25th
Anniversary edition
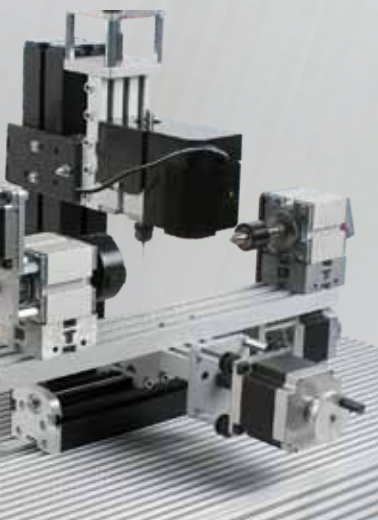
2018 Edition

MATRIX

Excellence in education for 25 years

∫ET | SCIENCE
ENGINEERING
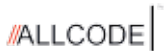TECHNOLOGY

www.matrixtsl.com

in 🐦 f

MATRIX

Matrix are proud to support the development of STEAM subjects in learning institutions around the World. 2018 is the UK's Year of Engineering and it seems there is no better time for you to get involved in promoting the development of young, enthusiastic engineers of the future. The products we develop and curriculum we write is always designed to give engineers the best possible start in their career and we are looking forward to working with you throughout the coming 12 months and beyond.

2018. THE YEAR OF

ENGINEERING

Contents

Product ranges

SET SCIENCE ENGINEERING TECHNOLOGY

FLOWCODE

E BLOCKS2

locktronics

ALLCODE

AUTOMATICS

MICRO CNC

MIAC

OptoSci

Lascells

ecio

worlddidac MEMBER

In 2017, we worked with many fantastic schools, colleges, universities and training providers to deliver excellent training solutions for their needs. Check out what some of them had to say...

"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

"The Department of Electrical Installation and Engineering has successfully used Matrix's solutions to develop student's skills whilst embedding electrical scientific theory using a practical approach. The simple and effective systems have been developed for ease of use and portability and correlate well to the City & Guilds syllabus, which we follow. The system's versatility has enabled us to offer a wide range of applications throughout various provisions including both BTEC National and Higher National Engineering."

Adam Brough, Bradford College, United Kingdom

"I have been using Matrix products for a number of years, across different and diverse curriculum areas. The platforms have been used all the way from Level 2 to BEng Degree students. The product is always of a high standard and the service support is second to none. One really great aspect is the vibrant and engaging community forums that support all the products. The online help and support files are also of a high quality. This keeps the students engaged and productive throughout the lessons."

Gavin Tyrrell, Blackpool & The Fylde College, United Kingdom

B&FC BLACKPOOL AND THE FYLDE COLLEGE

MATRIX

MATRIX

Solution (product code in brackets)	Pages	Science/Physics (pg. 7-10)	Fibre Optics, Photonics and Optical Science (pg. 14 - 20)	Computer Science (pg. 21 -25)	Electrical/Electronic Engineering (pg. 26 -47)	Mechanical Engineering (pg. 48 - 59)	Automation Robotics & Mechatronics (pg. 60 - 66)	Manufacturing Engineering (pg. 67 - 72)	Aviation (pg. 73 - 76)	Automotive (pg. 77 - 83)	Electrical Installation (pg. 84 - 89)
Electricity, magnetism & materials (LK9071-2)	8	1, 2									
Fundamentals of electricity (LK6444)	9	1									
Energy & the environment (LK7345-2)	9	2, 3									
Electrical and electronic principles (LK3929-2)	10	3									
Class pool kit (LK6802)	10	3									
Source - combined power supply and signal generator (LK6999)	11	All									
Thermodynamics kit (HP4159)	11	2, 3									
Basics of physical optics kit (PF4286)	12, 15	2, 3									
Basic fibre optics networks (FF5244)	12, 15	2, 3									
Advanced physical optics kit	13, 16		4*								
Principles of Optical Waveguiding kit (FP0294)	17		4*								
Advanced fibre optic communications kit (FP4010)	17		4*								
Bit error rate & eye diagrams kit (FP6269)	18		4*								
Optical network analysis & OTDR kit	18		4*								
Erbium doped fibre amplifiers kit (FP5366)	19		4*								
Principles of lasers kit (FP9068)	19		4*								
WDM components & systems and Bragg gratings kit	20		4*								
Introduction to Robotics	22, 65			All			All				
Programming Arduino microcontrollers	23			3, 4							
Programming PIC microcontrollers	23			3, 4							
Raspberry Pi development kit	24			3, 4							
AllCode robot arm production cell (RB6231)	24, 65			3, 4			3, 4				
PIC systems solution (LK8922-2)	25			3, 4							
Applied electrical science (LK9071-2)	27				2						
Electronic devices and communication applications (LK3889-2)	27				3						
Intermediate electrical and electronic engineering (LK6499-2)	28				3						
Industrial sensors, actuator and control application (LK5783-2)	28				3, 4						
Three phase systems (LK4961)	29				3, 4						
Electrical machines system (EM6637)	30				3						
Electrical machines AC & three phase add-on kit (EM6413)	31				4, 5						
AC machine thyristor speed control add-on pack (EM8069)	31				4, 5						
Operational amplifiers add-on pack (LK6906)	32				3						
Transformer construction and operation (LK1989)	32				3						
Combinational logic add-on packs (LK6904)	33				3						
Sequential logic add-on pack (LK6905)	33				3						
Transistor amplifiers add-on pack (LK9435)	34				3						
Principles and applications of electronic devices and circuits (LK9422)	34				3, 4						
Advanced electronic principles (LK6804)	35				3, 4						
TINA V11	35				3, 4, 5						
Advanced electrical, electronic and digital principles (LK9044)	36				4						
Fault finding in electronic circuits (LK3566)	36				3, 4						
Digital and Analogue electronic systems	37				3						
Power and energy electronics (LK3568)	37				3, 4, 5						
Power, Electronics and Storage	38				4, 5						
Industrial System	39				4, 5						
Programming Arduino microcontrollers	40				3, 4						
Programming PIC microcontrollers	41				3, 4						
Programming dsPIC microcontrollers	42				3, 4						
Programming AVR microcontrollers	42				3, 4						
Programming ARM microcontrollers	43				3, 4						
Raspberry Pi development kit	43				3, 4						
Electronic engineering communications solutions	44 - 47				4*						
Source - combined power supply and signal generator (LK6999)	47				All						
Mechanical kits	49 - 59					3, 4					
Thermodynamics kit (HP4159)	59					2, 3					
Automatics essentials solution (AU9020)	61						3, 4				
Electro-pneumatics add-on kit (EM6413)	61						3, 4				
Pneumatics control add-on kit	62						3, 4				
Pneumatics with your own PLC	62						3, 4				
Automatics interactive courseware (AW20780)	63						3, 4				
Miniature factory (AU4956)	63						3, 4				
PLC adaptor rail	64						3, 4				
Mechatronic systems (HP4550)	64						3, 4				
Formula AllCode football mat add-on (RB4938)	66						2*				
Micro CNC system controller and base plate (CN4079)	68							3			
2-axis Micro CNC lathe (CN2668)	68							3			
3-axis Micro CNC milling machine (CN4234)	69							3			
4-axis MicroCNC milling machine (CN8285)	69							3			

Solution (product code in brackets)	Pages	Science/Physics (pg. 7-10)	Fibre Optics, Photonics and Optical Science (pg. 14 - 20)	Computer Science (pg. 21 -25)	Electrical/Electronic Engineering (pg. 26 -47)	Mechanical Engineering (pg. 48 - 59)	Automation Robotics & Mechatronics (pg. 60 - 66)	Manufacturing Engineering (pg. 67 - 72)	Aviation (pg. 73 - 76)	Automotive (pg. 77 - 83)	Electrical Installation (pg. 84 - 89)
Complete MicroCNC set (CN3885)	70							3			
Deskproto CAM software	71							3			
CamBam software	71							3			
EASA electrical fundamentals (module 3) (LK9339)	74								3, 4, 5		
EASA electronic fundamentals (module 4) (LK9282)	74								3, 4, 5		
EASA electrical and electronic fundamentals (modules 3 and 4) (LK9282)	75								3, 4, 5		
Turbo jet engine model	76								3, 4, 5		
Electricity, magnetism and materials (LK9071-2)	78									1	
AC principles for automotive technicians (LK8222)	78									2	
An introduction to motors, generators and hybrid (LK7444)	79									2	
An introduction to digital electronics (LK4221)	79									2	
Combined level 2 automotive pack (LK4500CUS)	80									2	
Sensors and control in automotive applications (LK9834-2)	80									2	
CAN bus systems and operation (LK7629)	81									3	
CAN bus systems and operation solution with engineering panel (LK2839)	82									3	
Hybrid vehicle demonstration system (LK6483)	82									3	
Cutaway vehicle engines	83									3*	
Cutaway vehicle chassis	83									3*	
Electrical installation level 1 (LK5000)	85										1
Electrical installation level 2 (LK4063)	85										2
Level 2: Demonstration kit	86										2
Transformer construction and operation (LK1989)	86										2, 3
8202 level 2: Electronic components and circuits pack (LK2901)	87										3
8202 Level 3: Electrical installation circuit principles (LK4562)	87										3
8202 Level 3: Principles of lighting (LK2285)	88										3
Electrical machines system (EM6637)	88										3
Electrical machines AC & three phase add-on kit (EM6413)	89										3

Levels

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

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.

The world of educational technology is becoming more complex: customers now have a wide variety of needs in terms of the computer platforms and operating systems they are using and in the languages that students want to program systems in. This is particularly true of schools who now have increasing numbers of tablets, and students who want to use their Apple and Android phones.

To reflect this change in the market our development team is now designing systems that can be used with many computing platforms. The first examples of their work can be seen in this catalogue with our Formula AllCode robot buggy (page 142), our robot arm (pages 24 & 65) and our MIAC controllers (page 148).

To help you quickly identify which computers, operating systems and software are usable with our learning resources we have included icons by each product to show compatibility. The column opposite shows you what each icon means.

The list is not exhaustive: for example for Raspberry Pi compatible products we have included a Python icon as it is a very popular software used on RPi. There are other software tools on the Raspberry Pi that you can also use.

To facilitate this change in technology our engineers have developed Application Programming Interfaces (API). These are a little like an Operating System which includes calls that can be made to the hardware to effect a response. These API calls are designed to work with Bluetooth and Wi-fi which are increasingly replacing wired systems.

If you are in doubt whether the hardware and software you want to use are compatible with our products - or if you have additional requirements not listed here - then please call us.

The need for greater flexibility is no better evident than in the world of microcontroller based systems. This year, we have developed additional ease of use to our flagship software, Flowcode. This now allows Arduino users to more easily utilise the advanced capabilities of Flowcode into their development cycle. What's more, Raspberry Pi users can now also use Flowcode for control of their hardware. Find out more on page 90.

MATRIX

Matrix Technology Solutions Ltd,
The Factory,
33 Gibbet Street,
Halifax, HX1 5BA
United Kingdom
t: +44 (0) 1422 252380
f: +44 (0) 1422 341830
e: sales@matrixtsl.com

Note that inclusion of these icons does not mean that our products are approved by third party companies who supply such software/hardware.

Microsoft Windows compatible

Apple OS X compatible

Linux compatible

Google Android phone/tablet compatible

Raspberry Pi compatible

Flowcode compatible

Microchip MPLAB compatible (C or ASM)

Mathworks MATLAB compatible

National Instruments LabVIEW compatible

Python compatible

Arduino compatible

C code compatible

App Inventor compatible

Scratch compatible

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

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

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

Curriculum mapping

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

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

- 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

Ordering information	DIN	ANSI
Energy and environment solution	LK7345-2	LK7345-2A
Corresponding curriculum	LK7122	
You will also need:		
Multimeter pack		LK1110

Curriculum mapping

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

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

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 25.
To add Operational amplifier investigation to this kit see the Op-amp add-on kit on page 32.

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	Signal generator	HP7894
Picoscope	HP8279	Source - combined power supply and signal generator – COMING SOON, see page 11 for more information.	LK6999

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

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 laws
- AC circuits
- Capacitors
- Fleming's laws
- 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		

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

---

NEW

Source - combined power supply and signal generator

This general purpose 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				Specification			
Output	Voltage	Current	Features	Output	Voltage	Current	Features
Variable AC	10V p-p 50 Ω DC coupled	100mA	Instrumentation output 0Hz – 100kHz Sine/Square/Triangle Arbitrary waveform generator	Variable DC	3 - 10V	3A	Current limiter/monitor
	10V p-p AC coupled	1.3A pk	Audio output: 20Hz – 20kHz Sine/Square/Triangle Arbitrary waveform generator	+12V DC	12V	5A	Current limiter/monitor
	2V p-p AC coupled line output	N/A		+5V DC	5V	5A	Current limiter/monitor
				-12V DC	-12V	300m A max	

Ordering information	
Source - combined power supply and signal generator 110V	LK6999
Source – combined power supply and signal generator 240V	LK2975

COMING SOON

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:

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

Curriculum mapping

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

Ordering information	
Thermodynamics kit	HP4159

Basics of physical optics kit

This kit enables students to gain access to a basic optical bench that offers an enhanced set of accessories, allowing the user to perform introductory experiments in the field of optics. The 1-metre long bench includes a set of parts comprising of a housed lamp (with halogen bulb), lens holder along with 50mm diameter lenses (biconvex lens and biconcave lens), a set of diaphragms, mirror, translucent screen, transparent screen and object screen. Students follow a written curriculum workbook to understand more about optical principles.

Learning objectives:

- Reflection and refraction including Snell's Law, Refractive index determination, critical angle and TIR
- Principles of Diffraction including slits, apertures, reflection and transmission gratings
- Interference including Young's Slits

Curriculum mapping

- Suitable for A-level Physics courses in the UK

Instruments	
Instruments may be required, please contact us for further info	
Ordering information	
Basics of physical optics kit	FP4286

Basic fibre optics networks

This kit enables teachers to deliver the outcomes of basic fibre optics courses, which include practical activities such as preparing, checking, splicing and cleaning cables for insertion. Students follow a written curriculum of worksheets designed to deliver requirements through level 2, into level 3 qualifications and move on to more advanced experimentation with use of instrumentation including fusion splicers and OTDRs, which must be purchased separately, please contact us for further clarification.

Learning objectives:

- Insertion loss testing
- Inspection and preparing cable for splicing
- Splicing optical fibres in internal / external environments
- Installation of optical fibre in internal / external environments
- Cleaning / maintenance of optical fibres
- Return loss requirements
- Fusion or mechanical splicing techniques
- OTDR techniques

Curriculum mapping

- Suitable for courses in Fibre Optics from Level 2 and beyond
- Suitable for City & Guilds Information Technology, unit 3667: Communications, Cabling and Networks

Instruments	
OTDR (Optiocal Time Domain Reflectometer)	
Fibre optic cable splicing machine - Fusion splicing	
Fibre optic cable splicing machine – Mechanical splicing	
Ordering information	
Basic fibre optics networks kit	FP5244

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:

- 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

Instruments	
Instruments may be required, please contact us for further info	
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

Fibre Optics, Photonics and Optical Science

A new range of products, 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.

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

"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

Basics of physical optics kit

COMING SOON

This kit enables students to gain access to a basic optical bench that offers an enhanced set of accessories, allowing the user to perform introductory experiments in the field of optics. The 1-metre long bench includes a set of parts comprising of a housed lamp (with halogen bulb), lens holder along with 50mm diameter lenses (biconvex lens and biconcave lens), a set of diaphragms, mirror, translucent screen, transparent screen and object screen. Students follow a written curriculum workbook to understand more about optical principles.

Learning objectives:

- Reflection and refraction including Snell's Law, Refractive index determination, critical angle and TIR
- Principles of Diffraction including slits, apertures, reflection and transmission gratings
- Interference including Young's Slits

Curriculum mapping

- Suitable for A-level Physics courses in the UK

Instruments	
Instruments may be required, please contact us for further info	
Ordering information	
Basics of physical optics kit	FP4286

Basic fibre optics networks

COMING SOON

This kit enables teachers to deliver the outcomes of basic fibre optics courses, which include practical activities such as preparing, checking, splicing and cleaning cables for insertion. Students follow a written curriculum of worksheets designed to deliver requirements through level 2, into level 3 qualifications and move on to more advanced experimentation with use of instrumentation including fusion splicers and OTDRs which must be purchased separately, please contact us for further clarification.

Learning objectives:

- Insertion loss testing
- Inspection and preparing cable for splicing
- Splicing optical fibres in internal / external environments
- Installation of optical fibre in internal / external environments
- Cleaning / maintenance of optical fibres
- Return loss requirements
- Fusion or mechanical splicing techniques
- OTDR techniques

Curriculum mapping

- Suitable for courses in Fibre Optics from Level 2 and beyond
- Suitable for City & Guilds Information Technology, unit 3667: Communications, Cabling and Networks

Instruments	
OTDR (Optiocal Time Domain Reflectometer)	
Fibre optic cable splicing machine - Fusion splicing	
Fibre optic cable splicing machine – Mechanical splicing	
Ordering information	
Basic fibre optics networks kit	FP5244

NEW

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:

- 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

Curriculum mapping

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

Instruments	
Instruments may be required, please contact us for further info	
Ordering information	
Principles of optical waveguiding	FP0294
Optical waveguiding analysis software	FP7634

NEW

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:

- 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

Curriculum mapping

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

Instruments	
Instruments may be required, please contact us for further info	
Ordering information	
Advanced fibre optic communications kit	FP4010

NEW

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:

- 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

Instruments	
Instruments may be required, please contact us for further info	
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

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 17.

Learning objectives:

- 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

Curriculum mapping

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

Instruments	
Instruments may be required, please contact us for further info	
Ordering information	
Bit error rate & eye diagrams	FP6269

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:

- 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

Curriculum mapping

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

Instruments	
Instruments may be required, please contact us for further info	
Ordering information	
Optical network analysis & OTDR	FP0374
Optical network analysis kit (without OTDR)	FP2350

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:

- 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

Curriculum mapping

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

| Instruments	
Instruments may be required, please contact us for further info	
Ordering information	
Erbium doped fibre amplifiers kit	FP5366

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:

- 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

Curriculum mapping

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

Instruments	
Instruments may be required, please contact us for further info	
Ordering information	
Principles of lasers kit	FP9068
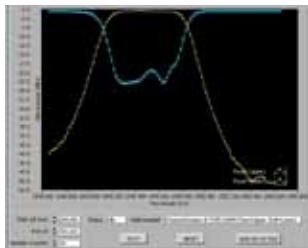
Wavelength scan of OADM
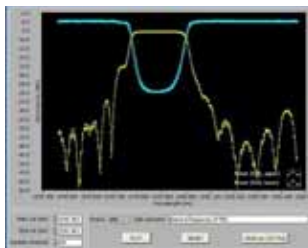
A Bragg grating

NEW

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:
- 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

Instruments	
Instruments may be required, please contact us for further info	
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
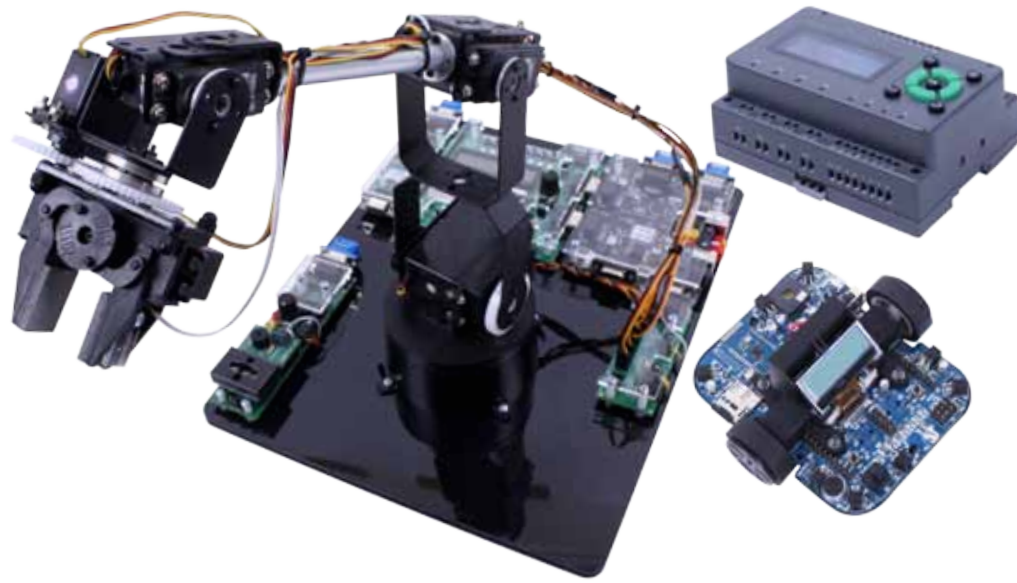
Computer Science

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.

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

"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

MATRIX

MATRIX
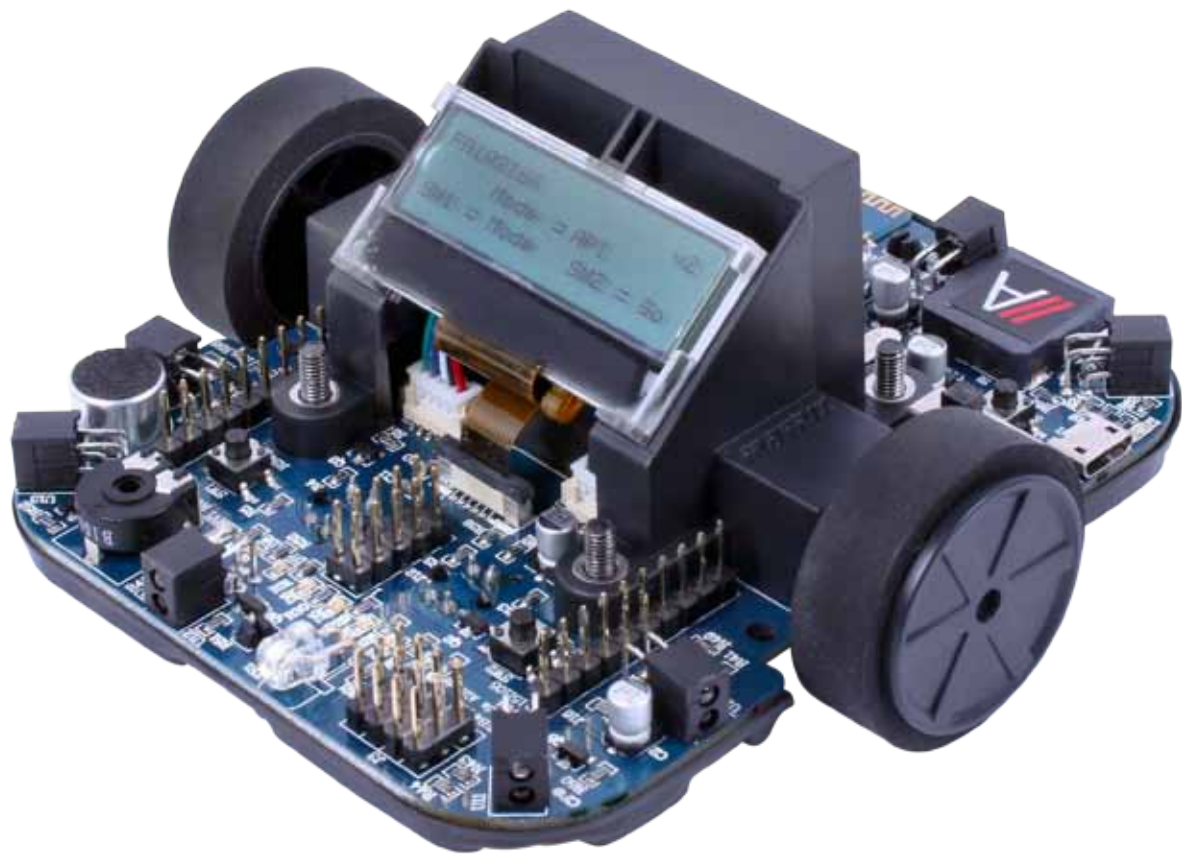
See Formula AllCode section for full details

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
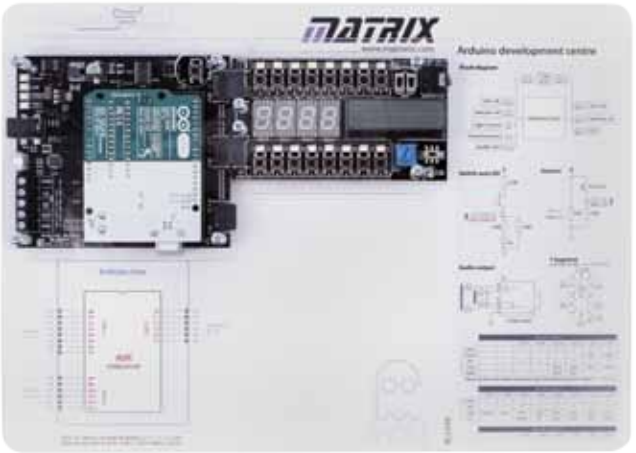
Curriculum mapping

- 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 and associated circuit diagram.

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 and associated circuit diagram.

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

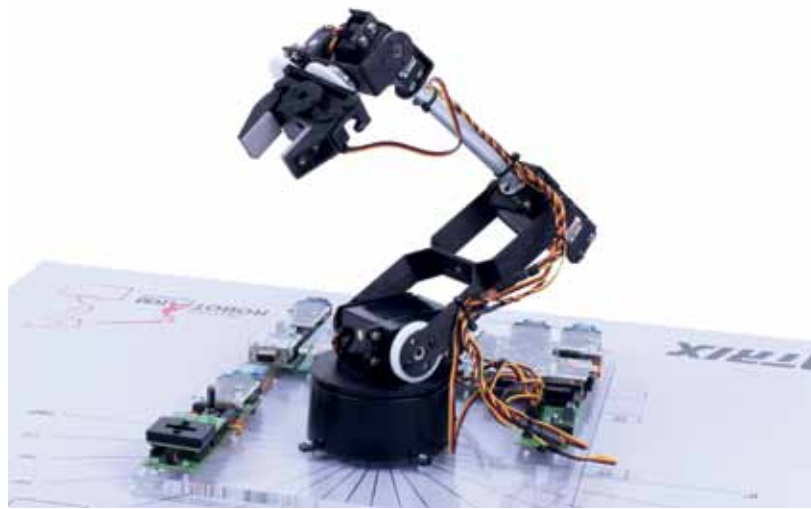| Ordering information	
PIC development centre and printed panel	BL0562
Flowcode	

Raspberry Pi development kit

This pack 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 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.

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

Curriculum mapping

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

Ordering information	
Raspberry Pi development centre and printed panel	BL0557
Flowcode	

AllCode robot arm production cell

Our robot arm production cell consists of a rugged servocontrolled 6 degrees of freedom arm bolted to a base plate and 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

PIC systems solution

This solution allows students to investigate circuits and systems based on the popular PICmicro 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

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 our new E-blocks2 platform for study of microcontroller systems, as well as telecommunications and embedded systems. This section also includes a range of Locktronics solutions and other platforms for study of key electronic and electrical engineering topics.

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.

"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

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

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

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

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

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

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

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

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

Also available with Rpi MIAC and Arduino MIAC

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

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
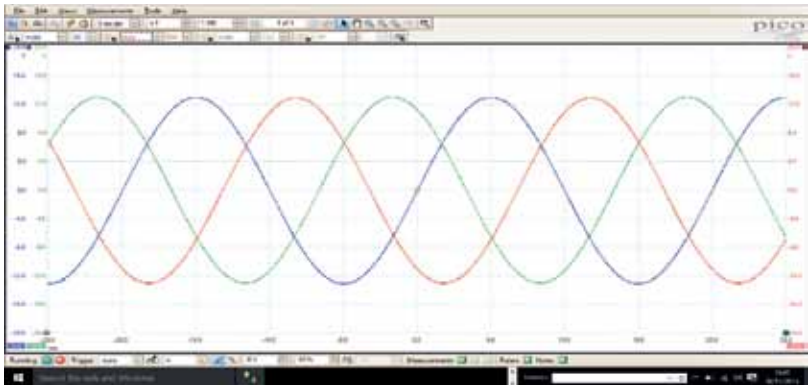
Three phase systems

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.
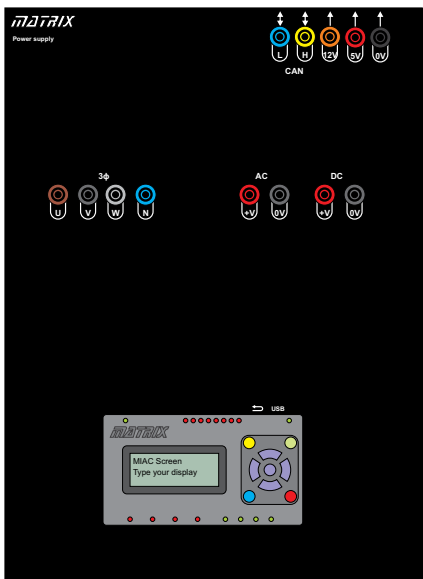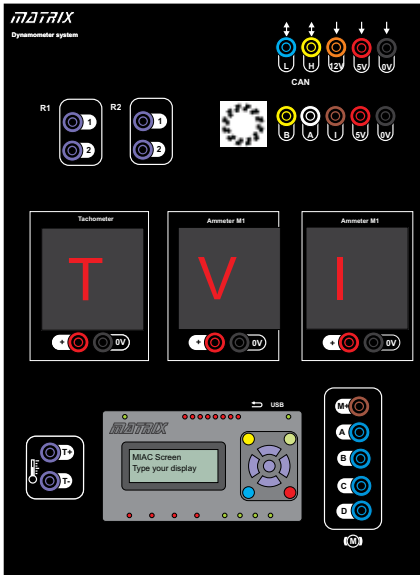
Learning objectives

- 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

COMING SOON

Electrical machines, AC & three phase add-on pack

Our Electrical machines AC & Three Phase add-on pack gives the user the ability to also study AC and three phase machines. The system contains a unit which houses several digital meters showing the current and voltage on the machine under test. The unit also contains banks of resistors and capacitors which are switched on using the MIAC controller on the dynamometer system control panel. This allows the characteristics of the windings in the system to be changed with the speed of the machine. Full student manuals are included and equipment is supplied in our standard storage trays.

Learning objectives / experiments:

- AC machine construction
- Universal motors
- AC induction motors, torque characteristics and efficiency
- Synchronous speed and slip
- Start up and run circuits
- AC generators
- Three phase AC machine construction
- Three phase motors, torque characteristics and efficiency
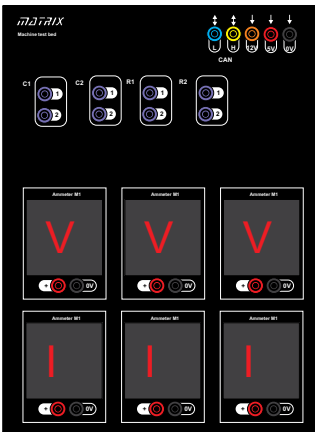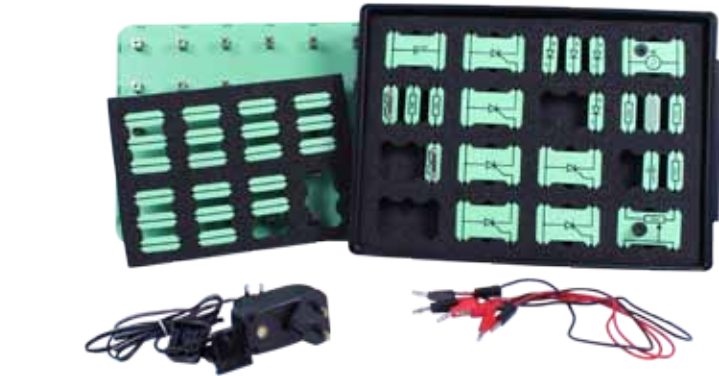- Operating three phase motors from a single phase

Curriculum mapping

- Suitable for BTEC National unit 15: Electrical machines
- Suitable for BTEC Higher National unit 21: Electrical machines; unit 31: Electrical systems and fault finding; unit 43: Further machines and drives; unit 45: Industrial systems

Ordering information	
Electrical machines AC & three phase add-on pack	EM6413

COMING SOON

AC machine thyristor speed control add-on pack

This pack consists of the Locktronics components needed to control the speed and direction of single and three phase AC machines using simple thyristors.

This pack can be added to the Electrical machines starter system and AC machines add-on kit. Users must ensure they also have access to these kits to follow the curriculum.

Learning objectives / experiments:

- Thyristor operation
- Power control in AC circuits
- Speed control in AC motor circuits using thyristors
- Phase shifting capacitor circuits
- Thyristor bridge circuits
- H-bridge thyristor direction control in single phase AC motor circuits
- Thyristor control of three phase induction motors

COMING SOON

Electrical machines system

Our Electrical machines system is the base level kit for this new range of equipment. A power supply, controlled via one of our MIAC controllers is the main control unit for the system. Alongside the power supply, we provide a dynamometer and physical rheostats, used as the load system to enable students to take readings. Full student manuals are included and equipment is supplied in our standard storage trays.

Learning objectives / experiments:

- DC machine construction
- Basic DC machines, torque characteristics and efficiency
- Varying DC machine speed with voltage
- DC machines with wound stators
- Compound DC machines
- DC motors as dynamos
- DC motor control using PWM
- Speed and position sensors in motor control systems
- Servo control systems
- Swinging arm dynamometer and torque measurement
- Link between HP, watts and joules

Curriculum mapping

- Suitable for BTEC National unit 15: Electrical machines
- Suitable for BTEC Higher National unit 21: Electrical machines; unit 31: Electrical systems and fault finding; unit 43: Further machines and drives; unit 45: Industrial systems

Ordering information	
Electrical machines system	EM6637

Curriculum mapping

- Suitable for unit 15 of the BTEC National award in Engineering : Electrical machines
- Suitable for unit 43 of BTEC Higher National: Further machines and drives

Ordering information	
AC machine thyristor speed control add-on pack	EM8069

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

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

| Instruments		
Source - combined power supply and signal generator – COMING SOON, see page 47 for more information		LK6999
Ordering information	DIN	ANSI
Operational amplifiers add-on-kit	LK6906	LK6906A
Corresponding curriculum	LK3061	

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.

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

Instruments	
Source - combined power supply and signal generator – COMING SOON, see page 47 for more information	LK6999
Ordering information	
Transformer construction and operation pack	LK1989
Corresponding curriculum	CP1933
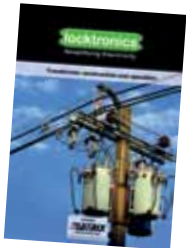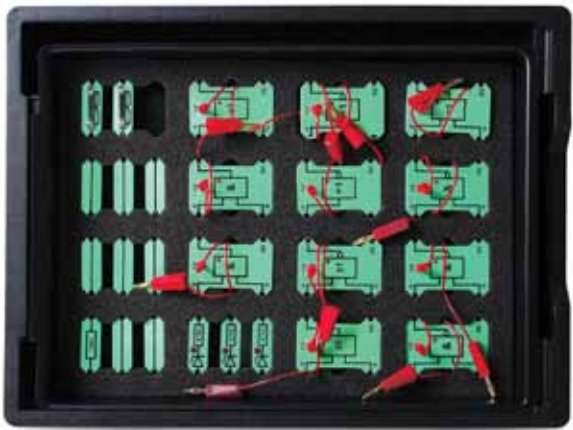
Combinational logic add-on pack

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

Curriculum mapping

- Suitable for use in a wide range of syllabuses

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

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

Curriculum mapping

- Suitable for use in a wide range of syllabuses

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

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

Curriculum mapping

- Suitable for use in a wide range of syllabuses

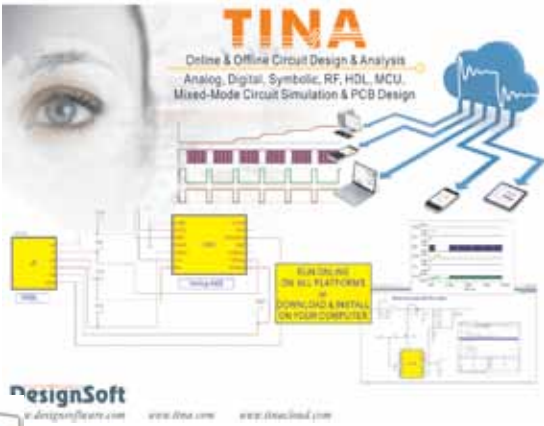| Ordering information	
Transistor amplifiers add-on pack	LK9435
Corresponding curriculum	LK4403

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

Curriculum mapping

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

Instruments	
Source - combined power supply and signal generator – COMING SOON, see page 47 for more information	LK6999
Ordering information	
Principles and applications of electronic devices and circuits	LK9422
Corresponding curriculum	LK3061, LK9945, LK2094, LK4403

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

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

Instruments		
Source - combined power supply and signal generator – COMING SOON, see page 47 for more information	LK6999	
Ordering information	DIN	ANSI
Advanced electronic principles	LK6804	LK6804A
Corresponding curriculum	LK3008	

TINA V11

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

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

Ordering information
Please call us for pricing and versions

MATRIX
MATRIX

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

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 – combined power supply and signal generator – COMING SOON, see page 47 for more information	LK6999	

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

## 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
Signal generator	HP7894		
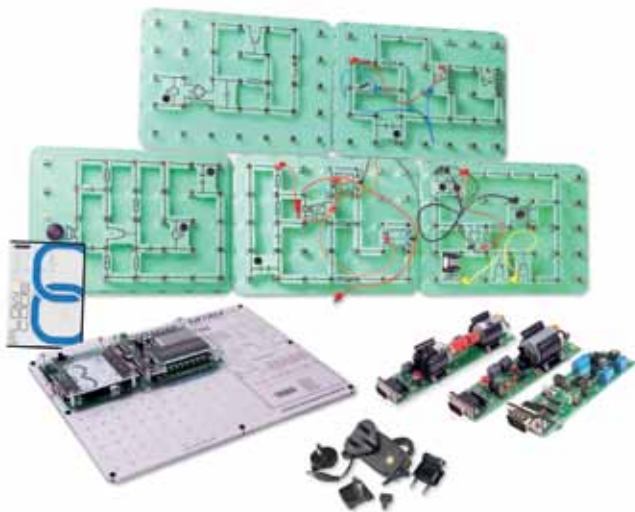
Digital and analogue electronic systems

This pack provides a suite of equipment for delivering the new 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 with regards to speed of conversion, Nyquist and other variables. Students can also use our Motors boards to investigate speed and position control. 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 / Arduino development centre on printed panel	BL0562 / BL0599
DC motor angle position trainer E-block	EB097
DC motor speed trainer E-block	EB096
SPI bus and D/A and memory board	EB013
Flowcode for PIC /Arduino	

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

Instruments	
Source – combined power supply and signal generator – COMING SOON, see page 47 for more information	LK6999

Ordering information	
Power and energy electronics	LK3568
Corresponding curriculum	CP3666

Power, electronics and storage

This kit 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. The energy meter is used to accompany the hardware and develop records in Excel, which can be exported into MATLAB/ Simulink or alternative appropriate software. 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:

- Technology and methods behind energy production
- Electric vehicle configurations
- Circuit topology
- Sources of renewable energy
- Energy efficiency
- Power conversion
- Use of Matlab/Simulink or alternative appropriate software

Curriculum mapping

- Suitable for BTEC Higher National unit 44: Industrial Power, Electronics and Storage

The Hybrid automotive principles kit is optional

Instruments	
Source - combined power supply and signal generator – COMING SOON, see page 47 for more information	LK6999
Ordering information	
Power, electronics and storage solution	LK1069
Hybrid automotive principles on engineering panel	LK6483
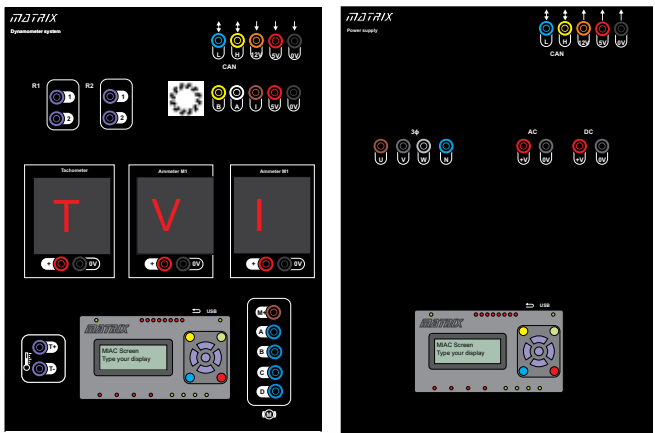
Industrial systems

This kit is designed to educate the user about the way specific control systems are selected for industrial processes. The industrial sense and control kit introduces users to the role of an industrial controller and gives the ability for students to explore control of systems using third party software packages such as Matlab. Students explore the uses and differences of various mechanical, electrical and electronic transducers such as relays, solenoids and sensors before exploring and considering current trends in technology including how the Internet of Things will influence the future of industrial systems. Finally, the characteristics and use of motors in electrical machines is also addressed through use of our electrical machines system (see page 30).

Learning objectives:

- Input & output devices; open and closed loop systems
- Interfacing with transducers
- Controllers/PLCs and their function
- Control of systems using Matlab, etc.
- 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
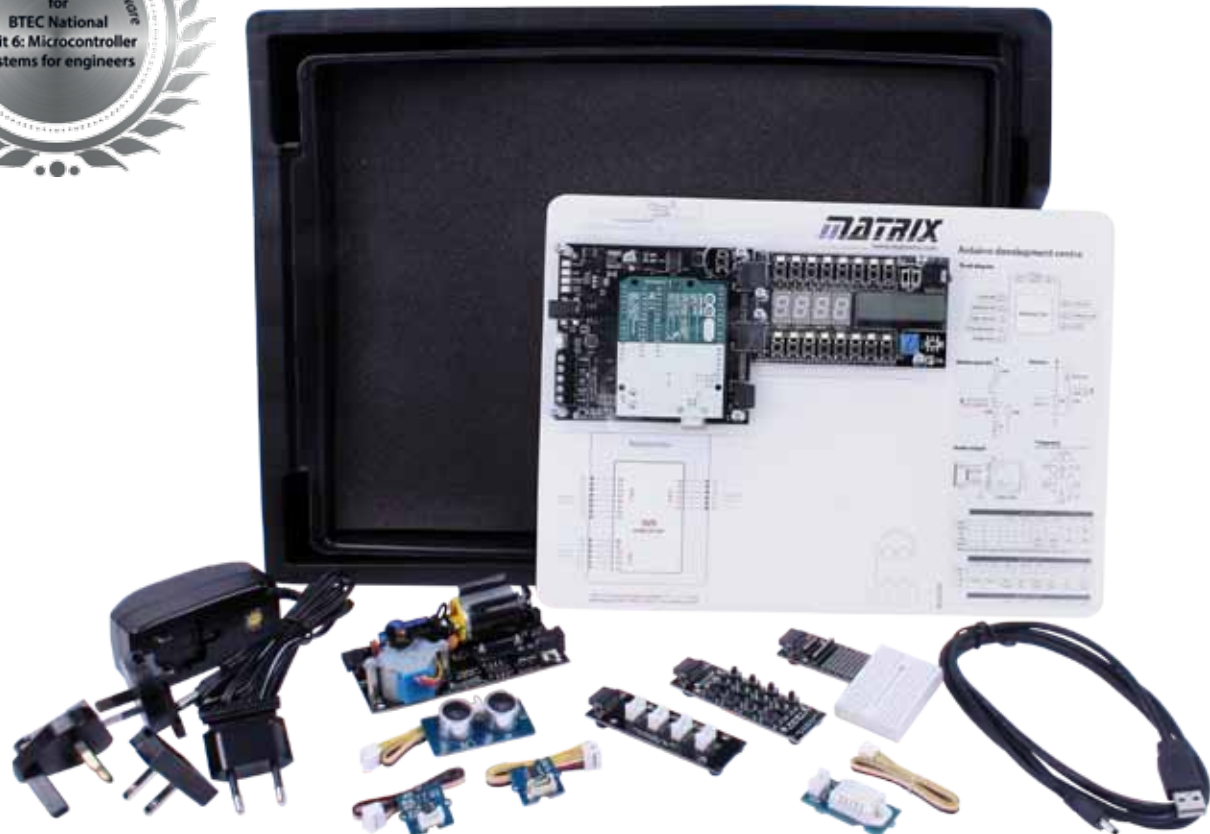
MATRIX

MATRIX

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 downstream "combo" board with 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 and combo board can also be purchased separately either with or without the printed panel.

- Flowchart programming
- Full simulation capabilities
- Full C code editor
- Ghost technology
- See page 90 onwards

Learning objectives:
- 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

Ordering information	
Arduino microcontroller system development kit	BL0540
Arduino development centre and printed panel	BL0599
Arduino programmer and combo board	BL0544
Flowcode	

- 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

---

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

- Assembler code programming
- 40 hours of learning
- Full assembler included
- See page 126

- C code programming
- 40 hours of learning
- Full C compiler
- See page 126

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 downstream "combo" board with 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 and combo board can also be purchased separately either with or without the printed panel.

- Flowchart programming
- Full simulation capabilities
- Full C code editor
- Ghost technology
- See page 90 onwards

Learning objectives:
- 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

Ordering information	
PIC microcontroller system development kit	BL0524
PIC development centre and printed panel	BL0562
PIC programmer and combo board	BL0505
Flowcode	
C for PIC microcontrollers	
Assembly for PIC microcontrollers	

- 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

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

Programming dsPIC microcontrollers

This pack guides 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 an 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:

• 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

• Flowchart programming
• Full simulation capabilities
• Full C code editor
• Ghost technology
• See page 90 onwards

Ordering information	
dsPIC microcontroller system development kit	BL0503
dsPIC development centre and printed panel	BL0514
dsPIC programmer and combo board	BL0564
Flowcode	

Curriculum mapping

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

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

Programming AVR microcontrollers

This pack guides 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:

• 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

• Flowchart programming
• Full simulation capabilities
• Full C code editor
• Ghost technology
• See page 90 onwards

Ordering information	
AVR microcontroller system development kit	BL0591
AVR development centre and printed panel	BL0518
AVR programmer and combo board	BL0570
Flowcode	

Curriculum mapping

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

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

Programming ARM microcontrollers

This pack guides 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:

• 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	

Curriculum mapping

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

Raspberry Pi development kit

This pack guides allows students to develop systems to control a Raspberry Pi and connected development boards. 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:

• 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

• Flowchart programming
• Simulation capabilities
• Ghost technology
• See page 90 onwards

Ordering information	
Raspberry Pi system development kit	BL0575
Raspberry Pi development centre and printed panel	BL0557
Raspberry Pi programmer and combo board	BL0560
Flowcode	

Curriculum mapping

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

Mobile phone technology 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

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

Ordering information	
Mobile phone technology training course	BL0579
Requires Flowcode, which must be ordered separately	

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

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

Ordering information	
Bluetooth training course	BL0506
Requires Flowcode, which must be ordered separately	

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

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

Ordering information	
Embedded internet training course	BL0531
Requires Flowcode, which must be ordered separately	

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

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

Ordering information	
CAN bus training course	BL0589
Requires Flowcode, which must be ordered separately	

Solutions for Arduino will be available later in 2018. Contact us for details

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

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

Curriculum mapping

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

Ordering information	
ZigBee training course	BL0516
Requires Flowcode, which must be ordered separately	

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

Curriculum mapping

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

Ordering information	
FPGA training course	BL0552

Solutions for Arduino will be available later in 2018. Contact us for details

COMING SOON

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:

- 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

Curriculum mapping

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

Ordering information	
Internet of Things solution	BL0569

NEW

Source - combined power supply and signal generator

This general purpose 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

Specification				Specification			
Output	Voltage	Current	Features	Output	Voltage	Current	Features
Variable AC	10V p-p 50 Ω DC coupled	100mA	Instrumentation output 0Hz – 100kHz Sine/Square/Triangle Arbitrary waveform generator	Variable DC	3 - 10V	3A	Current limiter/monitor
	10V p-p AC coupled	1.3A pk	Audio output: 20Hz – 20kHz Sine/Square/Triangle Arbitrary waveform generator	+12V DC	12V	5A	Current limiter/monitor
	2V p-p AC coupled line output	N/A		+5V DC	5V	5A	Current limiter/monitor
				-12V DC	-12V	300m A max	

Ordering information	
Source - combined power supply and signal generator 110V	LK6999
Source – combined power supply and signal generator 240V	LK2975

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 typically 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

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)

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

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

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

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

Ordering information	
Deflection of beam and cantilevers kit	HP5015
Essential base unit	HP5000

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

Curriculum mapping

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

Ordering information	
Torsion of circular sections kit	HP5020
Essential base unit	HP5000

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

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

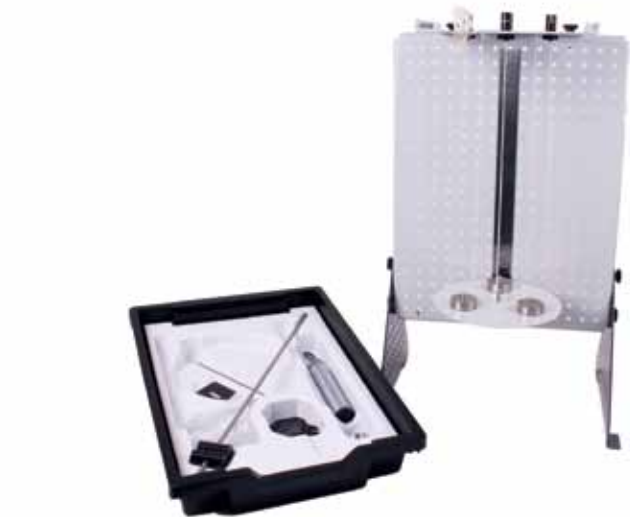| Ordering information	
Tensile tester kit	HP5025
Essential base unit	HP5000

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

Curriculum mapping

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

Ordering information	
Simple harmonic motion kit	HP5030
Essential base unit	HP5000

MATRIX

MATRIX

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 1 of BTEC National award: Engineering 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

Curriculum mapping

- Suitable for unit 39 of BTEC Higher National: Advanced mechanical principles

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

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.

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

Ordering information	
Cam, crank and toggle kit	HP5050
Essential base unit	HP5000

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

Curriculum mapping

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

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

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. Essential base unit and kit must be ordered separately.

Learning objectives / experiments:

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

Curriculum mapping

- Suitable for unit 39 of BTEC Higher National: Advanced mechanical principles

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. 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. 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. 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. 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

MATRIX

MATRIX

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

Learning objectives / experiments:

- Microcontroller programming and circuits, clocks, pins, inputs, outputs, ports, memory and memory types, current limits
- Programming using flowcharts, Arduino or MPLAB: input, system, output, loops, decision, subroutine, go to, calculations, delays, variables, strings, A/D conversion, interrupts, hardware macros, software macros, arrays
- Techniques: Binary, Hexadecimal, ASCII, calculations Components: clocking devices, switches, LEDs, LED arrays, sensors, LCD, 7-segment displays, quad 7-segment displays, power supply, EEPROM
- Techniques: switch de-bounce, Schmitt trigger, prototyping with E-blocks strip board

Curriculum mapping

- Suitable for BTEC National unit 6: Microcontrollers

COMING SOON

Curriculum mapping

- Suitable for multiple units in Thermodynamics at level 3 and beyond

Microcontrollers for mechanical engineers

This solution provides a suite of microcontroller hardware as well as a kit of parts from which a number of mechanical models can be constructed using the Tetrix construction kit. The kit can be based on our Development centre for either PIC or Arduino microcontrollers supplied with additional servo board, motor control board and screw terminal interface board.

Arm made up from Tetrix.

Ordering information		QTY	
Tetrix prime starter set	1	HP2810
PIC / Arduino development centre on printed panel	1	
E-blocks servo board	1	EB059
E-blocks motor control board	1	EB094
E-blocks screw terminal board	1	EB002
Power supply	1	HP2666
USB lead	1	HPUSB

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:

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

Ordering information	
Thermodynamics kit	HP4159

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.

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

"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

The 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.

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

Ordering information	
Automatics essentials solution	AU9020
You may also need	
Compressor	AU1050

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.

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

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

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
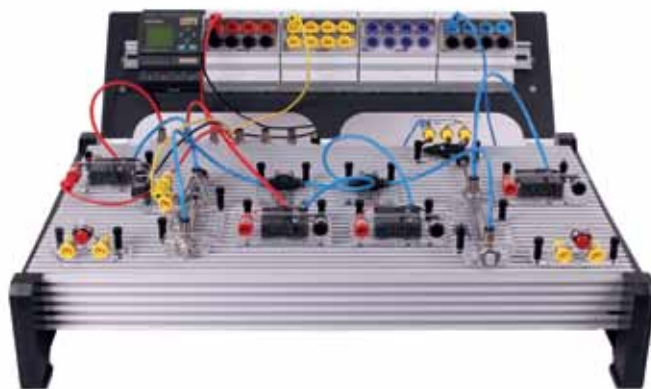
Curriculum mapping

- 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
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

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.

COMING SOON
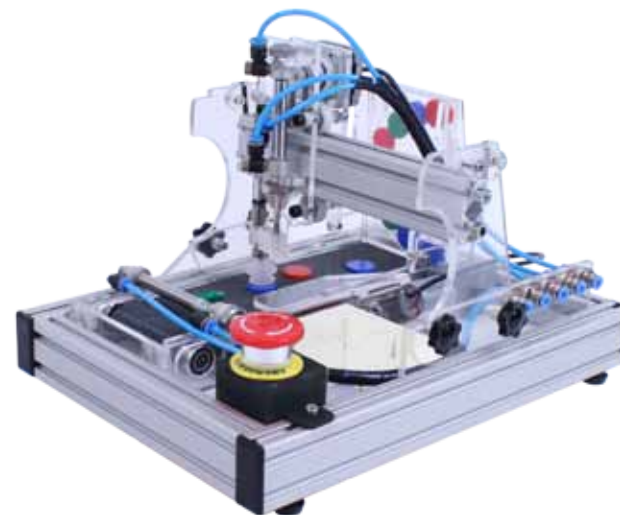
Curriculum mapping

- Suitable for unit 12 of the BTEC National: Pneumatic and Hydraulic systems
- Suitable for unit 15 of BTEC Higher National: Automation, robotics and PLCs

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.

Ordering information	
Automatics interactive courseware site licence	AW20780

Miniature factory

Our miniature factory allows students to get experience of a number of processes/technologies that are commonly used in manufacturing, including: conveyor systems, sensing systems, pneumatic pick and place technology, DC motor drives, and stepper motor drives. The factory includes of a number of coloured components—plastic discs. A conveyor belt moves these pieces into the factory where a colour sensor produces a voltage proportional to colour for each disc. Some are rejected by a piston. Others are picked off the conveyor by the suction device and a stepper motor controlled gantry sorts the discs into appropriately coloured containers. The miniature factory is completely self contained and can be stored away in one of our standard trays. The miniature factory can be used with any 12V or 24V PLC and is also compatible with our MIAC range of controllers which must be ordered separately.

Learning objectives / experiments:

- Factory control and automation systems
- Software design for automation
- DC motor and stepper drives
- Conveyor and gantry systems
- Vacuum pick and place systems
- Component sensing and sorting
- System design with more than one controller (some systems)

Ordering information	
Miniature factory	AU4956
Compressor	AU1050
MIAC - PIC8	MI0245
Corresponding curriculum	CP0571

PLC adaptor rail

Suitable for studying a range of Programmable Logic Controller units in a simple and easy way, using our other ranges such as Locktronics or Automatics, this PLC adaptor rail allows you to simply add 4mm shrouded connectors to any industrial PLC from the most renowned brands in industry. The rail consists of our PLC adaptor modules and a 500mm x 50mm DIN 'top hat' rail. These can be used alongside your own PLC (generally 12V but in some cases 24V) to provide easy connection to a wide variety of 4mm based equipment – from your own stock or from our Locktronics or Automatics ranges.

Learning objectives / experiments:

- Common PLC industrial applications
- Different PLC types and their features
- PLCs and their operation characteristics
- Fundamentals of ladder logic
- Plus, much more

Curriculum mapping

- Suitable for unit 15 of the BTEC National award in Engineering : Electrical machines
- Suitable for BTEC Higher National unit 42: further PLCs
- Suitable for City & Guilds Manufacturing Industry, unit 2303: Computer Aided Engineering

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

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.

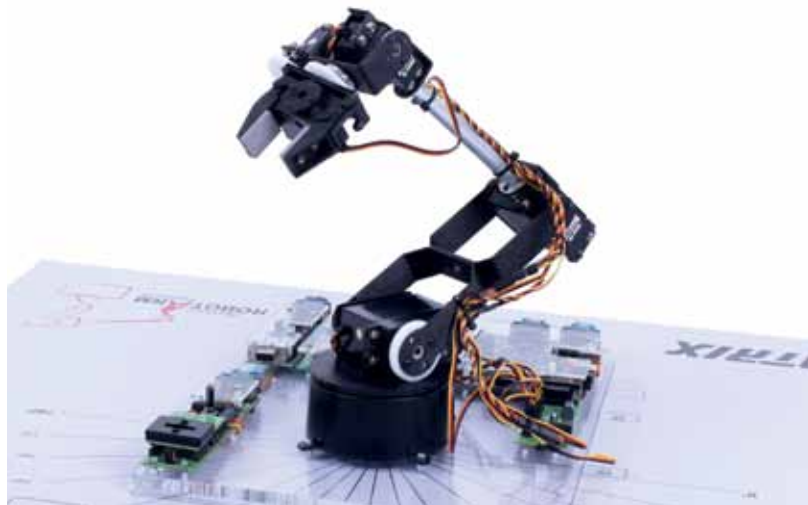### Learning objectives / experiments:

- 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

AllCode robot arm production cell

Our robot arm production cell consists of a rugged servocontrolled 6 degrees of freedom arm bolted to a base plate and 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.
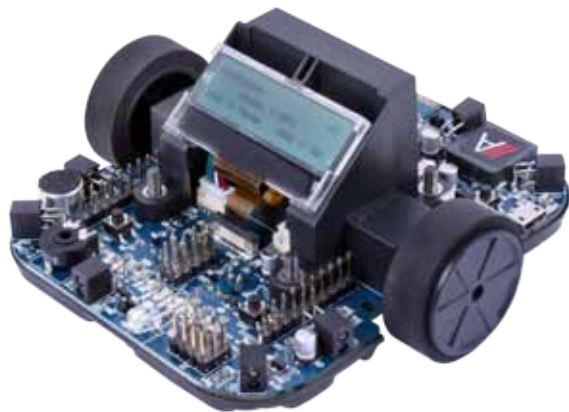
Learning objectives / experiments:

- 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

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.

See Formula AllCode section for full details

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 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

Ordering information	
Formula AllCode deluxe kit	RB7971
Formula AllCode standard class set	RB7240
Formula AllCode deluxe class set	RB7518
Corresponding curriculum	CP5894

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)

Learning objectives / experiments:

- Programming mobile phones
- Football algorithm development

Ordering information	
Formula AllCode football mat add-on	RB4938
Maze walls	RB8962

Curriculum mapping

- Suitable for technology or computer science syllabuses.

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
Wax cylinders	CN3300
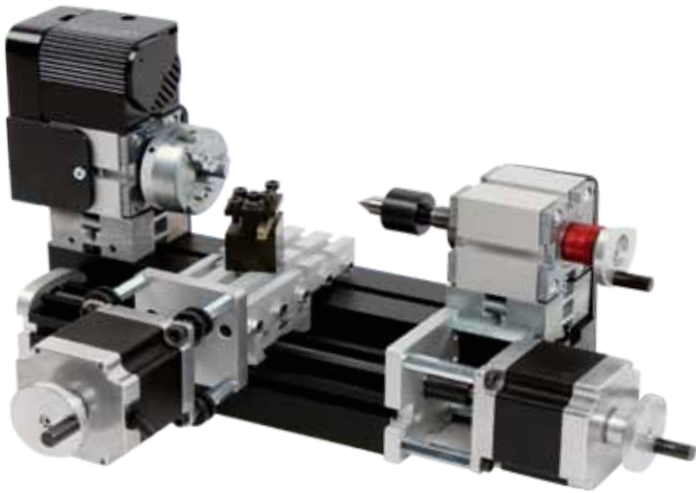
3-axis MicroCNC milling machine

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
Modelling blocks	CN9581
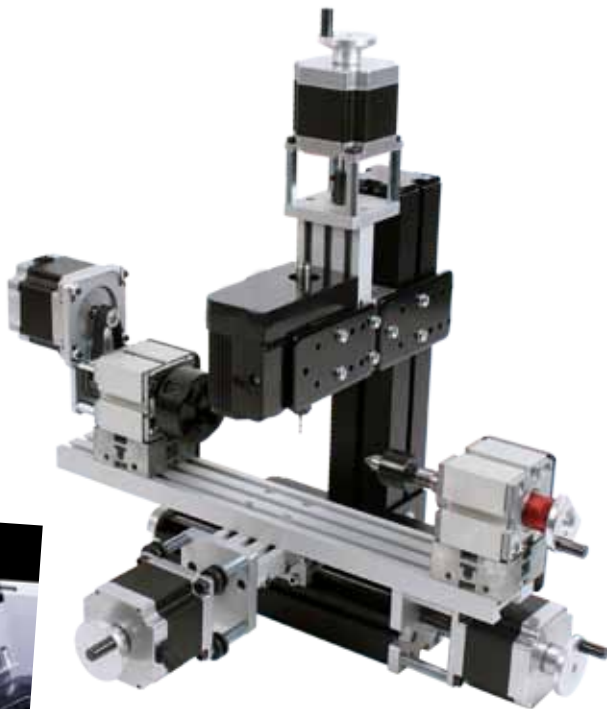
Curriculum mapping

- 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
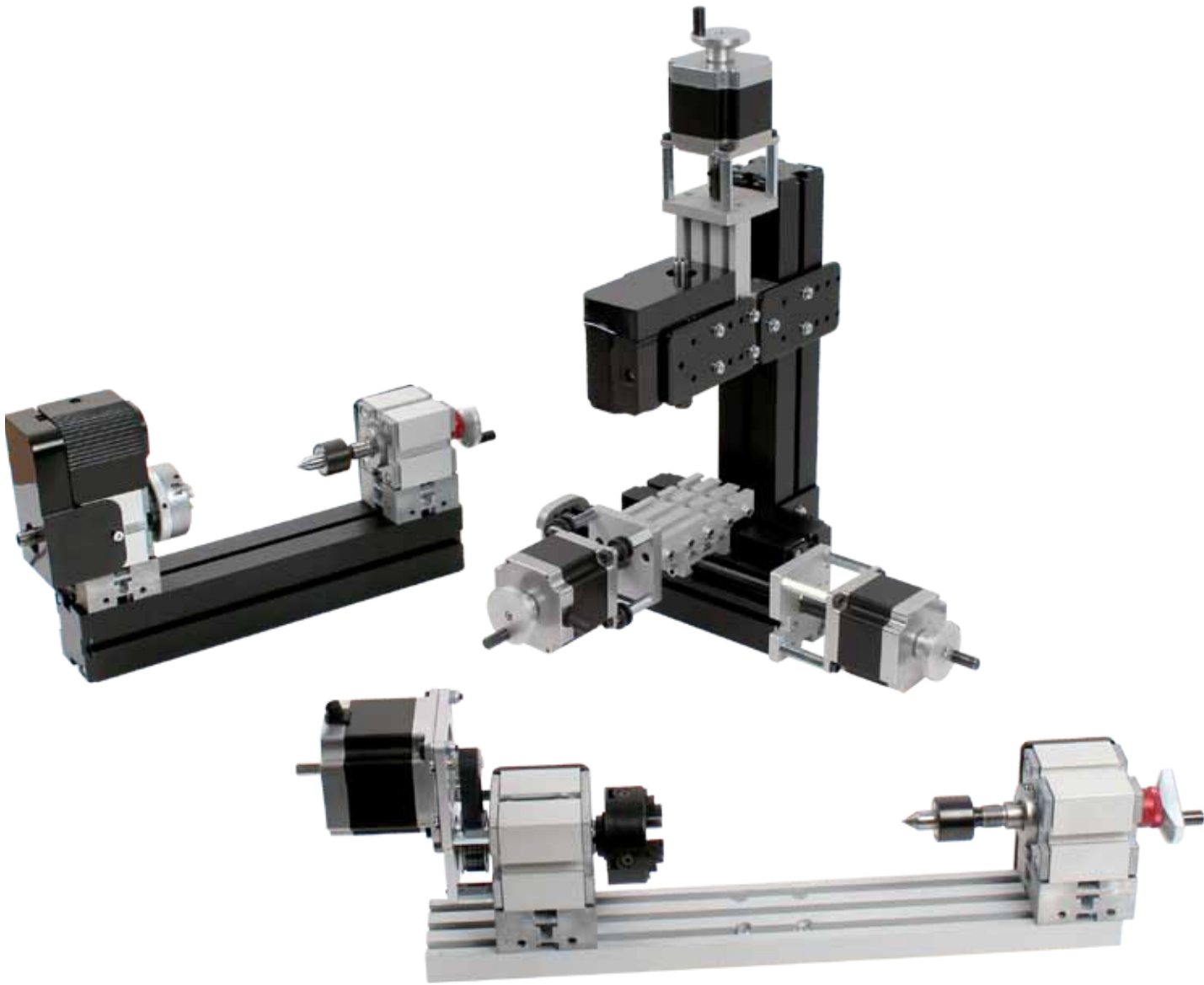
4-axis MicroCNC milling machine

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
Modelling blocks	CN9581

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

NEW

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

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

Ordering information	
Deskproto single license	CN3075
Deskproto site license	CN2498

NEW

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

NEW

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
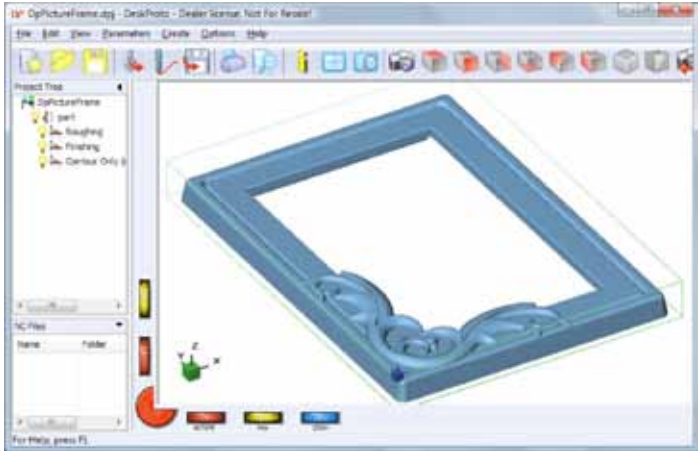- Manufacture of parts using a CAD CAM tool chain

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
Modelling blocks	CN9581
Wax cylinders	CN3300

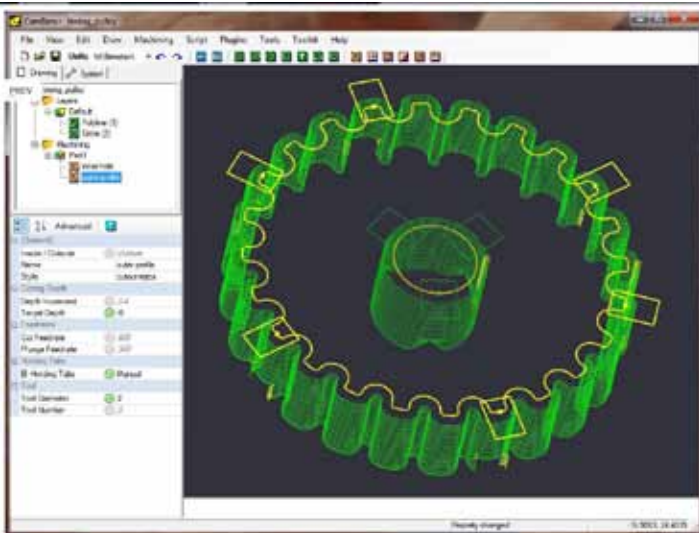### Curriculum mapping

- 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

Ordering information	
CamBam single license	CN8332
CamBam site license	CN2171

Wax cylinders

A pack of 10 wax cylinders for use with the MicroCNC lathe and the Complete MicroCNC set.

Ordering information	
Wax cylinders	CN3300

Modelling blocks

An accessory pack of 10 polyurethane blocks and 10 acrylic squares, for use with the MicroCNC 3-axis milling machine, MicroCNC 4-axis milling machine and Complete MicroCNC set.

Ordering information	
Modelling blocks	CN9581

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 also now include a showcase piece in our aviation range – a jet engine model – which allows technicians to understand the construction and operation system of an aviation engine.

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

"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.

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
EEASA 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 - combined power supply and signal generator – COMING SOON, see page 47 for more information	LK6999

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 - combined power supply and signal generator – COMING SOON, see page 47 for more information	LK6999

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

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

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

Turbo jet engine model

This model of a modern two-wave turbine shows in detail the construction and the operating system of a jet engine. The combustion chambers with injection nozzles and starting plugs, low pressure and high pressure compressor, low pressure and high pressure turbine are easily recognised thanks to the sectioned housing. The engine can be set in motion with the built in low power motor.

Two models are available: standard model and a model with high pressure compressor

Learning objectives / experiments:

- Jet engine operation
- Combustion
- Fuel injection
- Compression

Ordering information	
Turbo jet engine model—electric	MB9200
Turbo jet engine model—high pressure compressor—electric	MB9210

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.

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.
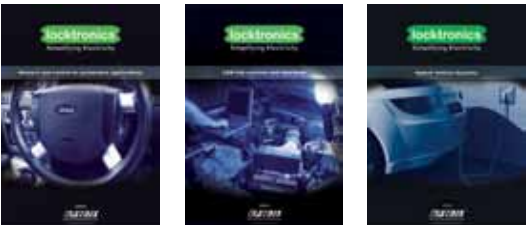
Locktronics automotive customers

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 3

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

Electricity, magnetism and materials

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

Learning objectives / experiments:

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

Curriculum mapping

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

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

AC principles for automotive technicians

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

Learning objectives / experiments:

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

Curriculum mapping

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

Ordering information	DIN	ANSI	
AC principles for automotive technicians solution	LK8222	LK8222A	
Corresponding curriculum	LK8392		
You will also need:			
Multimeter pack	LK1110	Picoscope	HP8279
Signal generator	HP7894		

An introduction to motors, generators and hybrid

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

Learning objectives / experiments:

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

Curriculum mapping

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

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

An introduction to digital electronics

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

Learning objectives / experiments:

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

Curriculum mapping

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

Ordering information	DIN	ANSI
An Introduction to digital electronics.	LK4221	LK4221A
Corresponding curriculum	LK9392	
You will also need:		
Multimeter pack		LK1110

Combined level 2 automotive pack

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

Learning objectives / experiments:

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

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 2 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	

Curriculum mapping

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

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	

CAN bus systems and operation solution with engineering panel

The LK2839 CAN has the same learning objectives and components as the LK7629 but is based on our engineering panel 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	

Curriculum mapping

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

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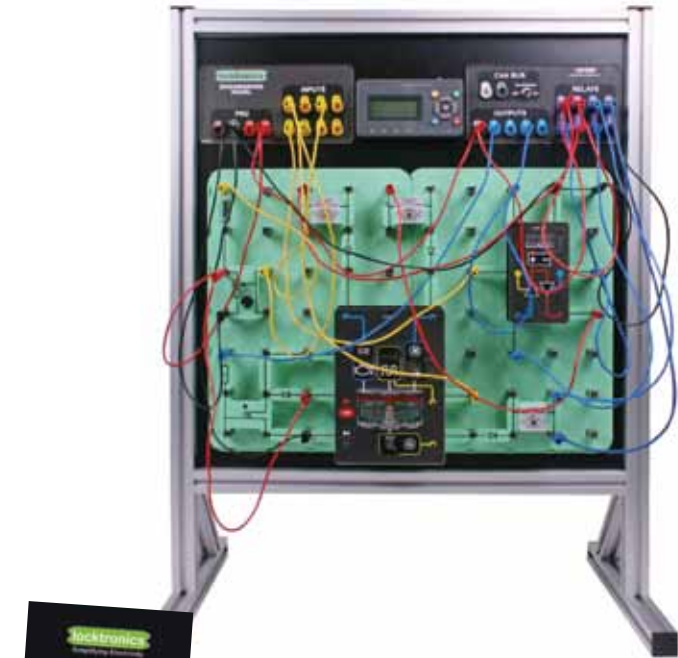
Ordering information	DIN	ANSI
Hybrid automotive principles on engineering panel	LK6483	LK6483A
Corresponding curriculum	LK4483	

Curriculum mapping

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

Cutaway vehicle engines

These fantastic cutaway petrol and diesel engine models allow students to see all the key parts of an engine, in full motion. Some models are moved by hand, and some are fitted with a low power electric motor which turns all parts. These highly visual and tangible models are great at giving students a really good understanding of how all the parts of a vehicle engine work. Models are carefully sectioned for training purposes, professionally painted with different colours to better differentiate various parts, cross sections, lubricating circuits, fuel system, cooling system etc. Many parts are chrome plated and galvanised for longer life. All engines are fitted onto a stand with wheels for moving around the lab. The ordering information below includes our most popular products—please contact us for a full list of products.

More models available - please call us for details

Learning objectives / experiments:

- Function of an engine/clutch/gearbox
- How parts of a vehicle link together
- Maintenance points and access
- Engine, clutch and gearbox systems

Ordering information - Petrol engines	
Toyota Hybrid engine with clutch and gearbox —hand	MB4500
Toyota Hybrid engine with clutch and gearbox —electric	MB4501
Mazda Wankel engine—hand	MB4004
Fiat 4 cylinder, 16 valve petrol - electric	MB4800
Fiat 4 cylinder, 16 valve petrol - hand	MB4801
Fiat 4 cylinder with clutch and gearbox—electric	MB4805
BMW 6 cylinder petrol engine + clutch and gearbox—electric	MB5170

Ordering information - Diesel engines	
Chrysler 4 cyl. turbodiesel engine—electric	MB6010
Chrysler 4 cyl. turbodiesel engine—manual	MB6011
Fiat 4 cyl. turbo diesel with clutch and gearbox—electric	MB6020
Turbodiesel 6 cyl, with clutch and gearbox—electric	MB6080
Iveco V8 truck engine—electric	MB6084

Curriculum mapping

- All automotive courses

Cutaway vehicle chassis

These cutaway vehicle chassis allow you to explain a host of vehicle functions in a hands on and direct fashion. The vehicles includes a full cutaway engine as well as fully working electrical systems, with simulated dashboard, that allow you to explain a huge variety of topics on vehicles.

All vehicle parts are mounted on a strong steel chassis with wheels. The ordering information below includes our most popular products—please contact us for a full list of products.

More models available - please call us for details

Learning objectives / experiments:

- Engine, clutch and gearbox functions
- Electrical and lighting systems
- Disc and drum brake systems
- Suspension systems
- Injection and carburetion systems
- Radiator and cooling systems

Ordering information - Petrol engines	
Fiat 4 cyl. front, injection, ABS + power steering + lights	MB5260
Fiat 4 cyl. 4 wheel drive, injection, + lights—electric	MB5260
Fiat 4 cyl. rear, injection, + lights—electric	MB5340

Ordering information - Diesel engines	
Fiat turbodiesel, 4 cyl, rear with lights - electric	MB6160
Fiat turbodiesel, 4 cyl., front, with lights—electric	MB6175

Curriculum mapping

- All automotive courses

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

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

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 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

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 AC theory
- Includes our new residual current device

Ordering information	
Electrical installation level 2	LK4063
Corresponding curriculum	CP8475
You may also need	
Multimeter	LK1110

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

Curriculum mapping

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

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

Curriculum mapping

• Suitable for City and Guilds 8202 level 3

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.

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

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

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.

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	
You will also need			
Multimeter pack x2	LK1110	AC power supply (240V: 12V @5amps)	HP3728

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
You might also need...	
Multimeter	LK1110

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.
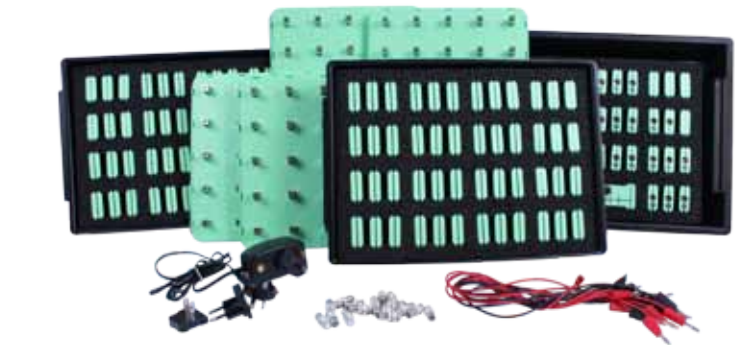
Learning objectives / experiments:

• 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	
You will also need			
Multimeter	LK1110	Signal generator	HP7894

This solution is also suitable for centres delivering training under the EAL awarding body.
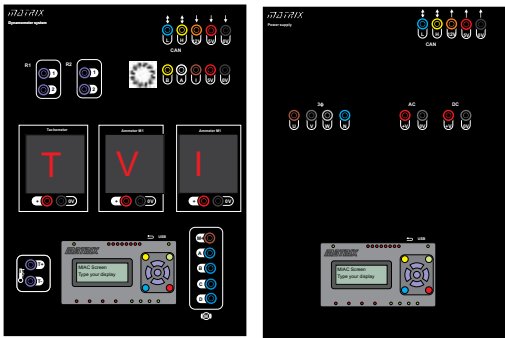
8202 Level 3: Principles of lighting

This pack allows students to understand the principles of designing lighting systems for domestic and industrial buildings. The kit consists of 4 Locktronics base boards, a set of high power MES LED bulbs, connectors and switches, and a light meter. Students can arrange the bulbs in varying positions and densities and measure light intensity using the light meter provided. Students can explore the different effects on light intensity through the angle of lighting, the distance away from the light source, and the density of light sources. The kit is supplied in standard storage trays and a full set of student worksheets is free on our web site. 1m rule included.

Learning objectives / experiments:

- Lighting system design
- Units of measurement for light
- Inverse square law
- Cosine law

Curriculum mapping

- Suitable for City and Guilds 8202 level 3

Instruments	
Further instruments may be required, please contact us	
Ordering information	
Principles of lighting pack	LK2285

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

8202 Level 3: Electrical machines system

Our Electrical machines system is the base level kit for this new range of equipment. A power supply, controlled via one of our MIAC controllers is the main control unit for the system. Alongside the power supply, we provide a dynamometer and physical rheostats, used as the load system to enable students to take readings. Full student manuals are included and equipment is supplied in our standard storage trays.
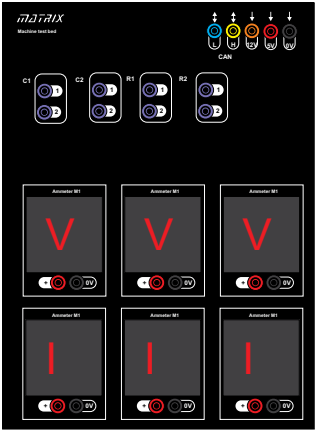
Learning objectives / experiments:

- DC machine construction
- Basic DC machines, torque characteristics and efficiency
- Varying DC machine speed with voltage
- DC machines with wound stators
- Compound DC machines
- DC motors as dynamos
- DC motor control using PWM
- Speed and position sensors in motor control systems
- Servo control systems
- Swinging arm dynamometer and torque measurement
- Link between HP, watts and joules

Curriculum mapping

- Suitable for City and Guilds 8202 level 3

Ordering information	
Electrical machines system	EM6637

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

8202 Level 3: Electrical machines, AC & three phase add-on pack

Our Electrical machines AC & three phase add-on pack gives the user the ability to also study AC and three phase machines. The system contains a unit which houses several digital meters showing the current and voltage in the machine under test. The unit also contains banks of resistors and capacitors which are switched on using the MIAC controller on the dynamometer system control panel. This allows the characteristics of the windings in the system to be changed with the speed of the machine. Full student manuals are included and equipment is supplied in our standard storage trays.

Learning objectives / experiments:

- AC machine construction
- Universal motors
- AC induction motors, torque characteristics and efficiency
- Synchronous speed and slip
- Start up and run circuits
- AC generators
- Three phase AC machine construction
- Three phase motors, torque characteristics and efficiency
- Operating three phase motors from a single phase

Curriculum mapping

- Suitable for City and Guilds 8202 level 3

Ordering information	
Electrical machines: advanced system	EM6413

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

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.

"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.

FLOW CODE

www.matrixtsl.com

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 you are using, 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.

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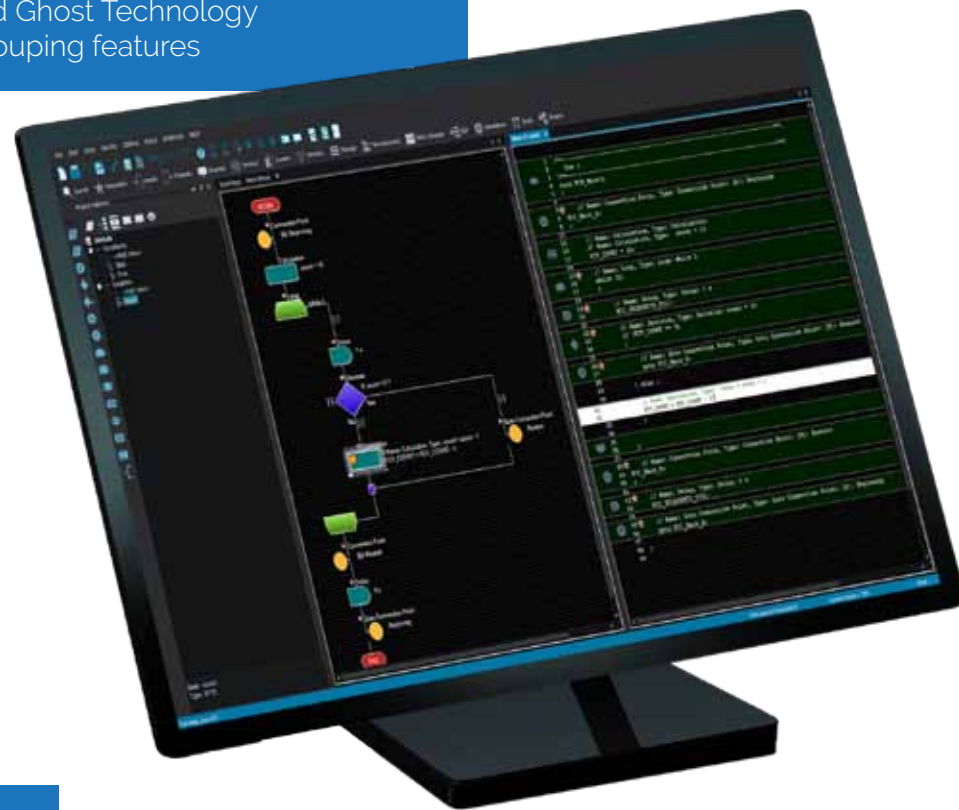
Did you know? Flowcode academic licences allow your students FREE Flowcode licences for use at home

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 is FLOWCODE

Test enviroment
- 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 mode

Mechatronic system development
- Robotics
- AllCode technology
- MIAC PLC

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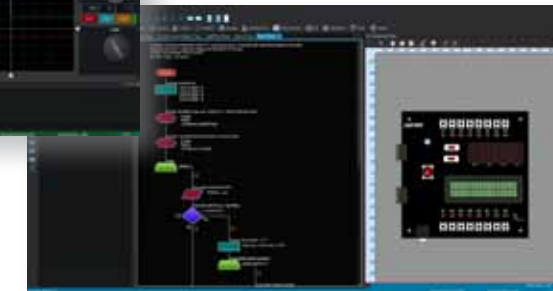- Simulate your C code
- Convert between C and flowcharts etc.

Wired & wireless communications
- Serial comms including I2C
- Comms hardware solutions available
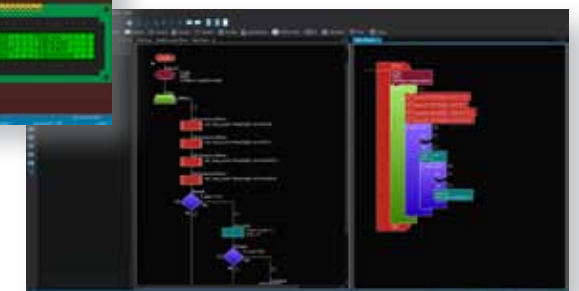- Internet of Things project development
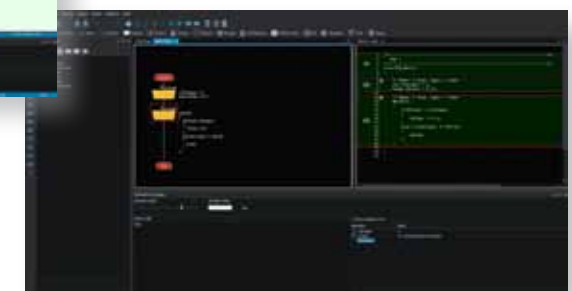
Sensor interface
- Sensor module support
- Grove sensor compatibility
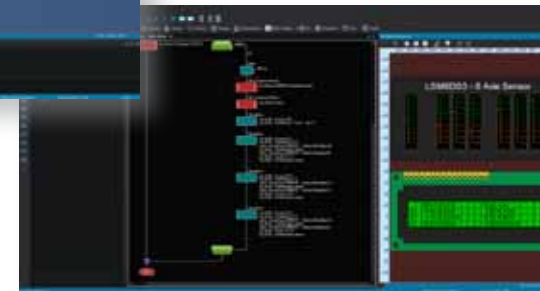
Multiple programming languages
- Flowcharts
- Blocks
- Pseudocode
- C code

MATRIX   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:
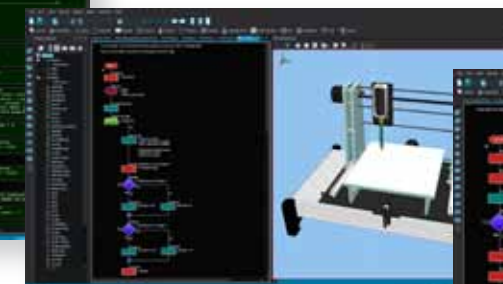· Flowcharts
· Blocks
· C code
· Pseudocode

Design

Electronic engineer
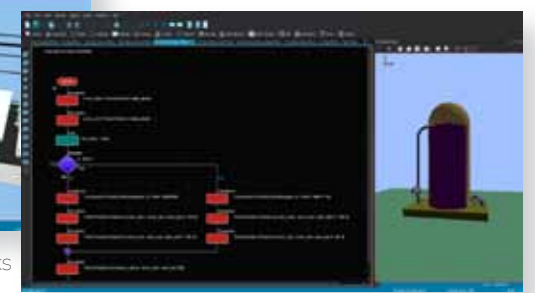

Electromechanical engineer

System engineer

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

Develop a mechanical system in Solidworks and characterise it for Flowcode. Develop a flowchart program for control and operational data conditioning.
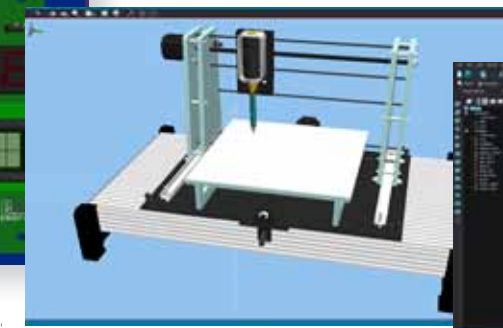
Develop a mathematical and/or physical model of your system, and develop a flowchart control program using Flowcode.

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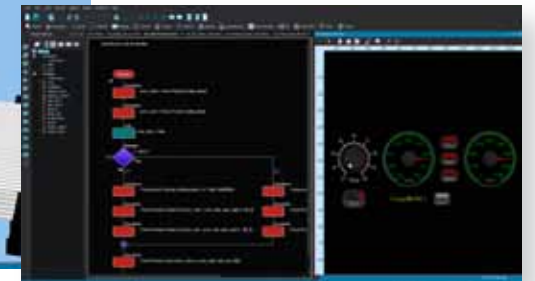
Use Flowcode Dashboard objects to simulate system performance in human friendly graphical format.

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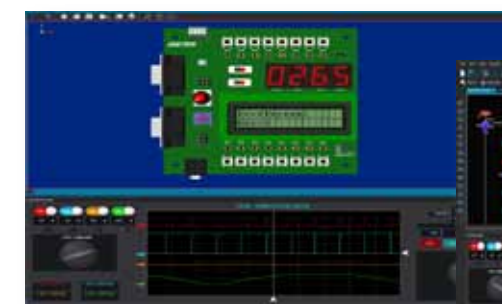
Download to the microcontroller in the E-blocks development system and use In-Circuit-Test and Oscilloscope feature to verify operation at pin level.

Use In-Circuit-Test to test and debug at a pin level.
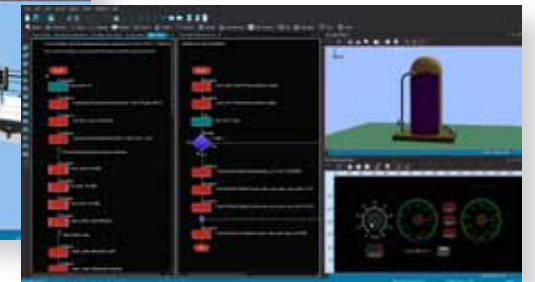
Link Dashboard objects, Oscilloscope and Console to third party instruments using DLLs in SCADA fashion to verify performance in real time.

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.

MATRIX
MATRIX

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.

Microcontroller system training & support for education

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 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

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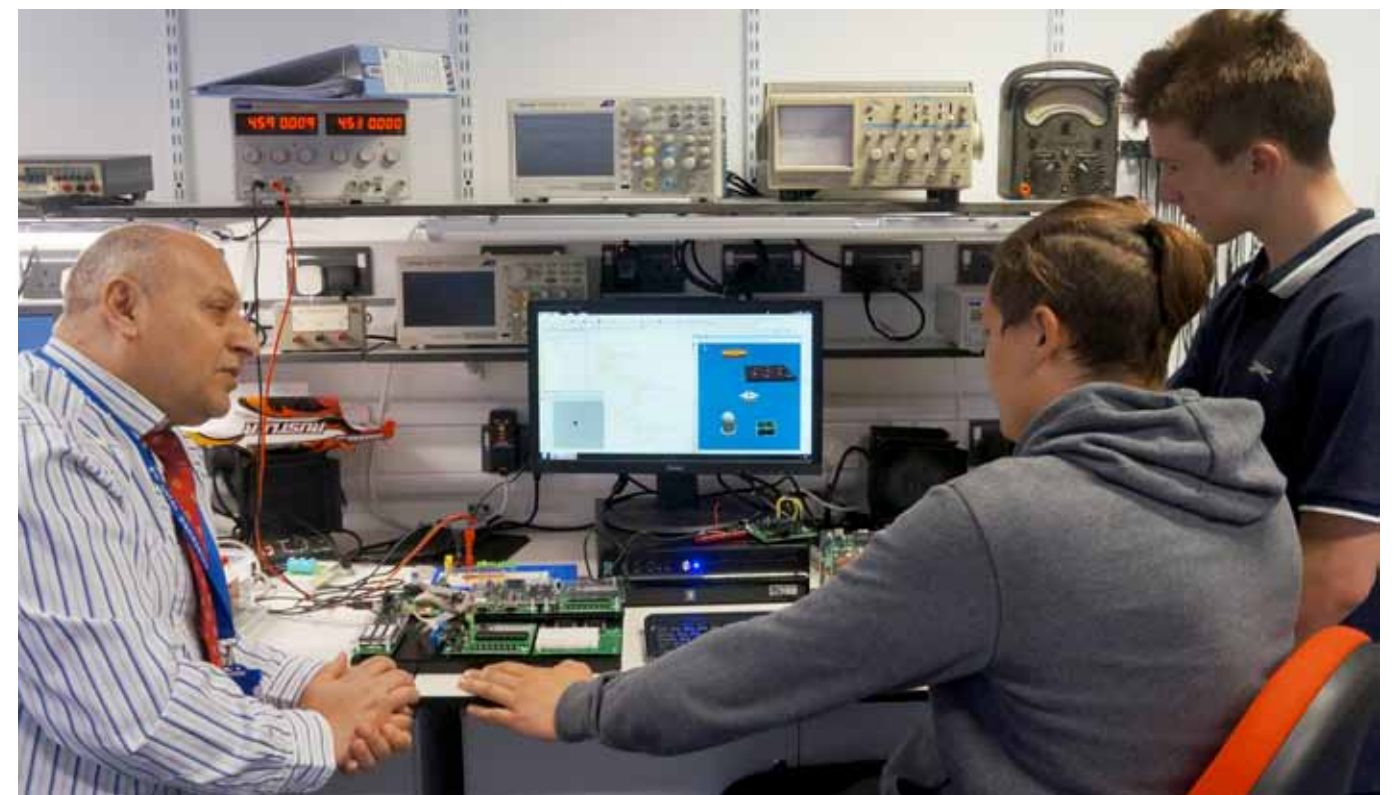
For further information on how we can help to give you what you need, do not hesitate to contact us today

Wiki	Forum	Course	Examples

"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.

"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.

locktronics
Simplifying electricity

"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
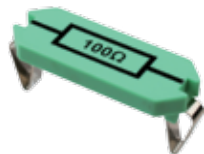
The Locktronics range includes:

Baseboards
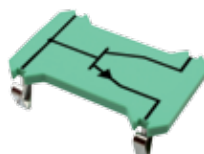*To which students add...*

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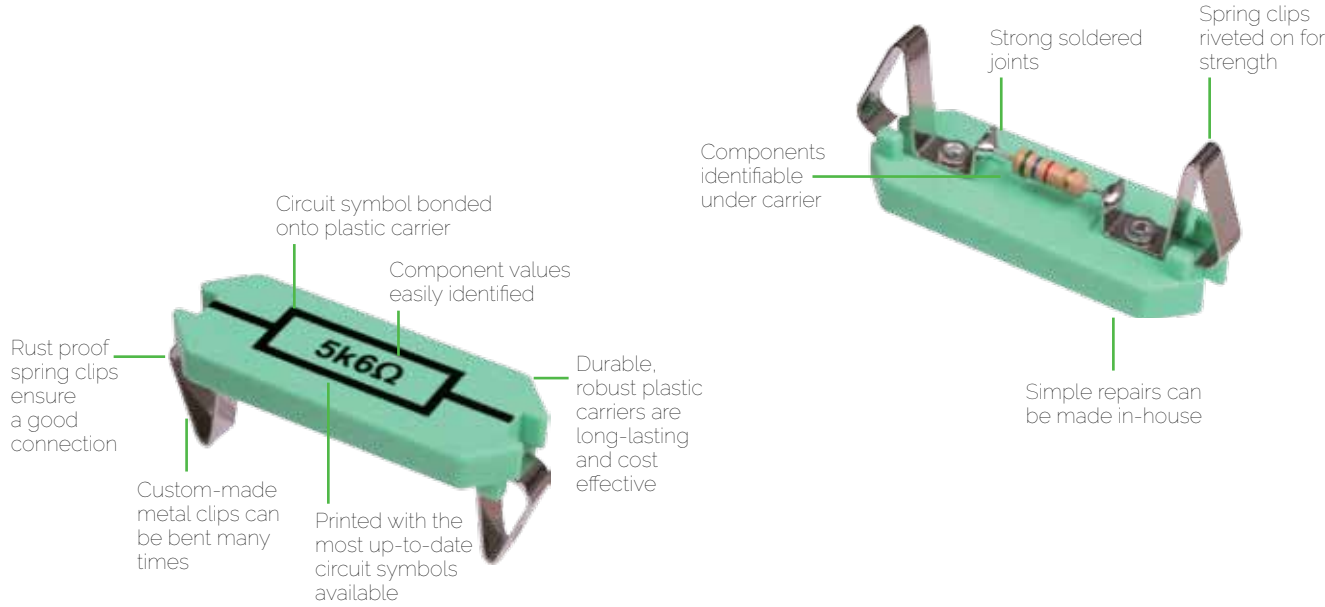
The core range consists of more than 200 electronic components mounted on rugged plastic carriers which are printed with the corresponding circuit symbol. Students use these carriers, in conjunction with a baseboard with interconnecting metal pillars, to build up a working circuit. They then use the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

Circuit symbol bonded onto plastic carrier

Component values easily identified

Rust proof spring clips ensure a good connection

5k6Ω

Durable, robust plastic carriers are long-lasting and cost effective

Custom-made metal clips can be bent many times

Printed with the most up-to-date circuit symbols available

Strong soldered joints

Spring clips riveted on for strength

Components identifiable under carrier

Simple repairs can be made in-house

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
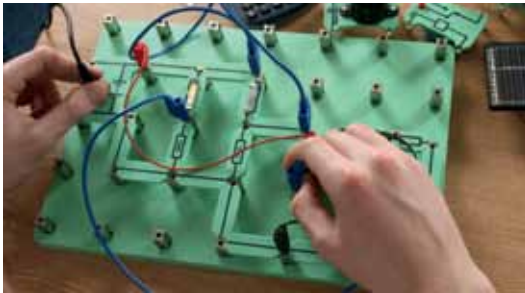- 12 month guarantee on all items
- Unlimited telephone support on all products

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.

MATRIX

MATRIX

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, techaclogy and automotive.

Choosing the right solution

Take a look at our range of curriculum packs that you can see on page 103. 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 request. 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.
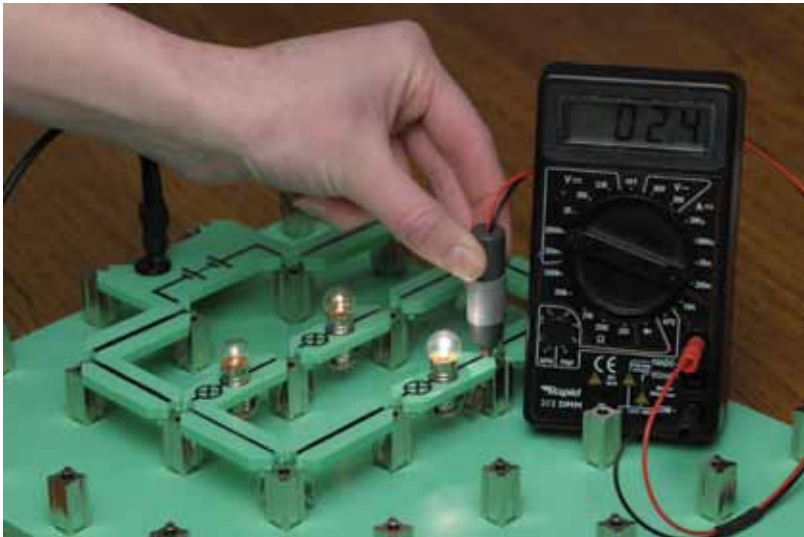
Component and kit variations

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 - see page 105 - 109.

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...

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

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

...with ANSI (North American) symbols...
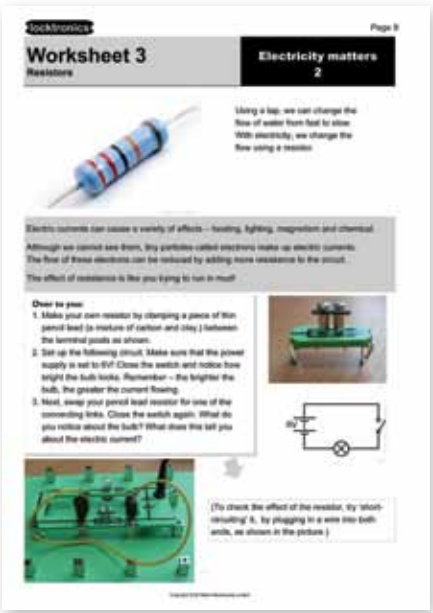
...and our active MIAC control unit.

Most worksheets follow the same format. Illustrated introduction to topic area and components supports student learning.
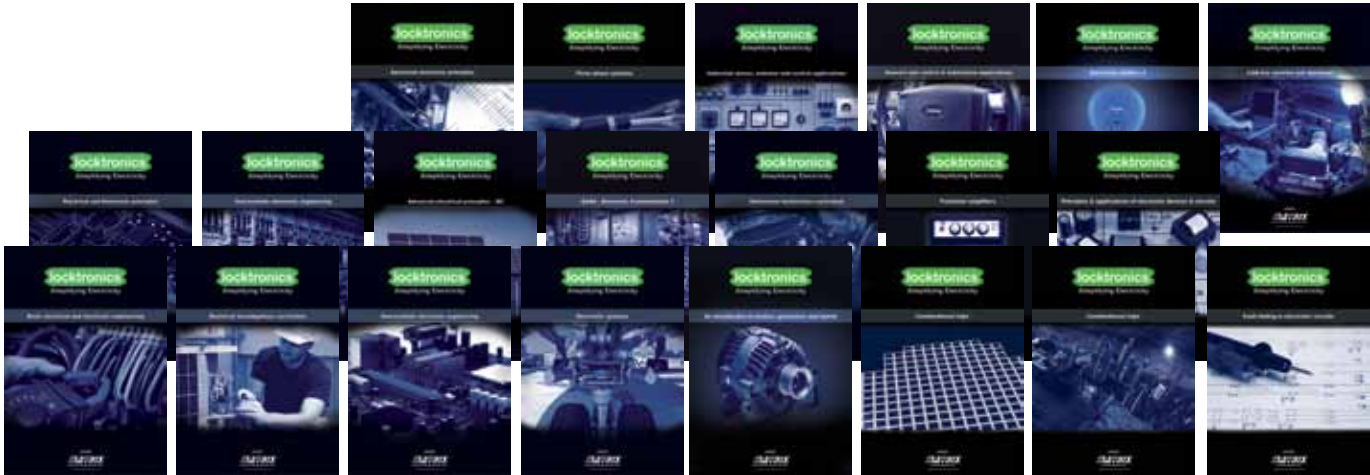
'Over to you' allows students to experiment based on what they have learnt and allows teachers to assess their understanding through a series of exercises.

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

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

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

MIAC technology

- 8 analogue or digital inputs
- CAN bus connectors
- 2 line 16 character LCD display
- Input status LEDs
- 4 x 10A relay outputs
- Output status LEDs
- User keypad
- 4 x motor outputs
- Power (up to 26V) and ground connectors

Code: MI0245

Features

- The world's only educational Electronic Control Unit
- A flexible resource with many uses in many areas of engineering
- Physically and electrically rugged
- Compatible with Flowcode, C, Assembly, LabView and Visual Basic
- 8 digital or analogue inputs, 4 relay outputs, 4 motor outputs with speed control, 4 line LCD display and control keys and CAN bus
- Compatible with a wide range of industrial sensors
- Fast CAN bus for networking

The MIAC is a fully specified industrial grade Programmable Logic Controller (PLC). It has 8 analogue or digital inputs, 4 high current relay outputs, 4 motor outputs and an integrated Controller Area Network (CAN) bus which allows many units to be networked together.

The MIAC is available in a rugged plastic case with all connections made available using 4mm shrouded 'banana' sockets. The status of all I/O lines is indicated with an individual LED. A keypad and 4 line 16 character display facilitate user interactions. The unit is programmed directly from a PC's USB port using Matrix's own Flowcode graphical programming language, C code or Assembly code. The unit can also be controlled via the LabView and Visual Basic development environments.
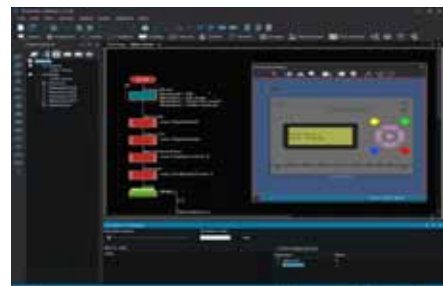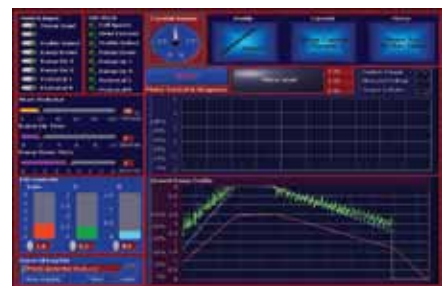

Use with Flowcode

Flowcode is an easy-to-use graphical programming language based on flow charts. Drag and click on icons and components to create a program, simulate on screen and then download to the MIAC.
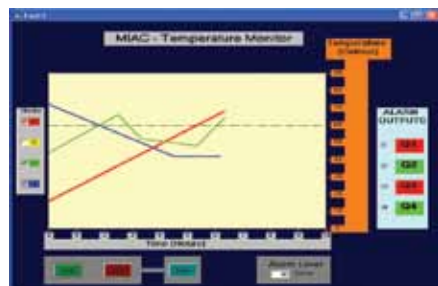
Visual Basic®

A free program can be downloaded to the MIAC which makes it function as a VB or LabView interface. A DLL with function calls is supplied which allows a wide variety of PC based control systems to be developed.
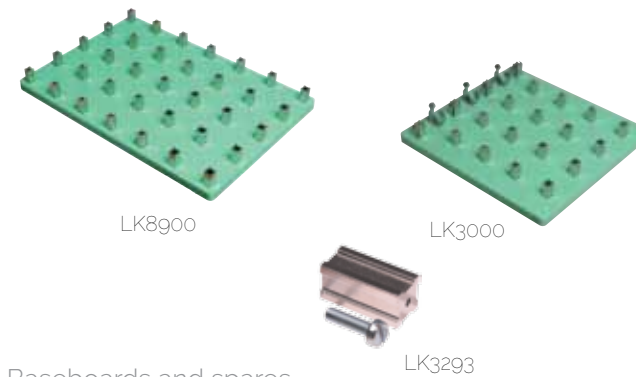

or LabView®

- PC based data capture and control
- LabView and VB via USB
- Ideal for advanced engineering concepts such as PID
- A flexible lab interface

Available in 5 versions:

Standard cased MIAC | Arduino cased MIAC | dsPIC cased MIAC | Raspberry Pi cased MIAC | AllCode cased MIAC

Copyright © 2018 Matrix Technology Solutions Limited

LK8900 | LK3000 | LK7936 | LK4786 | LK5250

LK3293

Baseboards and spares

Description	Part number
7 x 5 baseboard with 4mm pillars	LK8900
4 x 4 baseboard with 4mm pillars and battery holders	LK3000
Spare 4mm pillar and bolt	LK3293
Battery contact spring	LK3288
Battery retaining clip	LK8615

Miscellaneous carriers

Description	Part number
Connecting link	LK5250
Crossover link	LK5251
Fuse/universal component carrier	LK7936
Sampler	LK5290
Automotive fuse carrier	LK4786
Protoboard	LK4839

HP7894 | LK1110

LK4839 | LK8623

Instruments

Description	Part number
Multimeter	LK1110
Energy meter	LK8591
25MHz PC based oscilloscope / signal generator pack	HP8279
Benchtop signal generator pack	HP7894
AC/DC current clamp	HP5561
Three phase power supply	HP9390

Non-carrier products

Description	Part number
MES bulb, 2.5V, 0.2A	LK2341
MES bulb, 6V, 0.06A	LK2347
MES bulb, 6.5V, 0.3A	LK2350
MES bulb, 12V, 0.1A	LK2346
MES bulb, 12V, LED, red	LK6749
MES bulb, 12V, LED, yellow	LK6822
MES bulb, 12V, LED, white	LK6841
400 turn induction coil	LK5299
Terminal post	LK5294
Small bar magnet	LK0123
Small compass	LK0124
Lenz's law kit	LK7487
Faraday's law kit	LK7489
Fleming's motor rule apparatus	LK6482
Circuit breaker	LK8623
BNC male to dual 4mm binding post	HP6529
OBD2 to 4mm lead	LK5697
Three phase motor	HP3920

LK5298 | LK5607

Leads

Description	2mm option	Standard part
Lead, black, 1000mm, 4mm to croc clip	LK5297E	LK5297
Lead, red, 300mm, 4mm to 2mm stackable	LK5555E	LK5555
Pair of leads, red and black, 1000mm, 4mm to croc clip		LK5570
Lead, red, 1000mm, 4mm to croc clip	LK5298E	LK5298
Lead red, 500mm, 4mm to 4mm stackable		LK5603
4mm to 4mm lead, black		LK5604
Lead, green, 320mm, 4mm to 4mm stackable		LK5601
4mm to 4mm lead, yellow		LK5607
4mm to 4mm lead, blue		LK5609
General purpose lead set (LK5603 x 2, LK5604 x 2)		LK8022
Lead, D-type to yellow and blue 4mm for can analyser		LK5695
Lead, black, 300mm, 4mm to 2mm stackable	LK5556E	LK5556
Lead, white, 300mm, 4mm to 2mm stackable	LK5557E	LK5557
Lead, red, 2000mm, 4mm to 4mm plug		LK6574

HP9564 + HP7750 | HP2025Q

Packaging and storage

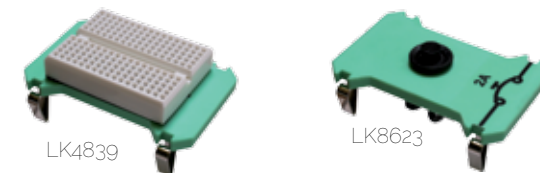| Description	Part number
Deep tray	HP5540
Shallow tray	HP2045
Tray lid	HP4039
62mm daughter tray	HP9564
Daughter tray foam insert	HP7750
18 tray trolley	HP3025N
12 tray trolley	HP2025Q

Need more information?

Our website includes photographs and descriptions of every product in the Locktronics range. Data sheets on many products are also available.

Copyright © 2018 Matrix Technology Solutions Limited

Capacitors

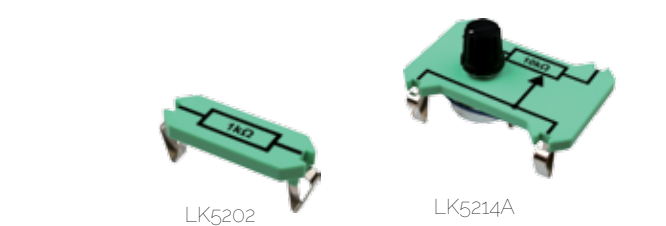| Description	Part number
Capacitor, 100pF, Ceramic	LK6283
Capacitor, 0.1µF, Polyester	LK5222
Capacitor, 0.47µF, Polyester	LK6216
Capacitor, 1µF, Polyester	LK6205
Capacitor, 2.2µF, Polyester	LK6217
Capacitor, 4.7µF, 25V	LK6206
Capacitor, 1µF, Polyester	LK6239
Capacitor, 100µF, 25V	LK6202
Capacitor, 150µF, 25V	LK6223
Capacitor, 1000µF, Electrolytic, 30V	LK4003
Capacitor, 2200µF, 25V	LK6203
Capacitor, 4700µF, Electrolytic, 16V	LK6653
Capacitor, 22000µF, Electrolytic, 16V	LK3662
Capacitor, 10uF, Electrolytic, 25V	LK5221
Capacitor, 47uF, Electrolytic, 25V	LK5224
Capacitor, Variable, 15-140PF	LK6214
Capacitor, 1nF, Polyester	LK6239
Capacitor, 33uF, non-electrolytic	LK5987

Inductors

Description	Part number
Choke, 5mH	LK6214R3
Choke, 10mH	LK6214R1
Choke, 47mH	LK6214R2
Choke, 68mH	LK6215
Choke, 200mH	LK9877
Transformer, 2:1 turns ratio	LK4123
Ferrite rod carrier	LK4021
1:1 transformer with retractable ferrite core	LK7483
400 turn coil	LK9998

Logic gates - CMOS

Gates are available with either American National Standards Institute (ANSI) symbols or with Systems Block (SB) symbols. All sub-systems and logic gates are fitted with 2mm power connector sockets. Gates are delivered with 2mm to 4mm power leads as standard - 'L'. Gates are also available with 2mm to 2mm leads for use in labs where only 2mm connectors are allowed - 'LE'.

| Description	Part no. SB 2mm to 2mm	Part no. ANSI 2mm to 2mm	Part no. SB 2mm to 4mm	Part no. ANSI 2mm to 4mm
AND gate with lead	LK6870LE	LK6860LE	LK6870L	LK6860L
NAND gate with lead	LK6873LE	LK6863LE	LK6873L	LK6863L
NOR gate with lead	LK6874LE	LK6864LE	LK6874L	LK6864L
NOT gate with lead	LK6872LE	LK6862LE	LK6872L	LK6862L
OR gate with lead	LK6871LE	LK6861LE	LK6871L	LK6861L
XOR gate with lead	LK6875LE	LK6865LE	LK6875L	LK6865L

Resistors

Here is our range of resistors. If you do not see the value you need, then you can make your own with our pre-printed blank carrier resistors.

| Description	Part no. DIN	Part No. ANSI
Resistor, 3.9Ω, 3W, 5%	LK5211	
Resistor, 10Ω, 3W, 5%	LK4025	LK4025A
Resistor, 12Ω, 3W, 5%	LK4100	LK4100A
Resistor, 47Ω, 3W, 5%	LK4065	LK4065A
Resistor, 68Ω, 3W, 5%	LK5217	LK5217A
Resistor, 100Ω, 3W, 5%	LK4002	LK4002A
Resistor, 120Ω, 0.5W, 5%	LK5206	LK5206A
Resistor, 180Ω, 0.5W, 5%	LK5207	LK5207A
Resistor, 220Ω, 0.5W, 5%	LK5215	LK5215A
Resistor, 270Ω, 0.5W, 5%	LK5205	LK5205A
Resistor, 500Ω, 0.5W, 5%	LK6237	
Resistor, 560Ω, 0.25W, 5%	LK6219	LK6219A
Resistor, 1KΩ, 0.5W, 5%	LK5202	LK5202A
Resistor, 2.2KΩ, 0.25W, 5%	LK6218	LK6218A
Resistor, 5KΩ, 0.25W, 5%	LK6230	
Resistor, 5.6KΩ, 0.25W, 5%	LK5209	LK5209A
Resistor, 10KΩ, 0.25W, 5%	LK5203	LK5203A
Resistor, 15KΩ, 0.25W, 5%	LK6213	LK6213A
Resistor, 22KΩ, 0.25W, 5%	LK6211	LK6211A
Resistor, 33KΩ, 0.25W, 5%	LK5201	LK5201A
Resistor, 50KΩ, 0.25W, 5%	LK6231	LK6231A
Resistor, 100KΩ, 0.25W, 5%	LK5218	LK5218A
Resistor, 150KΩ, 0.25W, 5%	LK6212	
Resistor, 200KΩ, 0.25W, 5%	LK6238	LK6238A
Resistor, 270KΩ, 0.25W, 5%	LK5204	LK5204A
Resistor, 330KΩ, 0.25W, 5%	LK6201	LK6201A
Resistor, 500KΩ, 0.25W, 5%	LK6232	LK6232A
Resistor, 1MΩ, 0.25W, 5%	LK6200	LK6200A
Resistor, 1.5MΩ, 0.25W, 5%	LK5210	
Resistor, 10MΩ, 0.25W, 5%	LK6233	
Resistor, Rx	LK5252	LK5252A
Potentiometer, 25Ω	LK5212	
Potentiometer, 250Ω	LK5208	LK5208A
Potentiometer, 1KΩ	LK4034	LK4034A
Potentiometer, 10KΩ	LK5214	LK5214A
Potentiometer, 100KΩ	LK5219	
Potentiometer, 1MΩ	LK5213	
Resistor, variable, 250Ω	LK3893	
Resistor, variable, 10KΩ	LK6630	
Resistor, variable, 100KΩ	LK6631	
Resistor, 50ohm, 1/4w, 2%	LK8980	

System blocks and other ICs

All sub-system and logic gates are fitted with 2mm power connector sockets. Gates are delivered with 2mm to 4mm power leads as standard - 'L'.

Description	Part number
Systems block transistor switch	LK6831
Systems block transducer driver	LK6832
Residual Current Device (RCD)	LK7928

Description	2mm to 2mm	2mm to 4mm
Op Amp module (TL081) with 2mm to 4mm leads only	LK6234LE	LK6234L
Voltage regulator (7805)	LK7208	LK7208
D-type flip-flop (horizontal) only 2mm to 4mm	LK6500LE	LK6500L
D-type flip-flop (vertical) only 2mm to 4 mm	LK6501LE	LK6501L
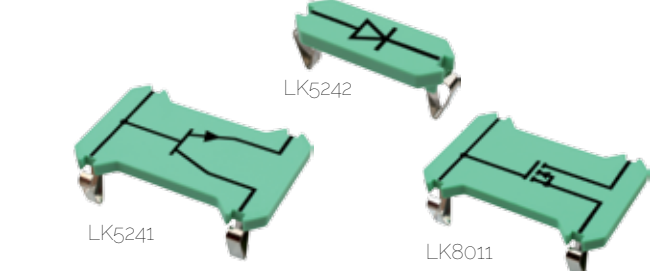
Semiconductors

Description	Part number
Diode, germanium	LK5242
Diode, power, 1A, 50V	LK5243
Diode, silicon	LK5249
Zener diode, 4.7V	LK5247
Zener diode, 6.8V	LK5253
Zener diode, 8.2V	LK5254
Zener diode, 12V	LK5258
Schottky diode	LK8000
Bridge rectifier	LK5266
Transistor LHF, NPN	LK5241
Transistor LHF, PNP	LK5256
Transistor RHF, NPN	LK5240
Transistor RHF, PNP	LK5255
Transistor, unijunction	LK5246
Power transistor, NPN, 1.5A	LK6705
Power transistor, NPN, 10A	LK7203
Transistor, JGFET	LK5146
Transistor, FET	LK7219
Power MOSFET transistor	LK8011
Thyristor	LK5248
Photodiode	LK7361
Phototransistor	LK7290
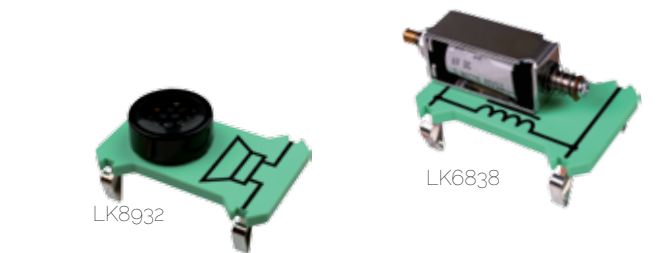
Electromechanical

Description	Part number
Solenoid	LK6838
Buzzer, 6V, 15mA	LK6423
Buzzer, 12V, 15mA	LK3246
Speaker	LK8932

Dimensions W: 60cm x H: 78cm

Engineering panel

Description	Part number
Engineering panel	HP2673
Demonstration panel	HP6320
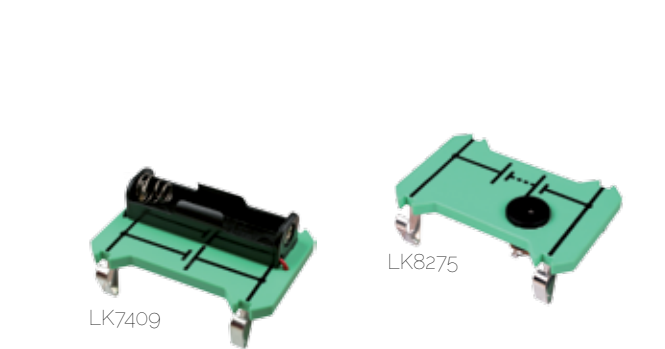
Power / battery carriers

Description	Part number
Power supply carrier with battery symbol	LK8275
Power supply carrier with voltage source symbol	LK7461
Dual voltage rail power supply carrier	LK8492
AC voltage source carrier	LK2340
AA battery holder carrier	LK7409

Relays

Description	Part number
Relay, 12V coil, 10A normally open	LK5280
Relay, 6V coil, 10A normally open	LK5403
Relay, 6V coil, 10A changeover with 2mm to 4mm lead	LK7889L
Relay, reed, changeover	LK4103
Relay, reed, normally open	LK5405
Relay, 12V coil, 10A changeover with 2mm to 4mm lead	LK7049L

Power supplies

Description	Part number
Adjustable DC power supply, 3V to 12V, 1A, no carrier	HP2666
AC power supply, 12VAC, 1.5A, UK	HP3728
AC power supply, 12VAC, 1.5A Europe	HP4429
AC power supply, 12VAC, 1.5A, USA	HP4688
Triple output power supply -12, +5, +12	HP8405
IEC mains connector lead, for +/-12 VDC PSU, Europe	HP3702
IEC mains connector lead, for +/-12 VDC PSU, USA	HP3703
DC power supply, 15VDC, 25A, UK	HP0056

LK7746

LK6635

Optoelectric and lights / lamps

Description	Part no. SB	Part no. ANSI
Lampholder, MES, for automotive LEDs	LK5287	
Lampholder, MES	LK5291	
LED, red	LK6635	LK6635A
LED, green	LK6636	LK6636A
LED, yellow	LK6637	LK6637A
Solar cell	LK7746	
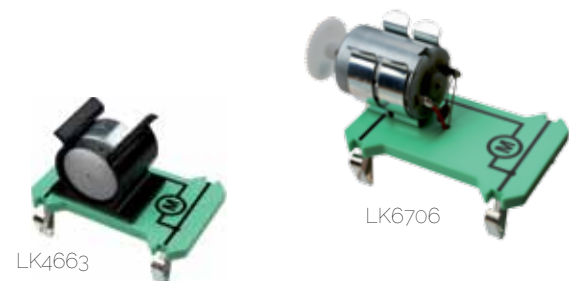
LK6706

LK4663

Motors / generators

Description	Part number
Motor, 3V to 12VDC, 0.7A	LK6706
Motor, 6V, open frame	LK4102
Stepper motor	LK4322
Low power solar motor	LK4663
Hand cranked generator	LK4893
Hand cranked generator spare handle	LK4894
Motor with reluctor	LK8113

LK5401

LK4121

Sensors

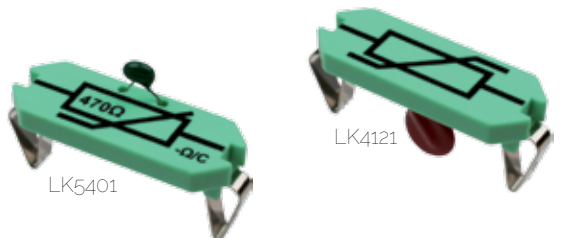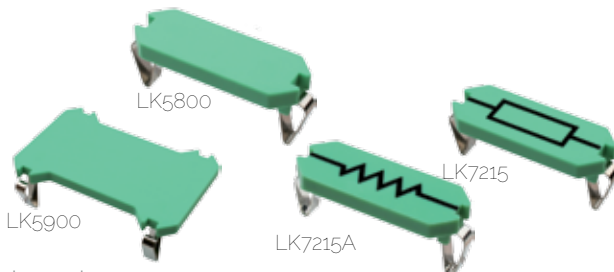| Description	Part no. DIN	Part no. ANSI
Hall effect switch	LK6734	
Thermistor, 470Ω, NTC	LK5401	LK5401A
Thermistor, 4.7KΩ, NTC	LK5402	LK5402A
Thermistor and moisture sensor PCB	LK6850	
Thermocouple carrier	LK8988	
Voltage dependent resistor	LK4121	
Slotted opto sensor with 2mm to 4mm lead	LK6707L	
Magnetic pickup	LK8743	

LK6207

LK6632

LK6633

Switches

Description	Part number
Switch, on/off, toggle	LK6633
Switch, push to make, metal strip	LK6207
Switch, normally open, reed	LK5404
Switch, reversing, toggle	LK6632
Switch, changeover, toggle	LK6224
Switch, changeover	LK6208
Microswitch	LK6634
Switch, on/off, metal strip	LK6209

LK5800
LK5900
LK7215
LK7215A

Blank carriers

Description	Part no. SB	Part no. ANSI
Blank carrier, large, pack of 10	LK5900	
Blank carrier, small, pack of 20	LK5800	
Blank resistor carrier	LK7215	LK7215A
Blank capacitor carrier	LK7216	
Blank electrolytic carrier	LK7217	
Blank diode carrier	LK8013	
Blank transistor carrier	LK7218	
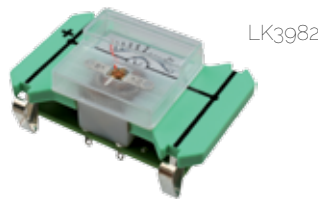
LK3982

Moving coil meters

Description	Part number
Voltmeter, 0V to 15V	LK3982
Voltmeter, +/-7.5V	LK9438
Ammeter, 0mA to 100mA	LK9381
Ammeter, 0A to 1A	LK8397

LK8150
LK8154

Resistivity carriers

Description	Part number
Nichrome 0.075mm² x 500mm	LK8150
Nichrome 0.075mm² x 250mm	LK8152
Nichrome 0.21mm² x 500mm	LK8154
Constantan 0.075mm² x 500mm	LK8156

Lenz's law apparatus

The Lenz's law apparatus allows students to easily see that, "An induced current is always in such a direction to oppose the motion or change causing it". The apparatus consists of a copper tube, with one side removed and two identical cylinders only one of which is magnetised. Lenz's law is demonstrated by the fact that when the metal cylinders are dropped through the copper tube, the magnetised cylinder falls at a much slower rate because of induced eddy currents in the copper tube wall. Students will be intrigued by this highly visual experiment which forms an ideal part of a course on motors and generators.

Description	Part number
Lenz's law apparatus	LK7487
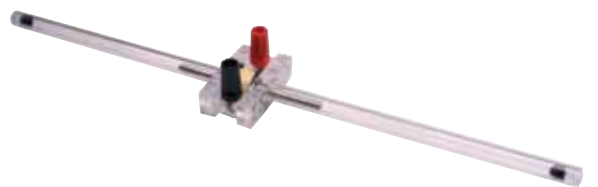
Faraday's law apparatus

This apparatus is ideal for demonstrating Faraday's law of electromagnetic induction. It consists of a clear plastic tube containing a powerful magnet, with a 400 turn coil bonded onto the surface of the tube. When the tube is inverted the magnet passes through the coil, inducing a voltage on the coil terminals. Students are able to use an oscilloscope or datalogger to easily see the induced voltage. This is an ideal precursor to understanding generator theory.

Description	Part number
Faraday's law apparatus	LK7489
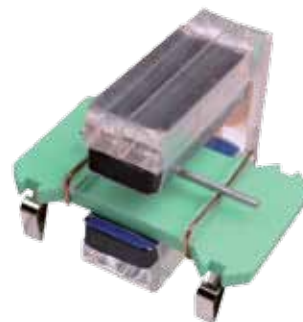
Fleming's motor rule apparatus

This apparatus is used to demonstrate the fact that a force is exerted on a current-carrying conductor when it is placed in a magnetic field. The apparatus consists of three parts - a large Locktronics carrier with two parallel wires, a powerful magnetic yoke with North and South poles clearly visible, and a thin metal tube as the conductor. The tube 'kicks' off the carrier when a current is passed through it. This highly visual apparatus provides an opportunity of demonstrating Fleming's left hand motor rule.

Description	Part number
Fleming's motor rule apparatus	LK6482

Energy meter

This simple meter is ideal for giving students a quantitative and qualitative feel for the unit of energy - the Joule - and power - the Watt. The meter measures voltage, current, power consumption and shows energy used over time. For simplicity, the instrument automatically adjusts the display to show suitable units and an appropriate number of decimal places so that it can deal with a very wide range of values (e.g. for energy, from 0.01 millijoules up to 300 kilojoules). The function button has four settings to select the desired quantities to be measured (energy and time, power, average power, voltage and current). The meter includes a 9V mains adaptor (UK only).

Description	Part number
Energy meter	LK8591

Locktronics PIC microcontroller

This carrier includes a reprogrammable PIC microcontroller with four general purpose input output pins. When used as inputs the pins can be configured to be analogue or digital. The carrier includes three slide switches which can be used for selecting one of 8 internal programs in the PIC. The device can also be reprogrammed from the USB port. Power can be derived from the on-board 2mm connectors or from the USB port.

Description	Part number
USB reprogrammable PIC MCU with 2mm to 4mm lead	LK4690L
USB2 high speed A to mini B lead	HPUAB

MIAC

MIAC is a powerful controller which has applications in Science, Technology, Electronics, Mechanical engineering, Automotive engineering and Chemical engineering. This version of the MIAC is supplied with 4mm shrouded sockets which are internally connected to all of the input outputs of the MIAC. The 4mm connectors mean that connection to Locktronics baseboards is extremely easy. Power supply and USB lead are not included.

Description	Part number
MIAC with 4mm shrouded sockets	MI0245
Power supply for MIAC (international)	HP2666
USB2 high speed A to B mini lead	HPUAB
Raspberry pi cased MIAC	MI5718
Arduino cased MIAC	MI5138
dsPIC cased MIAC	MI3494

MATRIX

MATRIX

Lascells MATRIX

These products from renowned UK education brand Lascells have been selected to specially enhance your study of various topics and disciplines found throughout our catalogue. For further information on these items, they will be introduced online at www.matrixtsl.com/lascells in Spring 2018.

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	AS3084
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
Photo Detector	AS2519
Fibre Optics system	AS4882
LED Light Source	AS8848
Emitter Detector Pair	AS3248
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.
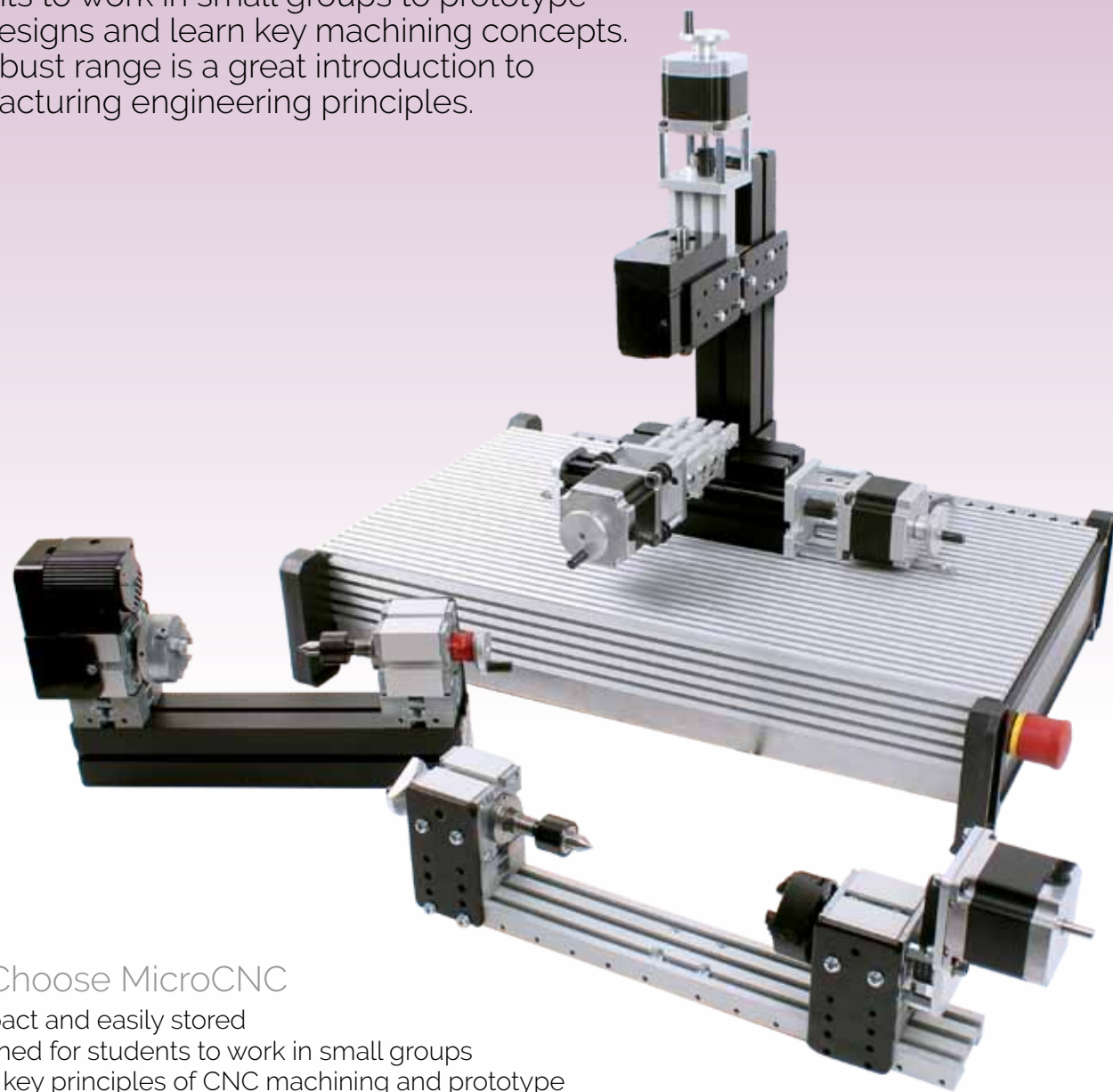
Why Choose MicroCNC

· 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.
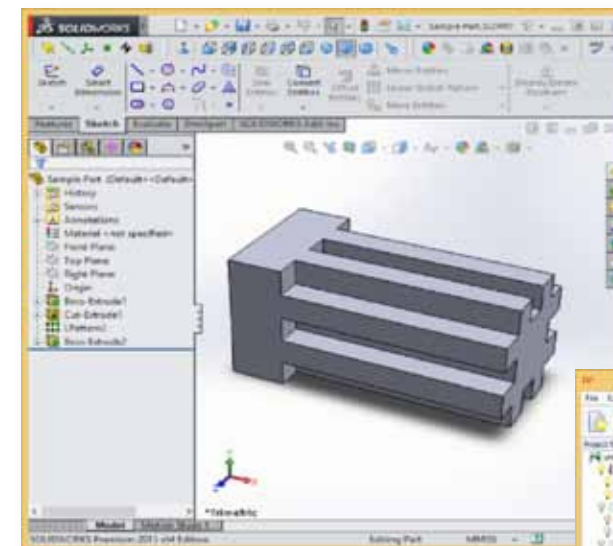
Step 2:

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.
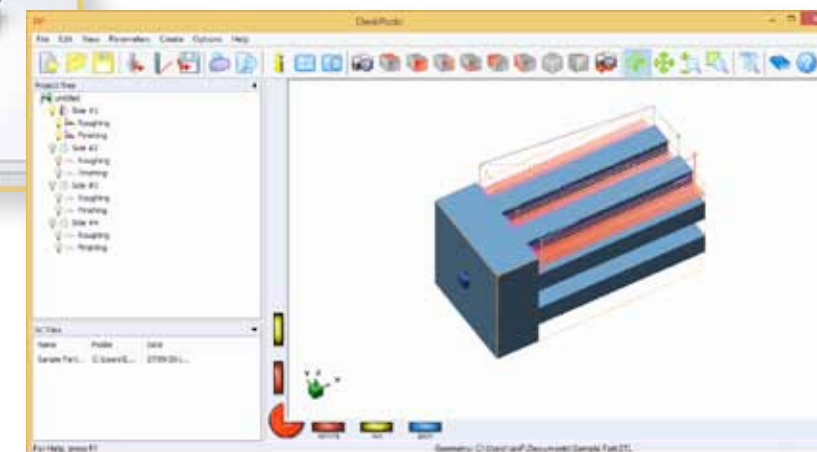
Step 3:

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 67 to 72
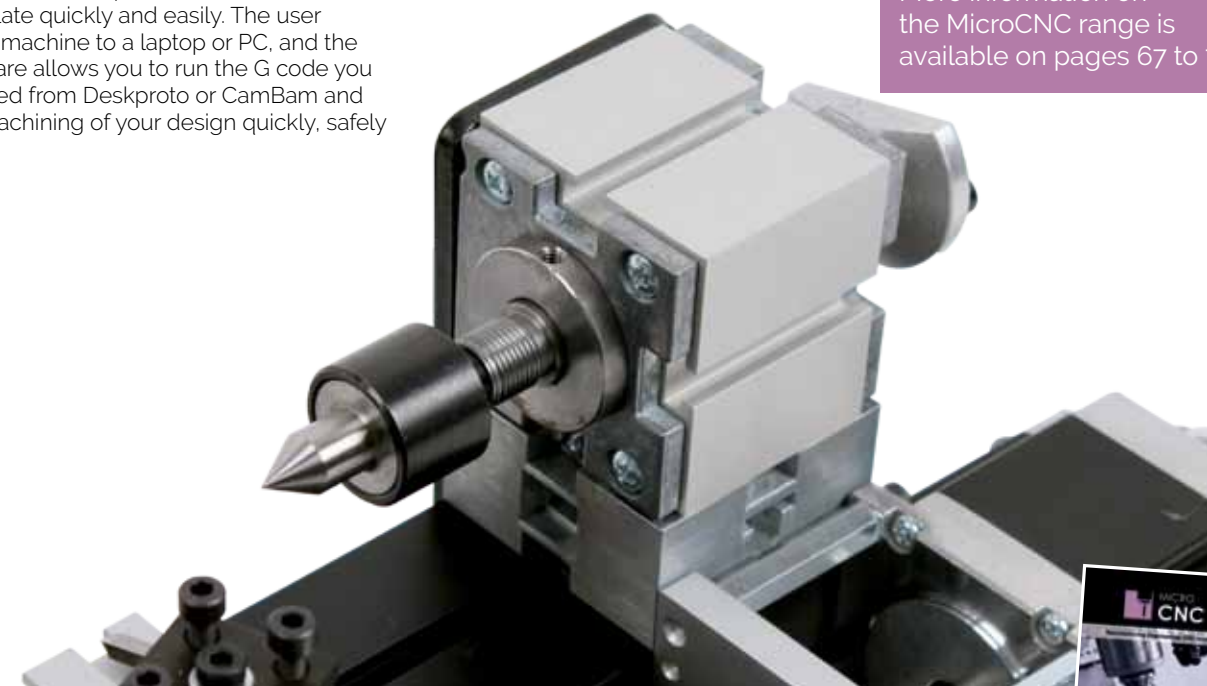
The MicroCNC curriculum is written to specifications from BTEC at National and Higher National Level and City & Guilds qualifications at Level 2 and above. These excellent UK awarding bodies produce some of the World's most well respected and well recognised technical education qualifications. At Matrix 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.

MATRIX
MATRIX

The E-blocks2 range includes:

A range of upstream programmer boards
To which students add:
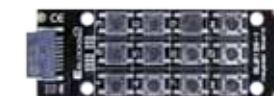
Input /output boards

Wired & wireless communications boards

Graphical displays

Motors and actuators boards
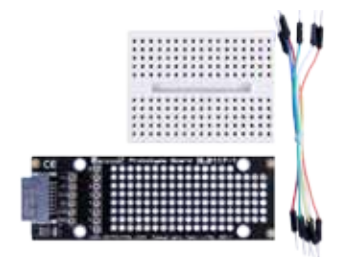
Prototype boards

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

E BLOCKS2

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.
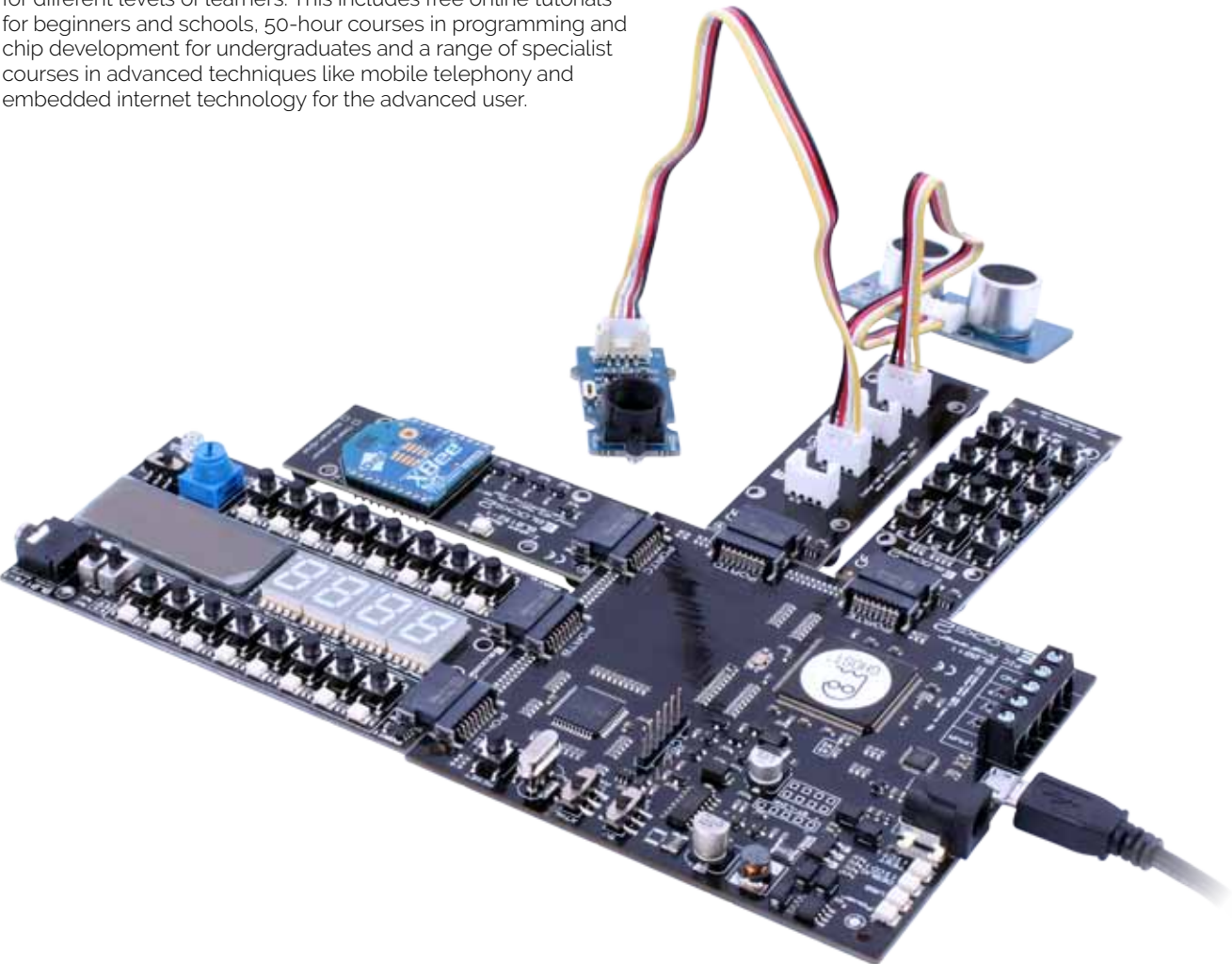
What is Ghost?

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.
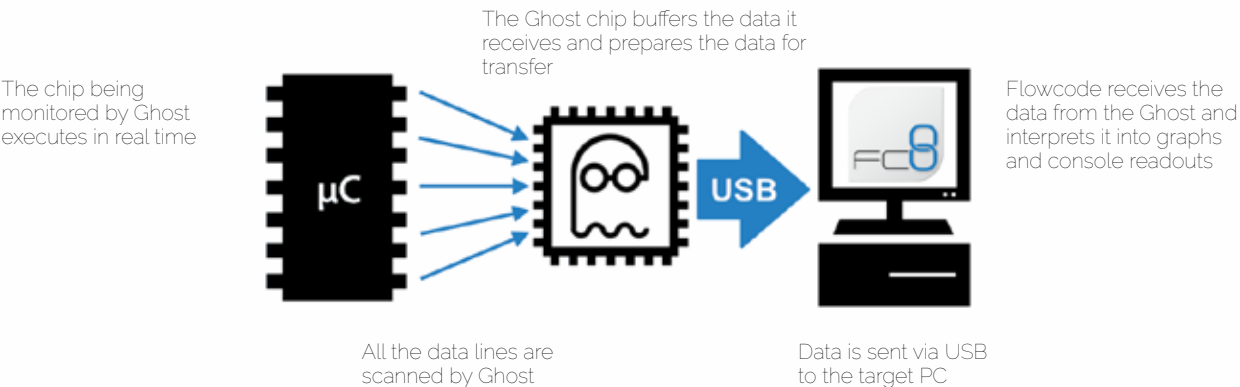
What Hardware can I use with Ghost?

BL0055 Arduino shield

BL0080 PIC Multiprogrammer board

EB006 v9 Multiprogrammer board

...Plus any other upstream board from page 127

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

μC

USB

All the data lines are scanned by Ghost

Data is sent via USB to the target PC

E-blocks2 Arduino shield

The Arduino shield can be used with various programming languages including Assembly, C, Arduino IDE and Flowcode.

To program your Arduino on the board a free tool called mLoader is available to download.

The board presents all port pins collected together as E-blocks2 sockets. The board takes power from an external power supply or from the micro USB port.

The E-blocks2 Arduino shield is compatible with Ghost 2 technology. Using the board with Flowcode allows the use of the advanced Ghost debugging features including in circuit debugging, real time pin monitoring and bus decoding.

Ordering information	
E-blocks2 Arduino shield	BL0055

E-blocks2 dsPIC programmer

The 16-bit dsPIC microcontroller programmer connects to a PC via USB to provide a powerful microcontroller programming and debugging platform. The 16-bit PIC programmer can be used with various programming languages including Assembly, C and Flowcode. The board comes complete with a powerful dsPIC33EP256MU806 microcontroller. The board presents all port pins collected together as E-blocks2 sockets. The board takes power from an external power supply or from the micro USB port.

Ordering information	
E-blocks2 dsPIC programmer	BL0032

E-blocks2 Raspberry-Pi shield

The Raspberry Pi shield allows you to connect a Raspberry Pi PCB computer up to an E-blocks system to provide you with a powerful programming and debugging platform. The board presents all GPIO and peripheral pins collected together as E-blocks2 sockets. The board takes power from an external power supply or from the micro USB port.

Ordering information	
E-blocks2 Raspberry-Pi shield	BL0036

E-blocks2 PIC multiprogrammer

The 8-bit PIC multiprogrammer can be used with various programming languages including Assembly, C and Flowcode. To program the PIC on the board, a free tool called mLoader is available.

The board will program a wide range of 18, 28 and 40 pin PIC microcontroller devices from the PIC16F and PIC18F series. The board presents all port pins collected together as E-blocks2 sockets and takes power from an external power supply or from the micro USB port.

A powerful 40 pin PIC16F18877 device is shipped with the multiprogrammer.

The E-blocks2 8-bit PIC multiprogrammer is compatible with Ghost 2 technology. Using the board with Flowcode allows the use of advanced Ghost debugging features including in circuit debugging, in circuit test, real time pin monitoring and bus decoding.

Ordering information	
E-blocks2 PIC multiprogrammer	BL0080

E-blocks2 PIC programmer

The 8-bit PIC programmer board can be used with various programming languages including Assembly, C and Flowcode. To program the PIC on the board a free tool called mLoader is available to download.

The board comes with a powerful PIC16F18877 microcontroller. The board presents all port pins collected together as E-blocks2 sockets. The board takes power from an external power supply or from the micro USB port.

The E-blocks2 PIC programmer is compatible with Ghost 2 technology. Using the board with Flowcode allows the use of the advanced Ghost debugging features including in circuit debugging, real time pin monitoring and bus decoding.

Ordering information	
E-blocks2 PIC programmer	BL0011

E-blocks2 ARM programmer

The ST32 ARM programmer connects to your PC via USB to provide you with a powerful microcontroller programming and debugging platform. To program the ARM on the board, a free tool called mLoader is available to download from our website. The board comes complete with a powerful series 4 ARM microcontroller. The board presents all port pins collected together as E-blocks2 sockets. The board takes power from an external power supply or from the micro USB port.

Ordering information	
E-blocks2 ARM programmer	BL0061

E-blocks2 AVR programmer

The AVR programmer connects to your PC via USB to provide a powerful microcontroller programming and debugging platform. To program the AVR on the board, a free tool called mLoader is available to download from our website. The board comes complete with a powerful ATMEGA328P microcontroller. The board presents all port pins collected together as E-blocks2 sockets. The board takes power from an external power s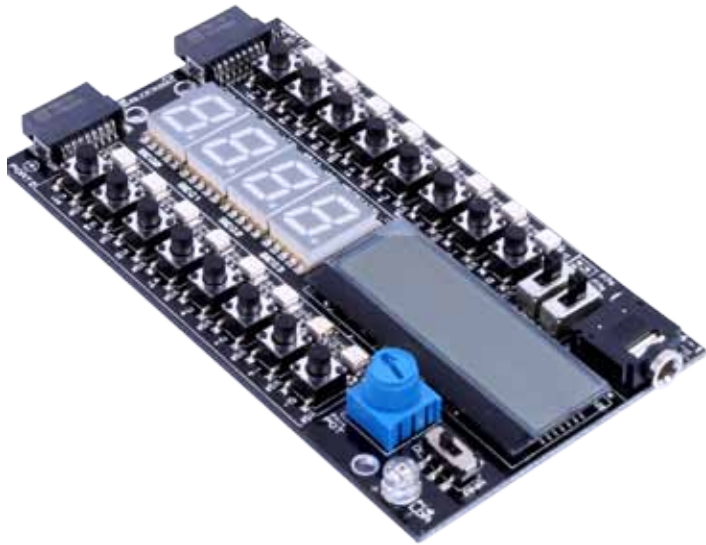upply or from the micro USB port. Microchip AVR-ISP compatible sockets are fitted to provide alternative reprogramming and debugging techniques.

| Ordering information	
E-blocks2 AVR programmer	BL0086

MATRIX

MATRIX

E-blocks2 Combo board

This flexible downstream board is an ideal platform for learning and project development. The E-blocks2 combo board will work with any upstream E-blocks2 programmer allowing multiple technologies to be explored using a single downstream E-blocks board.

The E-blocks2 Combo Board is an ideal resource to help learn programming using flowcharts, C or assembly code.

Ordering information	
E-blocks2 Combo board	BL0114
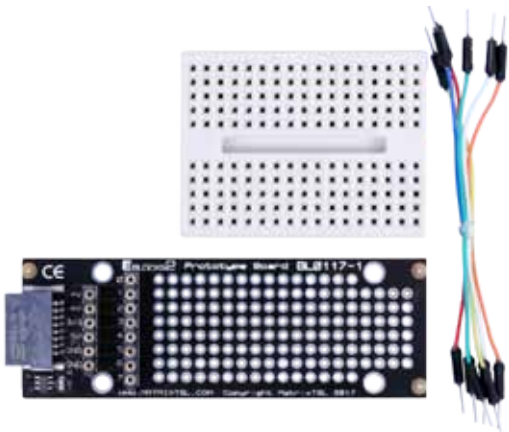
E-blocks2 Prototype board

The E-blocks2 Prototype Board provides an array of standard 2.54mm pitch holes which can be used to permanently solder electronics onto the E-blocks board. The board is also supplied with a small breadboard allowing for temporary electronics to be created and tested with the E-blocks2 system. The small breadboard features a sticky back so it can be attached to the top of the Prototype E-blocks2 circuit board if required. 6 prototype leads are also included with this board.

The board exposes the eight data lines from the microcontroller port as well as the various power connections +V, 3V3, 5V and GND via turned pin sockets suitable for linking to your circuitry using single core wire.

Ordering information	
E-blocks2 Prototype board	BL0117

E-blocks2 Click board

The Click board provides a simple way of connecting a Click module from MickroElektronika using the Mikrobus connection and layout standard. The Click board therefore allows a wide range of different modules to be compatible with the E-blocks2 system. Protection is provided on the board to ensure that 5V and 3V3 devices can work together seamlessly without causing any damage.

Ordering information	
E-blocks2 Click board	BL0106

E-blocks2 Grove Sensor Board

The E-blocks2 Grove Sensor board can be used with up to four Grove modules at a time. Care should be taken to ensure that the system voltage is compatible with all the connected Grove modules to avoid damaging the Grove module.

Ordering information	
E-blocks2 Grove Board	BL0129

E-blocks2 Wi-Fi board

The Wi-Fi board allows the E-blocks2 system to connect and communicate with an existing Wi-Fi network. It can also be used to create a data access point that other Wi-Fi enabled devices can connect to. Wi-Fi is provided via the popular ESP12F module which is fully certified and ruggedized. The on-board TCP/IP stack allows for easy communications without the need for a software TCP/IP stack running on the E-blocks2 controller.

Ordering information	
E-blocks2 Wi-Fi board	BL0136

E-blocks2 Actuators board

Included on the E-blocks2 Actuators board is a DC motor with both analogue and digital feedback, a servo motor and a stepper motor plus the circuitry to drive the motors.

The DC motor is driven using a standard H-Bridge driver IC and can be driven using simple digital on/off right through to analogue pulse width modulation (PWM) techniques. By monitoring the feedback, a closed loop control system can be made to control the speed of the motor. A second H-Bridge driver IC is used to drive the four coils of the stepper motor allowing for full step and half step operation. The stepper motor features an internal gearbox to provide a high level of torque and precise angle control. The servo motor is a standard R/C servo motor with a supplied actuator arm.

The board features a DC socket to allow the various drivers to be powered from a secondary power supply.

Ordering information	
E-blocks2 Actuators board	BL0127

E-blocks2 Keypad board

The E-blocks2 Keypad board is a useful tool as it allows you to enter numeric and textual data into the embedded system. The switches are all push to make type and read by controlling the logic level of the columns and reading back the state of the rows.

Only a single active switch on the keypad can be read at once.

Ordering information	
E-blocks2 Keypad board	BL0138

E-blocks2 Mono gLCD board

The mono graphical LCD board provides a 32 x 128 pixel monochrome graphical display capable of drawing text, displaying images and symbols.

Ordering information	
E-blocks2 Mono gLCD board	BL0139

E-blocks2 CAN bus board

The CAN bus board allows the E-blocks2 system controller to connect with other controllers. The board can be used with E-blocks controllers both with or without CAN bus peripherals allowing the maximum flexibility. The board includes both a CAN transceiver and a CAN controller which can be accessed via a simple SPI bus.

Ordering information	
E-blocks2 CAN bus board	BL0140

E-blocks2 Switch board

The E-blocks2 Switch x 8 is a useful tool allowing you to control what is happening in the system. The switches are push to make and active high, meaning the voltage to the microcontroller port pins is low when the switch is not pressed and high when the switch is pressed.

Ordering information	
E-blocks2 Switch board	BL0145

E-blocks2 Zigbee router board

The E-blocks2 Zigbee router board allows you to connect one or more E-blocks systems together using the ZigBee (wireless area network) standard, or to connect your system to third party ZigBee system.

Ordering information	
E-blocks2 Zigbee router board	BL0152R

E-blocks2 Zigbee co-ordinator board

The E-blocks2 Zigbee co-ordinator board allows you to connect one or more E-blocks systems together using the ZigBee (wireless area network) standard, or to connect your system to third party ZigBee system.
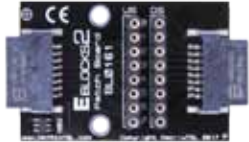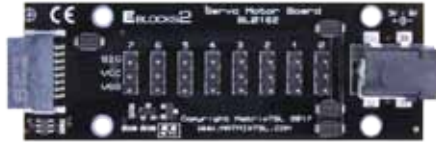
Ordering information	
E-blocks2 Zigbee co-ordinator board	BL0152C

E-blocks2 Manual patch board

The E-blocks2 patch board comes complete with six prototype leads, allowing you to easily assign the signals to your downstream board.

Ordering information	
E-blocks2 Manual patch board	BL0161

E-blocks2 Servo motor board

Up to eight channels can be individually controlled for connection to devices such as servo motors or brushless electronic speed controllers.

The board also provides a DC socket allowing the motors to be powered from an external DC power supply separate from the E-blocks2 supply rails. Over-voltage protection is built on to the board stopping any voltages greater than 6V from being allowed to damage the connected motors.
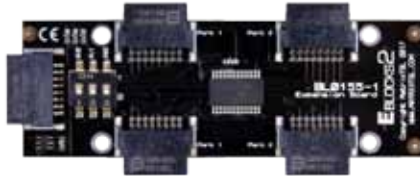
Ordering information	
E-blocks2 Servo motor board	BL0162

E-blocks2 SD card board

The E-blocks2 SD card board provides a means of reading and writing data to the SD card as well as providing level shifting to allow 5V and 3V3 systems to be compatible.

Ordering information	
E-blocks2 SD card board	BL0154

E-blocks2 Expander board

The expander board allows multiple E-blocks2 boards to be connected to a single upstream E-blocks2 port. The data pins are controlled using an MCP23S17 I/O expander IC via an SPI connection to the host microcontroller, which provides digital input and output functionality as well as more advanced features such as interrupt on change. The board also features three DIP switches which are used to set the address of the I/O expander allowing for up to 8 expander boards to exist on the same SPI connections.

Ordering information	
E-blocks2 Expander board	BL0155

E-blocks2 LED board

The E-blocks2 LED board allows you to indicate what is happening or the on going real time status of the system. LEDs can be driven in a digital way using on or off output states or an analogue way using pulse width modulation (PWM) techniques.

Ordering information	
E-blocks2 LED board	BL0167

E-blocks2 Alphanumeric LCD board

There are a number of key differences between the LCD display on the E-blocks2 Alphanumeric LCD board and the standard HD44780 type displays which are listed below.

- Scrolling and blinking cursor display commands are not supported
- Printing characters to the display automatically moves through lines 0,1,2,3 rather than the usual 0,2,1,3
- Enhanced character set support

Ordering information	
E-blocks2 Alphanumeric LCD board	BL0169

E-blocks2 Splitter board

The data pins are shared between the connected boards and the auto ID functionality is fowarded onto the connected boards. Please note that only one board should be connected to ports 1 and 2 to allow to auto ID to function correctly.

Ordering information	
E-blocks2 Splitter board	BL0156

E-blocks2 Colour GLCD board

The colour graphical LCD board features a dimmable backlight and provides a 160 x 128 pixel TFT colour graphical display capable of drawing text, displaying images and symbols in 16-bit colour. The display can be driven and fully simulated within the Flowcode simulation.

Ordering information	
E-blocks2 Colour GLCD board	BL0157

E-blocks2 Bluetooth board

The Bluetooth board contains a Microchip RN4677 module which adds fully certified Bluetooth 4.0 functionality to your E-blocks2 system. The Bluetooth module has a transmit power of +2dBm which should give a 100 yard transmission range at a data transfer rate of 50Kbps. The module is programmed using an asynchronous serial AT command style protocol which can be interfaced to any upstream controller with a UART facility.

Ordering information	
E-blocks2 Bluetooth board	BL0170

E-blocks2 Terminals board

Terminals are buffered by 220ohm resistors to provide protection for upstream boards. The various E-blocks2 supply voltage rails are also available as screw terminals allowing you to power your external electronic devices.

Ordering information	
E-blocks2 Terminals board	BL0173

E-blocks2 Relay board

The E-blocks2 relay board provides two electrically controllable relays which act as isolated switches. The external connections to the relays are provided using screw terminals and each relay features an LED to indicate when the relay is active.

Ordering information	
E-blocks2 Relay board	BL0183

E-blocks2 Ethernet board

The Ethernet board allows the E-blocks2 system to connect and communicate with an existing Ethernet network. Ethernet is provided via the popular ENC28J60 module. The on-board TCP/IP stack allows for easy communications without the need for a software TCP/IP stack running on the E-blocks controller.

Ordering information	
E-blocks2 Ethernet board	BL0187

E-blocks2 to E-blocks connector boards

The E-blocks upstream to E-blocks2 downstream connector is useful if you already have a 1st Generation E-blocks programmer board which you want to use with the new E-blocks2 peripheral boards.

The E-blocks2 upstream to E-blocks downstream connector is useful if you already have 1st Generation E-blocks peripheral boards and want to use these with the new E-blocks2 upstream boards.

The upstream connector board allows one upstream E-blocks2 board to be connected directly to another to allow for things like chip to chip communications to be explored and implemented. This board also features an IDC compatible header allowing for ribbon cables to be used to connect the boards together using simple push fit connections.

Ordering information	
E-blocks upstream to E-blocks2 downstream connector	BL0113
E-blocks2 upstream to E-blocks downstream connector	BL0119
E-blocks 2 upstream to upstream connector	BL0158

E-blocks2 Grove sensor development kit

The E-blocks2 Grove sensor development kit contains a selection of sensors from the popular Grove range of modules from Seeed Studio, along with one BL0129 E-blocks2 Grove sensor board.
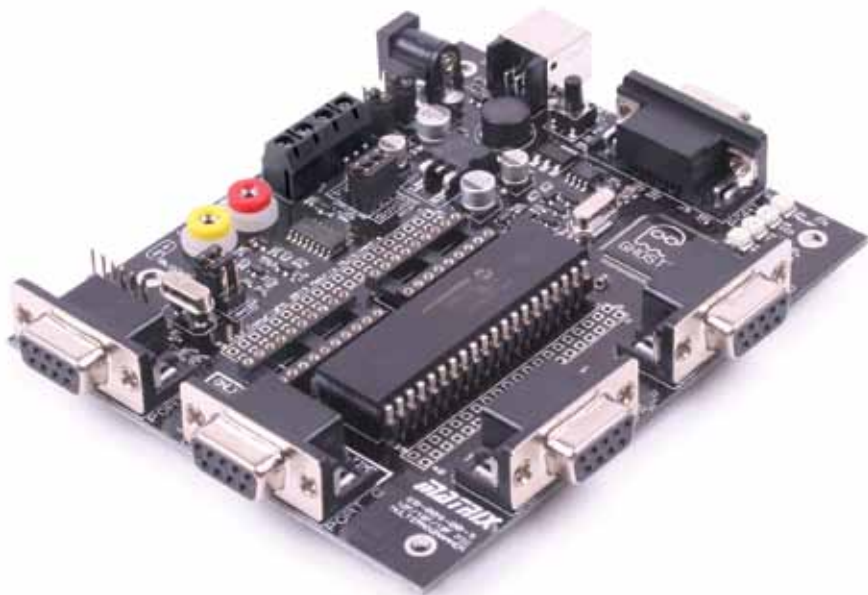
Ordering information	
E-blocks2 Grove sensor development kit	BL0555

e BLOCKS ®

Legacy

MATRIX

Assembly for PIC MCUs CD ROM

This CD ROM contains a complete 50 hour course in programming the PIC microcontroller. The tutorials start with fundamental concepts and extend up to complex programs including watchdog timers, interrupts and sleep modes. The CD ROM includes unique simulation tools which help students overcome key problems in programming in assembly code and a simplified development environment is included.

Typical tutorial screen

The virtual PIC microcontroller

Ordering information:	
Single user	EL629SI6
Site license	EL629SL6

C programming courseware and software

This CD ROM provides you with a complete solution to teaching and learning C programming for the PIC microcontroller.

The course is structured in two parts: firstly students are taken through the fundamentals of C programming in a series of on-screen tutorials that make use of our virtual microcontroller to explain to students how C works. This well proven methodology centres around a simulation of the microcontroller which allows students to clearly see the effects on the chip, internal variables and registers as each line of C code executes.

Once students have understood the basics, they carry out a series of labs using the Integrated Development Environment (IDE) and compiler provided. Tests and exercises to reinforce learning are provided. The software tools supplied on the CD are suitable for a wide variety of projects.

Students read through the tutorials, simulate the program on-screen, compile the source code in the IDE...

Tutorial and simulation screen

...and verify the program on the hardware

Ordering information:	
C for 16 series PIC microcontrollers	
Single user	EL543SI5
Site license	EL543SL5
Note that C compiler is only licensed for educational use	

PIC® microcontroller multiprogrammer

This board connects to a PC via USB to provide a high speed, low cost PIC MCU programmer for development and programming. This board can be used with assembly, C or Flowcode along with most third party compilers. The board programs a wide range of microcontroller devices and has 5 D-type sockets for E-blocks connection. When used with Flowcode this board provides full Ghost support and instrumentation including multi channel oscilloscope, multi channel logic analyser, packet decoder and data console.

Ordering information	
PIC® microcontroller multiprogrammer	EB006V9

AVR® microcontroller multiprogrammer

This board includes everything you need to program an AVR microcontroller and develop AVR projects. The board programs a wide range of AVR devices and has 4 D-type sockets for E-blocks. The programmer connects to your USB port and to the board which is compatible with 20 and 40 pin AVR devices.

Ordering information	
AVR® microcontroller multiprogrammer	EB194

Interface shield for Arduino Uno compatible boards

This board allows you to connect standard Arduino Uno compatible boards into an E-blocks system and take advantage of the large range of E-blocks boards. The D-type connectors provide a bus system that enables clean access to all I/O lines, allowing you to use standard E-blocks with the Arduino upstream microcontroller architecture. All the standard signals from the Arduino board are brought across onto the shield board. This board is compatible with a host of Arduino footprint boards including the Uno, Leonardo, Micro, Mini, Nano, STM Nucleo, Cypress PSOC ARM M0, Chip kit for Microchip PIC32 and many more. Arduino board not included.

Ordering information	
Interface shield for Arduino Uno compatible boards	EB093

E-blocks Arduino mega shield

This board allows you to connect the Arduino Mega and compatible boards into an E-blocks system and take advantage of the large range of E-blocks I/O boards. The D-type connectors provide a bus system that enables clean access to all I/O lines, allowing you to use standard E-blocks with the Arduino upstream microcontroller architecture. The standard signals from the Arduino Mega board are brought across onto the shield board. This board is designed around the mechanical and electrical requirements of the Arduino Mega and is also compatible with the Uno, Leonardo, Micro, Mini, and Nano. Arduino board not included.
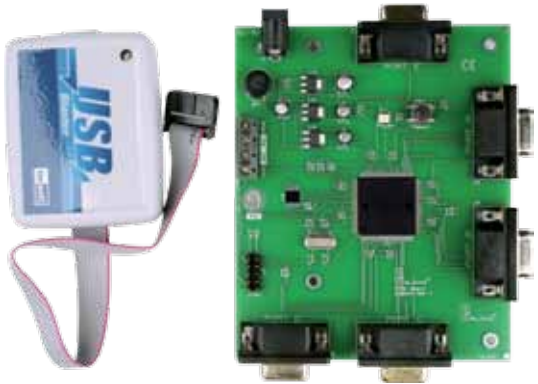
Ordering information	
E-blocks Arduino mega shield	EB092

E-blocks CAN Bus Faults board

A board for use with CAN bus systems for allowing faults to be inserted onto an active CAN bus. Also allows investigations between CAN systems and actual CAN hardware such as automobiles.

Ordering information	
E-blocks CAN bus faults board	EB048

Altera FPGA board

3.3V

The FPGA board contains a 10320 macrocell Cyclone IV series FPGA complete with configuration device to allow the code to be passed into the FPGA on power up. The board is packaged with and programmed via a USB-Blaster compatible USB JTAG dongle which allows the board to be re-programmed directly from within the Altera Quartus software using a standard USB port. The board provides five full E-blocks ports allowing other boards in the E-blocks range be connected to the upstream FPGA board. Courses and compilers for this board are available.

Ordering information	
FPGA board	EB089
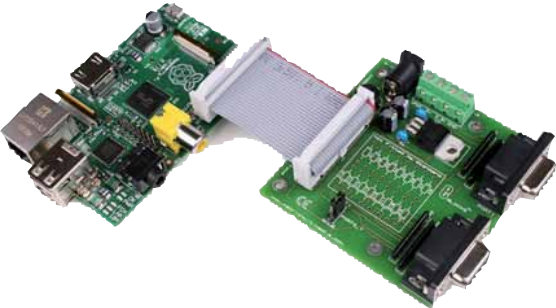
Raspberry Pi expansion board with cable

This adaptor board allows you to connect a Raspberry Pi device to downstream E-blocks boards, including the prototype board, using a 26-way IDC cable. Circuitry on the adaptor board offers protection for the Raspberry Pi pins from short circuits to ground or the supply voltage and presents the 17 general purpose I/O pins on D-type E-blocks connectors. Additional zener diodes can be added to the board for further circuit protection. Raspberry pi board not included.

Ordering information	
Raspberry Pi expansion module with cable	EB380
Raspberry Pi expansion board and case kit	EB385

Terminal board

3.3V   5V

Allows connection to all 8 pins of a standard E-blocks port with bare wires by using screw terminals.

Ordering information	
Terminal board	EB002

Sensor board

3.3V   5V

Contains a variable resistor and a light sensor for simple analogue experiments, as well as sockets which allow users to interface various other sensors.

Ordering information	
Sensor board	EB003

LED board

3.3V   5V

Has 8 LEDs which show the status of each bit on the port. Upstream and downstream E-blocks connectors allow this board to be used in bus configurations.

Ordering information	
LED board	EB004

LCD board

3.3V   5V
Flowcode macros available

Contains a 16 character, 2 line alphanumeric LCD display on a 5 wire serial bus. Contains a 16 character, 2 line alphanumeric LCD display on a 5 wire serial bus.

Ordering information	
LCD board	EB005

Switch board

3.3V   5V
Flowcode macros available
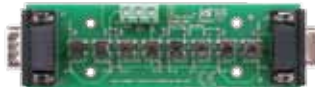
This board contains 8 push-to-make switches. Upstream and downstream E-blocks connectors allow this board to be used in bus configuration.

Ordering information	
Switch board	EB007

IR/IrDA transceiver board

3.3V   5V
Flowcode macros available

This board provides a complete solution to infrared communications - with both standard IR and IrDA protocol for communications with laptops or PDAs.

Ordering information	
IR/IrDA transceiver board	EB012

SPI bus D/A and memory board

3.3V   5V
Flowcode macros available

Adds serial memory (8K) and D/A functions (8 bit with amplifier and headphone socket) to any microcontroller / FPGA with an SPI interface.

Ordering information	
SPI bus D/A and memory	EB013

Keypad board

3.3V   5V
Flowcode macros available
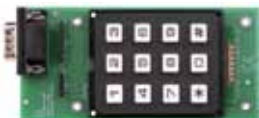
A simple 4 x 3 keypad that allows data entry into bus based systems.

Ordering information	
Keyboard board	EB014

RS232 board

3.3V   5V
Flowcode macros available

Provides an RS232 interface which can be used to facilitate communication between a microcontroller / FPGA and third party devices like PC serial ports, projectors etc.

Ordering information	
RS232 board	EB015

Prototype board

3.3V   5V

Contains a small prototype board for developing circuits and projects. Connectors for two E-blocks ports allow prototype wires and leads to be connected to the prototype board.

Ordering information	
Prototype board	EB016
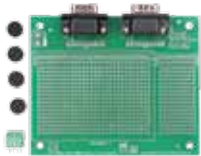
Patch board kit

3.3V   5V

Contains a small patch for developing circuits and projects. For use when a permanent circuit is required to add to your E-blocks system. D-type connectors need soldering on.

Ordering information	
Patch board kit	EB017

CAN bus board

3.3V   5V
Flowcode macros available

Allows you to add CAN bus functionality to any microcontroller with an SPI interface. The board includes both a CAN controller and a CAN transceiver.

Ordering information	
CAN bus board	EB018

USB232 board

3.3V   5V
Flowcode macros available

This board allows you to connect a microcontroller with a USART back to a PC via USB. A virtual COM port driver is supplied for interfacing to PC software applications.

Ordering information	
USB232 board	EB039

Zigbee board

3.3V   5V
Flowcode macros available

Gives the capability of developing 2.4GHz wireless networks based on the Zigbee standard.

Ordering information	
ZigBee coordinator board	EB051C
ZigBee router board	EB051R

MIDI interface board

3.3V   5V
Flowcode macros available

With MIDI in; out and thru ports, this E-block allows any microcontroller to generate, process or respond to any MIDI datastream.

Ordering information	
MIDI interface board	EB021

Internet board

3.3V   5V
Flowcode macros available

Adds Ethernet functionality to a microprocessor /FPGA system without the need for developing a TCP/IP software stack.

Ordering information	
Internet board	EB023

RFID board

5V
Flowcode macros available

This board allows you to develop RFID systems based on the Mifare, I-CODE and Ultralight protocols and includes a built-in antenna.

Ordering information	
RFID board	EB052

Pasco sensor board

5V

This E-block allows the Pasco Scientific range of Science Workshop sensors to be connected to a Matrix programmer board. The board provides two analog input channels and two bi-directional digital channels.

Ordering information	
E-blocks PASCO sensor board	EB054

Bluetooth board

3.3V   5V
Flowcode macros available

The Bluetooth board allows you to add Bluetooth capability to any microcontroller with UART functionality.

Ordering information	
Bluetooth board	EB024

Voice CODEC board

3.3V

This audio coder-decoder board allows students to investigate Bluetooth systems that use audio. The board is based on a Freescale MC145483 linear 13 bit CODEC.

Ordering information	
Voice CODEC board	EB032

USB interface board

5V
Flowcode macros available

Provides direct connection to the USB interface for microcontrollers that include an internal USB peripheral allowing you to easily communicate directly with your device.

Ordering information	
USB interface board	EB055

GPS board

3.3V   5V

Includes a UP500 GPS module from Fastrax. Once an initial position has been acquired, the GPS receiver continues to send position information directly to the microcontroller.

Ordering information	
GPS board	EB056

PS2 / VGA board

5V

Allows you to connect standard keyboards, mice and VGA monitors to an E-blocks system.

Ordering information	
PS2 / VGA board	EB033

Opto-isolator board

3.3V   5V

This board contains 4 separate isolated inputs to your E-blocks system for telecoms and Programmable Logic Controller applications.

Ordering information	
Opto-isolator board	EB035

Servo board

5V
Flowcode macros available

Allows up to 8 servo motors to be connected to an E-blocks systems for use with the Flowcode Servo component.

Ordering information	
Servo board	EB059

RC5 infrared transceiver

3.3V   5V
Flowcode macros available

Allows the exploration of the RC5 and other popular IR protocols. It features a tuned and filtered 36KHz IR receiver and an amplified IR emitter.

Ordering information	
RC5 infrared transceiver	EB060

MMC card reader board

3.3V   5V
Flowcode macros available

This MMC card reader sits on the serial port of a microcontroller and provides up to 32GB of memory to an E-blocks system. An MMC card must be bought separately.

Ordering information	
MMC card reader board	EB037

Relay board

3.3V   5V

This board contains 4 relays (choose high or low nibble) each rated at 250V and 6A. This is ideal for building PLC type applications.

Ordering information	
Relay board	EB038

RS485 board

5V
Flowcode macros available

Allows the exploration of RS485 communications. The board facilitates any type of RS485 configuration to be put together.

Ordering information	
RS485 board	EB062

ISM band RF comms

3.3V   5V
Flowcode macros available

Allows RF communications at various carrier frequencies.

Ordering information	
ISM-band RF board with 433 module	EB063-433
ISM-band RF board with 868 module	EB063-868
ISM-band RF board with 915 module	EB063-915

MATRIX

MATRIX

E-blocks basic sensors board

3.3V 5V
Flowcode macros available

The E-block Basic sensors board incorporates a light sensor, thermistor, hall effect sensor and potentiometer which can be used for simple experiments, projects and learning. Each of the sensors return a reading as an analogue voltage which can be between 0V and 5V.

Ordering information	
E-blocks basic sensors board	EB067

E-blocks motion sensor board

3.3V 5V
Flowcode macros available

This board features a 3-axis acceleration sensor which can be used for force meters, balancing robotics, calibration tools and digital spirit levels. The board can be used to measure G force or can also be used to measure orientation in terms of pan / tilt and roll.

Ordering information	
E-blocks motion sensor board	EB068

Wireless LAN board

3.3V 5V
Flowcode macros available

Allows easy access to standard wireless local area networks. It is capable of being a client or a server on a network. It can serve html and javascript web pages in either mode.

Ordering information	
Wireless Lan board	EB069V2

DSP input board

3.3V 5V
Flowcode macros available

The DSP input board features all the components required to allow high quality 16-bit audio into your microcontroller system. Includes on-board microphone, fully adjustable gain and filters.

Ordering information	
DSP input board	EB085

DMOS Motor driver board

The motor driver board allows the user to connect and independently drive two motors in full bridge configuration with up to 5.6A output peak current. The board operates with both 3v and 5v logic systems and with motor power supplies from 8 to 30 volts.

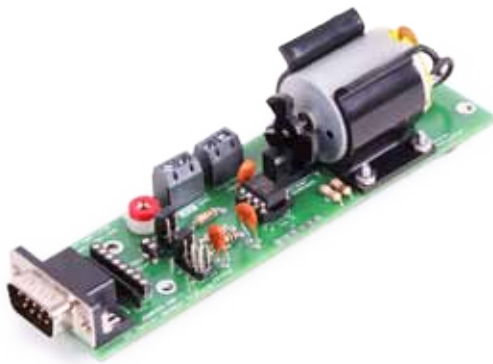| Ordering information	
DMOS Motor driver board	EB094

DSP output board

3.3V 5V
Flowcode macros available

The DSP output board features all the components required to allow high quality 16-bit audio from your microcontroller system. Featuring high quality potentiometers, an on-board speaker, fully adjustable gain and filters.

Ordering information	
DSP output board	EB086

E-blocks 4D touch screen board

3.3V 5V
Flowcode macros available

The E-blocks 3.2" multimedia board is a compact and cost effective all in one 'SMART' board that uses the latest state of the art LCD technology with an embedded graphics controller to deliver full colour functionality to any project. Powerful graphics, text, image, animation and countless more features are built inside the module.

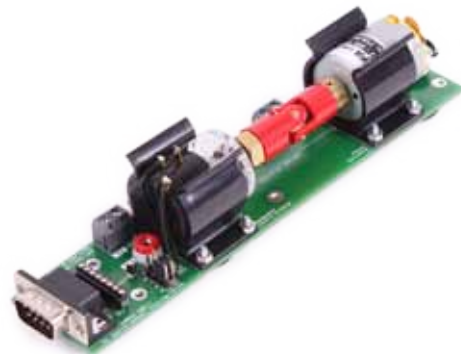| Ordering information	
E-blocks 4D touch screen board	EB076

DC Motor Speed Trainer E-block

3.3V 5V
Flowcode macros available

This board is designed to teach the basics of DC motor speed control. The board comes with a DC motor which is connected to an optical encoder to record how fast the motor is travelling. The digital signal from the encoder is fed into an IC on the E-block to convert the digital frequency into an analogue voltage which is proportional to the motor speed. This then makes it very easy to use advanced control techniques such as PID or fuzzy logic to control the motor speed.

| Ordering information	
DC Motor Speed Trainer E-block	EB096

DC Motor Servo Trainer E-block

3.3V 5V
Flowcode macros available

This board is designed to teach the basics of DC motor position control. The board comes with a DC motor which is connected to a 3-turn potentiometer to provide an analogue signal proportional to the angle of the motor shaft. This then makes it very easy to use advanced control techniques such as PID or fuzzy logic to control the motor position as can be seen in a standard servo motor.

Ordering information	
DC Motor Servo Trainer E-block	EB097
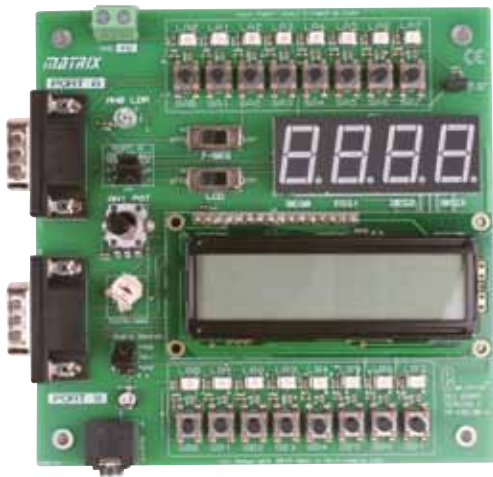
Development board

3.3V 5V
Flowcode macros available

The new E-blocks Development board works with any of our upstream boards to provide a physically compact development environment for your projects. The board plugs directly onto ports A and B and provides two banks of LEDs, two banks of switches, a 2 line 16 character LCD display, a light sensor, a potentiometer mimicking a sensor, a quad 7-segment display, and an audio output jack. An EB006 PIC Multiprogrammer and Development board replaces our older HP488 Development board but also gives full In Circuit Debug facilities when used with Flowcode.

Ordering information	
Development board	EB083
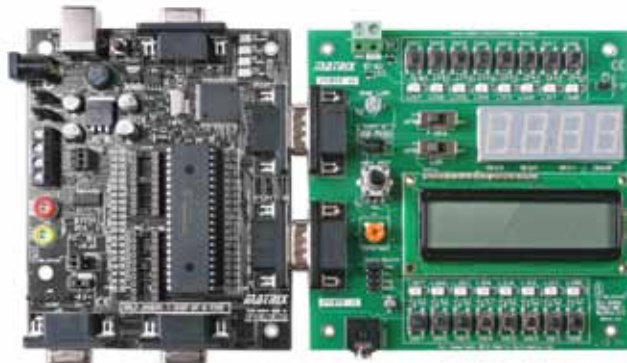
Development Board and EB006 Combo

3.3V 5V
Flowcode macros available

This pack consists of a EB006 PIC multiprogrammer and an EB083 Development board which together provide a low cost way of developing PIC projects and learning PIC programming. Descriptions of the EB006 and EB083 are available separately. Power supply and USB cable included.

Ordering information	
Development Board and EB006 Combo	HP4832

Compatible with 5V and 3.3V systems.

Arduino E-blocks shield and development board

3.3V   5V
Flowcode macros available

If you are an Arduino user and you are looking for a rugged and flexible way of turning an Arduino board into a rugged development platform then the HP7745 is the answer. The Arduino shield and Development board allow you to interface an Arduino Uno into the E-blocks system and also provide a rugged general purpose in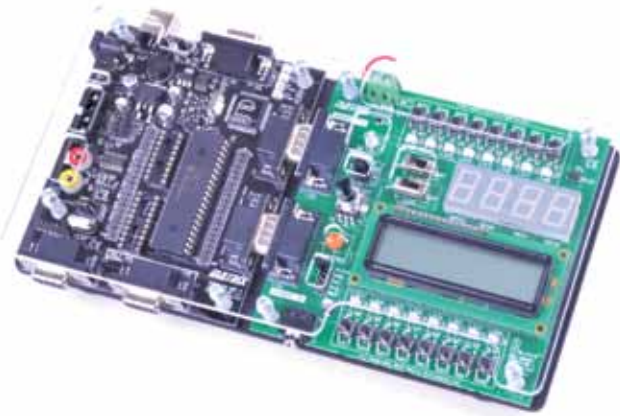terface board for learning and development with switches, sensors, LEDs and displays. A power supply and USB cable are included. Arduino board not included.

Ordering information	
Development board and Arduino shield combo	HP7745

PIC development centre kit

3.3V   5V
Flowcode macros available
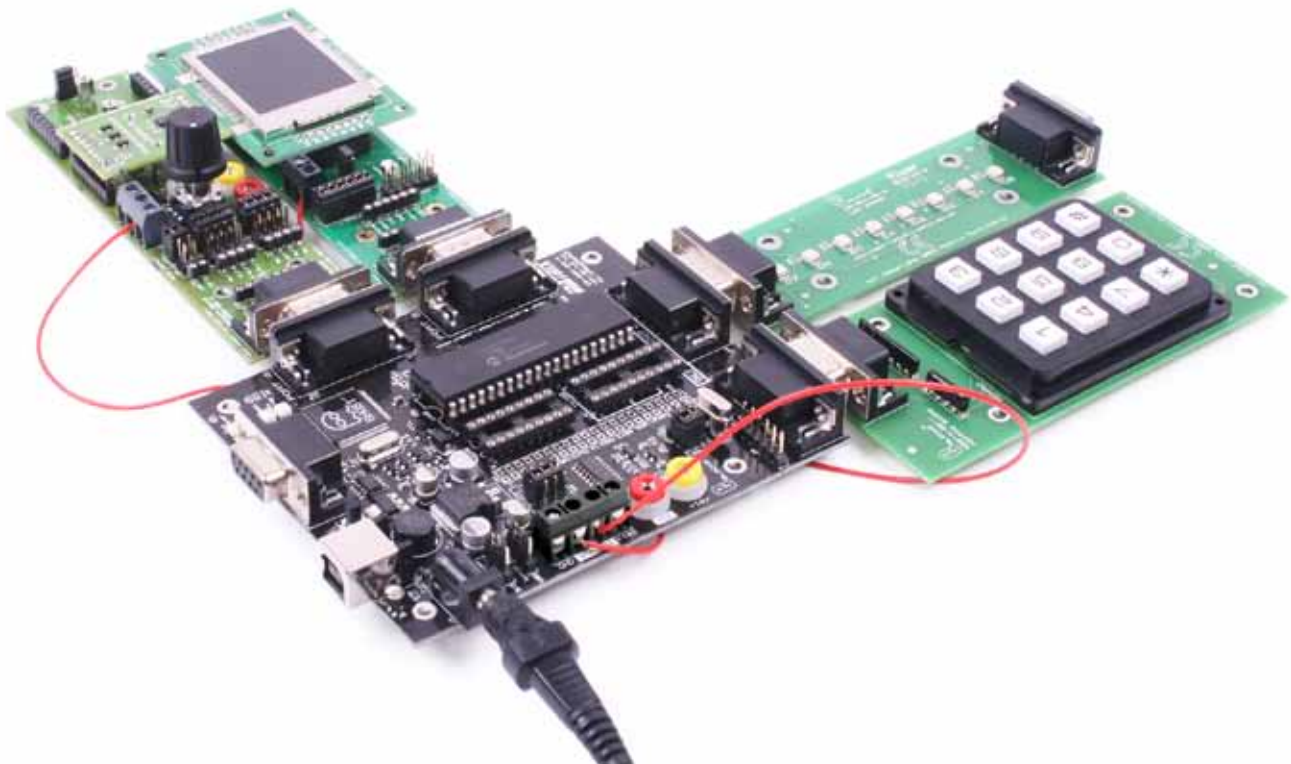
If you are looking for a protected and physically compact and rugged development environment for PIC projects then the HP7631 is ideal for you. The HP7631 Development Centre consists of a EB006 PIC Multiprogrammer (with 16F1937 40 pin device) and an EB083 Development board encased in a tough plastic enclosure. The plastic enclosure allows access to the switches and potentiometers needed for every day use but prevents users from interfering with key link settings or removing the PIC device. A power supply and USB cable are included.

This product is shipped in kit form and requires some light assembly. Posidrive screw driver and pliers needed.

Ordering information	
PIC development centre kit	HP7631

E-blocks sensors mother board

This range of electronic sensors can be used to both learn how sensors work and can be incorporated into your projects. The solution is based on the EB090 sensor mother board. Each sensor simply connects into the mother board using simple 0.1" header connectors. The mother board also includes a light sensor and a general purpose potentiometer.

Ordering information	
E-blocks sensors mother board	EB090

Potentiometer sensor board

This board consists of a standard shaft rotary potentiometer that provides a linear voltage output ranging between the microcontroller power rails. This can be connected to an Analogue to Digital input of the microcontroller in order to provide a control value.

Ordering information	
Potentiometer	EBM002

Thermistor sensor board

This board includes a 10K NTC thermistor and two screw terminals allowing two external thermistor based temperature probes to be wired up to the board.

Ordering information	
Thermistor	EBM003

Digital temperature sensor board

This board contains a LM75B Digital Temperature sensor that returns the temperature from an 11 bit ADC via an I2C two wire interface to the microcontroller. Temperature resolutions of 0.125°C can be achieved with an accuracy of up to ±2°C.

Ordering information	
Digital Temperature	EBM004

Dual trimmer sensor board

This board provides two screwdriver slotted pre-set rotary potentiometers. These output a linear voltage ranging between the microcontroller power rails, such that they can be connected to Analogue to Digital inputs of the microcontroller in order to provide, for example, calibration or other control values.

Ordering information	
Dual Trimmer	EBM006

Rotary encoder sensor board

Provides a rotary encoder with dual digital outputs that provide rotation and direction information. When connected to two digital inputs of a microcontroller a "digital pot" can be implemented to convert to digital values.

Ordering information	
Rotary Encoder	EBM007

Gyroscope sensor board

This board contains an L3G4200D three axis digital gyroscope. Pitch, Roll and Yaw parameter values are read via an I2C interface.

Ordering information	
Gyroscope	EBM009

Hall effect sensor board

The board has a Hall Effect sensor that gives a digital output in the presence of a
magnetic field (in the region of 60 Gauss) from a permanent magnet or electromagnet, either North or South pole.
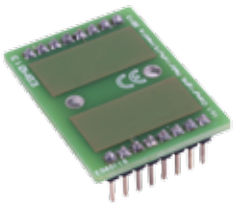
Ordering information	
Hall Effect	EBM011

PIR sensor board

This Passive Infrared sensor gives a digital output and illuminates an on-board LED when a heat source movement is detected.
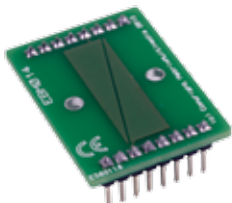
Ordering information	
PIR	EBM012

Touch pads sensor board

This board provides two touch areas for use with capacitive sensing. Hence two digital touch switches can be implemented.

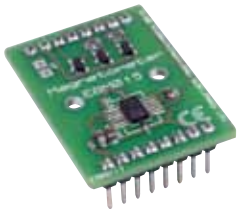| Ordering information	
Touch Pads	EBM013

Touch slider sensor board

This board provides a touch area for use with capacitive sensing. A sliding variable value can be determined from the relative touch position along the slider.

Ordering information	
Touch Slider	EBM014

Magnetometer sensor board

This board provides an LSM303DLHC sensor device which contains both a digital 3D accelerometer and a 3D magnetometer. All information is available via an I2C interface, such that a high performance e-compass with numerous applications can be implemented.

Ordering information	
Magnetometer	EBM015

Humidity sensor board

This board uses the SHT21 Humidity sensor and provides both digital relative humidity and temperature information via an I2C interface.

Ordering information	
Humidity	EBM016

Colour sensor board

The colour sensor provides a digital conversion of the colour of the incident light intensity in separate values for Red, Green and Blue light components. Reflected light can also be measured by using the on-board bright white light LED illuminators. A plastic housing is included to prevent white LED illuminators contaminating the colour sensor.

Ordering information	
Colour Sensor	EBM018

Ultrasonic distance sensor board

This board has a microcontroller controlled ultrasonic transmitter, driven by an on-board 40KHz oscillator and an amplifier-receiver. The receiver signal can be processed by a single channel ADC of the microprocessor to allow the measuring of distance from an object between 3cm and 3m.

Ordering information	
Ultrasonic Distance	EBM019

Infrared distance sensor board

The Infrared distance sensor board contains both an IR transmitter and receiver. The transmitter is enabled via a control signal and the receiver provides an analogue output.
By enabling the transmitter and reading the variable voltage output of the receiver it is possible to measure the distance of an object in the region of 1cm to 10cm.

Ordering information	
Infrared	EBM020

Vernier sensor socket

This sensor adaptor allows the superb range of lab sensors from Vernier (both analogue and digital) to be added to your development system.

Ordering information	
Vernier sensor socket	EBM021

E-blocks test pod

The loop through E-blocks test pod gives you a complete digital test bench in a small and affordable package. To help you debug your designs the test pod consists of two separate functions: a signal analyser and a signal generator. The signal analyser starts out as an easy-to-use Logic Analyser and Oscilloscope and adds serial bus decoding (including : I2C, SPI, USB, CAN, 1-Wire) that lets you solve your electronics problems quickly.

Features include:

- 8 channels
- 24Msps max sample rate
- Windows software
- USB powered
- Separate clock and trigger

Ordering information	
E-blocks test pod	EB070

ZigBee analyser

This wireless network analyser graphically displays wireless network traffic following the IEEE 802.15.4 specification on the 2.4GHz band. The analyser supports ZigBee, MiWi and MiWi PRP protocols. In conjunction with the hardware packet sniffer, the software can analyse complete network traffic and graphically display decoded packets. It can also display a graphical representation of the network topology and the messages as they flow through the network.

This information can then be saved and/or exported for further analysis. For developing with either ZigBee or the MiWi protocols, the ZigBee analyser is an essential development tool. Connects through USB.

The analyser is shipped in a rugged plastic case and can be mounted onto a standard E-blocks metal backplane.

Ordering information	
ZigBee USB analyser	HP387

Benchtop signal generator

The function generator is one of the most versatile pieces of test and measurement equipment available. It can generate a variety of precision waveshapes over a range of frequencies from mHz to MHz. It can provide a wide range of controlled amplitudes from a low-impedance source and maintain constant amplitude as the frequency is varied. The TG300 series represents the state-of-the-art in low-cost analogue function generators.

Ordering information	
Benchtop signal generator pack	HP7894
Free accessories. This pack also includes a pair of 4mm to croc clip leads, two 4mm stackable leads and a BNC male to dual 4mm binding post.	

Multimeter

This high accuracy multimeter is classroom ready with a rubber holster to protect it. It has a large 3½ digit LCD display and test positions for both transistors and diodes. It measures AC and DC voltage, current and resistance.

Ordering information	
Multimeter	LK1110

5MHz PC oscilloscope/signal generator pack

This pack is based on a PicoScope 2203 dual-channel PC oscilloscope which has a bandwidth of 5MHz and samples at 40M samples per second - 8 bit. It has two input channels which are used as oscilloscope or spectrum analyser inputs and it includes an arbitrary waveform.

25MHz PC oscilloscope/signal generator pack

This pack is based on a PicoScope 2205 dual-channel PC Oscilloscope which has a bandwidth of 25MHz and samples at 40M samples per second - 8 bit. It has two input channels which are used as oscilloscope or spectrum analyser inputs and it includes an arbitrary waveform generator.

Ordering information	
5MHz PC oscilloscope/signal generator pack	HP2577
25MHz PC oscilloscope/signal generator pack	HP8279
Free accessories. This pack also includes two scope probes, a BNC male to dual 4mm binding post, a pair of 4mm croc clip leads and a USB led.	

CAN analyser

This analyser provides a dual channel CAN bus interface through a standard USB interface. This analyser is capable of analysing traffic on two separate CAN busses simultaneously. The free software operates on all Windows platforms. This unit is supplied with a D-type to dual 4mm cable which makes it suitable for direct connection to MIAC units, or which can be modified for direct connection to a system's CAN bus.

Ordering information	
CAN analyser	EL3498

SCADA power supply

This high specification lab power supply integrates into Flowcode using a DLL to provide one part of a superb test or control rig that can be used as part of your projects. The 0-15V, 5A linear power supply with current limit is fully controllable from within Flowcode via the USB connection and a Flowcode component. Based on a TTI PL155-P.

Ordering information	
SCADA power supply	HP4449

SCADA function generator

This function/Arbitrary/pulse generator integrates into Flowcode using a DLL to provide one part of a superb test or control rig that can be used as part of your projects. The 50MHz generator is fully controllable from within Flowcode via the USB connection and a Flowcode component. Based on a TTI TG5011.

Ordering information	
SCADA function generator	HP8445
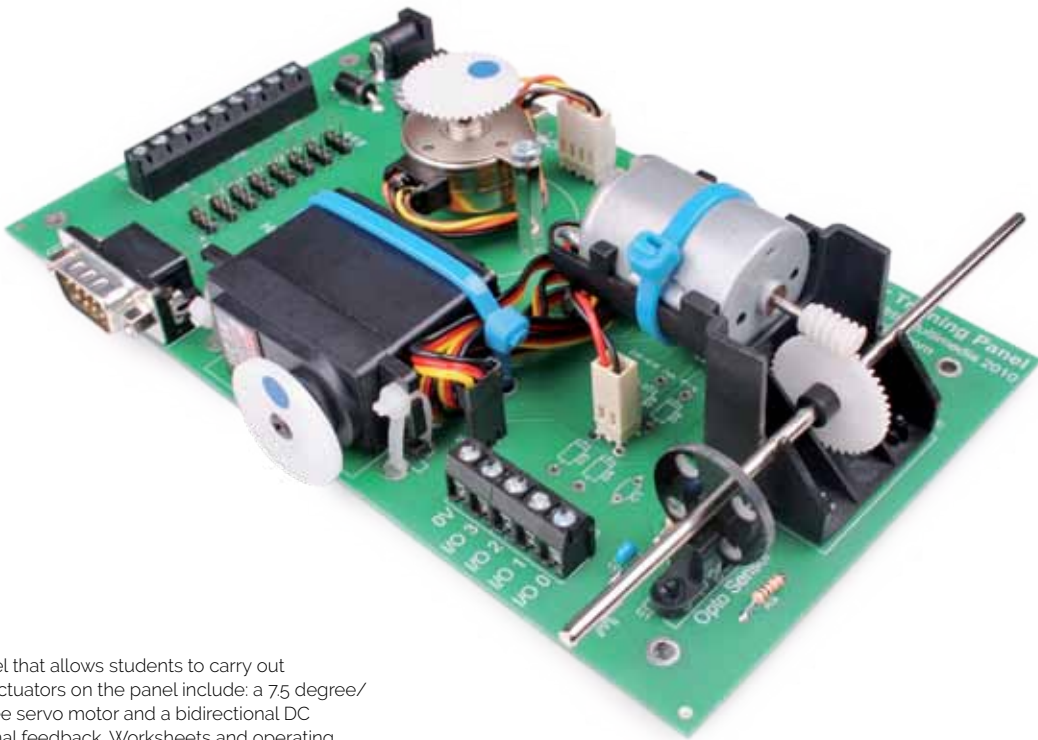
Actuators training panel

A general purpose training panel that allows students to carry out experiments with motors. The actuators on the panel include: a 7.5 degree/step stepper motor, a 120 degree servo motor and a bidirectional DC motor with gearbox and rotational feedback. Worksheets and operating instructions are included. An E-blocks compatible port facilitates connection with upstream boards.

Ordering information	
Actuators training panel	HPACT

RFID cards

A Mifare card and an I-code card are available. Each includes 1k of memory and is compatible with the E-blocks RFID card board.

Ordering information	
Mifare RFID card	HP089
I-code SLI card	HP459

IDC cables

These cables can be used to connect E-blocks boards together.

Ordering information	
Male - Male IDC connector	EB251
E-blocks cable Male - Male 500mm	EB251B
E-blocks IDC cable	EB634
E-blocks cable Male - Female 500mm	EB634B
Dual E-blocks IDC cable	EB635
Dual E-blocks IDC cable - short	EB635S

USB lead

This is a standard USB lead shipped with some Matrix USB compatible products.

Ordering information	
USB lead	HPUSB

Prototype board leads

This pack of 10 multi-strand leads allows you to design circuits using a prototype board.

Ordering information	
Prototype board lead pack	FLLPCK

USB high speed A to mini B

This lead connects a USB lead to the miniature USB plug as used on MIAC.

Ordering information	
USB high speed A to mini B	HPUAB

Tray trolleys

Storage trays can be mounted into one of our tray trolleys.

Ordering information	
12 tray trolley	HP2025Q
18 tray trolley	HP3025N

PIC programmer with ZIF sockets

This PIC microcontroller programmer will program any 8, 14, 18, 28 and 40 pin PIC device from the 16 or 18 series of PIC devices. The unit has two ZIF sockets which accept 0.3" or 0.6" pitch pins. The unit is powered by USB and is housed in a rugged plastic case. A USB cable is included.

Ordering information	
PIC microcontroller programmer with ZIF sockets	HP6339

M3 nuts and bolts

E-blocks covers are not supplied with fittings. These are required for attaching covers.

Ordering information	
100 x M3 anti-slip nuts	EB216
100 x M3 12mm bolts	EB217
100 x M3 25mm bolts	EB211
25 x M3 12mm spacers	EB210

Microcontroller devices

Chips for your project, compatible with E-blocks programmers.

Ordering information	
PIC16F1827 chip	HP16F1827
PIC16F877A chip	HP16F877
PIC16F88 chip	HP16F88
PIC18F4455 chip	HP18F4455
PIC24FJ64GB002 chip	HP24FJ64GB002
dsPIC30F2014 chip	HP30F3014
dsPIC33FJ128GP802 chip	HP33FJ128GP802
PIC16F1937 chip	HP16F1937

Headphones

Headphones with microphone.

Ordering information	
Headphones with microphone	HP347

Metal backplane

This backplane can be used to bolt development tools and E-blocks together to form a rigid backplane. The usable area is 270 x 250mm and these backplanes fit our standard trays.

Ordering information	
Metal backplane	BP232

Storage trays

These trays are ideal for storage of E-blocks and accessories.

Ordering information	
Shallow tray	HP2045
Clip on tray lid	HP4039
Foam layer insert	HP3844
4 section insert	HP2935

Adjustable power supply

This switched mode power supply can output seven easily selected voltages: 3V, 4.5V, 5V, 6V, 7.5V, 9V and 12V. Up to 1A of current can be supplied at all voltage settings. UK, European, US and Australian plug adaptors are included.

Ordering information	
Power supply	HP2666

E-blocks covers

These covers extend the life of your E-blocks boards. Boards are made 'student friendly' by protecting removable components.

Ordering information
Covers are available for most E-blocks. The product code is the same as the code of the board the cover is for, with a '7' replacing the first '0' in the code. For example, the code for the EB003 sensor board cover is an EB703. See the Matrix website for a complete list of available covers.

Plastic mounting pillars

Temporary mounting pillars to attach E-blocks to a backplane.

Ordering information	
Plastic mounting pillars x 25	HP6219

FlowKit

GHOST™

For an explanation of icons please see page 6.

FlowKit 2 can help you debug your Flowcode designed systems for:

- PIC
- dsPIC
- AVR/Arduino™

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.

Analogue and digital data are monitored and displayed
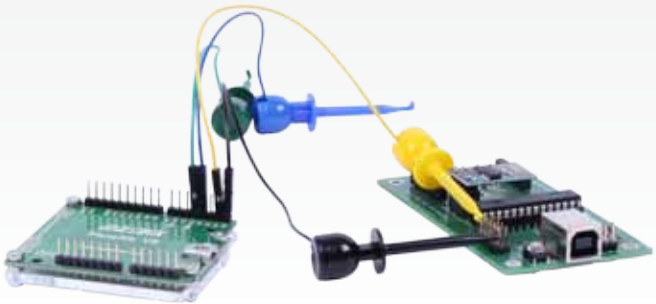
Attaching FlowKit to your own circuit board using the probes provided

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

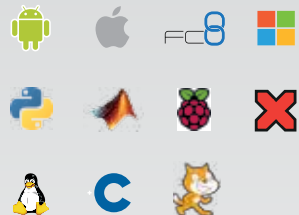The standard FlowKit is provided with 4 test clips.

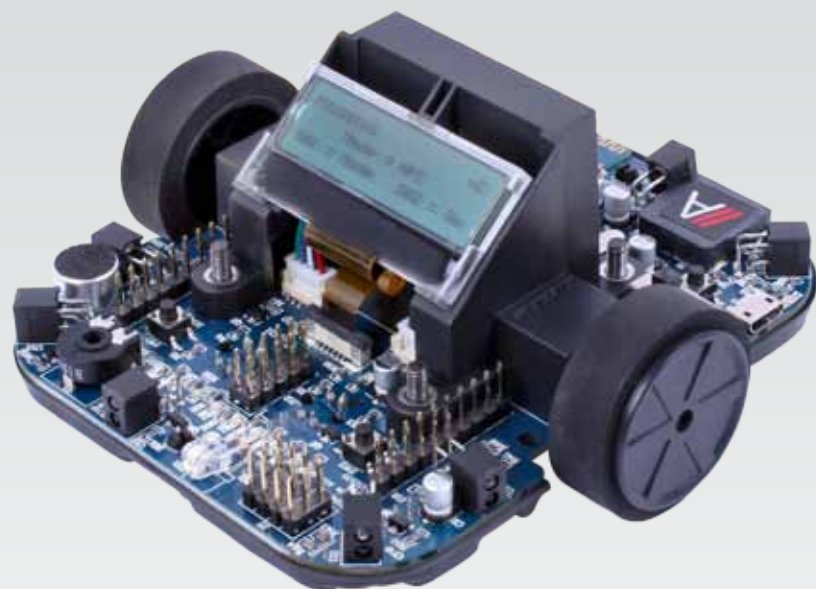| Ordering information	
Stand-alone FlowKit 2 with USB lead and 4 test clips	HP6031

Communication busses being decoded

FORMULA
//ALLCODE | ™

Formula AllCode is host independent and can be used with:

- Raspberry Pi
- Android
- iPhone
- Windows & MacOS
- And many more...

For an explanation of icons please see page 6

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 6 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.
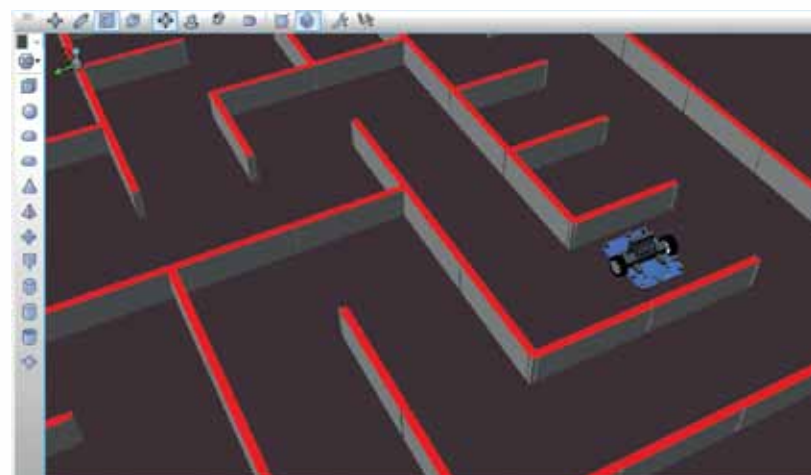
Formula AllCode uses it's high specification of sensors to follow lines and can even solve complex mazes. We are offering maze walls and maze mat with full examples to enhance your learning experience.

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

- Power switch
- Motor and metal gearbox with encoders
- Infrared distance sensor
- Micro reset switch
- Infrared distance sensor
- Speaker
- Infrared distance sensor
- USB rechargable lithium battery
- Integrated Bluetooth module
- Infrared distance sensor
- Micro SD card
- 128 x 32 pixel (4 x 20 char)
- Infrared distance sensor
- Motor and metal gearbox with encoders
- Infrared distance sensor
- Expansion port
- 4 servo outputs
- Push to make switch
- Light sensor
- E-blocks expansion port
- Push to make switch
- Microphone sensitivity adjuster
- Expansion port
- Infrared distance sensor
- Microphone

- Motor driver chip
- 2 line following sensors
- accelerometer / compass
- 16 bit dsPIC microcontroller

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	Robo-DJ	Robopop	Motor drive	Follow my line
Use on-board switches and LEDs to understand inputs, outputs and binary operation.	Use on-board loudspeaker to generate tones and play music.	Use the input mic to make the robot dance to music.	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.	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	Lefty	Measure my drive	Drag race	Daytona race
Use on-board light sensor to drive the buggy towards a light source.	Use the left hand wall-following technique to solve a simple maze.	Understand how wheel encoders are used to give feedback on exact distance travelled by each wheel and calibrate driving for each wheel.	Travel as fast as possible over a straight course, following a white line, then brake and stand still before hitting the end wall.	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	Tilt and turn	Stat panel	Full maze	Curve drawer
Use the internal compass sensor to guide the robot along a path to buried treasure.	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).	Develop apps in iPhone and Android that shows robot sensor status as it drives along a maze.	Solve an unknown maze by mapping it first and then driving the fastest courses as fast as possible.	Attach a pen to the robot and make it draw a given function (e.g. y=x2).

G forces	Pimp my ride	Mobile bug	Remote control	Swarm
Measure acceleration and wheel slip to optimise speed along a maze.	Develop a circuit board that attaches to the Formula AllCode robot using the servo outputs.	Create a spying device which drives to a location, records some speech, drives back and then plays the recorded speech back.	Use an old TV remote to make the robot move.	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.

Standard Formula AllCode

Standard Formula AllCode with USB cable for recharging/programming.

Ordering information	
Standard Formula AllCode	RB4191

Formula AllCode deluxe kit

The deluxe kit contains a carry case, Formula AllCode, set of Maze walls, USB cable, and an activity mat.

Ordering information	
Formula AllCode deluxe kit	RB7971

Formula AllCode standard class set

The standard class set contains 5 x Formula AllCode buggies, set of Maze walls, 2 x USB cables, and 2 activity mats.

Ordering information	
Formula AllCode standard class set	RB7240

Formula AllCode deluxe class set

The deluxe class set contains 10 x Formula AllCode buggies, set of Maze walls, 4 x USB cables, and 5 activity mats.

Ordering information	
Formula AllCode deluxe class set	RB7518

Formula AllCode maze walls

Desktop mounted maze wall kit that can make a 4 by 4 cell maze for problem solving and competitions.

Ordering information	
Formula AllCode maze walls	RB8962

Formula AllCode activity mat

This double sided activity mat includes a line following challenge a grid challenge as well as basic technical information on the AllCode buggy.

Ordering information	
Formula AllCode activity mat	RB8975

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 pitch area, and a printed mat that goes underneath the walls. Ideally you would glue the mat to a plywood or MDF board. Three 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.

This add-on is compatible with the Formula AllCode's maze walls which feature in the deluxe kit and class sets of Formula AllCode robots and are also available separately (RB8962).

Ordering information	
Formula AllCode football mat add-on	RB4938

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.

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.
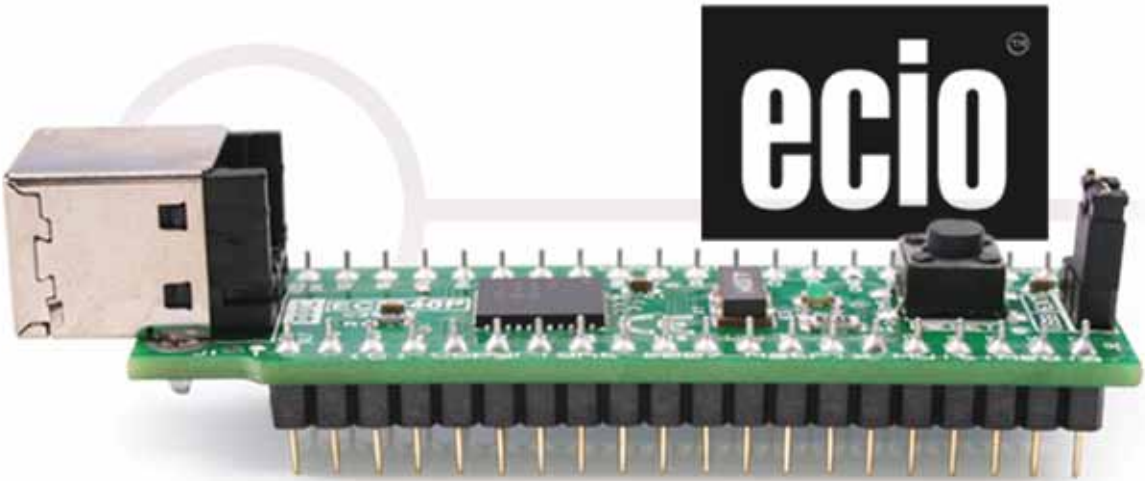
ECIOs are used by hobbyists, students and engineers to develop projects based on microcontroller technology and are particularly useful when in-field reprogrammability or USB features are required.

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.

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

E-blocks application board

The ECIO application board adds E-blocks compatibility to the ECIO 28 and 40 pin devices. The application board provides up to 5 E-blocks ports which allow you to attach a wide range of E-blocks boards- from simple LED and switch boards through to Bluetooth, IrDA and Internet communications boards.

Use ECIO modules with a prototype board (HPAD01), with the E-blocks application board (EB061) or build it into your own circuit. A free set of 10 basic worksheets are available on our website which can be used with the Student ECIO starter kit (EC2961).

Ordering information	
E-blocks application board	EB061
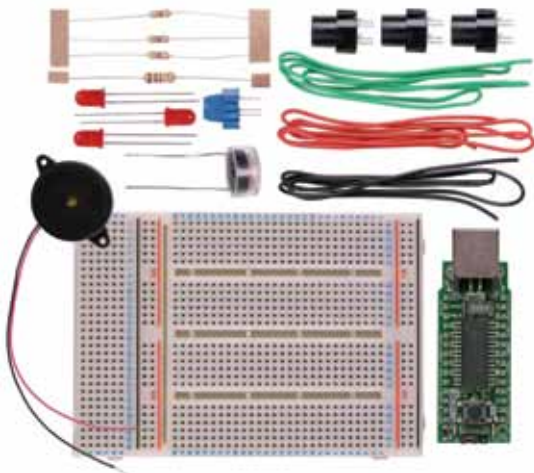
Student ECIO starter kit

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.
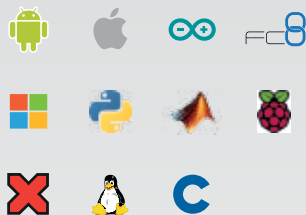
Ordering information	
Student ECIO starter kit	EC2961

MATRIX

MATRIX

MIAC

MIAC is now available in 5 models:

- PIC
- AVR/Arduino
- dsPIC
- Raspberry Pi
- AllCode

For an explanation of icons please see page 6

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.

MIACs have a wide range of uses:

MIACs used to control a mid scale hydroelectric power station in Sri Lanka.

Educational version of the MIAC used in a Pneumatics training rig.

Features

	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

A rugged aluminium platform
To which students add...

A compressor

A manifold

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.

Cylinders

Mechanical valves

Electrical valves

Connectors

Disciplines include:
- Pneumatics
- Automation
- Design technology
- PLC programming

Switches and sensors

A controller

Pneumatic tubing

Electrical cables

AUTOMATICS
Simplifying pneumatics

AU2280
AU2140

AU5200

AU3204

Cylinders

Cylinders provide the motive power of your pneumatic circuit. Single acting cylinders use a spring to return the piston to its rest position. All cylinders are a standard 10 mm diameter, the second figure represents the range of motion of the piston.
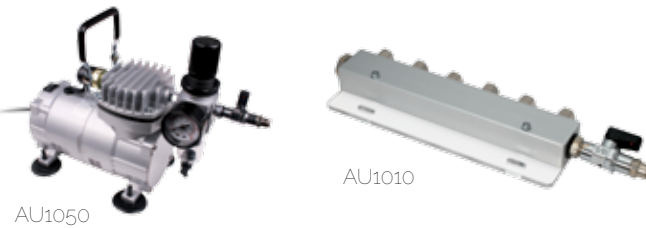
Description	Part number
Cylinder, single acting, 10 × 40 mm	AU2140
Cylinder, double acting, 10 × 80 mm	AU2280

Valves - mechanical

These valves are operated mechanically by buttons, levers, rollers or air pressure. 3/2 valves control the flow from the source to a single destination. 5/2 valves allow the source to be switched between two destinations.

Description	Part number
Valve, flow control	AU3022
Valve, mini shuttle	AU3203
Valve, 3/2, button-spring	AU3200
Valve, 3/2, roller-spring	AU3204
Valve, 3/2, lever-spring	AU3202
Valve, 3/2, diaphragm-spring	AU3201
Valve, 5/2, lever-spring	AU5200
Valve, 5/2, pilot-pilot	AU5201

4mm Tubing
AU1080

Tubing & connectors

Tubing is available in several colours, in bulk reels which are easily trimmed to length using the custom cutting tool. The connectors allow you to join lengths of tubing and create junctions.
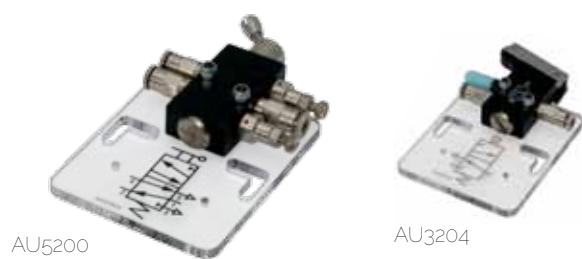
Description	Part number
Tubing, 4mm, blue, 30 m length	AU1072
Tubing, 4mm, yellow, 30 m length	AU1071
Tubing, 4mm, clear, 30 m length	AU1073
Tubing, 4mm, red, 30 m length	AU1070
Tube cutting tool	AU1080
Junction, equal tee	AU1030

AU6010

AU6015

Valves - electrical

These valves are operated by solenoids for control by discrete electrical circuits, or by the MIAC microcontroller unit.

Description	Part number
Valve, 3/2 solenoid-spring	AU6010
Valve, 5/2, double-solenoid	AU6015

AU1050

AU1010

Essentials

These are the basic components needed to supply pressurised air to your pneumatic circuits - and a sturdy physical platform to anchor everything in place.

Description	Part number
Compressor	AU1050
Manifold	AU1010
Platform	AU1040
Tee-bolts and sleeves (pack of 50)	AU1060

AU1020

Reservoir

Create time delays in your pneumatic circuits by allowing pressure to gradually build up inside the reservoir.

Description	Part number
Reservoir 45cc	AU1020

AU8030
AU8020

Electrical

Everything you need to integrate electrical and electronic control into your pneumatic systems.

Description	Part number
Reed switch and holder	AU8025
Switch, push to make	AU8030
Microswitch	AU8015
Light sensor	AU8010
Power supply	HP2666
Power panel	AU8020
Lead, 4mm to 4mm, red	LK5603
Lead, 4mm to 4mm, black	LK5604
Lead, 4mm to 4mm, yellow	LK5607

HP6700

HP6785
Platform not included

PLC adaptor modules

These adaptor modules fit onto a standard 50mm DIN rail and allow you to convert your own PLC to work easily with standard 4mm connectors and leads.

Description	Part number
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

MI0245

MIAC

The Matrix Industrial Automation Controller (MIAC) is an integrated programmable microcontroller unit. Its features include :-

- 8 analogue or digital inputs
- 4 high current relay outputs
- 4 powerful transistor outputs (2 with PWM)
- 4 line, 16 column LCD display
- Keypad
- User programmable via USB
- Expandable via CAN communication bus
- Rugged ABS casing and shrouded 4mm sockets

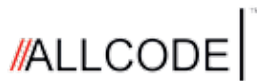You can design and upload your own custom programs for the MIAC using our Flowcode software.

Description	Part number
Cased MIAC with 4mm shrouded sockets	MI0245
MIAC controller	MI0235
Raspberry pi cased MIAC	MI5718
Arduino cased MIAC	MI5138
dsPIC cased MIAC	MI3494

AU9020

AU9010

Solutions

Our starter kit provides sufficient kit and teaching materials to learn the fundamental principles of pneumatic systems. As your students become more confident, you can then supplement this with the electro-pneumatics and/or control add-ons.

Description	Part number
Automatics essentials solution	AU9020
Automatics electro-pneumatics add-on kit	AU9015
Automatics control add-on kit (12V) with MIAC	AU9010
Automatics Control add-on kit (24V) no MIAC	AU9030

SET | SCIENCE ENGINEERING TECHNOLOGY

FLOWCODE

EBLOCKS2

locktronics

//ALLCODE

AUTOMATICS

MICRO CNC

MIAC

OptoSci
OPTOELECTRONIC SYSTEMS, COMPONENTS, INSTRUMENTATION

ASCELLs

ecio

Keep in touch with new developments:

MATRIX