

MATRIX



Excellence in education
for over 25 years

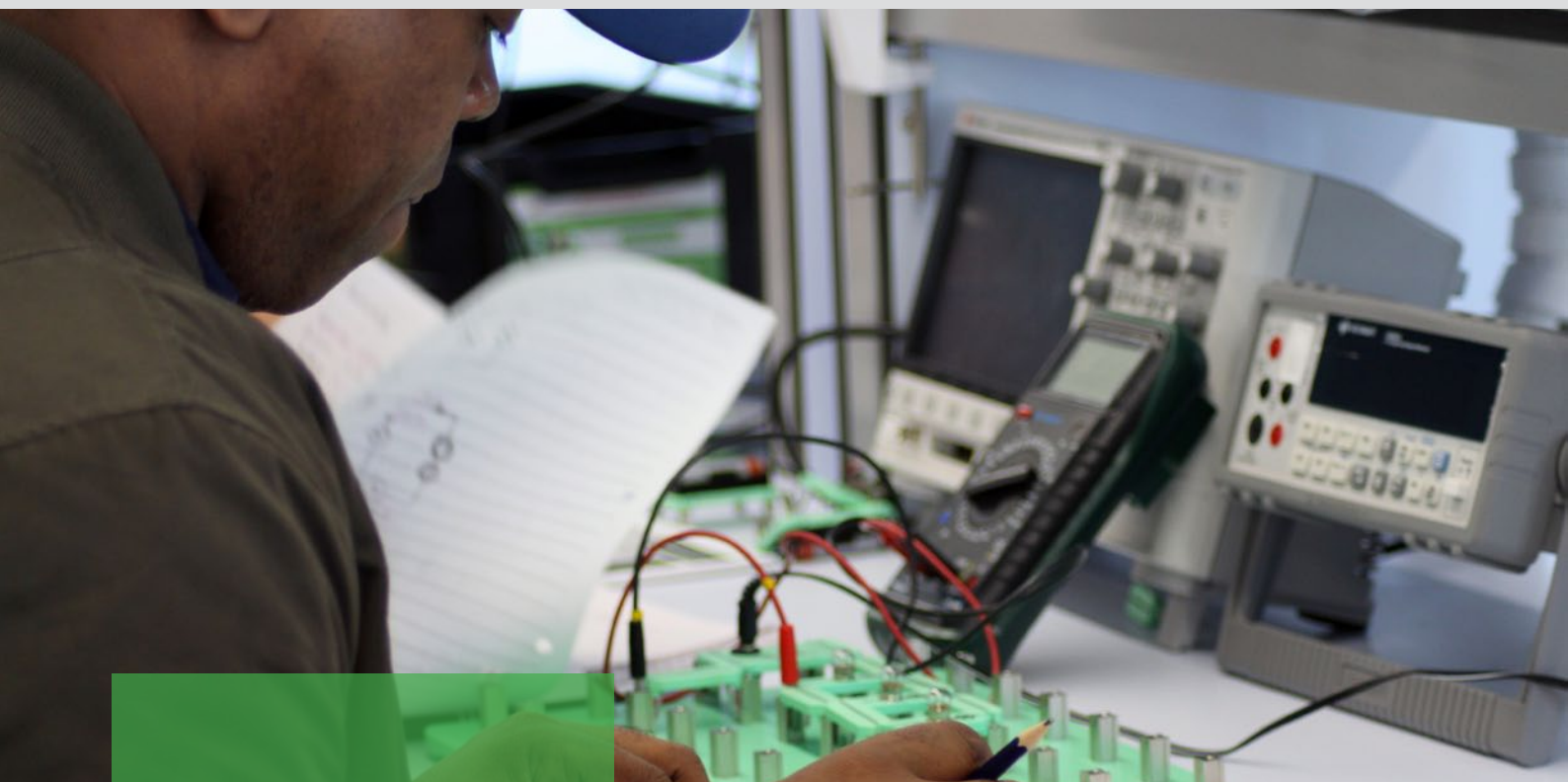
SET | SCIENCE
ENGINEERING
TECHNOLOGY

VOCATIONAL TRAINING

EDITION 2020

www.matrixtsl.com

Matrix are committed to developing intuitive solutions for teaching and learning at age 16 and above across many disciplines, spanning Science, Engineering and Technology. Within the vocational training edition of our catalogue, you will find systems designed for learning key principles within electrical installation and automotive at levels one, two and three.



Our learning solutions:

- Are safe to use in a classroom environment
- Are covered by EMC/CE compliancy where appropriate
- Are compact and portable
- Enable learning through a hands-on approach to teaching

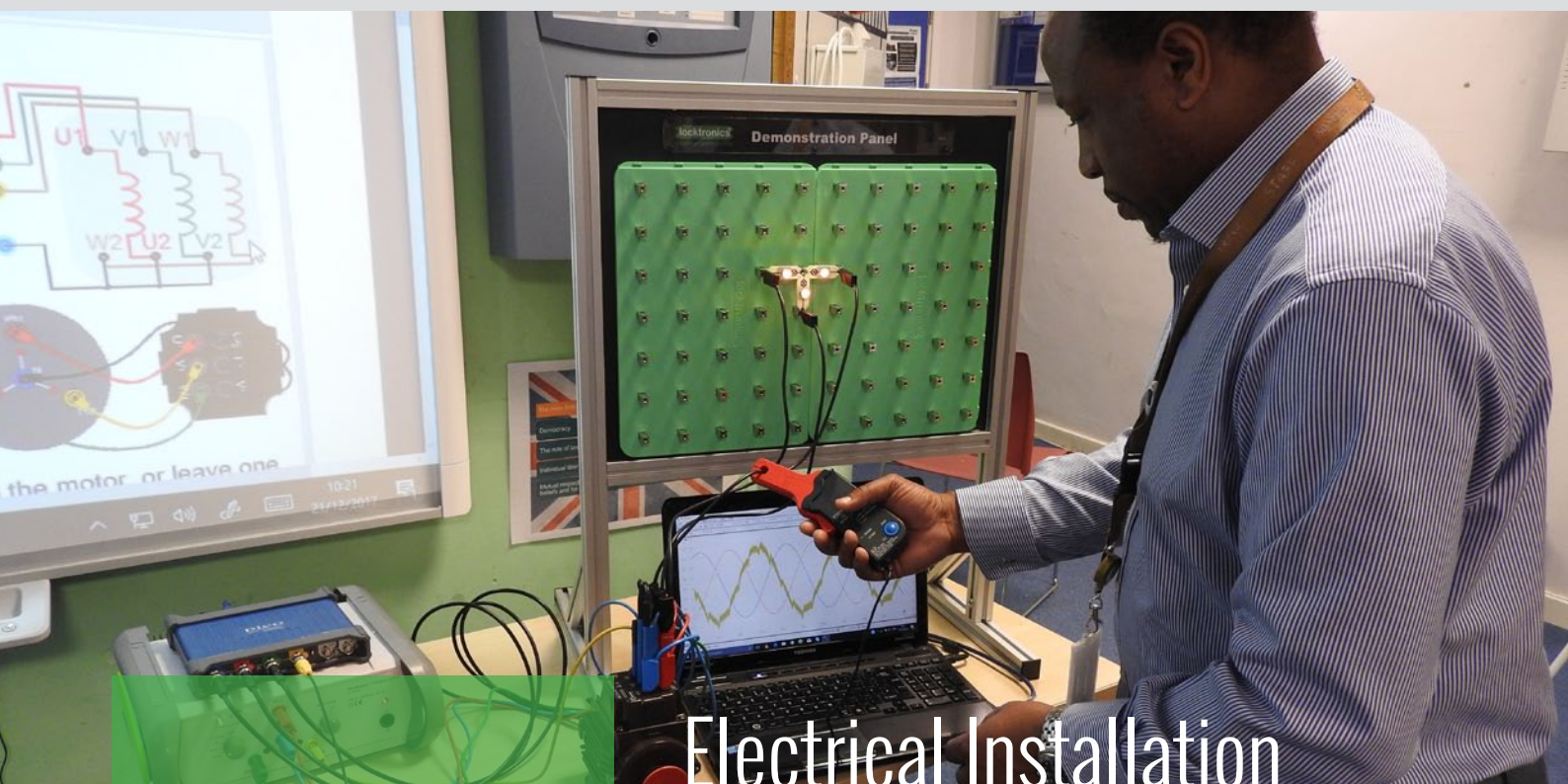
“Locktronics solutions are portable, easy to store and simple to use; Ideal for practical lab-work in classroom environments. The included curriculum material was suitably designed for teaching of BTEC qualifications and can be easily adapted to meet the Scottish Electrical engineering curriculum from National 4/5 through to HNC/D level. With these kits our students can quickly build and test a wide range of circuits. The simple connection method makes it easy for students to try different component values and configurations, thereby gaining a deeper understanding of electrical principles and circuit operation.”

Bill Crawford,
Forth Valley College, United Kingdom

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The electrical installation range has been designed to meet the requirements of the popular City and Guilds courses for both electricians and plumbers. The objective here is to help students understand the fundamental theory and practice of the Electrical Science parts of units 7202, 7365 with hands on activities. Following the success of our electrical installation range, we have developed five further solutions to allow technicians studying City & Guilds level 3 (units 8202) access to a suite of unique training equipment. All of our solutions in electrical installation are also suitable for the corresponding EAL qualifications.



Electrical Installation

Our learning solutions:

- Are designed around City and Guilds syllabuses
- Are accompanied by detailed colour workbooks
- Provide hands on equipment and activities
- Are supplied in rugged storage trays
- Are also suitable for EAL

“The Electrical Installation range has proven an invaluable tool in the teaching and learning of our science modules. Using real-life experiments consolidates our students learning through building practical exercises and makes the teaching so much more engaging. The free lesson plans save our lecturers hours of planning, and ensure the kits are used to their full potential, they are worth their weight in gold. Matrix were easy to work with from start to finish and I would definitely recommend them for their electrical installation range.”

Neil Benjamin-Miller
Uxbridge College

Electrical installation level 1



This solution is also suitable for centres delivering training under the EAL awarding body.

This solution allows students who aspire to go on to become plumbers or electricians to gain a fundamental understanding of the basic principles of electricity. The learning outcomes are closely aligned with City and Guilds 7202 unit 107 in Electrical science. The kit includes a comprehensive range of practical assignments in electricity, basic circuits, and the use of multimeters for measuring and fault diagnosis. The kit is supplied with a comprehensive set of printable worksheets and teacher's notes.

Learning objectives / experiments:

- The basic principles of electron flow theory
- Simple units of electrical measurement
- Using multimeters
- The effects of an electric current
- Simple electrical calculations
- AC and DC supplies
- Simple electrical circuits



Curriculum mapping

- Suitable for City and Guilds 7202 Level 1 diploma in electrical installation

| Ordering information | DIN | ANSI |
|---------------------------------|--------|---------|
| Electrical installation level 1 | LK5000 | LK5000A |
| Corresponding curriculum | LK4098 | |
| You will also need | | |
| Multimeter pack | LK1110 | |
| Components - See page 19 | | |

Electrical installation level 2



This solution is also suitable for centres delivering training under the EAL awarding body.

This kit allows students to understand the electrical science required to become a competent electrician at level 2 through completion of a range of worksheet driven tasks and experiments in electricity and electrical circuits. The learning outcomes are closely aligned with City and Guilds 8202 unit 202 in Electrical science. The kit includes a comprehensive range of practical assignments in electricity, basic circuits, and the use of multimeters for measuring and fault diagnosis. The kit is supplied with a comprehensive set of printable worksheets and teacher's notes.

Learning objectives / experiments:

- The principles of electricity
- The principles of basic electrical circuits
- The principles of electromagnetism
- The operating principles of a range of electrical equipment
- The principles of A.C theory
- Includes our new residual current device



Curriculum mapping

- Suitable for much of 8202 Unit 202 of the City and Guilds level 2 Diploma in Electrical Installation
- Suitable for BTEC National in Engineering unit 14: Electrical installation of hardware and cables
- Suitable for unit 31 of BTEC Higher National: Electrical systems and fault finding

| Ordering information | DIN | ANSI |
|---------------------------------|--------|---------|
| Electrical installation level 2 | LK4063 | LK4063A |
| Corresponding curriculum | CP8475 | |
| You will also need | | |
| Multimeter pack | LK1110 | |
| Components - See page 19 | | |

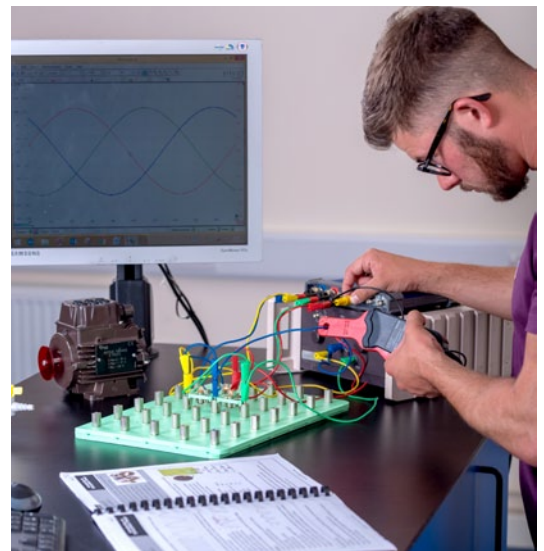
Three phase systems



This pack includes a suite of practical investigations into three phase systems and it includes a low voltage three phase generator and a low voltage three phase motor. The pack includes the parts needed to set up three phase systems based on star and delta topologies with balanced and unbalanced loads. Students work through the 33 page full colour workbook understanding three phase concepts as they progress. A 4 input Picoscope and current clamp is not included in the pack. Picoscope is optional. Current clamp is needed for some experiments.

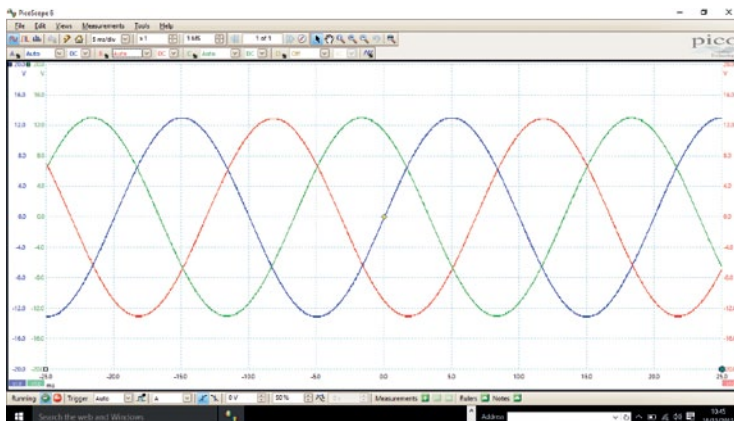
Learning objectives / experiments:

- Three phase circuits - star and delta
- Balanced and unbalanced loads
- Phase relationships in three phase systems
- Phase vectors
- Using a capacitor to create a phase shift for motors
- Three phase rectification - half and full
- Real, reactive and apparent power
- Three phase inductance and reactance
- Power in three phase systems
- Motors in three phase systems
- Using current clamps and PC oscilloscopes
- Power factor correction



Curriculum mapping

- Suitable for BTEC National unit 16: Three phase electrical systems
- Suitable for unit 52 of BTEC Higher National: Further electrical, electronics and digital principles



| Ordering information | DIN | ANSI |
|---------------------------------|--------|---------|
| Three phase systems | LK4961 | LK4961A |
| Corresponding curriculum | LK2686 | |
| Recommended | | |
| Pico 4 phase oscilloscope | HP5834 | |
| AC/DC current clamp | HP5561 | |
| Components - See page 20 | | |

Electronic components and circuits pack

This pack allows students to understand the operation of a range of commonly used components in both DC and AC circuits. The learning outcomes are closely aligned with the requirement of City and Guilds 8202 level 2 topic 4- Understand electronics components. The kit includes a range of practical assignments which guide students from simple circuits that allow them to understand component operation through to circuits that are made up of a number of components that perform useful tasks in electrical systems. A full set of colour printable worksheets and teacher's notes is supplied.

Learning objectives / experiments:

- Operation of resistors, capacitors, thermistors, diodes, zener diodes, photo transistor, transistor, and triac.
- AC and DC circuits including rectification, amplification, dimming, soft start, current limiting, light indicators, sensors
- Full worksheets available online
- Shipped in standard storage cases



This solution is also suitable for centres delivering training under the EAL awarding body.



Curriculum mapping

- Suitable for City and Guilds 8202 level 2

| Ordering information | DIN | ANSI |
|---|--------|---------|
| 8202 level 2- Electronic components and circuits pack | LK2901 | LK2901A |
| Corresponding curriculum | CP2813 | |
| You will also need | | |
| Multimeter pack | LK1110 | |
| Components - See page 20 | | |

Principles of lighting

This solution allows students to understand the principles of designing lighting systems for domestic and industrial buildings. The kit consists of a Locktronics base board, a set of high power MES LED bulbs, switch and connectors and a light meter.

Students can arrange the bulbs in varying positions and densities and measure light intensity using the light meter provided. Students can explore the different effects on light intensity through the angle of lighting, the distance away from the light source, and the density of light sources.

A full set of worksheets is available for download.

Further instruments may be required. Please contact us for information.

Learning objectives / experiments:

- Lighting system design
- Units of measurement for light
- Energy efficiency
- The effect of distance
- The effect of angles
- The effect of reflectors



This solution is also suitable for centres delivering training under the EAL awarding body.



Curriculum mapping

- Suitable for City and Guilds 8202 level 3

| Ordering information | DIN | ANSI |
|--------------------------------------|--------|---------|
| 8202 Level 3: Principles of lighting | LK2285 | LK2285A |
| Corresponding curriculum | CP2273 | |
| You will also need | | |
| Multimeter pack | LK1110 | |
| Components - See page 20 | | |

Transformer construction and operation

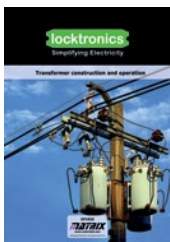
The Transformer construction and operation pack allows students to study not only how transformers work, but also study several different properties of induced magnetism. This kit consists of a plastic base, a laminated iron core, mounting fixtures, and six coils protected in a heat resistant film. Topics covered include Lenz' Law, Faraday's Law, how iron cores increase magnetic field strength, and electromagnetic induction itself. This versatile piece of equipment can also be used to teach about how transformers used by power companies carry electrical energy. Extensive instructions on how to use the apparatus as a demonstration as well as inquiry based lessons surrounding electromagnetic induction and transformers are included. The kit is supplied in our standard storage trays. AC power supply required.



This solution is also suitable for centres delivering training under the EAL awarding body.

Learning objectives / experiments:

- Power and energy in DC systems
- Power in AC systems, power factor, losses
- Transformer construction
- Reactive loads



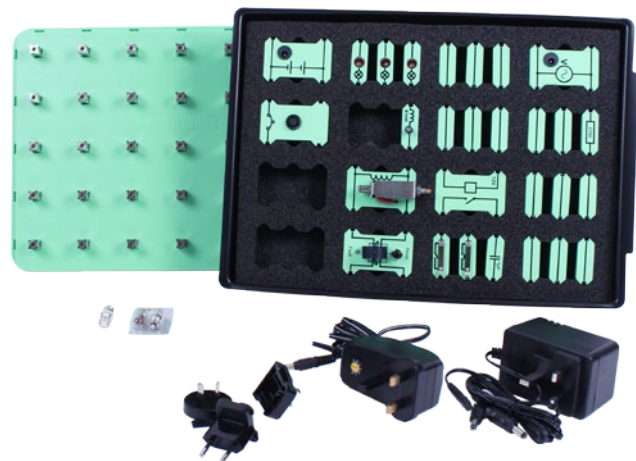
Curriculum mapping

- Suitable for City and Guilds 8202 level 3

| Ordering information | DIN | ANSI |
|---|--------|---------|
| Transformer construction and operation pack | LK1989 | LK1989A |
| Corresponding curriculum | CP1933 | |
| You will also need | | |
| Multimeter pack x2 | LK1110 | |
| AC power supply (240V: 12V @5amps) | HP3728 | |
| Components - See page 21 | | |

Electrical installation circuit principles

This pack covers two separate topics. Firstly students can use the Locktronics components and a signal generator to export inductive and capacitive reactance and to compare the effects these have on circuits with resistance. Secondly the pack includes a selection of components that allows students to explore how solenoids and relays are used in electronics circuits, and how circuit breakers and RCDs are used in electrical safety systems.



This solution is also suitable for centres delivering training under the EAL awarding body.

Learning objectives / experiments:

- Inductive and capacitive reactance
- Impedance in AC circuits
- Contactors, relays, solenoids
- Safety systems and earth systems
- MCB, RCD operation

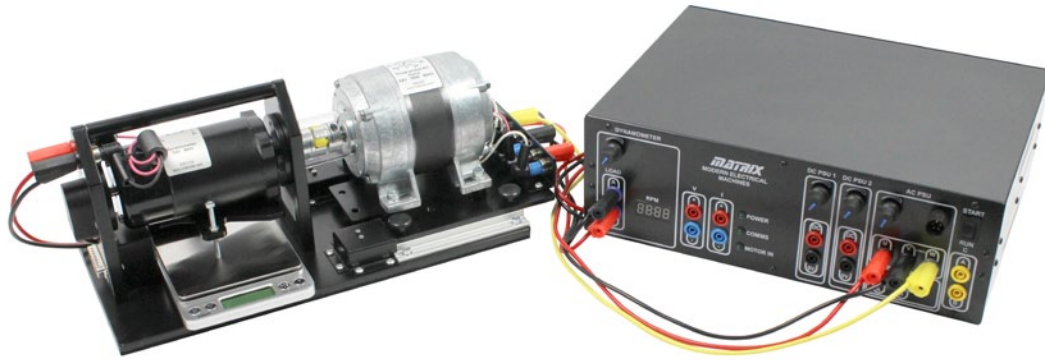


Curriculum mapping

- Suitable for City and Guilds 8202 level 3

| Ordering information | DIN | ANSI |
|--|--------|---------|
| Electrical installation circuit principles | LK4562 | LK4562A |
| Corresponding curriculum | CP0295 | |
| You will also need | | |
| Multimeter | LK1110 | |
| Signal generator | HP7894 | |
| Components - See page 21 | | |

Modern electrical machines



Our modern electrical machines training system is a revolutionary way of safely studying the characteristics of different motor types in a learning environment. This solution includes eight different types of machine, integrated power supply and control box and PC-based applications for advanced controller of the different machine types. Further to this, we provide four separate curriculum manuals for teaching electrical machines principles using manual control with external meters, using PC control or using MATLAB.

Learning objectives / experiments:

- It's safe to operate - all moving parts covered
- The system operates on 24V power, AC or DC
- All machines are small footprint, low power
- The system is easily stored and packed away
- Includes electronic measurement of voltage, current and power in AC and DC
- Both manual and full PC control
- DC power supply is included
- AC power supply single and three phase supply with variable frequency is included
- Full curriculum and experiments are included

This kit includes:

- Dynamometer with integrated load cell and rotary encoder
- DC Permanent Magnet Motor (also used as a DC Permanent Magnet Generator)
- DC Shunt Motor (also used as a DC Separately Excited Motor & Generator and DC Shunt Generator)
- DC Series Motor (also used as an AC / Universal Motor)
- AC Single Phase Induction Motor
- AC Three Phase Induction Motor (Star and Delta configurations)
- Brushless DC Motor (also AC Three Phase Permanent Magnet Synchronous Motor & Generator)
- Integrated power supply and control box
- PC-based applications for advanced control of the motors

Control box features

- Select DC, single-phase AC and 3-phase AC outputs
- Integrated voltage and current measurement
- Adjustable resistive loads for dynamometer and series winding resistor
- Switchable start and run capacitors
- 14 different instruments embedded within it
- A unique API, allowing connection to be made to the MATLAB environment
- A small size, around the size of a laptop, making it small enough to sit on a desk along with the rest of the kit and PC

Control box

At the heart of both manual and PC control of the machines is our control box. The control box houses all of the electronics including motor drivers, to control the modern electrical machines training system.



Control box features

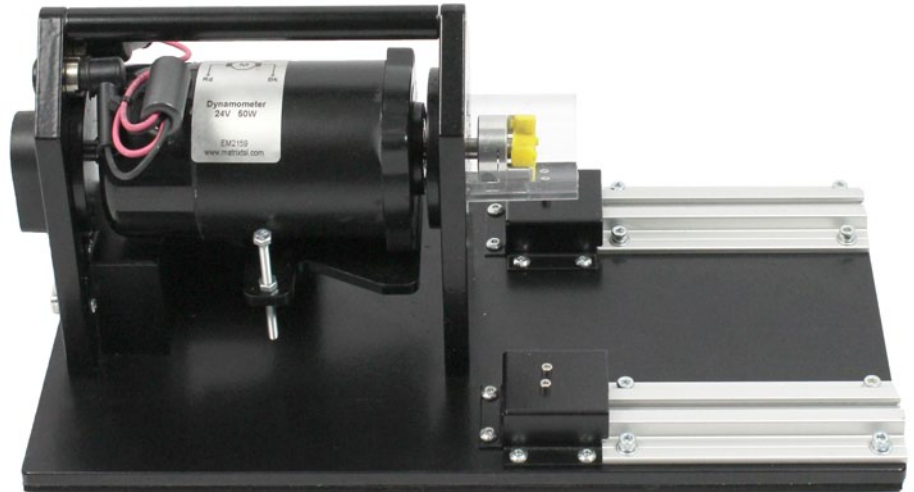
- 14 different instruments embedded within it
- A unique API, allowing connection to be made to the MATLAB environment
- A small size, around the size of a laptop, making it small enough to sit on a desk along with the rest of the kit and PC

Modern electrical machines

Motors

DC Dynamometer / motor and cradle

Operating voltage - 24V AC
 Max current - 2A
 Speed - 1500rpm



The aluminium cradle which houses our dynamometer features a rugged and safe sliding mechanism into which each of the other six motors in the range fix into position. The motor coupling meets the dynamometer in a protected housing and allows for safe study of each machine type at 24 volts. When using our system in manual mode, it is likely you will require two (per set) HP1324 Fluke 115 True RMS Digital Multimeter and one HP8067 Tektronix Digital oscilloscope.

Three phase induction motor

Operating voltage - 24V AC
 Frequency - 40-80Hz
 Max current - 1.4A
 Speed - 1400rpm



Shunt motor

Operating voltage - 24V AC
 Max current - 12A
 Speed - 1500rpm



Single phase induction motor

Operating voltage - 24V AC
 Frequency - 40-80Hz
 Max current - 1.4A
 Speed - 1400rpm



Universal / Series motor

Operating voltage - 24V AC
 Frequency - 50Hz
 Max current - 6A
 Speed - 1500rpm



DC motor

Operating voltage - 24V AC
 Frequency - 40-80Hz
 Speed - 1500rpm



Brushless DC motor / 3 phase generator

Operating voltage - 24V DC 3 Phase
 Max current - 2A
 Speed - 1500rpm



Curriculum mapping

- Teaches Electrical Installation students the basics of electrical machine operation, their speed / torque characteristics and the circuits and power supplies needed to drive them.

Ordering information

| | |
|---------------------------------------|----------------|
| Modern electrical machines | EM6637 |
| Corresponding curriculum | CP6490, CP4160 |
| You will also need | |
| Fluke 115 True RMS Digital Multimeter | HP1324 |
| Tektronix Digital Oscilloscope | HP8067 |

The Locktronics automotive range has been designed to meet the Automotive training requirements of both industry and education. The range is split into three levels for basic, intermediate and advanced students. The Locktronics approach is ideal for automotive technicians who gain a good understanding of components, circuits and circuit fault finding through the process of building Locktronics.



Automotive

Our learning solutions:

- Allow students to see circuits constructed
- Are supplied with full curriculum guides and worksheets
- Are split into three levels, for common automotive teaching
- Are used by industry leading automotive manufacturers

“During my career as an Automotive Technical Training Instructor, I have been using Matrix’s solutions for well over 15 years. They are the unequivocal leader in Automotive Electronic Instructional kits!

In fact, I had such a positive experience with their basic kits during my tenure with Jaguar Land Rover, I recommended shortly after my hire with Hyundai Auto Canada that we establish a working relationship with Matrix. Since 2016 we have added numerous Electrical, Sensor and Automotive CAN kits to our Canadian Training Centers. These kits are incredibly durable, in fact, virtually indestructible, as they are used 4/5 days most weeks to support our OEM curriculum. Matrix definitely sets the standard for: quality, durability, versatility and most importantly customer service. The folks at Matrix are a pleasure to deal with from the design phase, through purchase, shipping and aftersales. Highly recommended!”

Rob Jakubowski,
Hyundai Performance Academy, Canada

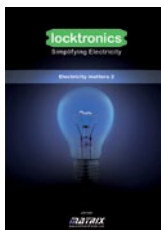
Locktronics automotive customers

Locktronics automotive equipment and curriculum is used by colleges, vocational schools, independent automotive training companies and some of the World's leading automotive companies including:



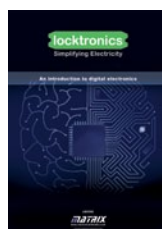
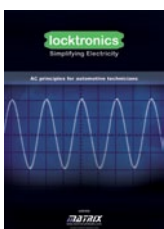
Level 1

At Level 1, the Electricity, magnetism and materials solution allows you to teach students how basic electrical components and circuits work.



Level 2

At Level 2 three solutions on AC principles, motors and generators and digital electronics builds on students' understanding of electricity, electrical circuits and electrical systems.



Level 3

At Level 3 the Sense and Control, the CAN bus systems solution and the Hybrid demonstration system give students experience and understanding of how Electronic Control Unit based systems in modern vehicles operate.



Electricity, magnetism and materials

This kit provides a comprehensive range of practical assignments in electricity and magnetism and is ideal for those who are studying science and electricity within a wide variety of academic or vocational courses. The kit is supplied with a comprehensive set of worksheets that cover the electrical properties of materials, and introduce students to electricity.

Learning objectives / experiments:

- Electrical properties of materials
- Simple circuits
- Heat and magnetism
- Basic circuit symbols
- Current flow
- Series and parallel circuits
- Patterns of voltage and current
- Electrical sensors
- Relays and electromagnets



Curriculum mapping

- Suitable for IMI and City and Guilds level 1 courses.



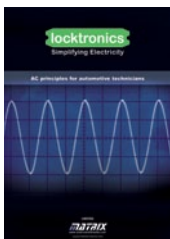
| Ordering information | DIN | ANSI |
|---|-----------------|-----------|
| Electricity, magnetism and materials solution | LK9071-2 | LK9071-2A |
| Corresponding curriculum | LK7325 & LK7326 | |
| You will also need | | |
| Multimeter pack | LK1110 | |
| Components - See page 22 | | |

AC principles for automotive technicians

This course provides an introduction to AC electrical principles that underpin many automotive units. A comprehensive set of curriculum worksheets and supporting documentation deliver experiments to illuminate the theory behind much of the automotive electrical technology.

Learning objectives / experiments:

- Batteries and their properties
- AC signal fundamentals
- DC equivalent, peak and RMS values
- Reactance, inductance and suppression
- Diode and zener diode behaviour
- Half and full wave rectifiers
- Battery charging systems



Curriculum mapping

- Suitable for IMI and City and Guilds level 2 courses.



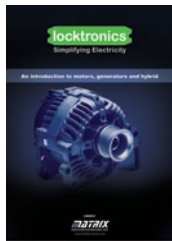
| Ordering information | DIN | ANSI |
|---|--------|---------|
| AC principles for automotive technicians solution | LK8222 | LK8222A |
| Corresponding curriculum | LK8392 | |
| You will also need | | |
| Multimeter pack | LK1110 | |
| Picoscope | HP8279 | |
| Signal generator | HP7894 | |
| Components - See page 22 | | |

An introduction to motors, generators and hybrid

This course investigates the electrical principles behind motors and generators and is designed to support the teaching of a range of automotive units. It is accompanied by a comprehensive set of curriculum worksheets and supporting documentation to facilitate the learning of this core topic in automotive electrical technology.

Learning objectives / experiments:

- Magnetic fields, field strength and flux density
- Electromagnets
- The force on a conductor in a magnetic field (Fleming's left-hand motor rule)
- DC motor principles
- The induced current when a conductor moves inside a magnetic field (Fleming's right-hand dynamo rule)
- Investigate the factors that determine the magnitude of the induced current
- AC generator principles
- Transformer construction and operation
- Electrical energy storage



Curriculum mapping

- Suitable for IMI and City and Guilds level 2 courses.

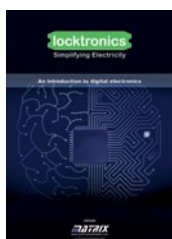
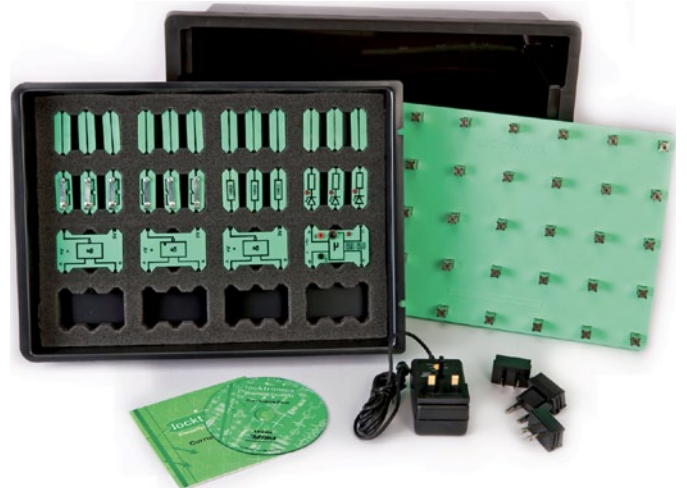
| Ordering information | DIN | ANSI |
|--|--------|---------|
| An introduction to motors, generators and hybrid | LK7444 | LK7444A |
| Corresponding curriculum | LK8822 | |
| You will also need | | |
| Multimeter pack | LK1110 | |
| Picoscope | HP8279 | |
| Signal generator | HP7894 | |
| Components - See page 23 | | |

An introduction to digital electronics

This course covers the basics of digital electronics, a core topic in modern automotive electrical technology. In doing so, it supports the delivery of a range of automotive units. It focuses on the use of logic functions and shows how these can be delivered through conventional discrete gates and through programmable logic systems. It is accompanied by a comprehensive set of curriculum worksheets and supporting documentation.

Learning objectives / experiments:

- Analogue and digital signals
- Binary and hexadecimal number systems
- A simple logic probe
- Truth tables for AND, OR, NOT, NAND, NOR
- NAND gates and circuits
- Microcontroller circuits and logic systems



Curriculum mapping

- Suitable for IMI and City and Guilds level 2 courses.

| Ordering information | DIN | ANSI |
|--|--------|---------|
| An Introduction to digital electronics | LK4221 | LK4221A |
| Corresponding curriculum | LK9392 | |
| You will also need | | |
| Multimeter pack | LK1110 | |
| Components - See page 23 | | |

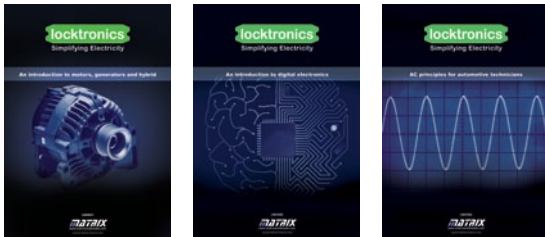
Combined level 2 automotive pack

This kit provides a comprehensive set of experiments for learning AC principles, motors, generators and hybrid basics, and an introduction to digital electronics. With a single base board, a number of trays of components and three separate workbooks with teacher's notes, this kit represents great value for money learning opportunities for level 2 automotive students.



Learning objectives / experiments:

- Batteries and their properties
- AC signal fundamentals
- DC equivalent, peak and RMS values
- Reactance, inductance and suppression
- Diode, zener diodes and rectifiers
- Battery charging systems
- Magnetic fields, field strength and flux density
- Electromagnets, induction and Fleming's rule
- Motor and generator principles
- Transformer construction and operation
- Electrical energy storage
- Analogue and digital signals
- Binary and hexadecimal number systems
- AND, OR, NOT, NOR and NAND gates and circuits
- Microcontroller circuits and logic systems



Curriculum mapping

- Suitable for IMI and City and Guilds level 2 courses.

Ordering information

| | |
|----------------------------------|------------------------|
| Combined level 2 automotive pack | LK4500CUS |
| Corresponding curriculum | LK8822, LK9392, LK8392 |

You will also need

| | |
|------------------|--------|
| Multimeter pack | LK1110 |
| Picoscope | HP8279 |
| Signal generator | HP7894 |

Components - See page 24

Sensors and control in automotive applications

This kit provides an introduction to the role of an Electric Control Unit. Students use a number of pre-written programs for the MIAC Electronic Control Unit (ECU) to enable them to construct a wide variety of Input - Process - Output circuits using sensors and actuators typically found in vehicles. A full curriculum pack is provided.

Learning objectives / experiments:

- DC motors with speed control
- Stepper motors
- Temperature sensor
- Light sensor
- Potential dividers and their use
- Transistors as switches
- Use of relays
- ECU action and function
- Automotive control systems
- Sensor and actuator waveforms and signals
- Sensors and motor faults



Curriculum mapping

- Suitable for IMI and City and Guilds level 3 courses.

Ordering information

| | DIN | ANSI |
|---|----------|-----------|
| Sensors and control in automotive applications solution | LK9834-2 | LK9834-2A |
| Sensors and control solution with engineering panel | LK6491-2 | LK6491-2A |
| Corresponding curriculum | LK8849 | |

Components - See page 25

CAN bus systems and operation



This kit allows a fully functioning CAN bus system, mimicking vehicle operation, to be set up using 5 MIAC Electronic Control Units representing Instrument Panel, Front ECU, Powertrain control, Rear ECU and system diagnosis. Students can set up a fully working CAN bus system, insert faults and use scan tools to understand fault diagnosis procedures and practice. Supplied with a full curriculum pack.

Learning objectives / experiments:

- ECU action and function
- Automotive control systems
- Wiring in CAN bus systems
- CAN bus faults
- Faults in sensors and actuators



Curriculum mapping

- Suitable for IMI and City and Guilds level 3 courses

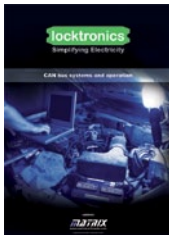
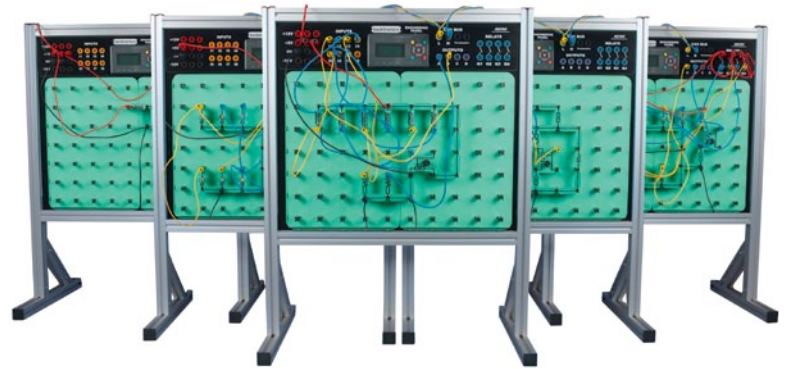
| Ordering information | DIN | ANSI |
|---|--------|---------|
| CAN bus systems and operation solution and Kvaser analyser | LK7629 | LK7629A |
| CAN bus systems make-up kit (allows 5 sensors and control kits to become a CAN bus kit) | LK9813 | LK9813A |
| Corresponding curriculum | LK9392 | |
| Components - See page 25 | | |

CAN bus systems and operation solution with engineering panel

The LK2839 CAN bus systems kit has the same learning objectives and components as the LK7629 but is based on our engineering panels which makes it more suitable for a dedicated automotive electrical training lab.

Learning objectives / experiments:

- ECU action and function
- Automotive control systems
- Wiring in CAN bus systems
- CAN bus faults
- Faults in sensors and actuators



Curriculum mapping

- Suitable for IMI and City and Guilds level 2 courses.

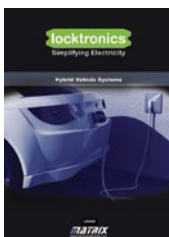
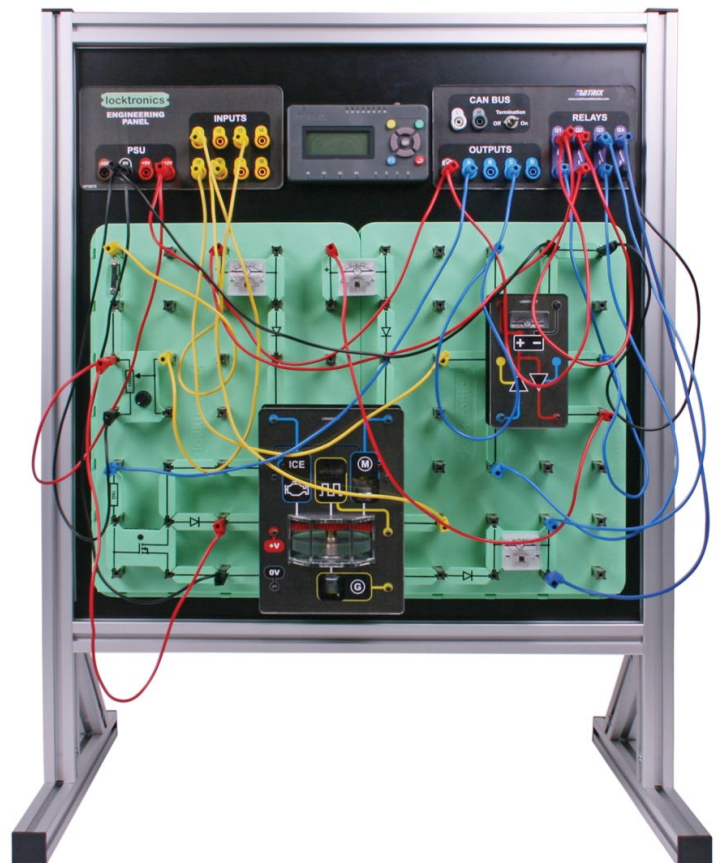
| Ordering information | DIN | ANSI |
|---|------------|-------------|
| CAN bus systems and operation solution with engineering panel | LK2839 | LK2839A |
| | LK2839-EU | LK2839A-EU |
| | LK2839-USA | LK2839A-USA |
| Corresponding curriculum | LK9893 | |
| You will also need | | |
| Multimeter pack | LK1110 | |
| Components - See page 26 | | |

Hybrid vehicle demonstration system

This Locktronics based hybrid demonstration system uses MIAC technology to demonstrate the energy pathways in hybrid systems and shows how the engine management system makes decisions on energy usage based on the State Of Charge (SOC) of the vehicle battery.

Learning objectives / experiments:

- Power modes in a series-parallel hybrid vehicle
- Regenerative braking
- Advantages of regenerative braking
- Factors affecting the acceleration of a vehicle
- Battery voltage, internal resistance, battery capacity, state of charge
- The role of the ECU in controlling the changes between power modes



Curriculum mapping

- Suitable for IMI and City and Guilds level 2 courses.

| Ordering information | DIN | ANSI |
|---|------------|-------------|
| Hybrid automotive principles on engineering panel | LK6483 | LK6483A |
| | LK6483-EU | LK6483A-EU |
| | LK6483-USA | LK6483A-USA |
| Corresponding curriculum | LK4483 | |
| Components - See page 26 | | |

COMPONENTS

Electrical installation level 1

| Components LK5000 | |
|--|--|
| 7 x 5 metric baseboard with 4mm pillars | Power supply carrier with battery symbol |
| Resistor, 12 ohm, 1W, 5% (DIN) | AC voltage source carrier |
| Potentiometer, 250 ohm (DIN) | AP EMM V2 Accessories pack |
| Connecting Link | Power supply |
| Lampholder, MES | AC power supply, 12VAC, 1.5A, UK |
| 400 Turn coil carrier | Hand cranked generator |
| Lead, red, 500mm, 4mm to 4mm stackable | MES bulb, 12V, LED, white |
| Lead, black, 500mm, 4mm to 4mm stackable | Switch, changover, metalstrip |
| Lead, blue, 500mm, 4mm to 4mm stackable | Switch, reversing, toggle |
| Switch, push to make, metal strip | Pair of leads, red and black, 1000mm, 4mm to croc clip |
| Switch, on/off, metal strip | Lampholder, MES, for automotive LEDs |
| Fuse/universal component carrier | |

Electrical installation level 2

| Components LK4063 | |
|---|---|
| Potentiometer, 250 ohm (DIN) | Lead, blue, 500mm, 4mm to 4mm stackable |
| AC voltage source carrier | Switch, push to make, metal strip |
| 7 x 5 metric baseboard with 4mm pillars | Switch, on/off, metal strip |
| Lead, red, 500mm, 4mm to 4mm stackable | Power supply carrier with battery symbol |
| Lead, black, 500mm, 4mm to 4mm stackable | Power supply |
| Pair of leads, red and black, 600mm, 4mm to croc clip | AC power supply, 12VAC, 1.5A, UK |
| MES bulb, 12V, LED, white | 2:1 transformer with retractable ferrite core |
| AP EMM V2 Accessories pack | Nichrome Wire Carrier, 0.075 x 500mm |
| Fleming's motor rule apparatus | Nichrome Wire Carrier, 0.075 x 250mm |
| Resistor, 12 ohm, 1W, 5% (DIN) | Nichrome Wire Carrier, 0.21 x 500mm |
| Resistor, 1k, 1/2W, 5% (DIN) | Constantan Wire Carrier, 0.075 x 500mm |
| Resistor, 10k, 1/4W, 5% (DIN) | Transformer, 2:1 turns ratio |
| Hand cranked generator | Fuse/universal component carrier |
| Switch, changover, metal strip | Diode, power, 1A, 50V |
| Switch, reversing, toggle | Capacitor, 2,200 uF, Electrolytic, 25V |
| Lampholder, MES | RCD block carrier |
| MES bulb, 12V, 0.1A | Circuit Breaker |
| 400 Turn coil carrier | Connecting Link |

Three phase systems

| Components LK4961 | |
|-----------------------------------|--|
| Three phase motor | Lampholder, MES |
| BNC male to dual 4mm Binding post | Lead - green - 320mm, 4mm to 4mm stackable |
| Three phase power supply | Lead, red. 500mm, 4mm to 4mm stackable |
| MES bulb 12V,0.1A | Lead, black, 500mm, 4mm to 4mm stackable |
| Resistor, 10 ohm, 1W 5% IN | Lead, yellow, 500mm, 4mm to 4mm stackable |
| Resistor, 1k, 1/2W, 5% (DIN) | Lead, blue, 500mm, 4mm to 4mm stackable |
| Diode, power, 1A, 50V | 33uF non-electrolytic capacitor |
| Connecting Link | Resistor, 2.2k, 1/4W, 5% DIN |

Electronic components and circuits

| Components LK2901 | |
|--|--|
| MES bulb, 6V, 0.06A | 7 x 5 metric baseboard with 4mm pillars |
| Switch, push to make, metal strip | AC voltage source carrier |
| Resistor, 47 ohm, 3W | Connecting Link |
| Resistor, 1M, 1/4W, 5% (DIN) | Lampholder, MES |
| Potentiometer, 25 ohm (DIN) | Triac - TIC206M |
| Thermistor, 470 ohm, NTC (DIN) | AC power supply, 12VAC, 1.5A, UK |
| Capacitor, 2.2 uF, Polyester | Potentiometer, 10k (DIN) |
| Capacitor, 1,000 uF, Electrolytic 30V | Power supply |
| Photodiode | Resistor, 1k, 1/2W, 5% (DIN) |
| Diode, silicon | MES bulb, 12V, 0.1A |
| Zener diode, 6.8V, 3W | Resistor, 100 ohm, 1W, 5% (DIN) |
| Power transistor, NPN, 1.5A | Resistor, 10k, 1/4W, 5% (DIN) |
| Power MOSFET transistor | Resistor, 10 ohm, 1W 5% (DIN) |
| Lead, red. 500mm, 4mm to 4mm stackable | Motor 3 to 12V DC, 0.7A |
| Lead, black, 500mm, 4mm to 4mm stackable | LED, Red |
| Lead, blue, 500mm, 4mm to 4mm stackable | Power supply carrier with battery symbol |

Principles of lighting

| Components LK2285 | |
|--|--|
| 7 x 5 metric baseboard with 4mm pillars | Lead, black, 500mm, 4mm to 4mm stackable |
| Power supply carrier with battery symbol | Lead, red. 500mm, 4mm to 4mm stackable |
| Connecting Link | Power supply |
| Lampholder, MES | Lux light meter |
| Switch, on/off, metal strip | MES bulb, 12V, 0.1A |
| MES power LED | Mirror Plastic (150 x 100mm) |

Transformer construction and operation

| Components LK1989 | |
|--|--|
| Coils and Cores Activity set | MES bulb, 6V, 0.06A |
| 7 x 5 metric baseboard with 4mm pillars | Switch, on/off, metal strip |
| Connecting Link | Lenz's law kit |
| AC power supply, 12VAC, 1.5A, UK | Small compass |
| AC voltage source carrier | 400 Turn coil carrier |
| Power supply | FERRITE ROD 100mmx10mm |
| Power supply carrier with battery symbol | Alnico rod magnet |
| Resistor, 100 ohm, 3W, 5% (DIN) | 4mm Shrouded Stackable Black |
| Resistor, 10 ohm, 3W 5% (DIN) | 4mm Shrouded Stackable Red |
| Lampholder, MES | Lead, black, 500mm, 4mm to 4mm stackable |
| MES power LED | Lead, red. 500mm, 4mm to 4mm stackable |

Electrical Installation circuit principles

| Components LK4562 | |
|--|--|
| Lampholder, MES | Lead, red. 500mm, 4mm to 4mm stackable |
| Switch, push to make, metal strip | Lead, black, 500mm, 4mm to 4mm stackable |
| Circuit Breaker | Sampler |
| Capacitor, 1 uF, Polyester | Resistor, 1k, 1/2W, 5% (DIN) |
| RCD block carrier | Potentiometer, 10k (DIN) |
| AC power supply, 12VAC, 1.5A, UK | 346 WIRE WOOL FINE (Gram) |
| Solenoid | 33uF non-electrolytic capacitor |
| Power supply carrier with battery symbol | Choke, 200mH |
| Power supply | Switch, on/off, toggle |
| MES bulb, 12V, 0.1A | 7 x 5 metric baseboard with 4mm pillars |
| Resistor, 270 ohm, 1/2W, 5% (DIN) | AC voltage source carrier |
| Choke, 47mH | Connecting Link |
| Relay, 12V coil, 10A, normally open | |

Electricity, magnetism and materials

| Components LK9071-2 | |
|-----------------------------------|--|
| Buzzer, 12V, 15mA | Pair of leads, red and black, 1000mm, 4mm to croc clip |
| Voltmeter, 0V to 15V | Switch, push to make, metal strip |
| Resistor, 100 Ohm, 1W, 5% (DIN) | Switch, on/off, metal strip |
| Resistor, 12 Ohm, 1W, 5% (DIN) | Resistor, 50k, 1/4W, 55 (DIN) |
| Motor, 6V, open frame | LED, red |
| Resistor, 1k, 1/2W, 5% (DIN) (x2) | Phototransistor Carrier |
| Resistor, 10k, 1/4W, 5% (DIN) | Fuse / universal component carrier |
| Potentiometer, 10k (DIN) | Power supply carrier with battery symbol |
| Diode, power, 1A, 50V | Ammeter, 0A to 1A |
| Connecting Link (x9) | 7 x 5 metric baseboard with 4mm pillars |
| Lampholder, MES (x3) | EMM V2 Accessories Pack |
| Thermistor, 4.7k, NTC (DIN) | 400 turn coil carrier |
| Relay, reed, normally open | |

AC principles for automotive technicians

| Components LK8222 | |
|-----------------------------------|---|
| Power Supply | Lampholder, MES (x3) |
| BNC male to dual 4mm binding post | Lead, red, 500mm, 4mm to 4mm stackable (x2) |
| AC voltage source carrier | Lead, black, 500mm, 4mm to 4mm stackable (x2) |
| MES bulb, 6V, 0.06A (x3) | Capacitor, 100uF, Electrolytic, 25V |
| Resistor, 1k, 1/2W, 5% (DIN) | Capacitor, 2,200uF, Electrolytic, 25V |
| Potentiometer, 250 Ohm (DIN) | Capacitor, 1uF, Polyester |
| Potentiometer, 10k (DIN) | Switch, on/off, metal strip (x2) |
| Diode, power, 1A, 50V | Choke 467mH |
| Connecting Link (x12) | Power supply carrier with battery symbol |
| Bridge rectifier | 7 x 5 metric baseboard with 4mm pillars |

An introduction to motors, generators and hybrid

| Components LK7444 | |
|--|---|
| Power Supply | Switch, push to make, metal strip |
| Capacitor 22,000uF, Electrolytic 16V | Fleming's motor rule apparatus |
| Voltmeter, 0V to 15V | Motor 3 to 12V DC, 0.7A |
| Transformer, 2:1 turns ratio | 2:1 transformer with retractable ferrite core |
| Hand-cranked generator | Alnico rod magnet |
| Resistor, 1k, 1/2W, 5% (DIN) | Lenz's law kit |
| Resistor, 270 Ohm, 1/2W, 5% (DIN) | Faraday's law kit |
| Potentiometer, 250 Ohm (DIN) | Ammeter, 0A to 1A |
| Diode, 1A, 50V | 7 x 5 metric baseboard with 4mm pillars |
| Zener diode, 4.7V | Ammeter, 0mA to 100mA |
| Bridge rectifier | 400 turn coil carrier |
| Pair of leads, red and black, 1000mm, 4mm to croc clip | Power supply carrier with battery symbol |
| Lead, red, 500mm, 4mm to 4mm stackable | Connecting Link (x8) |
| Lead, black, 500mm, 4mm to 4mm stackable | AC voltage source carrier |
| Capacitor, 2,200uF, Electrolytic, 25V | BNC male to dual 4mm binding post |

An introduction to digital electronics

| Components LK4221 | |
|---|--|
| Power Supply | AND Gate with 2mm to 4mm lead - ANSI |
| USB programmable PIC carrier with power leads | OR Gate with 2mm to 4mm lead - ANSI |
| Resistor, 10k, 1/4W, 5% (x2) | NOT Gate with 2mm to 4mm lead - ANSI |
| Connecting Link (x16) | NAND Gate with 2mm to 4mm lead - ANSI |
| Lead, yellow, 500mm, 4mm to 4mm stackable | NOR Gate with 2mm to 4mm lead - ANSI |
| Lead, blue, 500mm, 4mm to 4mm stackable | Phototransistor Carrier |
| Switch, on/off, metal strip (x2) | Power supply carrier with battery symbol |
| Resistor, 50k, 1/4W, 5% (DIN) | 7 x 5 metric baseboard with 4mm pillars |
| LED, red (x2) | |

Combined level 2 automotive pack

| Components LK4500CUS | |
|---|--|
| Power Supply | Faraday's law kit |
| AC power supply, 12 VAC, 1.5A | Power supply carrier with battery symbol |
| BNC male to dual 4mm binding post | Ammeter, 0A to 1A |
| Transformer, 2:1 turns ratio | 7 x 5 metric baseboard with 4mm pillars |
| USB reprogrammable PIC carrier with power leads | Ammeter, 0mA to 100mA |
| AC voltage source carrier | Bridge rectifier |
| Diode, power, 1A, 50V | Lampholder, MES (x3) |
| Zener diode, 1A 50V | Phototransistor Carrier |
| Pair of leads, red and black, 1000mm, 4mm to croc clip (x2) | Resistor, 50k, 1/4W 5% |
| Lead, red, 500mm, 4mm to 4mm stackable (x2) | Fleming's motor rule apparatus |
| Lead, black, 500mm, 4mm to 4mm stackable | LED, Red (x2) |
| Lead, yellow, 500mm, 4mm to 4mm stackable | Capacitor, 100uF Electrolytic 25V |
| Lead, blue, 500mm, 4mm to 4mm stackable | Capacitor, 2,200uF Electrolytic 25V |
| Switch, push to make, metal strip | Capacitor, 1uF, Polyester |
| Switch, on/off, metal strip | Connecting link (x16) |
| Choke, 47mH | MES bulb, 6V, 0.04A (x3) |
| Motor 3 to 12V DC, 0.7A | Capacitor, 22,000uF, Electrolytic 16V |
| AND Gate with 2mm to 4mm lead | Voltmeter, 0V to 15V |
| OR Gate with 2mm to 4mm lead | Hand cranked generator |
| NOT Gate with 2mm to 4mm lead | Resistor, 1k, 1/2W, 5% |
| NAND Gate with 2mm to 4mm lead | Resistor, 10k, 1/4W, 5% (x2) |
| NOR Gate with 2mm to 4mm lead | Resistor, 270ohm, 1/2W, 5% |
| 2:1 transformer with retractable ferrite core | Potentiometer, 250ohm |
| Alnico rod magnet | Potentiometer, 10k |
| Lenz's law kit | |

Sensors and control in automotive applications

| Components LK9834-2 | |
|--|--|
| MIAC warranty document | Lead, red, 500mm, 4mm to 4mm stackable |
| USB2 high speed A to mini B lead | Lead, black, 500mm, 4mm to 4mm stackable |
| Phototransistor carrier | Lead, yellow, 500mm, 4mm to 4mm stackable (x6) |
| Power supply carrier with battery symbol | Lead, blue, 500mm, 4mm to 4mm stackable (x6) |
| 7 x 5 metric baseboard with 4mm pillars | Switch, push to make, metal strip (x4) |
| Power supply | Switch, on/off, metal strip (x2) |
| Buzzer, 12V, 15mA | Microswitch |
| Resistor, 10 Ohm, 1W, 5% (DIN) | LED, red |
| Stepper motor | Capacitor, 4,700 uF, Electrolytic, 16V |
| Automotive fuse carrier | Motor 3 to 12V DC, 0.7A |
| Resistor, 1k, 1/2W, 5% (DIN) (x2) | Hall effect switch |
| Resistor, 10k, 1/4W, 5% (DIN) | Solenoid |
| Potentiometer, 10k (DIN) | MES bulb, 12V, LED white |
| Transistor RHF, NPN | Connecting Link (x16) |
| Relay, 12V coil, 10A, normally open | Cased MIAC with shrouded 4mm connectors |
| Lampholder, MES, for automotive LEDs white | Small bar magnet |
| Lampholder, MES | 12V 200mA miniature MES lamp |
| Thermistor, 4.7k, NTC (DIN) | |

CAN bus systems and operation

| Components LK7629 | |
|--|--|
| Cased MIAC with shrouded 4mm connectors (x5) | Connecting link (x53) |
| Lead, red, 500mm, 4mm to 4mm stackable (x19) | USB2 high speed A to mini B lead |
| Lead, black, 500mm, 4mm to 4mm stackable (x9) | Lead, D-type to yellow and blue 4mm got CAN analyser |
| OBD2 to 4mm lead | 7 x 5 metric baseboard with 4mm pillars (x3) |
| Lead, yellow, 500mm, 4mm to 4mm stackable (x24) | Switch, on/off, metal strip (x6) |
| Lead, blue, 500mm, 4mm to 4mm stackable (x24) | Resistor, 560 Ohm, 1/4W, 5% (DIN) |
| Lead, red, 2000mm, 4mm to 4mm plug (x4) | LED, red (x2) |
| 7 x 5 metric baseboard with 4mm pillars (x2) | Motor 3 to 12V DC, 0.7A |
| Relay, 12V coil, 10A, normally open | MES bulb, 12V, LED, red (x4) |
| Lampholder, MES, for automotive LEDs white (x13) | MES bulb, 12V, LED, yellow (x4) |
| Switch, push to make, metal strip (x3) | MES bulb, 12V, LED, white (x5) |
| Buzzer, 12V, 15mA | Zener diode, 8.2V |
| Automotive fuse carrier (x5) | Potentiometer, 10k (DIN) (x4) |
| Resistor, 1k, 1/2W, 5% (DIN) (x8) | Power supply (x4) |
| MIAC getting started guide | USB CAN sniffer |

CAN bus systems and operation solution with engineering panel

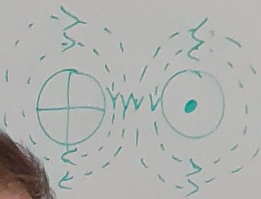
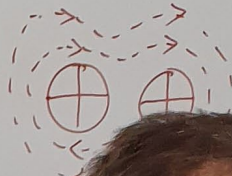
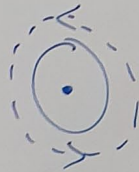
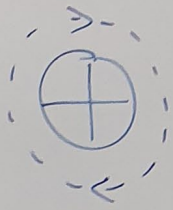
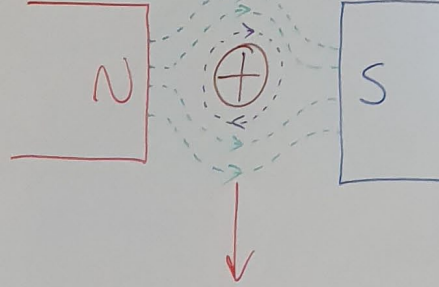
| Components LK2839 | |
|---|--|
| Power supply | Buzzer, 12V, 15mA |
| Locktronics engineering panel | Automotive fuse carrier |
| Lead, red, 500mm, 4mm to 4mm stackable | Resistor, 1k, 1/2W, 5% (DIN) |
| Lead, red, 500mm, 4mm to 4mm stackable | USB CAN sniffer |
| Lead, black, 500mm, 4mm to 4mm stackable | Potentiometer, 10k (DIN) |
| Lead, yellow, 500mm, 4mm to 4mm stackable | USB2 high speed A to mini B lead |
| Lead, blue, 500mm, 4mm to 4mm stackable | Lead, D-type to yellow and blue 4mm for CAN analyser |
| Lead, yellow, 1000mm 4mm to 4mm stackable | Zener diode, 8.2V |
| Lead, blue, 1000mm, 4mm to 4mm stackable | Switch, on/off, metal strip |
| Lead, black, 1000mm, 4mm to 4mm stackable | Resistor, 560 ohm, 1/4W, 5% (DIN) |
| Lead, red, 3000mm, 4mm to 4mm stackable | LED, Red |
| Lead, red, 2000mm, 4mm to 4mm plug | Motor 3 to 12V DC, 0.7A |
| Switch, push to make, metal strip | MES bulb, 12V, LED, red |
| Connecting Link | MES bulb, 12V, LED, yellow |
| Relay, 12V coil, 10A, normally open | MES bulb, 12V, LED, white |
| Lampholder, MES, for automotive LEDs | |

Hybrid vehicle demonstration system

| Components LK6483 | |
|--|--|
| Resistor, 1k, 1/2W, 5% (DIN) (x2) | Lead, blue, 500mm, 4mm to 4mm stackable (x6) |
| Power MOSFET transistor (x2) | Switch, push to make, metal strip |
| Potentiometer, 10k (DIN) | Hybrid Car battery Unit |
| Diode, power, 1A, 50V (x5) | Hybrid Car Motor Unit |
| Connecting link (x17) | Hybrid Car Input Power Meter (x2) |
| Lead, red, 500mm, 4mm to 4mm stackable (x9) | Hybrid car Power Output Meter |
| Lead, black, 500mm, 4mm to 4mm stackable (x5) | Engineering panel |
| Lead, yellow, 500mm, 4mm to 4mm stackable (x4) | |

$I = \text{current, Amperes, A}$

$L = \text{length, metres, m}$



“Having worked with the Matrix Locktronics kits in two different places of employment I can heartily recommend them as a teaching aid. While they are invaluable for use in my YouTube videos the real appeal lies in using them in my classroom on a daily basis. I will often connect a camera to the big screen when teaching to show the Locktronics board and then explain step by step what is taking place inside the circuits we have built. This has a really positive impact on learning, much more so than just drawing it out on a board or by a slide presentation and learners will often express their appreciation for the increased level of understanding. I can honestly say that these kits bring electrical science and principles to life in a way that is hard to match with other visual aids.”

Joe Robinson
Joe Robinson Training, United Kingdom





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