
2019 Edition

# MATRIX

SET SCIENCE ENGINEERING TECHNOLOGY

www.matrixtsl.com

Through this product catalogue, you will find solutions for various areas of technical and vocational education, focusing on areas of Science, Engineering and Technology. 2019 sees the introduction of new solutions including a range for the training of modern electrical machines, electronic engineering communications solutions based on the popular Arduino platform and much more. Below and throughout, you will find testimonials from some of the customers we have worked with during 2018.

*"We bought the Locktronics kits as part of the capital investment in our undergraduate teaching laboratories and have been very pleased with them over the past two years. We teach level 3/4 electronics to our foundation year and to engineering students of all disciplines in stage 1.*

*We have found the kits to be very robust and intuitive to use, with the supporting materials well written and easy for students to understand, especially since a significant number of entrants onto engineering programmes have little or no prior electronics knowledge or experience.*

*The design of the kits allows students to see the components in a circuit as well as the circuit diagram on the same panel. This facilitates an understanding of both component and circuit function, which is not always easy to do with a breadboard or PCB based circuit.*

*We find that the lab-based teaching approach with good supporting staff, is 'high gain' activity, enjoyable for students since they learn by doing and enabling staff to give more help to weaker students, which would be difficult with a lecture-based approach."*

Dr RW Clarke, University of Bradford, United Kingdom.

*"We have been using Flowcode since 2010 in our microcontroller laboratories. Flowcode is the ideal perfect system to teach the students a systematic and organized, but simple way of programming microcontrollers. Since Flowcode covers multiple microcontroller platforms, the students are not limited to one type of microcontroller. About three years ago, we updated our control laboratory, and we started using Flowcode for digital control on dsPIC microcontrollers. Flowcode is a great educational tool, updated frequently to keep up with the newest and most advanced technologies. Many of our students use Flowcode in the design and programming of their senior embedded system design projects. They love the advanced simulation and In Circuit Testing capability of Flowcode too (Ghost Technology). I cannot explain enough my appreciation and my students' enjoyment and satisfaction of learning using Flowcode. I must also mention the prompt help and support provided by Matrix at all times. Finally, after using Flowcode for several years, Flowcode proved to be the best tool for programming several microcontroller platforms from entry level student projects to very advanced and sophisticated projects."*

George Breidy, ECCE Laboratory Supervisor,
Notre Dame University, Lebanon



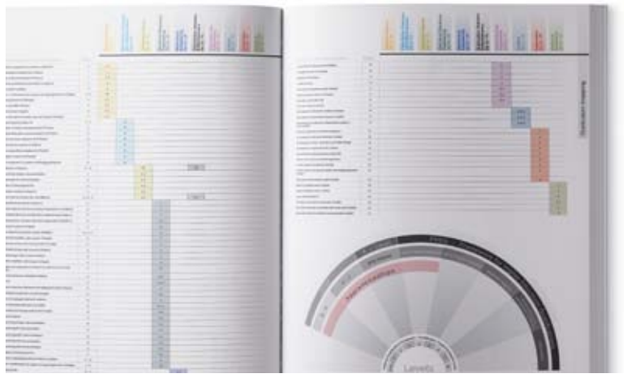



## Contents



## Product ranges

1. The Matrix curriculum map (pages 130 to 131), is designed to give you an idea of how each of our solutions fits in to each of the UK education levels. This is useful for our home, UK customers and aa guide to enable our international customers to understand more about our products.



2. Our solutions (pages 5 to 92) present each of our individual learning solutions and combine software, hardware and importantly, curriculum in the form of worksheets and examples. The solutions are designed for students of various age ranges, and each solution is mapped against a specific UK curriculum qualification. We split our solutions down into various disciplines/ subject areas.


3. Our product ranges (pages 93 to 129) showcase the brands under the Matrix umbrella. Most of these are designed and manufactured by Matrix and on these pages, you will find more information about how they are designed to be used.

4. The product code glossary (pages 132 to 137) gives those with the knowledge of a product name or product code the ability to search for it. For any products that cannot be found in our catalogue, please search the website at www.matrixtsl.com or contact us for more information.

# Science / Physics

Locktronics is used in around 2,000 schools and colleges for teaching the fundamental principles of electricity. In this section we list our solutions for science. These kits are designed for students studying electrical principles from a very early age through to age 16 + and in particular, A-level physics. You will also find a range of new solutions on these pages, focused on optics, fibre optics and thermodynamics.


## Our learning solutions:

- Meet RoHS compliancy stipulations and are rugged and designed to withstand the rigours of the lab or classroom
- Clearly display circuits to learners to develop their understanding of the topic being studied
- Allow for the building of solid foundational knowledge with the ability to build on this knowledge with advanced topics
- Include curriculum which guides students through the experiments and saves teachers' preparation time

*"The Locktronics kits and Matrix as a company were recommended to us by one of our partners, STEMWorks, and from discussions with teachers, the Energy & Environment kits were identified as the ones most suitable to support the new Physics GCSE syllabus in Wales.*

*The kits will mainly be used to teach KS4 Physics students within the schools, but the teachers were also interested in the opportunity that the kits will give them to use with lower ages groups, as well as with post-16 students. Horizon Nuclear Power is currently working with two KS4 Physics teachers from Anglesey to map the kits to the new Physics syllabus, with the mapping provision then being made available to the other 3 schools on the Island, as well as feature on the Horizon website, for schools across Wales and England to access the provision."*

Claire Burgess, Education Programme Coordinator at Horizon Nuclear Power



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## 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 studying electricity as part of a science course from ages 11 to 16 (In the UK suitable for KS3 and KS4)


| Ordering information | DIN | ANSI |
|---|---|---|
| Electricity, magnetism and materials solution | LK9071-2 | LK9071-2A |
| Corresponding curriculum | LK7325 & LK7326 | |

**You will also need:**

| | |
|---|---|
| Multimeter pack | LK1110 |

For a list of included components, search for the product code at www.matrixtsl.com and click on the resources tab




## Fundamentals of electricity

This kit provides an introduction to the fundamentals of electricity. It is ideal for those who are completely new to the subject, and is suitable for use from ages 8+. The kit is supplied with 30 pages of notes and worksheets.

### Learning objectives / experiments:

- What is electricity?
- Simple electrical components
- The simplest circuit
- Conductors and insulators
- Switches
- Two way switches
- Series circuits
- Parallel circuits
- Buzzers
- Motors


### Curriculum mapping

- Suitable for studies in Science at KS1 and KS2: ages 5 to 11

| Ordering information | DIN | ANSI |
|---|---|---|
| Fundamentals of electricity solution | LK6444 | LK6444A |
| Corresponding curriculum | LK6816 | |

For a list of included components, search for the product code at www.matrixtsl.com and click on the resources tab

## Energy and the environment

This course provides an introduction to renewable energy generation and energy saving measures through intelligent building control. As such, it addresses the aims of a number of courses in Science and Technology. A comprehensive set of curriculum worksheets and supporting documentation deliver experiments to illuminate the issues raised.

### Learning objectives / experiments:

- Advantages / disadvantages of renewable energy sources: photovoltaic, wind, wave, hydroelectric
- Solar cells and their operation
- Electricity generators
- Solar heating and energy storage
- Voltage regulation
- Efficiency of a filament lamp and LED lamp
- Insulation and double glazing
- Energy efficient building design using microcontrollers


### Curriculum mapping

- Suitable for studies in science age 11 – 16 and for environmental courses. Ideal for STEM

| Ordering information | DIN | ANSI |
|---|---|---|
| Energy and environment solution | LK7345-2 | LK7345-2A |
| Corresponding curriculum | LK7122 | |

**You will also need:**

| | |
|---|---|
| Multimeter pack | LK1110 |

For a list of included components, search for the product code at www.matrixtsl.com and click on the resources tab




Science / Physics

## Curriculum mapping

- Suitable for studying electricity as part of a Physics course aged 16 to 18 (A level courses in the UK)
- Suitable for unit 15 of BTEC National in Applied Science: Electrical circuits and their application

## Curriculum mapping

- Suitable for extending work in Physics to various topics at ages 16 to 18. Ideal for STEM
- Suitable for unit 15 of BTEC National in Applied Science: Electrical circuits and their application

# Electrical and electronic principles

The kit provides a comprehensive range of practical assignments for electricity and magnetism and is ideal for those who are studying science and electricity at a more advanced level. The kit is supplied with a comprehensive set of worksheets and teachers' notes.

*Note*

*To add PIC investigation to this kit please see the PIC add-on kit on page 22.*

*To add Operational amplifier investigation to this kit see the Op-amp add-on kit on page 30.*

| Ordering information | DIN | ANSI |
|---|---|---|
| A level electrical and electronic principles | LK9329-2 | LK9329-2A |
| Corresponding curriculum | LK7664 & LK7773 | |

**You will also need:**

| | | | |
|---|---|---|---|
| Multimeter pack | LK1110 | Source - DC PSU, AC PSU and signal generator | LK6999/ LK2975 |
| Picoscope | HP8279 | | |

For a list of included components, search for the product code at www.matrixtsl.com and click on the resources tab

# Class pool kit

This 'one per class' kit is designed to give you a flexible suite of parts that can be added to the Electrical and electronic principles pack to allow a much wider range of experiments and demonstration in Electronics from our Operational Amplifiers, PIC, Logic and Energy and environment solutions. The pack also includes useful equipment for teaching Lenz's law, Faraday's law and motor principles.

## Learning objectives / experiments:

- Batteries in series and parallel
- Internal resistance of batteries
- Power dissipation and efficiency
- Potential dividers
- Resistivity
- Kirchoff's law
- AC circuits
- Capacitors
- Fleming's law
- Inductors
- Faraday's and Lenz's laws
- Transformers

| Ordering information | DIN | ANSI |
|---|---|---|
| Class pool kit | LK6802 | LK6802A |
| Corresponding curriculum | LK 3061, LK7122, LK7209, LK9392 | |

**You will also need:**

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

For a list of included components, search for the product code at www.matrixtsl.com and click on the resources tab





NEW


# Source - DC PSU, AC PSU and signal generator

This general purpose DC/AC power supply/signal generator has a wide range of applications in education: in Physics, Technology and Electronics.

The unit is housed in a rugged enclosure with a large graphical back-lit display and input controls conveniently located at the top front of the display. The power supply has a number of fixed DC voltage outputs as well as variable DC and AC outputs.

The AC signal generator output is presented in three forms: ±10V 50ohm BNC output, high-power output via shrouded 4mm sockets for directly driving speakers and vibration generators, and a line-level output on a jack socket. This AC signal delivers 0.1Hz to 100KHz with sine, triangle, square and arbitrary waveform outputs.

The power supply operates from a supply of 110V or 240VAC.

## Functions:

- Fixed -12V, 5V and +12V outputs
- Variable 3 - 10V DC output
- Signal generator output: 0.1Hz - 100kHz
- Dot matrix backlit user display
- Rugged continuously rotating control and buttons
- Supplied with technician voltage limiting software
- Shrouded safety connectors

## Specification

| Output | Voltage | Current | | Features |
|---|---|---|---|---|
| Signal generator:<br><br>Sine,<br>Square,<br>Triangle,<br>Sawtooth,<br>Custom | Instrumentation<br>0.1Hz to 100KHz | 50 Ohm<br>DC coupled 10V p-p | | BNC |
| | Audio Output<br>20Hz to 20kHz / AC power supply | Loudspeaker/Transducer<br>AC coupled 10V p-p 1.3 Amp peak | | 4mm shrouded(+)<br>4mm shrouded(-) |
| | | Line Out<br>AC coupled 2V p-p<br>200 Ohm source impedance | | Mono Jack |
| Power Supply | 3-10V variable | up to 3A maximum | variable current limited, monitored | 4mm shrouded (brown) |
| | +12V | up to 5A maximum | variable current limited, monitored | 4mm shrouded (blue) |
| | +5V | up to 5A maximum | variable current limited, monitored | 4mm shrouded (red) |
| | -12V | up to 300 mA | current limited to 300mA | 4mm shrouded (yellow) |

| Ordering information | |
|---|---|
| Source - DC PSU, AC PSU and signal generator | LK6999 / LK2975 |

## Did you know?

You can find a list of the individual components included in all our Locktronics and Automatics kits on the Matrix website. Visit www.matrixtsl.com, find the kit you are looking for and click on "resources". Here, you will find a "bill of materials"

NEW

## Thermodynamics kit

This kit allows engineering students to carry out a wide range of practical experiments in Thermodynamics to help them understand the temperature related behaviour of mechanical systems. The kit includes experimental apparatus including metal blocks with heating elements, linear rods with heaters, Leslie cube and Jolly bulb. The kit also includes measuring instruments such as digital thermometers, energy meter, and infrared thermometer. A downloadable manual covers all experiments and includes teacher's notes. A unique feature of the kit is that all the experiments can be completed just with electricity as the heat source – no Bunsen burner is required.

### Learning objectives / experiments:

- Heat capacity of liquids
- Heat capacity of solids
- Linear expansion of heat
- Heat absorption
- Heat radiation
- Expansion of gases – Charles' law
- Boyle's law

**Ordering information**

| | |
|---|---|
| Thermodynamics kit | HP4159 |
| Corresponding curriculum | CP4261 |

**You will also need:**

| | |
|---|---|
| Source - DC PSU, AC PSU and signal generator | LK6999 / LK2975 |

### Curriculum mapping

- Suitable for studying electricity as part of a Physics course aged 16 to 18 (A level courses in the UK)

NEW

## Ripple tank MkIII

The unit is completely self-contained with the translucent viewing screen hinging away to reveal a 12cm water tank. The tank is removable for ease of use and has an integral multi-faceted beach which virtually eliminates unwanted reflections.

Illumination is from a high intensity built-in LED which can be automatically strobed in sync with the waves to give perfectly stationary images, or switched to allow the user independent control of the wave and strobe frequencies giving the impression of wave motion across the viewing screen.

The unit is supplied with three robust dippers which can be easily adjusted to suit the depth of water being used. A selection of barriers shapes and lenses are also provided to enable reflection, refraction, diffraction and interference along with the focusing properties of lenses to be demonstrated. All of the accessories can be stored neatly inside the unit when not in use.

**Ordering information**

| | |
|---|---|
| Ripple tank MkIII | AS0371 |

### Curriculum mapping

- Suitable for studying as part of a Physics course aged 14 to 18 (GCSE / A level courses in the UK)





NEW

## Cloud Chamber

The chamber is self-contained and thermoelectrically cooled. The chamber requires no dry ice or water; the only setup necessary is the addition of isopropyl alcohol and connection to a mains socket.

The chamber contains an integrated power supply and illumination of the chamber is provided by a high intensity LED.

Using the provided source, tracks should be visible within 10 minutes.

Once running the cloud chamber can be made to run for extended periods by adding more alcohol through the access provided in the lid.

**Ordering information**

| | |
|---|---|
| Cloud Chamber | AS4681 |

### Curriculum mapping

- Suitable for studying as part of a Physics course aged 14 to 18 (GCSE / A level courses in the UK)

NEW

## Digital Voltmeter/Ammeter class set

These digital bench meters are housed in robust ABS and PVC cases. Both feature ~50 minute auto off circuitry to conserve battery life and an LED indicator prompting battery change when necessary.

**Ordering information**

| | |
|---|---|
| Digital Voltmeter - class pack of 15 | AS1106 |
| Digital Ammeter - class pack of 15 | AS4472 |





Science / Physics

## Advanced physical optics kit

OptoSci's Principles of Physical Optics kit consists of four separate modules (polarisation, reflection and refraction, diffraction, interference and coherence) which enable students to experimentally investigate and acquire practical familiarity with the fundamentals of physical optics and the wave properties of light.

### Learning objectives / experiments:

- Polarisation - including Malus' Law, waveplate properties, states of polarisation, strain birefringence
- Reflection & Refraction - including Snell's Law, Fresnel Equations, refractive index determination
- Diffraction - including Slits, apertures, reflection and transmission gratings, laser wavelength determination
- Interference and Coherence - including Michelson interferometer, optical surface quality, laser coherence measurements

### Curriculum mapping

- Suitable for courses in Optical Science and Photonics at undergraduate level and beyond

**Ordering information**

| | |
|---|---|
| Reflection & refraction kit | FP8197 |
| Polarisation kit | FP7280 |
| Diffraction kit | FP8104 |
| Interference & coherence kit | FP7948 |
| Complete advanced physical optics kit | FP4615 |
| Modular advanced physical optics kit | FP0391 |

Instruments may be required, please contact us for further info




# Fibre Optics, Photonics and Optical Science

Our OptoSci training packages are designed to give universities and colleges an immediate solution to the provision of comprehensive and stimulating lab based courses in key areas of photonics technology, in particular in the field of optical fibre communications. Each educational solution includes all required optoelectronic hardware with extensive literature, and curriculum support. Instrumentation listed needs to be purchased separately. Please contact us for further clarification.

*"We have been using OptoSci educational kits for training students for over a decade. The self-contained experiments and detailed manuals are excellent for giving students a practical introduction to optical communications towards the end of Physics or Electronic Engineering programmes"*

Liam Barry, Dublin City University

### Our learning solutions

- Are supplied with all hardware required to perform the experimental programme
- Include manuals to guide the students through the background theory and experiments
- Include Instructor's manual with sample results and solutions for all experiments & exercises
- Are provided with a comprehensive set of background / lecture notes

## Advanced physical optics kit

OptoSci's advanced physical optics kit consists of four separate modules (polarisation, reflection and refraction, diffraction, interference and coherence) which enable students to experimentally investigate and acquire practical familiarity with the fundamentals of physical optics and the wave properties of light.

### Learning objectives / experiments:

- Polarisation - including Malus' Law, waveplate properties, states of polarisation, strain birefringence
- Reflection & Refraction - including Snell's Law, Fresnel Equations, refractive index determination
- Diffraction - including Slits, apertures, reflection and transmission gratings, laser wavelength determination
- Interference and Coherence - including Michelson interferometer, optical surface quality, laser coherence measurements

### Curriculum mapping

- Suitable for courses in Optical Science and Photonics at undergraduate level and beyond

**Ordering information**

| | |
|---|---|
| Reflection & refraction kit | FP8197 |
| Polarisation kit | FP7280 |
| Diffraction kit | FP8104 |
| Interference & coherence kit | FP7948 |
| Complete advanced physical optics kit | FP4615 |
| Modular advanced physical optics kit | FP0391 |

Instruments may be required, please contact us for further info





## Curriculum mapping

- Suitable for courses in Optical Science and Photonics at undergraduate level and beyond

## Principles of optical waveguiding kit

This kit enables students to investigate the conditions under which optical waveguiding occurs in dielectric media, and then appreciate how these fundamental principles are applied by examining mode propagation in multi-mode and single mode planar waveguides.

### Learning objectives / experiments:

- Reflection and refraction, Snell's Law
- Fresnel relationships Brewster's angle, the critical angle and total internal reflection
- Prism coupling and waveguide measurements
- Step and graded index waveguides
- Measurement and analysis of mode spectra
- Mode effective indices and index profile determination
- Design of single mode waveguides

**Ordering information**

| | |
|---|---|
| Principles of optical waveguiding | FP0294 |
| Optical waveguiding analysis software | FP7634 |

Instruments may be required, please contact us for further info

## Curriculum mapping

- Suitable for courses in Optical Science and Photonics at undergraduate level and beyond

## Advanced fibre optic communications kit

This kit covers the experimental characterisation of all the major components of a fibre optic communications link (i.e. LED and laser diode transmitter, the optical fibre and the receiver) and then investigates and compares the limits imposed on overall LED and laser system performance by attenuation and dispersion.

### Learning objectives / experiments:

- Source characterisation (LED & Laser)
- Fibre attenuation & connector loss
- Receiver noise & sensitivity
- Attenuation limited link lengths
- Fibre dispersion (material & modal)
- Bandwidth & Bit rate distance products (time & frequency domain)
- System comparison & design studies

**Ordering information**

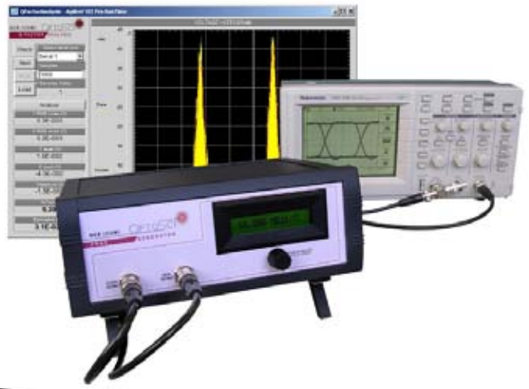
| | |
|---|---|
| Advanced fibre optic communications kit | FP4010 |

Instruments may be required, please contact us for further info





Fibre Optics, Photonics and Optical Science



## Curriculum mapping

- Suitable for courses in Optical Science and Photonics at undergraduate level and beyond

## Bit error rate & eye diagrams kit

This kit is designed as an extension to the FP4010 and FP1748 series of kits. This extension kit allows the student to generate and evaluate eye diagrams and investigate the effects of noise, attenuation and dispersion on eye diagrams and BER for the many communication system permutations allowed by the Advanced Fibre Optics Communications kit on page 15.

### Learning objectives / experiments:

- Basics of eye patterns
- Using eye patterns as a qualitative diagnostic tool
- Rise time, pulse width and jitter measurements
- Bit-rate limitations due to noise
- Bit-rate limitations due to dispersion
- Q-factors and Bit Error Rate (BER) from noise amplitudes
- Q-factors and BER from eye pattern histograms
- Compare LED and laser response over different fibre lengths and bit rates

**Ordering information**

| | |
|---|---|
| Bit error rate & eye diagrams | FP6269 |

Instruments may be required, please contact us for further info

## Optical network analysis & OTDR kit

This solution enables students to investigate the fundamental characteristics of optical time domain reflectometry using a commercial OTDR unit and observe how these principles are applied in practice to examine the response of optical fibre links, fibre optic components and optical fibre networks.

### Learning objectives / experiments:

- Fundamental properties and operation of OTDRs (dead zone, distance and spatial resolution, dynamic range etc.)
- Event identification and location
- Line, component, splice & bend loss measurements
- Network components and their characterisation at 1310nm and 1550nm
- Multi-branch and Wavelength division multiplexed (WDM) networks
- Bi-directional OTDR measurements, with deliberately introduced faults
- Analysis of networks with deliberately introduced faults

**Ordering information**

| | |
|---|---|
| Optical network analysis & OTDR | FP0374 |
| Optical network analysis kit (without OTDR) | FP2350 |

Instruments may be required, please contact us for further info





## Curriculum mapping

- Suitable for courses in Optical Science and Photonics at undergraduate level and beyond

## Erbium doped fibre amplifiers kit

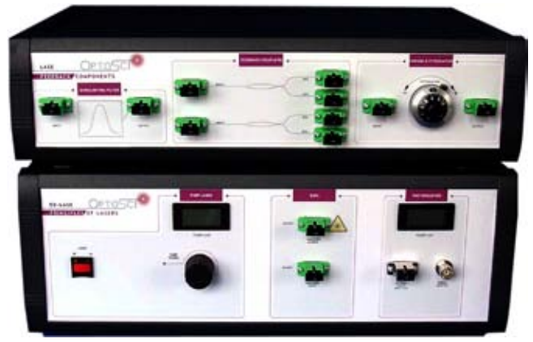
This solution enables students to investigate the basic principles of optical amplification, to characterise the key technical performance parameters of EDFAs, and to develop an appreciation of the engineering applications of optical amplifiers and their limitations within these applications.

### Learning objectives / experiments:

- Full gain characteristics: small and large signal gain
- Signal / gain saturation
- Pump saturation
- Transparency point, gain gradient and gain efficiency
- Saturated output power
- Amplified spontaneous emission (ASE) levels
- ASE-ASE & Signal-ASE beat noise
- Noise figure

**Ordering information**

| | |
|---|---|
| Erbium doped fibre amplifiers kit | FP5366 |



## Curriculum mapping

- Suitable for courses in Optical Science and Photonics at undergraduate level and beyond

## Principles of lasers kit

This solution enables students to consolidate their knowledge and understanding and to gain practical experience in the investigation of optical amplification and lasers. Students investigate the principles and characteristics of lasers using an Erbium Doped Fibre Ring Laser.

### Learning objectives / experiments:

- Construction of a fibre ring laser
- Measurement of lasing threshold
- Laser dynamics: relaxation oscillations, excitation lifetime, laser onset time
- Measurement of slope efficiency
- Effect of intra-cavity loss on the slope efficiency and threshold
- Influence of output coupling ratio on slope efficiency and threshold

**Ordering information**

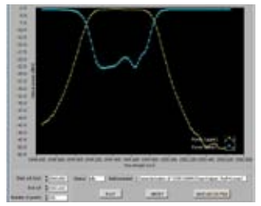
| | |
|---|---|
| Principles of lasers kit | FP9068 |

Instruments may be required, please contact us for further info

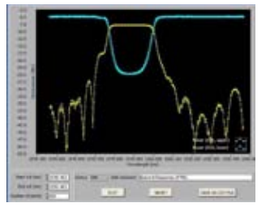




Fibre Optics, Photonics and Optical Science



Wavelength scan of OADM



A Bragg grating

## WDM components & systems and Bragg gratings kit

The full solution here consists of a base kit; WDM components kit, and three extension modules, 1310/1550nm WDM extension kit, DWDM extension kit and the Bragg extension kit. This allows immediate or future expansion of the kit as desired. The full series of kits enable students to consolidate their knowledge and understanding and to acquire practical experience in the investigation, analysis and characteristics of optical fibre components, laser diodes, various Wavelength Division Multiplexed (WDM) systems, and Bragg Gratings.

### Learning objectives / experiments:

- Measurement of insertion, back reflection /return losses and determination of isolation/extinction ratios of a series of optical components at 1550nm & 1310nm
- Characterisation & examination of the narrowband wavelength response of Bragg grating and DWDM modules
- Investigation of temperature tuning of a Bragg grating and its role as a temperature sensor
- Measurement and plotting of light, voltage, current (LVI) characteristics of lasers with operating temperature
- Characterisation of a two channel DWDM system, examination of channel add/drop, and measurement of system crosstalk / channel isolation
- Effect of wavelength drift on DWDM system crosstalk / channel isolation
- Investigation of crosstalk effects on the eye diagram / BER in DWDM systems (requires Bit Error Rate & Eye Diagrams kit)
- Assembly and characterisation of a two channel 1310nm & 1550nm WDM system
- Fibre attenuation, length & chromatic dispersion measurements with 1310nm & 1550nm sources (requires Bit Error Rate & Eye Diagrams kit)

### Curriculum mapping

- Suitable for courses in Optical Science and Photonics at undergraduate level and beyond

OPTOSCI

**Ordering information**

| | |
|---|---|
| WDM components kit | FP1748 |
| 1310/1550nm WDM extension kit | FP8451 |
| DWDM extension kit | FP5180 |
| Bragg extension kit | FP6057 |
| Bit error rate & eye diagrams kit | FP6269 |

Instruments may be required, please contact us for further info




# Computer Science

In the following pages we present our solutions for delivering a motivating course in areas of computer science. Solutions here are largely based around our AllCode technology, which allows students to control hardware using multiple programming languages. We're also proud to present a selected range of solutions from our new E-blocks2 range, which is presented alongside Flowcode.

*"We have used the Formula AllCode buggies with our first year Electronic and Computer Engineering students. They are a great vehicle for getting across a range of concepts in Computer Science and Electronic Engineering. We found them to be very motivational for students who are still getting to grips with the basics of the subject, yet they are flexible enough to be challenging for those who may be more advanced in their skills or knowledge."*

Mark Baxendale, Liverpool Hope University

### Our learning solutions

- Offer free Flowcode student licences for home use
- Deliver learning solutions for PIC microcontrollers, Arduino or Raspberry Pi
- Include robotic buggies and robotic arm solution based on AllCode
- Include hardware, software and curriculum throughout the range

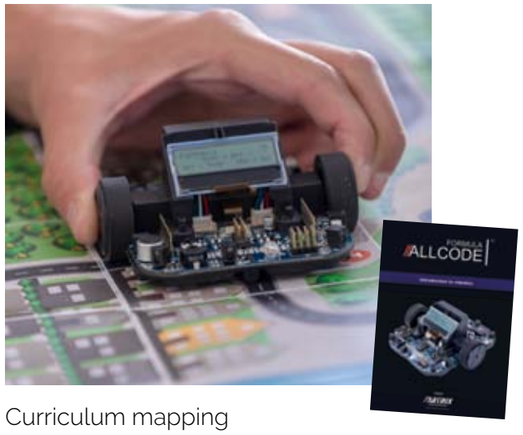
See Formula AllCode section for full details

## Introduction to Robotics

This training solution provides a course in robotics with a sequence of staged exercises including line following and maze solving. The course makes use of the high specification Formula AllCode robot which can be programmed with a number of languages on various operating systems including Flowcode, App Inventor, Python and LabView. This is great for introducing students to programming and robotics in a fun and motivating way with huge scope for further work and competitions. The deluxe kit and class sets are supplied with a large double-sided task mat and a set of maze walls.

### Learning objectives /experiments:

- Microcontroller programming and robotics
- Programming concepts: input, system, output, loops, decision, subroutine, go to, calculations, delays, simple variables, A/D conversion
- Robotic components: switches, LEDs, light sensors, distance sensors, infrared sensors, audio level sensors, speaker, motor drivers, motors and gearboxes
- Robotic tactics including logo-like commands, power control, motion control and steering, motor characterisation, obstacle avoidance
- Progressive exercises include: light following, line following, song and dance, time trials, races, simple maze solving, creating custom mechanics



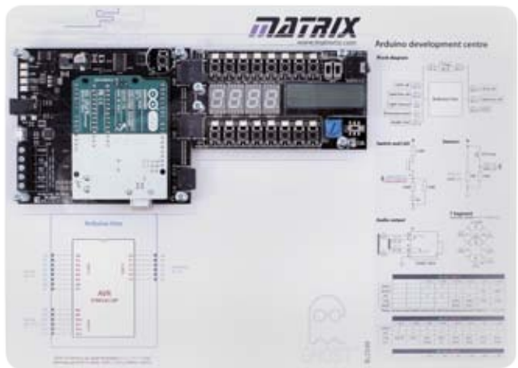

### Curriculum mapping

- Suitable for Design Technology and STEM related courses aged 11-18.
- Suitable for unit 10 BTEC National in Computer Science – Human-computer interface
- Suitable for various City & Guilds qualifications at Level 2 and beyond

**Ordering information**

| | |
|---|---|
| Formula AllCode deluxe kit | RB7971 |
| Formula AllCode standard class set | RB7240 |
| Formula AllCode deluxe class set | RB7518 |
| Corresponding curriculum | CP5894 |




## Programming Arduino microcontrollers

This pack provides a great platform for students to learn how to develop projects for Arduino and Arduino compatible hardware systems. The pack includes an Arduino/ E-blocks interface board and a 'Combo' board with switches, LEDs, 2 line 16 character LCD and sensors. The hardware is fixed to one of our panels which clearly shows the Arduino connections to the hardware.

### Learning objectives / experiments:

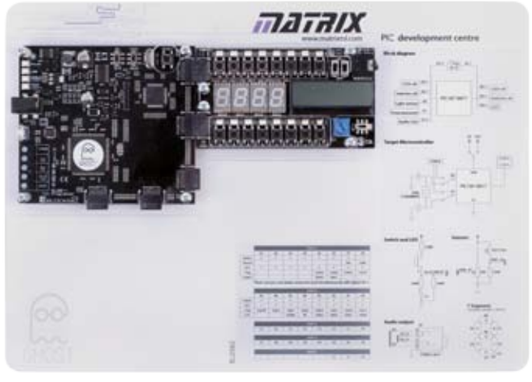
- Arduino boards and chip architecture
- Arduino software tools and programming
- Arduino command set: void, if-else, types, outputs, delays, case, break, while, for
- Simple programs with LEDs
- Serial communications and LCDs
- Analogue and digital signals
- Sensors and motor control
- Interrupts and timer interrupts

### Curriculum mapping

- Suitable for unit 10 BTEC National in Computer Science – Human-computer interface.
- Suitable for unit 26 BTEC National in Computer Science – Programmable Devices and Controllers

**Ordering information**

| | |
|---|---|
| Arduino development centre and printed panel | BL0599 |
| Flowcode | |




## Programming PIC microcontrollers

This pack provides a great platform for students to learn how to develop projects for PIC hardware systems. The pack includes an E-blocks2 PIC programmer board and a 'Combo' board with switches, LEDs, 2-line 16-character LCD and sensors. The hardware is fixed to one of our panels which clearly shows the PIC connections to the hardware.

### Learning objectives / experiments:

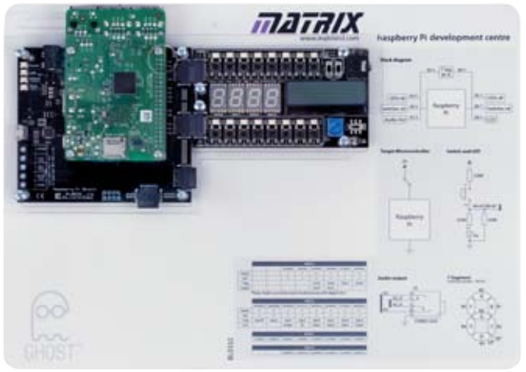
- PIC hardware and chip architecture
- Coding software including Flowcode or MPLAB
- Simple programs with LEDs
- Serial communications and LCDs
- Analogue and digital signals
- Sensors and motor control
- Interrupts and timer interrupts

### Curriculum mapping

- Suitable for unit 10 BTEC National in Computer Science – Human-computer interface.
- Suitable for unit 26 BTEC National in Computer Science – Programmable Devices and Controllers

**Ordering information**

| | |
|---|---|
| PIC development centre and printed panel | BL0562 |
| Flowcode | |




## Raspberry Pi development kit

This solution guides students through the process of developing systems to control a Raspberry Pi and connected development boards. The pack includes a downstream "combo" board with switches, LEDs, LCD and sensors and a Raspberry Pi programmer board which features Ghost Technology (when used with Flowcode) – providing In-Circuit-Test, In-Circuit-Debug, software oscilloscope, logic analyser and packet decoder. Circuit connections are provided using one of our printed panels.

### Learning objectives / experiments:

- Raspberry Pi hardware and chip architecture
- Coding software including Flowcode
- Simple programs with LEDs
- Serial communications and LCDs
- Analogue and digital signals
- Sensors and motor control
- Interrupts and timer interrupts

**Ordering information**

| | |
|---|---|
| Raspberry Pi development centre and printed panel | BL0557 |
| Flowcode | |

### Curriculum mapping

- Suitable for unit 10 BTEC National in Computer Science – Human-computer interface.

## PIC systems solution

This solution allows students to investigate circuits and systems based on the popular PIC microcontroller. The solution focuses on system construction with a pre-programmed PIC carrier which includes 8 programs, selectable by hardware switches. The work can be extended to include programming of PIC microcontrollers using flow charts with our Flowcode software. The solution includes component carriers, base board, power supply, and storage trays. Topics include:

- Switch inputs
- Sensors and sensor circuits
- Digital comparators
- Driving transducers
- Output transducers
- DC motor speed control
- Open and closed loop control

### Learning objectives / experiments:

- A complete solution to learning
- Compatible with the free version of Flowcode
- Includes carriers, baseboard and power supply
- ANSI version available

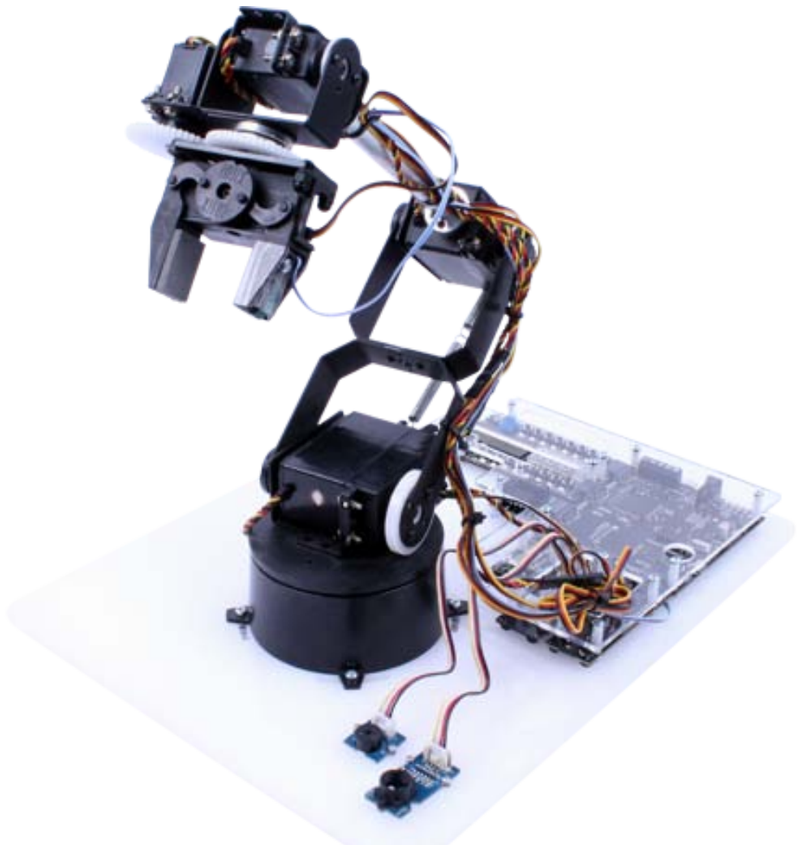
**Ordering information**

| | |
|---|---|
| PIC systems solution | LK8922-2 |
| Corresponding curriculum | LK7209 |

For a list of included components, search for the product code at www.matrixtsl.com and click on the resources tab





## AllCode robot arm production cell

Our robot arm production cell consists of a rugged servo controlled 6 degrees of freedom arm bolted to a base plate and a mat that provides a range of exercises mimicking industrial robot arm production cells. The arm itself delivers accurate and repeatable movement with base rotation, single plane shoulder, elbow, wrist motion, a functional gripper, and a wrist rotator. The arm is controlled by a dsPIC microcontroller with combo board (16 switches, 16 LEDs, 2 line 16 character LCD, quad 7-seg display and sensors), colour sensor board and Bluetooth board from our E-blocks range. The board can be programmed directly from Flowcode for dsPIC, or Microchip's MPLAB. A full Flowcode simulation is available free of charge. The control system is also shipped with a full Application Program Interface so that the robot can be controlled using any Bluetooth enabled device such as a PC, Android, or Apple MAC device using a range of software applications including C++, LabView, Python, and App Inventor as well as remote applications over the web. The kit is supplied with a number of coloured counters which can be moved by the arm into different locations in the work cell. A teacher's guide is available for download from our web site.

### Learning objectives / experiments:

- Robot cell design and programming
- Microcontroller programming
- Sensors and actuators in robotics
- Kinematics: 3D movement in robotic systems
- Web based control
- Programming in many languages

### Curriculum mapping

- Suitable for unit 6 of the BTEC National: Microcontroller systems for engineers
- Suitable for unit 15 of BTEC Higher National: Automation, robotics and PLCs
- Suitable for unit 38 of the BTEC National: Web site production to control devices

**Ordering information**

| | |
|---|---|
| AllCode robot arm production cell | RB6231 |
| Corresponding curriculum | CP8656 |

# Electrical / Electronic Engineering

Electrical and electronic engineering is an area of real expertise for the research and development team at Matrix. This year, we have introduced new solutions in our E-blocks2 range for study of microcontroller systems, as well as telecommunications and embedded systems. Brand new for 2019 is the release of our electrical machines system equipment, which comprises solutions for students to learn about the key characteristics of modern day electrical machines.

*"We have been using Matrix products for many years. We use a wide range of electronic training equipment and education resources sourced from Matrix. The variety and quality of the equipment from Matrix has enabled the college to provide an up-to-date training experience for our learners which meet the needs of industry. The types of resources we are now using allows our teachers to design more interactive lessons, which are more hands on, student led, and deliver a better overall learning experience.*

*We have found the Matrix staff to be very helpful and a good resource. The delivery of equipment has always been prompt. Matrix is usually a first point of call for Reaseheath Engineering when looking to purchase new equipment."*

Engineering department,
Reaseheath College

## Our learning solutions

- Meet RoHS compliancy stipulations
- Are rugged and long-lasting, in order to stand up to the demands of engineering lab requirements
- Include relevant and in-depth curriculum guides throughout
- Are often compatible with our microcontroller programming software, Flowcode.




## Applied electrical science

The Electricity, magnetism and materials solution 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

| Ordering information | DIN | ANSI |
|---|---|---|
| Electricity, magnetism and materials solution with storage, baseboard and power supply | LK9071-2 | LK9071-2A |
| Corresponding curriculum | LK7325 & LK7326 | |

**You will also need:**

| | |
|---|---|
| Multimeter pack | LK1110 |

For a list of included components, search for the product code at www.matrixtsl.com and click on the resources tab

### Curriculum mapping

- Suitable for much of unit 4 of the BTEC First award in Engineering: 'Applied electrical science'

## Electronic devices and communication applications

This solution provides a broad-based introduction to electronics and provides substantial syllabus coverage of the relevant BTEC First Award (Unit 7). It provides a series of practical investigations that allow students to unify theoretical work with practical skills - from bulbs in series to radio circuits. The kit is supplied with a comprehensive 60 page manual which includes experiments and notes for teachers.

### Learning objectives / experiments:

- Phototransistors and thermistors
- Diodes and their function
- Combinational logic
- Transistors as a switch/amplifier
- Operational amplifiers
- Timers
- Simple radio circuits

| Ordering information | DIN | ANSI |
|---|---|---|
| Intermediate electronic engineering solution with storage, baseboard and power supply | LK3889-2 | LK3889-2A |
| Corresponding curriculum | LK8293 | |

**You will also need:**

| | |
|---|---|
| Multimeter pack | LK1110 |

For a list of included components, search for the product code at www.matrixtsl.com and click on the resources tab

### Curriculum mapping

- Suitable for much of unit 7 of the BTEC First award in Engineering: Electronic devices and communication applications

## Curriculum mapping

- Suitable for unit 1 of the BTEC National: Engineering principles
- Suitable for unit 3 of the BTEC Higher National: Engineering science
- Suitable for City & Guilds Engineering, unit 2850: Engineering

For a list of included components, search for the product code at www.matrixtsl.com and click on the resources tab

## Curriculum mapping

- Suitable for unit 36 of BTEC National: Programmable logic controllers
- Suitable for unit 45 of BTEC Higher National: Industrial systems
- Suitable for City & Guilds Engineering, unit 2850: Engineering

# Intermediate electrical and electronic engineering

This kit, with its accompanying workbook, is intended to reinforce the learning that takes place in the classroom or lecture room for intermediate level electrical engineering. The 70 page workbook provides a series of practical activities and investigations that are designed to complement learning in the classroom and a comprehensive set of teacher's notes is included.

## Learning objectives / experiments:

- Current and voltage measurement
- Current and voltage dividers
- Kirchoff's laws
- Power in DC circuits
- Electrostatics and capacitors
- AC measurements
- L-R, C-R and L-C-R circuits
- Transformers
- Diode characteristics
- Half and full wave bridge rectifiers

| Ordering information | DIN | ANSI |
|---|---|---|
| Intermediate electrical and electronic engineering | LK9862 | LK9862A |
| Corresponding curriculum | LK4583 | |

**You will also need:**

| | |
|---|---|
| Multimeter pack | LK1110 |

For a list of included components, search for the product code at www.matrixtsl.com and click on the resources tab

# Industrial sensors, actuator and control application

This kit provides an introduction to the role of industrial controllers - under control of conventional controller software, as well as with third party applications like LabView™ and Visual Basic™. Students are given several industrial applications that they need to construct and develop programs for and sample applications in Flowcode, Visual Basic and LabView are provided.

## Learning objectives / experiments:

- DC motors with speed control
- Stepper motors
- Relays and solenoids
- Temperature and light sensors
- Potential dividers and their use
- Transistors as switches
- Electric controllers and their function
- Open and closed loop feedback
- Control system operation and function
- Control of systems using Flowcode, Visual Basic and LabView

| Ordering information | DIN | ANSI |
|---|---|---|
| Industrial sensor, actuator and control solution | LK5783-2 | LK5783-2A |
| Industrial sensor, actuator and control solution on engineering panel | LK6499-2 | LK6499-2A |
| Corresponding curriculum | LK8739 | |

**You will also need:**

| | |
|---|---|
| Multimeter pack | LK1110 |





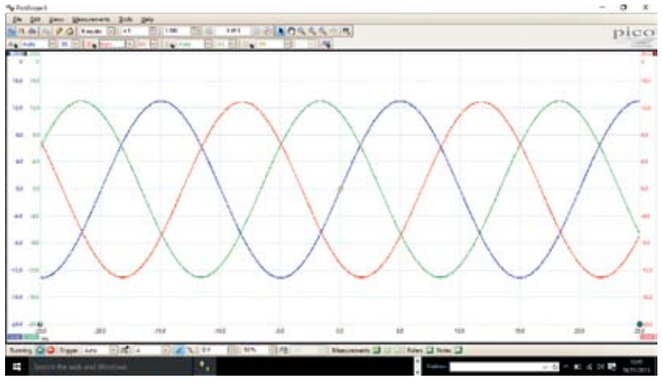


# Three phase systems

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

**Recommended**

| | |
|---|---|
| Pico 4 phase oscilloscope | HP5834 |
| AC/DC current clamp | HP5561 |

**Ordering information**

| | |
|---|---|
| Three phase systems | LK4961 |
| Corresponding curriculum | LK2686 |

For a list of included components, search for the product code at www.matrixtsl.com and click on the resources tab

EM ELECTRICAL MACHINES

NEW

## Modern electrical machines system

This new solution is an intuitive and exciting way for students to explore the characteristics of electrical machines, in the form of electric motors and generators, which form part of our everyday lives; from the motor in our smartphones, buzzing to indicate a 'silent' message to the generator in a nuclear power station feeding power into the national grid for all our household appliances.

The equipment can be controlled either using manual controls on the control box or by using a set of PC-based applications. *Please note, manual control requires the use of separate voltage and current meters.*

To succeed in the study of this course, students should have previously studied (or should be currently studying) BTEC Level 3, Unit 1 (Engineering Principles) or should have equivalent knowledge at Level 2. A good grounding in GCSE level mathematics and science (Physics) is also desirable.

A full student manual is included, and equipment is supplied in our standard storage trays.

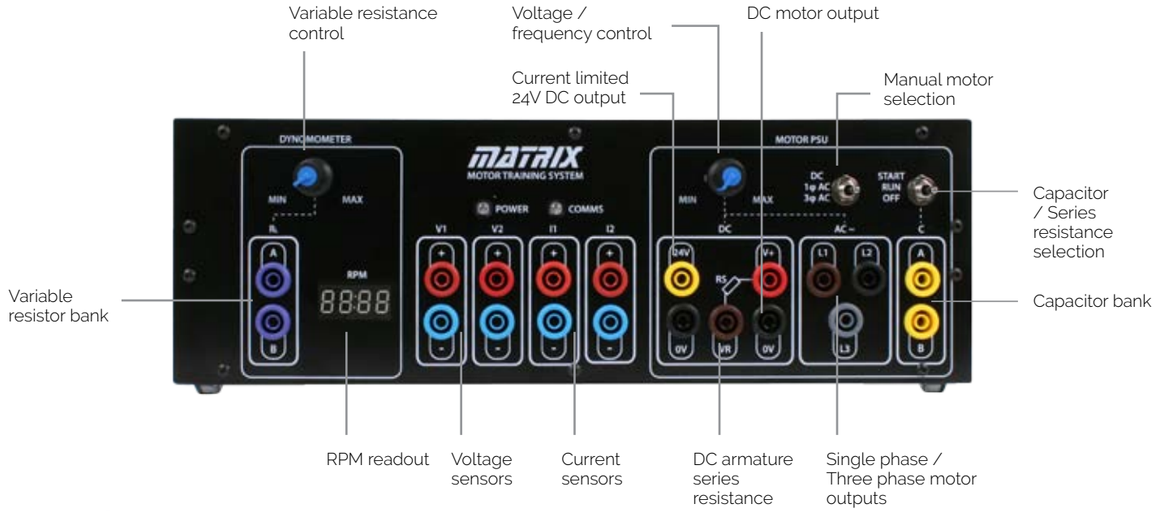
### Learning objectives / experiments:

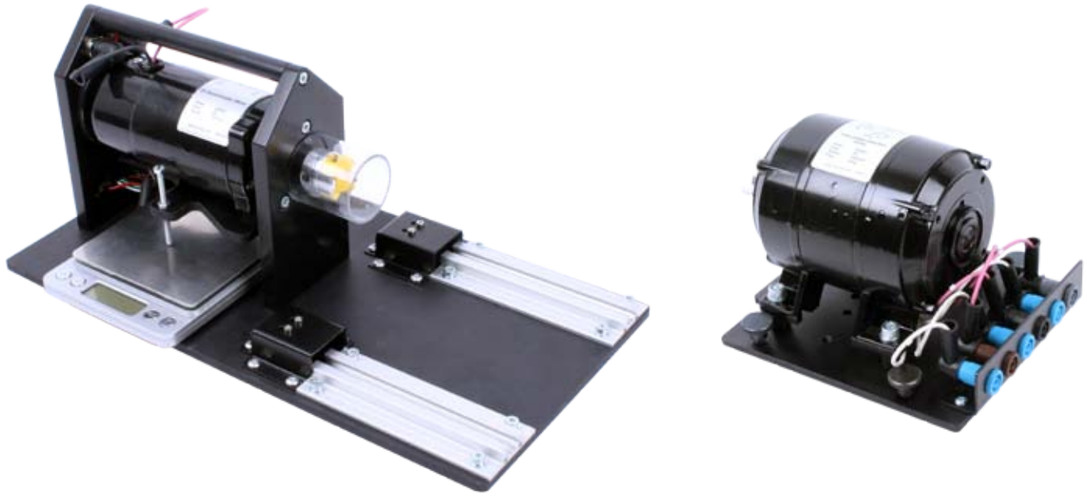
- How to safely operate electrical machines.
- The function and operation of test meters and the dynamometer.
- How to determine current, voltage and power in DC, single phase AC and three phase AC circuits.
- How to measure torque, power output and efficiency of an electrical machine.
- The operation of DC motors and generators.
- The control of DC motors and generators.
- The operation of single-phase AC machines.
- The operation of the universal motor.
- The operation of a brushless motor.
- How to calculate the synchronous speed and slip on a single-phase AC motor.
- The operation of three phase AC induction motors.
- Speed control of a three phase AC induction motor using variable frequency drives.
- The operation of three phase AC permanent magnet generators (PMGs).
- The difference between real power, apparent power and reactive power and why power factor is important.
- How to calculate the efficiency of a system.
- Evaluate three phase electrical machines connected in 3-wire star and 3 wire delta configurations.





Electrical / Electronic Engineering



The system includes DC, AC, Three Phase and Brushless motor types as well as swinging-arm dynamometer and cradle (see above).


Above: The machines can be controlled manually, using the control box provided or through a PC based environment. Different panels are used, dependent on the motor type being studied.

### Curriculum mapping

- Unit 15 of the BTEC National award in Engineering: Electrical machines
- Unit 31 of BTEC Higher National: Electrical systems and fault finding
- Unit 21 of BTEC Higher National: Electrical machines
- Unit 43 of BTEC Higher National: Further machines and drives
- Unit 45 of BTEC Higher National: Industrial systems
- Unit 15 of the BTEC National award in Engineering: Electrical machines
- Unit 31 of BTEC Higher National: Electrical systems and fault finding
- Unit 21 of BTEC Higher National: Electrical machines
- Unit 43 of BTEC Higher National: Further machines and drives
- Unit 45 of BTEC Higher National: Industrial systems

**Ordering information**

| | |
|---|---|
| Modern electrical machines system | EM6637 |
| Corresponding curriculum | CP6490 |

## Curriculum mapping

- Suitable for unit 21 of BTEC Higher National: Electrical machines
- Suitable for unit 43 of BTEC Higher National: Further machines and drives
- Suitable for use in a wide range of syllabuses

## Operational amplifiers add-on pack

This add-on pack can be added to one of our basic kits to allow students to investigate the properties and function of operational amplifiers. It is suitable for students studying engineering or applied science aged 16+. The solution includes a 33 page workbook with student instructions and teacher's notes.

### Learning objectives / experiments:

- Operational amplifier properties
- Comparator and Schmitt trigger
- Non-inverting and inverting amplifier
- Voltage follower
- Summing and different amplifier
- Active filter
- Relaxation oscillator

| Ordering information | DIN | ANSI |
|---|---|---|
| Operational amplifiers add-on-kit | LK6906 | LK6906A |
| Corresponding curriculum | LK3061 | |

| You will also need | |
|---|---|
| Source - DC PSU, AC PSU and signal generator | LK6999/LK2975 |

For a list of included components, search for the product code at www.matrixtsl.com and click on the resources tab

## Curriculum mapping

- Suitable for City and Guilds 8202 level 3

## 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.

### Learning objectives / experiments:

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

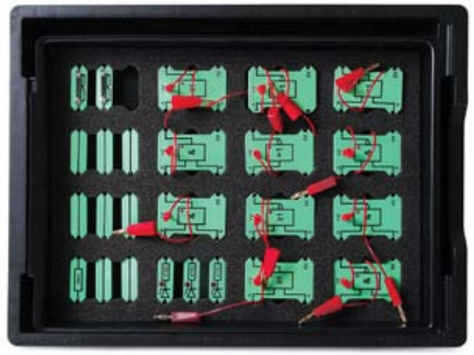
| Ordering information | |
|---|---|
| Transformer construction and operation pack | LK1989 |
| Corresponding curriculum | CP1933 |

| You will also need | |
|---|---|
| Source - DC PSU, AC PSU and signal generator | LK6999/ LK2975 |

For a list of included components, search for the product code at www.matrixtsl.com and click on the resources tab







## Curriculum mapping

- Suitable for use in a wide range of syllabuses

## Combinational logic add-on pack

This kit is designed to be added to one of our basic kits to allow extended work in understanding logic gates and combinational logic systems. The pack starts by allowing students to understand basic logic gate operation and builds up to circuits and systems with up to four logic gates. A full set of worksheets and teacher's notes are provided.

### Learning objectives / experiments:

- Logic gates NOT, AND, NAND, OR, NOR, XOR
- Three input gates
- Equivalent gates
- Boolean expressions
- Combinational logic circuits: adder, encoder, multiplexer
- RS bistables

| Ordering information | |
|---|---|
| Combinational logic add-on pack | LK6904 |
| Corresponding curriculum | LK2094 |

For a list of included components, search for the product code at www.matrixtsl.com and click on the resources tab

## Curriculum mapping

- Suitable for use in a wide range of syllabuses

## Sequential logic add-on pack

The worksheets used with this kit assume a customer has bought one of our basic kits, like LK9071, as well as the Combinational logic add-on pack, LK6904. Together these kits allow students to do extended work in understanding sequential logic circuits and systems. The pack starts by allowing students to understand basic flip flop operation and builds up to the design of circuits and systems with three flip flops. A full colour workbook with teacher's notes is included.

### Learning objectives / experiments:

- JK Bistable
- D-type flip flop
- Monostables and bistables
- Synchronous and asynchronous circuits
- Debounce circuits
- Latches
- 3 stage counter
- BCD counter
- 7-segment displays
- 3 stage shift register – PISO and PIPO
- R2R ladder DAC

| Ordering information | |
|---|---|
| Sequential logic add-on pack | LK6905 |
| Corresponding curriculum | LK9945 |

For a list of included components, search for the product code at www.matrixtsl.com and click on the resources tab





Electrical / Electronic Engineering

## Curriculum mapping

- Suitable for use in a wide range of syllabuses

## Transistor amplifiers add-on pack

This add-on pack can be added to one of our basic kits to allow students to understand the use of transistors in amplifier circuits. Students construct a number of different types and classes of transistor amplifiers including classes A, B and AB, and analyse their behaviour. A full colour workbook, supplied in PDF format, contains all the experiments, worksheets and teacher's notes.

### Learning objectives / experiments:

- Testing transistors
- BJT transistor characteristics
- Transistor as a switch
- Transistor as an amplifier
- Transformer coupled amplifier
- Stabilised common-emitter amplifier
- Two-stage amplifier
- Push - pull amplifier

| Ordering information | |
|---|---|
| Transistor amplifiers add-on pack | LK9435 |
| Corresponding curriculum | LK4403 |

For a list of included components, search for the product code at www.matrixtsl.com and click on the resources tab

## Curriculum mapping

- Suitable for unit 19 of the BTEC National: Electronic devices and circuits

## Principles and applications of electronic devices and circuits

This unit provides a practical introduction to basic electronic devices and analogue and digital electronic principles. It provides learners with an opportunity to investigate the operation of diodes, transistors, operational amplifiers, logic gates, and their associated circuits. The pack includes a full suite of worksheets and a teacher's guide.

### Learning objectives / experiments:

- Diodes and zener diodes
- Half wave rectifiers
- NPN and PNP transistors
- Transistors bias and circuits
- Transistor amplifiers
- Operational amplifiers
- Inverting and non-inverting amplifiers
- Filters and oscillators
- AND, OR, NAND, NOR, and NOT gates
- Combinational logic circuits
- RS and JK flip flops
- Counters and shift registers

| Ordering information | |
|---|---|
| Principles and applications of electronic devices and circuits | LK9422 |
| Corresponding curriculum | LK3061, LK9945, LK2094, LK4403 |

| You will also need | |
|---|---|
| Source - DC PSU, AC PSU and signal generator | LK6999/LK2975 |

For a list of included components, search for the product code at www.matrixtsl.com and click on the resources tab





## Curriculum mapping

- Suitable for unit 20 of the BTEC National: Analogue electronics circuits
- Suitable for unit 22 of BTEC Higher National: Electronic circuits and devices

## Advanced electronic principles

The experiments in this pack are designed for the more advanced students of electronics who need to understand the theory and practice of a wide range of electronic components and circuits: from basic diode circuits through to feedback and oscillator design. The 42 experiments are guided by a 100 page book and full instructor notes are included.

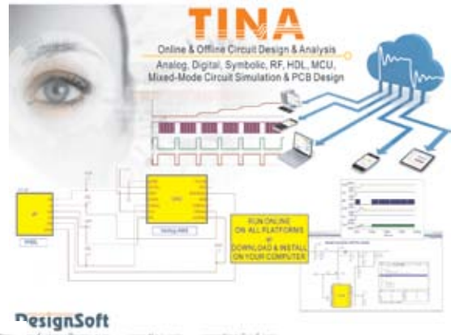
### Learning objectives / experiments:

- Semiconductor devices: diodes, zener diodes, transistors, photodiodes, thyristor, voltage regulator, operational amplifiers.
- Semiconductor circuits: Full and half wave rectifiers, transistors as switches and amplifiers
- Amplifiers: characteristics, power amplifiers (A, B, AB), inverting, non-inverting, tuned, integrator, differentiator, comparator, Schmitt, filters (high pass, low pass, band pass, notch)
- Amplifiers with feedback
- Oscillators: Wien bridge, twin T, RC ladder, LC coupled, crystal

| Instruments | |
|---|---|
| Source - DC PSU, AC PSU and signal generator | LK6999/LK2975 |

| Ordering information | DIN | ANSI |
|---|---|---|
| Advanced electronic principles | LK6804 | LK6804A |
| Corresponding curriculum | LK3008 | |

For a list of included components, search for the product code at www.matrixtsl.com and click on the resources tab




## Curriculum mapping

BTEC National:
- Unit 19: Electronic design and circuits
- Unit 20: Analogue electronics
- Unit 22: Electronic circuit board design and manufacture

BTEC Higher National:
- Unit 52 of BTEC Higher National: Further electrical, electronics and digital principles
- Unit 47 of BTEC Higher National: Analogue electronics systems

## TINA

TINA is a powerful yet affordable circuit simulation and PCB design software package for analysing, designing, and real time testing of analogue, digital, VHDL, microcontroller, and mixed electronic circuits and their PCB layouts. You can also analyse Switched Mode Power supplies, RF, communication, and optoelectronic circuits; and test microcontroller applications in a mixed circuit environment. Electrical engineers will find TINA an easy to use, high performance tool, while educators will welcome its unique features for the training environment.

### Learning objectives / experiments:

- Schematic entry with more than 20,000 component models
- Mixed signal circuit simulation
- Full simulation suite with virtual instruments
- PCB design with full data output for PCB manufacture and 3D visualisation
- Microcontroller circuit simulator for PIC, AVR and ARM with test and debug facilities from Assembler or C with external C compiler
- VHDL and Verilog design suite with simulation

| Ordering information |
|---|
| Please call us for pricing and versions |





Electrical / Electronic Engineering

## Advanced electrical, electronic and digital principles

This pack brings together the different aspects of electrical, electronic and digital principles. Students start by understanding circuit theorems to analyse voltage and current in electrical circuits with passive components. Having learned the basic principles, students move on to understanding circuits containing reactive components with series and parallel combinations. Then they construct a number of different types and classes of amplifiers: discrete and based on op-amps. Finally, students investigate digital components and simple digital logic circuits. A full colour workbook with teacher's notes is available.

### Learning objectives / experiments:

- Series and parallel LCR circuits
- Frequency response and Q factor of reactive circuits
- Norton, Kirchoff, Thevenin theorems
- Transistor amplifiers – A, B, AB
- Logic gates NOT, AND, NAND, OR, NOR, XOR
- Simple logic gate circuits
- Combinational logic circuits
- Sequential logic circuits


### Curriculum mapping

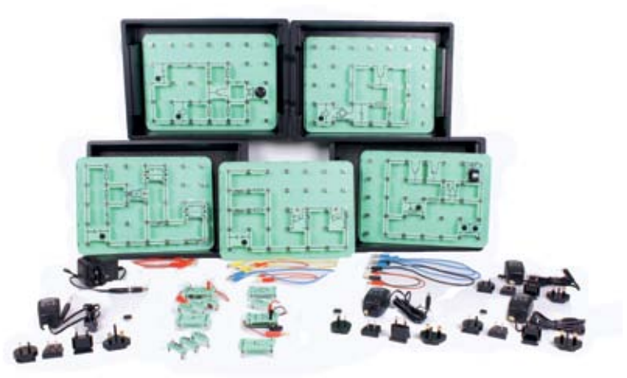
- Suitable for unit 19 of BTEC Higher National: Electrical and electronic principles
- Suitable for unit 52 of BTEC Higher National: Further electrical, electronics and digital principles

| Ordering information | DIN | ANSI |
|---|---|---|
| Advanced electrical, electronic and digital principles | LK9044 | LK9044A |
| Corresponding curriculum | LK8473, LK8749 | |

**You will also need:**

| | | | |
|---|---|---|---|
| Multimeter pack | LK1110 | Picoscope | HP8279 |
| Source - DC PSU, AC PSU and signal generator | | | LK6999/ LK2975 |

For a list of included components, search for the product code at www.matrixtsl.com and click on the resources tab



## Fault finding in electronic circuits

This solution allows students to gain experience of fault finding on several analogue and digital systems. Students first learn how to use test equipment and test the major groups of active and passive components. Then students are given a fully working circuit so that they can understand the circuit's function. Supervisors then insert one of a number of faults on each circuit and the student must deduce the fault through the use of the appropriate instruments.

Faulty components are clearly marked underneath the carrier. Five fully tested and assembled circuits supplied.

### Learning objectives / experiments:

- Safety in fault finding
- Using multimeters
- PC based oscilloscopes
- Testing diodes and transistors

### Fault finding circuits:

- Combinational logic circuit
- Counter circuit
- Motor control circuit
- Regulated AC power supply circuit
- Astable multivibrator
- Class C transistor amplifier circuit


### Curriculum mapping

- Suitable for unit 13 of BTEC First in Engineering: Operation and maintenance of electronic systems and Unit 60, BTEC National in Engineering: Fault finding
- Suitable for unit 21 of the BTEC National: Electronic measurement and testing of circuits
- Suitable for City & Guilds Engineering, unit 2850; Engineering

| Ordering information | |
|---|---|
| Fault finding in electronic circuits | LK3566 |
| Corresponding curriculum | LK9333 |

**You will also need:**

| | | | |
|---|---|---|---|
| Multimeter pack | LK1110 | Picoscope | HP8279 |

For a list of included components, search for the product code at www.matrixtsl.com and click on the resources tab




## Digital and analogue electronics systems

This pack provides a range of equipment for delivering the BTEC National unit in digital and analogue electronic systems. The microcontroller development board is a modern way of allowing students to investigate a range of digital systems that can easily be built using our Flowcode programming software: students can quickly design their own programme to investigate the factors in A/D and D/A systems. Students can also investigate fault finding in Analogue and Digital systems using our range of five fault finding panels including combinational logic with counter, power motor control, regulated AC power supply, Astable multivibrator, Class C transistor amplifier circuit.

### Learning objectives / experiments:

- Open and closed loop systems
- Testing electronic systems
- Analogue systems
- Digital systems
- Analogue to digital conversion
- Digital to analogue conversion
- Fault finding techniques
- Fault diagnosis in analogue and digital systems


### Curriculum mapping

- Suitable for unit 23 of the BTEC National: Digital and analogue electronics system

| Ordering information | |
|---|---|
| Fault finding in electronic circuits | LK3566 |
| PIC microcontroller system development kit | BL0502 |
| Flowcode for 8-bit PIC | |

## Power and energy electronics

This kit is suitable for teaching students the technology behind modern power electronics systems which are used to convert one form of electrical energy into another in vehicles, domestic energy systems and a new wave of electronics devices. The kit first explores power components including diodes, BJT, MOSFET, IGBT, SCR, thyristors and triacs and then moves on to showing how these are used in power circuits including rectifiers, converters and inverters. A full suite of worksheets is supplied which guides students through the learning activities. For this course a frequency adjustable three phase power supply is available which mimics the output of a wind turbine.

### Learning objectives / experiments:

- Diodes, BJT, MOSFET, IGBT, SCR, thyristors and triac components
- Speed control of DC motors
- Half and full wave rectifiers
- Fixed voltage regulators
- Buck and boost converters
- Modern power electronics topologies
- Sources of renewable energy


### Curriculum mapping

- Suitable for unit 17 of the BTEC National: Power and energy electronics
- Suitable for unit 43 of BTEC Higher National: Further machines and drives
- Suitable for unit 44 of BTEC Higher National: Industrial power, electronics and storage

| Ordering information | |
|---|---|
| Power and energy electronics | LK3568 |
| Corresponding curriculum | CP3666 |

**You will also need**

| | |
|---|---|
| Source - DC PSU, AC PSU and signal generator | LK6999/ LK2975 |

For a list of included components, search for the product code at www.matrixtsl.com and click on the resources tab

COMING SOON

## Renewables and storage add-on kit

This kit is an add-on kit to the LK3568 Power & Energy Electronics kit and presents the user with a solution for studying curriculum containing learning objectives around renewable energy. We combine our Locktronics solution with a miniature clean energy technology system and energy meter. Students learn how to power an electrical circuit via a solar panel or wind turbine. Users can then go on to generate hydrogen through water electrolysis and convert it into electricity using a PEM fuel cell. Another optional part of this kit is for users to utilise the Hybrid vehicle demonstrator, which explains the processes and topology of a hybrid vehicle.

### Learning objectives / experiments:

- Technology and methods behind energy production
- Electric vehicle configurations
- Circuit topology
- Sources of renewable energy
- Energy efficiency
- Power conversion

### Curriculum mapping

- Suitable as an introduction to the BTEC Higher National unit 44: Industrial Power, Electronics and Storage
- Suitable for unit 17 of the BTEC National: Power and energy electronics

The Hybrid automotive principles kit is optional

| Instruments | |
|---|---|
| Source - DC PSU, AC PSU and signal generator | LK6999/ LK2975 |

| Ordering information | |
|---|---|
| Renewables and storage add-on kit | LK1069 |
| Hybrid automotive principles on engineering panel | LK6483 |





Electrical / Electronic Engineering

COMING SOON

## Industrial systems

This kit is designed to educate the user about the way specific control systems are selected for industrial processes. Our industrial sense and control kit helps students to understand sensors and control systems in the context of industrial systems - to understand the components, the circuit diagrams, and the role of the Programmable Logic Controller (PLC).

Alongside the industrial sense and control kit, our electrical machines solution interfaces to MATLAB to capture data that can be used to model industrial systems. Furthermore, there is the ability to observe PID using MATLAB. From these outcomes, students will have the option to work out equations and predict the performance of a change to the systems in place.

The final equipment in this offering is our Internet of Things solution, which allows students to explore and consider current trends in technology including how they will influence the future of industrial systems.

### Learning objectives / experiments:

- Input & output devices; open and closed loop systems
- Interfacing with transducers
- Controllers/PLCs and their function
- Control of systems using MATLAB
- Characteristics and use of AC and DC motors
- Consideration of the Internet of Things

### Curriculum mapping

- Suitable for BTEC Higher National unit 45: Industrial systems

| Ordering information | |
|---|---|
| Industrial sensor, actuator and control solution | LK5783-2 |
| Electrical machines system | EM6637 |
| Internet of Things solution | BL0569 |


Ghost & Flowcode provide:
- In-Circuit-Test
- In-Circuit-Debug
- Software oscilloscope
- Packet decoder
- Auto-ID

## Programming Arduino microcontrollers

This pack guides students through the process of developing microcontroller-based electronic products using Arduino microcontrollers and is based on our new E-blocks2 range. The pack includes a range of downstream E-blocks2 boards, such as switches, LEDs, LCD and sensors and an Arduino shield complete with Arduino Uno board which features Ghost Technology (when used with Flowcode) – providing In-Circuit-Test, In-Circuit-Debug, software oscilloscope, logic analyser and packet decoder along with Auto-ID for your hardware.

Circuit connections are provided using one of our printed panels and students are guided through the process using a free course, provided online. The course is written to specific curriculum specifications from level 3 to level 5 and includes up to 50 hours of student-centered learning.

*This product is available as a development kit in Gratnell's tray with all necessary boards included. The programmer board can also be purchased separately with a "combo" board either with or without the printed panel.*

### Learning objectives / experiments:

- Programming microcontrollers with flowcharts, or C (using Arduino IDE)
- Control hardware and specifications for Arduino microcontrollers
- Input and output devices
- Assembling and operating a microcontroller system
- Programming/coding constructs and techniques

### Curriculum mapping

- Suitable for BTEC National Unit 6: Microcontroller systems for engineers
- Suitable for unit 46 of BTEC Higher National: Embedded systems
- Suitable for various City & Guilds qualifications at Level 2 and beyond

- Flowchart programming
- Full simulation capabilities
- Full C code editor
- Ghost technology
- See page 93 onwards

**Ordering information**

| | |
|---|---|
| Arduino microcontroller system development kit (modular) | BL0554 |
| Arduino development centre and printed panel | BL0599 |
| Arduino programmer and combo board | BL0544 |
| Flowcode | |





Ghost & Flowcode provide:
- In-Circuit-Test
- In-Circuit-Debug
- Software oscilloscope
- Packet decoder
- Auto-ID

## Programming PIC microcontrollers

This pack guides students through the process of developing microcontroller-based electronic products using PIC microcontrollers and is based on our new E-blocks2 range. The pack includes a range of downstream E-blocks2 boards, such as switches, LEDs, LCD and sensors and an 8-bit PIC programmer board which features Ghost Technology (when used with Flowcode) – providing In-Circuit-Test, In-Circuit-Debug, software oscilloscope, logic analyser and packet decoder along with Auto-ID for your hardware.

Circuit connections are provided using one of our printed panels and students are guided through the process using a free course, provided online. The course is written to specific curriculum specifications from level 3 to level 5 and includes up to 50 hours of student-centered learning.

*This product is available as a development kit in Gratnell's tray with all necessary boards included. The programmer board can also be purchased separately with a "combo" board either with or without the printed panel.*

### Learning objectives / experiments:

- Programming microcontrollers with flowcharts, C or assembler
- Control hardware and specifications for PIC microcontrollers
- Input and output devices
- Assembling and operating a microcontroller system
- Programming/coding constructs and techniques

### Curriculum mapping

- Suitable for BTEC National Unit 6: Microcontroller systems for engineers
- Suitable for unit 46 of BTEC Higher National: Embedded systems
- Suitable for WJEC A-level electronics
- Suitable for various City & Guilds qualifications at Level 2 and beyond



- Assembler code programming
- 40 hours of learning
- Full assembler included

- C code programming
- 40 hours of learning
- Full C compiler

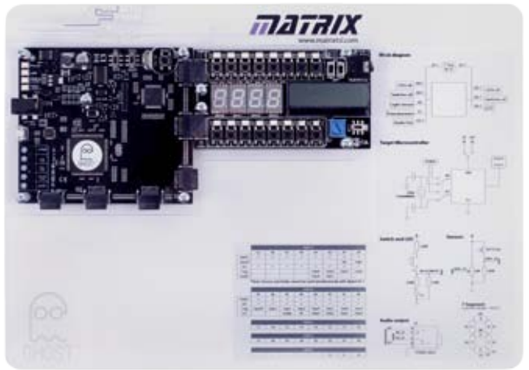


- Flowchart programming
- Full simulation capabilities
- Full C code editor
- Ghost technology
- See page 93 onwards

**Ordering information**

| | |
|---|---|
| PIC microcontroller system development kit (modular) | BL0502 |
| PIC development centre and printed panel | BL0562 |
| PIC programmer and combo board | BL0505 |
| Flowcode | |
| C for PIC microcontrollers | |
| Assembly for PIC microcontrollers | |

Ghost & Flowcode provide:
- In-Circuit-Test
- In-Circut-Debug
- Software oscilloscope
- Packet decoder
- Auto-ID



- Flowchart programming
- Simulation capabilities
- Ghost technology
- See page 93 onwards

## Curriculum mapping

- Suitable for unit 46 of BTEC Higher National: Embedded systems

# Programming dsPIC microcontrollers

This pack allows students to develop microcontroller-based electronic products using dsPIC microcontrollers and is based on our new E-blocks2 range. The pack includes a downstream "combo" board with switches, LEDs, LCD and sensors and a 16-bit dsPIC programmer board which features Ghost Technology (when used with Flowcode) – providing In-Circuit-Test, In-Circuit-Debug, software oscilloscope, logic analyser and packet decoder along with Auto-ID for your hardware. Circuit connections are provided using one of our printed panels.

*This product is available as a development kit in Gratnell's tray with all necessary boards included. The programmer board and combo board can also be purchased separately either with or without the printed panel.*

## Learning objectives / experiments:

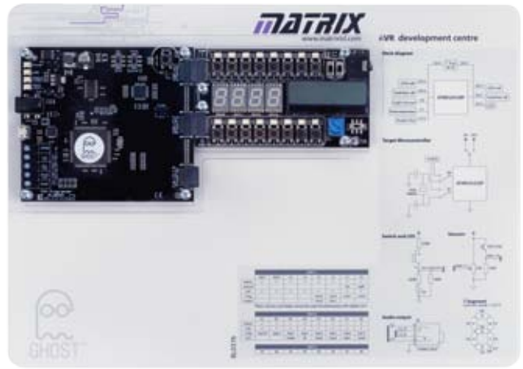
- Programming dsPIC microcontrollers
- Control hardware and specifications for dsPIC microcontrollers
- Input and output devices
- Assembling and operating a microcontroller system
- Programming/coding constructs and techniques

**Ordering information**

| | |
|---|---|
| dsPIC microcontroller system development kit | BL0503 |
| dsPIC development centre and printed panel | BL0514 |
| dsPIC programmer and combo board | BL0564 |

Flowcode

Ghost & Flowcode provide:
- In-Circuit-Test
- In-Circut-Debug
- Software oscilloscope
- Packet decoder
- Auto-ID



- Flowchart programming
- Simulation capabilities
- Ghost technology
- See page 93 onwards

## Curriculum mapping

- Suitable for unit 46 of BTEC Higher National: Embedded systems

# Programming AVR microcontrollers

This pack allows students to develop microcontroller-based electronic products using AVR microcontrollers and is based on our new E-blocks2 range. The pack includes a downstream "combo" board with switches, LEDs, LCD and sensors and an AVR programmer board which features Ghost Technology (when used with Flowcode) – providing In-Circuit-Test, In-Circuit-Debug, software oscilloscope, logic analyser and packet decoder along with Auto-ID for your hardware. Circuit connections are provided using one of our printed panels.

*This product is available as a development kit in Gratnell's tray with all necessary boards included. The programmer board and combo board can also be purchased separately either with or without the printed panel.*

## Learning objectives / experiments:

- Programming AVR microcontrollers
- Control hardware and specifications for AVR microcontrollers
- Input and output devices
- Assembling and operating a microcontroller system
- Programming/coding constructs and techniques

**Ordering information**

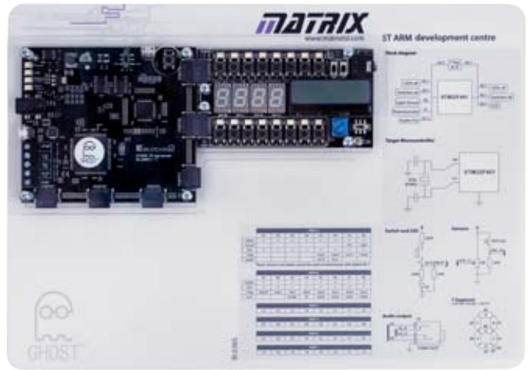
| | |
|---|---|
| AVR microcontroller system development kit | BL0591 |
| AVR development centre and printed panel | BL0518 |
| AVR programmer and combo board | BL0570 |

Flowcode





Ghost & Flowcode provide:
- In-Circuit-Test
- In-Circut-Debug
- Software oscilloscope
- Packet decoder
- Auto-ID



- Flowchart programming
- Simulation capabilities
- Ghost technology
- See page 93 onwards

## Curriculum mapping

- Suitable for unit 46 of BTEC Higher National: Embedded systems

# Programming ARM microcontrollers

This pack allows students to develop microcontroller-based electronic products using ARM microcontrollers and is based on our new E-blocks2 range. The pack includes a downstream "combo" board with switches, LEDs, LCD and sensors and an ARM programmer board which features Ghost Technology (when used with Flowcode) – providing In-Circuit-Test, In-Circuit-Debug, software oscilloscope, logic analyser and packet decoder along with Auto-ID for your hardware. Circuit connections are provided using one of our printed panels.

*This product is available as a development kit in Gratnell's tray with all necessary boards included. The programmer board and combo board can also be purchased separately either with or without the printed panel.*

## Learning objectives / experiments:

- Programming ARM microcontrollers
- Control hardware and specifications for ARM microcontrollers
- Input and output devices
- Assembling and operating a microcontroller system
- Programming/coding constructs and techniques

**Ordering information**

| | |
|---|---|
| ARM microcontroller system development kit | BL0546 |
| ARM development centre and printed panel | BL0593 |
| ARM programmer and combo board | BL0596 |

Flowcode

Ghost & Flowcode provide:
- In-Circuit-Test
- In-Circut-Debug
- Software oscilloscope
- Packet decoder
- Auto-ID

- Flowchart programming
- Simulation capabilities
- Ghost technology
- See page 93 onwards

## Curriculum mapping

- Suitable for unit 46 of BTEC Higher National: Embedded systems

# Raspberry Pi development kit

This solution guides students through the process of developing systems to control a Raspberry Pi and connected development boards. The pack includes a downstream "combo" board with switches, LEDs, LCD and sensors and a Raspberry Pi programmer board which features Ghost Technology (when used with Flowcode) – providing In-Circuit-Test, In-Circuit-Debug, software oscilloscope, logic analyser and packet decoder. Circuit connections are provided using one of our printed panels.

*This product is available as a development kit in Gratnell's tray with all necessary boards included. The programmer board and combo board can also be purchased separately either with or without the printed panel.*

## Learning objectives / experiments:

- Working with Raspberry Pi architecture
- Control hardware and specifications for Raspberry Pi
- Human-computer-interfacing
- Input and output devices
- Assembling and operating a microprocessor system
- Programming/coding constructs and techniques

**Ordering information**

| | |
|---|---|
| Raspberry Pi system development kit | BL0575 |
| Raspberry Pi development centre and printed panel | BL0557 |
| Raspberry Pi programmer and combo board | BL0560 |

Flowcode

NEW Arduino Solutions

Ghost & Flowcode provide:
- In-Circuit-Test
- In-Circut-Debug
- Software oscilloscope
- Packet decoder
- Auto-ID

## Arduino GSM training course

This training solution provides a complete course in developing communication systems. In completing the 20 hour course, students will learn about communications systems, the AT command protocol, communications strategies and many aspects of project development and management. The solution includes a fully working mobile phone based on E-blocks. A 50 page teacher's manual contains a range of exercises and is available to download from our website.

### Learning objectives / experiments:

Programming:
- General programming of systems including LCD, Keypad etc
- RS232 protocol and programming
- String construction and deconstruction in communications
- The use of state machines in controlling electronic systems

Communications:
- RS232 communications and handshaking protocols
- ASCII representation of characters in messages
- AT command structure and command protocols used in telecommunications
- Sending and receiving text messages in mobile phone systems
- Modem control and messaging

**Ordering information**

| | |
|---|---|
| Arduino GSM training course | BL0521 |
| PIC GSM training course | BL0579 |

Requires Flowcode, which must be ordered separately

### Curriculum mapping

- Suitable for courses in microcontrollers and digital communications at undergraduate level

NEW Arduino Solutions

Ghost & Flowcode provide:
- In-Circuit-Test
- In-Circut-Debug
- Software oscilloscope
- Packet decoder
- Auto-ID

## Arduino Bluetooth training course

This 20 hour training solution allows students to carry out investigations into the Bluetooth standard using high level macros written in Flowcode. Students use the hardware, software (available separately) and curriculum (available to download from our website) to investigate various Bluetooth protocols and functions including the serial protocol (SPP), local area protocol (LAP) and the headset protocol (HPP). An 80 page teacher's manual covers system set-up, Bluetooth theory and a range of exercises for students to work through.

### Learning objectives / experiments:

- Data communication between microcontroller and Bluetooth modules
- AT command structure and programming strategy in AT controlled systems
- Bluetooth visibility
- Device discovery, pass keys and addresses
- Responses - sequence flow and error checking
- Connecting and pairing
- Data communication
- Using Bluetooth for control applications
- Audio and implementation of the audio gateway
- Headset and telephone profiles

**Ordering information**

| | |
|---|---|
| Arduino Bluetooth training course | BL0563 |
| PIC Bluetooth training course | BL0506 |

Requires Flowcode, which must be ordered separately

### Curriculum mapping

- Suitable for courses in microcontrollers and digital communications at undergraduate level





NEW Arduino Solutions

Ghost & Flowcode provide:
- In-Circuit-Test
- In-Circut-Debug
- Software oscilloscope
- Packet decoder
- Auto-ID

## Arduino embedded internet training course

This 40 hour training solution gives students a full understanding of modern digital communications protocols and the development of embedded internet-based products. An 80 page teacher's manual is available to download from our website and covers system set-up, digital communications theory and contains a range of exercises for students to work through.

### Learning objectives / experiments:

- OSI model and layers
- Ethernet, DLC, MAC, ARP, TCP, IP, UDP, ICMP, HTTP and POP3 protocols
- MAC packet structure and message creation using microcontrollers
- Communication strategy and information flow
- Packet injectors and debuggers

Labs include:
- ARP scanning
- Ping
- Time and date messages using UDP
- Sending HTML using HTTP protocol
- Receiving HTML
- Sending an email using SMTP protocol

Advanced tasks include:
- Custom messaging using UDP
- A firewall application

**Ordering information**

| | |
|---|---|
| Arduino embedded internet training course | BL0535 |
| PIC embedded internet training course | BL0531 |

Requires Flowcode, which must be ordered separately

NEW Arduino Solutions

Ghost & Flowcode provide:
- In-Circuit-Test
- In-Circut-Debug
- Software oscilloscope
- Packet decoder
- Auto-ID

## Arduino CAN bus training course

This 20 hour training solution is designed to facilitate the development and investigation of systems that use the CAN bus protocol. The solution is suitable for both automotive students and for electronics undergraduates. Four fully programmable CAN nodes are included in the solution, along with circuit boards which mimic the functions of indicator lamps, switches and sensors. A CAN bus analyser and message generator are also included. An 80 page teacher's manual contains a range of exercises for automotive technicians upwards and is available to download from our website.

### Learning objectives / experiments:

- CAN technology, wiring, topology and networks
- CAN message structure and physical layer transmission
- Understanding CAN bus protocols
- Using buffers in CAN systems
- Using CAN transmit and receive messages
- Errors in CAN systems
- Programming techniques in CAN systems
- Masks and filters in CAN systems
- Higher level protocols
- Development of complete CAN systems based on microcontrollers

**Ordering information**

| | |
|---|---|
| Arduino CAN bus training course | BL0587 |
| PIC CAN bus training course | BL0589 |

Requires Flowcode, which must be ordered separately

### Curriculum mapping

- Suitable for courses in microcontrollers and digital communications at undergraduate level.





Electrical / Electronic Engineering

NEW Arduino Solutions

Ghost & Flowcode provide:
- In-Circuit-Test
- In-Circut-Debug
- Software oscilloscope
- Packet decoder
- Auto-ID

## Curriculum mapping

- Suitable for courses in microcontrollers and digital communications at undergraduate level

# Arduino ZigBee training course

This training solution provides a complete 20 hour course in developing wireless area networks based on the ZigBee standard. It gives students who are familiar with microcontrollers an understanding of the programming techniques involved in developing ZigBee wireless communications systems. A ZigBee packet analyser is included in the solution, along with four fully working ZigBee nodes based on E-blocks. A 50 page teacher's manual contains a range of exercises and is available to download from our website.

## Learning objectives / experiments:

- Zigbee protocols, message transmission and reception, and networks
- Zigbee principles, topologies and components
- Development of microcontroller based systems using Zigbee technology
- Moulding the network
- Adding nodes
- Expanding the network
- Reducing power consumption
- Dynamic networks
- Message routing
- Data logging gateways
- A complete modular fire and burglar alarm
- Improving network security

### Ordering information

| | |
|---|---|
| Arduino ZigBee training course | BL0536 |
| PIC ZigBee training course | BL0516 |

Requires Flowcode, which must be ordered separately





NEW Arduino Solutions

Ghost & Flowcode provide:
- In-Circuit-Test
- In-Circut-Debug
- Software oscilloscope
- Packet decoder
- Auto-ID

## Curriculum mapping

- Suitable for courses in microcontrollers and digital communications at undergraduate level

# Arduino RFID training course

This training solution provides a complete 20 hour course in developing RFID systems. It gives students who are familiar with microcontrollers an understanding of the programming involved in developing RFID systems. An E-blocks RFID board and four RFID tags embedded into credit cards are included. This hardware allows students to learn about reading and writing transponder data in both I-code and Mifare mode. A 50 page teacher's manual contains a range of exercises and is available to download from our website.

## Learning objectives / experiments:

- RFID systems and applications
- Configuring RFID readers
- Commands and syntax used in reading and writing data to and from RFID cards
- Communication with both Mifare and I-code systems
- Development of microcontroller based systems using RFID technology

### Ordering information

| | |
|---|---|
| Arduino RFID training course | BL0548 |
| PIC RFID training course | BL0510 |

Requires Flowcode, which must be ordered separately





## Curriculum mapping

- Suitable for unit 20 of BTEC Higher National: Digital principles
- Suitable for courses in electronics at undergraduate level

# FPGA training course

This training solution provides a complete 40 hour course in the techniques of developing projects based on FPGAs using either Verilog or VHDL using an Altera FPGA and the free version of the Quartus design software, which requires registration with Altera. The equipment is ideal for learning and for project work and students can go on to develop more advanced projects which might even include embedding NIOS processors. A full instructors' manual is available to download from our website.

## Learning objectives / experiments:

- FPGA design techniques
- Quartus development environment: top down and bottom up projects
- VHDL design language
- Verilog design language
- Combinational logic circuits: simple circuits, encoders, decoders, parity checkers, adders, subtractors, multipliers
- Sequential logic circuits: SR, D, JK flip flops, asynchronous up, down and BCD counters, synchronous binary up and down counters, state machines
- Project work

### Ordering information

| | |
|---|---|
| FPGA training course | BL0552 |

COMING SOON

## Curriculum mapping

- Suitable for BTEC Higher National unit 45: Industrial systems
- Suitable for Internet of Things related courses at level 3 and beyond

# Internet of Things solution

The Internet of Things solution is designed to allow students to give consideration of current trends in technology, including the future of industrial systems, the impact of digital developments, the increase of wireless and remote control and the Internet of Things. Our IoT course is based on Arduino (also available based on a Raspberry Pi) and gives students the ability to program our E-blocks2 platform to send and receive data remotely via Wi-Fi using pre-built cloud-based services. Users can also develop their own cloud-based solutions (e.g. using ThingsSpeak). The IoT solution includes microcontroller-based hardware, pre-built web-based applications and a 15 hour course in Internet of Things system development.

## Learning objectives / experiments:

- Development of microcontroller-based IoT applications
- Development of cloud-based IoT applications
- Exchanging data between IoT devices and cloud-based applications
- Security implications for IoT
- Remote datalogging, sensing and control

### Ordering information

| | |
|---|---|
| Internet of Things solution | BL0569 |





Electrical / Electronic Engineering

NEW





## Specification

| Output | Voltage | Current | | Features |
|---|---|---|---|---|
| Signal generator:<br><br>Sine,<br>Square,<br>Triangle,<br>Sawtooth,<br>Custom | Instrumentation<br>0.1Hz to 100KHz | 50 Ohm<br>DC coupled 10V p-p | | BNC |
| | Audio Output<br>20Hz to 20kHz / AC power supply | Loudspeaker/Transducer<br>AC coupled 10V p-p 1.3 Amp peak | | 4mm shrouded(+)<br>4mm shrouded(-) |
| | | Line Out<br>AC coupled 2V p-p<br>200 Ohm source impedance | | Mono Jack |
| Power Supply | 3-10V variable | up to 3A maximum | variable current limited, monitored | 4mm shrouded (brown) |
| | +12V | up to 5A maximum | variable current limited, monitored | 4mm shrouded (blue) |
| | +5V | up to 5A maximum | variable current limited, monitored | 4mm shrouded (red) |
| | -12V | up to 300 mA | current limited to 300mA | 4mm shrouded (yellow) |

## Source - DC PSU, AC PSU and signal generator

This general purpose DC/AC power supply/signal generator has a wide range of applications in education: in Physics, Technology and Electronics.

The unit is housed in a rugged enclosure with a large graphical back-lit display and input controls conveniently located at the top front of the display. The power supply has a number of fixed DC voltage outputs as well as variable DC and AC outputs.

The AC signal generator output is presented in three forms: ±10V 50ohm BNC output, high-power output via shrouded 4mm sockets for directly driving speakers and vibration generators, and a line-level output on a jack socket. This AC signal delivers 0.1Hz to 100KHz with sine, triangle, square and arbitrary waveform outputs.

The power supply operates from a supply of 110V or 240VAC.

## Functions:

- Fixed -12V, 5V and +12V outputs
- Variable 3 - 10V DC output
- Signal generator output: 0.1Hz - 100kHz
- Dot matrix backlit user display
- Rugged continuously rotating control and buttons
- Supplied with technician voltage limiting software
- Shrouded safety connectors
- Waveform generator

### Ordering information

| | |
|---|---|
| Source - DC PSU, AC PSU and signal generator | LK6999 / LK2975 |

Learning Centre

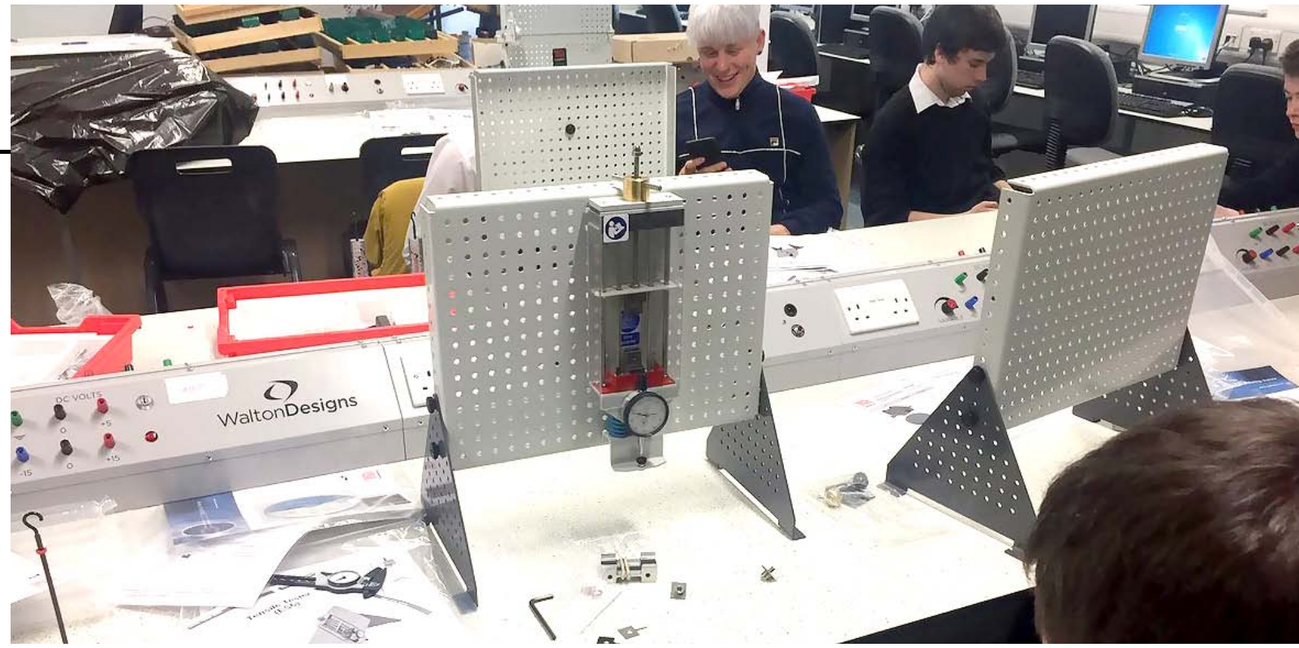
**Did you know?**

You can view our extensive wealth of curriculum, worksheets and guides for all of the solutions in this catalogue for free, by visiting our Learning Centre at www.matrixtsl.com/learning




# Mechanical Engineering

Many of the mechanical engineering solutions found in this section of the catalogue are a suite of topics which work by users taking the base board (HP5000) and following the supplied worksheets in order to teach at levels 3 and 4 of the UK syllabus map. Also in this section, you will find solutions specially designed for mechanical engineers who are required to learn about typical electronic engineering topics such as microcontroller systems for engineers.




## Our learning solutions

- Are supplied with the necessary instructions and worksheets
- Are designed for students to work in pairs, to ensure maximum learning capacity is achieved
- Are extremely long-lasting and rugged and are covered by our standard warranty terms
- Include solutions for mechanical engineers faced with challenging units within their qualification, which are more common to electronic engineering

## Curriculum mapping

- Suitable for unit 1 of BTEC National award: Engineering principles
- Suitable for unit 3 of BTEC Higher National: Engineering science
- Suitable for unit 8 of BTEC Higher National: Mechanical principles
- Suitable for unit 27 of BTEC National award: Mechanical principles in practice

# Forces Kit

This kit includes a set of different plastic shapes which fit onto an essential base unit for experiments in centres of gravity of two-dimensional objects. It also includes pulleys, weights and a magnetic protractor for experiments in concurrent and non-concurrent coplanar forces and angles. The selection of pulleys and weights allows you to create force triangles, polygons and linked polygons. The guidance notes show how to analyse and predict forces using Bow's Notation and the parallelogram of forces. Worksheets, guidance notes and lecturer notes (with answers) needed for typical experiments are supplied with the essential base unit. Essential base unit and kit must be ordered separately.

## Learning objectives / experiments:

- Centre of gravity
- Force triangles
- Force Polygons and Bow's Notation
- Linked Polygons (non-current forces)

**Ordering information**

| | |
|---|---|
| Forces kit | HP5005 |
| Essential base unit | HP5000 |

# Moments Kit

This kit includes a rigid beam for experiments in the principle of moments, extending to levers and beams. It shows the three main lever types (1st, 2nd and 3rd order) and includes an 'L' shape plate for experiments in bell crank levers. A pulley allows extra experiments with moments caused by oblique forces. The rigid beam allows experiments that show the use of moments to find unknown weights, creating simple beam balances. It also works with spring balances to show reaction forces on beams with point loads and uniformly distributed loads (UDLs). Worksheets, guidance notes and lecturer notes (with answers) needed for typical experiments are supplied with the essential base unit. Essential base unit and kit must be ordered separately.

## Learning objectives / experiments:

- Principle of moments
- Beam Balances
- 1st, 2nd and 3rd order levels
- Bell Crank Level
- Beam Reactions

## Curriculum mapping

- Suitable for unit 1 of BTEC National award: Engineering principles
- Suitable for unit 3 of BTEC Higher National: Engineering science
- Suitable for unit 8 of BTEC Higher National: Mechanical principles
- Suitable for unit 27 of BTEC National award: Mechanical principles in practice

**Ordering information**

| | |
|---|---|
| Moments kit | HP5010 |
| Essential base unit | HP5000 |





## Curriculum mapping

- Suitable for unit 1 of BTEC National award: Engineering principles
- Suitable for unit 2 of BTEC Higher National: Engineering Science
- Suitable for unit 3 of BTEC Higher National: Engineering science
- Suitable for unit 8 of BTEC Higher National: Mechanical principles
- Suitable for unit 27 of BTEC National award: Mechanical principles in practice

# Deflection of beams and cantilevers Kit

This kit includes different beams and fixing blocks. The fixing blocks work as clamps or knife-edge supports. They hold the beams in different ways, such as a cantilever, simply supported, fixed (encastre) and a propped cantilever. Students set up a beam on the supports and add weights to deflect the beams. An accurate dial indicator measures the deflection at the point of loading. The choice of different beams allow extra experiments, showing the relationships between beam deflection and 'I' (second moment of area) value. They also allow comparisons of different beam material and how it affects deflection, introducing Young's Modulus. Students also use the cantilever for easy experiments showing the relationship between beam length and deflection. Worksheets, guidance notes and lecturer notes (with answers) needed for typical experiments are supplied with the essential base unit. Essential base unit and kit must be ordered separately.

## Learning objectives / experiments:

- Beam length and deflection
- Beam material and deflection (Young's Modulus)
- Beam 'I' value and deflection
- Beam supports (cantilever, propped cantilever, fixed beam and simply supported) and deflection

**Ordering information**

| | |
|---|---|
| Deflection of beam and cantilevers kit | HP5015 |
| Essential base unit | HP5000 |

## Curriculum mapping

- Suitable for unit 8 of BTEC Higher National: Mechanical principles

# Torsion of circular sections kit

This kit includes different circular section specimens and adjustable chucks which fit on to an essential base unit for experiments in torsion. Students fix the specimens in the chucks and apply weights to a lever arm. The arm applies a moment (torque) to one end of the specimen. A scale on the arm shows the angle of twist. Standard tests show the relationship between torsion and 'J' (polar second moment of area) value. Students use this to predict the twist angle for any given specimen. The choice of different specimens allows comparisons of different specimen material and how it affects torsion, introducing the Modulus of Rigidity. Students also move the chuck positions for easy experiments showing the relationship between specimen length and angle of twist. Worksheets, guidance notes and lecturer notes (with answers) needed for typical experiments are supplied with the essential base unit. Essential base unit and kit must be ordered separately.

## Learning objectives / experiments:

- Specimen length and angle of twist
- Specimen material and angle of twist (Modulus of Rigidity)
- Specimen 'J' value and angle of twist

**Ordering information**

| | |
|---|---|
| Torsion of circular sections kit | HP5020 |
| Essential base unit | HP5000 |





Mechanical Engineering

## Curriculum mapping

- Suitable for unit 1 of BTEC National award: Engineering principles
- Suitable for unit 3 of BTEC Higher National: Engineering science
- Suitable for unit 9 of BTEC Higher National: Materials, properties and testing
- Suitable for unit 27 of BTEC National award: Mechanical principles in practice

# Tensile tester kit

This kit includes specimens of different materials, which fit on to an essential base unit to show students the principles of tensile tests. Students use the tensile tester to stretch the specimens to destruction, while measuring the extension and force. The tests introduce students to tensile test terms including: overall stress and strain, yield properties, tensile strength and elongation. The choice of different specimens allows comparisons of different specimen material and how it affects its tensile properties. Worksheets, guidance notes and lecturer notes (with answers) needed for typical experiments are supplied with the essential base unit. Essential base unit and kit must be ordered separately.

## Learning objectives / experiments:

- Tensile tests (to destruction) of different materials
- Finding the tensile strength of a material
- Material behaviour in the elastic and plastic region
- Creating a force and extension chart

**Ordering information**

| | |
|---|---|
| Tensile tester kit | HP5025 |
| Essential base unit | HP5000 |

## Curriculum mapping

- Suitable for unit 8 of BTEC Higher National: Mechanical principles

# Simple harmonic motion kit

This kit includes different pendulums and a spring which fit onto an essential base unit to show students the principles and use of simple harmonic motion. Students test different pendulums and a spring to see how different factors, such as mass or pendulum length affect simple harmonic motion and the period of oscillation. The theory shows how to predict the period of oscillation for a given pendulum or spring for comparison with actual results. The kit includes an experiment with the Kater's pendulum that shows the relationship between simple harmonic motion and gravity, for prediction of gravity to a reasonable accuracy. The kit also introduces students to a simple 'spring rate' test, and key scientific terms such as moments of inertia and parallel axis theorem. Worksheets, guidance notes and lecturer notes (with answers) needed for typical experiments are supplied with the essential base unit. Essential base unit and kit must be ordered separately.

## Learning objectives / experiments:

- Simple harmonic motion of simple, bifilar and trifilar pendulums of different length and mass
- Simple harmonic motion of a spring with different masses, and a simple spring rate test
- Simple harmonic motion of a compound pendulum
- Simple harmonic motion and gravity using a Kater's pendulum

**Ordering information**

| | |
|---|---|
| Simple harmonic motion kit | HP5030 |
| Essential base unit | HP5000 |





## Curriculum mapping

- Suitable for unit 1 of BTEC National award: Engineering principles

# Friction and inclined plane kit

This kit includes parts which fit on to an essential base unit to show experiments in friction and forces on a flat or inclined plane. The plane has an inclinometer and adjustment to allow the student to set the plane to any angle between zero and 90 degrees. The parts include different friction surfaces, a roller set, a rolling car or sled with adjustable mass and a simple roller. Students fit the different parts to the plane and apply masses. They learn how different surface finishes and mass affect friction and how surface angles and mass affect forces around a body on a plane. The experiments introduce students to important engineering and scientific terms, such as the coefficient of friction, sliding friction and kinetic friction. The inclinable plane allows students to do the classic 'forces on an inclined plane experiments'. It also shows the relationship between frictional forces and angles other than horizontal. Worksheets, guidance notes and lecturer notes (with answers) needed for typical experiments are supplied with the essential base unit. Essential base unit and kit must be ordered separately.

## Learning objectives / experiments:

- Forces on an inclined plane
- Rolling and Sliding Friction on different surfaces
- Kinetic and Static Sliding Friction between different surfaces
- Surface angle and friction between different surfaces

**Ordering information**

| | |
|---|---|
| Friction and inclined plane kit | HP5035 |
| Essential base unit | HP5000 |

## Curriculum mapping

- Suitable for unit 36 of BTEC Higher National: Advanced mechanical principles

# Potential and kinetic energy kit

This kit includes a pendulum, a spring and a flywheel which fit onto a essential base unit for experiments in potential and kinetic energy. Students test each part to discover the difference between potential and kinetic energy and the transfer of energy from one form to another. The kit introduces students to key engineering terms such as 'moment of inertia' and 'elastic potential energy'. Worksheets, guidance notes and lecturer notes (with answers) needed for typical experiments are supplied with the essential base unit. Essential base unit and kit must be ordered separately.

## Learning objectives / experiments:

- Kinetic and potential energy in a pendulum
- Elastic potential energy in a spring
- Kinetic energy in a flywheel

**Ordering information**

| | |
|---|---|
| Potential and kinetic energy kit | HP5040 |
| Essential base unit | HP5000 |





Mechanical Engineering

## Drive systems kit

This kit includes three different drive systems, which fit on to an essential base unit, to show their relative advantages and disadvantages. Students test a universal coupling, a belt drive and a chain drive to see how they work and how they differ in the way they transfer motion (power). The kit includes extra parts to help show the importance of the angle of lap around a pulley and its relationship with friction. The kit introduces students to key engineering terms such as gear ratio, pulley ratio and efficiency. Worksheets, guidance notes and lecturer notes (with answers) needed for typical experiments are supplied with the essential base unit. Essential base unit and kit must be ordered separately.

### Learning objectives / experiments:

- Power transfer, efficiency and direction in a belt drive
- Power transfer and efficiency in a chain drive
- Friction and angle of lap on a pulley

**Ordering information**

| | |
|---|---|
| Drive systems kit | HP5045 |
| Essential base unit | HP5000 |

### Learning objectives / experiments:

- Displacement and angle characteristics of pear, heart, round and spiral cams
- Characteristics of a mechanical toggle
- Turning moments and forces during crank motion

## Cam, crank and toggle kit

This kit includes a crank and slider, which fit onto an essential base unit, to show the relative forces during crank motion. It also includes four popular cam shapes to show their different characteristics. Another set of parts in the kit shows the characteristics of a mechanical toggle. Students fit the crank and slider with weights and a spring balance to see the change in linear and rotational forces (moments) as the crank turns. They also use the slider with different followers on a set of four popular shape cams - heart, pear, spiral and round. This gives several cam and follower combinations to help students understand the different characteristics of each cam and why engineers choose between them for different applications. The last set of parts in the kit has a simple linkage that allows students to see the characteristics of a toggle mechanism. Its shows the relative forces and angular conditions of the toggle in its initial state and how they affect the point at which it locks or 'snaps' into a horizontal state. The kit introduces students to key engineering terms such as a 'flat follower', a 'roller follower' and 'toggle action'. Worksheets, guidance notes and lecturer notes (with answers) needed for typical experiments with each kit are supplied with the essential base unit. Essential base unit and kit must be ordered separately.

**Ordering information**

| | |
|---|---|
| Cam, crank and toggle kit | HP5050 |
| Essential base unit | HP5000 |





## Curriculum mapping

- Suitable for unit 8 of BTEC Higher National: Mechanical principles
- Suitable for unit 36 of BTEC Higher National: Advanced mechanical principles

## Gear trains kit

This kit includes a selection of different gears which fit on to an essential base unit for experiments to find their unique characteristics. The gears include Spur Gears, a Bevel Gear and a Worm Drive. The spur gears have two sets of teeth on the same shaft, allowing extra experiments in compound gear trains. Students test each set of gears to see how it works and note the differences in characteristics (such as efficiency, gear ratio and mechanical advantage) of each set. The gear sets are a selection of the most common sets, similar to those used in real applications, such as automobile gear boxes, domestic and industrial hand tools and clockwork instruments. Each has advantages and disadvantages that make them suitable for a particular job. The kit introduces students to key engineering terms such as gear ratio, efficiency, mechanical advantage and velocity ratio. Worksheets, guidance notes and lecturer notes (with answers) needed for typical experiments are supplied with the essential base unit. Essential base unit and kit must be ordered separately.

### Learning objectives / experiments:

- Characteristics of Spur Gears, including single and compound gear trains and the 'idler' gear
- Characteristics of a Bevel Gear
- Characteristics of a Worm Drive

**Ordering information**

| | |
|---|---|
| Gear trains kit | HP5055 |
| Essential base unit | HP5000 |

## Simple mechanisms kit

This kit includes three popular mechanisms which fit on to an essential base unit for experiments in conversion of motion from linear to rotary or rotary to linear. These include the Scotch Yoke (sometimes called 'donkey crosshead' or 'slotted link'), the Crank and Slider and the Quick Return mechanisms. Students test each mechanism to see how it works and note the differences in the way that each mechanism converts the motion. The three mechanisms are the same as those used in real applications, such as combustion engines, power assisted valves or fluid pumping systems. Each has a unique way of converting motion, shown by the experiments. The kit introduces students to key engineering terms such as reciprocating motion, rotary to linear motion and linear to rotary motion. Worksheets, guidance notes and lecturer notes (with answers) needed for typical experiments are supplied with the essential base unit. Essential base unit and kit must be ordered separately.

### Learning objectives / experiments:

- Conversion of motion using the 'Scotch Yoke' (or 'slotted link')
- Conversion of motion using the Quick Return mechanism
- Conversion of motion using the Crank and Slider

**Ordering information**

| | |
|---|---|
| Simple mechanisms Kit | HP5060 |
| Essential base unit | HP5000 |





Mechanical Engineering

## Curriculum mapping

- Suitable for unit 36 of BTEC Higher National: Advanced mechanical principles

## Spring tester kit

This versatile kit allows many experiments using different arrangements of its parts. Students, teachers or lecturers fit the parts of the kit to the essential base unit to study or demonstrate an engineering science topic. This kit includes different coiled springs for experiments in spring testing. These include extension springs, compression springs, parallel springs and springs that can connect in series. Students test the springs to prove Hooke's Law and find their spring rate, comparing it with given manufacturer's values. They also test springs in parallel and series to see how this affects the overall spring rate. The kit helps students to understand the link between spring rate, spring extension and the design and construction of springs. It introduces students to key engineering terms such as: Spring rate, Hooke's Law, Spring pretension. Worksheets, guidance notes and lecturer notes (with answers) needed for typical experiments are supplied with the essential base unit. Essential base unit and kit must be ordered separately.

### Learning objectives / experiments:

- Spring extension
- Hooke's law
- Springs in parallel and series

**Ordering information**

| | |
|---|---|
| Spring tester kit | HP1282 |
| Essential base unit | HP5000 |

## Centrifugal force kit

This kit includes a manually rotated frame with a low-friction cantilever linkage. The frame has mounting positions for adjustable masses and a spring that applies a fixed frictional force value to a rotating drum. The range of mounting positions and masses allows many variations of the experiment to help students understand the relationships between the variables of speed, mass and radial position. Students fit the chosen masses to one side of the frame and an equal counterbalance to the opposite side of the frame. They rotate the assembly which will overcome the spring frictional force at a given speed, working as centrifugal clutch that regulates its own speed. The frame has a durable 'clicking' tab that students use with a stopwatch (supplied) to measure the speed. They use their measurements to calculate the forces due to the rotating masses and compare them with the opposing force from the spring. The kit introduces students to key engineering terms such as centrifugal and centripetal force, while explaining the fictitious term 'centrifugal' force and its accepted use. It also shows the use of 'radians' in rotational velocity measurement. Worksheets, guidance notes and lecturer notes (with answers) needed for typical experiments are supplied with the essential base unit. Essential base unit and kit must be ordered separately.

### Learning objectives / experiments:

- Centripetal and centrifugal force
- Newton's second law
- Rotational dynamics
- Balancing masses

**Ordering information**

| | |
|---|---|
| Centrifugal force kit | HP0232 |
| Essential base unit | HP5000 |





## Bar linkages kit

This kit includes a selection of over 20 perforated bars of different lengths and pivots or 'joints' to allow students to create an unlimited choice of linkages. Students assemble the bars and joints in any arrangement and note how the linkage converts movement from one form to another (for example; rotary motion to linear motion). Bar linkages are one of the most basic mechanisms used in mechanical engineering. The kit includes magnetic 'wipeable' sheets and holders for non-permanent markers so the student can trace the relative movements of the linkages or joints. The kit introduces students to key engineering terms such as four-bar linkages, rotary and linear movement, and planar linkages. Worksheets, guidance notes and lecturer notes (with answers) needed for typical experiments are supplied with the essential base unit. Essential base unit and kit must be ordered separately.

### Learning objectives / experiments:

- Conversion of motion through bar linkages
- Crank, rocker, double rocker, drag link, parallelogram
- Straight line linkages

**Ordering information**

| | |
|---|---|
| Bar linkages kit | HP7622 |
| Essential base unit | HP5000 |

## Additional mechanisms kit

This kit includes two popular mechanisms for experiments in conversion of motion from one form to another. These include the Geneva mechanism (sometimes called the Maltese Cross mechanism or crank and star), and a ratchet mechanism. Students test each mechanism to see how it works and note the differences in the way that each mechanism converts the motion. The two mechanisms are the same as those used in real applications, such as CNC machines, hand tools, turnstiles and lifting hoists. Each has a unique way of converting motion, shown by the experiments. Worksheets, guidance notes and lecturer notes (with answers) needed for typical experiments are supplied with the essential base unit. Essential base unit and kit must be ordered separately.

### Learning objectives / experiments:

- Ratchet mechanisms
- Geneva mechanisms

**Ordering information**

| | |
|---|---|
| Additional mechanisms kit | HP6207 |
| Essential base unit | HP5000 |

## Rotational friction kit

This kit includes a screw jack (or 'jackscrew'), a wedge and different bearings. It helps students understand how rotational friction affects the efficiency of popular machine elements and bearing materials. It shows why engineers choose some materials and devices above others for any given application. Students fit the parts to the base unit and apply effort and load weights to find their relative mechanical advantage and efficiency. The kit introduces students to key engineering terms such as: Mechanical advantage, Velocity ratio, Efficiency and Overhaul. Worksheets, guidance notes and lecturer notes (with answers) needed for typical experiments are supplied with the essential base unit. Essential base unit and kit must be ordered separately.

### Learning objectives / experiments:

- Friction, mechanical advantage, efficiency
- Bearings, wedges, screw jacks
- Machines using rotational friction

**Ordering information**

| | |
|---|---|
| Rotational friction kit | HP8604 |
| Essential base unit | HP5000 |

## Pulley kit

This kit includes a wheel and axle with single, double and triple wheel or 'sheave' pulleys for experiments in mechanical advantage. Students test fixed, movable and compound pulleys attached to load and effort weights to test their mechanical advantage. The kit includes a unique pulley - the Weston Differential pulley - to show how two different size sheaves on one pulley has a dramatic effect on mechanical advantage. The kit introduces students to key engineering terms such as machine efficiency, velocity ratio and 'work done'. Worksheets, guidance notes and lecturer notes (with answers) needed for typical experiments are supplied with the essential base unit. Essential base unit and kit must be ordered separately.

### Learning objectives / experiments:

- Efficiency and mechanical advantages of pulleys
- Simple and compound pulleys
- Wheel and axle pulleys
- Weston differential pulley

**Ordering information**

| | |
|---|---|
| Pulley kit | HP9771 |
| Essential base unit | HP5000 |






## Complete mechanics

This kit includes all of our mechanical experimentation kits, three base boards and a large storage trolley.

The Complete mechanics range consists of 18 experiment kits in fundamental Engineering Science topics common to most mechanical engineering disciplines. This includes the study of forces, moments, friction, materials science, vibration, gears pulleys, chains and mechanisms. The system is modular, and each kit allows many experiments to be carried out making the system flexible and great value for money. Three essential base units are supplied with this kit.

### Learning objectives / experiments:

- Newton's laws of motion
- Dynamics
- Rotational dynamics
- Forces and moments
- Materials testing
- Simple machines
- Mechanisms
- Vibration, friction and energy

**Ordering information**

| | |
|---|---|
| Complete mechanics | HP8797 |

## Linear and rotational dynamics

This kit includes a dynamics track, handheld datalogger with LCD screen, and a range of sensors and accessories that allow students and teachers to carry out a range of experiments in dynamics. The datalogger can be used independently of a PC for many experiments with data automatically passed to Excel for further analysis. The datalogger has a VGA output which makes the equipment perfect for classroom demonstrations. The equipment is supplied with a suite of worksheets and teacher support material.

### Learning objectives / experiments:

- Parameters of Kinetics: displacement, velocity, acceleration
- Equations of motion
- Parameters of dynamics: inertia, acceleration, force, momentum, mechanical work and power
- Newton's laws of motion, conservation of momentum and energy
- Linear and angular motion
- Rotational dynamics
- Simple harmonic motion

### Curriculum mapping

- Suitable for unit 1 of the BTEC National in Engineering: Engineering principles
- Suitable for unit 3 of BTEC Higher National: Engineering science
- Suitable for unit 8 of BTEC Higher National: Mechanical principles
- Suitable for unit 28 of the BTEC National in Engineering: Dynamic mechanical principles and practice

*The datalogger included is fully self-contained and has a VGA output for connection to a projector for class demonstrations.*

**Ordering information**

| | |
|---|---|
| Linear and rotational dynamics | HP5099 |

## Thermodynamics kit

This kit allows engineering students to carry out a wide range of practical experiments in Thermodynamics to help them understand the temperature related behaviour of mechanical systems. The kit includes experimental apparatus including metal blocks with heating elements, linear rods with heaters, Leslie cube and Jolly bulb. The kit also includes measuring instruments such as digital thermometers, energy meter, and infrared thermometer. A downloadable manual covers all experiments and includes teacher's notes. A unique feature of the kit is that all the experiments can be completed just with electricity as the heat source – no Bunsen burner is required.

### Learning objectives / experiments:

- Heat capacity of liquids
- Heat capacity of solids
- Linear expansion of heat
- Heat absorption
- Heat radiation
- Expansion of gases – Charles' law
- Boyle's law

**Ordering information**

| | |
|---|---|
| Thermodynamics kit | HP4159 |
| Corresponding curriculum | CP4261 |

**You will also need:**

| | |
|---|---|
| Source - DC PSU, AC PSU and signal generator | LK6999 / LK2975 |

### Curriculum mapping

- Suitable for studying electricity as part of a Physics course aged 16 to 18 (A level courses in the UK)

NEW

## Engineering science kit

Our Engineering science kit is designed to meet the required outcomes of the Scottish Qualifications Authority (SQA). All aspects of the kit are available as individual units and include equipment for the study of pneumatic systems, electronic control systems, analogue systems, forces, moments, materials and programming robotics. The kit is perfect to give students an introductory or in depth overview into the key elements of engineering science principles.

### Learning objectives / experiments:

- Understanding basic valves, cylinders, reservoirs, and various types of pneumatic circuits
- Current and voltage measurement and dividers, Kirchoff's laws, DC circuits, AC measurements, transformers and more
- Tensile tests, material behaviour and strength
- Principle of moments, beam balances and reactions, Bell Crank Level
- Centre of gravity, force triangles, force polygons and Bow's Notation
- Programming of microcontrollers and robotics using blocks, flowcharts or scripted code

**Ordering information**

| | |
|---|---|
| Automatics essentials | AU9020 |
| Compressor | AU1050 |
| Intermediate electrical and electronic engineering | LK9862 |
| Tensile tester kit | HP5025 |
| Essential base unit | HP5000 |
| Forces kit | HP5005 |
| Moments kit | HP5010 |
| Formula AllCode | |

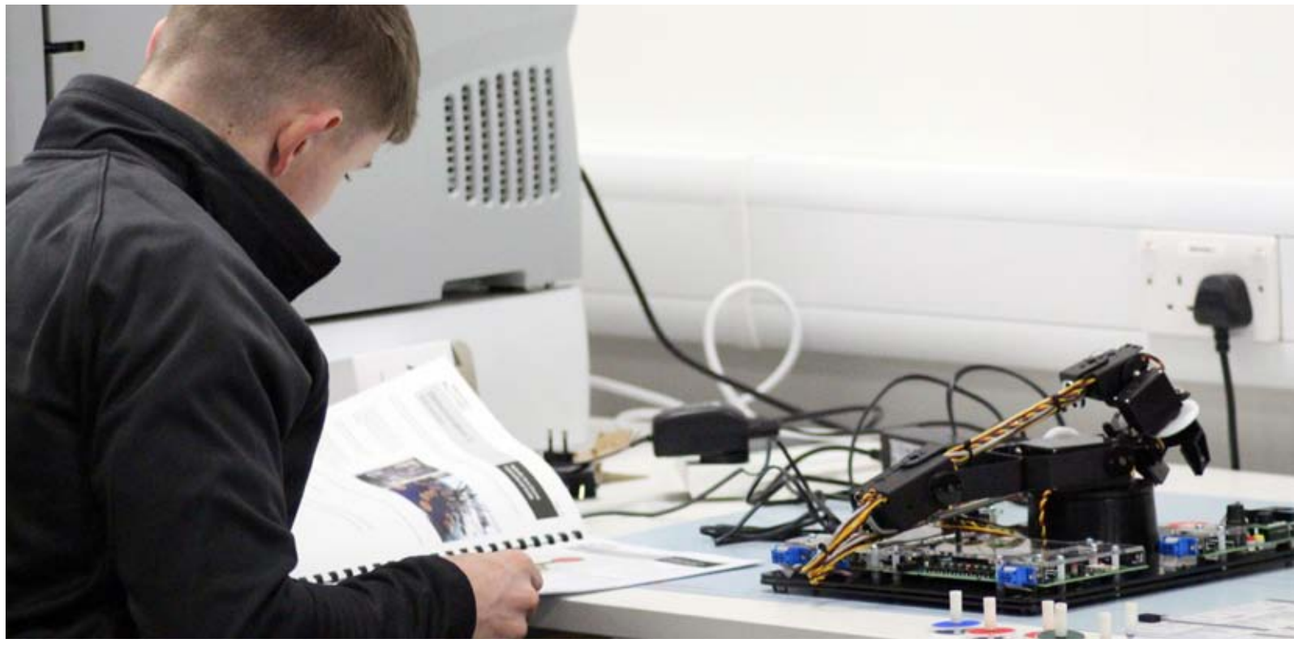
### Curriculum mapping

- Suitable for delivery of the SQA qualification in Engineering Science at levels 4 and 5.




# Automation, Robotics & Mechatronics

Robotics is a relatively new area of focus for Matrix, however last year we developed two of the market's leading and most unique solutions based on the AllCode concept which means users can program our Formula AllCode and AllCode Robot Arm through the programming language of their choice. This is one of the first solutions of its kind in the industry. We're seeing more Mechatronic courses being developed year on year and as a result, our offering in mechatronics has also grown. We now present solutions for PLC programming, automation and pick and place.



*"At Aberystwyth University we were looking for an upgrade to the robots we used for teaching undergraduate coursework. After evaluating several different options we chose the Matrix Formula AllCode, as it provides an all-in-one solution including Bluetooth connectivity, a good range of on-board sensors and built-in battery charging circuitry. The PIC microcontroller used in the AllCode robots allows us to teach more advanced control courses than would be possible with similar Arduino-based products."*

Pete Todd, Aberystwyth University

### Our learning solutions

- Are supplied with many hours of in-depth curriculum
- Are unique in their appearance and learning outcomes
- Give students the ability to focus on a broad breadth of programming languages
- For automation are compatible with industrial PLC's from the common industrial manufacturers

## Learning objectives / experiments:

- Understanding the different varieties of valves and where each is appropriate in a system
- Understanding the basic types of cylinder, controlling speed and the factors that influence power output
- Combining valves to produce logic functions
- Semi-automatic and automatic reciprocation
- Creating sequences of movements
- Using reservoirs to create time delays
- Air bleed and pilot operated circuits
- Component symbols and circuit diagrams
- Staying safe when using air at high pressure


## Curriculum mapping

- Suitable for unit 12 of the BTEC national: Pneumatic and hydraulic systems
- Suitable for unit 29 of BTEC Higher National: Electro, pneumatic and hydraulic systems

# Automatics essentials solution

This kit provides a complete introduction to pneumatic circuit design and construction. The curriculum pack includes a comprehensive set of worksheets that allow students to progress from first principles through to circuits of moderate complexity; including reciprocating circuits and generating sequences of movements.

The solution is intended for students in their early teens and older who are learning technology and engineering subjects. Tasks are designed to be suitable for pairs of students sharing a single kit.

Everything you will need to teach the course is included in the solution pack, with the exception of an air compressor.

**Ordering information**

| | |
|---|---|
| Automatics essentials solution | AU9020 |
| Corresponding curriculum | AW2080 |

**You may also need**

| | |
|---|---|
| Compressor | AU1050 |

For a list of included components, search for the product code at www.matrixtsl.com and click on the resources tab


## Learning objectives / experiments:

- Understand the operation of electrically controlled pneumatic valves
- Use of electrical switching to control circuit operation
- Using microswitches to sense cylinder position
- Sensing position without physical contact using reed switches
- Expressing electrical circuits using ladder diagrams
- Electrically operated reciprocal circuits
- Sequential control circuits
- Analysing real world problems and formulating solutions

## Curriculum mapping

- Suitable for unit 12 of the BTEC national: Pneumatic and hydraulic systems
- Suitable for unit 29 of BTEC Higher National: Electro, pneumatic and hydraulic systems

# Electro-pneumatics add-on kit

This kit supplements the Automatics essentials solution by adding a selection of electrically operated valves and a range of sensors. By following the curriculum, students will learn how to use these new components to create systems in which pneumatics and electrical circuits are combined into complete systems.

The electrical components are connected together quickly and reliably using 4mm connectors, for which all of the necessary leads and accessories are provided. Electrical components are robustly mounted to the Automatics platform using the same 'tee' bolt system used for the pneumatic parts and are printed with standard circuit symbols.

Working two to a kit, students follow the detailed worksheets to gain a comprehensive understanding of electro-pneumatics. By the end of the course, students will be able to create reciprocating and sequential circuits, and will have an understanding of how these are used to solve real world engineering problems.

**Ordering information**

| | |
|---|---|
| Electro-pneumatics add-on kit | AU9015 |
| Corresponding curriculum | AW2079 |

For a list of included components, search for the product code at www.matrixtsl.com and click on the resources tab




Also available with Rpi MIAC and Arduino MIAC

## Learning objectives / experiments:

- Reading sensors and switches
- Issuing commands to the pneumatic circuits
- Learning the difference between digital and analogue signals
- Using flowcharts to visualise programs
- Program flow and decision making
- Programming sequences
- Using feedback to enhance reliability and improve safety

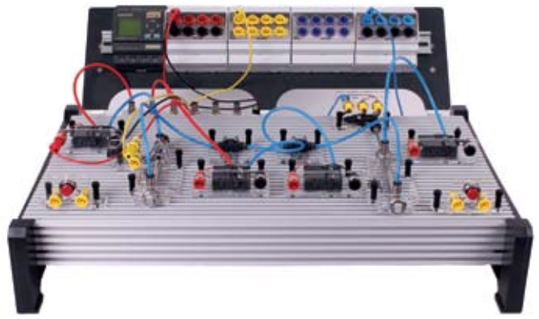

For a list of included components, search for the product code at www.matrixtsl.com and click on the resources tab

## Curriculum mapping

- Suitable for unit 12 of the BTEC national: Pneumatic and hydraulic systems
- Suitable for unit 29 of BTEC Higher National: Electro, pneumatic and hydraulic systems

Control add-on pack with 12 or 24V compatibility now available

Works with Siemens S7, Mitsubishi, Omron or any standard PLC which fits onto a 50 mm DIN rail







For a list of included components, search for the product code at www.matrixtsl.com and click on the resources tab

## Curriculum mapping

- Suitable for unit 29 of BTEC Higher National: Electro, pneumatic and hydraulic systems
- Unit 36 of the BTEC National: Programmable logic controllers

# Pneumatics control add-on kit

This kit extends your Automatics pneumatics solution by adding a powerful programmable microcontroller unit, the MIAC, together with the pneumatic components necessary to put it through its paces.

By following the included curriculum, students will learn how the combination of a controller and custom software can create powerful and flexible pneumatic systems.

Students will learn how to establish the state of a pneumatic machine using sensors, the use of logic to process that data and the issuing of commands to the included solenoid valves.

Two versions of the curriculum are supplied. In the first, students use pre-programmed control systems supplied in the MIAC's built in memory. A more advanced course, Control plus, teaches students how to write their own programs for the controller.

This kit can also be supplied without the MIAC PLC, for those who wish to integrate their own industrial PLC into our system. Please see ordering information below, the product at the bottom of the page, or contact us for more information.

**Ordering information**

| | |
|---|---|
| Automatics control add-on kit (12V) with MIAC | AU9010 |
| Automatics control add-on kit (24V) no MIAC | AU9030 |
| Corresponding curriculum | AW4956 / AW4957 |

**You may also need**

| | |
|---|---|
| Automatics essentials solution | AU9020 |
| Flowcode | |

# Pneumatics with your own PLC

We are now able to supply pneumatics training equipment which can be used with any PLC with the Automatics PLC adaptor rail. The Adaptor rail allows students to connect to relay and motor outputs using standard 4mm connectors which connect directly to other Automatics components. This pack combines standard pneumatics components with Control pneumatics components to provide a complete learning platform for pneumatics and PLC programming in one package. A PLC is not included. Any programming language - including ladder logic - can be used. Worksheets are based on flow charts. PLC adaptor modules included: power distribution, inputs (8), motor outputs (8), relays (4).

## Learning objectives / experiments:

- Pneumatic components, circuits and circuit diagrams
- Sensors and switches in pneumatic systems
- Digital and analogue signals
- PLC programming with ladder logic or block diagrams
- PLC inputs and outputs
- Logic functions

**Ordering information**

| | |
|---|---|
| PLC Adaptor - input module | HP6700 |
| PLC Adaptor - power module | HP6711 |
| PLC Adaptor - motor module | HP6723 |
| PLC Adaptor - relay module | HP6752 |
| PLC adaptor - mounting bracket | HP6785 |

**You may also need**

| | |
|---|---|
| Automatics essential solution | AU9020 |
| Automatics control add-on kit (24V) no MIAC | AU9030 |




Automation / Robotics / Mechatronics


NEW

## Pneumatics control with S7-1200 Siemens PLC add-on

This kit can be added to the Automatics essentials solution to produce learning outcomes for those wishing to study about rugged, industrial PLCs. By following the provided curriculum, students will learn how the combination of a rugged Siemens industrial controller and related software can create powerful and flexible pneumatic systems. Students will learn how to establish the state of a pneumatic machine using sensors, the use of logic to process that data and the issuing of commands to the included solenoid valves.

Two versions of the curriculum are supplied. In the first, students use pre-programmed control systems supplied in the Siemens S7-1200's built in memory. A more advanced course, Control plus, teaches students how to write their own programs for the PLC.

### Learning objectives / experiments:

- Reading sensors and switches
- Issuing commands to the pneumatic circuits
- Learning the difference between digital and analogue signals
- Using flowcharts to visualise programs
- Program flow and decision making
- Programming sequences
- Programming industrially rugged programmable logic controllers PLC
- Using feedback to enhance reliability and improve safety

SIEMENS

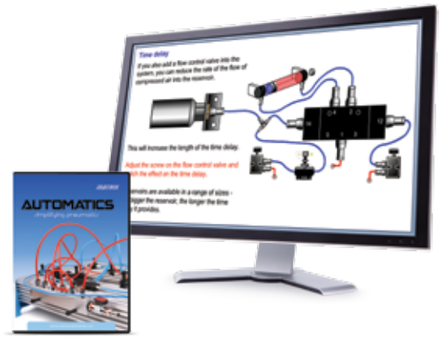

### Curriculum mapping

- Suitable for unit 12 of the BTEC national: Pneumatic and hydraulic systems
- Suitable for unit 29 of BTEC Higher National: Electro, pneumatic and hydraulic systems
- Unit 36 of the BTEC National: Programmable logic controllers

**Ordering information**

| | |
|---|---|
| Pneumatics control with S7-1200 Siemens PLC add-on | AU9077 |




## Automatics interactive courseware

The Automatics interactive courseware is a complete pneumatics and automation curriculum in the form of an interactive PC application.

Students are guided through the construction of systems using onscreen simulations of the physical Automatics components and a simple drag and drop interface.

The courseware is a complete curriculum, covering everything from basic component identification and learning circuit symbols, through to the construction of complete automated systems.

The similarity between the graphical representation and real components then make it very simple for students to apply what they have learned when they are constructing real systems using the Automatics hardware solutions.

Automatics interactive courseware is compatible with all versions of Windows and has very modest PC requirements. It is available with an educational site licence.

### Learning objectives / experiments:

- Single and double acting cylinders
- Three port valves, valve actuators, flow control valves, five port valves, pilot-operated five port valves
- Piston speed control with flow control valves
- Semi-automatic return circuits, automatic return circuits and applications
- Reservoirs, time delays and applications, diaphragm valves, pressure decay sensing
- AND and OR functions
- Sequential circuits and applications, cascade method
- Electrical control of pneumatics with solenoid valves, switches, toggle switches, microswitches, reed switches, and computer control
- Circuit diagrams and circuit symbols
- Force exerted by a cylinder and calculations
- Instroke and outstroke forces and calculations
- Construction of pneumatic and electropneumatic systems

### Curriculum mapping

- Suitable for much of unit 24 of the BTEC First award in Engineering : Operation and maintenance of fluid power systems and components.

**Ordering information**

| | |
|---|---|
| Automatics interactive courseware site licence | AW20780 |


For a list of included components, search for the product code at www.matrixtsl.com and click on the resources tab

## Mechatronic systems

This pack contains products from three of our ranges of equipment: Locktronics, E-blocks and Automatics. The pack includes a wide variety of resources suitable for studying mechatronics using three types of control system: a PIC microcontroller, a micro PLC, and a PC. Students can learn the basics of control using flow charts before progressing to other languages like C++ or LabView software (C++ and LabView not included). A wide range of curriculum is included in the packs covering Industrial sense and control, flow chart programming of microcontrollers, Industrial sense and control with C++ or LabView programming, and design of pneumatic control systems. Further curriculum options for programming in C or Assembly are available.

### Learning objectives / experiments:

- PIC and controller programming using flow charts
- Programming options: Flowcode, Embedded C, Assembly, C++ or LabView
- Mathematical models of sensors
- PID control of DC motors with speed and position (2nd order)
- Sensors: thermistor, light, thermocouple, rotary, Gyroscope, Hall effect, PIR, Cap touch, Magnetometer, Ultrasonic, Colour
- Actuators: relays, stepper motors, DC motors with feedback, servo motors

### Curriculum mapping

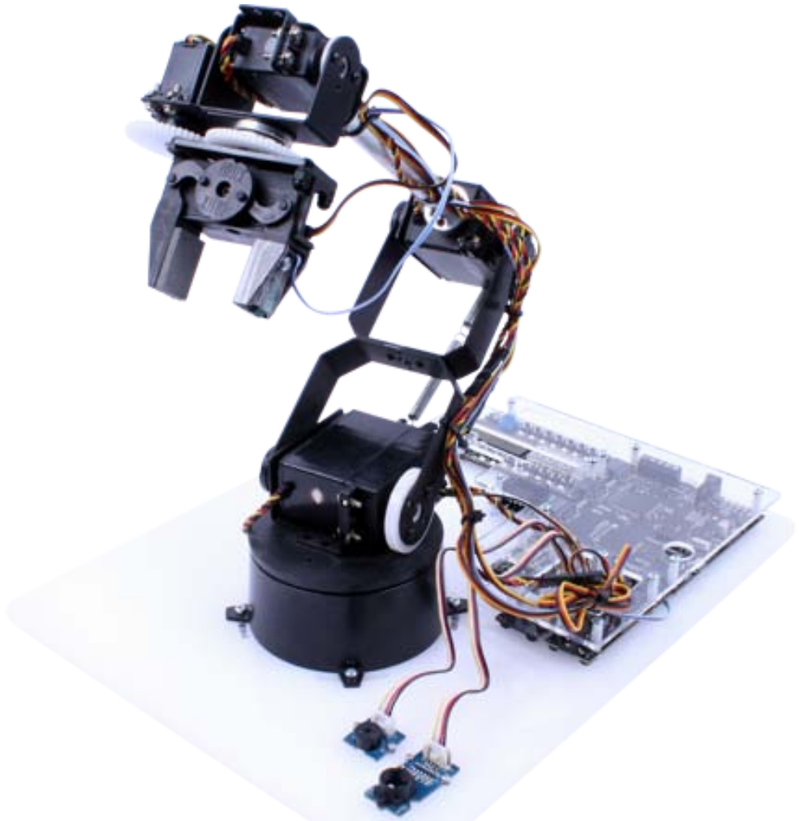
- Suitable for unit 6 of BTEC Higher National: Mechatronics
- Suitable for AQA Tech-level in Engineering: Mechatronics
- Suitable for OCR Cambridge Technicals in Engineering at Level 3

**Ordering information**

| | |
|---|---|
| Mechatronic systems | HP4550 |
| Corresponding curriculum | LK8739, AW2080, AW4956, WS0247 |

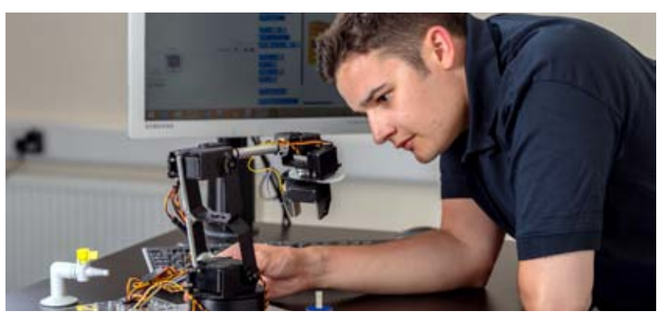



Automation / Robotics / Mechatronics



## AllCode robot arm production cell

Our robot arm production cell consists of a rugged servo controlled 6 degrees of freedom arm bolted to a base plate and a mat that provides a range of exercises mimicking industrial robot arm production cells. The arm itself delivers accurate and repeatable movement with base rotation, single plane shoulder, elbow, wrist motion, a functional gripper, and a wrist rotator. The arm is controlled by a dsPIC microcontroller with combo board (16 switches, 16 LEDs, 2 line 16 character LCD, quad 7-seg display and sensors), colour sensor board and Bluetooth board from our E-blocks range. The board can be programmed directly from Flowcode for dsPIC, or Microchip's MPLAB. A full Flowcode simulation is available free of charge. The control system is also shipped with a full Application Program Interface so that the robot can be controlled using any Bluetooth enabled device such as a PC, Android, or Apple MAC device using a range of software applications including C++, LabView, Python, and App Inventor as well as remote applications over the web. The kit is supplied with a number of coloured counters which can be moved by the arm into different locations in the work cell. A teacher's guide is available for download from our web site.



### Learning objectives / experiments:

- Robot cell design and programming
- Microcontroller programming
- Sensors and actuators in robotics
- Kinematics: 3D movement in robotic systems
- Web based control
- Programming in many languages

### Curriculum mapping:

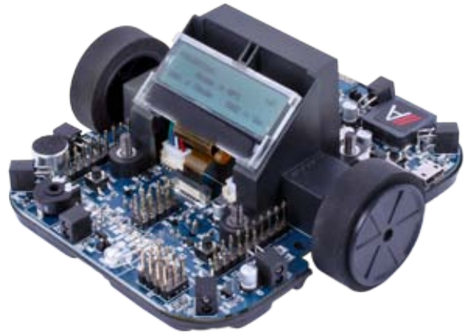
- Suitable for unit 6 of the BTEC National: Microcontroller systems for engineers
- Suitable for unit 15 of BTEC Higher National: Automation, robotics and PLCs
- Suitable for unit 38 of the BTEC National: Web site production to control devices

**Ordering information**

| | |
|---|---|
| AllCode robot arm production cell | RB6231 |
| Corresponding curriculum | CP8656 |







See Formula AllCode section for full details

## Curriculum mapping

- Suitable for unit 6 of the BTEC National: Microcontroller systems for engineers
- Suitable for unit 15 of BTEC Higher National: Automation, robotics and PLCs
- Suitable for various City & Guilds qualifications at Level 2 and beyond

## Introduction to Robotics

This training solution provides a course in robotics with a sequence of staged exercises including line following and maze solving. The course makes use of the high-specification Formula AllCode robot which can be programmed with a number of languages on various operating systems including Flowcode, App Inventor, Python and LabView. This is great for introducing students to programming and robotics in a fun and motivating way with huge scope for further work and competitions. The solutions are supplied with a large double-sided task mat and a set of maze walls.

### Learning objectives / experiments:

- Microcontroller programming and robotics
- Programming concepts: input, system, output, loops, decision, subroutine, go to, calculations, delays, simple variables, A/D conversion
- Robotic components: switches, LEDs, light sensors, distance sensors, infrared sensors, audio level sensors, speaker, motor drivers, motors and gearboxes
- Robotic tactics including logo-like commands, power control, motion control and steering, motor characterisation, obstacle avoidance
- Progressive exercises include: light following, line following, song and dance, time trials, races, simple maze solving, creating custom mechanics

**Ordering information**

| | |
|---|---|
| Formula AllCode deluxe kit | RB7971 |
| Formula AllCode standard class set | RB7240 |
| Formula AllCode deluxe class set | RB7518 |
| Corresponding curriculum | CP5894 |

## Learning objectives / experiments:

- Programming mobile phones
- Football algorithm development

## Curriculum mapping

- Suitable for technology or computer science syllabuses.

## Formula AllCode football mat add-on

This football pitch is an add-on pack for our Formula Allcode which allows you to run football competitions to motivate and challenge your students. The pitch consists of a number of plastic walls that screw together to form the goals and corners, and a printed mat that goes underneath the walls. Ideally you would glue the mat to a plywood or MDF board. Two table tennis balls are included. Students are tasked with programming their mobile phones using App Inventor, or similar, to control their Allcode robots. Ideally 3 robots to a team.

*Note: This add-on requires the Formula AllCode maze walls which feature in the RB7971, RB7240, RB7518 and are also available separately (see below).*

**Ordering information**

| | |
|---|---|
| Formula AllCode football mat add-on | RB4938 |
| Maze walls | RB8962 |





Automation / Robotics / Mechatronics

# Manufacturing engineering

The heart of our manufacturing engineering range is based on our new MicroCNC range of machines. The concept of these low cost CNC machines is simple: allow students to individually get lots of practice in manufacturing on a lower specification CNC machine before they progress to a more advanced industrial or educational machine. The machines are low voltage, low power, safe, easy to store and low cost. But don't be fooled: they are programmed just like production CNC machines, and the hours students spend on them really prepares students for CNC manufacturing.

We have developed an impressive learning process for students in this section:

- First, students design their parts using familiar CAD packages such as Autodesk, Solidworks or other software.
- Then, students take their designs to Deskproto or CamBam software (supplied by us), and use one of our MicroCNC machines alongside a Windows based G code editor to manufacture real parts.

This lower cost route to teaching design and manufacture using CNC technology gives students a great introduction to the principles of manufacturing engineering.






## MicroCNC system controller and base plate

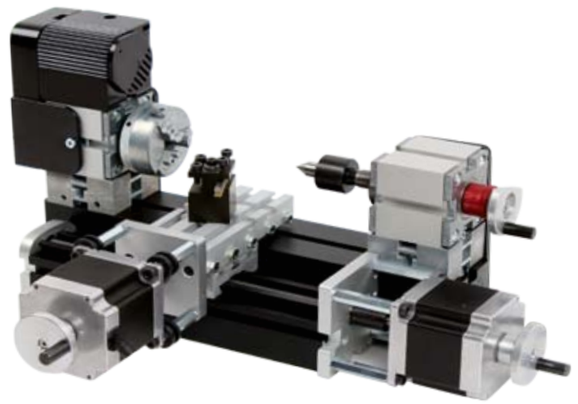
The MicroCNC system controller and base plate allows you to control our MicroCNC machines using a variety of software packages. The CNC system controller is compatible with our range of multi axis CNC machines. The base plate includes all power supplies and an industrial standard computer with stepper motor driver circuitry and a USB port for connection to your PC. The unit is fitted with a single IEC mains connector and includes a number of output sockets for the stepper motors of the CNC machines.

The individual machine components are easily fastened to the base plate, providing a solid and tidy machine which can easily be put away for storage. Windows compatible.

**Ordering information**

| | |
|---|---|
| MicroCNC system controller and base plate | CN4079 |

## 2-axis MicroCNC lathe



The 2-axis MicroCNC lathe allows students to understand how G codes are used to control a CNC lathe. The two stepper motors and DC motor connect to our CNC system controller hardware to allow full control of the lathe using the G code file host software. Students can use the hardware and lathe to see how each G code command affects the lathe operation and they can create complex work pieces from wax cylinders.

This kit is stored in our standard plastic storage tray and can be assembled in minutes.

### Learning objectives / experiments:

- Lathe construction and operation
- Simple G and M code protocol
- CNC machine operation using G codes
- Creation of milled parts using CNC technology

*Supplied as a kit which needs modest assembly.*
*You will also need: MicroCNC system controller and base plate*


### Curriculum mapping

- Suitable for unit 23 of BTEC Higher National: CAD/CAM
- Suitable for unit 43 of the BTEC National award in Engineering : Manufacturing CNC machine processes
- Suitable for various City & Guilds qualifications at Level 2 and beyond

**Ordering information**

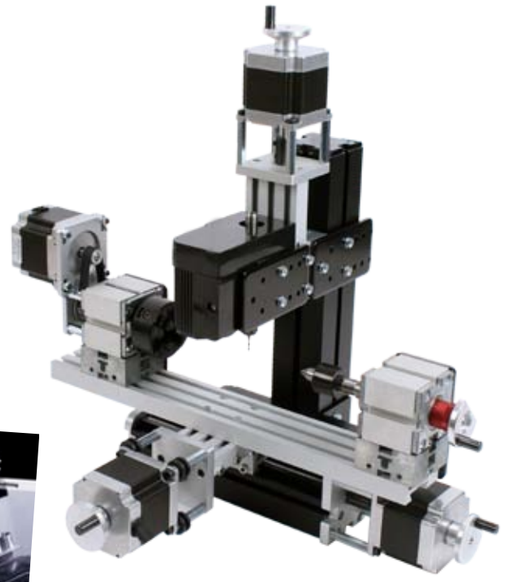
| | |
|---|---|
| 2-axis MicroCNC lathe | CN2668 |
| MicroCNC system controller and base plate | CN4079 |
| Corresponding curriculum | CP7449 |

**You will also need**

| | |
|---|---|
| CamBam software | CN8332/ CN2171 |


## Curriculum mapping

- Suitable for unit 23 of BTEC Higher National: CAD/CAM
- Suitable for unit 43 of the BTEC National award in Engineering : Manufacturing CNC machine processes
- Suitable for various City & Guilds qualifications at Level 2 and beyond




## Curriculum mapping

- Suitable for unit 23 of BTEC Higher National: CAD/CAM
- Suitable for unit 43 of the BTEC National award in Engineering : Manufacturing CNC machine processes
- Suitable for various City & Guilds qualifications at Level 2 and beyond

## 3-axis MicroCNC milling machine

The 3-axis MicroCNC milling machine allows students to understand how G codes are used to control a CNC operated milling machine. The three stepper motors and DC  motor connect to our CNC system controller hardware to allow full control of the miller using the G code file host software. Students can use the hardware and software to see how each G code command affects the machine operation and create complex work pieces from polyurethane blocks or acrylic pieces.

### Learning objectives / experiments:

- 3-axis CNC machine construction
- Simple G and M code protocol
- CNC machine operation using G codes
- Creation of milled parts using CNC technology

*You will also need: MicroCNC system controller and base plate*

### Ordering information

| | |
|---|---|
| 3-axis MicroCNC milling machine | CN4234 |
| MicroCNC system controller and base plate | CN4079 |
| Corresponding curriculum | CP7449 |

### You will also need

| | |
|---|---|
| Deskproto CAM software | CN2498/ CN3075 |

## 4-axis MicroCNC milling machine

The 4-axis MicroCNC milling machine allows students to understand how G codes are used to control a CNC operated milling machine. The four stepper motors and DC motor connect to our CNC system controller hardware to allow full control of the miller using the G code file host software. Students can use the hardware and software to see how each G code command affects the machine operation and create complex work pieces from polyurethane blocks or acrylic pieces.

### Learning objectives / experiments:

- 4-axis CNC machine construction
- Simple G and M code protocol
- CNC machine operation using G codes
- Creation of milled parts using CNC technology

*Supplied as a kit which needs modest assembly.*
*You will also need: MicroCNC system controller and base plate.*

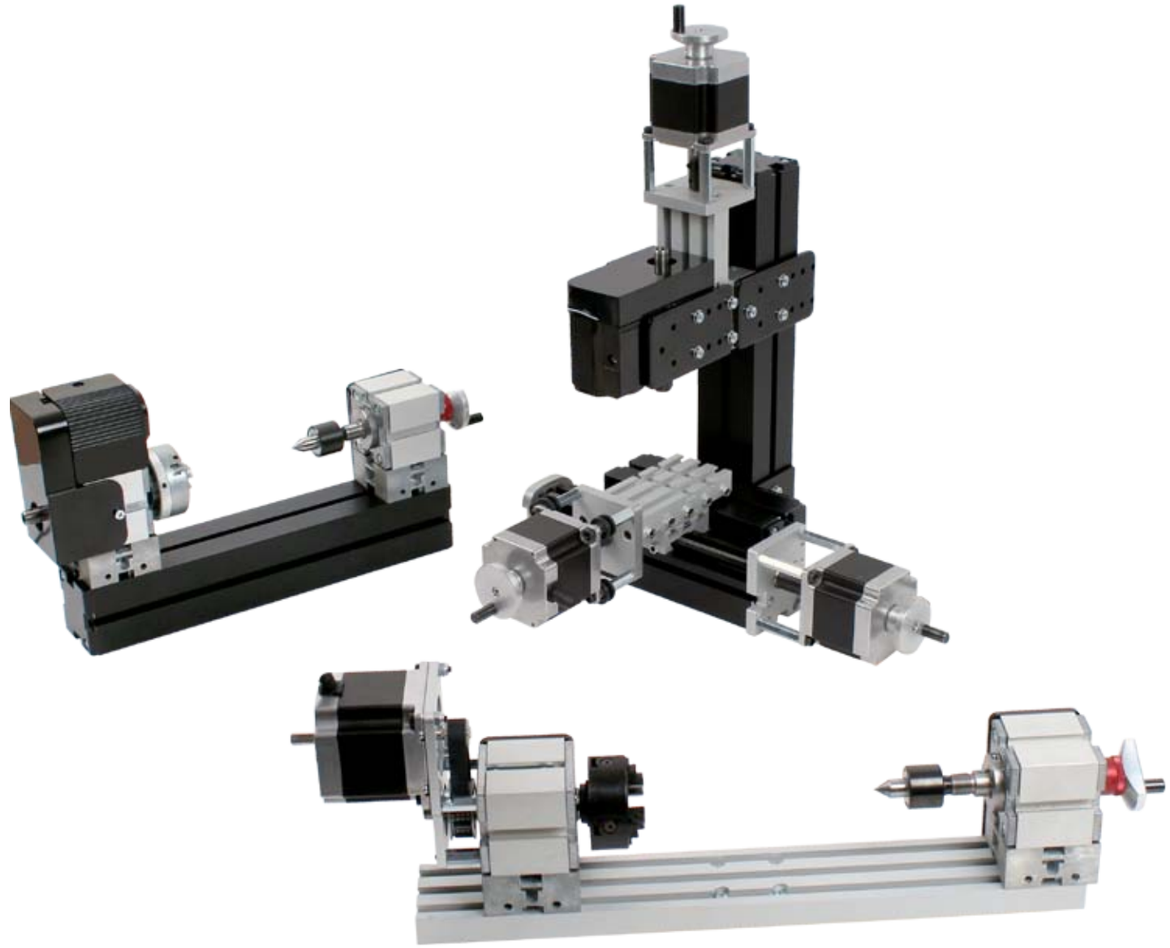
### Ordering information

| | |
|---|---|
| 4-axis MicroCNC milling machine | CN8285 |
| MicroCNC system controller and base plate | CN4079 |
| Corresponding curriculum | CP7449 |

### You will also need

| | |
|---|---|
| Deskproto CAM software | CN2498/ CN3075 |



## Complete MicroCNC set

This kit of parts allows students to assembly all four of our MicroCNC machines (only one at any one time). The kit is supplied with all necessary parts and is shipped with a full manual describing how each machine can be assembled. When combined with our system controller and base plate, students can then program each machine to manufacture parts in wax, acrylic and polyurethane blocks using G code editor supplier.

### Learning objectives / experiments:

- Construction of a range of CNC machines
- G and M code commands and CNC programming
- Manufacturing a part using a G code editor
- Design of parts using a 3D package
- Manufacture of parts using a CAD CAM tool chain

*You will also need the MicroCNC system controller and base plate*

## Curriculum mapping

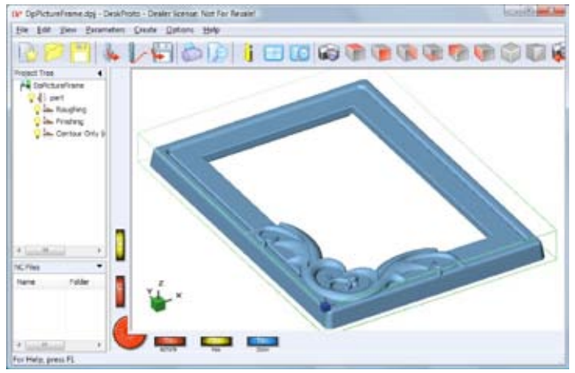
- Suitable for unit 23 of BTEC Higher National: CAD/CAM
- Suitable for unit 43 of the BTEC National award in Engineering : Manufacturing CNC machine processes
- Suitable for various City & Guilds qualifications at Level 2 and beyond


### Ordering information

| | |
|---|---|
| Complete MicroCNC set | CN3885 |
| MicroCNC system controller and base plate | CN4079 |
| Corresponding curriculum | CP7449 |

### You will also need

| | |
|---|---|
| Deskproto CAM software | CN2498/ CN3075 |
| CamBam software | CN8332/ CN2171 |



## Deskproto CAM software

Whilst our CAD/CAM simulation software can produce G code files from very simple shapes, the Deskproto software takes this function to the next level. Deskproto can import STL files from any 3D CAD program, calculate CNC toolpaths and then write a G code program file for any brand of CNC milling machine - 3-axis, 4-axis or 5-axis. Deskproto is used by a wide variety of industrial companies as well as educational institutions.

This software is compatible with Solidworks, AutoCAD and other CAD packages.

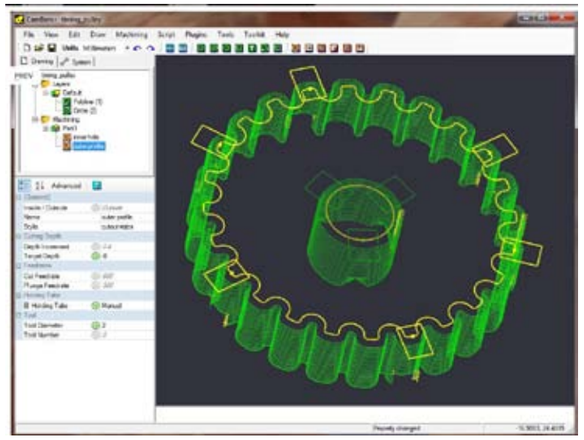
*Compatible with 3-axis milling machine, 4-axis milling machine and the complete MicroCNC set*

### Ordering information

| | |
|---|---|
| Deskproto single license | CN3075 |
| Deskproto site license | CN2498 |

## Curriculum mapping

- Unit 23 of BTEC Higher National: CAD/CAM
- Unit 40 of the BTEC National award in Engineering: Computer Aided Manufacturing
- Unit 43 of the BTEC National award in Engineering: Manufacturing CNC machines processes
- Suitable for various City & Guilds qualifications at Level 2 and beyond



## CamBam software

CamBam is an application to create CAM files, G code, from CAD source files or its own internal geometry editor and has many users worldwide from CNC hobbyists to professional machinists and engineers.

## CamBam currently supports:

- Reading from and writing to 2D DXF files
- 2.5D profiling machine operations with auto-tab support
- 2.5D pocketing operations with auto island detection
- Drilling (Normal, Peck, Spiral Milling and Custom Scripts)
- Engraving
- True Type Font (TTF) text manipulation and outline (glyph) extraction
- Conversion of bitmaps to heightmaps
- 3D geometry import from STL, 3DS and RAW files
- 3D surfacing operations
- Extendable through user written plugins and scripts

*Compatible with 2-axis lathe and the complete MicroCNC*

### Ordering information

| | |
|---|---|
| CamBam single license | CN8332 |
| CamBam site license | CN2171 |

## Curriculum mapping

- Unit 23 of BTEC Higher National: CAD/CAM
- Unit 40 of the BTEC National award in Engineering: Computer Aided Manufacturing
- Unit 43 of the BTEC National award in Engineering: Manufacturing CNC machines processes
- Suitable for various City & Guilds qualifications at Level 2 and beyond






## Learning objectives / experiments:

- Understanding the different varieties of valves and where each is appropriate in a system
- Understanding the basic types of cylinder, controlling speed and the factors that influence power output
- Combining valves to produce logic functions
- Semi-automatic and automatic reciprocation
- Creating sequences of movements
- Using reservoirs to create time delays
- Air bleed and pilot operated circuits
- Component symbols and circuit diagrams
- Staying safe when using air at high pressure

## Curriculum mapping

- Suitable for unit 12 of the BTEC national: Pneumatic and hydraulic systems
- Suitable for unit 29 of BTEC Higher National: Electro, pneumatic and hydraulic systems

## Automatics essentials solution

This kit provides a complete introduction to pneumatic circuit design and construction. The curriculum pack includes a comprehensive set of worksheets that allow students to progress from first principles through to circuits of moderate complexity; including reciprocating circuits and generating sequences of movements.

The solution is intended for students in their early teens and older who are learning technology and engineering subjects. Tasks are designed to be suitable for pairs of students sharing a single kit.

Everything you will need to teach the course is included in the solution pack, with the exception of an air compressor.

### Ordering information

| | |
|---|---|
| Automatics essentials solution | AU9020 |
| Corresponding curriculum | AW2080 |

### You may also need

| | |
|---|---|
| Compressor | AU1050 |

For a list of included components, search for the product code at www.matrixtsl.com and click on the resources tab

## Electro-pneumatics add-on kit

This kit supplements the Automatics essentials solution by adding a selection of electrically operated valves and a range of sensors. By following the curriculum, students will learn how to use these new components to create systems in which pneumatics and electrical circuits are combined into complete systems.

The electrical components are connected together quickly and reliably using 4mm connectors, for which all of the necessary leads and accessories are provided. Electrical components are robustly mounted to the Automatics platform using the same 'tee' bolt system used for the pneumatic parts and are printed with standard circuit symbols.

Working two to a kit, students follow the detailed worksheets to gain a comprehensive understanding of electro-pneumatics. By the end of the course, students will be able to create reciprocating and sequential circuits, and will have an understanding of how these are used to solve real world engineering problems.

## Learning objectives / experiments:


- Understand the operation of electrically controlled pneumatic valves
- Use of electrical switching to control circuit operation
- Using microswitches to sense cylinder position
- Sensing position without physical contact using reed switches
- Expressing electrical circuits using ladder diagrams
- Electrically operated reciprocal circuits
- Sequential control circuits
- Analysing real world problems and formulating solutions

## Curriculum mapping

- Suitable for unit 12 of the BTEC national: Pneumatic and hydraulic systems
- Suitable for unit 29 of BTEC Higher National: Electro, pneumatic and hydraulic systems

### Ordering information

| | |
|---|---|
| Electro-pneumatics add-on kit | AU9015 |
| Corresponding curriculum | AW2079 |

For a list of included components, search for the product code at www.matrixtsl.com and click on the resources tab

Also available with Rpi MIAC and Arduino MIAC

## Learning objectives / experiments:


- Reading sensors and switches
- Issuing commands to the pneumatic circuits
- Learning the difference between digital and analogue signals
- Using flowcharts to visualise programs
- Program flow and decision making
- Programming sequences
- Using feedback to enhance reliability and improve safety

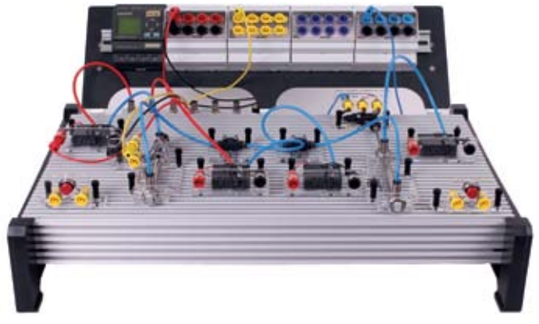
For a list of included components, search for the product code at www.matrixtsl.com and click on the resources tab

## Curriculum mapping

- Suitable for unit 12 of the BTEC national: Pneumatic and hydraulic systems
- Suitable for unit 29 of BTEC Higher National: Electro, pneumatic and hydraulic systems

Control add-on pack with 12 or 24V compatibility now available

Works with Siemens S7, Mitsubishi, Omron or any standard PLC which fits onto a 50 mm DIN rail







For a list of included components, search for the product code at www.matrixtsl.com and click on the resources tab

## Curriculum mapping

- Suitable for unit 29 of BTEC Higher National: Electro, pneumatic and hydraulic systems
- Unit 36 of the BTEC National: Programmable logic controllers

# Pneumatics control add-on kit

This kit extends your Automatics pneumatics solution by adding a powerful programmable microcontroller unit, the MIAC, together with the pneumatic components necessary to put it through its paces.

By following the included curriculum, students will learn how the combination of a controller and custom software can create powerful and flexible pneumatic systems.

Students will learn how to establish the state of a pneumatic machine using sensors, the use of logic to process that data and the issuing of commands to the included solenoid valves.

Two versions of the curriculum are supplied. In the first, students use pre-programmed control systems supplied in the MIAC's built in memory. A more advanced course, Control plus, teaches students how to write their own programs for the controller.

This kit can also be supplied without the MIAC PLC, for those who wish to integrate their own industrial PLC into our system. Please see ordering information below, the product at the bottom of the page, or contact us for more information.

### Ordering information

| | |
|---|---|
| Automatics control add-on kit (12V) with MIAC | AU9010 |
| Automatics control add-on kit (24V) no MIAC | AU9030 |
| Corresponding curriculum | AW4956, AW4957 |

### You may also need

| | |
|---|---|
| Automatics essentials solution | AU9020 |
| Flowcode | |

# Pneumatics with your own PLC

We are now able to supply pneumatics training equipment which can be used with any PLC with the Automatics PLC adaptor rail. The Adaptor rail allows students to connect to relay and motor outputs using standard 4mm connectors which connect directly to other Automatics components. This pack combines standard pneumatics components with Control pneumatics components to provide a complete learning platform for pneumatics and PLC programming in one package. A PLC is not included. Any programming language - including ladder logic - can be used. Worksheets are based on flow charts. PLC adaptor modules included: power distribution, inputs (8), motor outputs (8), relays (4).

## Learning objectives / experiments:

- Pneumatic components, circuits and circuit diagrams
- Sensors and switches in pneumatic systems
- Digital and analogue signals
- PLC programming with ladder logic or block diagrams
- PLC inputs and outputs
- Logic functions

### Ordering information

| | |
|---|---|
| PLC Adaptor - input module | HP6700 |
| PLC Adaptor - power module | HP6711 |
| PLC Adaptor - motor module | HP6723 |
| PLC Adaptor - relay module | HP6752 |
| PLC adaptor - mounting bracket | HP6785 |

### You may also need

| | |
|---|---|
| Automatics essential solution | AU9020 |
| Automatics control add-on kit (24V) no MIAC | AU9030 |


COMING SOON

# Pneumatics control with S7-1200 Siemens PLC add-on

This kit can be added to the Automatics essentials solution to produce learning outcomes for those wishing to study about rugged, industrial PLCs. By following the provided curriculum, students will learn how the combination of a rugged Siemens industrial controller and related software can create powerful and flexible pneumatic systems. Students will learn how to establish the state of a pneumatic machine using sensors, the use of logic to process that data and the issuing of commands to the included solenoid valves.

Two versions of the curriculum are supplied. In the first, students use pre-programmed control systems supplied in the Siemens S7-1200's built in memory. A more advanced course, Control plus, teaches students how to write their own programs for the PLC.

## Learning objectives / experiments:

- Reading sensors and switches
- Issuing commands to the pneumatic circuits
- Learning the difference between digital and analogue signals
- Using flowcharts to visualise programs
- Program flow and decision making
- Programming sequences
- Programming industrially rugged programmable logic controllers PLC
- Using feedback to enhance reliability and improve safety

SIEMENS



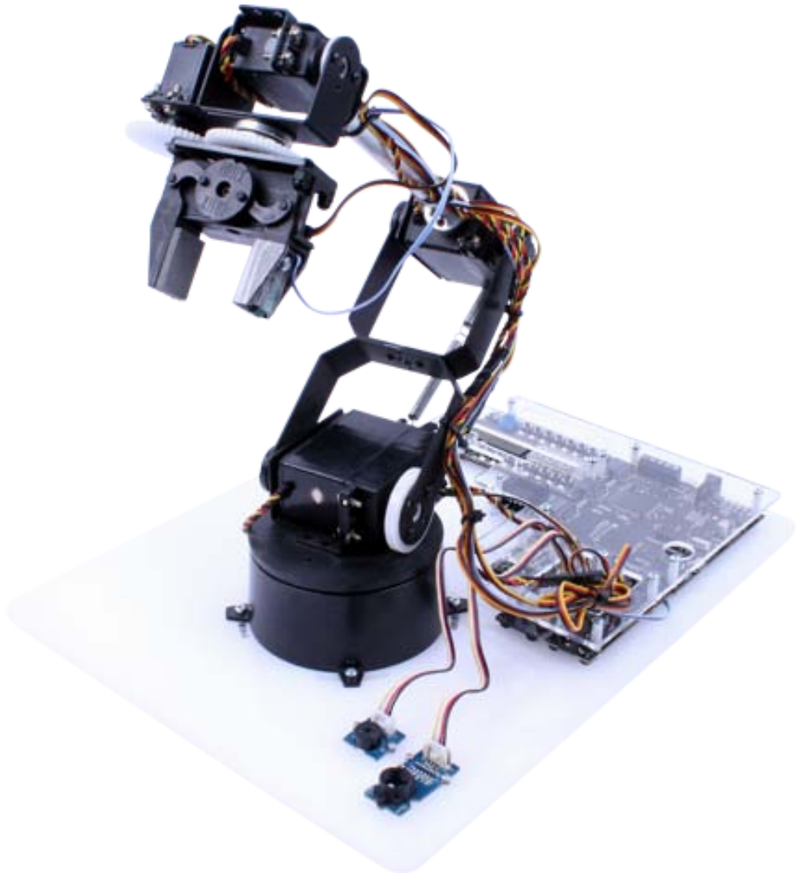


## Curriculum mapping

- Suitable for unit 12 of the BTEC national: Pneumatic and hydraulic systems
- Suitable for unit 29 of BTEC Higher National: Electro, pneumatic and hydraulic systems
- Unit 36 of the BTEC National: Programmable logic controllers

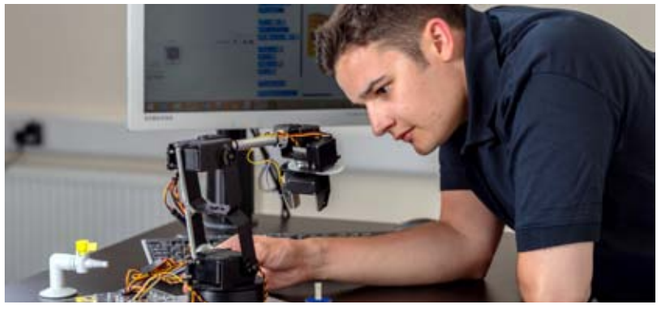
### Ordering information

| | |
|---|---|
| Pneumatics control with S7-1200 Siemens PLC add-on | AU9077 |



## AllCode robot arm production cell

Our robot arm production cell consists of a rugged servo controlled 6 degrees of freedom arm bolted to a base plate and a mat that provides a range of exercises mimicking industrial robot arm production cells. The arm itself delivers accurate and repeatable movement with base rotation, single plane shoulder, elbow, wrist motion, a functional gripper, and a wrist rotator. The arm is controlled by a dsPIC microcontroller with combo board (16 switches, 16 LEDs, 2 line 16 character LCD, quad 7-seg display and sensors), colour sensor board and Bluetooth board from our E-blocks range. The board can be programmed directly from Flowcode for dsPIC, or Microchip's MPLAB. A full Flowcode simulation is available free of charge. The control system is also shipped with a full Application Program Interface so that the robot can be controlled using any Bluetooth enabled device such as a PC, Android, or Apple MAC device using a range of software applications including C++, LabView, Python, and App Inventor as well as remote applications over the web. The kit is supplied with a number of coloured counters which can be moved by the arm into different locations in the work cell. A teacher's guide is available for download from our web site.



### Learning objectives / experiments:

- Robot cell design and programming
- Microcontroller programming
- Sensors and actuators in robotics
- Kinematics: 3D movement in robotic systems
- Web based control
- Programming in many languages

### Curriculum mapping:

- Suitable for unit 6 of the BTEC National: Microcontroller systems for engineers
- Suitable for unit 15 of BTEC Higher National: Automation, robotics and PLCs
- Suitable for unit 38 of the BTEC National: Web site production to control devices

**Ordering information**

| | |
|---|---|
| AllCode robot arm production cell | RB6231 |
| Corresponding curriculum | CP8656 |





Manufacturing Engineering

EM ELECTRICAL MACHINES

NEW

## Modern electrical machines system

This new solution is an intuitive and exciting way for students to explore the characteristics of electrical machines, in the form of electric motors and generators, which form part of our everyday lives; from the motor in our smartphones, buzzing to indicate a 'silent' message to the generator in a nuclear power station feeding power into the national grid for all our household appliances.

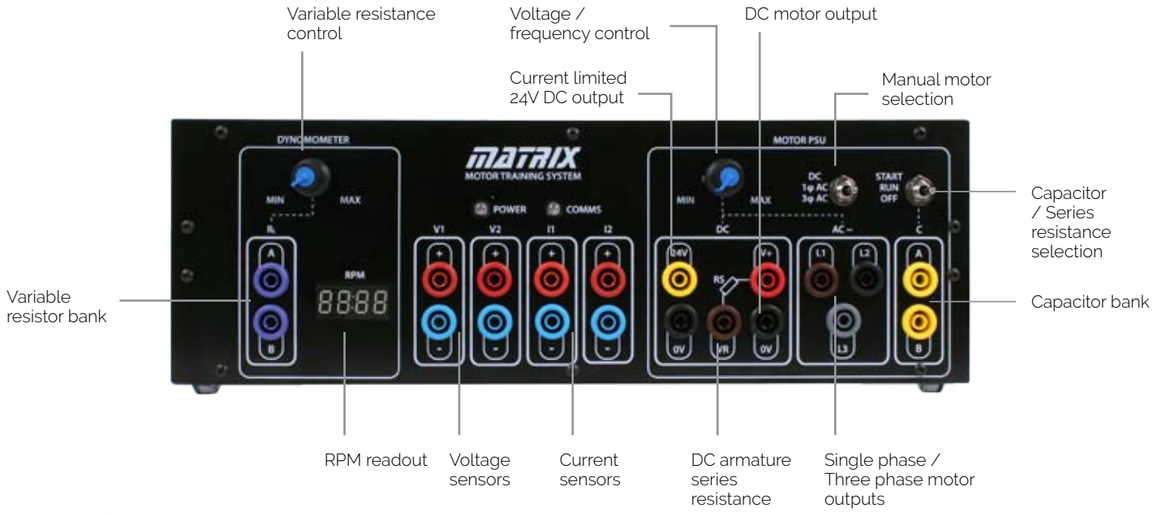
The equipment can be controlled either using manual controls on the control box or by using a set of PC-based applications. *Please note, manual control requires the use of separate voltage and current meters.*

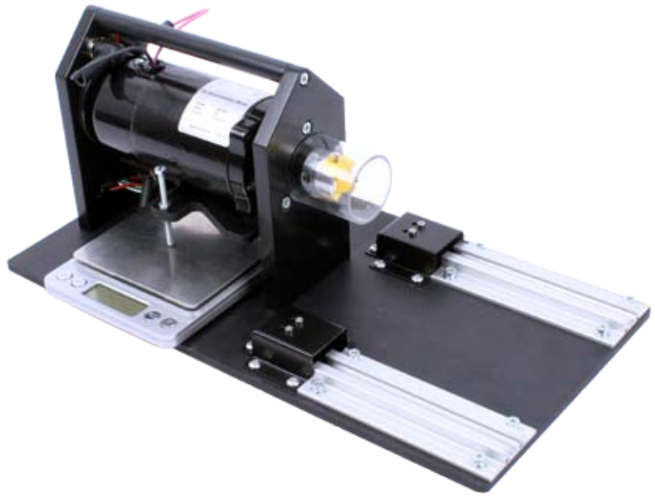
To succeed in the study of this course, students should have previously studied (or should be currently studying) BTEC Level 3, Unit 1 (Engineering Principles) or should have equivalent knowledge at Level 2. A good grounding in GCSE level mathematics and science (Physics) is also desirable.

A full student manual is included, and equipment is supplied in our standard storage trays.

### Learning objectives / experiments:

- How to safely operate electrical machines.
- The function and operation of test meters and the dynamometer.
- How to determine current, voltage and power in DC, single phase AC and three phase AC circuits.
- How to measure torque, power output and efficiency of an electrical machine.
- The operation of DC motors and generators.
- The control of DC motors and generators.
- The operation of single-phase AC machines.
- The operation of the universal motor.
- The operation of a brushless motor.
- How to calculate the synchronous speed and slip on a single-phase AC motor.
- The operation of three phase AC induction motors.
- Speed control of a three phase AC induction motor using variable frequency drives.
- The operation of three phase AC permanent magnet generators (PMGs).
- The difference between real power, apparent power and reactive power and why power factor is important.
- How to calculate the efficiency of a system.
- Evaluate three phase electrical machines connected in 3-wire star and 3 wire delta configurations.



The system includes DC, AC, Three Phase and Brushless motor types as well as swinging-arm dynamometer and cradle (see above).


Above: The machines can be controlled manually, using the control box provided or through a PC based environment. Different panels are used, dependent on the motor type being studied.

## Curriculum mapping

- Unit 15 of the BTEC National award in Engineering: Electrical machines
- Unit 31 of BTEC Higher National: Electrical systems and fault finding
- Unit 21 of BTEC Higher National: Electrical machines
- Unit 43 of BTEC Higher National: Further machines and drives
- Unit 45 of BTEC Higher National: Industrial systems
- Unit 15 of the BTEC National award in Engineering: Electrical machines
- Unit 31 of BTEC Higher National: Electrical systems and fault finding
- Unit 21 of BTEC Higher National: Electrical machines
- Unit 43 of BTEC Higher National: Further machines and drives
- Unit 45 of BTEC Higher National: Industrial systems

**Ordering information**

| | |
|---|---|
| Modern electrical machines system | EM6637 |
| Corresponding curriculum | CP6490 |




# Aviation

In this section we introduce you to two kits that satisfy the requirements of Part 66 modules 3 and 4 of the European Aviation Safety Agency syllabus which is internationally recognised as the gold standard for training Aviation maintenance engineers.

*"We value the Locktronics equipment during the training of apprentices and engineers progressing down the route of EASA part 66 Maintenance Engineers Licence. They are invaluable as demonstration equipment on short courses and for apprentices conducting their own experiments, constructing circuits, testing and understanding electrics, electronics and digital techniques".*

Tony Russell, British Airways.

## Our learning solutions:

- Are designed around the requirements of modules 3 and 4
- Include 8 sets of full colour PDF worksheets with thorough topic coverage and teacher's notes
- Meet RoHS compliancy
- Are rugged and durable to stand up to the rigours of technical labs
- Are supplied in rugged storage trays

## EASA electrical fundamentals (module 3)

This comprehensive solution is designed to fulfil the learning requirements of the European Safety Agency (EASA) module 3 - electrical fundamentals - for aircraft maintenance engineers. The solution contains all the Locktronics parts needed as well as 4 separate workbooks covering each of the sub-modules in the EASA specification.

| Ordering information | DIN | ANSI |
|---|---|---|
| EASA electrical fundamentals solution including storage trays, baseboard, DC (multinational) and AC (UK) power supplies. | LK9339 | LK9339A |
| Corresponding curriculum | LK7378, LK7381, LK7393 & LK7415 | |

**You will also need:**

| | | | |
|---|---|---|---|
| Multimeter pack | LK1110 | Picoscope | HP8279 |
| Signal generator | HP7894 | Source - DC PSU, AC PSU and signal generator | LK6999 / LK2975 |

For a list of included components, search for the product code at www.matrixtsl.com and click on the resources tab

## EASA electronic fundamentals (module 4)

This solution is designed to fulfil the learning requirements of the European Safety Agency (EASA) module 4 - electronic fundamentals - for aircraft maintenance engineers. The solution contains all the Locktronics parts needed including 4 separate workbooks covering each of the sub-modules in the EASA specification.

| Ordering information | DIN | ANSI |
|---|---|---|
| EASA electronic fundamentals solution including storage trays, baseboard, DC (multinational) and AC (UK) power supplies. | LK9282 | LK9282A |
| Corresponding curriculum | LK7419, LK7422, LK7426 & LK7430 | |

**You will also need:**

| | | | |
|---|---|---|---|
| Multimeter pack | LK1110 | Picoscope | HP8279 |
| Signal generator | HP7894 | Source - DC PSU, AC PSU and signal generator | LK6999 / LK2975 |

For a list of included components, search for the product code at www.matrixtsl.com and click on the resources tab



### Module 3 EASA Electrical fundamentals 1

- Series and parallel circuits
- Measuring voltage and current
- Cells and batteries
- Thermocouples
- Photocells
- Ohm's law

### Module 3 EASA Electrical fundamentals 2

- Resistors in series and in parallel
- Series/parallel networks
- Voltage and current dividers
- Kirchoff's laws
- Power in DC circuits
- Power transfer

### Module 3 EASA Electrical fundamentals 3

- Capacitors and electrostatics
- Inductors and inductance
- DC motors
- Generator principles
- Transformers and their construction
- Transformer losses

### Module 3 EASA Electrical fundamentals 4

- AC measurements
- Inductance and capacitance
- LR and CR series AC circuits
- LCR series AC circuits
- LR and CR parallel AC circuits
- LCR parallel AC circuits
- Q factor and bandwidth
- Low pass and high pass filters
- Band pass and band stop filters







## EASA electrical and electronic fundamentals (modules 3 and 4)

This comprehensive solution is designed to fulfil the learning requirements of the European Safety Agency (EASA) modules 3 and 4 for aircraft maintenance engineers. The solution contains all the Locktronics parts needed as well as 8 separate workbooks covering each of the sub-modules in the EASA module 3 and 4 specification.

For a complete list of parts in this solution please contact us.

| Ordering information | DIN | ANSI |
|---|---|---|
| EASA electronic fundamentals solution including storage trays, baseboard, DC (multinational) and AC (UK) power supplies. | LK9672 | LK9672A |

For a list of included components, search for the product code at www.matrixtsl.com and click on the resources tab

### Module 4 EASA Electronic fundamentals 1

- Diodes and diode types
- Full and half wave rectifiers
- Rectifier efficiency
- Reservoir capacitors
- Voltage multipliers
- Thyristor and SCR circuits
- Zener diodes and circuits
- LEDs in AC and DC circuits

### Module 4 EASA Electronic fundamentals 2

- NPN and PNP transistors
- Transistor characteristics
- Transistor bias and decoupling
- Common base, common emitter and common collector circuits
- Class A, B and C amplifiers
- Other transistor circuits

### Module 4 EASA Electronic fundamentals 3

- AND, OR, NAND, NOR and NOT gates
- Simple logic circuits
- Operational amplifiers
- Inverting and non-inverting amplifiers
- Integrator, differentiator, comparator
- Positive and negative feedback in amplifiers

### Module 4 EASA Electronic fundamentals 4

- Open and closed loop systems
- Analogue transducers
- Damping in feedback systems

# Automotive

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.

*"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.



## Curriculum mapping

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

# 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

| Ordering information | DIN | ANSI |
|---|---|---|
| Electricity, magnetism and materials solution | LK9071-2 | LK9071-2A |
| Corresponding curriculum | LK7325 & LK7326 | |

**You will also need:**

| | |
|---|---|
| Multimeter pack | LK1110 |

For a list of included components, search for the product code at www.matrixtsl.com and click on the resources tab

## Curriculum mapping

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

# 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

| 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 | | |

For a list of included components, search for the product code at www.matrixtsl.com and click on the resources tab





## Curriculum mapping

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

# 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

| 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 | | |

For a list of included components, search for the product code at www.matrixtsl.com and click on the resources tab

## Curriculum mapping

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

# 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

| Ordering information | DIN | ANSI |
|---|---|---|
| An Introduction to digital electronics. | LK4221 | LK4221A |
| Corresponding curriculum | LK9392 | |

**You will also need:**

| | |
|---|---|
| Multimeter pack | LK1110 |

For a list of included components, search for the product code at www.matrixtsl.com and click on the resources tab

For a list of included components, search for the product code at www.matrixtsl.com and click on the resources tab

## Curriculum mapping

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

# 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

**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 | | |

## Curriculum mapping

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

# 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

| 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 | |

For a list of included components, search for the product code at www.matrixtsl.com and click on the resources tab

# 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 | LK9893 | |

For a list of included components, search for the product code at www.matrixtsl.com and click on the resources tab



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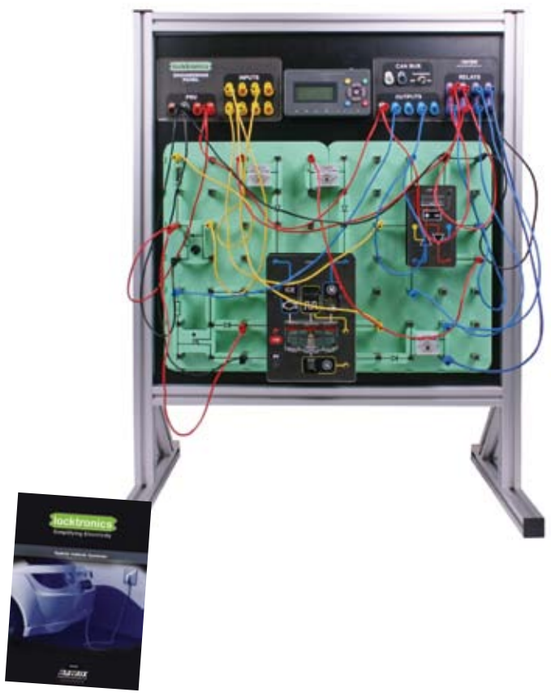
Automotive


## Curriculum mapping

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




## Curriculum mapping

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

## 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

| Ordering information | DIN | ANSI |
|---|---|---|
| CAN bus systems and operation solution with engineering panel | LK2839 | LK2839A |
| Corresponding curriculum | LK9893 | |

For a list of included components, search for the product code at www.matrixtsl.com and click on the resources tab

## 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:

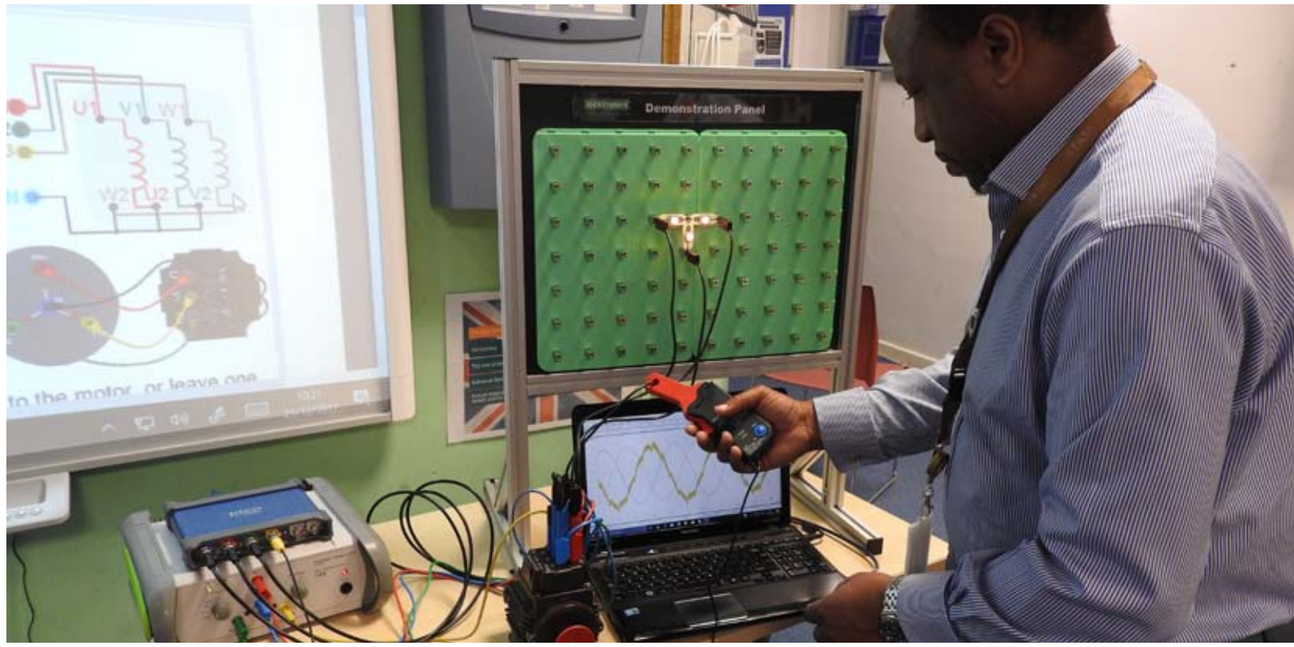
- Power modes in a series-parallel hybrid vehicle
- Regenerative braking
- Advantages of regenerative braking
- Factors affecting the acceleration of a vehicle
- Battery voltage, internal resistance, battery capacity, state of charge
- The role of the ECU in controlling the changes between power modes

| Ordering information | DIN | ANSI |
|---|---|---|
| Hybrid automotive principles on engineering panel | LK6483 | LK6483A |
| Corresponding curriculum | LK4483 | |

For a list of included components, search for the product code at www.matrixtsl.com and click on the resources tab

# Electrical Installation

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.




## 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



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


## Curriculum mapping

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

## Electrical installation level 1

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

### Ordering information

| | |
|---|---|
| Electrical installation level 1 | LK5000 |
| Corresponding curriculum | LK4098 |

### You may also need

| | |
|---|---|
| Multimeter | LK1110 |

For a list of included components, search for the product code at www.matrixtsl.com and click on the resources tab

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


## 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

## Electrical installation level 2

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

### Ordering information

| | |
|---|---|
| Electrical installation level 2 | LK4063 |
| Corresponding curriculum | CP8475 |

### You may also need

| | |
|---|---|
| Multimeter | LK1110 |

For a list of included components, search for the product code at www.matrixtsl.com and click on the resources tab





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


## Learning objectives / experiments:

- Understand three phase circuits and configurations
- Understand the principles of electrical machines
- Current and voltage phase shift in electrical systems
- Understanding and measuring energy and power
- Mechanical levers
- Faraday's law of electromagnetic induction

## Curriculum mapping

- Suitable for part of 8202 of the City and Guilds level 3 Diploma in Electrical Installation

## Level 2: Demonstration kit

This pack consists of some of the more expensive pieces of equipment that allow teachers to demonstrate selected principles of engineering science relevant to the Electrical installation courses. The equipment covers the principles of three phase supplies and three phase motors up to level 3, the principles of mechanical levers at level 2, the principles of energy and power measurement, current/voltage phase difference and Faraday's law. Part of the kit is a high specification four phase oscilloscope which is great as a white board tool for a large number of demonstrations of electrical theory – including three phase.

### Ordering information

| | |
|---|---|
| Three phase systems | LK4961 |
| Pico 4 phase oscilloscope | HP5834 |
| AC/DC current clamp | HP5561 |
| Moments kit with base unit | HP5010, HP5000 |
| Faraday's law apparatus | LK7489 |
| Energy meter (DC) | LK8591 |
| Locktronics demo panel | HP6320 |
| Lenz's law apparatus | LK7487 |

For a list of included components, search for the product code at www.matrixtsl.com and click on the resources tab

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

## 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.


### Ordering information

| | |
|---|---|
| Transformer construction and operation pack | LK1989 |
| Corresponding curriculum | CP1933 |

### You will also need

| | | | |
|---|---|---|---|
| Multimeter pack x2 | LK1110 | AC power supply (240V: 12V @5amps) | HP3728 |

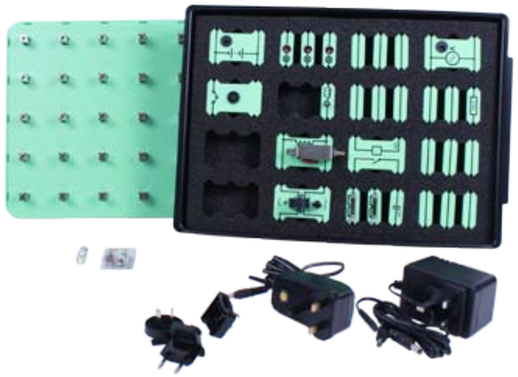
For a list of included components, search for the product code at www.matrixtsl.com and click on the resources tab

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


## Curriculum mapping

- Suitable for City and Guilds 8202 level 2

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




## Curriculum mapping:

- Suitable for City and Guilds 8202 level 3

## 8202 Level 2: 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

**Ordering information**

| | |
|---|---|
| 8202 level 2: Electronic components and circuits pack | LK2901 |
| Corresponding curriculum | CP2813 |

**You might also need**

| | |
|---|---|
| Multimeter | LK1110 |

For a list of included components, search for the product code at www.matrixtsl.com and click on the resources tab

## 8202 Level 3: 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.

### Learning objectives / experiments:

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

**Ordering information**

| | | | |
|---|---|---|---|
| 8202 level 3: Electrical installation circuit principles | LK4562 | | |
| Corresponding curriculum | CP0295 | | |

**You will also need**

| | | | |
|---|---|---|---|
| Multimeter | LK1110 | Signal generator | HP7894 |

For a list of included components, search for the product code at www.matrixtsl.com and click on the resources tab


EM ELECTRICAL MACHINES

NEW

## Modern electrical machines system

This new solution is an intuitive and exciting way for students to explore the characteristics of electrical machines, in the form of electric motors and generators, which form part of our everyday lives; from the motor in our smartphones, buzzing to indicate a 'silent' message to the generator in a nuclear power station feeding power into the national grid for all our household appliances.

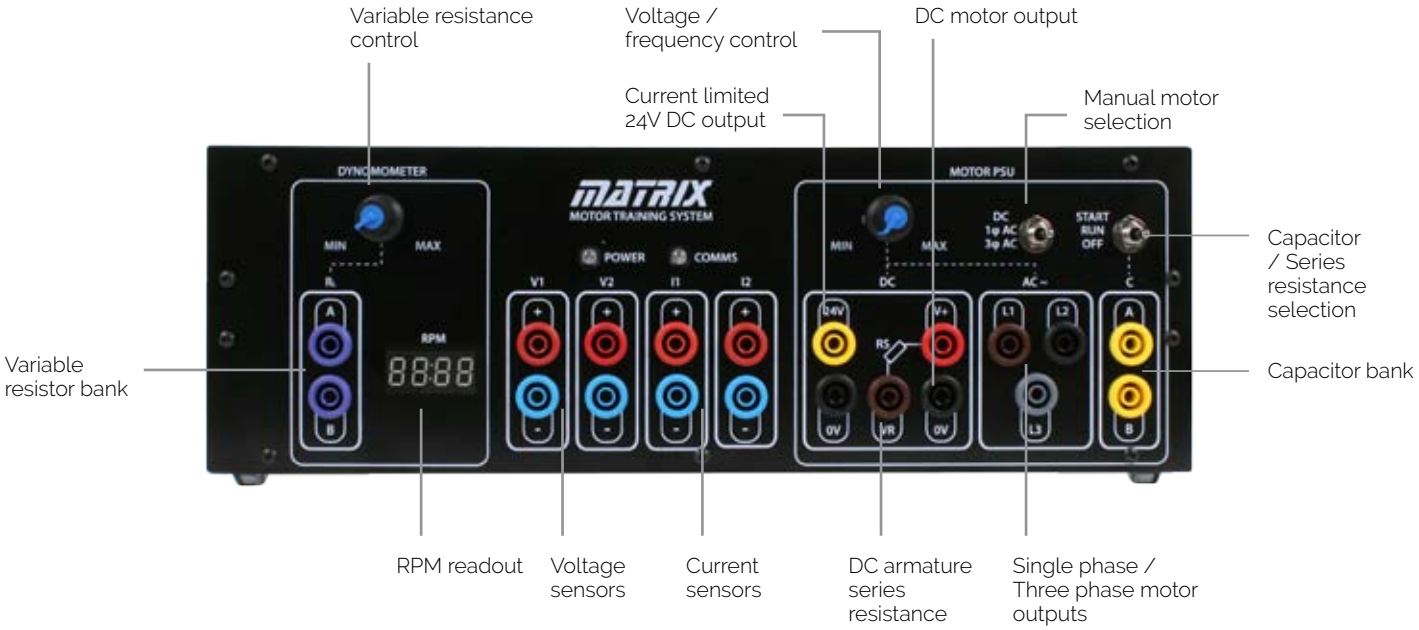
The equipment can be controlled either using manual controls on the control box or by using a set of PC-based applications. *Please note, manual control requires the use of separate voltage and current meters.*

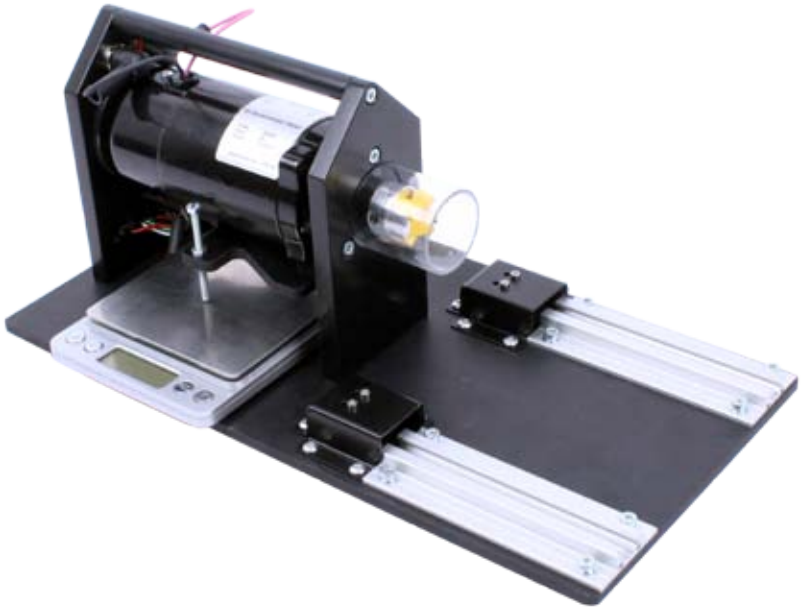
To succeed in the study of this course, students should have previously studied (or should be currently studying) BTEC Level 3, Unit 1 (Engineering Principles) or should have equivalent knowledge at Level 2. A good grounding in GCSE level mathematics and science (Physics) is also desirable.

A full student manual is included, and equipment is supplied in our standard storage trays.

### Learning objectives / experiments:

- How to safely operate electrical machines.
- The function and operation of test meters and the dynamometer.
- How to determine current, voltage and power in DC, single phase AC and three phase AC circuits.
- How to measure torque, power output and efficiency of an electrical machine.
- The operation of DC motors and generators.
- The control of DC motors and generators.
- The operation of single-phase AC machines.
- The operation of the universal motor.
- The operation of a brushless motor.
- How to calculate the synchronous speed and slip on a single-phase AC motor.
- The operation of three phase AC induction motors.
- Speed control of a three phase AC induction motor using variable frequency drives.
- The operation of three phase AC permanent magnet generators (PMGs).
- The difference between real power, apparent power and reactive power and why power factor is important.
- How to calculate the efficiency of a system.
- Evaluate three phase electrical machines connected in 3-wire star and 3 wire delta configurations.



The system includes DC, AC, Three Phase and Brushless motor types as well as swinging-arm dynamometer and cradle (see above).


Above: The machines can be controlled manually, using the control box provided or through a PC based environment. Different panels are used, dependent on the motor type being studied.

## Curriculum mapping

- Unit 15 of the BTEC National award in Engineering: Electrical machines
- Unit 31 of BTEC Higher National: Electrical systems and fault finding
- Unit 21 of BTEC Higher National: Electrical machines
- Unit 43 of BTEC Higher National: Further machines and drives
- Unit 45 of BTEC Higher National: Industrial systems
- Unit 15 of the BTEC National award in Engineering: Electrical machines
- Unit 31 of BTEC Higher National: Electrical systems and fault finding
- Unit 21 of BTEC Higher National: Electrical machines
- Unit 43 of BTEC Higher National: Further machines and drives
- Unit 45 of BTEC Higher National: Industrial systems

### Ordering information

| | |
|---|---|
| Modern electrical machines system | EM6637 |
| Corresponding curriculum | CP6490 |


FLOW
CODE

Brunel University London

*"I used Flowcode for the students in a module called "Embedded Systems Engineering" (MSc and MEng module). Some students have never used microcontrollers before and they were able to use Flowcode easily for basic microcontroller based embedded system design on a ping pong game.*

*The students moved on to use Flowcode for a project on Zigbee based wireless network system for environment monitoring. The project was very successful."*

Hongying Meng,
Brunel University, London.

UNIVERSITY OF LEEDS

*"As the Senior Electrical/Electronic Technician in the Faculty of Engineering, I find that using 'Flowcode' is an invaluable tool, to clearly convey the Embedded Code to be used in applications with Microchip's 18F4455 & 18F2455 (ECIO Modules). Previously, the School of Electrical & Electronic Engineering have introduced students to the 'Formula Flowcode' with the little robot vehicle at their command. The School of Mechanical Engineering students build their own buggy designs and I am confident a few incorporate 'Flowcode' Modules into their designs."*

Matthew Buckley,
Leeds University, UK.

Cambridge Regional College

*"At Cambridge Regional College we teach students from the BTEC level 2 up to HND. Flowcode has become an essential part of the coursework and fits in extremely well with the syllabus. Flowcode offers our students an overview of microcontroller systems and allows problematic thinking to evolve with microelectronic designs.*

*Using Flowcode allows advanced designs to be constructed from start to finish. Students can work at their own skill level and adopt personal project design.*

*The software is unique in the educational workspace and creates an almost limitless new learning environment.*

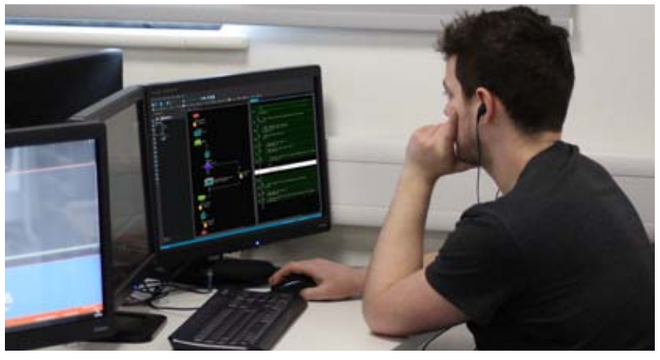
*There is so much creativity now available to our students that we can run a great deal of our classes using the program.*

*We believe the Flowcode experience is something students should all have access to for its designing and learning possibilities. The people at Matrix have created something truly amazing and Flowcode cannot be called anything other than a world class product."*

Steve Collins,
Cambridge Regional College

*"We have been using Flowcode and E-blocks in most of the electronics courses all over Flanders for the past 8 years. It's a great tool to put your first steps in embedded programming and it's also great to do the high level stuff like embedded webservers, Bluetooth and USB. The excellent and fast support of the Matrix team gives teachers the necessary confidence to take their projects to the next level."*

Bart Huyskens,
St.Jozefinstituut, Schoten, Belgium.







Flowcode 8

## Flowcode software allows you to develop complex electronic and electromechanical systems with ease.

Flowcode is an advanced integrated development environment (IDE) for electronic and electromechanical system development. Engineers - both professional and academic - use Flowcode to develop systems for control and measurement based on microcontrollers, computers, or on rugged industrial interfaces using Windows compatible personal computers.

Flowcode 8 is the latest version to be released and is packed full of exciting new features. Users can program Arduino, PIC, AVR and ARM MCU's that have been available in previous versions, but there is also the ability to control hardware running on a Raspberry Pi.

Furthermore, Flowcode 8 allows full simulation (including simulation of C code), with users also being able to convert C code to flowcharts and other programming languages.

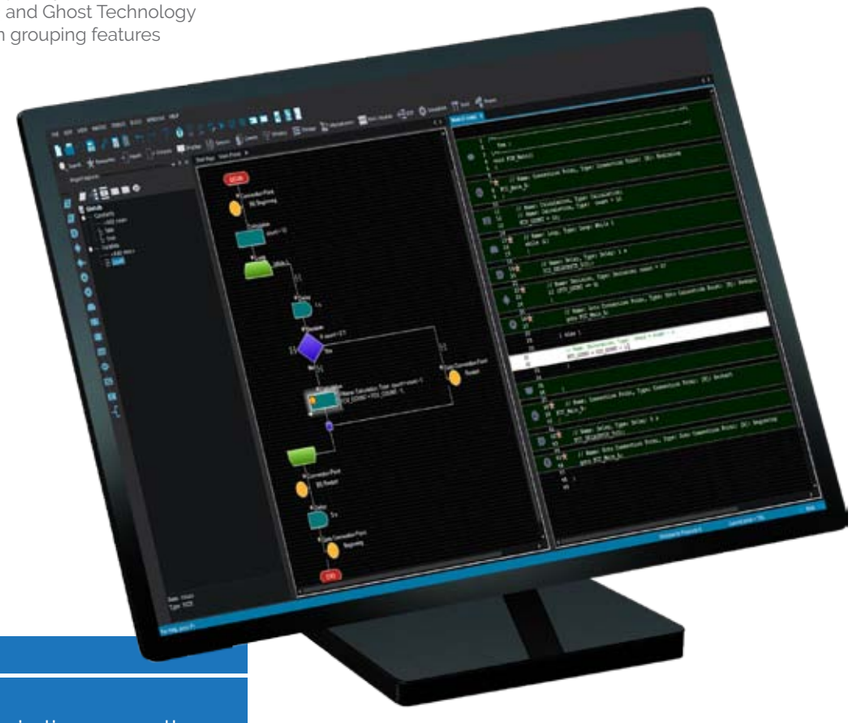
Other brand new features included the ability to Auto ID your E-blocks2 hardware, improved compatibility with Arduino hardware, to give a more streamlined and smooth approach to programming this popular family, and SCADA mode – meaning users can now control external hardware from their PC, using this impressive feature.

As with previous versions, a 2D and 3D graphical development interface allows users to construct a complete electronic system on-screen, develop a program based on standard flowcharts, simulate the system and then produce hex code for programming a range of devices including Arduino, Microchip's PIC MCU; 8-bit, 16-bit and 32-bit, as well as Atmel AVR, ARM and Raspberry Pi devices.

- Multiple programming languages means it's easy to use the language you are familair with
- Microcontroller flexibility - switch between multiple hardware platforms
- Advanced simulation - including compatibility with CAD packages including Solidworks
- Test & debugging - using built in data recorder and oscilloscope
- Enables development of comms based projects using built-in comms support for UART, Bluetooth, I2C, SPI etc.
- Open architecture - all aspects of Flowcode are fully customisable for your projects
- Fully supported - with online videos, courses, documentation and an active online community

## What's new in Flowcode 8?

- C code to flowchart converter and C code simulation
- Two new programming modes: "Blocks" and "Pseudocode"
- Auto ID your hardware
- SCADA mode
- Compatibility with Raspberry Pi
- Improved test, debug and Ghost Technology
- Code folding and icon grouping features



**Did you know?**

Flowcode academic licences allow your students FREE Flowcode licences for use at home

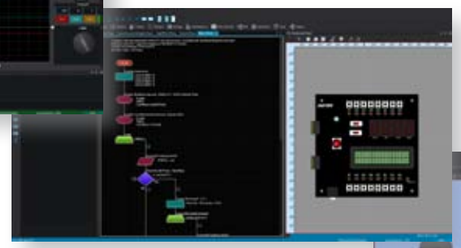
# What is FLOWCODE

## Test environment

- Full simulation capabilities
- In-Circuit-Test
- In-Circuit-Debugging
- Ghost Technology

## MCU programming

- 8, 16 and 32-bit PIC
- AVR
- Arduino
- 32-bit STM32 ARM MCU's
- Raspberry Pi



## SCADA IDE

- Hardware support
- Separate SCADA runtime mode

## Mechatronic system development

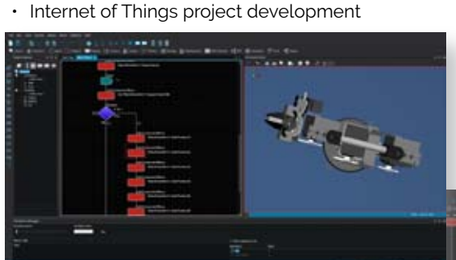
- Robotics
- AllCode technology
- MIAC PLC

## C code editor

- Full C code editor
- Simulate your C code
- Convert between C and flowcharts etc.

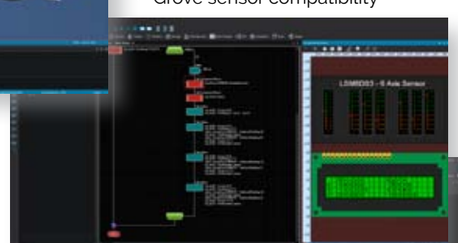
## Wired & wireless communications

- Serial comms including I2C
- Comms hardware solutions available
- Internet of Things project development



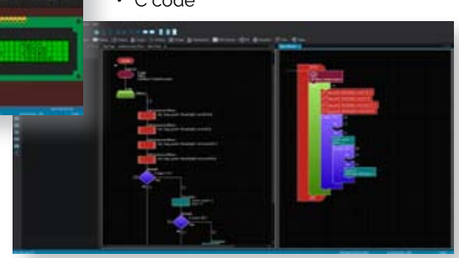
## Sensor interface

- Sensor module support
- Grove sensor compatibility



## Multiple programming languages

- Flowcharts
- Blocks
- Pseudocode
- C code







MATRIX

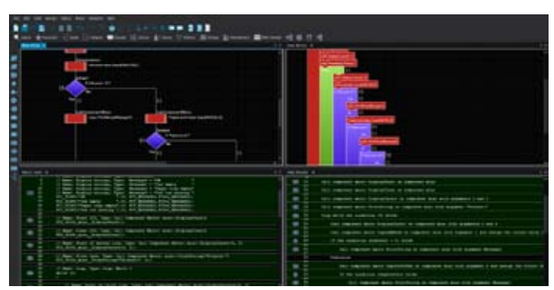


The new version 8 user interface allows students to design, simulate and test a wide variety of microcontroller based systems with ease.


1. **Icon tool bar** - drag and drop standard flowchart icons onto your flowchart. Click to edit properties for a syntax-correct program.
2. **Project explorer** - instantly see all the ports, macros, variables, constants and components in your project.
3. **C code program** - monitor the C code equivalent of your flowchart; as fast, syntax correct code is generated automatically on a per icon basis.
4. **Control tool bar** - use the standard tool bar for editing your program and also for simulating your program and running In-Circuit-Debug / Test.
5. **Component tool bar** - choose your electromechanical component from our large library of parts; from simple switch to Bluetooth module.
6. **Flowchart program** - drag, drop and edit standard flowchart icons to create a program. Design flowchart macros that can be called from other icons. Use Flowcode's powerful PC-side language to control external instruments, and monitor your systems.
7. **Properties editor** - see and edit the properties of all components.
8. **Component debug** - see the API calls in your program and component design.
9. **Icon list window** - for search results, error messages, breakpoints and bookmarks.
10. **Analogue window** - see the state of the analogue inputs in your design.
11. **System panel** - design your system using the multi-view system panel. Use off-the-shelf electromechanical components or design your own. Import your model from a program like SketchUp or Solidworks.
12. **Dashboard panel** - control and monitor your program in simulation and In-Circuit-Test. Write programs using simulation API commands to show real world equivalents of your data in human-friendly formats.
13. **Data recorder** - use this to show time-varying signals in your system. Link the scope to simulation data or real data during In-Circuit-test.
14. **Chip** - use the chip window to view and control the status of the inputs and outputs on your chip in simulation and In-Circuit-Test.
15. **Oscilloscope** - another important debugging tool that displays important data from your project.

**Did you know? Flowcode 8 now allows you to embrace multiple programming languages including:**

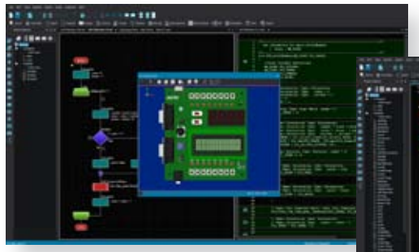
- Flowcharts
- Blocks
- C code
- Pseudocode



MATRIX

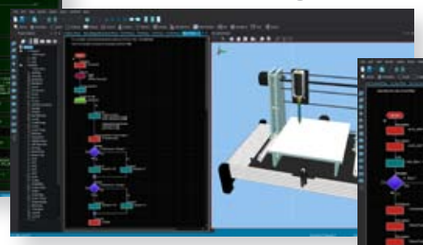
## Design

Electronic engineer



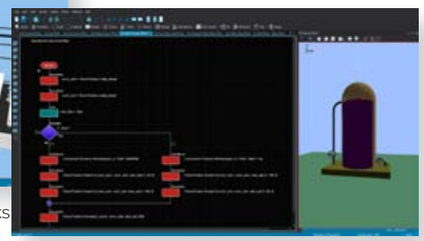
Design a virtual circuit board with PCB level components that connect to a virtual microcontroller and develop the program using flowcharts.

Electromechanical engineer



Develop a mechanical system in Solidworks and characterise it for Flowcode. Develop a flowchart program for control and operational data conditioning.

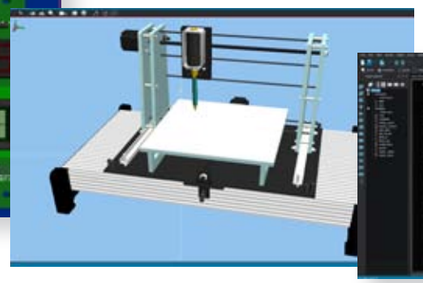
System engineer



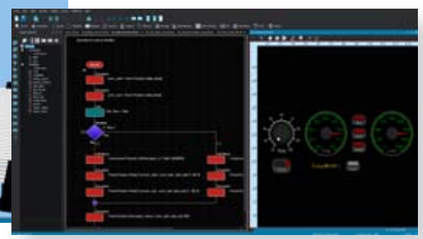
Develop a mathematical and/or physical model of your system, and develop a flowchart control program using Flowcode.

## Simulate

Simulate the program and circuit board components to check function using LEDs, and interact with virtual switches to control the system.



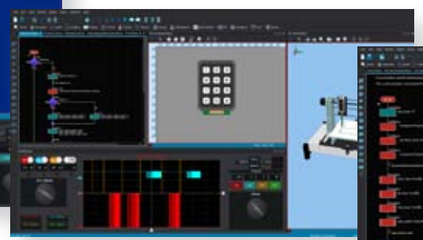
Simulate the mechanical system, the electronic system and the data decoding algorithms all in one package.



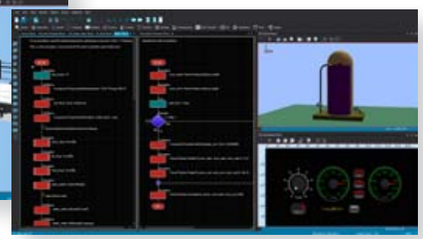
Use Flowcode Dashboard objects to simulate system performance in human friendly graphical format.

## Test

Download to the microcontroller in the E-blocks development system and use In-Circuit-Test and Oscilloscope feature to verify operation at pin level.



Use In-Circuit-Test to test and debug at a pin level.



Link Dashboard objects, Oscilloscope and Console to third party instruments using DLLs in SCADA fashion to verify performance in real time.

## Deploy

Develop the final circuit board and release to market.

Develop the final product, verify operation and release to market.

Deploy your system in a control system based on microcontrollers, MIAC controller or Windows PC linked to third party controllers using DLLs.





Flowcode 8

## Supported devices

### E-blocks2

Use Flowcode to program Matrix's new hardware platform E-blocks2; the perfect platform for learners, engineers and electronic system developers to prototype designs on a rugged platform. A range of programming boards and peripheral downstream boards such as input, output, communications, prototype boards and more make this the ultimate development platform.

### MIAC

The MIAC range from Matrix gives electronic engineers a rugged industrial platform on which to develop their designs. With MIACs now available not only with an 8bit PIC MCU but also 16bit PIC, Arduino and Raspberry Pi (not compatible with Flowcode), users have a rugged PLC which is easy to program and perfect for harsh, industrial environments.

### Arduino

One of the major benefits of using Flowcode, is that it simplifies the programming of Arduino platforms. AVR support means you can do more with your Arduino than you ever dreamed – you can even integrate it into our E-blocks modules with our E-blocks Arduino Shields.

Did you know? Flowcode academic licences allow your students FREE Flowcode licences for use at home

### 8bit PIC

Flowcode provides support for the entire performance range of 8-bit microcontrollers from Microchip, with easy-to-use development tools, complete technical documentation and post design in support through a global sales and distribution network.

### 16bit PIC

Flowcode also supports Microchip's 16bit family of MCU's - also known as dsPIC or PIC24 devices.

### 32bit PIC

The PIC32 family delivers 32bit performance and more memory to solve increasing complex embedded system design challenges.

### Raspberry Pi - NEW

New for version 8 is the ability to control Raspberry Pi devices using Flowcode. We have even developed a hardware platform, on which your Raspberry Pi becomes compatible with the whole new range of E-blocks2 boards. Perfect for those in Computer Science, or who wish to develop using the Pi.

### AVR & ARM

Atmel's AVR devices including the popular Arduino, plus a range of 32-bit STM32 ARM MCU's are also supported in Flowcode 8.

## Academic support and support for learners

Flowcode delivers outcomes not only in professional, and industrial businesses but also at a number of levels of education. For many years Flowcode has delivered at further and higher education levels.

Students can use Flowcode for learning programming, electronic design, robotics, and pneumatics and can link programs to a range of Matrix hardware systems including our low cost Prototype and Projects boards, Formula AllCode robot, our MIAC and Automatics solutions and any third party hardware that accepts hex code for the appropriate microcontroller devices.

What's more, Flowcode also has compatibility with packages including Solidworks meaning users can characterise electronic elements and parts in their mechanical designs.

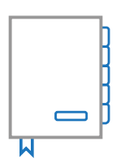
Flowcode is very well supported. Complete beginners will find our free online resources great for covering the basics of developing electronic systems.

All users will value the support offered by our engineers, valued contributors, and extended online community.

The Flowcode Wiki site provides you with a detailed glossary style overview of the aspects of the Flowcode environment. The Matrix forum is a great place to share ideas and solve problems with our well established community of long term as well as new users. It's attended to and updated by our own engineers on a daily basis.

Wiki

Forum



Course

Examples

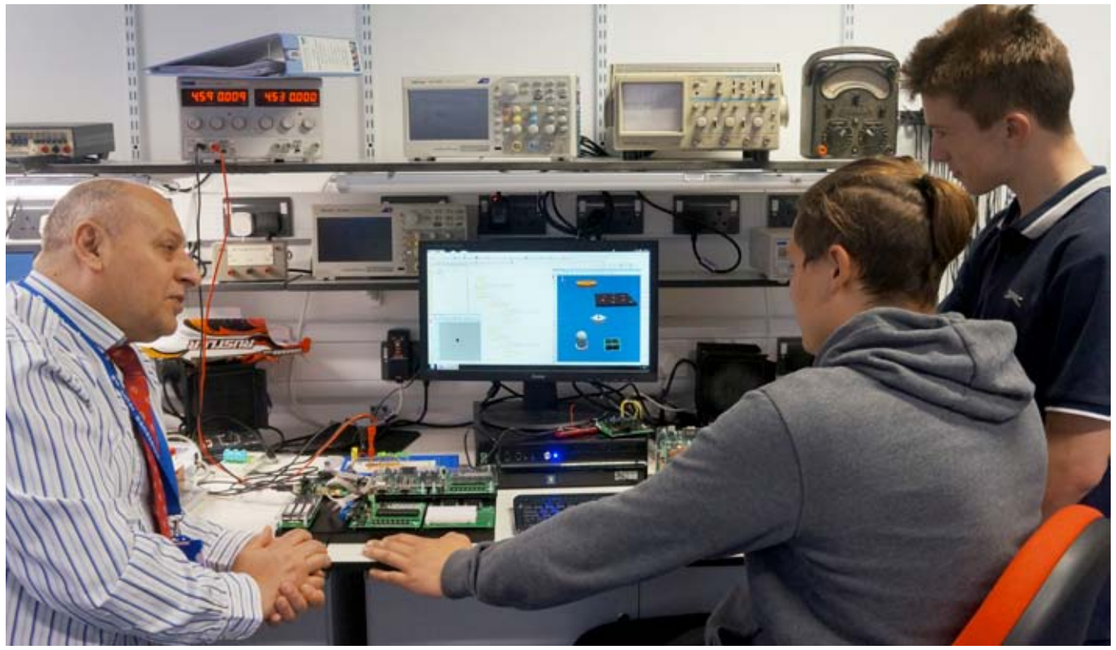
## Microcontroller system training & support for education

Approved hardware and software for BTEC National unit 6: Microcontroller systems for engineers

Flowcode is a unique platform for studying a range of subjects and disciplines. None more so than the development of microcontroller systems. As a software, Flowcode is approved by Pearson's BTEC Engineering qualification at level 3 for the new mandatory unit (6) on microcontroller systems for engineers. For this unit and many others across vocational and higher education, we are proud to develop and offer an option for your institution that delivers an excellent development environment, engages students in their projects based on multiple hardware platforms including Arduino, and we are confident that our expertise in training, support and curriculum will give you the perfect choice for teaching electronics and microcontroller related subject areas.

Try out the free version at
www.matrixtsl.com/flowcode

For further information on how we can help to give you what you need, do not hesitate to contact us today







MATRIX

*"I use Locktronics to teach Motor Vehicle students through all levels. It is a simple, easy to use, teaching resource that allows students to learn at their own pace. With easy to read symbols students can see their circuits come to life which is a great way of reinforcing learning".*

Paul Mangan, Leicester College.

*Automotive Locktronics:*

*"The kits have proven invaluable for the Nissan production programmes. They are learning about Basic Electric all the way up to battery technology and AC/DC motor theory etc. They are an excellent teaching aid for our programmes".*

Steve Burr, Auto Skills Centre Manager, Gateshead College.

*"Having used the Student Automotive kits for over 15 years, I have found them to be an excellent teaching and instructional aid in giving our students a better understanding of Basic Electrical principles.*

*Because of more and more complex systems now being introduced to our vehicles, in the last year we have purchased a number of new kits (CAN) which has allowed us to structure our courses to an even greater extent practically.*

*Increasing the practical content when using these kits, has a distinct advantage in that it gives our students more of a hands on approach to these new technologies.*

*Being able to construct and test a CAN network using the Locktronics kits, they find it easier to understand the principles and operation of Multiplex systems, when they are applied to our vehicles.*

*The new kits allow us to simulate all these systems on a table top, which certainly has the benefit in that all the students are involved at the same time."*

Kevan Woodier, IVECO

*"We value the Locktronics equipment during the training of apprentices and engineers progressing down the route of EASA part 66 Maintenance Engineers Licence. They are invaluable as demonstration equipment on short courses and for apprentices conducting their own experiments, constructing circuits, testing and understanding electrics, electronics and digital techniques".*

Tony Russell, British Airways.





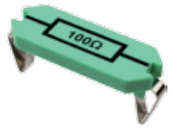


## The Locktronics range includes:

Baseboards

*To which students add...*


Capacitors

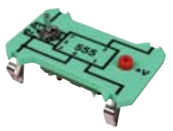



Resistors


Inductors

Semiconductors

Logic gates



System blocks

Electromechanical

Lamps and LEDs

Curriculum packs

Power supplies

## Simplifying Electricity & Electronics

Locktronics is a range of products that simplifies the process of learning and teaching electricity and electronics.

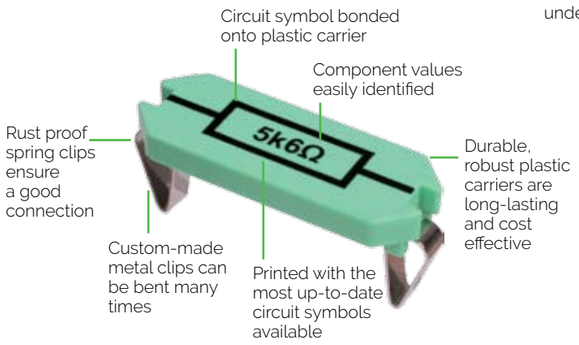
The core range consists of more than 200 electronic components mounted on rugged plastic carriers which are printed with the corresponding circuit symbol. Students use these carriers, in conjunction with a baseboard with interconnecting metal pillars, to build up a working circuit. They then use the curriculum provided to carry out experiments in electricity and electronics.

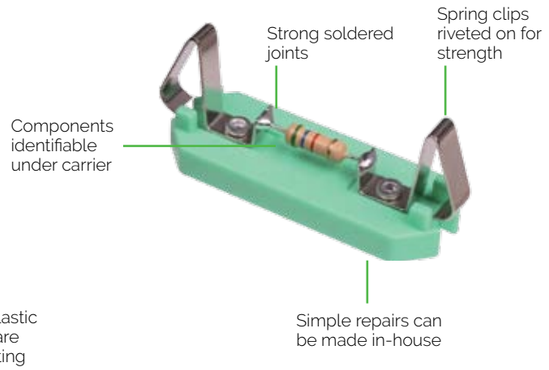
The key benefit of Locktronics is that as students construct the working circuit, they can also see the corresponding circuit diagram. This helps students link theory to practice and simplifies the process of learning electricity and electronics.

Locktronics can be used in a wide range of subject areas.

## Disciplines include:

- Science and technology
- Electronics
- Engineering
- Automotive
- Aviation maintenance
- Electrical installation




## Simplifying Electricity & Electronics

Locktronics is used in over 10,000 schools worldwide. Teachers and students like to use Locktronics for a number of reasons:

### Makes learning easier

- Students can see the circuit diagram and the real circuit
- Circuits are fast to build and easy to work with
- Support materials guide students step-by-step

### Saves preparation time

- Locktronics is reliable and works year after year
- Curriculum and worksheets are provided

### It lasts and lasts

- Components mounted on rugged plastic carriers
- Simple, effective, strong baseboards
- Component legend bonded to plastic carriers

### Versatility

- Can be used in many subject areas, at many levels
- Vast range of components
- Ideal for demonstrations, projects and practical work.

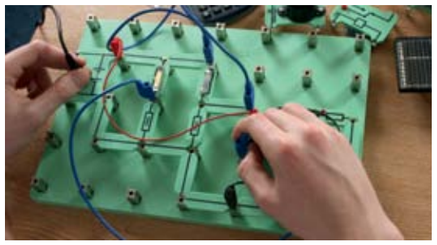
### Support

- Components and curriculum now updated
- 12 month guarantee on all items
- Unlimited telephone support on all products

Theory

*Teach students electrical theory in the classroom using text books, CD ROMs, or other means...*

Application



*...students apply theory to practice using Locktronics kits...*

Understanding

*...understanding comes from completing assignments in curriculum packs.*







In the earlier part of this catalogue, you can choose from our extensive range of kits tailored to syllabuses in primary education, secondary education and further education, in engineering, science, technology, automotive and more.

### Choosing the right solution

Take a look at our range of curriculum packs that you can see on page 106. View them on our website and make sure the experiments are right for you.

### Choosing accessories and extras

Bills of material showing the complete contents of each kit are available on our website. Make sure you have the test equipment you need for teaching your course. Most courses require the use of one or two multimeters. Some require signal generators and oscilloscopes.

### Component and kit variations

Make sure you choose the correct version of your solution - components are available with ANSI (USA) and DIN (European) circuit symbols.

### Making up your own kit

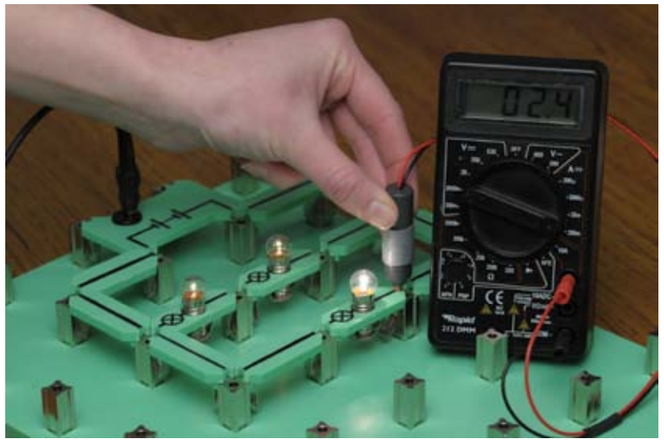
If the kits we have don't suit you then you can make up your own kit from our vast library of parts.

### Choosing additional manuals and parts

If you already have some Locktronics parts, then you can download free updated manuals from our website and can buy additional components which will allow you to deliver new courses.

*Take a look at our curriculum packs online...*

*...choose one of our solutions...*



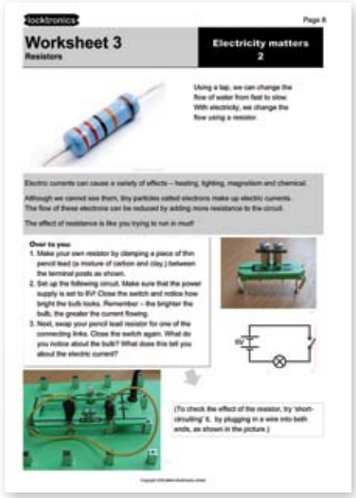
*...with accessories like our current probe...*


*...or DIN/SB (European) symbols...*


*...with ANSI (North American) symbols...*


*...and our active MIAC control unit.*

*Most worksheets follow the same format. Illustrated introduction to topic area and components supports student learning.*


locktronics

Page 8

**Worksheet 3**
Resistors

**Electricity matters 2**

Using a tap, we can change the flow of water from fast to slow. With electricity, we change the flow using a resistor.

Electric currents can cause a variety of effects – heating, lighting, magnetism and chemical.

Although we cannot see them, tiny particles called electrons make up electric currents. The flow of these electrons can be reduced by adding more resistance to the circuit.

The effect of resistance is like you trying to run in mud!

**Over to you:**

1. Make your own resistor by clamping a piece of thin pencil lead (a mixture of carbon and clay ) between the terminal posts as shown.
2. Set up the following circuit. Make sure that the power supply is set to 9V! Close the switch and notice how bright the bulb looks. Remember – the brighter the bulb, the greater the current flowing.
3. Next, swap your pencil lead resistor for one of the connecting links. Close the switch again. What do you notice about the bulb? What does this tell you about the electric current?

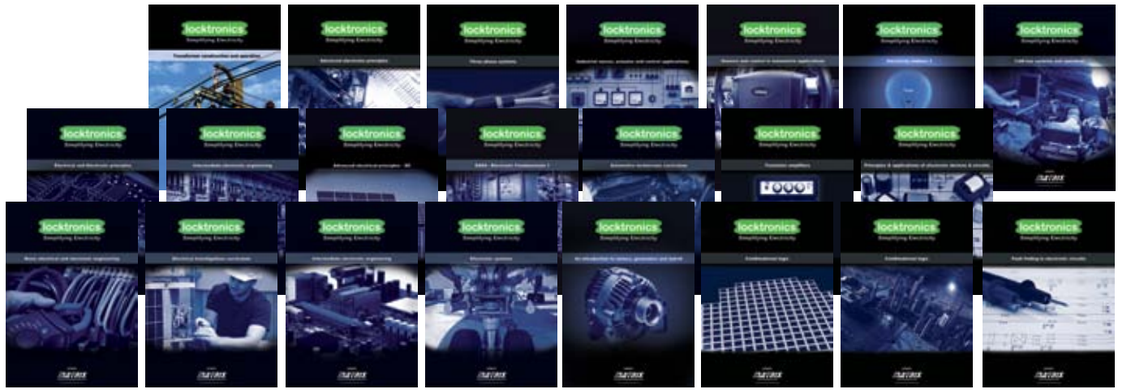
(To check the effect of the resistor, try 'short-circuiting' it, by plugging in a wire into both ends, as shown in the picture.)

*'Over to you' allows students to experiment based on what they have learnt and allows teachers to assess their understanding through a series of exercises.*

There are over 40 different curriculum packs available for the Locktronics range covering a wide spectrum of topics: from simple electricity for wiring technicians, through to advanced transistor characteristics for undergraduate electronic engineers. The table below shows the complete list of products currently available.

For up to date curriculum, please visit our website: www.matrixtsl.com/locktronics/resources

*Additional information to support the outcomes of the exercises for students to read or copy, often leading them into the next worksheet.*




| Description | Part No. |
|---|---|
| Fundamentals of electricity (primary) | LK6816 |
| Operational amplifiers | LK3061 |
| Electricity matters 1 | LK7325 |
| Electricity matters 2 | LK7326 |
| Electricity matters 3 | LK7664 |
| Electricity matters 4 | LK7773 |
| Advanced electrical principles DC | LK8473 |
| Advanced electrical principles AC | LK8749 |
| Automotive sense and control | LK8849 |
| CAN bus systems and operation | LK9893 |
| PICmicro microcontroller systems | LK7209 |
| Industrial sensor, actuator and control | LK8739 |
| Energy and the environment | LK7122 |
| AC principles for automotive technicians | LK8392 |
| An introduction to motors, generators and hybrid | LK8822 |
| An introduction to digital electronics | LK9392 |
| EASA electrical fundamentals 1 | LK7378 |
| EASA electrical fundamentals 2 | LK7381 |
| EASA electrical fundamentals 3 | LK7393 |
| EASA electrical fundamentals 4 | LK7415 |
| EASA electronic fundamentals 1 | LK7419 |

| Description | Part No. |
|---|---|
| EASA electronic fundamentals 2 | LK7422 |
| EASA electronic fundamentals 3 | LK7426 |
| EASA electronic fundamentals 4 | LK7430 |
| Hybrid vehicle systems | LK4483 |
| PICmicro getting started guide | LK8741 |
| Combinational logic systems | LK2094 |
| Sequential logic systems | LK9945 |
| Fault finding in electronic circuits | LK9333 |
| Transistor amplifiers | LK4403 |
| Advanced electronic principles | LK3008 |
| Three phase systems | LK2686 |
| Power and energy electronics | CP3666 |
| Electrical installation 1 | LK4098 |
| Electrical installation 2 | CP8475 |
| Sensors and control in automotive applications | LK8849 |
| Intermediate electrical and electronic principles | LK4583 |
| Intermediate electronic engineering | LK8293 |
| Electronic components and circuits 2 | CP2813 |
| Electrical installation 3 | CP2095 |
| Principles of lighting | CP2273 |
| Transformer construction and operation | CP1933 |






# Lascells

These products from renowned UK education brand Lascells have been specially selected to enhance your study of various topics and disciplines found throughout our catalogue. For further information on these items, visit www.matrixtsl.com/lascells

## Meters

These digital bench meters are housed in robust ABS and PVC cases. Both types of meter feature ~50 minute 'auto off' circuitry to conserve battery life and an LED indicator prompting battery change when necessary.

| Description | Part number |
|---|---|
| Digital Voltmeter | AS2563 |
| Digital Voltmeter - Class Pack of 15 | AS1106 |
| Digital Ammeter | AS9084 |
| Digital Ammeter - Class Pack of 15 | AS4472 |

## Applied Science & Waves

This range of equipment helps you study the properties of waves, the colour of light and the stretch and strain of different materials.

| Description | Part number |
|---|---|
| Strip and wire tester | AS9269 |
| Colour mixer | AS3973 |
| Speed of sound | AS4256 |
| Colour filter set | AS9130 |
| Ultrasonic System | AS7043 |
| Stationary Wave Apparatus | AS3529 |
| Ripple Tank III | AS0371 |
| Cloud Chamber | AS4681 |
| Spare Cloud Chamber Source | AS5069 |

## Basic Optics

This equipment is a range of basic parts to study physical optics or fibre optic systems.

| Description | Part number |
|---|---|
| Plane Mirror (Set Of 10) | AS7316 |
| Mirror Support Blocks | AS5432 |
| Optics Screen | AS0933 |
| Optics Board | AS3665 |
| Simple Timer | AS3403 |
| Fibre Optics system | AS4882 |
| LED Light Source | AS8848 |
| LED raybox | AS6838 |
| Optics Bench Pair | AS7068 |

## Motors

The Demonstration Electric Motor is a ready built fully functional unit showing all the essential features of a simple motor. A single rectangular coil rotates in a linear magnetic field with a simple commutator and brush arrangement. Field directions can be reversed by reversing the ferrite slab magnets and current direction can be reversed by reversing the leads. Requires DC voltage in the range 1.5V - 6V.

| Description | Part number |
|---|---|
| Demonstration electric motor | AS1855 |

## Electrical installation

These items show applications of electromagnetic devices (the solenoid) and bi-metal strips as well as bringing them all together to demonstrate the key principles of the modern domestic circuit breaker. Alongside this is an apparatus which shows all of the working parts of a modern RCCB type fuse as used in domestic consumer units.

| Description | Part number |
|---|---|
| Circuit breaker | AS9997 |
| Residual Current Circuit Breaker (RCCB) Demo | AS4810 |


## Magnetism

The B.I.L coil is a printed circuit board coil on a support handle with 5 and 10 turns rated at 2A. When current is passed through the coil the force can easily be measured by the change in reading on the accompanied balance. The adjustable magnet is used to determine the flux density in the gap.

| Description | Part number |
|---|---|
| B.I.L coil | AS4672 |
| Adjustable magnet | AS8623 |


## Electronics

These products are designed as standalone items to compliment anyone studying electrical or electronic engineering topics covering areas including AC principles, bridge rectifiers or capacitors. These items are designed as demonstration items and can be used alongside our Locktronics kit to provide an intuitive course in electronic principles.

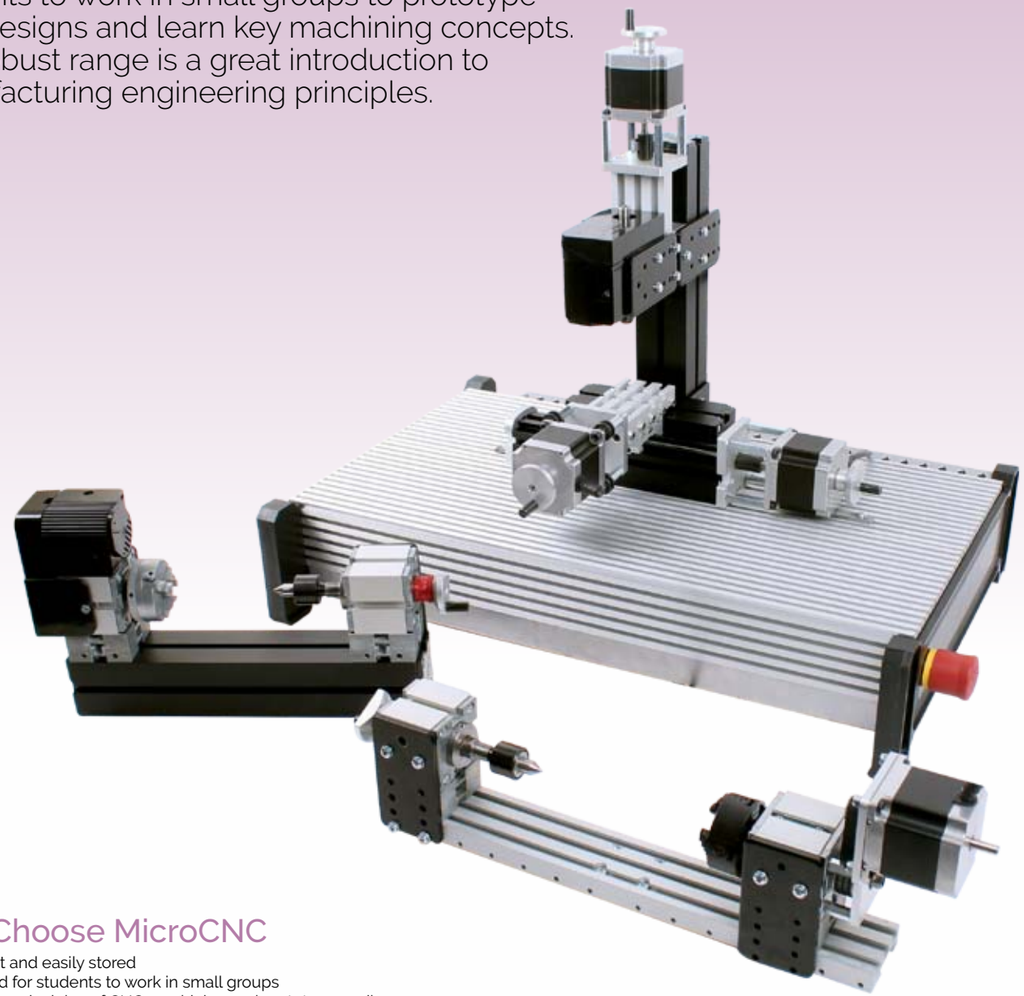
| Description | Part number |
|---|---|
| Bridge rectifier system | AS8553 |
| AC waveform demo | AS8722 |






# MICRO CNC

Our MicroCNC range of machines are low voltage, easy to store and cost-effective; allowing students to work in small groups to prototype their designs and learn key machining concepts. The robust range is a great introduction to manufacturing engineering principles.

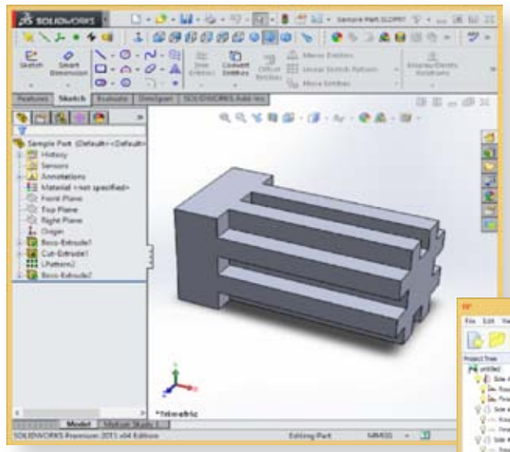


## Why Choose MicroCNC

- Compact and easily stored
- Designed for students to work in small groups
- Learn key principles of CNC machining and prototype easily
- 2-axis lathe and 3 and 4-axis milling machines
- Includes software to easily convert your CAD designs

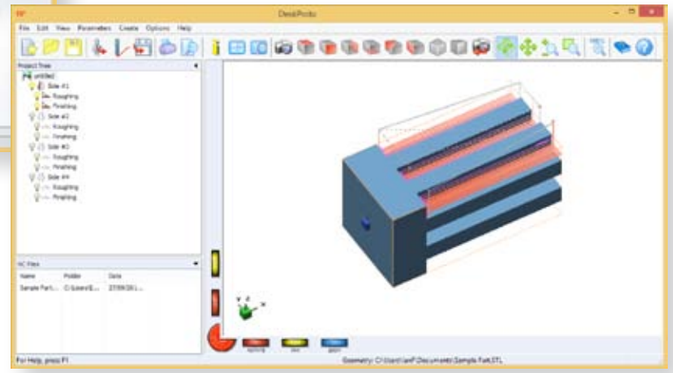
## Step 1:

Utilising the CAD software of your choice - Solidworks, AutoCAD or any other design software, users are able to develop designs, which they wish to be machined using the MicroCNC range.



## Step 2:

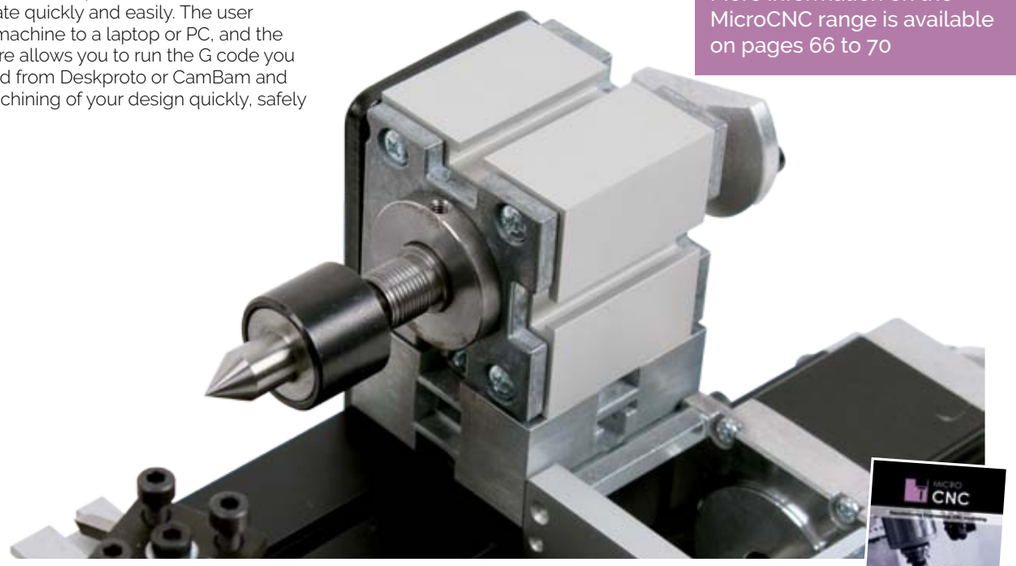
Next up is the job to convert designs to G code. We supply Deskproto and CamBam software, which imports STL files from a CAD program, calculates CNC toolpaths and then writes a G code program file, allowing prototyping using materials including wax, PU board and acrylic, suitable for lathing, milling, engraving etc.



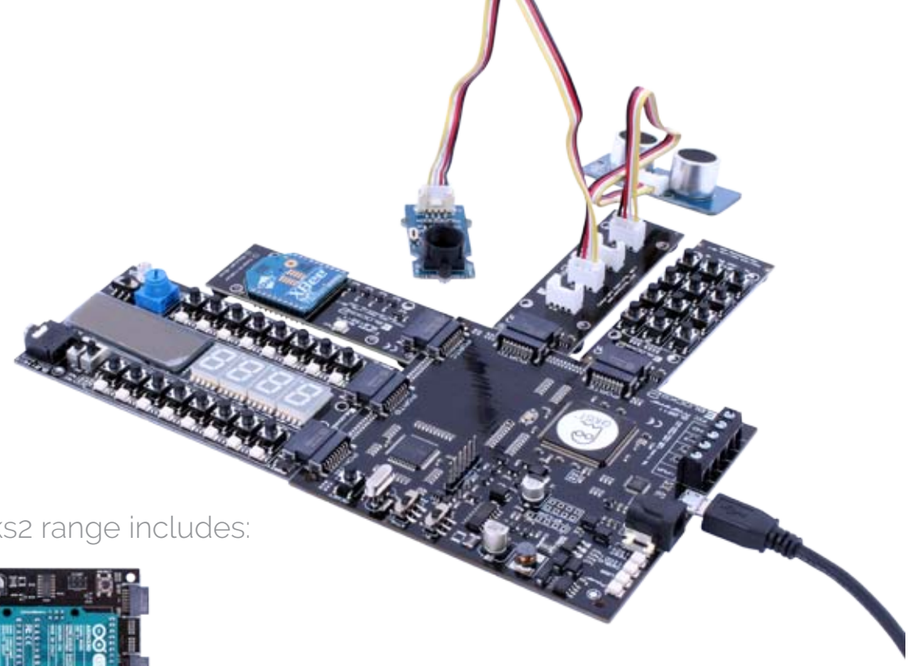
## Step 3:

MicroCNC machine components are secured to the base plate quickly and easily. The user connects the machine to a laptop or PC, and the in-built software allows you to run the G code you have generated from Deskproto or CamBam and enable the machining of your design quickly, safely and easily.

More information on the MicroCNC range is available on pages 66 to 70



The MicroCNC curriculum is written to specifications from BTEC at National and Higher National Level and City & Guilds qualifications at Level 2 and above. These excellent UK awarding bodies produce some of the World's most well respected and well recognised technical education qualifications. At Matrix we are proud to say that our curriculum is written with these qualifications in mind to ensure our customers are delivering to the highest standards possible.

## The E-blocks2 range includes:

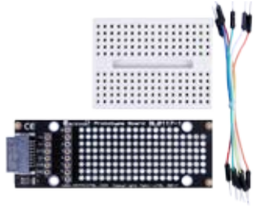
A range of upstream programmer boards
To which students add:

Input /output boards

Wired & wireless communications boards

Graphical displays

Motors and actuators boards



Prototype boards

Sensor boards

E-blocks2 to E-blocks connector boards

## Flexibility through modular design

E-blocks2 is the latest generation of microcontroller boards from Matrix. E-blocks2 modular boards provide learners and developers with a flexible suite of electronic blocks that snap together using rugged har-flex® connectors, to form a wide variety of electronic systems.

E-blocks2 are small circuit boards each of which contains a block of electronics that you would typically find in an electronic system. The E-blocks2 system is ideal for everyone, from those learning in an educational environment to engineers in the industrial world. Use of E-blocks2 is well supported with complementary ranges of software (including Arduino IDE, Flowcode, C and Assembly), and support for Grove® sensors and Click Boards™. Technical support is available from our dedicated development team through our online forums.

## Disciplines include:

- Computer Science
- Electrical / Electronic Engineering
- Mechanical Engineering
- Mechatronics
- Design Technology
- Robotics






## Flexibility

The modular nature of the E-blocks2 boards makes them one of the most flexible kits available. Almost anything in modern digital electronics that you want to teach, learn or construct can be done with the E-blocks2 system.

## Supported programmable devices

To give you flexibility in the courses you can deliver with E-blocks2, we support a wide range of programmable devices:

- Arduino
- 8-bit PIC MCUs
- 16-bit PIC MCUs
- 32-bit PIC MCUs
- 32-bit STM32 ARM MCUs
- Atmel AVR MCUs
- Altera Cyclone IV FPGA
- Raspberry Pi

## Supported programming languages

The E-blocks2 range is supplied with download utilities for native hex code which means that most chip programming languages are supported.

## Comms systems compatibility

Most chip to chip and system to system communications standards are supported. The list includes: CAN, Bluetooth, GSM, RS232, RS485, IrDA, PS2, VGA, TCP/IP, MIDI, SPI, I2C, ZigBee, RFID, VGA, USB, GPS, SD/ FAT16/FAT32, RF(ISM), RC5, Wi-Fi

## Curriculum support

E-blocks2 is well supported with a range of curriculum materials for different levels of learners. This includes free online tutorials for beginners and schools, 50-hour courses in programming and chip development for undergraduates and a range of specialist courses in advanced techniques like mobile telephony and embedded internet technology for the advanced user.

## Rugged design

E-blocks2 has been designed to be electrically and mechanically rugged to withstand the pressures of the lab: downstream board interfaces include damage protection resistors and cannot be damaged by programming errors. We can supply boards on impressive printed panels, to make them mechanically rugged during use. Plastic covers are also available for panel based products to offer further protection and prevent chips from being removed.

## Product information

All E-blocks2 boards are provided with complete datasheet, which includes circuit diagrams. The datasheet and examples can be downloaded from our website. Up to date drivers for all boards are also available online.

## Forum support

The Matrix development team provides excellent support for our products online through our very active forums. Additional support is provided by our network of valued contributors via our forums.

## Tight integration with Flowcode

E-blocks2 are tightly integrated with Flowcode and Flowcode components are available for all E-blocks2 boards as they are released.

## Industry standard technology

E-blocks2 is used as much by engineers in industry as they are used by students and teachers in education. The technology is real, up to date, and provides a great base for training the next generation of engineers.

GHOST™

## What is Ghost?

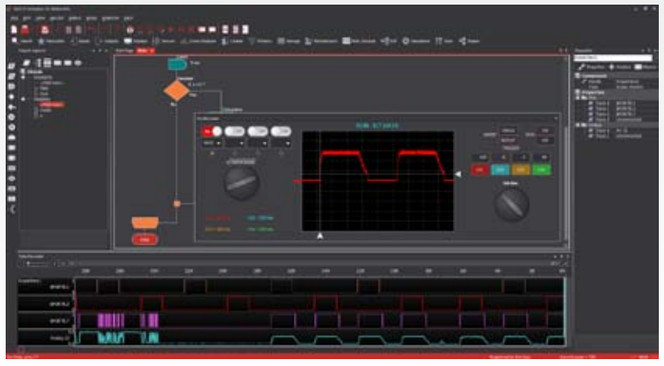
Ghost is a technology which, when combined with Flowcode, provides a revolutionary way of debugging electronic systems.

Ghost technology provides a real-time log of the status of all the pins on the microcontroller whilst a Flowcode program is running on the device. Ghost data can be viewed on the Flowcode Oscilloscope at the same time as the flow chart simulation. We call this 'In-Circuit-Test'. You can run, pause, and step through your program and view Ghost data at the same time and view variables, registers and other memory locations. We call this 'In-Circuit-Debug'

When this data is combined with the PC-side processing capabilities of Flowcode it provides a very powerful debugging and learning tool. As an example of this the 5 steps below show how ICT works to collect a stream of GPS digital data gathered from the E-blocks system and processed into layers of meaningful information to help the design process.

This saves huge amounts of development time - whether you are working at a pin level and getting your first program to work, or whether you are an advanced user wanting to perform a sanity check to make sure communications baud rates are set at the correct speed.

Both analogue and digital data is gathered through Ghost ICT and displayed on the Flowcode Oscilloscope. For communications busses decoding overlays for UART, SPI, and I2C are available. Ghost data can also be passed to simulation/SCADA components in Flowcode to provide Human Machine Interface style debug features.

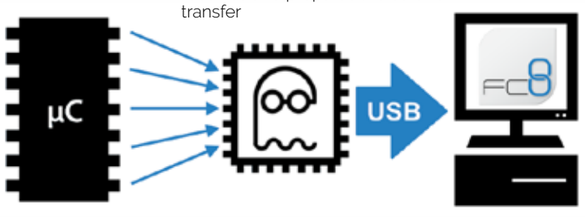


## How does Ghost work?

Ghost is a unique piece of technology, the entire system works in real time as ghost monitors all the I/O on the target chip and streams that data directly into Flowcode via USB, below is a diagram explaining how the system works.

The chip being monitored by Ghost executes in real time

The Ghost chip buffers the data it receives and prepares the data for transfer




Flowcode receives the data from the Ghost and interprets it into graphs and console readouts

All the data lines are scanned by Ghost

Data is sent via USB to the target PC

## What Hardware can I use with Ghost?

BL0055 Arduino shield

BL0080 PIC Multiprogrammer board

Other upstream boards available:

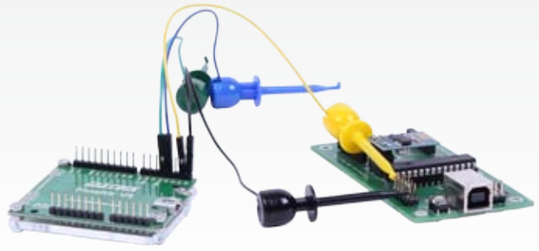
- BL0032 dsPIC Programmer board
- BL0011 PIC Programmer board
- BL0086 AVR Programmer board
- BL0036 Raspberry Pi shield




# FlowKit


## Microcontroller system debugging

FlowKit 2 can be connected to microcontroller based hardware systems to provide In Circuit Test and In Circuit Debug features for third party hardware. With FlowKit it is possible to step through your Flowcode program on the PC and step through the program in the hardware at the same time. FlowKit can also monitor up to 8 analogue channels and up to 16 digital channels at sample rates up to 1MHz. Signal decoding is provided for I2C, SPI, and RS232 busses using Ghost technology.



Attaching FlowKit to your own circuit board using the probes provided

*Communication busses being decoded*

GHOST™

FlowKit 2 can help you debug your Flowcode designed systems for:

- PIC
- dsPIC
- AVR/Arduino

Analogue and digital data are monitored and displayed

### Arduino/Genuino compatible FlowKit 2

The Arduino/ Genuino version of FlowKit mounts directly onto an Arduino compatible circuit board.

**Ordering information**

| | |
|---|---|
| Arduino/Genuino compatible FlowKit 2 | HP6012 |

### Stand-alone FlowKit 2 with USB lead and test clips

The standard FlowKit is provided with 4 test clips.

**Ordering information**

| | |
|---|---|
| Stand-alone FlowKit 2 with USB lead and 4 test clips | HP6031 |

# ELECTRICAL MACHINES



## Our new modern electrical machines system is a revolutionary way of safely studying the characteristics of different motor types in a learning environment. Observations of alternative market offerings are:

- They are too expensive
- They are too complicated
- They take up too much space in a department – often with a dedicated room
- They are often not electrically safe

## With this in mind we have developed a range which has the following features:

- Safe operation: all moving parts covered
- Electrical machines including those found on the following page
- Machines which operate on 24V power, AC or DC
- Manual (reduced specification) or full PC control
- Electronic measurement of voltage, current and power in DC and AC
- DC power supply included
- AC power supply single and three phase supply with variable frequency included
- All machines are small footprint, low power
- All equipment can be easily stored and packed away
- Full documentation and experiments included

## This kit includes the following equipment:

- 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 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

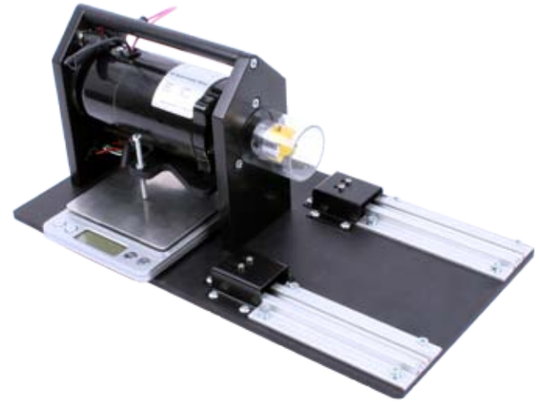
## Control box features:

- 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

Compatibility with MATLAB, allows the user to capture data that can be used to model industrial systems. For this, a separate curriculum exists and more information can be found on page 37.




# Electrical machines motor specifications



## DC Dynamometer / motor and cradle

| | |
|---|---|
| Operating voltage | 24V AC |
| Max current | 2A |
| Speed | 1500rpm |
| | **EM2159** |

## Three phase induction motor

| | |
|---|---|
| Operating voltage | 24V AC |
| Frequency | 40 – 80Hz |
| Max current | 1.4A |
| Speed | 1400rpm |
| | **EM2391** |

## Single phase induction motor

| | |
|---|---|
| Operating voltage | 24V AC |
| Frequency | 40 – 80Hz |
| Max current | 1.4A |
| Speed | 1400rpm |
| | **EM8614** |

## DC motor

| | |
|---|---|
| Operating voltage | 24V AC |
| Frequency | 40 – 80Hz |
| Speed | 1500rpm |
| | **EM6574** |

## Shunt motor

| | |
|---|---|
| Operating voltage | 24V DC |
| Max current | 12A |
| Speed | 1500rpm |
| | **EM9856** |

## Universal / series motor

| | |
|---|---|
| Operating voltage | 24V AC |
| Frequency | 50Hz |
| Max current | 6A |
| Speed | 1500rpm |
| | **EM7432** |

## Brushless DC motor / 3 phase generator

| | |
|---|---|
| Operating voltage | 24V DC 3 phase |
| Max current | 2A |
| Speed | 1500rpm |
| | **EM5337** |

# SOURCE

The Matrix general purpose AC/DC power supply and signal generator has a wide range of applications in education: in Physics, Technology and Electronics.

The unit is housed in a rugged enclosure with a large graphical back-lit display and input controls conveniently located at the top front of the display. The power supply has a number of fixed DC voltage outputs as well as variable DC and AC outputs.

The AC signal generator output is presented in three forms: +10V p-p 50 Ohm DC coupled BNC output, high-power output via shrouded 4mm sockets for directly driving speakers and vibration generators, and a line-level output on a jack socket. This AC signal delivers 0.1Hz to 100KHz with sine, triangle, square and arbitrary waveform outputs.


## Features

- Outputs: -12V, 5V and +12V
- Variable 3-10V DC output
- Signal 0.1Hz - 100kHz
- Dot matrix backlit display
- Rugged control and buttons
- Current limiting feature
- Shrouded safety connectors





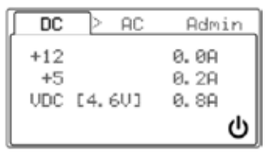
## Outputs specification table

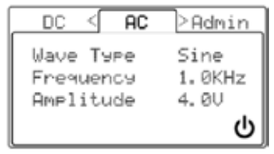
| Feature | Output | Details | | Terminal |
|---|---|---|---|---|
| Signal Generator: Sine, Square, Triangle, Sawtooth, Custom | Instrumentation 0.1Hz to 100KHz | 50 Ohm DC coupled 10V p-p | | BNC |
| | Audio Output 20Hz-20KHz | Loudspeaker/Transducer AC coupled 10V p-p 1.3 Amp peak | | 4mm shrouded(+) 4mm shrouded(-) |
| | | Line Out AC coupled 2V p-p 200 Ohm source impedance | | Mono Jack |
| Power Supply | 3-10V variable | up to 3A maximum | variable current limited, monitored | 4mm shrouded (brown) |
| | +12V | up to 5A maximum | variable current limited, monitored | 4mm shrouded (blue) |
| | +5V | up to 5A maximum | variable current limited, monitored | 4mm shrouded (red) |
| | -12V | up to 300 mA | current limited to 300mA | 4mm shrouded (yellow) |

## The menu system

The unit is controlled via a tabbed menu system.

When one of the top row tab names is highlighted the tabbed page can be changed by turning the rotary control knob. If a tab name is not highlighted, press the "up" push button (4) until it is.



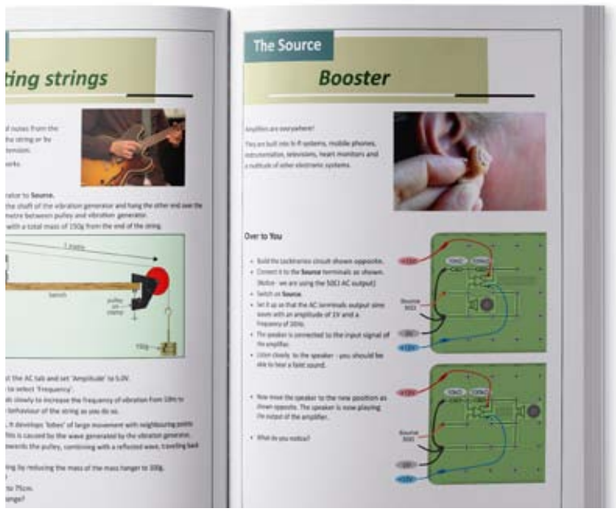





## Curriculum workbooks available online

The worksheets cover topics of sound and light science. The worksheets include:

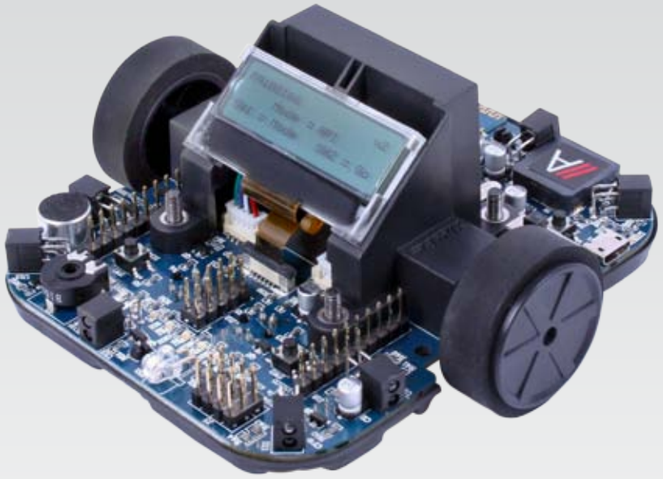
- Just listen
- Piped music
- Weird wobbles
- Vibrating strings
- Hear the beat
- Flashy
- In sequence
- Booster
- Filter the treble



# FORMULA //ALLCODE™

Formula AllCode is host independent and can be used with:

- Raspberry Pi
- Android
- iPhone
- Windows & MacOS
- And many more…



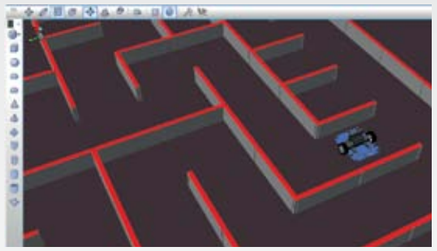
## Learn robotics your way

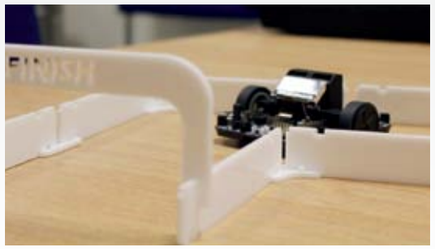
Formula AllCode is a complete robotics course consisting of a high specification robot buggy, a course, and a range of accessories that present learning activities for students. The robot is Bluetooth compatible and is shipped with a full Application Programming Interface. This means that it can be controlled via Bluetooth from any computer, tablet or phone with a Bluetooth interface using a host of different programming languages from Python to C++.

The free, accompanying course includes a range of activities with varied levels of difficulty; from flashing an LED through to maze solving. Students are guided through the activities by a suite of worksheets. To get students started example programs on all major platforms are provided, including: Flowcode, MATLAB, LabVIEW, Python and AppInventor. Flowcode simulation environments and components are provided for Flowcode users (dsPIC version required). Programs written in Flowcode or C can be downloaded to the robot to make it behave autonomously.

This is our second generation educational robot buggy evolved from many years of experience in the market.

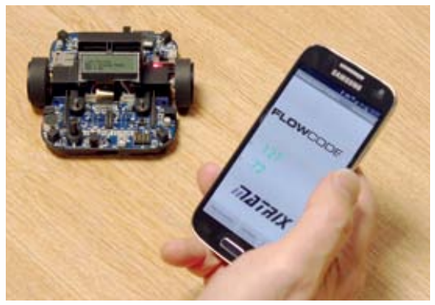
By the way: the word 'Formula' in the name refers to the popular 'Formula Ford' racing competitions where drivers race on a track using the same specification of car.





*Formula AllCode uses it's high specification of sensors to follow lines and can even solve complex mazes. We are offering maze walls and maze mat with full examples to enhance your learning experience.*

*In Finland, Robotics students taking part in the Finnish World Skills in 2018 used Formula AllCode as a automated robot to solve a constructed maze in the fast time, using sensor technology and a remote control system using mobile phones.*

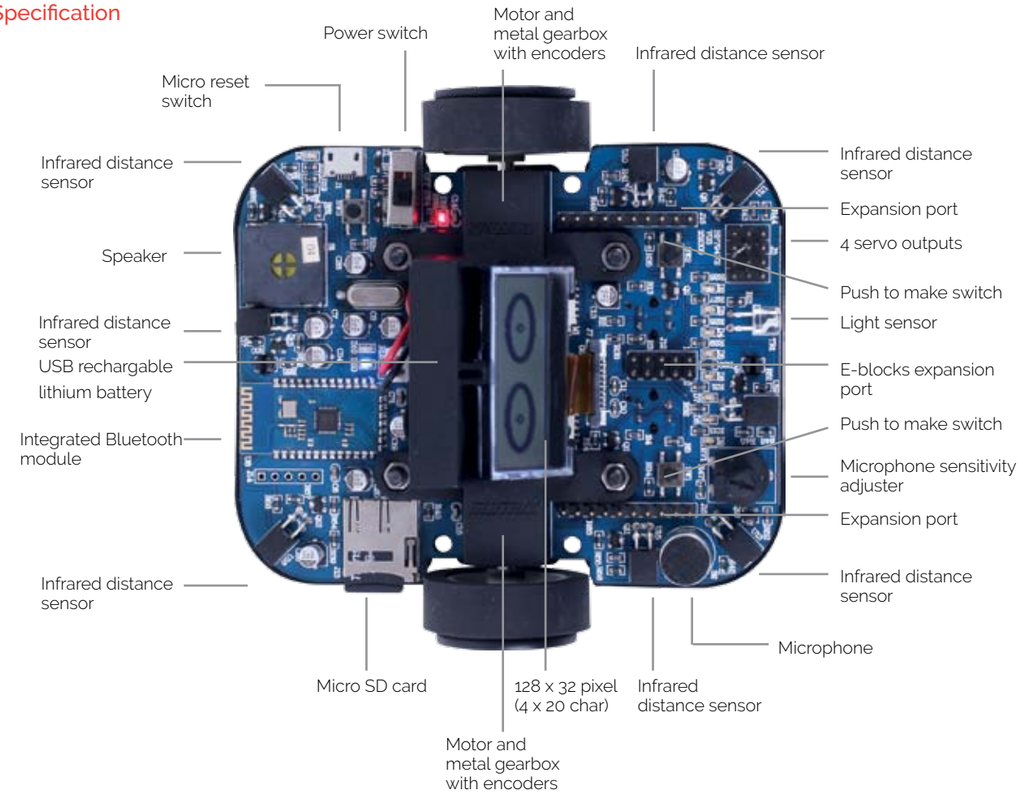


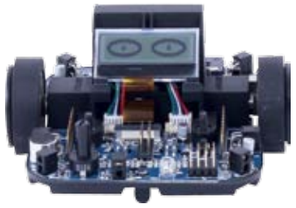

*Program the Formula AllCode with any Android device. Use programs such as App Inventor to develop and directly control the Formula AllCode. You can even use iOS and RPi platforms to control the buggy.*

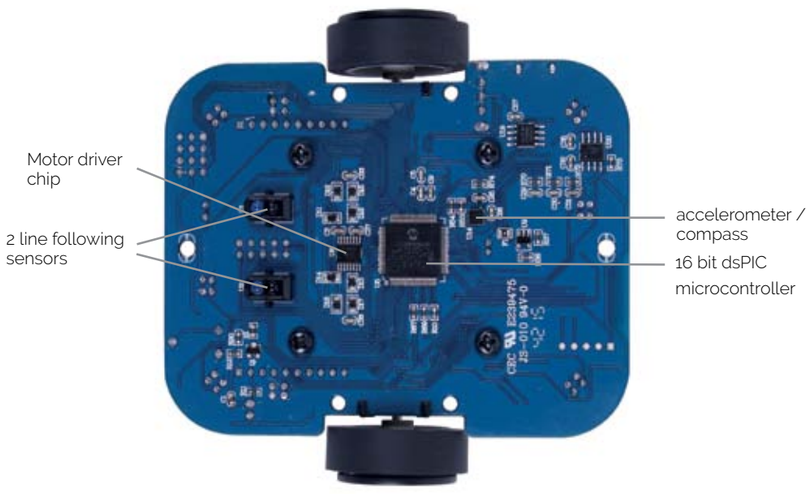


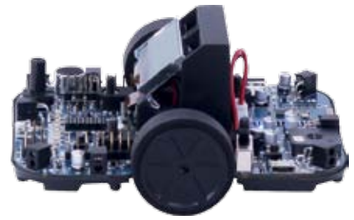



## Specification





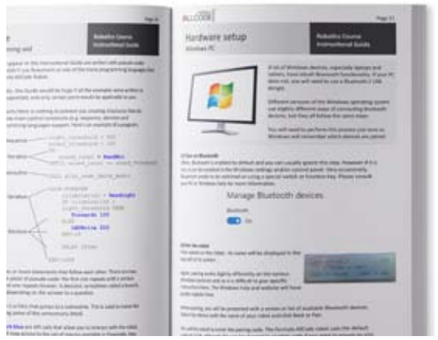
# Learning Activities

Learning activities are at the heart of Formula AllCode and have driven its specification.

The range of activities is what makes AllCode so powerful. Students can learn basic code constructs starting with flashing an LED. They can learn the principles of robotics using the on-board sensors and the motors. Then students can progress to solving system level problems like maze solving and navigation.

Maze solving is really special: using a left hand wall following algorithm it is possible to solve most mazes. But using the AllCode to first map a full maze and then work out the fastest way of going from start to finish is a real challenge for coders. Whatever you end up doing with your students there is a little bit of magic in seeing robot buggies running around mazes.

Here you can see a list of some of the learning activities that are possible with the Formula AllCode.




## RobotIO

Use on-board switches and LEDs to understand inputs, outputs and binary operation.

## Robo-DJ

Use on-board loudspeaker to generate tones and play music.

## Robopop

Use the input mic to make the robot dance to music.

## Motor drive

Program the robot to drive the motors with a specific speed and direction so that predetermined figures such as a triangle, a square, a circle or a spiral are made. We will have a logo-like commands in the API.

## Follow my line

Use the on-board line sensors to follow a black line on a white background. Extend the exercise with various markings on the line following mat.

## See the light

Use on-board light sensor to drive the buggy towards a light source.

## Lefty

Use the left hand wall-following technique to solve a simple maze.

## Measure my drive

Understand how wheel encoders are used to give feedback on exact distance travelled by each wheel and calibrate driving for each wheel.

## Drag race

Travel as fast as possible over a straight course, following a white line, then brake and stand still before hitting the end wall.

## Daytona race

Do three laps around the maze as fast as possible, the fastest mouse wins. One second will be added for every time you hit a wall or make a 'touch'.

## Navigation

Use the internal compass sensor to guide the robot along a path to buried treasure.

## Tilt and turn

Develop apps in iPhone and Android that control the robot using the tilt sensor in your mobile phone/tablet, or control using a simple program on a PC (etc).

## Stat panel

Develop apps in iPhone and Android that shows robot sensor status as it drives along a maze.

## Full maze

Solve an unknown maze by mapping it first and then driving the fastest courses as fast as possible.

## Curve drawer

Attach a pen to the robot and make it draw a given function (e.g. y=x2).

## G forces

Measure acceleration and wheel slip to optimise speed along a maze.

## Pimp my ride

Develop a circuit board that attaches to the Formula AllCode robot using the servo outputs.

## Mobile bug

Create a spying device which drives to a location, records some speech, drives back and then plays the recorded speech back.

## Remote control

Use an old TV remote to make the robot move.

## Swarm

Use the Ir sensors to communicate between robots.

# API example commands

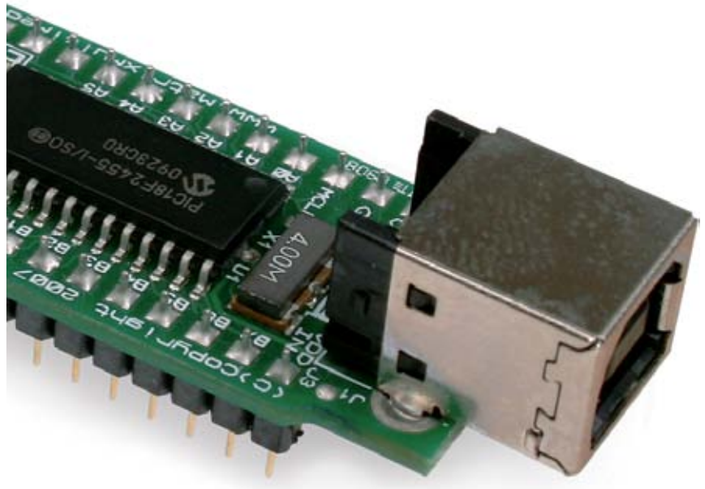
There are two ways of programming the AllCode: firstly students can construct a program using Flowcode or MPLAB and can download this program using USB or Bluetooth. The program will run autonomously in the robot.

Secondly students can use the AllCode as a Bluetooth connected slave to a host using a suite of commands we have provided. We call these commands the Application Programming Interface or 'API'. This means that it is easy to control the AllCode from computing platforms such as Android, MACOS, Windows, Raspberry Pi. The API is available in many languages (Python, App Inventor, Windows DLL, and more) and instructions on connecting major platforms to the AllCode are provided.

The table above lists some examples of the API.





# ECIO

ECIO hardware provides a low cost and simple way to move your projects to a finished state by allowing you to commit the ECIO into a static design. The ECIO boards all feature a direct USB connection to the microcontroller allowing for very easy USB communications and power. ECIO combined with Flowcode should all work great out of the box without having to worry about complicated road blocks such as configurations and oscillator circuits. They also provide one of the fastest and lowest cost ways of embedding advanced intelligence and control into your project.

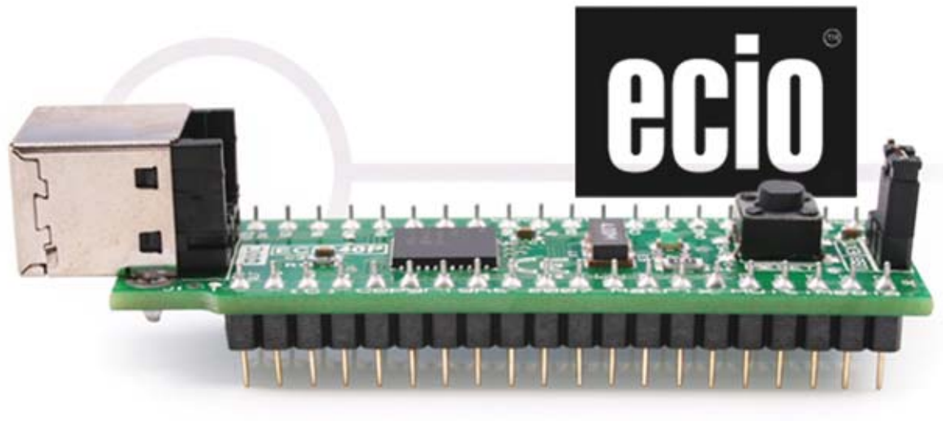
ECIOs are used by hobbyists, students and engineers to develop projects based on microcontroller technology and are particularly useful when in-field reprogrammability or USB features are required.

The ECIO family of USB programmable single board computers provides an incredibly simple way of adopting microcontroller technology into your projects. ECIO devices include a microcontroller with clock, power and programming circuitry on a standard 0.6" DIL header. When you plug the USB lead in to an ECIO you can reprogram the device or use the USB interface for communications with a PC.

Currently there are three ECIO devices based on PIC and dsPIC microcontrollers. ECIO devices are compatible with hex code from a number of compilers including Flowcode, BASIC, C and assembler.

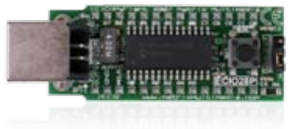
**ECIO single board computers provide one of the fastest and lowest cost ways of embedding advanced intelligence and control into your project.**

- 28 and 40 pin 0.6" footprint, professional capability.
- Adds USB reprogrammability to your own circuit boards.
- Programmable from USB, power from USB.
- Compatible with Flowcode, C, Assembly, LabView and Visual Basic.



The ECIO family of USB programmable microcontroller modules behave just like a normal microcontroller - but when you plug the USB lead in and press the reset switch you can send a new program to the device. This, along with the low cost, makes ECIO ideal for student work at home and for incorporating into student circuit boards. ECIO microcontrollers are pre-programmed with a bootloader program which allows you to send a new program to the microcontroller via USB. ECIO is compatible with hex code from any appropriate compiler including Flowcode, C compilers and MPLAB.

Flowcode programs and Windows drivers are available for ECIO devices making them suitable for use with LabView, Visual Basic, C++ etc.



## 28 pin PIC 18 ECIO

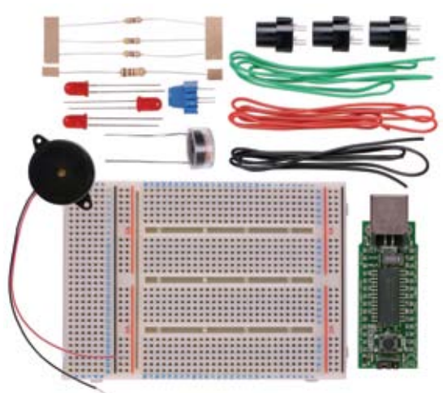
| | |
|---|---|
| Base chip | PIC18F2455 |
| Oscillator | 4MHz ext, 48MHz internal |
| I/O lines | 19 |
| A/D | 10 x 10 bit |
| A/D sample rate | 100ksps |
| Program memory | 24K bytes |
| RAM | 2K bytes |
| EEPROM | 256 bytes |
| Power | 5V, USB or external |
| PWM channels | 2 |
| Timers | 1 x 8 bit, 3 x 16 bit |
| Interfaces | EUSART, MI²C, SPI, USB2.0 |
| Package | 28 pin, 0.6", DIP compatible |
| | **ECIO28P** |

## 40 pin PIC 18 ECIO

| | |
|---|---|
| Base chip | PIC18F4455 |
| Oscillator | 4MHz ext, 48MHz internal |
| I/O lines | 30 |
| A/D | 13 x 10 bit |
| A/D sample rate | 100ksps |
| Program memory | 24K bytes |
| RAM | 2K bytes |
| EEPROM | 256 bytes |
| Power | 5V, USB or external |
| PWM channels | 5 |
| Timers | 1 x 8 bit, 3 x 16 bit |
| Interfaces | EUSART, MI²C, SPI, USB2.0 |
| Package | 40 pin, 0.6", DIP compatible |
| | **ECIO40P** |

## 40 pin dsPIC ECIO

| | |
|---|---|
| Base chip | dsPIC33EP256MU806 |
| Oscillator | 8MHz ext., 70MHz internal |
| I/O lines | 34 |
| A/D | 20 x 12 bit |
| A/D sample rate | 1.1 Msps |
| Program memory | 256K bytes |
| RAM | 28K bytes |
| EEPROM | 0 (internal ROM overwrite) |
| Power | 5V, USB or external |
| PWM channels | 16 |
| Timers | 9 x 16 bit |
| Interfaces | 4 x UART, 2 x MI2C, 4 x SPI, 2 x CAN, USB2.0 |
| Package | 40 pin DIP, 0.6" compatible |
| | **ECIO40P16** |



## Student ECIO starter kit

This kit is designed for students and hobbyists who want to start learning microcontroller circuit development at home. The kit is supplied with a high quality HPAD01 prototype board, a 28 PIN PICmicro microcontroller ECIO device (ECIO28P), 1.5 metres of single core prototype wire (red, black and green) and 13 electronic components which allow a wide range of experiments to be conducted. A suite of worksheets which includes build and software development instructions for 10 analogue and digital experiments are available from our website.

**Ordering information**

| | |
|---|---|
| Student ECIO starter kit | EC2961 |





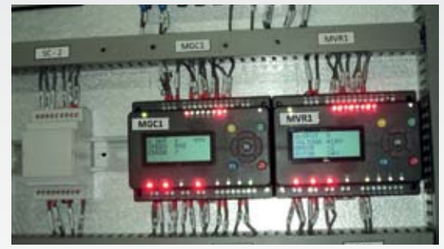


# MIAC

MIAC is now available in 5 models:

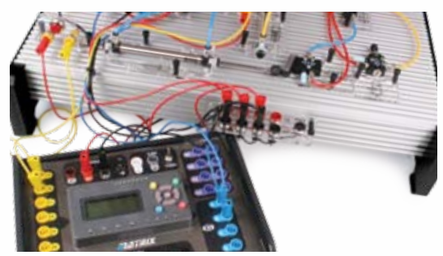
- PIC
- AVR/Arduino
- dsPIC
- Raspberry Pi
- AllCode

## MIACs have a wide range of uses:



*MIACs used to control a mid scale hydroelectric power station in Sri Lanka.*

*A dsPIC MIAC's CAN bus capabilities being used in an automotive application. Only the MIAC can handle CAN and Modbus without 'extra' extensions, it is easy to program, it has a build-in display and function keys*



*Educational version of the MIAC used in a Pneumatics training rig.*

MIAC controllers provide learners and developers with a high power, flexible electronic system in a rugged industrial standard case that sits on a standard 25mm 'top hat' DIN rail.

MIACs are electrically and physically compatible with a huge range of industrial accessories and expansion modules: from sensors to powerful motor controllers. MIAC controllers are based on a number of different microcontroller platforms (PIC, Arduino, Raspberry Pi) and can be programmed with a range of development tools.

There are now 5 different models of MIAC: PIC, dsPIC, AVR/Arduino, Raspberry Pi and AllCode. The choice you make will depend on the software tools you want to use and your application.

The range of inputs and outputs of the MIAC are well specified with analogue/digital inputs, motor control outputs, internal relays, and a number of communications interfaces including CAN, RS232, and RS485. Optional Bluetooth and Wi-Fi interfaces make MIAC perfect for Internet Of Things applications.

MIAC is fully compatible with our own Flowcode software (PIC, Arduino, dsPIC) and a full simulation of MIAC is available within Flowcode.

An educational version of the basic PIC MIAC with rugged plastic case and 4mm connectors is available.

# Features

PIC

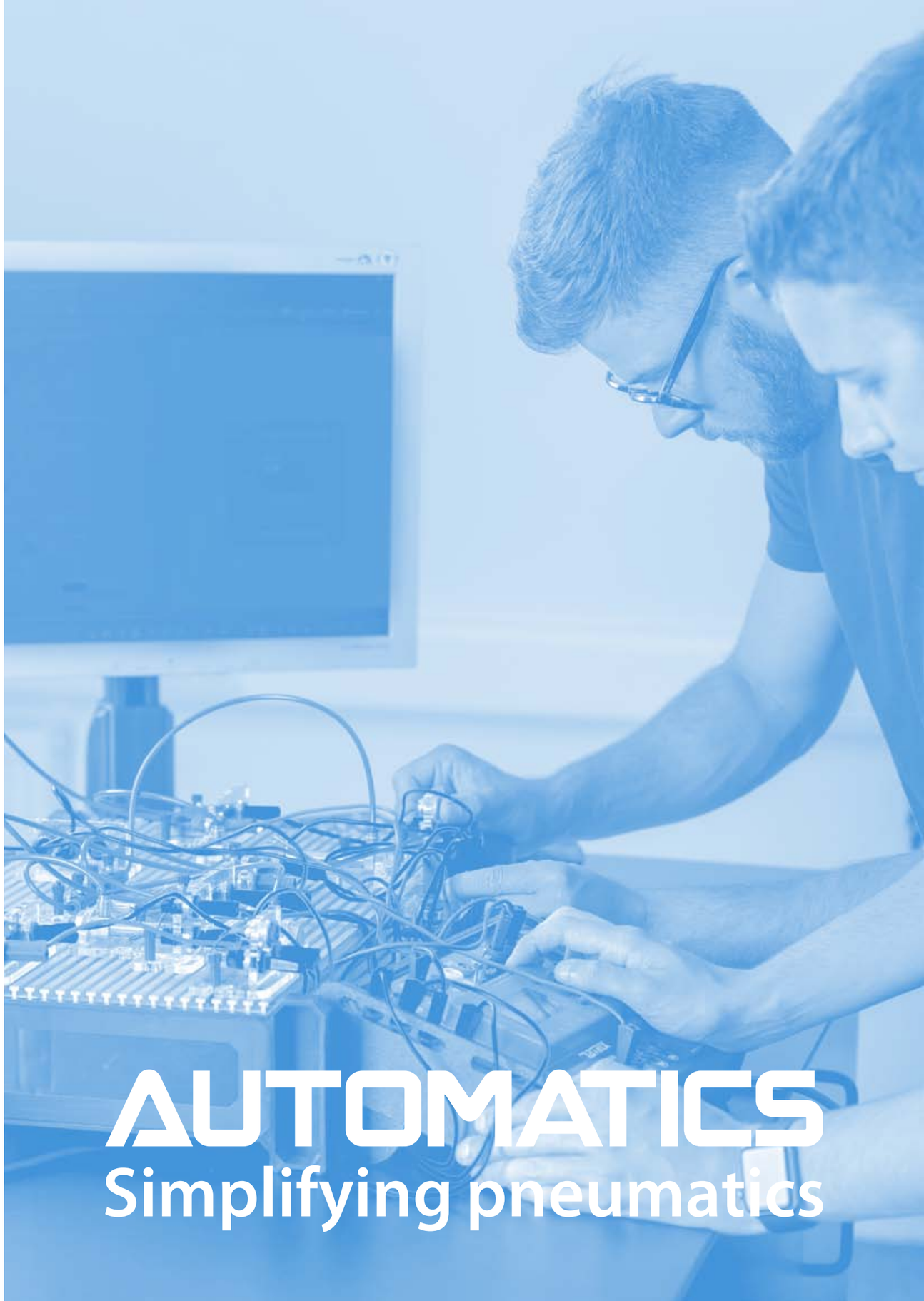
Arduino

dsPIC

RPi

AllCode

| | PIC | Arduino | dsPIC | RPi | AllCode |
|---|---|---|---|---|---|
| **Processor** | | | | | |
| | 8 bit, PIC18F | 8bit AVR/Arduino | 16bit dsPIC | 32bit ARM/RPi | 16bit dsPIC |
| **Processing speed** | | | | | |
| | 12 MIPS | 8 MIPS | 70 MIPS | 800MIPS | 70 MIPS |
| **Memory** | | | | | |
| | 32KB ROM, 2KB RAM | 128KB ROM, 8KB RAM | 256KB ROM, 28KB RAM | 4GB ROM, 512MB RAM | 256KB ROM, 28KB RAM |
| **Display** | | | | | |
| | 4 line 16 char LCD | 5 line 20 char. | 5 line 20 char. | 5 line 20 char. | 5 line 20 char. |
| | | Blue backlit graphical LCD | Blue backlit graphical LCD | Blue backlit graphical LCD | Blue backlit graphical LCD |
| **Communications formats** | | | | | |
| | CAN | RS232, RS485, CAN | RS232, RS485, CAN | RS232, RS485, CAN | RS232, CAN |
| | | | | Wi-fi as standard | |
| **Comms options** | | | | | |
| | | Wi-fi or Bluetooth | Wi-fi or Bluetooth | Bluetooth | Wi-fi or Bluetooth |
| | | (replacing RS485) | (replacing RS485) | (replacing RS485) | |
| **Internal peripherals** | | | | | |
| | | Micro SD card slot | Micro SD card slot | Micro SD card slot | Micro SD card slot |
| | | Real Time Clock | Real Time Clock | Real Time Clock | Real Time Clock |
| **Inputs - all either analogue or digital** | | | | | |
| | 8 x 0-12, 10 bit | 8 x 0-12, 10 bit | 8 x 0-12, 10 bit | 8 x 0-12, 10 bit | 8 x 0-12, 10 bit |
| **Outputs** | | | | | |
| | 4 x solid state (1.75A total) | 4 x solid state (5.6A total) | 4 x solid state (5.6A total) | 4 x solid state (5.6A total) | 4 x solid state (5.6A total |
| | 4 x relay (8A) | 4 x relay (8A) | 4 x relay (8A) | 4 x relay (8A) | 4 x relay (8A) |
| **Operating voltage** | | | | | |
| | 12V | 9 - 24V | 9 - 24V | 9 - 24V | 9 - 24V |
| **Software options** | | | | | |
| | Flowcode, C, ASM | Flowcode, C, ASM | Flowcode, C, ASM | Linux based | API provides which allows control to any host system with Bluetooth or Wi-Fi |
| | | Arduino C++ tool chain | | Python, C++ etc. | |
| | | | | Using remote desktop technology | |
| | | | | | |
| **Product codes - standard version** | | | | | |
| | MI0235 | MI5466 | MI5809 | MI5769 | With Wi-fi: MI5331 |
| | | With Wi-fi: MI9935 | With Wi-fi: MI8615 | With Bluetooth: MI6693 | With Bluetooth: MI5528 |
| | | With Bluetooth: MI3449 | With Bluetooth: MI8759 | | |
| **Product codes - education version with 4mm connectors** | | | | | |
| |  |  |  |  |  |
| | MI0245 | MI5138 | MI3494 | MI5718 | MI3971 |



## Simplifying pneumatics and automation

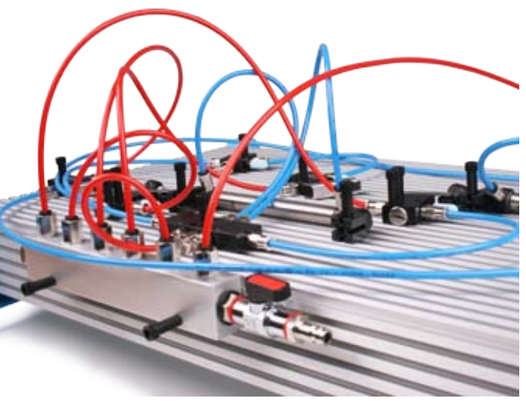
Automatics is a range of products that simplifies the process of teaching and learning about pneumatics and automation systems.

The Automatics range consists of separate rugged components that mount onto a stable aluminium platform. Components are clearly marked with the appropriate pneumatic or electrical symbol. Students take the rugged components, mount them to the platform using plastic 'tee' bolts and connect the components together with nylon tubing to build working pneumatic circuits.

They then use the curriculum provided to carry out experiments in pneumatic and electronic control.

## Disciplines include:

- Pneumatics
- Automation
- Design technology
- PLC programming



## The Automatics range include:

A rugged aluminium platform

*To which students add...*

A compressor

A manifold

Cylinders

Mechanical valves

Electrical valves

Connectors

Switches and sensors

A controller

Pneumatic tubing

Electrical cables

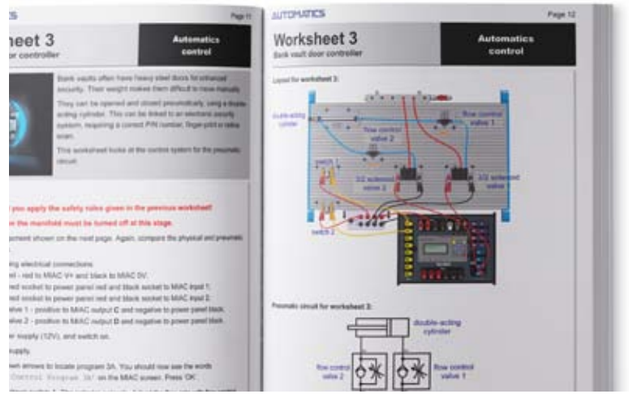






## Automatics Curriculum

Curriculum can be downloaded for free from our website. These workbooks provide lesson plans, student worksheets and teacher's notes for a variety of courses that can be used individually or as a coherent series. Students are guided through each subject in a logical sequence with clear, concise learning objectives at each stage, complete with quizzes and short tests by which their progress can be assessed.

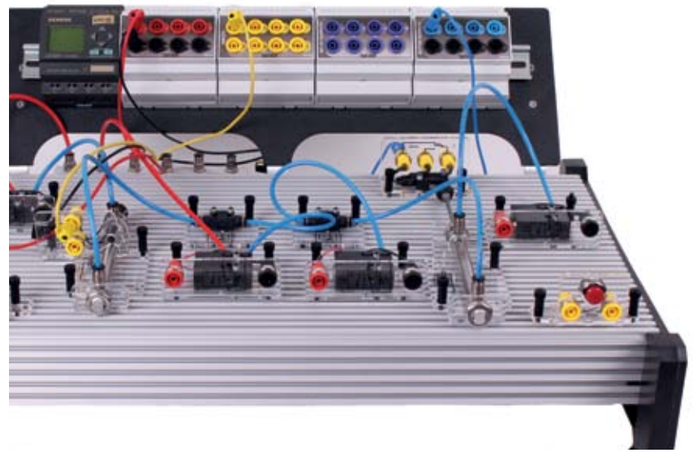



## Automatics Solutions

Automatics solutions fit into many different disciplines as they can be used to teach Technology/Computer science, Basic engineering and Mechanical engineering. Solutions are packed in rugged plastic trays and include power supplies where necessary and generous quantities of 'consumables' such as pneumatic tubing and fixings. Add-on packs are also available that are designed to extend the features of your core solution.

## Automatics in Industry

Now available is the Automatics PLC adaptor rail, meaning that the Automatics range can be used with any PLC. The adaptor rail allows PLCs to connect to relay and motor outputs using standard 4mm connectors which connect directly to other Automatics components. Any programming language, including ladder logic, can be used. PLC adaptor modules available are power distribution, inputs, motor outputs and relays.



## Why Choose Automatics

- Makes learning easier
- Rugged and reliable
- Integrate Pneumatics & Control
- Covers a range of subject areas
- Extensive free curriculum
- Range of individual components
- Sturdy storage for solutions
- Minimal assembly required

Check out industrial PLCs as part of our partnership with Siemens on page 62

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| Energy & the environment (LK7345-2) | 7 | 2, 3 | | | | | | | | | |
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| Cloud Chamber (AS4681) | 10 | 2, 3 | | | | | | | | | |
| Digital Voltmeter/Ammeter class set (AS1106/AS4472) | 11 | 2, 3 | | | | | | | | | |
| Advanced physical optics kit | 12, 14 | | 4* | | | | | | | | |
| Principles of Optical Waveguiding kit (FP0294) | 15 | | 4* | | | | | | | | |
| Advanced fibre optic communications kit (FP4010) | 15 | | 4* | | | | | | | | |
| Bit error rate & eye diagrams kit (FP6269) | 16 | | 4* | | | | | | | | |
| Optical network analysis & OTDR kit (FP0374 / FP2350) | 16 | | 4* | | | | | | | | |
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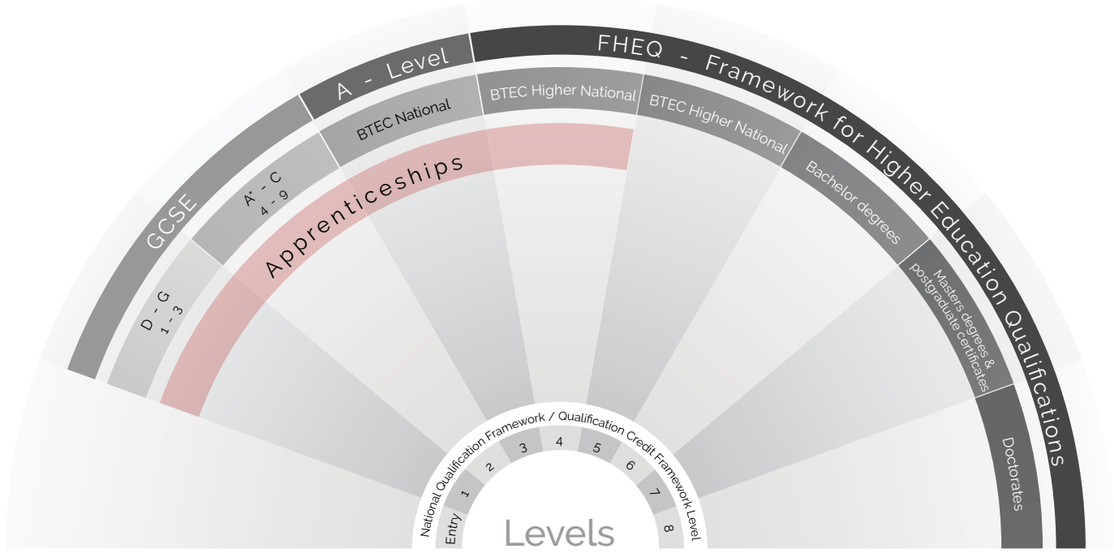


The Matrix curriculum map is designed to give you an idea of the educational levels for which our products are developed. The wheel-diagram on this page explains more about levels of educational achievement in the United Kingdom.

We map our curriculum to internationally renowned syllabi, from:

- Pearson (mainly through the BTEC qualifications)
- City & Guilds
- EAL
- WJEC/Eduqas
- AQA
- OCR
- European Aviation Safety Authority
- Institute of Motor Industry
- OAL

We're also able to develop specific equipment for a range of higher education qualifications at undergraduate and postgraduate level and we work with some of the World's most prestigious Universities.

Throughout our catalogue, each solution details selected curriculum units, so you can select what you require accordingly, however this is by no means a definitive list.

For further explanation or help with this, do not hesitate to get in touch.

## AllCode

| Product Code | Description |
|---|---|
| RB4191 | Formula AllCode standard kit |
| RB4938 | Formula AllCode football mat add-on |
| RB6231-2 | Robot Arm solution |
| RB7240 | Formula AllCode standard class set |
| RB7518 | Formula AllCode deluxe class set |
| RB7971 | Formula AllCode deluxe kit |
| RB8962 | Maze Walls (for Formula AllCode) |
| RB8975 | Maze Mat (for Formula AllCode) |

## Automatics

| Product Code | Description |
|---|---|
| AU1010 | Manifold |
| AU1020 | Reservoir 45cc |
| AU1030 | Junction, equal tee |
| AU1040 | Platform |
| AU1050 | Compressor |
| AU1060 | Tee-bolts and sleeves (pack of 50) |
| AU1070 | TuBing, 4mm, red, 30 m length |
| AU1071 | TuBing, 4mm, yellow, 30 m length |
| AU1072 | TuBing, 4mm, blue, 30 m length |
| AU1073 | TuBing, 4mm, clear, 30 m length |
| AU1080 | Tube cutting tool |
| AU2140 | Cylinder, single acting, 10 * 40 mm |
| AU2280 | Cylinder, double acting, 10 * 80 mm |
| AU3022 | Valve, flow control |
| AU3200 | Valve, 3/2, button-spring |
| AU3201 | Valve, 3/2, diaphragm-spring |
| AU3202 | Valve, 3/2, lever-spring |
| AU3203 | Valve, mini shuttle |
| AU3204 | Valve, 3/2, roller-spring |
| AU5200 | Valve, 5/2, lever-spring |
| AU5201 | Valve, 5/2, pilot-pilot |
| AU6010 | Valve, 3/2, solenoid-spring |
| AU6015 | Valve, 5/2, double-solenoid |
| AU8010 | Light sensor |
| AU8015 | Microswitch |
| AU8020 | Power panel |
| AU8025 | Reed switch and holder |
| AU8030 | Switch, push to make |
| AU9010 | Automatics control add-on kit |
| AU9015 | Automatics electro-pneumatics add-on |
| AU9020 | Automatics essentials solution |
| AU9025 | Automatics control add-on kit (without MIAC) 12 Volt |
| AU9030 | Automatics control add-on kit (no MIAC) 24 Volt |
| AW20780 | Automatics interactive courseware |

## E-blocks2

| Product Code | Description |
|---|---|
| BL0011 | E-blocks2 PIC programmer |
| BL0032 | E-blocks 2 - dsPIC programmer |
| BL0036 | E-blocks2 Raspberry Pi shield |
| BL0055 | E-blocks2 Arduino shield |
| BL0061 | E-blocks2 ARM programmer |
| BL0080 | E-blocks2 - PIC Multiprogrammer |
| BL0086 | E-blocks2 AVR programmer |
| BL0106 | E-blocks2 - Click board |
| BL0113 | E-block2 Converter board 2 |
| BL0114 | E-blocks2 Combo board |
| BL0117 | E-blocks2 - Protoype board |
| BL0119 | E-blocks2 - Converter board 1 |
| BL0127 | E-blocks2 Actuators board |
| BL0129 | E-blocks2 - Grove board |
| BL0136 | E-blocks2 Wi-Fi board |
| BL0138 | E-blocks2 - Keypad |
| BL0139 | E-blocks2 Mono gLCD board |
| BL0140 | E-blocks2 CAN bus board |
| BL0145 | E-blocks2 - Switch board |
| BL0152C | E-blocks2 Zigbee co-ordinator board |
| BL0152R | E-blocks2 Zigbee router board |
| BL0154 | E-blocks2 uSD board |
| BL0155 | E-blocks2 - Expander |
| BL0156 | E-blocks2 - Splitter board |
| BL0157 | E-blocks2 Colour gLCD board |
| BL0158 | E-blocks2 upstream to upstream connector |
| BL0161 | E-blocks2 manual patch board |
| BL0162 | E-blocks2 servo motor board |
| BL0167 | E-blocks2 - LED board |
| BL0169 | E-blocks2 LCD board |
| BL0170 | E-blocks2 Bluetooth board |
| BL0173 | E-blocks2 Terminal board |
| BL0183 | E-blocks2 Relay board |
| BL0502 | PIC microcontroller system development kit (modular) |
| BL0503 | dsPIC Microcontroller system development kit |
| BL0505 | PIC programmer and combo board |
| BL0514 | dsPIC development centre and printed panel |
| BL0518 | AVR development centre and printed panel |
| BL0524 | PIC microcontroller system development kit (combo) |
| BL0540 | Arduino microcontroller system development kit (combo) |
| BL0544 | Arduino programmer and combo board |
| BL0546 | ARM microcontroller system development kit |
| BL0554 | Arduino microcontroller system development kit (modular) |
| BL0555 | E-blocks2 Grove sensor development kit |
| BL0557 | Raspberry Pi development centre and printed panel |
| BL0560 | Raspberry Pi programmer and combo board |
| BL0562 | PIC development centre and printed panel |
| BL0564 | dsPIC programmer and combo board |
| BL0570 | AVR programmer and combo board |
| BL0575 | Raspberry Pi Microcontroller system development kit |
| BL0591 | AVR Microcontroller system development kit |
| BL0593 | ARM development centre and printed panel |
| BL0596 | ARM programmer and combo board |
| BL0599 | Arduino development centre and printed panel |

## Lascells

| Product Code | Description |
|---|---|
| AS0371 | Ripple tank Mk III |
| AS0933 | Optics screen |
| AS1106 | Digital voltmeter - class pack of 15 |
| AS1855 | Demonstration electric motor |
| AS2519 | Photo detector |
| AS2563 | Digital voltmeter |
| AS3248 | Emitter detector pair |
| AS3403 | Simple Timer |
| AS3529 | Stationary wave apparatus |
| AS3665 | Optics board |
| AS3973 | Colour mixer |
| AS4256 | Speed of sound |
| AS4472 | Digital ammeter - class pack of 15 |
| AS4672 | B.I.L. coil |
| AS4681 | Cloud chamber |
| AS4810 | Residual current circuit breaker (RCCB) demo |
| AS4882 | Fibre optics system |
| AS5069 | Spare cloud chamber source |
| AS5432 | Mirror support blocks |
| AS6838 | LED raybox |
| AS7043 | Ultrasonic system |
| AS7068 | Optics bench pair |
| AS7316 | Plane mirror (set of 10) |
| AS8553 | Bridge rectifier system |
| AS8623 | Adjustable magnet |
| AS8722 | AC waveform demo |
| AS8848 | LED light source |
| AS9084 | Digital ammeter |
| AS9130 | Colour filter set |
| AS9269 | Strip and wire tester |
| AS9997 | Circuit breaker |

## Locktronics

| Product Code | Description |
|---|---|
| HP2673 | Locktronics engineering panel |
| HP6320 | Locktronics demo panel |
| LK0123-00 | Small bar magnet |
| LK0124 | Small compass |
| LK1110 | Multimeter |
| LK1989 | Transformer construction and operation |
| LK2285 | Principles of Lighting solution |
| LK2340 | AC voltage source carrier |
| LK2341 | MES bulb, 2.5V, 0.2A |
| LK2346 | MES bulb, 12V, 0.1A |
| LK2347 | MES bulb, 6V, 0.06A |
| LK2350 | MES bulb, 6.5V, 0.3A |
| LK2364 | 12V 200mA minature mes lamp |
| LK2839 | CAN bus systems and operation with Engineering panel (DIN) |
| LK2839A | CAN bus systems and operation with Engineering panel (ANSI) |
| LK2901 | 8202 Level 2 - Electronic componentsand circuits solution |
| LK2975 | Source - combined power supply & signal generator 240V |
| LK3000 | 4 x 4 baseboard with 4mm pillars and battery holders |
| LK3246 | Buzzer, 12V, 15mA |
| LK3288 | Battery contact spring |
| LK3293 | Spare 4mm pillar and bolt |
| LK3566 | Fault Finding in Electronic Circuits |
| LK3568 | Power and Energy Electronics solution |
| LK3662 | Capacitor, 22,000uF, Electrolytic 16V |
| LK3889-2 | Intermediate electronic engineering solution |
| LK3889-2A | Intermediate electronic engineering (ANSI) |
| LK3893 | Resistor, variable, 250 ohm |
| LK3982 | Voltmeter, 0V to 15V |
| LK4002 | Resistor, 100 ohm, 3W, 5% (DIN) |
| LK4002A | Resistor, 100 ohm, 3W, 5% (ANSI) |
| LK4003 | Capacitor, 1,000 uF, Electrolytic 30V |
| LK4021 | Ferrite rod carrier |
| LK4025 | Resistor, 10 ohm, 3W 5% (DIN) |
| LK4025A | Resistor, 10 ohm, 3W 5% (ANSI) |
| LK4034 | Potentiometer, 1k (DIN) |
| LK4034A | Potentiometer, 1k (ANSI) |
| LK4063 | Electrical Installation 2 solution |
| LK4065 | Resistor, 47 ohm, 3W, 5% (DIN) |
| LK4065A | Resistor, 47 ohm, 3W, 5% (ANSI) |
| LK4100 | Resistor, 12 ohm, 3W, 5% (DIN) |
| LK4100A | Resistor, 12 ohm, 3W, 5% (ANSI) |
| LK4102 | Motor, 6V, open frame |
| LK4103L | Changeover Reed Relay with 2mm to 4mm lead |
| LK4121 | Voltage dependant resistor |
| LK4123 | Transformer, 2:1 turns ratio |
| LK4221-2 | An introduction to digital electronics solution |
| LK4221-2A | An introduction to digital electronics solution (ANSI) |
| LK4322 | Stepper Motor |
| LK4500CUS | Automotive Combination kit |
| LK4562 | Electrical installation circuit principles |
| LK4663 | Low power solar motor |
| LK4690L | USB reprogrammable PIC carrier with power leads |
| LK4786 | Automotive fuse carrier |
| LK4839 | Locktronics mini prototype board |
| LK4893 | Hand cranked generator |
| LK4961 | Three Phase Systems |
| LK5000 | Electrical Installation 1 solution |
| LK5054 | Lead, 2m BNC plug to croc clips |
| LK5100 | Locktronics current probe |
| LK5146 | Transistor, JGFET |
| LK5201 | Resistor, 33k, 1/4W, 5% (DIN) |
| LK5201A | Resistor, 33k, 1/4W, 5% (ANSI) |
| LK5202 | Resistor, 1k, 1/2W, 5% (DIN) |
| LK5202A | Resistor, 1k, 1/2W, 5% (ANSI) |
| LK5203 | Resistor, 10k, 1/4W, 5% (DIN) |
| LK5203A | Resistor, 10k, 1/4W, 5% (ANSI) |
| LK5204 | Resistor, 270k, 1/4W, 5% (DIN) |
| LK5204A | Resistor, 270k, 1/4W, 5% (ANSI) |
| LK5205 | Resistor, 270 ohm, 1/2W, 5% (DIN) |
| LK5205A | Resistor, 270 ohm, 1/2W, 5% (ANSI) |
| LK5206 | Resistor, 120 ohm, 1/2W, 5% (DIN) |
| LK5206A | Resistor, 120 ohm, 1/2W, 5% (ANSI) |
| LK5207 | Resistor, 180 ohm, 1/2W, 5% (DIN) |
| LK5207A | Resistor, 180 ohm, 1/2W, 5% (ANSI) |
| LK5208 | Potentiometer, 250 ohm (DIN) |
| LK5208A | Potentiometer, 250 ohm (ANSI) |
| LK5209 | Resistor, 5.6k, 1/4W, 5% (DIN) |
| LK5209A | Resistor, 5.6k, 1/4W, 5% (ANSI) |
| LK5210 | Resistor, 1.5M, 1/4W, 5% (DIN) |
| LK5211 | Resistor, 3.9 ohm, 3W, 5% (DIN) |
| LK5212 | Potentiometer, 25 ohm (DIN) |
| LK5213 | Potentiometer, 1M (DIN) |
| LK5214 | Potentiometer, 10k (DIN) |

Product glossary



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| | |
|---|---|
| LK5214A | Potentiometer, 10k (ANSI) |
| LK5215 | Resistor, 220 ohm, 1/2W, 5% (DIN) |
| LK5215A | Resistor, 220 ohm, 1/2W, 5% (ANSI) |
| LK5217 | Resistor, 68 ohm 3W, 5% (DIN) |
| LK5217A | Resistor, 68 ohm 3W, 5% (ANSI) |
| LK5218 | Resistor, 100k, 1/4W, 5% (DIN) |
| LK5218A | Resistor, 100k, 1/4W, 5% (ANSI) |
| LK5219 | Potentiometer, 100k (DIN) |
| LK5221 | Capacitor, 10 uF, Electrolytic, 25V |
| LK5222 | Capacitor, 100nF, Polyester |
| LK5224 | Capacitor, 47uF, Electrolytic, 25V |
| LK5240 | Transistor RHF, NPN |
| LK5241 | Transistor LHF, NPN |
| LK5242 | Diode, germanium |
| LK5243 | Diode, power, 1A, 50V |
| LK5246 | Transistor, unijunction |
| LK5247 | Zener diode, 4.7V |
| LK5248 | Thyristor |
| LK5249 | Diode, silicon |
| LK5250 | Connecting Link |
| LK5251 | Crossover link |
| LK5252 | Resistor, Rx (DIN) |
| LK5252A | Resistor, Rx (ANSI) |
| LK5253 | Zener diode, 6.8V |
| LK5254 | Zener diode, 8.2V |
| LK5255 | Transistor RHF, PNP |
| LK5256 | Transistor LHF, PNP |
| LK5258 | Zener diode, 12V |
| LK5266 | Bridge rectifier |
| LK5280 | Relay, 12V coil, 10A, normally open |
| LK5287 | Lampholder, MES, for automotive LEDs |
| LK5290 | Sampler |
| LK5291 | Lampholder, MES |
| LK5294 | Terminal post |
| LK5297 | Lead, black, 600mm, 4mm to croc clip |
| LK5297E | Lead, black, 320mm, 2mm to croc clip |
| LK5298 | Lead, red, 600mm, 4mm to croc clip |
| LK5298E | Lead, red, 320mm, 2mm to croc clip |
| LK5299 | 400 turn induction coil |
| LK5401 | Thermistor, 470 ohm, NTC (DIN) |
| LK5401A | Thermistor, 470 ohm, NTC (ANSI) |
| LK5402 | Thermistor, 4.7k, NTC (DIN) |
| LK5402A | Thermistor, 4.7k, NTC (ANSI) |
| LK5403 | Relay, 6V coil, 10A, normally open |
| LK5404 | Switch, reed, normally open |
| LK5405 | Relay, reed, normally open |
| LK5555 | Lead, red, 250mm, 4mm to 2mm stackable |
| LK5555E | Lead, red, 300mm, 2mm to 2mm stackable |
| LK5556 | Lead, black, 300mm, 4mm to 2mm stackable |
| LK5556E | Lead, black, 300mm, 2mm to 2mm stackable |
| LK5557 | Lead, white, 300mm, 4mm to 2mm stackable |
| LK5557E | Lead, white, 300mm, 2mm to 2mm stackable |
| LK5570 | Pair of leads, red and black, 600mm, 4mm to croc clip |
| LK5601 | Lead - green - 320mm, 4mm to 4mm stackable |
| LK5603 | Lead, red, 500mm, 4mm to 4mm stackable |
| LK5603E | Lead, red, 500mm, 4mm shrouded to 2mm stackable |
| LK5604 | Lead, black, 500mm, 4mm to 4mm stackable |
| LK5604E | Lead, black, 500mm, 4mm shrouded to 2mm stackable |
| LK5607 | Lead, yellow, 500mm, 4mm to 4mm stackable |
| LK5607E | Lead, yellow, 500mm, 2mm to 2mm stackable |
| LK5609 | Lead, blue, 500mm, 4mm to 4mm stackable |
| LK5620 | Lead, yellow, 1000mm 4mm to 4mm stackable |
| LK5640 | Lead, blue, 1000mm, 4mm to 4mm stackable |
| LK5660 | Lead, black, 1000mm, 4mm to 4mm stackable |
| LK5680 | Lead, red, 3000mm, 4mm to 4mm stackable |
| LK5695 | Lead, D-type to yellow and blue 4mm for CAN analyser |
| LK5697 | OBD2 to 4mm Lead |
| LK5783-2 | Industrial sensor, actuator and control solution |
| LK5783-2A | Industrial sensor, actuator and control solution (ANSI) |
| LK5800 | Blank Carrier - small (Pack of 20) |
| LK5822 | PICmicro microcontroller add-on kit (DIN) |
| LK5822A | PICmicro microcontroller add-on kit (ANSI) |
| LK5900 | Blank Carrier - large (Pack of 10) |
| LK5940 | 4 x 4 baseboard with 2mm pillars and battery holders |
| LK5987 | 33uF non-electrolytic capacitor |
| LK6200 | Resistor, 1M, 1/4W, 5% (DIN) |
| LK6200A | Resistor, 1M, 1/4W, 5% (ANSI) |
| LK6201 | Resistor, 330k, 1/4W, 5% (DIN) |
| LK6201A | Resistor, 330k, 1/4W, 5% (ANSI) |
| LK6202 | Capacitor, 100uF, Electrolytic, 25V |
| LK6203 | Capacitor, 2,200 uF, Electrolytic, 25V |
| LK6205 | Capacitor, 1 uF, Polyester |
| LK6206 | Capacitor. 4.7uF, electrolytic, 25V |
| LK6207 | Switch, push to make, metal strip |
| LK6208 | Switch, changover, metal strip |
| LK6209 | Switch, on/off, metal strip |
| LK6211 | Resistor, 22k, 1/4W, 5% (DIN) |
| LK6211A | Resistor, 22k, 1/4W, 5% (ANSI) |
| LK6212 | Resistor, 150k, 1/4W, 5% (DIN) |
| LK6213 | Resistor, 15k, 1/4W, 5% (DIN) |
| LK6213A | Resistor, 15k, 1/4W, 5% (ANSI) |
| LK6214 | Capacitor, variable, 15-140pF |
| LK6214R1 | Choke, 10mH |
| LK6214R2 | Choke, 47mH |
| LK6214R3 | Choke, 5mH |
| LK6215 | Choke, 68 mH |
| LK6216 | Capacitor, 470nF, Polyester |
| LK6217 | Capacitor, 2.2 uF, Polyester |
| LK6218 | Resistor, 2.2k, 1/4W, 5% (DIN) |
| LK6218A | Resistor, 2.2k, 1/4W, 5% (ANSI) |
| LK6219 | Resistor, 560 ohm, 1/4W, 5% (DIN) |
| LK6219A | Resistor, 560 ohm, 1/4W, 5% (ANSI) |
| LK6223 | Capacitor, 150 uF, Electrolytic, 25V |
| LK6224 | Switch, changeover, toggle |
| LK6230 | Resistor, 5k, 1/4W, 5% (DIN) |
| LK6231 | Resistor, 50k, 1/4W, 5% (DIN) |
| LK6231A | Resistor, 50k, 1/4W, 5% (ANSI) |
| LK6232 | Resistor, 500k, 1/4W, 5% (DIN) |
| LK6232A | Resistor, 500k, 1/4W, 5% (ANSI) |
| LK6233 | Resistor, 10M, 1/4W, 5% (DIN) |
| LK6234L | Op Amp Carrier (TL081) with 2mm to 4mm Leads |
| LK6234LE | Op Amp Carrier (TL081) with 2mm to 2mm Leads |
| LK6237 | Resistor, 500 ohm, 1/2W, 5% (DIN) |
| LK6238 | Resistor, 200k, 1/4W, 5% (DIN) |
| LK6238A | Resistor, 200k, 1/4W, 5% (ANSI) |
| LK6239 | Capacitor, 1nF, Polyester |
| LK6283 | Capacitor, 100pF, Ceramic |
| LK6299 | Capacitor, 4n7, Ceramic |
| LK6423 | Buzzer, 6V, 15mA |
| LK6444 | Fundamentals of electricity solution (DIN) |
| LK6444A | Fundamentals of electricity solution (ANSI) |
| LK6482 | Fleming's motor rule apparatus |
| LK6483 | Hybrid automotive principles on engineering panel (DIN) |
| LK6483A | Hybrid automotive principles on engineering panel (ANSI) |
| LK6491-2 | Sensors and control for automotive with panel (DIN) |
| LK6491-2A | Sensors and control for automotive with panel (ANSI) |
| LK6499-2 | Industrial, sensor, actuator and control solution on panel |
| LK6500L | D-Type Flip-Flop (horizontal) with 2mm to 4mm lead |
| LK6500LE | D-type flip flop - horizontal with 2mm to 2mm lead |
| LK6501L | D-Type flip flop (vertical) with 2mm to 4mm leads |
| LK6501LE | D-Type flip flop (vertical) with 2mm to 2mm leads |
| LK6574 | Lead, red, 2000mm, 4mm to 4mm plug |
| LK6630 | Resistor, variable, 10k (DIN) |
| LK6631 | Resistor, variable 100k (DIN) |
| LK6632 | Switch, reversing, toggle |
| LK6633 | Switch, on/off, toggle |
| LK6634 | Microswitch carrier |
| LK6635 | LED, Red |
| LK6635A | LED, Red (ANSI) |
| LK6636 | LED, Green |
| LK6636A | LED, Green (ANSI) |
| LK6637 | LED, Yellow |
| LK6637A | LED, Yellow (ANSI) |
| LK6653 | Capacitor, 4,700 uF, Electrolytic, 16V |
| LK6705 | Power transistor, NPN, 1.5A |
| LK6706 | Motor 3 to 12V DC, 0.7A |
| LK6707L | Slotted opto sensor with 2mm to 4mm lead |
| LK6709 | NPN Darlington Transistor carrier |
| LK6734 | Hall effect switch |
| LK6749 | MES bulb, 12V, LED, red |
| LK6802 | New Class pool kit |
| LK6802A | New Class Pool Kit (ANSI) |
| LK6804 | Advanced Electronic Principles |
| LK6804A | Advanced Electronic Principles (ANSI) |
| LK6822 | MES bulb, 12V, LED, yellow |
| LK6831L | Systems Block Transistor Switch |
| LK6832 | Systems Block transducer driver |
| LK6838 | Solenoid |
| LK6841 | MES bulb, 12V, LED, white |
| LK6850 | Thermistor and moisture sensor PCB |
| LK6854 | Lead - red - 300mm, 2mm to 2mm stackable |
| LK6860L | AND Gate with 2mm to 4mm lead - ANSI |
| LK6860LE | AND gate with 2mm to 2mm lead - ANSI |
| LK6861L | OR Gate with 2mm to 4mm lead - ANSI |
| LK6861LE | OR gate with 2mm to 2mm lead - ANSI |
| LK6862L | NOT Gate with 2mm to 4mm lead - ANSI |
| LK6862LE | NOT gate with 2mm to 2mm lead - (ANSI) |
| LK6863L | NAND Gate with 2mm to 4mm lead - ANSI |
| LK6863LE | NAND gate with 2mm to 2mm lead - ANSI |
| LK6864L | NOR Gate with 2mm to 4mm lead - ANSI |
| LK6864LE | NOR gate with 2mm to 2mm lead - ANSI |
| LK6865L | XOR Gate with 2mm to 4mm lead - ANSI |
| LK6865LE | XOR gate with 2mm to 2mm lead - ANSI |
| LK6870L | AND Gate with 2mm to 4mm lead - SB |
| LK6870LE | AND gate with 2mm to 2mm lead - SB |
| LK6871L | OR Gate with 2mm to 4mm lead - SB |
| LK6871LE | OR gate with 2mm to 2mm lead - SB |
| LK6872L | NOT Gate with 2mm to 4mm lead - SB |
| LK6872LE | NOT gate with 2mm to 2mm lead - SB |
| LK6873L | NAND Gate with 2mm to 4mm lead - SB |
| LK6873LE | NAND gate with 2mm to 2mm lead - SB |
| LK6874L | NOR Gate with 2mm to 4mm lead - SB |
| LK6874LE | NOR gate with 2mm to 2mm lead - SB |
| LK6875L | XOR Gate with 2mm to 4mm lead - SB |
| LK6875LE | XOR gate with 2mm to 2mm lead - SB |
| LK6904 | Combinational logic add-on kit |
| LK6904A | Combinational Logic add-on pack (ANSI) |
| LK6905 | Sequential logic add-on kit. (DIN) |
| LK6905A | Sequential logic add-on kit (ANSI) |
| LK6906 | Operational amplifiers add-on kit (DIN) |
| LK6906A | Operational amplifiers add-on kit (ANSI) |
| LK6908 | Electronic Devices and Circuits add-on kit |
| LK6908A | Electronic Devices and Circuits add-on kit |
| LK6910 | Locktronics logic add on kit |
| LK6910A | Locktronics logic add on kit (ANSI) |
| LK6999 | Source - combined power supply & signal generator 110V |
| LK7049L | Relay, 12V coil, 10A, changeover with 2mm to 4mm lead |
| LK7148-2 | Operational amplifiers solution |
| LK7148-2A | Operational amplifiers solution (ANSI) |
| LK7203 | Power transistor, NPN, 10A |
| LK7208 | Voltage regulator (7805) |
| LK7215 | Blank resistor carrier (SB) |
| LK7215A | Blank resistor carrier (ANSI) |
| LK7216 | Blank capacitor carrier |
| LK7217 | Blank electrolytic capacitor carrier |
| LK7218 | Blank NPN transistor carrier |
| LK7219 | Transistor, FET |
| LK7290 | Phototransistor Carrier |
| LK7302 | 7 x 5 baseboard with 2mm pillars |
| LK7345-2 | Energy and Environment solution (DIN) |
| LK7345-2A | Energy and Environment solution (ANSI) |
| LK7361 | Photodiode |
| LK7409 | AA battery holder carrier |
| LK7444 | An Intro to motors, generators & hybrid solution (DIN) |
| LK7444A | An Introduction to Motors and Generators solution (ANSI) |
| LK7461 | Power supply carrier with voltage source symbol |
| LK7483 | 1:1 transformer with retractable ferrite core |
| LK7485 | Alnico Rod Magnet (2 per pack) |
| LK7487 | Lenz's law kit |
| LK7489 | Faraday's law kit |
| LK7582L | 555 timer carrier |
| LK7629 | CAN bus systems and operation (DIN) |
| LK7629A | CAN bus systems and operation (ANSI) |
| LK7746 | Solar cell |
| LK7889L | Relay, 6V, 10A, changeover, with 2mm to 4mm lead |
| LK7936 | Fuse/universal component carrier |
| LK8000 | Schottky diode |
| LK8011 | Power MOSFET transistor |
| LK8013 | Blank diode carrier |
| LK8022 | General purpose lead set (LK5603 x 2, LK5604 x 2) |
| LK8113 | Motor with reluctor |
| LK8150 | Nichrome Wire Carrier, 0.075 x 500mm |



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| | |
|---|---|
| LK8152 | Nichrome Wire Carrier, 0.075 x 250mm |
| LK8154 | Nichrome Wire Carrier, 0.21 x 500mm |
| LK8156 | Constantan Wire Carrier, 0.075 x 500mm |
| LK8222 | AC Principles for Automotive Technicians solution (DIN) |
| LK8222A | AC Principles for Automotive Technicians solution (ANSI) |
| LK8275 | Power supply carrier with battery symbol |
| LK8397 | Ammeter, 0A to 1A |
| LK8492 | Dual rail power supply carrier |
| LK8591 | Energy Meter |
| LK8615 | Battery retaining clip |
| LK8623 | Circuit Breaker |
| LK8743 | Magnetic Pickup |
| LK8900 | 7 x 5 metric baseboard with 4mm pillars |
| LK8922-2 | Locktronics PIC systems solution |
| LK8922-2A | Locktronics PIC systems solution (ANSI) |
| LK8932 | Speaker |
| LK8980 | Resistor, 50ohm, 1/4W, 2% |
| LK8988 | Thermocouple and carrier |
| LK8990 | 3MHz signal generator |
| LK9044 | Advanced electrical, electronic and digital principles (DIN) |
| LK9044A | Advanced electrical electronic and digital principles (ANSI) |
| LK9071-2 | Electricity, magnetism and materials solution V2 |
| LK9071-2A | Electricity, magnetism and materials solution V2 (ANSI) |
| LK9282 | EASA electronic fundamentals (module 4) |
| LK9282A | EASA electronic fundamentals (Module 4) ANSI |
| LK9329-2 | New electrical and electronics principles solution |
| LK9329-2A | New electrical and electronic principles solution (ANSI) |
| LK9339 | EASA electrical fundamentals (module 3) |
| LK9339A | EASA electrical fundamental module 3 (ANSI) |
| LK9381 | Ammeter, 0mA to 100mA |
| LK9422 | Principles & applications of Electronic Devices & Circuits |
| LK9422A | Principles & applications of Electronic Device (ANSI) |
| LK9435 | Transistor amplifiers add-on pack |
| LK9435A | Simple transistor amplifiers add-on pack (ANSI) |
| LK9438 | Voltmeter, +/- 7.5V |
| LK9672 | EASA electrical and electronic fundamentals (3 and 4) (DIN) |
| LK9672A | EASA electrical and electronic fundamentals (3 and 4) (ANSI) |
| LK9834-2 | Sensors and control in automotive solution (DIN) |
| LK9834-2A | Sensors and control in automotive solution (ANSI) |
| LK9862 | Intermediate electrical and electronic engineering |
| LK9862A | Intermediate electrical and electronic engineering (ANSI) |
| LK9877 | Choke, 200mH |
| LK9998 | 400 Turn coil carrier |

## Mechanical kits & other

| Product Code | Description |
|---|---|
| HP0232 | Centrifugal Force Kit |
| HP1282 | Spring Tester Kit |
| HP2810 | Tetrix Prime Starter Set |
| HP4159 | Thermodynamics Kit |
| HP4550-V2 | Mechatronic systems V2 |
| HP5000 | Essential Base Unit |
| HP5005 | Forces Kit |
| HP5010 | Moments Kit |
| HP5015 | Deflections of Beams and Cantilevers Kit |
| HP5020 | Torsion of Circular Sections Kit |
| HP5025 | Tensile Tester Kit |
| HP5030 | Simple Harmonic Motion Kit |
| HP5035 | Friction and Inclined Plane Kit |
| HP5040 | Potential and Kinetic Energy Kit |
| HP5045 | Drive Systems Kit |
| HP5050 | Cam, Crank and Toggle Kit |
| HP5055 | Gear Trains Kit |
| HP5060 | Simple Mechanisms Kit |
| HP5099 | Linear & Rotational Dynamics Kit |
| HP6207 | Additional Mechanisms Kit |
| HP7622 | Bar Linkages Kit |
| HP8604 | Rotational Friction Kit |
| HP8797 | Complete Mechanics |
| HP9771 | Pulley Kit |

## MIAC

| Product Code | Description |
|---|---|
| MI0235 | MIAC controller |
| MI0245 | Cased MIAC with 4mm shrouded sockets |
| MI3449 | MIAC (Arduino processor) with Bluetooth |
| MI3932 | MIAC (AllCode processor) |
| MI5331 | MIAC (Allcode) with WiFi |
| MI5466 | MIAC (Arduino processor) |
| MI5528 | MIAC (AllCode with Bluetooth) |
| MI5769 | MIAC (Rpi processor) with WiFi |
| MI5809 | MIAC (dsPIC processor) |
| MI6693 | MIAC (Rpi processor) with WiFi and Bluetooth |
| MI8615 | MIAC (dsPIC processor with WiFi) |
| MI8759 | MIAC (dsPIC processor with bluetooth) |
| MI9335 | MIAC (Arduino processor) with WiFi |

## MicroCNC

| Product Code | Description |
|---|---|
| CN1292 | Drill bits for the CNC range |
| CN2171 | CAMBAM software site |
| CN2498 | Deskproto site |
| CN2668 | 2 axis Micro CNC lathe |
| CN3075 | Deskproto 1 user |
| CN3300 | Pack of Wax Cylinders for lathe |
| CN3885 | Complete Micro CNC set |
| CN4079 | MicroCNC system controller and baseplate |
| CN4234 | 3 axis Micro CNC milling machine |
| CN8285 | 4 axis Micro CNC milling machine |
| CN8332 | CAMBAM software 1 user |
| CN9581 | Pack of modelling Blocks & acrylic squares for milling |

## Miscellaneous & accessories

| Product Code | Description |
|---|---|
| HP001 | 4 MHz Crystal |
| HP002 | 2 GB Memory Card |
| HP0056 | DC bench top automotive power supply, 15V @25A |
| HP0274 | Flowcode Test Bundle (Hardware) |
| HP089 | Mifare RFID card |
| HP16F1827 | PIC16F1827-I/P - 8 Bit Microcontroller |
| HP16F1937 | PIC16F1937-I/P - 8 Bit Microcontroller |
| HP16F628 | PIC16F628A-I/P - 8 Bit Microcontroller |
| HP16F877 | PIC16F877A-I/P - 8 Bit Microcontroller |
| HP16F88 | PIC16F88-I/P - 8 Bit Microcontroller |
| HP18F2455 | PIC18F2455-I/SP - 8 Bit Microcontroller |
| HP18F2455PPP | PIC18F2455-I/SP - PPP Firmware pre-loaded |
| HP18F4331 | PIC18F4331-I/P - 8 Bit Microcontroller |
| HP18F4455 | PIC18F4455-I/P - 8 Bit Microcontroller |
| HP2025Q | 12 tray trolley |
| HP2045 | Plastic shallow tray BLACK |
| HP229 | Philips screw driver |
| HP24FJ64GB002 | PIC24FJ64GB002-I/SP - 16 Bit Microcontroller |
| HP2577 | 5MHz PC based oscilloscope/signal generator pack |
| HP2642 | Holed foam for E-Blocks trays |
| HP2666 | Power supply |
| HP3025N | 18 tray trolley |
| HP30F3014 | DSPIC30F3014-30I/P - 16 Bit Microcontroller |
| HP30F4013 | DSPIC30F4013-30I/P - 16 Bit Microcontroller |
| HP338 | Ethernet crossover cable |
| HP33FJ128GP802 | DSPIC33FJ128GP802-E/SP - 16 Bit Microcontroller |
| HP347 | Headphones with microphone |
| HP3701 | IEC Mains Lead (UK) |
| HP3702 | IEC Main Lead (Euro) |
| HP3703 | IEC Mains Lead (USA) |
| HP3728 | AC power supply, 12VAC, 1.5A, UK |
| HP3844 | Thin foam tray insert 355x270x5mm |
| HP387 | ZigBee USB analyser |
| HP3920 | Three phase motor |
| HP3937 | E-blocks "slow clock" for multiprogrammer |
| HP4039 | Tray Lid |
| HP4429 | AC power supply, 12VAC, 1.5A, Europe |
| HP4449 | TTI PL155-P SCADA Power Supply |
| HP459 | I-Code SLI card |
| HP4688 | AC power supply, 12VAC, 1.5A, USA |
| HP481 | M3 nut spinner |
| HP4915 | Fujikura OFL280 FlexTester |
| HP5540 | Deep tray |
| HP5561 | AC/DC current clamp |
| HP5834 | 4 input picoscope |
| HP6012 | Flowkit V2 Arduino shield |
| HP6031 | Flowkit V2 (inc leads) |
| HP6700 | PLC Adaptor - Input module |
| HP6711 | PLC Adaptor - Power module |
| HP6723 | PLC Adaptor - Motor module |
| HP6752 | PLC Adaptor - Relay module |
| HP6785 | PLC adaptor - mounting bracket |
| HP7631 | PICmicro Development Centre |
| HP7750 | Daughter tray foam cutout |
| HP7894 | Benchtop signal generator pack |
| HP8067 | Tektronix digital oscilloscope |
| HP8279 | 25MHz PC based oscilloscope/signal generator pack |
| HP8405 | Triple Output Power Supply -12, +5, +12 |
| HP8445 | TTI TG5011A - SCADA Function Generator |
| HP9390 | Three phase power supply |
| HP9564 | 62mm daughter tray |
| HPUAB | USB2 high speed A to mini B lead |
| HPUSB | USB lead |

## OptoSci

| Product Code | Description |
|---|---|
| FP0294 | Principles of optical waveguiding kit |
| FP0374 | Optical network analysis and OTDR kit |
| FP0391 | Complete advanced physical optics kit (modular) |
| FP1748 | WDM component characterisation base kit |
| FP2350 | Optical network analysis without OTDR kit |
| FP4010 | Advanced fibre optic communications kit |
| FP4615 | Complete advanced physical optics kit (complete) |
| FP5180 | DWDM extension kit |
| FP5366 | Erbium doped fibre amplifiers kit |
| FP6057 | Bragg extension kit |
| FP6269 | Bit error rate and eye diagrams kit |
| FP7280 | Polarisation kit |
| FP7634 | Optical waveguide analysis software |
| FP7948 | Interference and coherence kit |
| FP8104 | Diffraction kit |
| FP8197 | Reflection and refraction kit |
| FP8451 | 1310/1550nm WDM extension kit |
| FP9068 | Principles of lasers kit |

Product glossary



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Notes

Notes



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