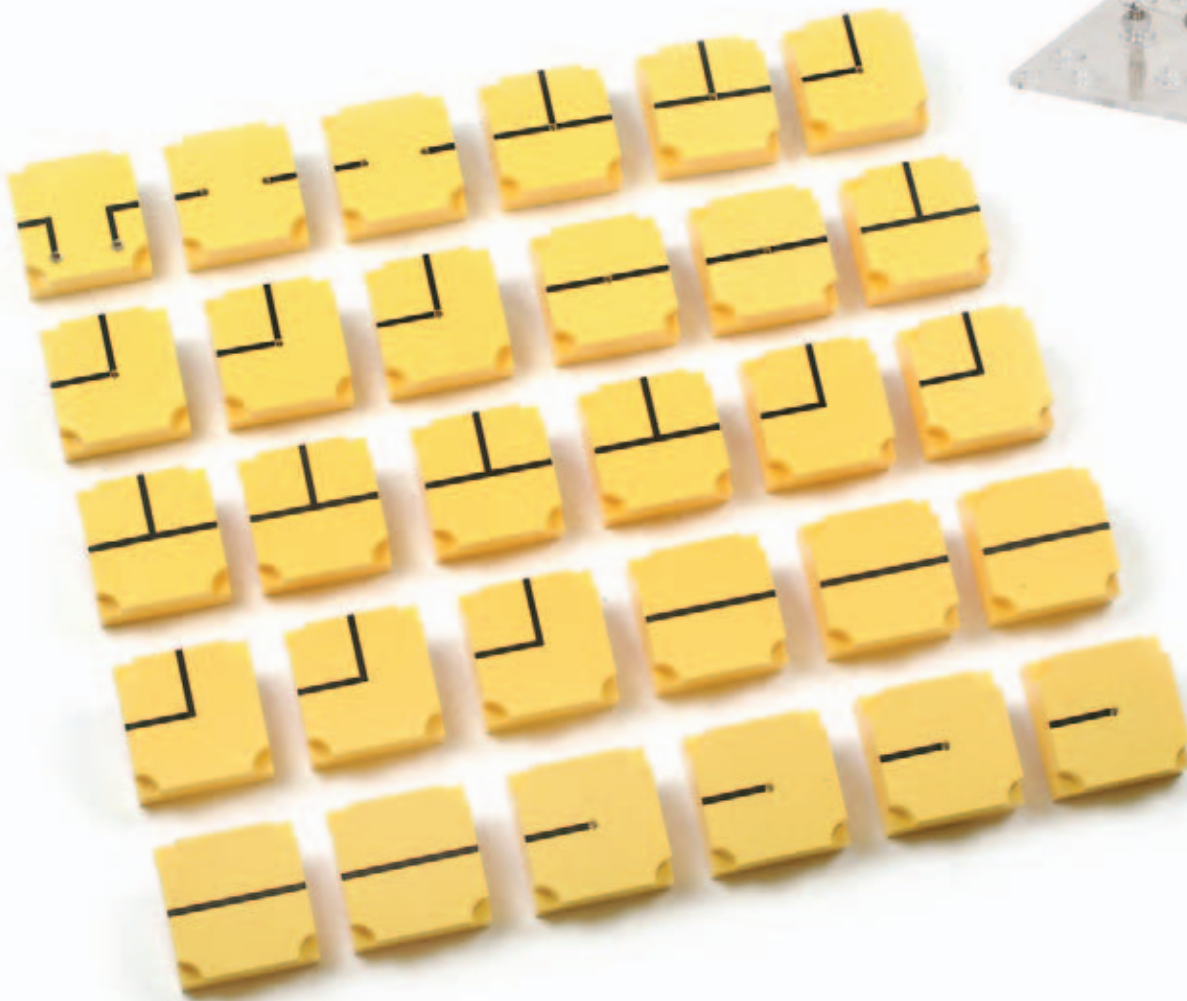
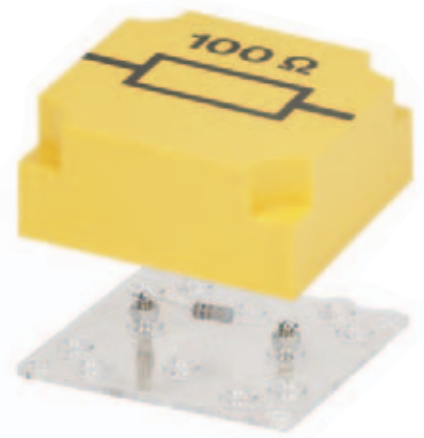


Experiment:
Charging and discharging a capacitor



Plug-in board modules “demo” (PIBD)

Housing made of yellow ABS plastic, with recesses at the corners making it easy to remove a module from a circuit that has been set up; each module is labelled in black according to the built-in circuitry which may be viewed through the transparent bottom panel; holes for inserting up to four 4-mm plugs (multi-polar modules); the bottom panel of the housing is attached with four screws, allowing internal components to be replaced easily
 Max. operating voltage allowed: **max. 42 (protected extra-low voltage)**
 Dimensions: 81x81x35 mm



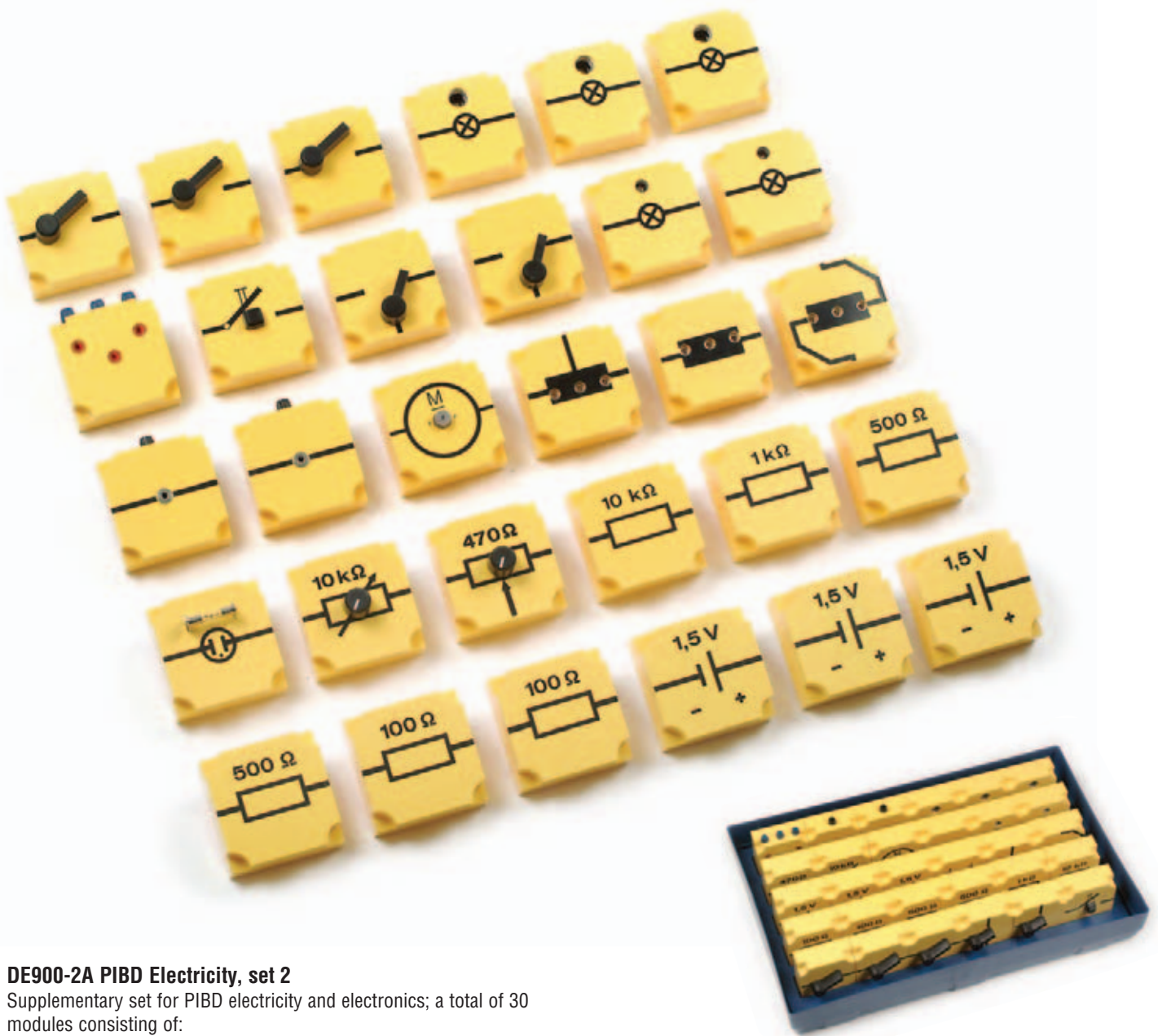
DE900-1A PIBD Electricity, set 1

Basic set for PIBD electricity and electronics, including 30 modules with built-in wiring, some of them with 4-mm jacks for connecting power supplies and measuring instruments, and consisting of:

- DE920-1D 2x PIBD Wires, straight, with socket
- DE920-1C 5x PIBD Wires, straight
- DE920-1G 5x PIBD Wires, right-angled
- DE920-1H 4x PIBD Wires, right-angled, with socket
- DE920-1F 2x PIBD Wires, t-shaped, with socket
- DE920-1E 5x PIBD Wires, t-shaped
- DE920-1K 1x PIBD Wire, interrupted, right-angled
- DE920-1J 2x PIBD Wires, uninterrupted
- DE920-1B 4x PIBD Connectors
- P7806-1B 1x Storage box, large
- P7810-1A 1x Box insert PIBD



pibd electricity



DE900-2A PIBD Electricity, set 2

Supplementary set for PIBD electricity and electronics; a total of 30 modules consisting of:

DE920-3G	2x	PIBD Resistors 100 ohms Load capacity: 2 W; tolerance: $\pm 5\%$
DE920-3M	2x	PIBD Resistors 500 ohms Load capacity: 2 W; tolerance: $\pm 5\%$
DE920-3O	1x	PIBD Resistor 1 kOhm Load capacity: 2 W; tolerance: $\pm 5\%$
DE920-3R	1x	PIBD Resistor 10 kOhms Load capacity: 2 W; tolerance: $\pm 5\%$
DE920-3S	1x	PIBD Potentiometer 470 ohms Load capacity: 4 W; tolerance: $\pm 10\%$
DE920-3T	1x	PIBD Variable resistor 10 kOhms Load capacity: 4 W; tolerance: $\pm 10\%$
DE927-1M	1x	PIBD Geared motor Slotted pulley for cord, 28:1 gear ratio
DE920-2K	3x	PIBD Batteries, 1.5 V DC (C-size cells supplied)

DE920-2B	1x	PIBD Glow lamp
DE922-1L	1x	Coil
DE922-1B	1x	PIBD for coils with terminal
DE922-1A	1x	PIBD for coils
DE920-2S	1x	PIBD Push button
DE920-2R	3x	PIBD ON-OFF switches
DE920-2T	2x	PIBD Double-throw switches
DE920-2A	2x	PIBD Light bulb sockets, E10
DE920-2F	3x	PIBD Light bulb sockets, E14
DE920-2L	2x	PIBD with screw posts For securing a holder with solid pin
DE920-2M	1x	PIBD Holder for support rods Three holes and clamping screws for securing support rods up to 10 mm in diameter
P7806-1B	1x	Storage box, large
P7810-1A	1x	Box insert PIBD



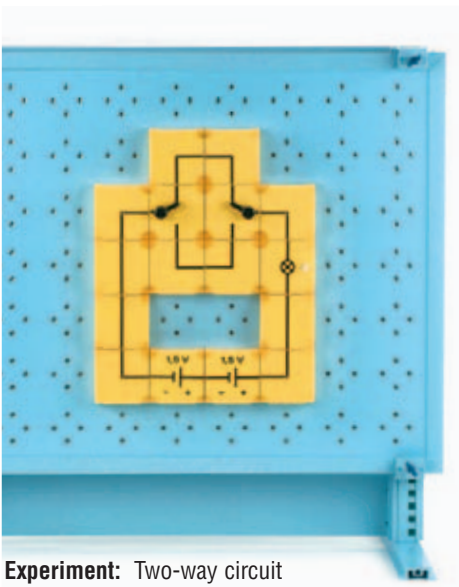
DE900-3A PIBD Electricity, set 3

Supplementary set to PIBD electricity and electronics for electrochemistry, electromagnetism and induction, consisting of:

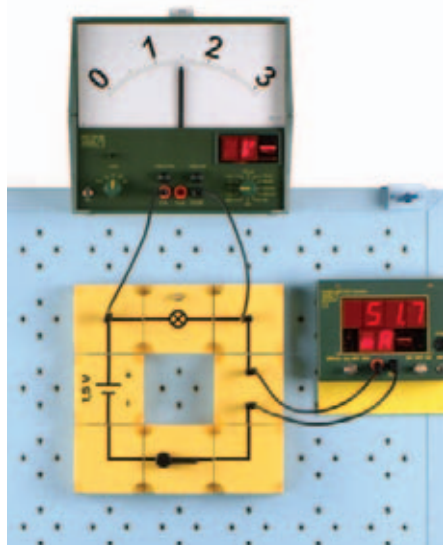
DE921-1D	1x	U-shaped core with yoke, laminated Core 30x16mm, blue powder-coated, with fixing screw	DE920-2D	1x	PIBD with scale
DE921-1D	1x	U-shaped core with yoke, laminated Core 30x16mm, blue powder-coated, with fixing screw	DE930-2R	1x	Pulley with pointer For assembling a model hot-wire measuring instrument; pulley mounted on a pivot bearing and support (D=10 mm), with a pointer; including a grooved edge for a cord; pointer length: 160 mm
DE921-1L	1x	Iron core, laminated, long Blue powder-coated; dimensions: 163x30x16mm	DE312-1B	2x	Battery holders Fits in PIBDs with an interrupted wire, takes a 1.5-V C-size battery
DE922-2B	1x	Coil with 800 turns ; may be plugged in Max. current: 2 A	DE921-3U	1x	Heating element, plug-in
DE922-2C	1x	Coil with 2 x 800 turns ; may be plugged in Max. current: 1A	P3325-2A	1x	Electrodes, set Consisting of electrode plates (65x25 mm): 2x Pb, 2x Zn, 1x Al, 1x Fe, 1x brass; and 2x carbon rods (65x5 mm)
DE450-1D	1x	Moving coil with pointer For demonstrating the force of a magnetic field acting on a current-carrying moving coil i.e. the principle of a moving coil measuring device; two 4-mm plug pins allow it to be plugged into a PIBD with ball bearing (DE920-2C); includes two permanently attached leads with 4-mm plugs for providing power; coil diameter: 90 mm	P3911-3D	4x	Crocodile clip with plug
DE450-1E	1x	Conductor swing For demonstrating the force of a magnetic field acting on a current-carrying conductor; aluminium bracket permanently connected to two very flexible leads with 4-mm plugs and mounted on an insulated base with two 4-mm plugs, 40 mm apart, fitting into the PIBD with an interrupted wire DE920-1J	P3310-1A	2x	Crocodile clips, plain metal
DE920-2C	1x	PIBD with ball bearing Pivot bearing for a moving coil or magnet holder	P3325-1A	1x	Conductors and non-conductors, set
DE320-1E	3x	Plug pin clamps Allow wires without insulation up to 4 mm in diameter to be fixed in place quickly	DE922-1D	1x	Platform with plug pins For supporting the electrolysis tank; may be plugged into the PIBD with the interrupted, right-angled wire
DE451-1D	1x	Striker For bell and relay assemblies, L=285 mm	P3325-2C	1x	Electrolysis tank Transparent plastic; dimensions: 78x54x46 mm
DE451-1C	1x	Bell gong D=70 mm, with 4-mm plug	DE320-1C	1x	Contact pin with wolfram point, L=100 mm
			P1810-1D	1x	Flat spring , steel, 300x25x0,6 mm
			DE320-1D	1x	Bimetallic strip , demo, 180x20 mm
			DE921-3B	2x	Holder with solid pins Metal bolts with a slot and hole, used to hold and fix in place metal strips (flat springs, strikers, bimetallic strips etc.) or small metal rods (contact pins etc.)
			DE921-3A	2x	Holder with plug pin Metal bolts with a slot and hole, used to hold and fix in place plates (e.g. plate electrodes) or small metal rods (e.g. carbon rods) up to 6 mm in diameter; L=60 mm
			P7806-1B	1x	Storage box, large
			P7810-1B	1x	Box insert PIBD electricity set 3



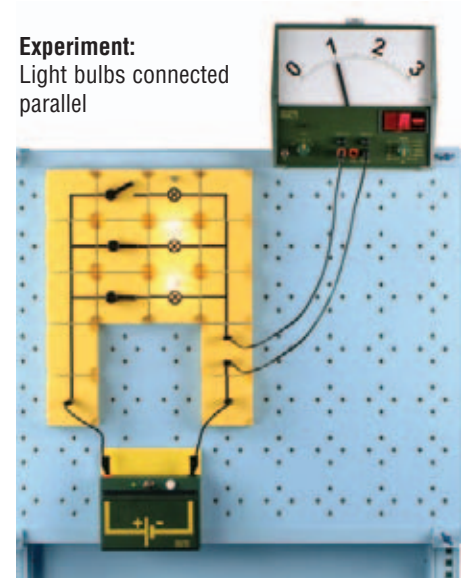
pidb electricity



Experiment: Two-way circuit



Experiment: Measuring current and voltage



Experiment:
Light bulbs connected
parallel

ELECTRICITY EXPERIMENTS (STBD)

Conductors - Non-conductors

- ELD 1.1 Electrical circuits
- ELD 1.2 Conductors and non-conductors (solids)
- ELD 1.3 Electrical circuits - repetition
- ELD 1.4 Two-way switch
- ELD 1.5 Is tap water a conductor?
- ELD 1.6 Sugar and salt: conductors or non-conductors?
- ELD 1.7 Acidic and basic solutions as conductors
- ELD 1.8 Is soil a conductor or non-conductor?
- ELD 1.9 The human body: conductor or non-conductor?
- ELD 1.10 The human body in contact with water as an electrical conductor
- ELD 1.11 The human body conducts electricity
- ELD 1.12 Conductivity of tap water
- ELD 1.13 Conductivity of deionized water
- ELD 1.14 Conductivity of salt and sugar solutions
- ELD 1.15 Conductivity of an acidic solution
- ELD 1.16 Dry earth conducts electricity poorly, wet earth well
- ELD 1.17 Closing a circuit by grounding

Measuring voltage sources - voltage sources

- ELD 2.1 Measuring voltage
- ELD 2.2 Terminal voltage - open-circuit voltage
- ELD 2.3 Voltage drop across a switch
- ELD 2.4 Voltage drop across a light bulb
- ELD 2.5 Amperage is the same everywhere in a simple circuit
- ELD 2.6 Amperage in circuits with branches
- ELD 2.7 Voltage sources in series and parallel circuits - voltage measurement
- ELD 2.8 Voltage sources in series and parallel circuits - amperage measurement
- ELD 2.9 Voltage sources in series and parallel circuits - short-circuit current

Ohm's law - resistor circuits

- ELD 3.1 The greater the voltage, the greater the amperage: Ohm's law
- ELD 3.2 The shorter the wire, the greater the amperage
- ELD 3.3 The thicker the resistance wire, the smaller the resistance
- ELD 3.4 Resistance depends on what the resistance wire is made of
- ELD 3.5 Iron wire is a PTC conductor
- ELD 3.6 A light bulb is a PTC conductor
- ELD 3.7 Ohm's law demonstrated using fixed resistors
- ELD 3.8 Resistors in series circuits I
- ELD 3.9 Resistors in series circuits II
- ELD 3.10 Resistors in parallel circuits I
- ELD 3.11 Resistors in parallel circuits II
- ELD 3.12 Resistors in parallel circuits III
- ELD 3.13 Voltage drop
- ELD 3.14 Model of a potentiometer
- ELD 3.15 Voltage drop and light bulbs
- ELD 3.16 Potentiometer and a light bulb used as an indicator
- ELD 3.17 Model of a fader



Electrical appliances - safety devices

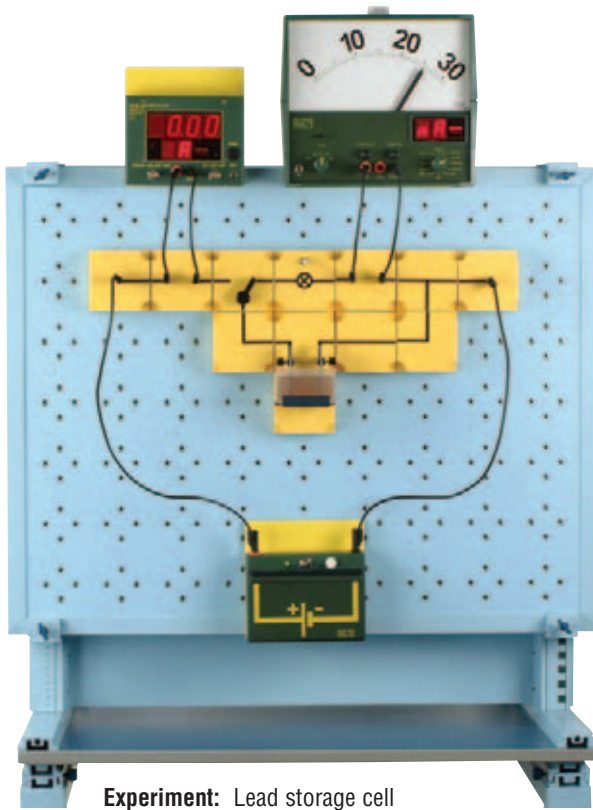
- EELD 4.1 Work and power of electrical current
- ELD 4.2 Electrical devices are wired parallel and not in series in a circuit
- ELD 4.3 Resistance wire converts electrical energy to thermal energy
- ELD 4.4 Model of an immersion heater
- ELD 4.5 Fires caused by electricity
- ELD 4.6 Short circuits are a fire hazard
- ELD 4.7 Fuses prevent fire hazards
- ELD 4.8 Bridging fuses is dangerous!
- ELD 4.9 The incandescent effect of a filament
- ELD 4.10 Overloading causes fire hazards - fuses prevent hazards
- ELD 4.11 Model of a hot-wire instrument
- ELD 4.12 Model of a thermostat
- ELD 4.13 Bi-metallic strip as circuit-breaker

Thermocouple element - electrochemistry

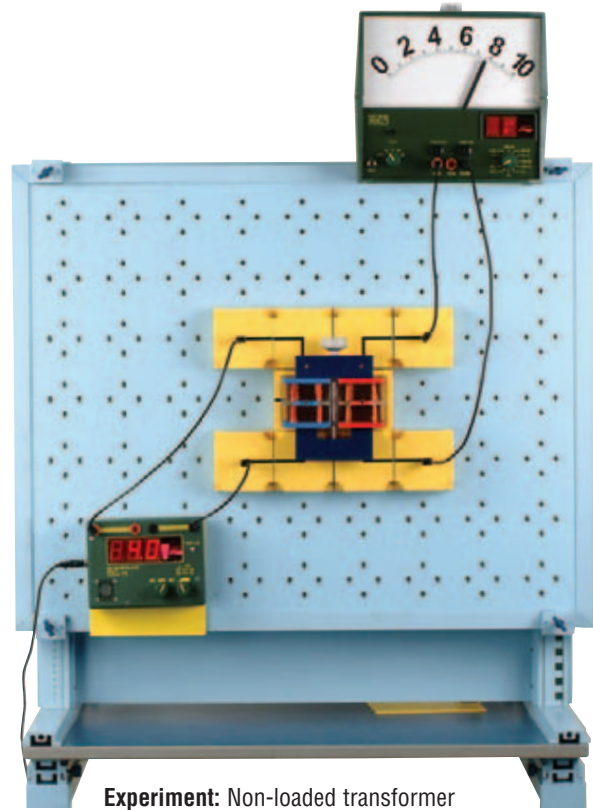
- ELD 5.1 Principle of a thermocouple element
- ELD 5.2 Thermocouple element
- ELD 5.3 Principle of galvanic voltage
- ELD 5.4 Measuring voltage using an oscilloscope
- ELD 5.5 Voltage from ammonia and a salt solution
- ELD 5.6 The Leclanche cell (flashlight battery)
- ELD 5.7 Lead storage cell
- ELD 5.8 NiFe storage cell
- ELD 5.9 Electrolysis in a zinc-iodine solution
- ELD 5.10 Electrolysis in a copper-chloride solution
- ELD 5.11 Electrolysis in a table salt solution
- ELD 5.12 Copper-plating zinc
- ELD 5.13 An electrolytic rectifier

Electromagnetism

- ELD 6.1 Oersted's experiment
- ELD 6.2 Force on a current-carrying conductor in a magnetic field I
- ELD 6.3 Force on a current-carrying conductor in a magnetic field II
- ELD 6.4 A coil's magnetic field
- ELD 6.5 Strength of a coil's magnetic field



Experiment: Lead storage cell



Experiment: Non-loaded transformer

- ELD 6.6 An iron core reinforces a current-carrying coil's magnetic field
- ELD 6.7 Model of a hoisting magnet
- ELD 6.8 Ferromagnetic materials can be magnetized
- ELD 6.9 Model of a moving-iron instrument
- ELD 6.10 Opening and closing a circuit with the aid of a bar magnet
- ELD 6.11 Model of a relay with break contact
- ELD 6.12 Model of a relay with make contact
- ELD 6.13 Model of a relay with break and make contact
- ELD 6.14 Relay with make contact
- ELD 6.15 Relay with break contact
- ELD 6.16 Relay as a double-throw switch
- ELD 6.17 Wagner's hammer
- ELD 6.18 Buzzer
- ELD 6.19 Electric bell
- ELD 6.20 Model of a magnetic fuse

Electromagnetic induction

- ELD 7.1 A microphone converts sound into alternating current
- ELD 7.2 Representation of audio frequency alternating current
- ELD 7.3 How induced voltage is generated
- ELD 7.4 Dependence of induced current on the magnetic field
- ELD 7.5 Dependence of induced current on the number of turns of a coil
- ELD 7.6 Making induced voltage visible
- ELD 7.7 Self-induction in a coil
- ELD 7.8 Model of a dynamo
- ELD 7.9 Measuring short-circuit current
- ELD 7.10 Power of induced current - an estimate

Transformers

- ELD 8.1 DC transformer with windings on one axis
- ELD 8.2 DC transformer with windings on parallel axes
- ELD 8.3 DC transformer with iron core - one variety
- ELD 8.4 DC transformer with iron core - another variety
- ELD 8.5 Transformer used with a frequency generator I
- ELD 8.6 Transformer used with a frequency generator II
- ELD 8.7 Transformer used with a frequency generator and oscilloscope
- ELD 8.8 AC-powered transformer used with a frequency generator and oscilloscope
- ELD 8.9 AC-powered transformer (50 Hz)
- ELD 8.10 Voltage transformation in a non-loaded transformer
- ELD 8.11 Secondary voltage and winding position
- ELD 8.12 Voltage transformation in a loaded transformer I
- ELD 8.13 Voltage transformation in a loaded transformer II
- ELD 8.14 Primary amperage in a non-loaded and loaded transformer I
- ELD 8.15 Primary amperage in a non-loaded and loaded transformer II
- ELD 8.16 Primary amperage in a non-loaded and loaded transformer III

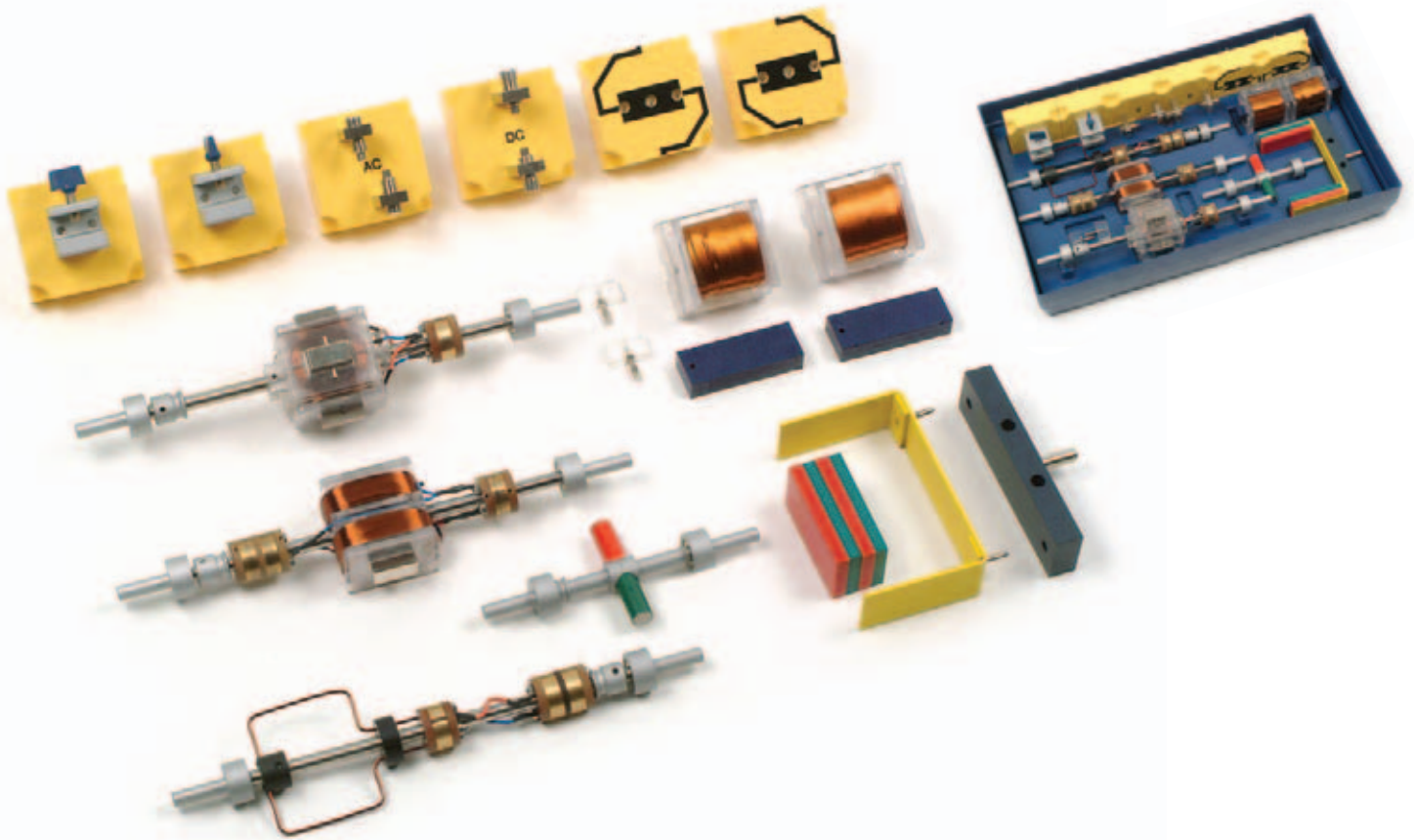
Ordering information for apparatus needed to perform the electricity experiments listed here with the "demo" plug-in system:

DE920-1A	1x Plug-in panel, demo
DS101-1G	1x Support base, large, L=500 mm
DS600-6G	1x Board holders, pair, magnetic
DE900-1A	1x PIBD Electricity, set 1
DE900-2A	1x PIBD Electricity, set 2
DE900-3A	1x PIBD Electricity, set 3
P9103-4D	1x Experiment manual, electricity PIBD
DE330-9S	1x Set of wires (PIBD)
DE310-9S	1x Set of light bulbs (PIBD)
DE590-1S	1x Set of connecting leads (PIBD)

See pages 382 and 383 for accessories, power supplies and measuring instruments



PIBD electric machines

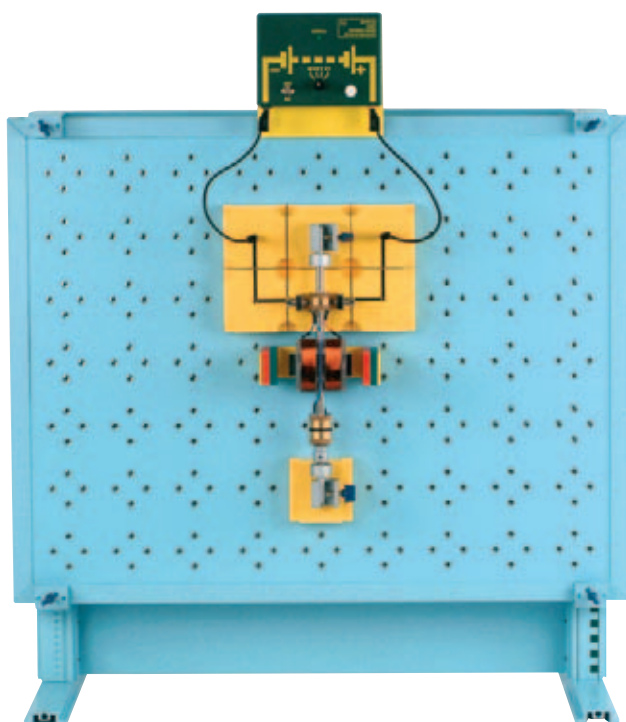


DE900-4M Electric machines PIBD, set

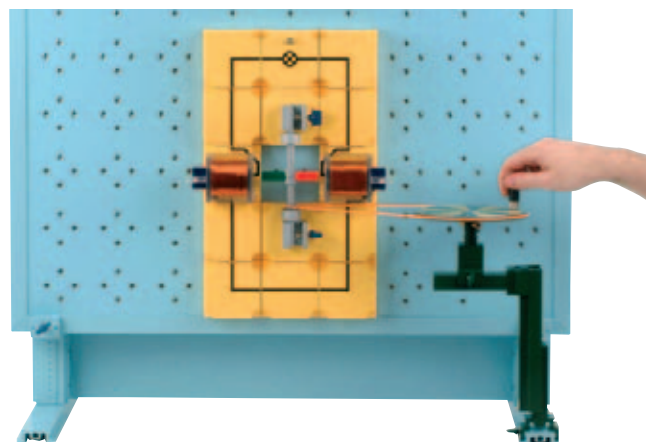
Supplementary set for PIBD electric machines consisting of:

DE925-1D	1x	PIBD Carbon brushes DC Adjustable, spring-mounted carbon rods in a holder, suitable for a commutator		
DE925-1A	1x	PIBD Carbon brushes AC Adjustable, spring-mounted carbon rods in a holder, suitable for slip rings		
DE920-1M	2x	STBD with clamp		
DE922-1L	1x	PIBD for coil L Lead with connector on left side		
DE922-1R	1x	PIBD for coil R Lead with connector on right side		
DE922-2A	2x	Coil with 400 turns May be plugged in; max. current: 4A		
DE921-1I	2x	Iron core, laminated, short Blue powder-coated; dimensions: 83x30x16 mm		
DE454-1F	2x	Flat plugs For fastening iron cores in place in coils; plate 6 mm in width with a 4-mm plug pin		
DE460-1C	1x	Magnet bracket For holding block magnets DE460-1D; yellow powder-coated metal bracket with two 4-mm plugs Dimensions: 150x40x90 mm		
DE460-1H	1x	Magnet bracket adapter For fastening the magnet bracket to support rods; Dimensions: 150x40 mm		
DE460-1E	2x	Block magnets Extremely strong ferrite magnets, each embedded in a red or green plastic casing; Dimensions: 82x42x17 mm		
DE460-1M	1x	Magnet rotor For assembling a functioning generator model; AlNiCo magnet, 80x15 mm, mounted on a metal shaft with ball bearings; including a belt pulley for a belt drive; L=190 mm		
DE460-1A	1x	Two-pole rotor For assembling functioning models of electric machines; double-t-shaped anchor piece, with an iron core, mounted on a metal shaft with ball bearings; two solid, brass slip rings; two-piece brass collector (commutator); including a belt pulley for a belt drive; total length: 356 mm		
DE460-1B	1x	Four-pole rotor For assembling functioning models of electric machines; four-pole anchor piece, with an iron core, mounted on a metal shaft with ball bearings; four-piece brass collector; including a belt pulley for a belt drive; total length: 356 mm		
DE460-1L	1x	Conductor loop For demonstrating the effect of a wire loop rotating in a magnetic field; conductor loop mounted on a metal shaft with ball bearings; two solid, brass slip rings; two-piece brass collector; including a belt pulley for a belt drive; total length: 356 mm		
P7806-1B	1x	Storage box, large		
P7810-1C	1x	Box insert PIBD electric machines		

PIBD electric machines



Experiment: electromotor with two-pole rotor



Experiment: Revolving field generator - bicycle dynamo

EXPERIMENTS WITH MOTORS AND GENERATORS (STBD)

Generators

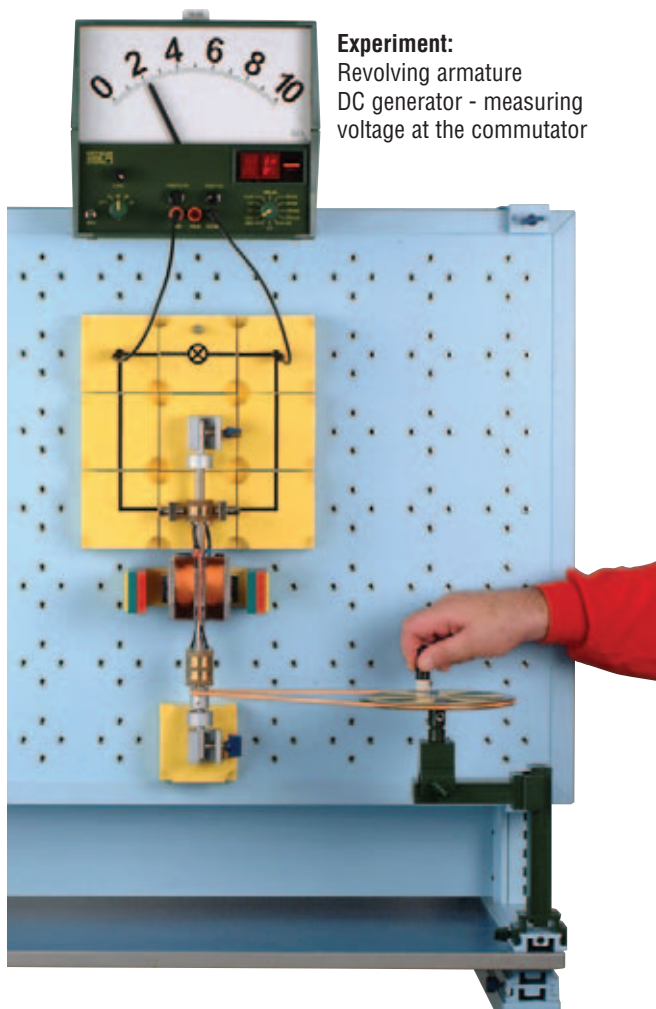
- ELD 9.1 Electromagnetic induction - basic experiment
- ELD 9.1 Electromagnetic induction - dynamo
- ELD 9.3 Rotating conductor loop
- ELD 9.4 AC generator
- ELD 9.5 DC generator
- ELD 9.6 AC generator with an electromagnetic stator
- ELD 9.7 DC generator with an electromagnetic stator
- ELD 9.8 Self-exciting DC generator
- ELD 9.9 Self-exciting AC generator

Motors

- ELD 10.1 The magnetic field of a rotating magnet
- ELD 10.2 The magnetic field of a two-pole rotor with slip rings
- ELD 10.3 The magnetic field of a two-pole rotor with a commutator
- ELD 10.4 Two-pole rotor with a magnetic field
- ELD 10.5 DC motor with a permanent magnet stator field
- ELD 10.6 DC motor with an electromagnet stator field
- ELD 10.7 Shunt-wound electric motor
- ELD 10.8 Shunt-wound electric motor - current consumption under load
- ELD 10.9 Series-wound electric motor
- ELD 10.10 Synchronous motor
- ELD 10.11 DC motor without a commutator



Experiment:
Revolving armature
DC generator - measuring
voltage at the commutator



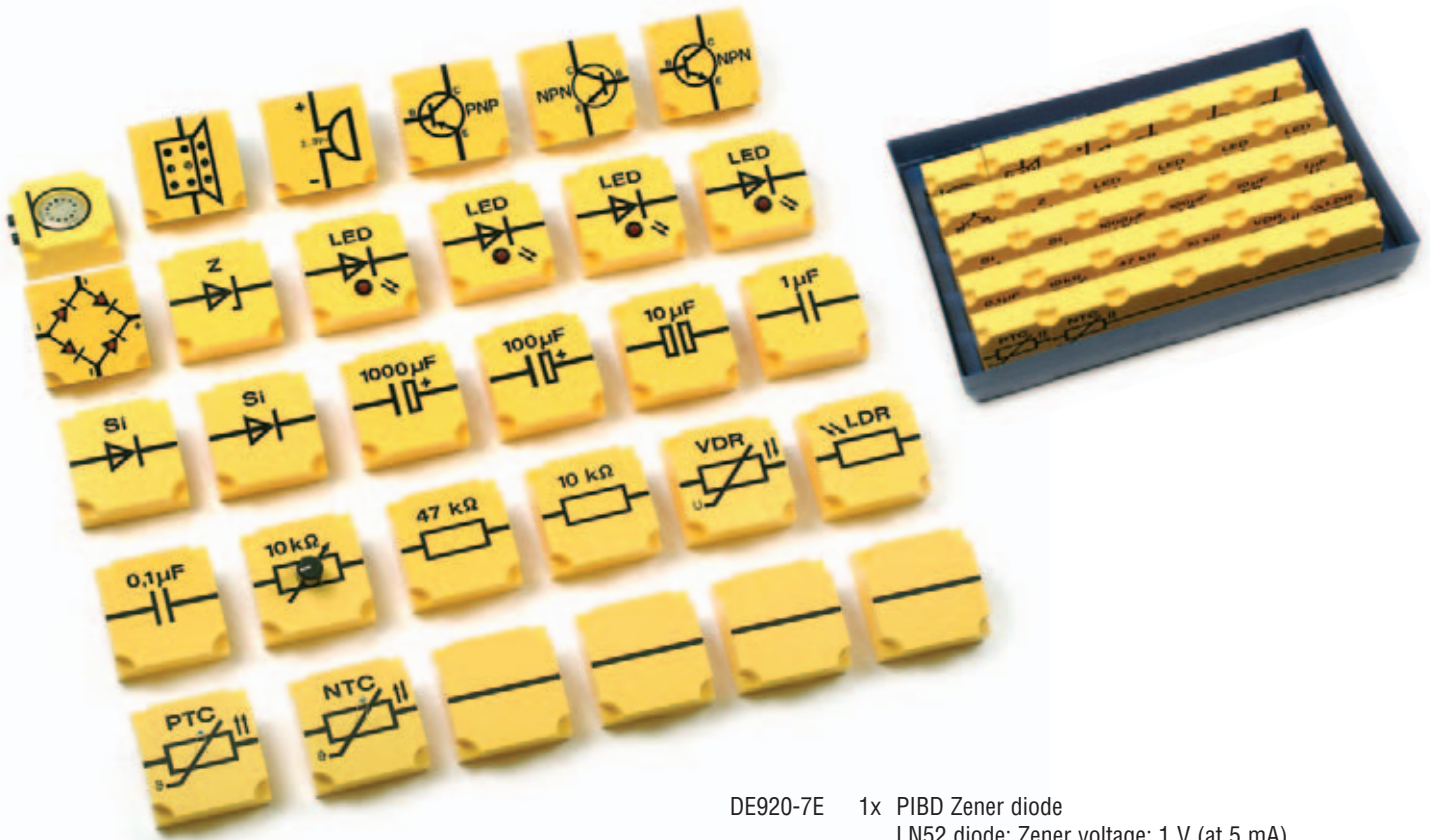
Ordering information for apparatus needed to perform the experiments with electric machines listed here with the "demo" plug-in system:

- | | |
|----------|----------------------------------------|
| DE920-1A | 1x Plug-in panel, demo |
| DS101-1G | 1x Support base, large, L=500 mm |
| DS600-6G | 1x Board holders, pair, magnetic |
| DE900-1A | 1x PIBD Electricity, set 1 |
| DE900-4M | 1x Electric machines PIBD, set |
| P9103-4D | 1x Experiment manual, electricity PIBD |
| DE310-9S | 1x Set of light bulbs (PIBD) |
| DE590-1S | 1x Set of connecting leads (PIBD) |

See pages 382 and 383 for accessories, power supplies and measuring instruments



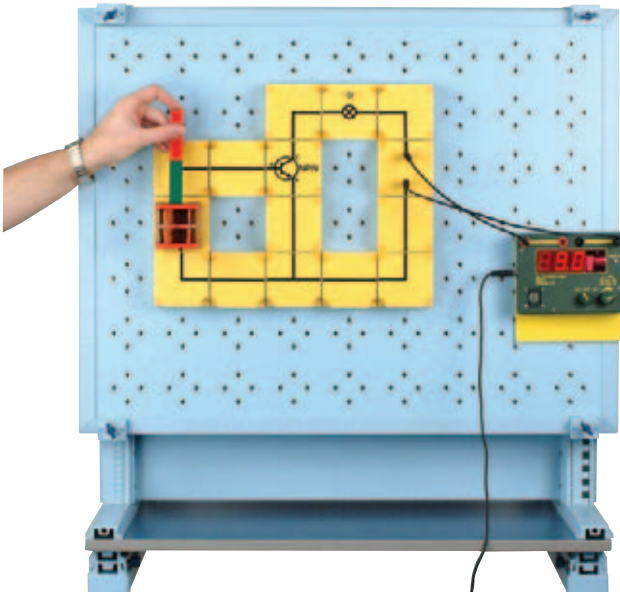
PIBD electronics



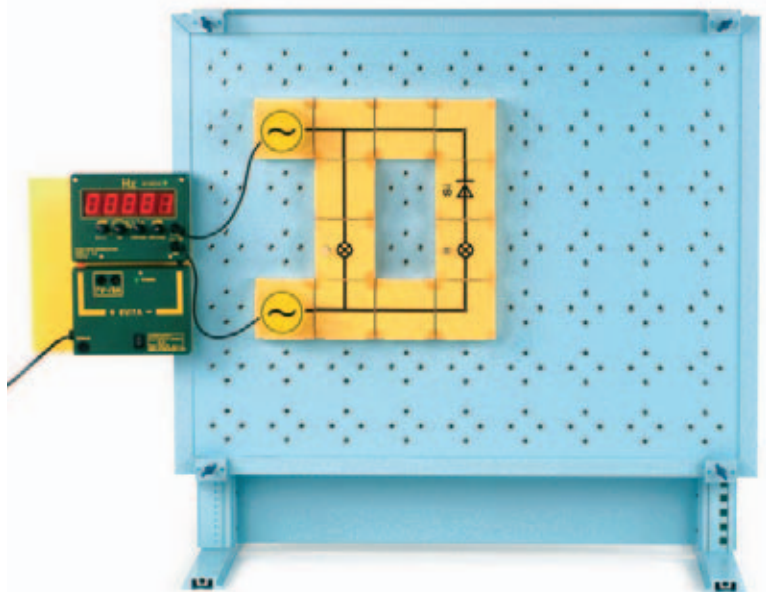
DE900-4A PIBD Electronics, set 1

Basic set for PIBD electronics; a total of 30 modules consisting of:

DE920-3R	1x PIBD Resistor 10 kOhms Load capacity: 2 W; tolerance: $\pm 5\%$	DE920-7E	1x PIBD Zener diode LN52 diode; Zener voltage: 1 V (at 5 mA)
DE920-3U	1x PIBD Resistor 47 kOhms Load capacity: 2 W; tolerance: $\pm 5\%$	DE920-7T	1x STBD Bridge rectifier With 4 LEDs, D=5 mm
DE920-3T	1x PIBD Variable resistor 10 kOhms Load capacity: 4 W; tolerance: $\pm 10\%$	DE920-8A	1x STBD Transistor NPN, base left BD139, UCE=80 V, I _{max} =2A
DE920-4J	1x PIBD Photo resistor LDR Silicon photo resistor with PN junction, suitable for use as a diode (20 V cut-off voltage) Light-sensitive surface area: 4.84 mm ² Photoelectric current increase and decay time: 20 ns Resistance in the dark at approx. 10 V: >1 GOhm	DE920-8B	1x STBD Transistor NPN, base right BD139, UCE=80 V, I _{max} =2A
DE920-4E	1x PIBD PTC Thermistor Base resistance: 110 ohms, $\pm 25\%$ Thermal time constant: 18 s Operating voltage: 30 V Max. resistance: 50 kOhms	DE920-2A	1x PIBD Buzzer Operating voltage: 4-9 V Max. sound pressure: approx. 70 dB; Frequency: 450 Hz
DE920-4A	1x PIBD NTC Thermistor Base resistance: 4.7 kOhms, $\pm 10\%$ Operating temperature: max. 125 °C Thermal time constant: 20 s Max. load: 0.75 W	DE920-8C	1x STBD Transistor PNP BD140, UCE=80 V, I _{max} =2A
DE920-4K	1x PIBD Varistor Operating voltage: 14 V, max. 36 V Constant power rating: 0.1 W; peak: 3.2 W Response time: approx. 50 ns	DE920-6D	1x STBD Capacitor 0.1 μ F Voltage rating: 100 V; tolerance: $\pm 20\%$
DE920-7A	2x PIBD Si-Diode 1N4007 diode; cut-off voltage: 1000 V	DE920-6G	1x STBD Capacitor 1 μ F Voltage rating: 100 V; tolerance: $\pm 20\%$
DE920-7K	4x STBD LED, red D=88 mm	DE920-6J	1x STBD Electrolytic capacitor 10 μ F Voltage rating: 35 V; tolerance: $\pm 20\%$
		DE920-6N	1x STBD Electrolytic capacitor 100 μ F Voltage rating: 35 V; tolerance: $\pm 20\%$
		DE920-6Q	1x STBD Electrolytic capacitor 1000 μ F Voltage rating: 35 V; tolerance: $\pm 20\%$
		P3921-2C	1x Microphone module Carbon capsule housed in an NTL module with two 4-mm jacks Max. load: max. 40 mA; impedance: 80 ... 250 Ω
		DE921-2B	1x STBD Loudspeaker Permanent-magnet, dynamic loudspeaker Impedance: 8 Ω ; power: 1W
		DE920-1C	4x PIBD wires, straight
		P7806-1B	1x Storage box, large
		P7810-1A	1x Box insert PIBD



Experiment: The transistor as an amplifier - amplifying induced current



Experiment: Half-wave rectification

ELECTRONICS I EXPERIMENTS (STBD)

Semiconductors - Resistors

- EOD 1.1 PTC Thermistor
- EOD 1.2 Automatic protection from overheating
- EOD 1.3 NTC Thermistor
- EOD 1.4 Model of an electric thermometer
- EOD 1.5 Photo resistor (LDR)
- EOD 1.6 Model of a light meter
- EOD 1.7 Varistor (VDR)
- EOD 1.8 Amperage across a VDR under AC
- EOD 1.9 VDR characteristic

Diodes

- EOD 2.1 Silicon diode
- EOD 2.2 The silicon diode as a rectifier
- EOD 2.3 Characteristic curve of semi-conducting diodes
- EOD 2.4 Basic materials: germanium and silicon
- EOD 2.5 Light-emitting diode (LED)
- EOD 2.6 Zener diode
- EOD 2.7 Zener diode under AC voltage
- EOD 2.8 Curve characteristic of the zener diode
- EOD 2.9 Protection against overloading
- EOD 2.10 Basic experiment for stabilizing voltage
- EOD 2.11 An Si-diode can protect from overloading
- EOD 2.12 Polarity tester

Transistors I

- EOD 3.1.1 The transistor as a double diode (NPN)
- EOD 3.1.2 The transistor as a double diode (PNP)

- EOD 3.2.1 Base current lets collector current through (NPN)
- EOD 3.2.2 Base current lets collector current through (PNP)
- EOD 3.3 Only one power source for base and collector current
- EOD 3.4 Light sets off alarm
- EOD 3.5 Base voltage divider
- EOD 3.6 Burglar alarm with trip wire
- EOD 3.7 Automatic illumination
- EOD 3.8 Alarm using light barrier
- EOD 3.9 Fire detector
- EOD 3.10 Model of an electric thermometer
- EOD 3.11 Induction voltage controlling a transistor
- EOD 3.12 LF amplifier
- EOD 3.13 Microphone amplifier
- EOD 3.14 The conducting transistor

Capacitors

- EOD 4.1 A capacitor can store charges
- EOD 4.2 Direction of charging and discharging current
- EOD 4.3 Charging a capacitor
- EOD 4.4 Discharging a capacitor
- EOD 4.5 Capacitor supplies base current
- EOD 4.6 An uncharged capacitor acts as a short circuit
- EOD 4.7 Capacitor behaves unexpectedly
- EOD 4.8 Capacitor under AC voltage
- EOD 4.9 Capacitor as an alternating current resistor
- EOD 4.1 A capacitor separates DC voltage

Multivibrator circuits

- EOD 5.1 Bistable multivibrator
- EOD 5.2 Support from a capacitor
- EOD 5.3 Monostable multivibrator
- EOD 5.4 Flashing circuit

- EOD 5.5 Astable multivibrator (functioning)
- EOD 5.6 Multivibrator music
- EOD 5.7 Light generates music
- EOD 5.8 Square and triangle generator

Rectifier Circuits

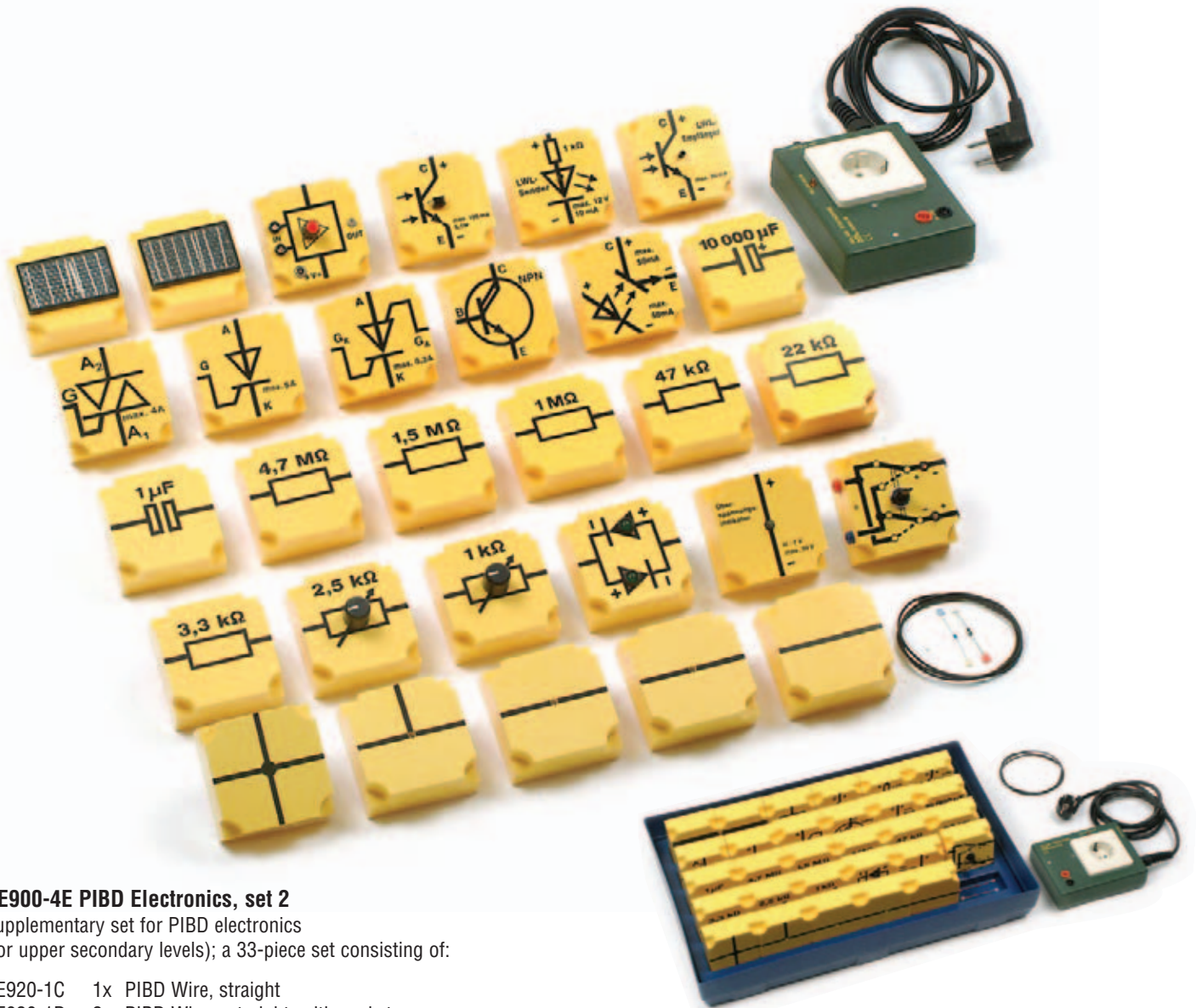
- EOD 6.1 Half-wave rectification
- EOD 6.2 Bridge rectifier I
- EOD 6.3 Bridge rectifier II
- EOD 6.4 Centre-tap circuit
- EOD 6.5 The centre-tap circuit in practice
- EOD 6.6 Doubling voltage

Ordering information for apparatus needed to perform the electronics experiments listed here with the "demo" plug-in system:

- | | |
|-----------|----------------------------------------|
| DE920-1A | 1x Plug-in panel, demo |
| DS101-1G | 1x Support base, large, L=500 mm |
| DS600-6G | 1x Board holders, pair, magnetic |
| DE900-1A | 1x PIBD Electricity, set 1 |
| DE900-2A | 1x PIBD Electricity, set 2 |
| DE900-4A | 1x PIBD Electronics, set 1 |
| P9103-4FE | 1x Experiment manual, electronics PIBD |
| DE310-9S | 1x Set of light bulbs (PIBD) |
| DE590-1S | 1x Set of connecting leads (PIBD) |
- See pages 382 and 383 for accessories, power supplies and measuring instruments



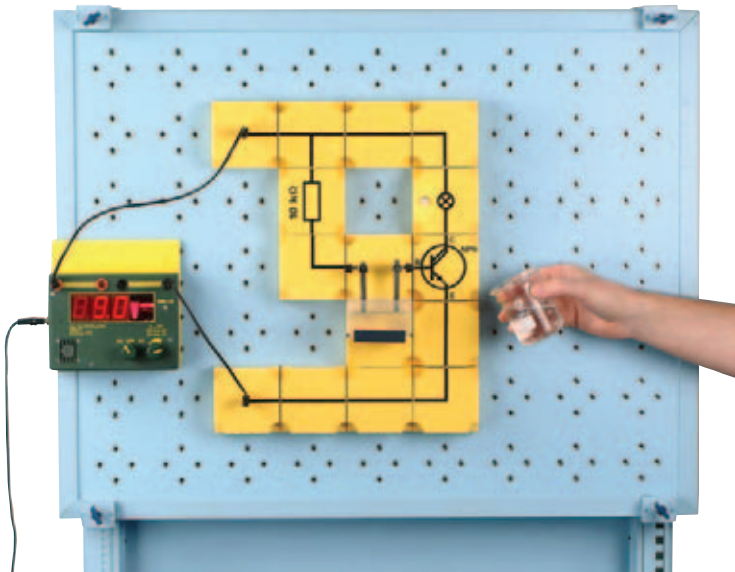
PIBD electronics



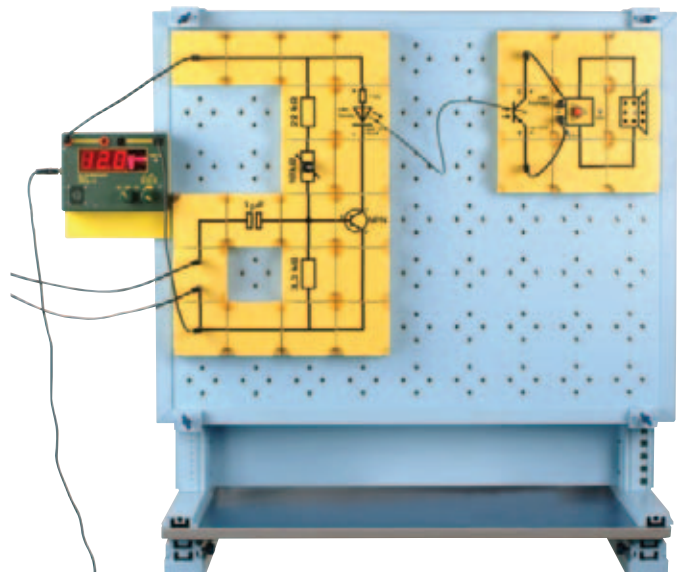
DE900-4E PIBD Electronics, set 2

Supplementary set for PIBD electronics
(for upper secondary levels); a 33-piece set consisting of:

DE920-1C	1x PIBD Wire, straight	DE920-8D	1x PIBD Darlington transistor
DE920-1D	2x PIBD Wires, straight, with socket	DE920-8P	1x PIBD Phototransistor
DE920-1F	1x PIBD Wire, t-shaped, with socket	DE920-8O	1x PIBD Optocoupler
DE920-2X	1x PIBD Four-way switch with polarity indicator	DE920-7U	1x PIBD Overvoltage indicator
DE920-1N	1x PIBD Wires, crossed	DE920-LS	1x PIBD Optical fibre cable transmitter
DE920-3P	1x PIBD Resistor 3.3 kOhms	DE920-LE	1x PIBD Optical fibre cable receiver
DE920-3Q	1x PIBD Resistor 22 kOhms	DE926-3W	1x PIBD Amplifier
DE920-3U	1x PIBD Resistor 47 kOhms		Miniature amplifier, built into a plug-in module, which achieves maximum power when connected to an 8-Ω loudspeaker and supplied with 15 V; any loudspeaker may be connected when using audio transformer P3180-LF, 8-16-Ω loudspeakers require no audio transformer; takes dynamic microphones with an impedance of 50-250 Ω; 10 kOhm potentiometer controls volume
DE920-3Y	1x PIBD Resistor 1 MOhm	DE920-LW	1x Optical fibre cable
DE920-3Z	1x PIBD Resistor 1.5 MOhms	DG500-1R	1x Relay (in "inno" case)
DE920-3N	1x PIBD Resistor 4.7 MOhms	P7806-1B	1x Storage box, large
DE920-3K	1x PIBD Variable resistor 1 kOhm, 4 W	P7810-1A	1x Box insert PIBD
DE920-3L	1x PIBD Variable resistor 2.5 kOhms, 4 W		
DE920-6I	1x STBD Capacitor 1 μF, bipolar		
DE920-6R	1x STBD Electrolytic capacitor 10000 μF		
DE920-4S	2x PIBD Solar cells		
DE920-7G	1x Ge-Diode, unfinished		
DE920-7S	1x Si-Diode, unfinished		
DE920-8E	1x PIBD Thyristor, 5A, cathode gate		
DE920-8F	1x PIBD Thyristor, double gate		
DE920-8G	1x PIBD Triac 4 A		
DE920-7R	1x PIBD Current direction indicator		



Experiment: Gauging the level of a liquid using a Darlington transistor



Experiment: Transmission of music using optical fibre cable

ELECTRONICS II EXPERIMENTS (STBD)

Transistors II

- EOD 7.1 The transistor as a switch
- EOD 7.2 The transistor as a controllable resistor
- EOD 7.3 The transistor as an amplifier (emitter circuit)
- EOD 7.4 Setting the operating point
- EOD 7.5 Characteristic curve of a transistor
- EOD 7.6 The operating point needs to be set properly
- EOD 7.7 Negative feedback
- EOD 7.8 Base voltage and collector current
- EOD 7.9 Negative feedback in practice
- EOD 7.10 Common base circuit
- EOD 7.11 Collector circuit
- EOD 7.12 Stabilizing voltage supply
- EOD 7.13 Constant current source
- EOD 7.14 Constant current with two transistors

Thyristors

- EOD 8.1 A thyristor consists of four regions
- EOD 8.2 Thyristor under DC
- EOD 8.3 Thyristor gate conditions
- EOD 8.4 Thyristor under AC
- EOD 8.5 Phase angle control
- EOD 8.6 Controlling power by triac
- EOD 8.7 Thyristor overvoltage protection

Photoelectronics

- EOD 9.1 Light sets charge carriers free

- EOD 9.2 Solar cells connected parallel
- EOD 9.3 Solar cells connected in series
- EOD 9.4 Solar voltage dependent on angle of incidence and temperature
- EOD 9.5 Sensitive indicator for lighting changes
- EOD 9.6 Phototransistor
- EOD 9.7 Optically coupling electrical circuits
- EOD 9.8 Light gate
- EOD 9.9 Registering oscillations with a light gate
- EOD 9.10 Optocoupler
- EOD 9.11 DC circuit controls AC voltage
- EOD 9.12 Optocoupler controls higher voltage
- EOD 9.13 Fibre optic transmitter
- EOD 9.14 Fibre optic receiver
- EOD 9.15 Signal transmission through optical fibre
- EOD 9.16 Audio transmission through optical fibre

Transistor Circuits

- EOD 10.1 Darlington collector circuit
- EOD 10.2 Darlington emitter circuit
- EOD 10.3 Principle of the Darlington circuit
- EOD 10.4 The human body as a resistor
- EOD 10.5 Liquid level gauge
- EOD 10.6 Gauging the level of a liquid using a Darlington transistor
- EOD 10.7 Sensor contact
- EOD 10.8 Controlling mains voltage
- EOD 10.9 A simple light organ
- EOD 10.10 Transmission of music I

- EOD 10.11 Transmission of music II
- EOD 10.12 Two-stage transistor circuit
- EOD 10.13 Faulty light bulbs replaced automatically
- EOD 10.14 Universal alarm circuit
- EOD 10.15 Universal circuit using a thyristor
- EOD 10.16 Two-stage amplifier
- EOD 10.17 Direct coupling of amplifier stages

Ordering information for apparatus needed to perform the electronics experiments listed here with the "demo" plug-in system:

- | | |
|-----------|----------------------------------------|
| DE920-1A | 1x Plug-in panel, demo |
| DS101-1G | 1x Support base, large, L=500 mm |
| DS600-6G | 1x Board holders, pair, magnetic |
| DE900-1A | 1x PIBD Electricity, set 1 |
| DE900-2A | 1x PIBD Electricity, set 2 |
| DE900-4A | 1x PIBD Electronics, set 1 |
| DE900-4E | 1x PIBD Electronics, set 2 |
| P9103-4FE | 1x Experiment manual, electronics PIBD |
| DE310-9S | 1x Set of light bulbs (PIBD) |
| DE590-1S | 1x Set of connecting leads (PIBD) |
- See pages 382 and 383 for accessories, power supplies and measuring instruments



PIBD accessories

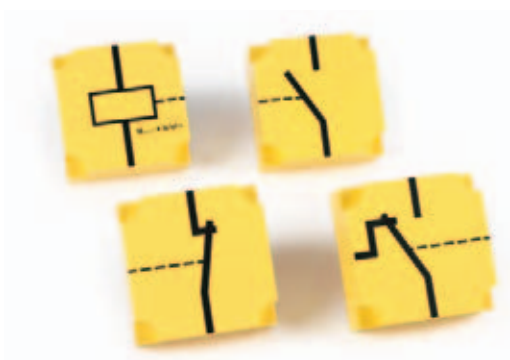


DE929-1Z STBD Empty module with transparent bottom panel

DE929-4S Plug pins, set

4-mm bunch plugs with hex nuts, set of 4

DE929-3S Phillips screws, set of 4



DE926-2R PIBD Relay

Built-in coil with iron core; switching voltage: min. 7V

DE926-20 PIBD Break contact

Built in Reed contact; max. load: 3 mA

DE926-2S PIBD Make contact

Built in Reed contact; max. load: 3A

DE926-2W PIBD Changeover contact

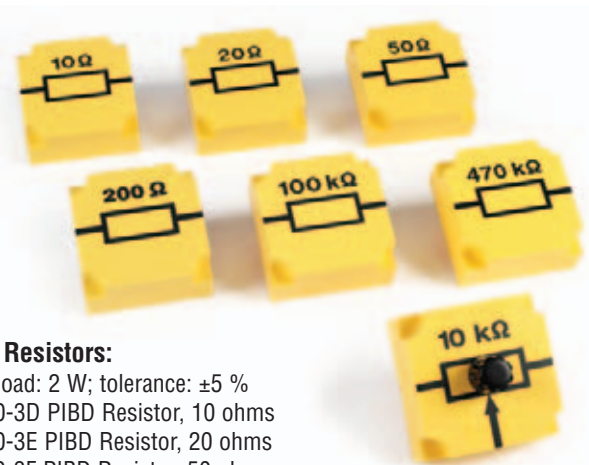
Built in Reed contact; max. load: 3A



PIBD Precision resistors:

Max. load: 4 W; tolerance: $\pm 0.2\%$

- DE920-4L PIBD Precision resistor, 10 ohms
- DE920-4M PIBD Precision resistor, 20 ohms
- DE920-4N PIBD Precision resistor, 50 ohms
- DE920-4O PIBD Precision resistor, 100 ohms



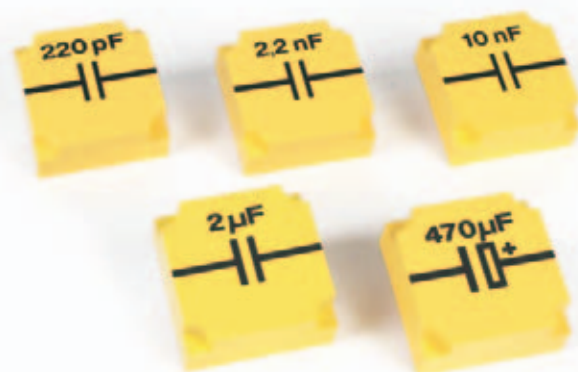
PIBD Resistors:

Max. load: 2 W; tolerance: $\pm 5\%$

- DE920-3D PIBD Resistor, 10 ohms
- DE920-3E PIBD Resistor, 20 ohms
- DE920-3F PIBD Resistor, 50 ohms
- DE920-3H PIBD Resistor, 200 ohms
- DE920-3W PIBD Resistor, 100 ohms
- DE920-3X PIBD Resistor, 470 ohms

DE920-3V PIBD Potentiometer, 10 kOhms

Max. load: 4 W; tolerance: $\pm 10\%$



PIBD capacitors:

Voltage rating: 100 V; tolerance: $\pm 20\%$

- DE920-6A PIBD Capacitor 220 pF
- DE920-6B PIBD Capacitor 2.2 nF
- DE920-6C PIBD Capacitor 10 nF
- DE920-6H STBD Capacitor 2 μ F
- DE920-6O STBD Capacitor 470 μ F

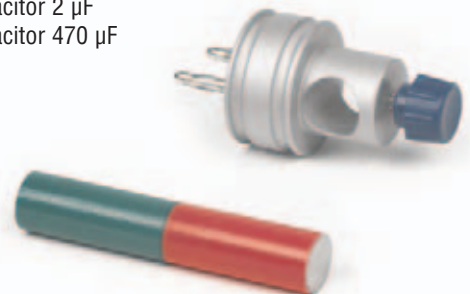


DE920-7B PIBD Ge-Diode

AA118 diode

Cut-off voltage: 100 V

Max. forward current: 50 mA



DE920-3C Magnet holder

Holder with through hole and clamping screw accepting round apparatus up to 15 mm in diameter (e.g. cylindrical magnet DE410-1L); two 4-mm plug pins, 19 mm apart, allow mounting on the PIBD with ball bearing; two grooves for drive belts

DE410-1L Bar magnet, AlNiCo, 80x15 mm

PIBD accessories



DE529-1S PIBD Plug-in symbols, set

Nine yellow plastic chips (D=62 mm) with 4-mm plug pins for labelling connection and measurement points within a circuit; eight of the chips are pre-printed with electrical symbols



Adapter plates, magnetic

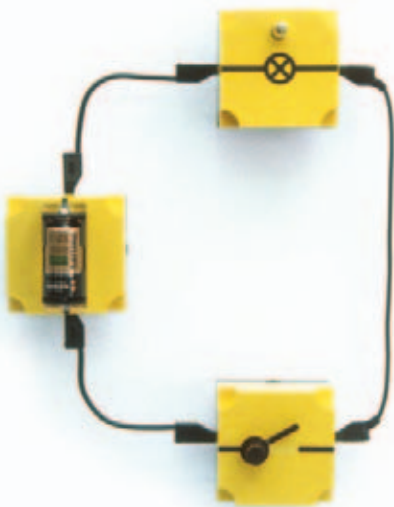
Durable blue plastic plates with 4-sockets for attaching plug-in “demo” modules (PIBDs); 4-mm safety jacks on the side for connecting leads; strong neodymium magnets are inset in the base for magnetic mounting; including stick-on pads to prevent slippage

DE320-1B Adapter plate, single, magnetic

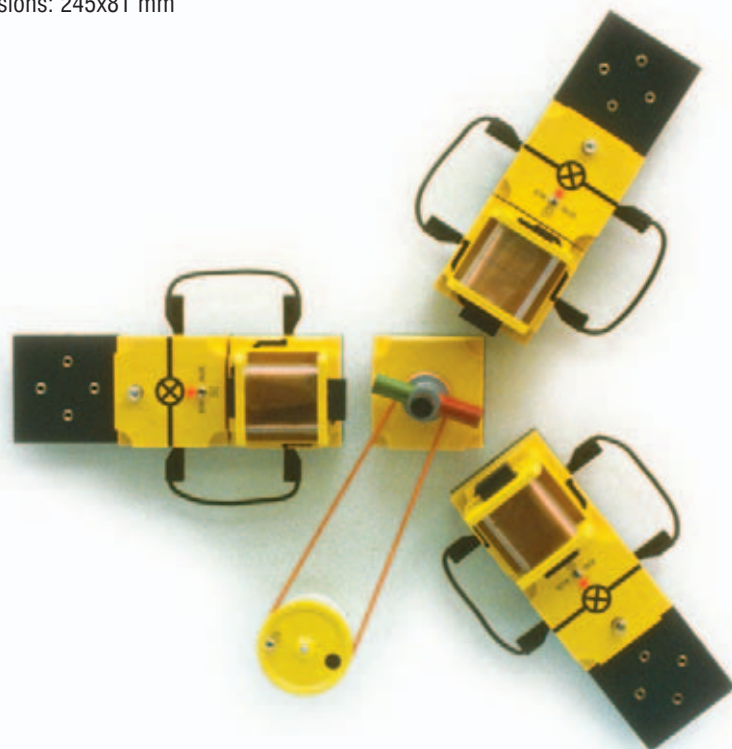
Dimensions: 81x81 mm

DE320-3B Adapter plate, triple, magnetic

Dimensions: 245x81 mm



Experiment: simple circuit set up with the plug-in system - magnetic panel assembly PIBDs, mounted on adapter plates, connected easily and flexibly by leads with 4-mm plugs



Experiment: three-phase generator with the plug-in system - magnetic panel assembly with adapter plates, PIBDs can be arranged at any angle to one another



DE920-3A PIBD Light bulb socket, E10, with transistor amplification

A lamp lights up, indicating very low induction voltage levels (e.g. when used with a three-phase AC generator); built-in ON-OFF switch; LED battery level indicator; 9 V battery (supplied)



PIBD accessories



DE330-9S Set of wires (PIBD)

consisting of:

- 1 Roll of constantan wire, D=0.2 mm, L=30 m
- 1 Roll of constantan wire, D=0.5 mm, L=15 m
- 1 Roll of iron wire, D=0.2 mm, L=30 m
- 1 Roll of copper wire, D=0.2 mm, L=30 m



DE310-9S Set of light bulbs (PIBD)

consisting of:

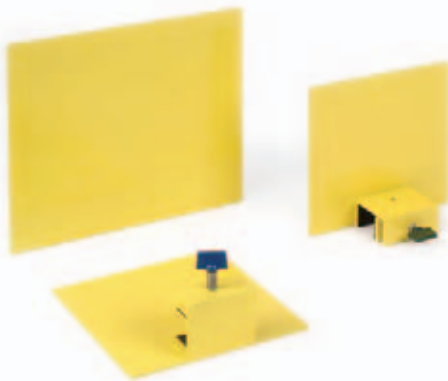
- 5 Light bulbs 4 V/40 mA, E10
- 5 Light bulbs 6 V/50 mA, E10
- 5 Light bulbs 6 V/500 mA, E10
- 5 Light bulbs 10 V/50 mA, E10
- 2 Light bulbs 24 V/25 W, E14
- 3 Light bulbs 12 V/25 W, E14
- 1 Storage container with lid



DG590-1S Set of connecting leads (PIBD)

consisting of:

- 4 Connecting leads, 50 cm, black
- 2 Connecting leads, 100 cm, black
- 2 Connecting leads, 100 cm, red
- 2 Connecting leads, 100 cm, blue



Metal platforms on clamp saddles

Metal platforms, yellow powder-coated, for mounting on the frame of demo plug-in panel DE920-1A and used to support a magnetic "inno" device: e.g. the "inno" panelmeter, the "inno" universal multimeter, the "inno" oscilloscope etc.

P3121-6A Metal platform PIBD, small, external

For magnetically mounting "inno" devices outside of the plug-in panel
Dimensions: 160x160 mm

P3121-6B Metal platform PIBD, small, internal

For magnetically mounting "inno" devices within the plug-in panel
Dimensions: 160x160 mm

P3121-7G Metal platform PIBD, large

For magnetically mounting the "inno" universal multimeter or the "inno" oscilloscope outside of the plug-in panel
Dimensions: 260x230 mm



P3130-2B Universal transformer II with digital display

Two three-digit, 26-mm LED displays;
Output terminals: 0 ... 25 V AC and 0 ... 20 V DC, continuously variable, max. 6 A
0 ... 15 V DC, continuously variable, stabilized, max. 1 A
6 V and 12 V AC fixed, max. 6 A
Overload protection by means of thermal cut-outs (overcurrent protection switch)
Voltage source: 230 V AC/50 ... 60 Hz
Dimensions: 260x150x210 mm
Weight: approx. 8.3 kg



P3160-3A Function generator with digital display "demo"

Six-digit, 26-mm LED display
Output signals: sine, triangle, square and sawtooth
Both amplitude and frequency able to be modulated
Frequency range: 0.1 Hz ... 100 kHz
Output voltage: 0 ... 10 Veff, max. 2 Aeff
Permanent protection against short circuits and backlash potential
Voltage source: 230 V AC/50...60 Hz
Dimensions: approx. 260x150x210 mm
Weight: approx. 3.9 kg



P3130-3M Low-voltage transformer with digital display, "inno"

Three-digit, 20-mm LED display;
Output terminals: 0 ... 12 V DC, stabilized and smoothed, continuously variable, max. 3 A; and 3, 6, 9 or 12 V AC, variably selectable, max. 3 A. All output terminals electronically protected against overloading
Voltage source: 230 V AC/50...60 Hz
Dimensions: approx. 160x120x45 mm



P3120-3F Function generator SE Output signals: sine, triangle and square

Frequency range: 0.1 Hz ... 100 kHz
Output voltage: 0...4 Veff, max. 4 W
Protection against short circuits and backlash potential; input voltage: 12 V AC
Dimensions: approx. 160x120x45 mm

PIBD accessories



DE710-00 Universal multimeter "inno", magnetic

Durable remote-control measuring instrument with three insertable double scales
Arc length of scale: approx. 200 mm
Digit height: 26 mm
LED display indicates measuring units and type of current

Measuring ranges: 1 mV, 1 ... 30 V (DC), 1 V ... 30 V (AC)

DC A/AC A: 100 μ A ... 10 A

Dimensions: approx. 260x230x60 mm

Weight: approx. 2.7 kg



DE700-1M Demonstration measuring instrument, digital/analogue

Voltage ranges: 9 ranges for AC and DC
Amperage ranges: 11 ranges for AC and DC

Resistance ranges: 11 ranges

Scale type: double scale (3 and 10 units) with mirror background and LED indicators
Arc length of scale: 200 mm

Overload protection: fine-wire fuses in sockets

Voltage source: 230 V/50...60 Hz

Dimensions: 260x230x210 mm



DE722-1P Panelmeter "inno"

Display: 3 1/2-digit LED display; digit height 26 mm

Measuring ranges: 0 ... 200 mA, 0 ... 20 A, 0 ... 40 V AC/DC

Fuses: fine-wire fuse F 10A

Dimensions: approx. 160x120x45 mm

Weight: approx. 540 g



DE710-20 DE710-20 NTL video oscilloscope "inno"

Two-channel, magnetically mounting digital memory oscilloscope

5.6" TFT colour monitor;

Resolution: 256x256 pixels (8 bit/8 bit)

Genuine PAL video output for directly

connecting a TV set or a video beamer

Vertical operating modes: Y1, Y2, Y1 and Y2,

Y1+Y2, Y1-Y2, XY

4-mm safety jacks for input, no adapter necessary

Dimensions: approx. 260x230x60 mm

Weight: approx. 1.9 kg



DE750-3A Oscilloscope, two-channel, 30 MHz

Monitor size: 80x100 mm, with measuring grid
Y deflection: 1mV ... 5 V/DIV, with fine adjustment

Max. input voltage: 400 V AC/DC

Operating modes: Ch1, Ch2, Ch1+Ch2, Ch1-Ch2, XY display

X deflection: 0.2 s ... 20 ns/DIV, with fine adjustment

Voltage source: 230 V AC/50 ... 60 Hz

Dimensions: approx. 316x132x410 mm

Weight: approx. 7.8 kg

Additionally required:

DG500-4A BNC to 4-mm socket adapter



DE722-10 Ohmmeter "inno"

Display: 3 1/2-digit LED display

Digit height: 26 mm

Measuring ranges: 200 Ohms; 2, 20, 200, kOhms; 2 MOhms; 2 V (diode testing)

Dimensions: approx. 160x120x45 mm

Weight: approx. 450 g