MATRIX

2017 Edition

SET | SCIENCE
ENGINEERING
TECHNOLOGY

www.matrixtsl.com

for
BTEC National
unit 6: Microcontroller
systems for engineers

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MATRIX

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Outstanding Training for Industry by Industry

   MATRIX

Technical education in 2017

2017 will prove to be another significant year in the world of technical and vocational education. Over the past 12 months, we have seen unprecedented levels of interest in our education solutions. For the first time ever, our 2017 catalogue now includes over 100 'columns' covering disciplines from Science and Computer Science to Electrical / Electronic Engineering, Manufacturing Engineering, Electrical Installation, Automotive and more. What's more, all of our solutions are again mapped to curriculums (find out more from our curriculum map on pages 4 and 5).

Highlights...

SCIENCE, ENGINEERING, TECHNOLOGY

At Matrix, our whole-hearted focus as you'll see throughout the catalogue is on developing and manufacturing high quality, affordable kits for education and training. We aim to supply portable, rugged and packaged training equipment which can be used by a wide range of educational age-groups and for industrial training.

APPRENTICESHIPS

With the introduction of the apprenticeship levy in the UK in April 2017, the number of apprentices in engineering-like disciplines will grow hugely over the next number of years. We've established a growing portfolio of apprentice ready solutions and we're driving this through our support of GTA England.

ROBOTICS

A new focus for our development team over the past 12 months has been on developing a new range for the study of robotics. Last year we introduced the Formula AllCode whereby microcontroller programming can be studied with a programming language of choice. This year, we've added the robotic arm and more to give the biggest automation, robotics and mechatronics section we've ever had.

UNIVERSITY TECHNICAL COLLEGES

We've seen a continued growth in University Technical Colleges in the UK over the past few years, and in 2016, Matrix supplied training equipment into a record number of them. Through 2017 we'll be looking to work with further new and existing UTCs to show how our solutions are perfect for the 14-18 year-old engineers of the future.

ENGINEERING

We are known throughout the world for technical education and training, and this year we are introducing brand new solutions for motors training including electrical machines and CNC training as well as growing existing ranges such as our Automatics pneumatic training equipment and electrical installation offerings.

AROUND THE WORLD

2016 saw a record number of global dealers for Matrix with the supply of automotive solutions on a global scale across Africa and the United States, and coding labs for study of electronic engineering and microcontroller programming in the Middle East. In 2017 we will work with our network of dealers in over 40 countries to deliver the best training equipment to your engineers.

"Although we are only at the beginning of our mechatronics journey at UTC Leeds, the systems provided by Matrix are already proving invaluable. Pupils have very quickly been able to access industrial standard applications whilst seeing their relevance to the everyday products that they are familiar with. As a teacher it is very easy to follow the courseware Matrix provide, whilst still having the freedom to use the systems independently."

Andrew Mangham, Engineering Lecturer, University Technical College, Leeds.
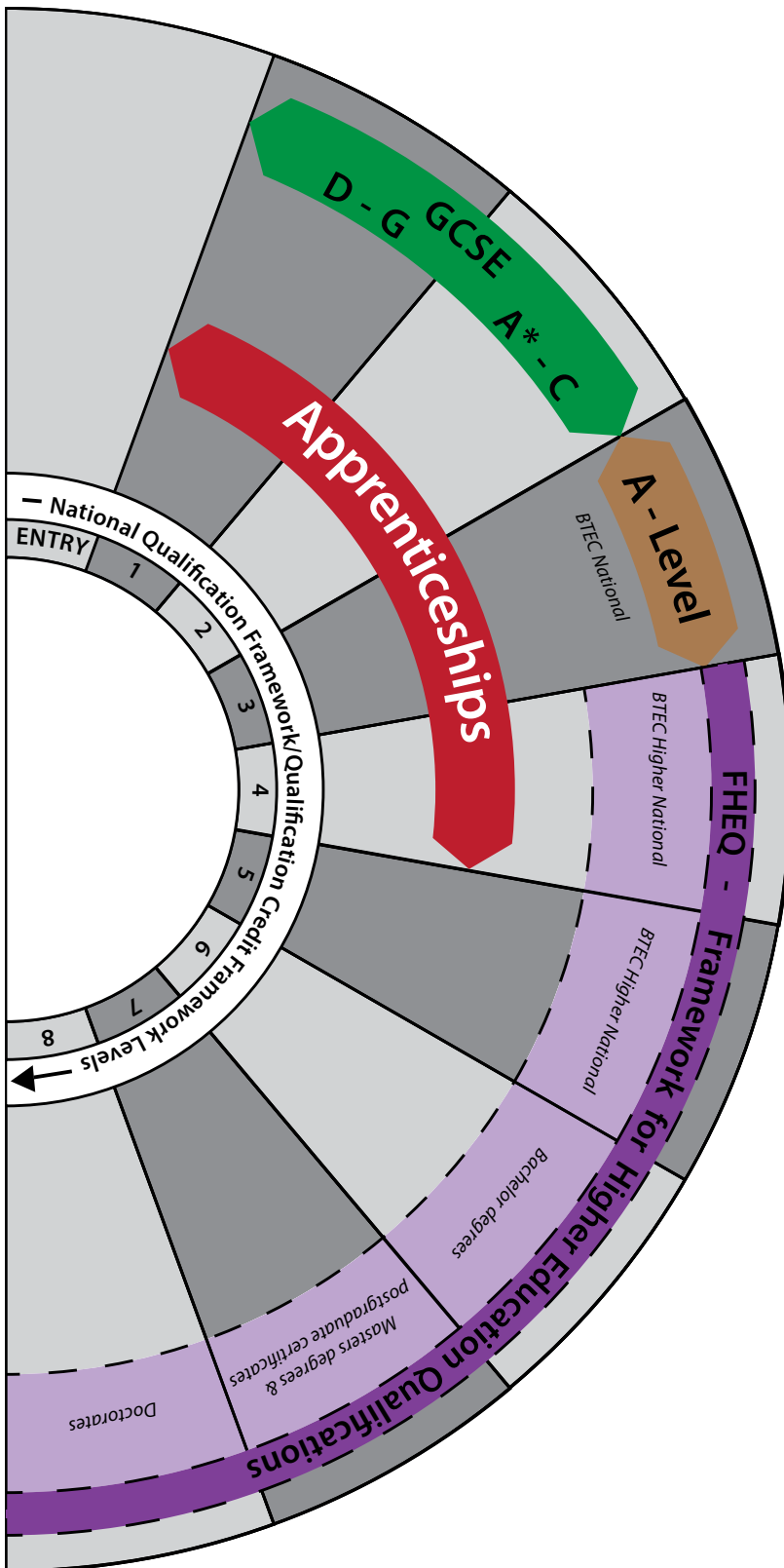
SET SCIENCE ENGINEERING TECHNOLOGY

locktronics

e BLOCKS®

ecio®

FLOWCODE7

AUTOMATICS

MIAC

FORMULA //ALLCODE™

The Matrix curriculum map is designed to give those reading our catalogue 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 syllabuses from BTEC (National & Higher National) to City & Guilds, EAL, WJEC, European Aviation Safety Authority & Institute of Motor Industry qualifications.

Throughout our catalogue, each solution details carefully selected curriculum units, so you can select what you require. For further explanation or help with this, do not hesitate to get in touch.

 matrix

Curriculum mapping

Solution (product code in brackets)	Pages	Science/Physics (pg. 7-10)	Computer Science (pg. 11-12)	Electrical/Electronic Engineering (pg. 14-35)	Mechanical Engineering (pg. 36-48)	Automation, Robotics & Mechatronics (pg. 49-55)	Manufacturing Engineering (pg. 56-60)	Aviation (pg. 61-64)	Automotive (pg. 65-72)	Electrical Installation (pg. 73-77)
Fundamentals of electricity (LK6444)	8	1								
Electricity, Magnetism & Materials (LK9071-2)	8	1, 2		2					1	
Energy & the environment (LK7345-2)	9	2, 3								
Physics A level solution (LK9329)	9	3								
Class pool kit (LK6802)	10	3								
Introduction to Robotics (Formula AllCode)	12		All levels	All levels		All levels				
Programming Arduino microcontrollers (HP9769)	12		All levels	All levels		All levels				
Applied electrical science (LK9071-2)	15			2						
Electronic devices & communication applications (LK3889)	15			2						
Fault finding in electronic circuits (LK3566)	25			2, 3						
Intermediate electrical & electronic principles (LK9862)	16			3, 4	3, 4		3, 4			
Industrial sensors, actuator & control applications (LK5783)	16			3	3	3	3			
Three phase systems (LK4961)	17			3						3
Electrical machines system (& add-ons)	17-18			3						
Operational amplifiers add-on pack (LK6906)	20			3						
Combinational logic add-on pack (LK6904)	21			3						
Sequential logic add-on pack	22			3						
Transistor amplifiers add-on pack (LK9435)	22			3						
Principles & applications of electronic devices & circuits (LK9422)	23			3, 4						
Advanced electronic principles (LK6804)	23			3, 4						
TINA v10 circuit simulation & PCB design software	24			3, 4, 5						
Advanced electrical, electronic & digital principles (LK9044)	24			4						
Digital & Analogue electronic systems (LK3566)	25			3						
Power & energy electronics (LK3568)	26			3, 4, 5						
Prototyping electronic circuits (HP512)	27			3, 4						
Programming PIC microcontrollers with Flowcode, C or Assembly (HP4988)	28 - 29			3, 4, 4	3, 4, 5	3, 4, 5	3, 4, 5			
Programming Arduino microcontrollers with Flowcode, C or Assembly (HP9769)	28			3, 4, 5	3, 4, 5	3, 4, 5	3, 4, 5			
Microcontroller standard & deluxe starter packs	30			3, 4, 5	3, 4, 5	3, 4, 5	3, 4, 5			
Electronic engineering communications solutions	31 - 35			5, 6						
Mechanical Engineering solutions	37 - 46				3, 4					
Automatics; pneumatic essentials, electronic & control solutions	50 - 51			3, 4	3, 4	3, 4	3, 4			
Automatics; pneumatics with industrial PLC's	51			3, 4, 5	3, 4, 5	3, 4, 5	3, 4, 5			
Automatics; Miniature factory (AU4039)	52				3	3	3			
Mechatronic systems solution (HP4550)	53			3, 4		3, 4				
Robot arm production cell (RB6231)	54					3, 4				
CNC CAD/CAM & simulation software (MB6809)	57						3			
MicroCNC system solutions	57						3			
Deskproto CAM software (CN2498)	60						3			
EASA electrical fundamentals (module 3) (LK9339)	62							3, 4, 5		
EASA electronic fundamentals (module 4) (LK9282)	63							3, 4, 5		
Turbo jet engine model (MB9200)	64							3, 4, 5		
AC principles for automotive technicians (LK8222)	66								2	
An introduction to motors, generators & hybrid (LK7444)	67								2	
An introduction to digital electronics (LK4221)	67								2	
Sensors & control in automotive applications (LK9834)	68								3	
CAN bus systems & operation (LK7629)	69								3	
Hybrid vehicle demonstration system (LK6483)	70								3	
Cutaway vehicle engine & chassis	72								All levels	
Electrical installation level 1 (LK5000)	74									1
Electrical installation level 2 (LK4063)	74									2
Transformer construction and operation (LK1989)	75									2, 3
Principles of lighting (LK2285)	77									3
Electrical Installation circuit principles (LK4562)	76									3
Electrical machines (EM5066)	77									3

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 120), our new robot arm (page 54) and our new MIAC controllers (page 126).

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 Rpi 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.

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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

Locktronics is used in around 2,000 schools and colleges for teaching the fundamental principles of electricity from age 8 upwards. 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. Look out for our Locktronics power supply / signal generator which will be launched later this year.

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


Locktronics kits have been very simple to use, and the printed symbols have allowed learners to see how the circuit diagrams they are learning from are really put together. The kits are robust, very adaptable, and easy to store and keep track of - ideal for use with teenagers, and easy to look after in a classroom environment. They are simple to connect and use, with a wide range of components and kits available to adapt to the needs of the National 5 and Higher curriculum for Engineering Science in Scotland. I have found that Locktronics has added a welcome practical experience that can make learning more real - circuits can be designed and simulated in other software packages such as Yenka, but this doesn't replace real testing in real life.

Graham Dick, Levenmouth Academy

NB: Image shows students at the Port Moresby International School Science Fair in Papa New Guinea using Locktronics for a sustainable technology and the environment project in November 2016.

Suitable for studies in Science at KS1 and KS2: ages 5 to 11.
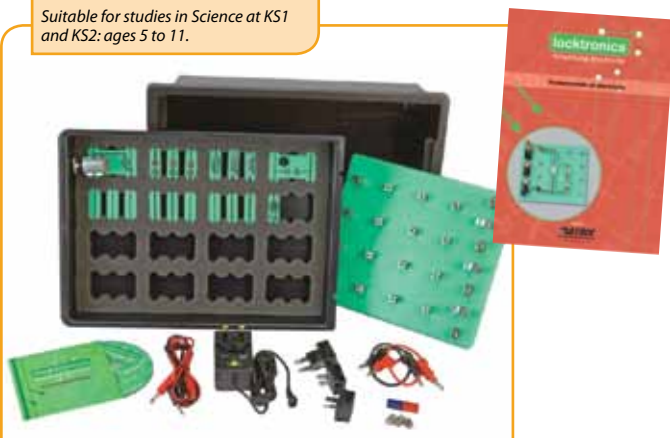
Fundamentals of electricity

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

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

Electricity, magnetism and materials V2

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

Components included

9	Connecting Link	1	Power supply carrier with battery symbol
3	Lampholder, MES	1	Power supply
1	Switch, push to make, metal strip	1	Pair of leads, red and black, 600mm, 4mm to croc clip
1	Switch, on/off, metal strip	1	Small bar magnet
1	Buzzer, 6V, 15mA	1	Locktronics User Guide
1	Motor 3 to 12V DC, 0.7A	1	Switch, reed, normally open
1	4 x 4 baseboard with 4mm pillars and battery holders	1	Lead, red. 500mm, 4mm to 4mm stackable
2	MES bulb, 2.5V, 0.2A	1	Lead, black, 500mm, 4mm to 4mm stackable
3	MES bulb, 6.5V, 0.3A		

Ordering information		DIN	ANSI
Fundamentals of electricity with baseboard, storage tray and DC power supply.		LK6444	LK6444A
Corresponding curriculum		LK6816	

Instruments

To deliver this course you will also need:

LK1110	Multimeter pack		

Components included

1	Switch, push to make, metal strip	1	400 Turn coil carrier
1	Power supply	1	Thermistor, 4.7k, NTC (DIN)
1	Resistor, 12 ohm, 1W, 5% (DIN)	1	LED, red, 12V (SB)
1	Motor, 6V, open frame	1	Voltmeter, 0V to 15V
1	Phototransistor	1	Relay, reed, normally open
2	Resistor, 1k, 1/4W, 5% (DIN)	1	Pair of leads, red and black, 600mm, 4mm to croc clip
1	Resistor, 10k, 1/4W, 5% (DIN)	1	Power supply carrier with battery symbol
1	Potentiometer, 10k (DIN)	1	Fuse/universal component carrier
1	Diode, power, 1A, 50V	1	Buzzer, 12V, 15mA
9	Connecting Link	1	Switch, on/off, metal strip
3	Lampholder, MES	1	Resistor, 100 ohm, 1W, 5% (DIN)
1	7 x 5 metric baseboard with 4mm pillars	1	EMM V2 Accessories pack
1	Ammeter, 0A to 1A	1	Resistor, 50K, 1/4W, 5%

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

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Suitable for studies in science age 11 – 16 and for environmental courses. Ideal for STEM.
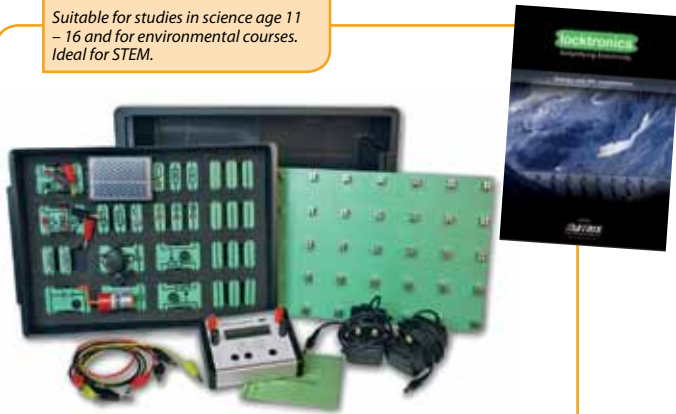
Energy and the environment

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

Instruments

To deliver this course you will also need:

LK1110	Multimeter pack		

Components included			
1	Power supply carrier with battery symbol	1	Resistor, 50K, 1/4W, 5%
1	USB reprogrammable PIC carrier with power lead	1	Lead, yellow, 500mm, 4mm to 4mm stackable
2	Thermistor, 470 ohm, NTC (DIN)	2	Lead, black, 500mm, 4mm to 4mm stackable
1	Phototransitor	2	Lead, red. 500mm, 4mm to 4mm stackable
2	Lampholder, MES	1	Lampholder, MES, for automotive LEDs
12	Connecting Link	2	Switch, push to make, metal strip
1	Solar cell	1	Locktronics User Guide
1	Hand cranked generator	1	MES bulb, 6.5V, 0.3A
1	MES bulb, 6V, 0.04A	1	Potentiometer, 10k (DIN)
1	Slotted opto sensor with 2mm to 4mm lead	1	Resistor, 1k, 1/4W, 5% (DIN)
2	Power supply	1	7 x 5 metric baseboard with 4mm pillars
1	Capacitor, 22,000uF, Electrolytic 16V	1	Energy Meter
1	LED, red, 5V (SB)	1	MES bulb, 12V, LED, white

Ordering information	DIN	ANSI
Energy and environment solution including storage, power supply and energy meter.	LK7345-2	LK7345-2A
Corresponding curriculum	LK7122	

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

A level 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 PICmicro investigation to this kit please see the PICmicro add-on kit on our web site.
To add Operational amplifier investigation to this kit see the Op-amp add-on kit on page 20.

Instruments

To deliver this course you will also need:

LK1110	Multimeter pack	HP8279	Picoscope
HP7894	Signal generator		

Components included			
1	Resistor, 10 ohm, 1W 5% (DIN)	3	Lampholder, MES
1	2:1 transformer with retractable ferrite core	1	Resistor, 5.6k, 1/4W, 5% (DIN)
1	Capacitor, 22,000uF, Electrolytic 16V	1	Transformer, 2:1 turns ratio
1	Phototransitor	1	Resistor, 3.9 ohm, 3W, 5% (DIN)
1	Thermistor, 4.7k, NTC (DIN)	1	Potentiometer, 250 ohm (DIN)
1	Resistor, 22k, 1/4W, 5% (DIN)	1	Resistor, 2.2k, 1/4W, 5% (DIN)
1	Resistor, 1k, 1/4W, 5% (DIN)	1	Capacitor, 2,200 uF, Electrolytic, 25V
1	Resistor, 100 ohm, 1W, 5% (DIN)	1	Constantan Wire Carrier, 0.075 x 500mm
1	LED, red, 12V (SB)	1	Nichrome Wire Carrier, 0.21 x 500mm
1	Resistor, 47 ohm, 1/2W, 5% (DIN)	1	Nichrome Wire Carrier, 0.075 x 250mm
1	Choke, 47mH	1	Nichrome Wire Carrier, 0.075 x 500mm
1	Switch, on/off, metal strip	1	Capacitor, 1,000 uF, Electrolytic 30V
1	Power supply	1	Small bar magnet
1	7 x 5 metric baseboard with 4mm pillars	1	Power supply carrier with battery symbol
1	Resistor, 68 ohm 1/2W, 5% (DIN)	12	Connecting Link
1	Locktronics User Guide	3	AA battery holder carrier
1	Resistor, 270 ohm, 1/2W, 5% (DIN)	3	MES bulb, 6V, 0.04A
1	Resistor, 10k, 1/4W, 5% (DIN)	1	400 turn induction coil
1	Capacitor, 1 uF, Polyester		

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

Suitable for extending work in Physics to various topics at ages 16 to 18. Ideal for STEM.

COMING SOON

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, PICmicro, 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

Instruments			
To deliver this course you will also need:			
LK1110	Multimeter pack	HP8279	Picoscope
HP7894	Signal generator		

Components included			
2	Resistor, 10k, 1/4W, 5% (DIN)	2	Lead, red, 300mm, 4mm to 2mm stackable
2	MES bulb, 6.5V, 0.3A	2	Lead, black, 300mm, 4mm to 2mm stackable
2	Capacitor, 10 uF, Electrolytic, 25V	1	Lead, black, 500mm, 4mm to 4mm stackable
1	Capacitor. 4.7uF, Electrolytic, 25V	2	Lead, yellow, 500mm, 4mm to 4mm stackable
1	Capacitor, 1 uF, Polyester	2	Lead, blue, 500mm, 4mm to 4mm stackable
1	Capacitor, 0.1 uF, Polyester	4	Connecting Link
1	Thermistor, 4.7k, NTC (DIN)	1	Low power solar motor
1	Thermistor, 470 ohm, NTC (DIN)	1	Speaker
1	Potentiometer, 10k (DIN)	1	Energy Meter
1	Resistor, variable, 250 ohm	1	Solar cell
1	Potentiometer, 25 ohm (DIN)	1	Slotted opto sensor with 2mm to 4mm lead
1	Resistor, 270k, 1/4W, 5% (DIN)	1	NOR Gate with 2mm to 4mm lead - ANSI
1	Diode, power, 1A, 50V	1	Capacitor, 100uF, Electrolytic, 25V
1	Resistor, 22k, 1/4W, 5% (DIN)	1	OR Gate with 2mm to 4mm lead - ANSI
1	Bridge rectifier	2	Lead, black, 300mm, 4mm to 2mm stackable
1	Resistor, 180 ohm, 1/2W, 5% (DIN)	1	AND Gate with 2mm to 4mm lead - ANSI
1	Resistor, 120 ohm, 1/2W, 5% (DIN)	1	USB reprogrammable PIC carrier with power lead
1	Resistor, 47 ohm, 1/2W, 5% (DIN)	1	Op Amp module (TL081)
1	Resistor, 10 ohm, 1W 5% (DIN)	1	Hand cranked generator
1	Switch, on/off, metal strip	2	400 turn induction coil
1	Switch, push to make, metal strip	1	Faraday's law kit
1	LED, yellow, 12V (SB)	1	Lenz's law kit
1	LED, green, 12V (SB)	1	Motor 3 to 12V DC, 0.7A
2	LED, red, 12V (SB)	1	Fleming's motor rule apparatus
1	Lampholder, MES, for automotive LEDs	1	Choke, 200mH
1	MES bulb, 12V, LED, white	1	Choke, 10mH
1	Resistor, 100k, 1/4W, 5% (DIN)	1	NAND Gate with 2mm to 4mm lead- ANSI
1	NOT Gate with 2mm to 4mm lead - ANSI		

Ordering information		DIN	ANSI
Electrical and electronics principles class pool kit.		LK6802	LK6802A

Locktronics power supply / 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 plastic 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. A USB connection allows control of the output from a PC using Flowcode and also allows supervisors to fix the outputs to a preset level using proprietary software.

Features

- 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
- USB programmable
- Supplied with technician voltage limiting software
- Shrouded safety connectors
- Waveform generator

Specification			
Output	**Voltage**	**Current**	**Features**
Variable AC	+/- 10V 50R DC coupled	200mA	Instrumentation output 0Hz – 100kHz Sine/Square/Triangle Arbitrary waveform generator
	10V p-p AC coupled	1.3A pk	Audio output: 20Hz – 20kHz Sine/Square/Triangle Arbitrary waveform generator
	2V p-p AC coupled line output	N/A	
Variable DC	3 - 10V	3A	Gain control Current limiter/monitor
+12V DC	12V	5A	Current limiter/monitor
+5V DC	5V	5A	Current limiter/monitor
-12V DC	-12V	300m A max	

Ordering information	
Locktronics power supply/signal generator	LK6999

Matrix

In the following pages, we present some of the off-the-shelf solutions we have for delivering a motivating course in areas of computer science. Solutions here are based around our new robotics range including the Formula AllCode robot buggy and also programming of microcontrollers using Flowcode, our flowchart programming software. You can learn more about Flowcode in the Flowcode section of the catalogue (page 78 onwards).

Our learning solutions:

- Free Flowcode licences for students to learn at home
- Learning solutions for PIC, Arduino or RPi
- Hardware, software and curriculum
- Ideal for collaboration between Technology and Computer science departments

"The staff at Matrix have been very helpful since the first tentative pricing inquiry. I have been given very honest and reliable advice about what products suit my needs and the national curriculum I am delivering, including what products I need and the ones I don't.

Follow-up customer care has been very impressive and on a personal level - if I have any technical queries Matrix have been only a phone call or an email away. I can thoroughly recommend the training courses offered for Flowcode, where the training materials were first class, delegates were very well looked after, and assistance was always available.

Overall, I am delighted to recommend Matrix to other schools who want to start delivering Engineering Science courses, or who need to replace old kit coming to the end of its time."

Graham Dick, Levenmouth Academy

Computer science

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

Suitable for Design technology and Engineering Science age 11 – 18. Ideal for STEM.

Suitable for Computer Science age 11 – 16.

See Formula AllCode section for full details

For an explanation of icons please see page 6

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.

Suitable for Computer Science age 11 – 16.

Suitable for Design Technology age 11 – 16.

Accelerate your student's learning with a copy of Flowcode for Arduino.

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

For an explanation of icons please see page 6

Components included

1	Arduino E-blocks interface shield	1	E-blocks Combo board
1	Power supply	1	USB cable

Ordering information

Arduino development centre with printed base plate	HP9769
Flowcode	FC9227
Corresponding curriculum	CP4375

Engineering

In this section we present some of our solutions for learning various aspects of engineering. In most cases these are linked to a British qualification such as a BTEC, which is considered by many in the UK to be the gold standard in engineering education. Remember that if you don't see exactly what you are looking for you can make up your own solution from the many parts in the various ranges.

Our learning solutions:

- Deliver a focus on 'learning through building' which motivates and challenges students
- Take students from understanding of basic engineering principles through to complex, focused engineering topics
- Provide solutions in topics including electronics, robotics, automation and mechatronics
- Deliver fantastic value for money with multiple hours of learning curriculum and teachers notes with each offering
- Are easily transported between labs and stored neatly in Gratnell's trays

The School of Electronic and Aeronautical Engineering (SEAE), one of the British Army's key training establishments in the United Kingdom, has reacted to the need to dominate the Digital Battlefield by equipping a number of classrooms and project rooms with a comprehensive range of E-Block modules and Flowcode. The E-blocks system has enabled SEAE to develop courses to teach the students fault-finding procedures applicable to microprocessor and/or embedded microcontroller systems.

This means that the students can develop practical experience of designing, programming and building systems similar to what they will encounter during an operational tour of duty.

A particular success has been the student project work on CAN bus which is a communications system used to link sub systems together in military vehicles. Students are split into groups, given real automotive components and tasked with developing a functional vehicle electronic control system.

SEAE, British Army, United Kingdom

At Matrix, we're well known for our high quality solutions for teaching electronic engineering. In this section, you'll find equipment based on our popular Locktronics and E-blocks ranges, covering a number of topics from level 2 units within the BTEC first award, through to degree level telecommunications solutions which are supplied with many hours of well supported curriculum from our team of curriculum writers. Whether you're looking to teach basic electrical concepts, or move into the complexity of microcontroller programming with flowcharts, C or Assembly, there is sure to be something for you.

Our Learning solutions

- Meeting 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.

The Formula AllCode robot buggies came highly recommended by a colleague who had used Matrix solutions in the past. I was impressed with the products on offer and value for money seemed great in comparison to other products available on the market. We use the buggies with different programming languages from Scratch to Python and also App Inventor. Initially we will be using the buggies as part of a computer science extracurricular activity. We will then move on to use the buggies as part of the Computer Science curriculum at our school for KS4 students. The service received from Matrix has been excellent. Every time I have contacted Matrix, the response time has been quick and professional.

Shamim Ahmed, Salendine Nook Academy, West Yorkshire

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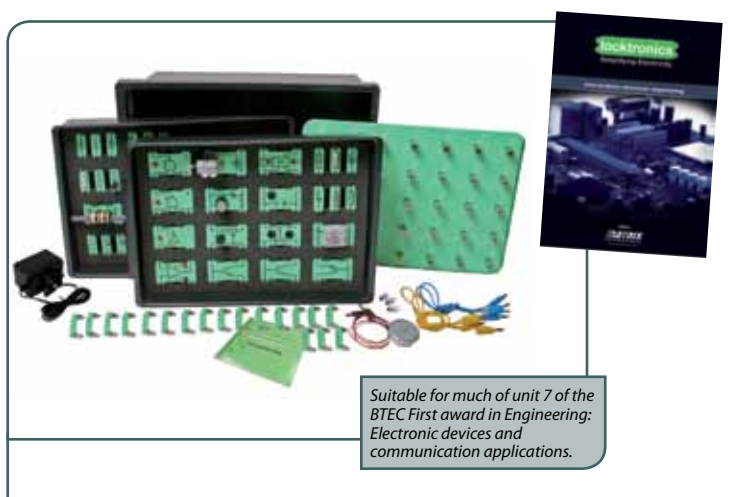
Applied electrical science

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

Instruments			
To deliver this course you will also need:			
LK1110	Multimeter pack		
Components included			
1	Switch, push to make, metal strip	1	400 Turn coil carrier
1	Power supply	1	Thermistor, 4.7k, NTC (DIN)
1	Resistor, 12 ohm, 1W, 5% (DIN)	1	LED, red, 12V (SB)
1	Motor, 6V, open frame	1	Voltmeter, 0V to 15V
1	Phototransistor	1	Relay, reed, normally open
2	Resistor, 1k, 1/4W, 5% (DIN)	1	Pair of leads, red and black, 600mm, 4mm to croc clip
1	Resistor, 10k, 1/4W, 5% (DIN)	1	Power supply carrier with battery symbol
1	Potentiometer, 10k (DIN)	1	Fuse/universal component carrier
1	Diode, power, 1A, 50V	1	Buzzer, 12V, 15mA
9	Connecting Link	1	Switch, on/off, metal strip
3	Lampholder, MES	1	Resistor, 100 ohm, 1W, 5% (DIN)
1	7 x 5 metric baseboard with 4mm pillars	1	EMM V2 Accessories pack
1	Ammeter, 0A to 1A	1	Resistor, 50K, 1/4W, 5%

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

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

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

Instruments			
To deliver this course you will also need:			
LK1110	Multimeter pack		
Components included			
1	Systems block, 555 timer, with 4mm to 2mm lead	2	Resistor, 100k, 1/4W, 5% (DIN)
1	7 x 5 metric baseboard with 4mm pillars	2	Resistor, 10k, 1/4W, 5% (DIN)
2	Transistor RHF, NPN	2	LED, red, 5V (SB)
1	Transistor RHF, PNP	1	Resistor, 100 ohm, 1W, 5% (DIN)
1	2:1 transformer with retractable ferrite core	18	Connecting Link
1	Voltmeter, +/- 7.5V	1	Power supply carrier with battery symbol
1	Op Amp Carrier (TL081) with 2mm to 4mm Lead	2	Resistor, 1k, 1/4W, 5% (DIN)
1	Speaker	1	Potentiometer, 10k (DIN)
1	Motor 3 to 12V DC, 0.7A	2	Capacitor, 0.47 uF, Polyester
2	Power supply	1	Thermistor, 4.7k, NTC (DIN)
2	Lead, blue, 500mm, 4mm to 4mm stackable	1	Capacitor, 47uF, Electrolytic, 25V
1	Voltmeter, 0V to 15V	1	Diode, germanium
1	Locktronics User Guide	1	Diode, power, 1A, 50V
1	NOT Gate with 2mm to 4mm lead - ANSI	1	Capacitor, 4n7, Ceramic
1	NOR Gate with 2mm to 4mm lead - ANSI	3	Lampholder, MES
2	Lead, yellow, 500mm, 4mm to 4mm stackable	3	MES bulb, 12V, 0.1A
1	OR Gate with 2mm to 4mm lead - ANSI	1	Capacitor, 100pF, Ceramic
1	NAND Gate with 2mm to 4mm lead - ANSI	1	Choke, 10mH
1	AND Gate with 2mm to 4mm lead - ANSI	1	Dual rail power supply carrier
1	Ammeter, 0mA to 100mA	1	Buzzer, 6V, 15mA
1	Phototransitor	2	Capacitor. 4.7uF, electrolytic, 25V
1	Switch, push to make, metal strip	1	Resistor, 50K, 1/4W, 5%
2	Switch, on/off, metal strip		

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

Suitable for unit 1 of the BTEC National: Engineering principles

Suitable for unit 3 of the BTEC Higher National: Engineering science

Intermediate electrical and electronic principles

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

Instruments

To deliver this course you will also need:

LK1110	Multimeter pack

Components included

1	Potentiometer, 250 ohm (DIN)	2	Lead, yellow, 500mm, 4mm to 4mm stackable
3	MES bulb, 12V, 0.1A	1	Voltmeter, 0V to 15V
1	AC voltage source carrier	3	AA battery holder carrier
1	Power supply	1	Choke, 47mH
12	Connecting Link	1	Resistor, 100 ohm, 1W, 5% (DIN)
1	Resistor, 180 ohm, 1/2W, 5% (DIN)	1	400 Turn coil carrier
1	Resistor, 270 ohm, 1/2W, 5% (DIN)	1	Capacitor, 1 uF, Polyester
1	Resistor, 1k, 1/4W, 5% (DIN)	1	2:1 transformer with retractable ferrite core
2	Resistor, 10k, 1/4W, 5% (DIN)	1	Ammeter, 0mA to 100mA
1	Locktronics User Guide	1	Switch, push to make, metal strip
1	Capacitor, 47uF, Electrolytic, 25V	1	Power supply carrier with battery symbol
1	Capacitor, 1,000 uF, Electrolytic 30V	1	Resistor, 22k, 1/4W, 5% (DIN)
1	Transformer, 2:1 turns ratio	1	Capacitor, 2,200 uF, Electrolytic, 25V
2	Pair of leads, red and black, 1000mm, 4mm to croc clips	3	Lampholder, MES
2	Lead, blue, 500mm, 4mm to 4mm stackable	1	Capacitor, 150 uF, Electrolytic, 25V
1	Diode, germanium	1	Capacitor, 100uF, Electrolytic, 25V
1	7 x 5 metric baseboard with 4mm pillars	1	Resistor, 2.2k, 1/4W, 5% (DIN)
1	Diode, power, 1A, 50V	1	Small bar magnet
1	Bridge rectifier		

Ordering information	DIN	ANSI
Intermediate electrical and electronic principles	LK9862	LK9862A
Corresponding curriculum		LK4583

Suitable for unit 36 of BTEC National: Programmable logic controllers

Suitable for unit 45 of BTEC Higher National: Industrial systems

Industrial sensors, actuator and control applications

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

Also available with Rpi MIAC and Arduino MIAC

Instruments

To deliver this course you will also need:

LK1110	Multimeter pack

Components included

1	Relay, 12V coil, 10A, normally open	1	Microswitch
4	Switch, on/off, metal strip	1	LED, green, 12V (SB)
4	Switch, push to make, metal strip	1	Buzzer, 12V, 15mA
6	Lead, yellow, 500mm, 4mm to 4mm stackable	1	Solenoid
1	Lead, red. 500mm, 4mm to 4mm stackable	1	Motor 3 to 12V DC, 0.7A
1	Switch, reed, normally open	1	Power supply carrier with battery symbol
2	LED, red, 12V (SB)	1	Potentiometer, 10k (DIN)
1	Lampholder, MES	1	Cased MIAC with Shrouded 4mm Connectors
6	Lead, blue, 500mm, 4mm to 4mm stackable	1	Power supply
1	Diode, power, 1A, 50V	1	USB2 high speed A to mini B lead
1	Resistor, 10k, 1/4W, 5% (DIN)	1	Small bar magnet
2	Resistor, 1k, 1/4W, 5% (DIN)	1	MES bulb, 12V, LED, white
1	Phototransistor	1	Transistor LHF, NPN
1	Stepper Motor	14	Connecting Link
1	Potentiometer, 1k (DIN)	1	Locktronics User Guide
1	Resistor, 10 ohm, 1W 5% (DIN)	1	MIAC Getting Started Guide
1	Thermistor, 4.7k, NTC (DIN)	1	7 x 5 metric baseboard with 4mm pillars
1	LED, yellow, 12V (SB)	1	MES bulb, 14V, 0.06A
1	Lead, black, 500mm, 4mm to 4mm stackable		

Ordering information	DIN	ANSI
Industrial sensor, actuator and control applications solution with storage trays, power supply and leads.	LK5783-2	LK5783-2A

Ordering information	DIN	ANSI
Industrial sensor, actuator and control applications with storage trays, PSU, leads and engineering panel	LK6499-2	LK6499-2A
Corresponding curriculum		LK8739

MATRIX

Suitable for BTEC National unit 16: Three phase electrical systems

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

Suitable for unit 15 of the BTEC National award in Engineering : Electrical machines

COMING SOON

Suitable for unit 31 of BTEC Higher National: Electrical systems and fault finding

Suitable for unit 21 of BTEC Higher National: Electrical machines

Suitable for unit 43 of BTEC Higher National: Further machines and drives

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

Oscilloscope traces showing three phase supply

Electrical machines starter system

This starter system allows students to understand the basics of DC machines. The core system consists of a base plate, a DC generator / dynamometer, a DC motor, a DC power supply and appropriate instruments for taking measurements. Students can use the equipment to understand the basic principles of DC machines and their speed/torque/power characteristics. A full student manual is included. Equipment is shipped 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
- Swinging arm dynamometer and torque measurement
- The link between HP, watts and joules

Components included

1	7x5 baseboard with 4mm pillars	4	Lead, yellow 4mm to 4mm, stackable
10	Connecting link	2	Lead, green, 320mm, 4mm to 4mm stackable
3	MES lampholder	5	Lead, red, 500mm, 4mm to 4mm stackable
3	MES bulb, 12V	6	Lead, black, 500mm, 4mm to 4mm stackable
1	Three phase power supply	1	Lead, blue, 500mm, 4mm to 4mm stackable
1	Three phase motor	1	33uF non-electrolytic capacitor
6	Diode, silicon, 1A	1	Resistor, 2.2k, 1/4W, 5% (DIN)
3	Resistor, 1k, 1/4W, 5%	4	BNC male to dual 4mm Binding post
2	Resistor, 10 ohm, 1W 5% (DIN)		

Recommended

Pico 4 phase oscilloscope	HP5834
AC/DC current clamp	HP5561

Ordering information

Three phase systems	LK4961
Corresponding curriculum	LK2686

Components included

1	Machines base plate	1	24V variable DC power supply
1	Tacho meter	1	Lead pack
1	Swinging arm dynamometer machine	2	V I meter pairs
1	DC machine	1	Energy meter
1	Balance	1	Power rheostat

Ordering information

Electrical machines starter system	EM6637

Suitable for unit 15 of the BTEC National award in Engineering : Electrical machines

COMING SOON

Suitable for unit 21 of BTEC Higher National: Electrical machines

Suitable for unit 31 of BTEC Higher National: Electrical systems and fault finding

Suitable for unit 43 of BTEC Higher National: Further machines and drives

Suitable for unit 15 of the BTEC National award in Engineering : Electrical machines

Suitable for unit 21 of BTEC Higher National: Electrical machines

Suitable for unit 43 of BTEC Higher National: Further machines and drives

AC machines add-on pack

This AC motors add-on pack allows students to extend their investigations into electrical machines into the realm of AC motors. The add-on pack includes an AC motor and power supply. The AC motor can be linked to the dynamometer in the starter system to allow students to understand the different topologies of AC machine drives and their advantages and disadvantages. A full student manual is included. Equipment is shipped 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 machines add-on pack

The three phase add-on pack allows students to understand the operation of three phase motors. It includes a three phase machine, a phase shift capacitor and additional Voltmeter/Ammeter pairs that allow measurements across all three phases to be made.

Please note the three phase add-on pack requires the AC machines add-on pack.

Learning objectives / experiments

- Three phase AC machine construction
- Three phase motors, torque characteristics and efficiency
- Operating three phase motors from a single phase

Instruments	
Further instruments may be required, please contact us	

Components included			
1	AC machine	1	24V AC power supply

Ordering information	
AC motors add-on pack	EM0024

Instruments	
Further instruments may be required, please contact us	

Components included			
1	Three phase machine	1	Phase shift capacitor
2	VI meter pairs		

Ordering information	
Three phase machines add-on pack	MB6413

Electrical/Electronic engineering

DC machine speed and position control

This pack consists of a MIAC controller and leads that allow students to write a variety of programs to control the position and speed of a DC motor using Pulse Width Modulation.

Note that as an alternative to this add-on pack customers can use their own 24V PLC to control motor speed.

Learning objectives / experiments
- DC motor control using PWM
- Speed and position sensors in motor control systems
- Servo control systems

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

Components included			
1	7 x 5 nmetric baseboard with 4mm pillars	2	Resistor 1K ohm
1	AC voltage source carrier	1	Lead pack
20	Connecting link	2	Resistor 1M ohm
6	Thyristor	1	Capacitor, 47uF
1	Potentiometer, 10K ohm	2	Push to make switch
1	33uF capacitor	2	Resistor 10k ohm
4	Power diode		

Components included	
1	dsPIC MIAC

Ordering information	
DC machine speed and position control	EB6579

Ordering information	
AC machine thyristor speed control pack	EM8069

COMING SOON

Suitable for unit 15 of the BTEC National award in Engineering : Electrical machines

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.

Complete electrical machines

This kit allows students to conduct a wide range of experiments in DC, AC, and three phase electrical machines with DC motor speed control using a microcontroller based PLC, and AC control of single phase motors using simple thyristor circuits. The pack consists of our Electrical machines starter system, the AC machines add-on pack, the three phase machines add-on pack, the DC machine speed and position add-on pack and the AC machine thyristor pack. A full student manual is included. Equipment is shipped in our standard storage trays.

Learning objectives / experiments
- Power transformer systems
- DC machines
- Dynamometer machines
- AC machines
- Three phase machines
- DC speed control
- AC speed control

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

The operational amplifiers add-on kit can be added to our basic LK9071 Electricity, magnetism and materials kit.

Components included			
1	Machines base plate	1	24V DC power supply
1	Thyristor speed control addon pack	1	Lead pack
1	Swinging arm dynamometer machine	4	V I meter pairs
1	DC machine	1	Energy meter
1	Balance	1	Tacho meter
1	AC machine	1	24V AC power supply
1	Three phase machine	1	Phase shift capacitor
1	dsPIC MIAC	1	Locktronics DC machine speed control pack
1	Power rheostat		
Ordering information			
Complete machines solution			EM7004

Operational amplifiers add-on-kit			
1	Capacitor, 100uF, Electrolytic, 25V	1	Power supply
2	BNC male to dual 4mm binding post	3	Lead, black, 500mm, 4mm to 4mm stackable
1	AC voltage source carrier	1	Capacitor, 1 uF, Polyester
1	Resistor, 100 ohm, 1W, 5% (DIN)	1	LED, red, 5V (SB)
1	Low power solar motor	1	LED, green, 5V (SB)
1	Resistor, 1k, 1/4W, 5% (DIN)	1	Op Amp Carrier (TL081) with 2mm to 4mm Lead
2	Resistor, 10k, 1/4W, 5% (DIN)	1	Dual rail power supply carrier
1	Potentiometer, 10k (DIN)	1	Speaker
1	Capacitor, 0.1 uF, Polyester	1	Voltmeter, +/- 7.5V
9	Connecting Link	1	Lead, blue, 500mm, 4mm to 4mm stackable
1	Thermistor, 470 ohm, NTC (DIN)	2	Lead, red. 500mm, 4mm to 4mm stackable
Ordering information		**DIN**	**ANSI**
Operational amplifiers add-on-kit		LK6906	LK6906A
Corresponding curriculum		LK3061	

COMING SOON

Suitable for City and Guilds 8202 level 3

Suitable for use in a wide range of syllabuses.

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

Combinational logic add-on packs

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

The combinational logic add-on pack can be added to our basic LK9071 Electricity, magnetism and materials kit.

Components included			
1	AND gate carrier with 2mm to 4mm lead	2	LED green
1	OR gate carrier with 2mm to 4mm lead	3	LED, red, 5V
1	NOT gate carrier with 2mm to 4mm lead	2	Switch, on/off metal strip
1	NAND gate carrier with 2mm to 4mm lead	12	Connecting link
1	NOR gate carrier with 2mm to 4mm lead	6	Lead, red, 500mm, 4mm to 4mm stackable
1	XOR gate carrier with 2mm to 4mm lead	8	Lead, black, 500mm, 4mm to 4mm stackable
1	Voltmeter, 0V to 15V	2	Lead, yellow, 500mm, 4mm to 4mm stackable
1	Resistor, 10k, 1/W, 5%		

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

Instruments	
To deliver this you will also need:	
LK1110	Mutimeter x 2
HP3725	AC power supply (240V: 12V @5amps)

Ordering information - Diesel engines	
Transformer construction and operation pack	LK1989

Suitable for use in a wide range of syllabuses.

Sequential logic add-on pack

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

Learning objectives / experiments

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

The sequential logic add-on pack can be added to our basic LK9071 Electricity, magnetism and materials kit and should be used in conjunction with the LK6904 Combinational add-on pack.

Components included			
1	Resistor, 100k, 1/4W, 5% (DIN)	2	Resistor, 5k, 1/4W, 5% (DIN)
1	Capacitor, 47uF, Electrolytic, 25V	1	Systems Block, 555 timer, with 4mm to 2mm lead
7	Connecting Link	3	D-Type Flip-Flop (horizontal) with 2mm to 4mm lead
1	Capacitor, 100uF, Electrolytic, 25V	1	Systems Block display decoder - 7-segment
1	Switch, changeover, toggle	1	LED, Yellow

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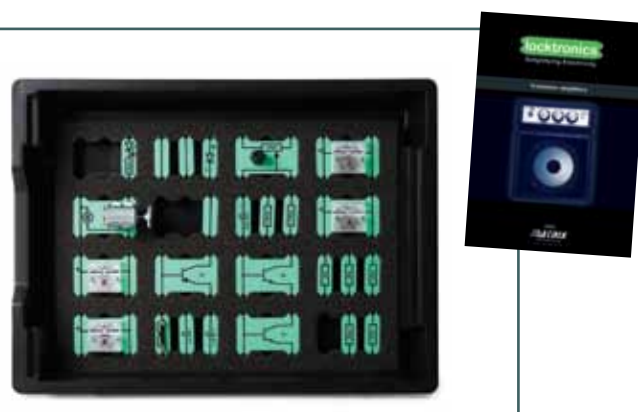
Transistor amplifiers add-on pack

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

The transistor amplifiers add-on pack can be added to our basic LK9071 Electricity, magnetism and materials kit.

Components included			
2	Voltmeter, 0V to 15V	1	Transistor, JGFET
2	Resistor, 1k, 1/2W, 5%	1	Resistor, 10k, 1/4W, 5%
1	Resistor, 270 ohm, 1/2W, 5%	1	Potentiometer, 250 ohm
2	Resistor, 100k, 1/4W, 5%	1	Capacitor, 47uF, Electrolytic, 25V
2	Transistor LHF, PNP	1	Diode, power, 1A, 50V
3	Connecting Link	1	Transistor RHF, PNP
2	Capacitor. 4.7uF, electrolytic, 25V	1	Resistor, 560 ohm, 1/4W, 5% (DIN)
1	Transformer, 2:1 turns ratio	1	Resistor, 5k, 1/4W, 5% (DIN)
2	Ammeter, 0mA to 100mA	1	Resistor, 200k, 1/4W, 5% (DIN)
1	Power MOSFET transistor	1	Speaker

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

matrix

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

Suitable for unit 20 of the BTEC National: Analogue electronics circuits

Suitable for unit 22 of BTEC Higher National: Electronic circuits and devices

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

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, transitors, 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

Components included		
2	Power supply	1	AC voltage source carrier
1	Voltmeter, 0V to 15V	1	Resistor, 100 ohm, 1W, 5% (DIN)
1	Capacitor, 1,000 uF, Electrolytic 30V	1	Transformer, 2:1 turns ratio
1	Low power solar motor	3	Resistor, 1k, 1/2W, 5% (DIN)
3	Resistor, 10k, 1/4W, 5% (DIN)	1	Resistor, 270 ohm, 1/2W, 5% (DIN)
2	Resistor, 180 ohm, 1/2W, 5% (DIN)	1	Potentiometer, 250 ohm (DIN)
2	Potentiometer, 10k (DIN)	2	Resistor, 100k, 1/4W, 5% (DIN)
2	Capacitor, 47uF, Electrolytic, 25V	1	Transistor RHF, NPN
1	Transistor LHF, NPN	1	Diode, germanium
3	Diode, power, 1A, 50V	1	Zener diode, 4.7V
1	Thyristor	12	Connecting Link
1	Zener diode, 8.2V	1	Transistor RHF, PNP
1	Transistor LHF, PNP	1	Bridge rectifier
1	Thermistor, 4.7k, NTC (DIN)	2	Lead, red. 500mm, 4mm to 4mm stackable
2	Lead, black, 500mm, 4mm to 4mm stackable	2	Lead, yellow, 500mm, 4mm to 4mm stackable
2	Lead, blue, 500mm, 4mm to 4mm stackable	1	Capacitor, 100uF, Electrolytic, 25V
1	Capacitor, 1 uF, Polyester	4	Capacitor. 4.7uF, electrolytic, 25V
2	Switch, push to make, metal strip	1	Switch, on/off, metal strip
1	Capacitor, variable, 15-140pF	3	Capacitor, 0.47 uF, Polyester
1	Resistor, 2.2k, 1/4W, 5% (DIN)	1	Switch, changeover, toggle
1	Resistor, 500k, 1/4W, 5% (DIN)	1	Op Amp Carrier (TL081) with 2mm to 4mm Leads
1	Resistor, 200k, 1/4W, 5% (DIN)	1	Capacitor, 1nF, Polyester
1	Motor 3 to 12V DC, 0.7A	2	LED, Red
1	2:1 transformer with retractable ferrite core	1	AA battery holder carrier
1	Dual rail power supply carrier	2	Power supply carrier with battery symbol
2	Ammeter, 0mA to 100mA	2	7 x 5 metric baseboard with 4mm pillars
1	Triac	1	Photodiode
1	Phototransistor	1	Transistor. JGFET

Components included		
1	Resistor, 1k, 1/2W, 5% (DIN)	1	Diode, power, 1A, 50V
9	Connecting Link	1	7 x 5 metric baseboard with 4mm pillars
1	Power supply carrier with battery symbol	1	Power supply
1	2200uF capacitor	1	Potentiometer 250ohm
1	Full wave rectifier	1	6v8 zener diode
1	4v7 zener diode	1	Pair of leads, red and black, 600mm, 4mm to croc clip
1	Voltmeter, 0V to 15V	1	Combinational logic add-on pack
1	Operational amplifier add-on pack	1	Transistor amplifier add-on pack
1	Sequential logic add-on pack		

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

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

BTEC Higher National:
Unit 52 of BTEC Higher National: Further electrical, electronics and digital principles
*Unit 47 of BTEC Higher National: Analogue electronics systems*
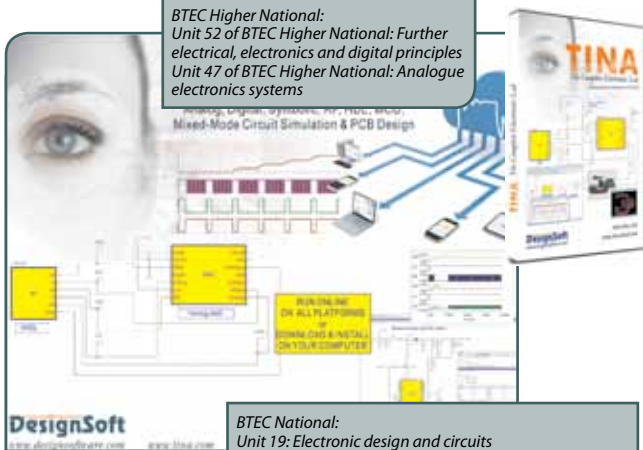
BTEC National:
Unit 19: Electronic design and circuits
Unit 20: Analogue electronics
Unit 22: Electronic circuit board design and manufacture

TINA V10

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

Learning objectives / experiments

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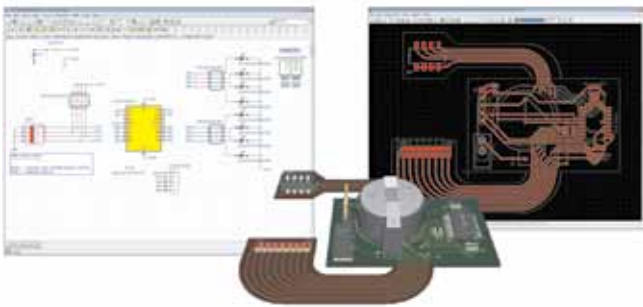
Ordering information

Please call us for pricing and versions.

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

Suitable for unit 19 of BTEC Higher National: Electrical and electronic principles

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
- Superposition and maximum power transfer
- Transistor amplifiers – A, B, AB
- Logic gates NOT, AND, NAND, OR, NOR, XOR
- Simple logic gate circuits
- Combinational logic circuits
- Sequential logic circuits

Instruments			
To deliver this course you will also need:			
LK1110	Multimeter pack	HP8279	Picoscope
Components included			
1	Advanced electrical principles pack	1	Transistor amplifiers add-on pack
1	Combinational logic add-on pack		
Ordering information		DIN	ANSI
Advanced electrical, electronic and digital principles		LK9044	LK9044A
Corresponding curriculum		LK8473, LK8749, LK2094, LK4403	

matrix

Suitable for unit 21 of the BTEC National: Electronic measurement and testing of circuits

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 23 of the BTEC National: Digital and analogue electronics system

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: one set is sufficient for 10 students working in rotation.

Learning objectives

- 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

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

For an explanation of icons please see page 6

Instruments			
To deliver this course you will also need:			
LK1110	Multimeter pack	HP8279	Picoscope
HP7894	Signal generator		

Components included			
5	Power supplies	1	AC power supply circuit
1	Combinational logic circuit	1	Multivibrator circuit
1	Counter circuit	1	Class C amplifier
1	Motor control circuit	1	Set faulty components

Ordering information	
Fault finding in electronic circuits	LK3566
Corresponding curriculum	LK9333

Ordering information	
Fault finding in electronic circuits	LK3566
PICmicro / Arduino dev centre	HP4988/HP9769
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 PICmicro /Arduino	FC9227

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

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. A desk mounted solar panel is also available – this will need to be placed facing a window in daylight to produce the required output.

Learning objectives / experiments

- Diodes, BJT, MOSFET, IGBT, SCR, thyristors and triac components
- Speed control of DC motors
- Using inductive components for energy transfer
- Half and full wave rectifiers
- Fixed voltage regulators
- Buck and boost converters
- Single phase inverters using MOSFET and thyristor
- Modern power electronics topologies
- Sources of renewable energy

Locktronics power supply / 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 plastic 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. A USB connection allows control of the output from a PC using Flowcode and also allows supervisors to fix the outputs to a preset level using proprietary software.

Features

- 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
- USB programmable
- Supplied with technician voltage limiting software
- Shrouded safety connectors
- Waveform generator

Ordering information

Power and energy electronics	LK3568
Solar panel	HP2898
Corresponding curriculum	CP3666

Specification

Output	Voltage	Current	Features
Variable AC	+/- 10V 50R DC coupled	200mA	Instrumentation output 0Hz – 100kHz Sine/Square/Triangle Arbitrary waveform generator
	10V p-p AC coupled	1.3A pk	Audio output: 20Hz – 20kHz Sine/Square/Triangle Arbitrary waveform generator
	2V p-p AC coupled line output	N/A	
Variable DC	3 - 10V	3A	Gain control Current limiter/monitor
+12V DC	12V	5A	Current limiter/monitor
+5V DC	5V	5A	Current limiter/monitor
-12V DC	-12V	300m A max	

Ordering information

Locktronics power supply/signal generator	LK6999

NEW

*BTEC National award in Engineering :
Unit 19—Electronic devices and circuits.
Unit 20—Analogue electronics.*

*Suitable for BTEC National Unit 6:
Microcontroller systems for engineers*

Prototyping electronic circuits

The pack allows students to investigate electronics by building a range of circuits based on a prototype board. The kit is based on our Protostation which includes a large prototyping area (0.1" pitch), switches, potentiometers, LEDs and sensors that are easily connected to the prototype area using single core wires or connector links. The Protostation provides -12V, +3.3V, +5V and +12V power sources. An on-board variable frequency signal generator provides sine or square waves between 10Hz and 10KHz. A full course in prototyping sequential logic circuits is provided. A wide range of additional material on analogue circuits and system is available in books.

Learning objectives / experiments
- Flexible pack for circuit development based on prototype boards
- 60 page course in sequential logic construction
- Includes Protostation:
  - Power supply: +5V, +12V, -12V, variable
  - Variable frequency signal generator: sin, triangle, square
  - LEDs, potentiometers, and switches on board
- Ideal starting point for practical courses in electronics

Programming PIC microcontrollers with flow charts

This pack guides students through the process of developing microcontroller based electronic products using flowcharts with our Flowcode software. The pack includes a downstream 'Combo' board with switches, LEDs, LCD and sensors, and a PIC programmer board with Ghost technology - which provides in-circuit-debug, oscilloscope, logic analyser and packet decoder functions. Circuit connections are provided using one of our new full colour printed platforms. Students are guided through the learning process using a free online course – 'Introduction to microcontroller programming' which provides up to 50 hours of student centered learning. Tasks and Excel marking scheme included.

Learning objectives / experiments
- Microcontroller programming and circuits, clocks, pins, inputs, outputs, ports, memory and memory types, current limits
- Programming using flowcharts: 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, buzzers, keypad, LCD, 7-segment displays, quad 7-segment displays, power supply, EEPROM
- Techniques: switch debounce, Schmitt trigger, prototyping with E-blocks strip board, PCBs and proto boards, using batteries

Instrumentation included
Ghost and Flowcode provide:
- In-Circuit-Debug
- In-Circuit-Test
- Multi channel oscilloscope
- Multi channel logic analyser
- Multi channel packet decoder
- Data console display

GHOST™
See pg 100
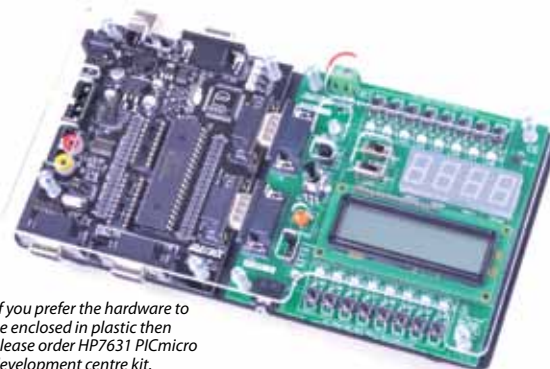
If you prefer the hardware to be enclosed in plastic then please order HP7631 PICmicro development centre kit.
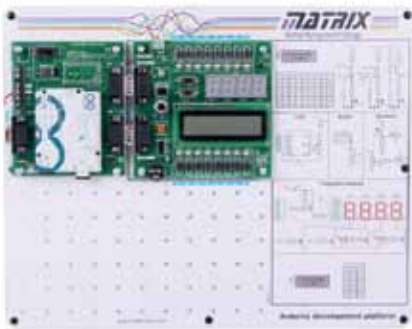
For an explanation of icons please see page 6

Ordering information	
Protostation	HP512
Power supply: +/- 12VDC	HP8405

Ordering information	
PIC development centre with printed base plate	HP4988
PICmicro development centre	HP7631

Suitable for BTEC National Unit 6: Microcontroller systems for engineers

Suitable for BTEC National Unit 6: Microcontroller systems for engineers

Suitable for unit 46 of BTEC Higher National: Embedded systems

Programming Arduino microcontrollers with flow charts

This pack guides students through the process of developing microcontroller based electronic products using flowcharts with our Flowcode software. The pack includes a downstream 'Combo' board with switches, LEDs, LCD and sensors, and an Arduino/E-blocks interface shield. Circuit connections are provided using one of our new full colour printed platforms. Students are guided through the learning process using a free online course – 'Introduction to microcontroller programming' which provides up to 50 hours of student centered learning. Tasks and Excel marking scheme included.

Learning objectives / experiments

- Microcontroller programming and circuits, clocks, pins, inputs, outputs, ports, memory and memory types, current limits
- Programming using flowcharts: 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, buzzers, keypad, LCD, 7-segment displays, quad 7-segment displays, power supply, EEPROM
- Techniques: switch debounce, Schmitt trigger, prototyping with E-blocks strip board, PCBs and proto boards, using batteries

Also an ideal platform for learning C/C++ with Arduino

Programming microcontrollers with C

By working through this pack students will acquire the skills needed to program microcontrollers in C code and develop simple electronic products based on them. The CD ROM based learning resources (around 40 hours) take students through the fundamentals of C programming in a series of on-screen tutorials. Once students have understood the basics they carry out a series of labs using the Integrated Development Environment and C compiler provided, to help build on their understanding. Tests and exercises to reinforce learning are provided. The pack includes a PIC programmer board, and a downstream 'Combo' board with switches, LEDs, LCD and sensors. C compiler/IDE and program send utility are provided.

Learning objectives / experiments

- What is a C program?: Comments, The main function header, The main function body, The end of the line
- Variables: Types, Characters, Declaration, Initialization, Names, Assigning statements, Expressions, Operators and Operands, Operators and divide, Working on bits, Casting
- Conditional Statements: Logical operators, Equality, Else, Unary operators in conditions
- Statements and Blocks: Blocks in Blocks, Global and local variables, Local variable scope
- Looping the loop: While, Counting, For loop, Breaking out of loops, Continuing loops
- Functions: When to use a function, return values, parameters
- Arrays: The need for arrays, Declaring, elements in an array, Sorting
- Switches: The switch condition, Switches and breaks
- Pointers: Declaring, Using a pointer, Comparing a pointer, Null pointers, Functions, Strings
- Structures: Creating, How structures work, Pointers in structures, Structures in structures
- The pre-processor: include directive, magic numbers and define, Conditional compilation
- Software engineering in C : Deciding on specification, test, creating functions, Using functions, Making a project, External data
- Labs: Lab 1: flashing lights, Lab 2: Switches and torches, Lab 3: Follow the leader, Lab 4: LEDs and Clocks, Lab 5: LCDs and libraries, Lab 6: Mystic LCD, Lab 7: The Electronic lock, Lab 8: reaction timer, Lab 9: Inspect your morse, Lab 10 – Analogue fun

For an explanation of icons please see page 6

Components included			
1	Arduino E-blocks interface shield	1	E-blocks Combo board
1	Power supply	1	USB cable

Ordering information	
Arduino development centre with printed base plate	HP9769
Flowcode for Arduino	FC9227

For an explanation of icons please see page 6

Ordering information	
PIC development centre with printed base plate	HP4988
PICmicro development centre	HP7631
C for 16 series PICmicro microcontrollers	EL543SI5

Electrical/Electronic engineering

Suitable for unit 46 of BTEC Higher National: Embedded systems

Suitable for WJEC A-level electronics

Unit 6 of the BTEC National award in Engineering: Microcontroller systems.

Programming microcontrollers with Assembly

This pack includes the hardware, software and courseware needed to teach students to program microcontrollers in Assembly code and to develop simple electronic systems. The pack includes a PIC programmer board, and a downstream 'Combo' board with switches, LEDs, LCD and sensors. The pack makes use of Microchip's MPLAB programming suite which includes a full IDE and Assembler and links into our own wend utility. The courseware shipped on CD ROM includes around 40 hours of course material which is based on a sequence of labs that take students from first principles of programming through to programs of medium complexity. This course is perfect for delivering A Level electronics courses.

Learning objectives / experiments
- Introduction: An introduction to the PICmicro series of microcontrollers, to the Assembly for PICmicro microcontrollers package and to the structure of the CD ROM
- Getting started: Information to get you up and running quickly and to let you check out your development kit
- Section 1: tutorials 1 - 14 Machine code assembler, downloading files to the PICmicro MCU, binary, basic commands, Input and output ports, switch monitoring, flags, loops and control structures
- Section 2: tutorials 15 - 29 Audio tone generation, subroutines, tables, indirect addressing, timers, driving 7-segment LED displays, simple clocks
- Section 3: tutorials 30 - 39 LCD displays, 24-hour clock program, burglar alarm (with circuit), EEPROM data memory use, watchdog timer, interrupts, sleep mode
- Section 4: tutorials 40 – 45 Library and include files, different PICs, ADC, internal EEPROM, serial comms

Introduction to microcontroller programming

This free course is designed to give students a thorough understanding of programming microcontrollers using Flowcode. It can be used with either PIC or Arduino microcontrollers. The course includes a wealth of written material, examples, and a suite of labs for self test and assessment. The structure for the course is based on Pearson's BTEC national unit 6 and is a complete student-centred solution for delivering this unit. The PDF based course is available as a free download from our web site.

Learning objectives /experiments
- Microcontroller hardware
- Input devices including switches, potentiometers, sensors
- Output devices including LED, 7-segment displays, LCD displays, relays, speakers, motors with PWM
- System development techniques including modules and breadboards
- Coding constructs and programming techniques
- I2C chip to chip communications

For an explanation of icons please see page 6

Ordering information	
PIC development centre with printed base plate (for ASM course)	HP5625
PICmicro development centre (for ASM course)	HP4609
Assembly for PICmicro microcontrollers	EL629SI6
Slow clock	HP3937
PIC16F88 chip	HP16F88

Ordering information	
Introduction to microcontroller programming	CP4375

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**Ghost is only available with Flowcode**
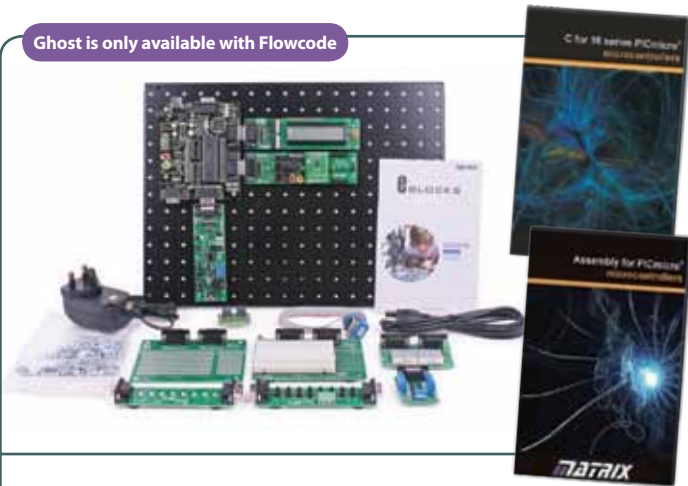
Standard starter packs

If you are looking for greater flexibility for learning and project work then the E-blocks starter packs are ideal general purpose kits which enable studying and projects in a variety of programming languages. Packs are available for PIC, AVR, Arduino, ARM and dsPIC / PIC24 cores. Many other processors can also be used from vendors with Arduino compatible products. The packs include the relevant E-blocks boards, a metal backplane, quick snap mounting pillars, leads, power supplies and rugged storage cases. Additional E-blocks and sensor boards can be added to these packs as required.

Learning objectives /experiments

Typical 50 hour self-guided learning courses in device programming in Flowcode, C, Assembly are all available from Matrix. These packs are also compatible with a wide variety of books and third party software languages.
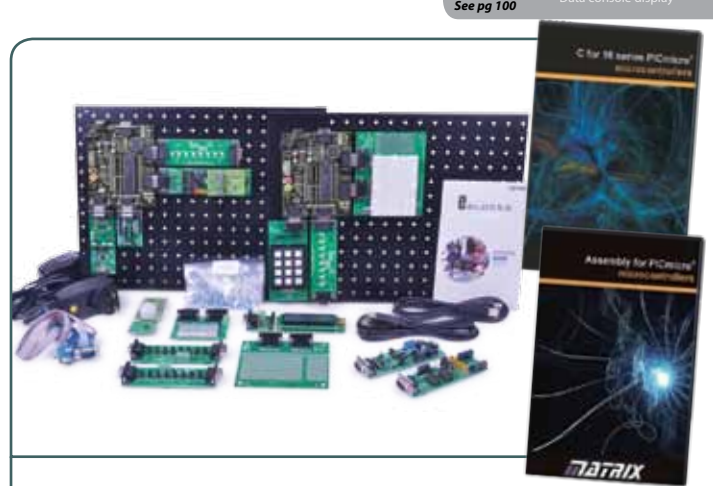
Deluxe starter packs

These packs are great for the more sophisticated learner and developer who needs to learn more than just the basics of microcontroller programming - particularly where communications between one microcontroller and another are an important issue - and for this reason they include two device programmer boards/shields. Packs are available for PIC, AVR, Arduino, ARM and dsPIC /PIC24 cores. Many other processors can also be used from vendors with Arduino compatible products. The packs include the relevant E-blocks boards, a metal backplane, quick snap mounting pillars, leads, power supplies and rugged storage cases. Additional E-blocks and sensor boards can be added to these packs as required.

Learning objectives /experiments

Typical 50 hour self-guided learning courses in device programming in Flowcode, C, Assembly are all available from Matrix. These packs are also compatible with a wide variety of books and third party software languages.

The Arduino version of these products is compatible with a large range of additional processors from many vendors including Intel (Edisson), STM (STM32 Nucleo), microchip (Chip kit 32), Freescale (ARM coretex M0) and many others.

Arduino uno   *Cypress*

For an explanation of icons please see page 6

Nucleo   *Freescale ARM*

For an explanation of icons please see page 6

Components included

1	Device programmer board/ shield	1	Patch board
1	LED board	1	Digital temperature sensor
1	Switch board	1	Thermistor sensor
1	Terminal board	1	Set of leads and accessories
1	Quad 7-segment display	1	Power supply
1	SPI and D/A board	1	Backplane
1	Sensor mother board	1	Storage trays and packaging
1	Prototype board	1	

Ordering information

Standard PICmicro starter pack	EB2161
Standard AVR starter pack	EB3441
Standard ARM starter pack	EB1401
Standard dsPIC/PIC24 starter pack	EB6002
Standard Arduino starter pack	EB9488

Note that Arduino based versions include an E-blocks Arduino shield, the Arduino board itself must be sourced separately.

Components included

2	Device programmer board/ shield	1	1 USB232 board
2	LED boards	1	Digital temperature sensor
2	Switch boards	1	Thermistor sensor
1	Terminal board	1	Gyroscope sensor
1	Quad 7-segment display	1	PIR sensor
1	SPI and D/A board	1	Magnetometer sensor
1	Sensor mother board	1	Set of leads and accessories
1	Prototype board	2	Power supplies
1	Patch board	2	Backplanes
1	Power board	1	Storage trays and packaging

Ordering information

Deluxe PICmicro starter pack	EB4838
Deluxe AVR starter pack	EB9532
Deluxe ARM starter pack	EB7859
Deluxe dsPIC/PIC24 starter pack	EB0177
Deluxe Arduino starter pack	EB7021

matrix

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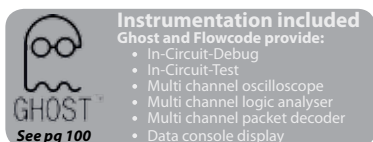
Suitable for courses in microcontrollers and digital communications at undergraduate level.

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

Instrumentation included
Ghost and Flowcode provide:
- In-Circuit-Debug
- In-Circuit-Test
- Multi channel oscilloscope
- Multi channel logic analyser
- Multi channel packet decoder
- Data console display

See pg 100

For an explanation of icons please see page 6

Components included

2	LED boards	1	Kvaser analyser
2	Switch boards	1	Curriculum
4	CAN communications boards	2	Backplanes
1	Prototype board	2	Power supplies
1	Sensor interface	1	Set of leads
1	16 x 2 LCD board	1	Temperature sensor
1	PIC Multiprogrammer boards	1	Storage trays and packaging
1	CAN faults board		

Ordering information

CAN bus training course	EB237
Requires Flowcode, which must be ordered separately	FC9227

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

For an explanation of icons please see page 6

Components included

1	LED board	2	Sets headphones
2	Switch boards	2	Backplanes
2	Bluetooth boards	2	Power supplies
1	Prototype board	1	Set of leads
2	Voice CODEC boards	1	Keypad board
1	16 x 2 LCD board	1	Curriculum
2	PIC Multiprogrammer boards	1	Storage trays and packaging

Ordering information

Bluetooth training course	EB860
Requires Flowcode, which must be ordered separately	FC9227

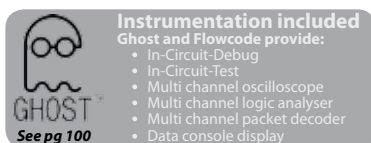*Suitable for courses in microcontrollers and digital communications at undergraduate level.*

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

For an explanation of icons please see page 6

Components included			
1	LED board	1	RS232 board
1	Switch board	2	Backplanes
1	D/A and memory board	1	Power supply
1	Prototype board	1	Miniature speaker
1	Sensor interface	1	Set of leads
1	16 x 2 LCD board	1	Curriculum
1	PIC Multiprogrammer board/ shield	1	Patch board
1	Keypad board	1	Storage trays and packaging

Ordering information	
Mobile phone technology training course	EB118
Requires Flowcode, which must be ordered separately	FC9227

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

Embedded internet training course

This 40 hour "Internet of Things" 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

Instrumentation included
Ghost and Flowcode provide:
- In-Circuit-Debug
- In-Circuit-Test
- Multi channel oscilloscope
- Multi channel logic analyser
- Multi channel packet decoder
- Data console display

GHOST
See pg 100

For an explanation of icons please see page 6

Components included			
1	LED board	1	Temperature sensor
2	Switch boards	1	Backplane
2	Internet boards	1	Power supply
1	Sensor interface board	1	Set of leads
1	Keypad board	1	Keypad board
1	16 x 2 LCD board	1	Curriculum
1	PIC Multiprogrammer boards	1	Storage trays and packaging

Ordering information	
Embedded internet training course	EB643
Requires Flowcode, which must be ordered separately	FC9227

matrix

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

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

RFID training course

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

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

For both Icode and Mifare modes:
- Transponder unique ID
- Reading transponder data
- Writing transponder data
- Value format

Instrumentation included
Ghost and Flowcode provide:
- In-Circuit-Debug
- In-Circuit-Test
- Multi channel oscilloscope
- Multi channel logic analyser
- Multi channel packet decoder
- Data console display

GHOST
See pg 100

For an explanation of icons please see page 6

Components included			
1	LED board	1	I-code RFID cards
1	Switch board	1	Backplane
1	RFID board	1	Power supply
1	Sensor interface	1	Set of leads
1	16 x 2 LCD board	1	Curriculum
1	PIC Multiprogrammer board	2	Mifare RFID cards
1	Keypad board	1	Storage trays and packaging

Ordering information	
RFID training course	EB699
Requires Flowcode, which must be ordered separately	FC9227

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

For an explanation of icons please see page 6

Components included			
1	LED board	2	Sensor boards
1	Switch board	2	Backplanes
3	Zigbee router boards	2	Power supplies
1	Keypad board	1	Set of leads
1	Colour LCD board	1	Zigbee coordinator board
1	16 x 2 LCD board	1	Curriculum
4	PIC Multiprogrammer boards	1	Storage trays and packaging
1	USB232 board	1	Zigbee message analyser

Ordering information	
Zigbee training course	EB284
Requires Flowcode, which must be ordered separately	FC9227

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

Suitable for courses in electronics at undergraduate level.

Suitable for unit 20 of BTEC Higher National: Digital principles

USB training course

This training solution provides a complete 20 hour course allowing students to carry out a number of practical exercises in USB technology. Students learn about USB through eight different systems: mouse, joystick, temperature logger, USB terminal, USB to RS232 converter, basic slave, storage scope and oscilloscope with variable trigger. By working through these exercises, students build an understanding of the various types of USB system including Human Interface Devices, communications devices and slave devices. A 50 page teacher's manual contains a range of exercises and is available to download from our website.

Learning objectives /experiments
- USB protocol and packet structure
- Devices, descriptors and configuration
- USB HID, Serial and slave protocols
- Development of microcontroller based systems using USB technology

Exercises include the development of:
- HID Mouse
- HID Keyboard
- HID Datalogger
- HID USB terminal
- HID RS232
- Storage and triggered scope

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

Instrumentation included
Ghost and Flowcode provide:
- In-Circuit-Debug
- In-Circuit-Test
- Multi channel oscilloscope
- Multi channel logic analyser
- Multi channel packet decoder
- Data console display

See pg 100

For an explanation of icons please see page 6

Components included			
1	LED board	1	Backplanes
1	USB interface board	1	Power supply
1	RS232 board	1	Set of leads
1	Sensor interface	1	Curriculum
1	16 x 2 LCD board	1	Mifare RFID cards
1	PIC Multiprogrammer board	1	Storage trays and packaging

Ordering information	
USB training course	EB479
Requires Flowcode, which must be ordered separately	FC9227

For an explanation of icons please see page 6

Components included			
1	LED board	1	Backplane
1	Switch board	1	Power supply
1	Dual 7-segment display	1	Set of leads
1	FPGA board	1	Curriculum
1	Keypad board	1	Storage trays and packaging

Ordering information	
FPGA training course	EB940

matrix

Suitable for Music technology and electronics courses at undergraduate level.
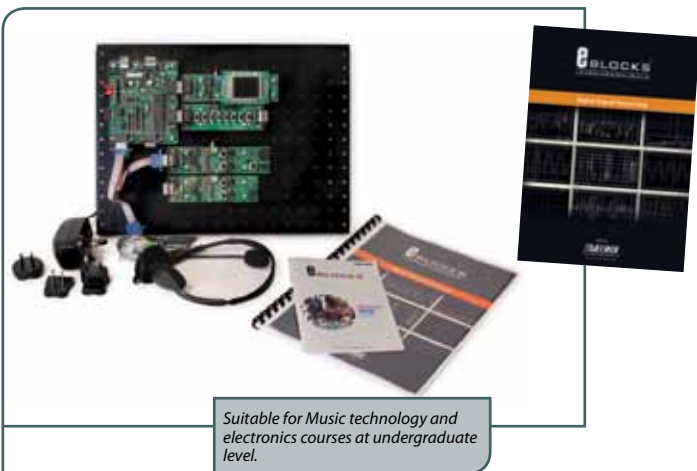
Audio DSP training course

This training solution provides a complete 25 hour course on the development of audio Digital Signal Processing systems based on the popular Microchip dsPIC series of processors. This highly motivating course uses systems charts made up of the DSP functional blocks contained in Flowcode and focusses on practical aspects of DSP, concealing the high-level mathematics involved. A 60 page teacher's manual contains a range of exercises and is available to download from our website.

Learning objectives /experiments

- Flowcode DSP software and set up
- Sampling rates, ticks, Nyquist and DSP basics
- Audio A/D and D/A processes
- Simple audio in/out systems
- Mixing audio signals in audio systems
- Tone generation and guitar tuning
- Digital filters
- Echo and reverb techniques

Instrumentation included
Ghost and Flowcode provide:
- In-Circuit-Debug
- In-Circuit-Test
- Multi channel oscilloscope
- Multi channel logic analyser
- Multi channel packet decoder
- Data console display

GHOST
See pg 100

For an explanation of icons please see page 6

Components included				
1	LED board	1	Prototype board
1	DSP input board	1	Sensor board
1	DSP output board	1	7-segment display board
1	dsPIC Multiprogrammer	1	Backplane
1	16 x 2 LCD board	1	Power supply
1	Switch board	1	Storage trays and packaging
1	EB084 colour graphical LCD	1	Curriculum
1	Terminal board	1	Set of leads
1	Patch board		

Ordering information	
Audio DSP training course	EB650
Requires Flowcode, which must be ordered separately	FC9227

SILENT

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

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 1 of BTEC National award: Engineering principles

Suitable for unit 27 of BTEC National award: Mechanical principles in practice

Suitable for unit 3 of BTEC Higher National: Engineering science

Suitable for unit 8 of BTEC Higher National: Mechanical principles

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)

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

Ordering information	
Forces Kit	HP5005
Essential base unit	HP5000

Ordering information	
Moments Kit	HP5010
Essential base unit	HP5000

Suitable for unit 8 of BTEC Higher National: Mechanical principles

Suitable for unit 3 of BTEC Higher National: Engineering science

Suitable for unit 1 of BTEC National award: Engineering principles

Suitable for Unit 2 of BTEC Higher National: Engineering Science

Suitable for unit 27 of BTEC National award: Mechanical principles in practice

Suitable for unit 8 of BTEC Higher National: Mechanical principles

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

Torsion of Circular Sections Kit

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

Learning objectives /experiments
- Specimen length and angle of twist
- Specimen material and angle of twist (Modulus of Rigidity)
- Specimen 'J' value and angle of twist

Ordering information	
Deflection of Beam and Cantilevers Kit	HP5015
Essential base unit	HP5000

Ordering information	
Torsion of Circular Sections Kit	HP5020
Essential base unit	HP5000

Suitable for unit 1 of BTEC National award: Engineering principles
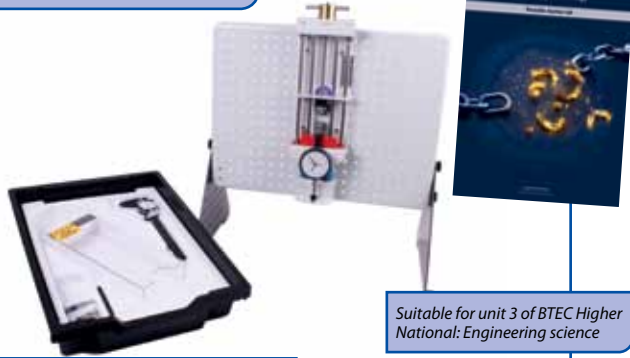
Suitable for unit 3 of BTEC Higher National: Engineering science

Suitable for unit 9 of BTEC Higher National: Materials, properties and testing

Suitable for unit 27 of BTEC National award: Mechanical principles in practice

Suitable for unit 8 of BTEC Higher National: Mechanical principles

Tensile Tester Kit

This kit includes specimens of different materials, which fit onto a 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

Simple Harmonic Motion Kit

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

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

Ordering information	
Tensile Tester Kit	HP5025
Essential base unit	HP5000

Ordering information	
Simple Harmonic Motion Kit	HP5030
Essential base unit	HP5000

Suitable for unit 1 of BTEC National award: Engineering principles

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

Friction and Inclined Plane Kit

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

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

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	
Friction and Inclined Plane Kit	HP5035
Essential base unit	HP5000

Ordering information	
Potential and Kinetic Energy Kit	HP5040
Essential base unit	HP5000

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

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	
Drive Systems Kit	HP5045
Essential base unit	HP5000

Ordering information	
Cam crank and Toggle Kit	HP5050
Essential base unit	HP5000

Suitable for unit 8 of BTEC Higher National: Mechanical principles

Gear Trains Kit

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

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

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	
Gear trains Kit	HP5055
Essential base unit	HP5000

Ordering information	
Simple Mechanisms Kit	HP5060
Essential base unit	HP5000

NEW

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

NEW

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

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	
Spring tester kit	HP1282
Essential base unit	HP5000

Ordering information	
Centrifugal force kit	HP0232
Essential base unit	HP5000

NEW

NEW
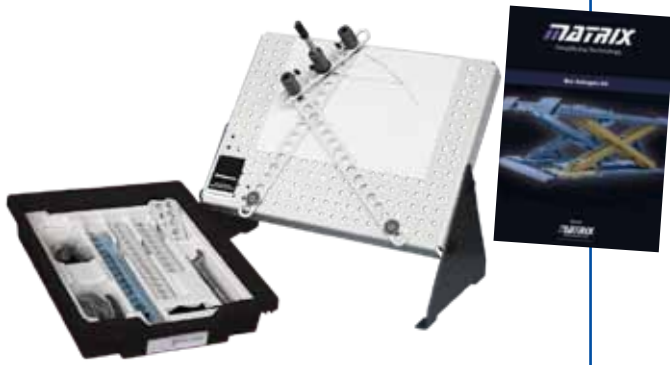
Bar linkages kit

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

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	
Bar linkages kit	HP7622
Essential base unit	HP500

Ordering information	
Additional mechanisms kit	HP6207
Essential base unit	HP5000

NEW

NEW

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

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	
Rotational friction kit	HP8604
Essential base unit	HP5000

Ordering information	
Pulley kit	HP9771
Essential base unit	HP5000

NEW

Suitable for unit 1 of the BTEC National in Engineering: Engineering principles

Suitable for unit 28 of the BTEC National in Engineering: Dynamic mechanical principles and practice

Suitable for unit 3 of BTEC Higher National: Engineering science

Suitable for unit 8 of BTEC Higher National: Mechanical principles

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

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

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

Ordering information	
Complete mechanics	HP8797

Ordering information	
Linear and rotational dynamics	HP5099

matrix

Suitable for BTEC National unit 6: Microcontrollers

Unit 6 of the BTEC national award in Engineering: Microcontroller systems

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 PICmicro or Arduino microcontrollers supplied with additional servo board, motor control board and screw terminal interface board.

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

Arm made up from Tetrix.

For an explanation of icons please see page 6

Ordering information	QTY	
Tetrix prime starter set	1	HP2810
Either: Arduino development centre with printed base plate	1	HP9769
Or: PIC development centre with printed base plate	1	HP4988
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

Mechanical / Automotive engineering simulation pack

This Flowcode add-on pack has been developed for mechanical engineering students who want to study programming of microcontroller or PLC based systems in a motivating context. The pack includes a simulation of a fully working car seat controlled by 3 motors with linear actuators. Students study this system in four separate stages: rotational to linear conversion, encoders and end stops, 3D control with 3 motors, position and memory control. The pack includes a site licence for all simulations and a set of worksheets.

Learning objectives /experiments

- Motor speed control
- Linear control of mechanical systems using motors
- Electromechanical system design and control

Ordering information	
Mechanical engineering simulation pack	FC4037

NEW
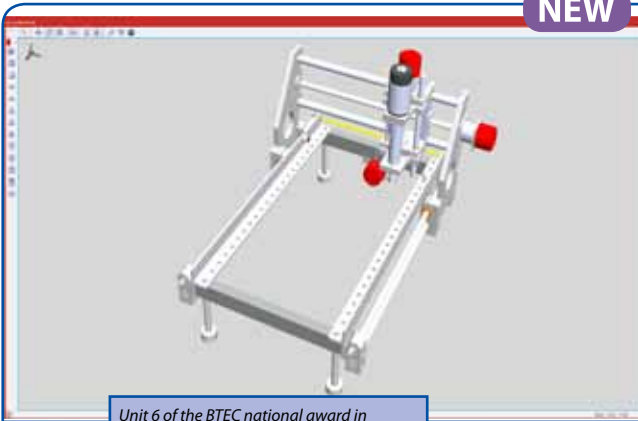
Unit 6 of the BTEC national award in Engineering: Microcontroller systems

Manufacturing engineering simulation pack

This Flowcode add-on pack has been developed for manufacturing engineering students who want to understand how microcontroller based systems are used to control CNC machines. The simulation makes use of a virtual 3 axis CNC machine which can be programmed and moved on the screen. Students are tasked with creating a simple linear G code protocol that can be used to control the machine's movement. They then create programs to 'execute' a sequence of G code instructions and move the machine accordingly.

Learning objectives / experiments
- Stepper motor control of machines
- G code command construction
- Simple G and M code protocol
- CNC machine operation using G codes.
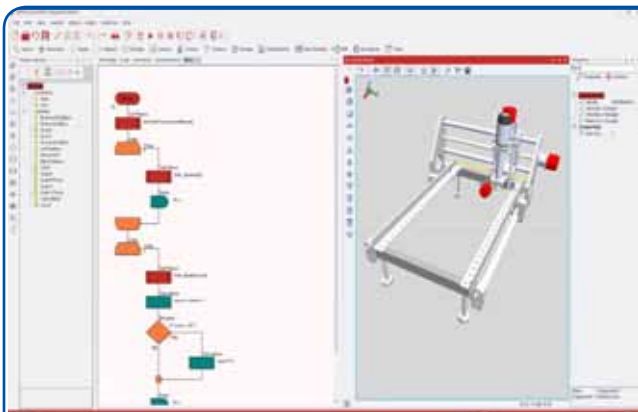
Ordering information	
Manufacturing engineering simulation pack	FC4009

MATRIX

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.
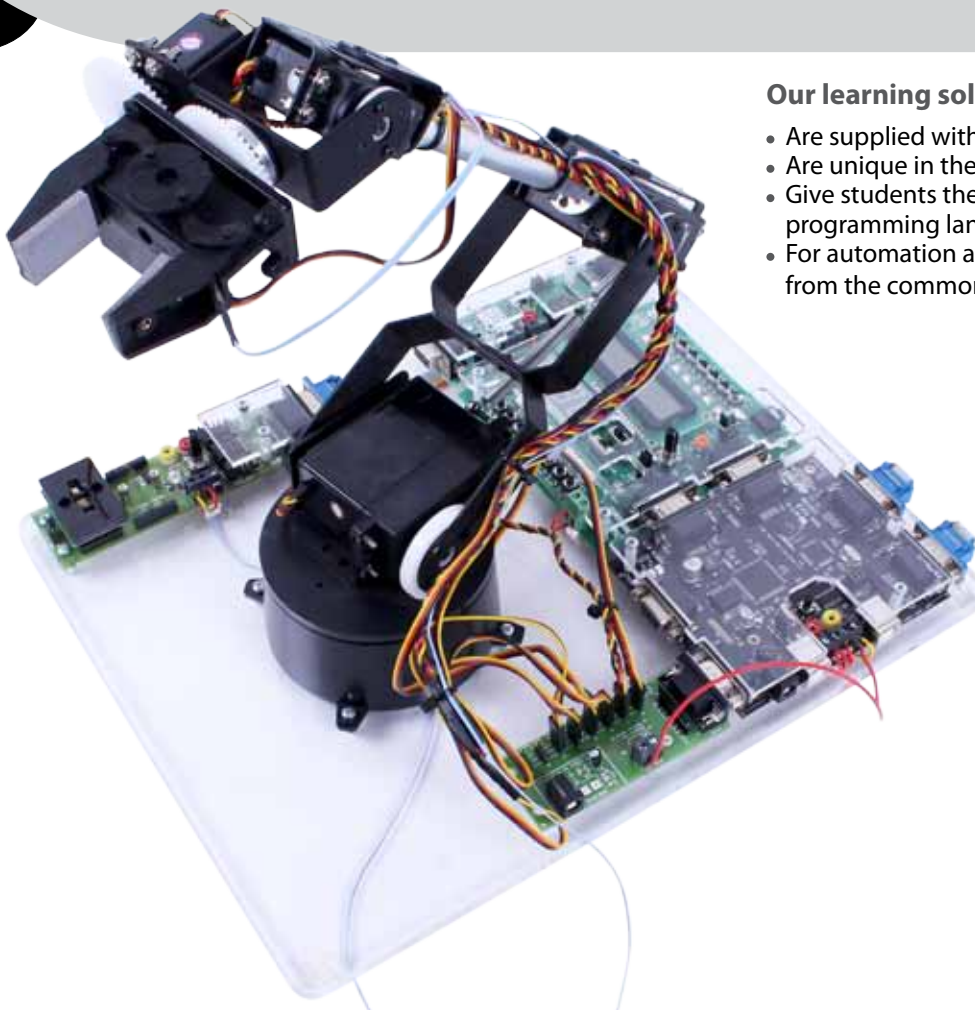
Our learning solutions

- 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

The Formula AllCode robot buggies came highly recommended by a colleague who had used Matrix solutions in the past. I was impressed with the products on offer and value for money seemed great in comparison to other products available on the market. We use the buggies with different programming languages from Scratch to Python and also App Inventor. Initially we will be using the buggies as part of a computer science extracurricular activity. We will then move on to use the buggies as part of the Computer Science curriculum at our school for KS4 students. The service received from Matrix has been excellent. Every time I have contacted Matrix, the response time has been quick and professional.

Shamim Ahmed, Salendine Nook Academy, West Yorkshire

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

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

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

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
- 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

Components included			
1	Cylinder, single acting	2	Cylinder, double acting
1	Valve, 3/2, button-spring	1	Valve, 3/2, lever-spring
4	Valve, 3/2, roller-spring	1	Valve, 3/2, diaphragm
1	Valve, 5/2, lever-spring	3	Valve, 5/2, pilot-pilot
1	Valve, shuttle	2	Valve, flow control
1	Reservoir	1	Automatics platform
1	Manifold	1	Tubing, red, 5 m
1	Tubing, yellow, 30 m	1	Tubing, blue, 30 m
4	Connector, tee junction	1	Tee bolts (pack of 50)
1	Tube cutting tool	1	Set of storage trays

Ordering information	
Automatics essentials solution	AU9020

You may also need...	
Compressor	AU1050

Components included			
2	Reed switch and holder	2	Switch, push to make
2	Microswitch	1	Valve, 3/2, solenoid-spring
1	Valve, 5/2, solenoid -spring	2	Valve, double solenoid
6	Lead, 4mm plugs, black	6	Lead, 4mm plugs, red
1	Power supply		

Ordering information	
Electro-pneumatics add-on kit	AU9015

You may also need...	
Automatics essentials solution	AU9020

Matrix

Suitable for unit 12 of the BTEC national: Pneumatic and hydraulic systems

Suitable for unit 29 of BTEC Higher National: Electro, pneumatic and hydraulic systems

Unit 36 of the BTEC National: Programmable logic controllers.

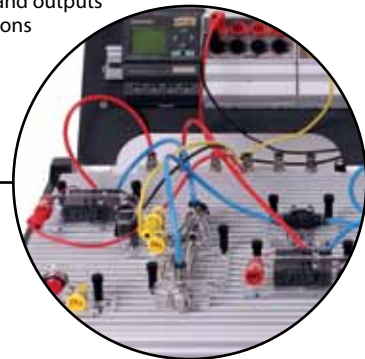*Suitable for unit 29 of BTEC Higher National: Electro, pneumatic and hydraulic systems*

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.

Learning objectives

- 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

Control Plus

This curriculum introduces students to writing their own programs for the control system.

This is done using our Flowcode software - which makes programming easy by using graphical flowcharts. Note that you may need to purchase Flowcode separately.

Also available with Rpi MIAC and Arduino MIAC

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).

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

Learning objectives

- 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

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

Components included			
1	MIAC controller	2	Switch, push to make
1	Reed switch and holder	2	Valve, flow control
1	Light sensor	4	Valve, 3/2, solenoid-spring
1	Power supply	1	Power distribution carrier
6	Lead, 4mm plugs, red	6	Lead, 4mm plugs, black
2	Lead, 4mm plugs, yellow		

Ordering informations	
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	FC9227

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

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

Suitable for unit 15 of BTEC Higher National: Automation, robotics and PLCs

Suitable for unit 12 of the BTEC National: Pneumatic and Hydraulic systems
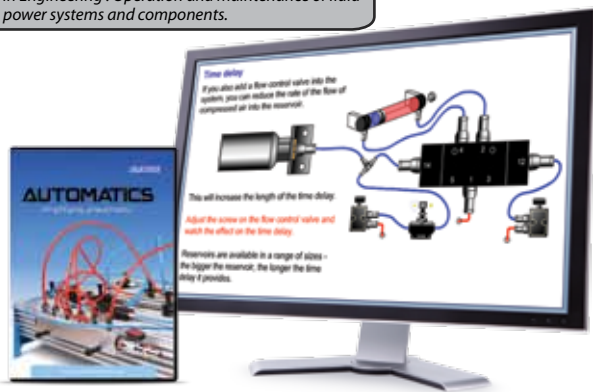
Automatics interactive courseware

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 from Windows 95 upwards, and has very modest PC requirements. It is available with an educational site licence.

Learning objectives
- 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
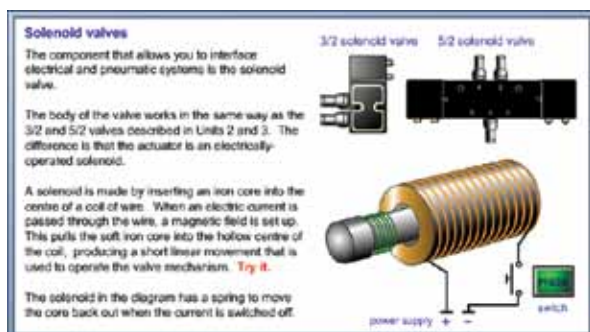
Virtual lab on solenoid valves

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	
Automatics interactive courseware site licence	AW20780

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

Suitable for unit 15 of BTEC Higher National: Automation, robotics and PLCs

NEW

Suitable for BTEC Higher National unit 42: further PLCs

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 12 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.

Note: industrial PLC's not supplied by Matrix TSL.

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

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

Suitable for unit 6 of BTEC Higher National: Mechatronics

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
- 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

For an explanation of icons please see page 6

Components included			
1	Locktronics Industrial sense and control kit	1	Standard PICmicro starter pack
1	Sensors add-on pack	1	Motor control training solution
1	Automatics essentials kit	1	Compressor
1	Automatics Control add-on kit	1	Introduction to microcontrollers (online)

Ordering information	
Mechatronic systems	HP4550
Corresponding curriculum	LK8739, AW2080, AW4956, WS0247

Suitable for unit 6 of the BTEC National: Microcontroller systems for engineers
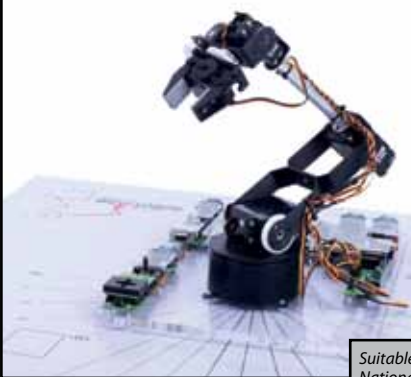
Suitable for unit 15 of BTEC Higher National: Automation, robotics and PLCs

Suitable for unit 38 of the BTEC National: Web site production to control devices

Robot arm production cell

Our new robot arm production cell consists of a rugged servo-controlled 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
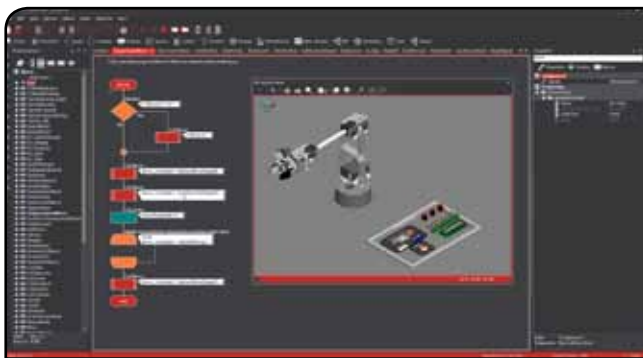
Using Flowcode to simulate and program the robot arm

For an explanation of icons please see page 6

Ordering information	
Robot arm cell	RB6231
Corresponding curriculum	CP8656

Suitable for unit 6 of the BTEC National: Microcontroller systems for engineers

Suitable for unit 15 of BTEC Higher National: Automation, robotics and PLCs

Introduction to Robotics

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

Learning objectives /experiments

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

See Formula AllCode section for full details

For an explanation of icons please see page 6

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

NEW

Suitable for technology or computer science syllabuses.

Formula AllCode football mat add-on

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

Note: This add-on requires the Formula AllCode maze walls which feature in the deluxe kit and class sets of Formula AllCode robots and are also available separately.

Learning objectives /experiments
- Programming mobile phones
- Football algorithm development

Playing robot football with Android phones.

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

Manufacturing engineering

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

COMING SOON
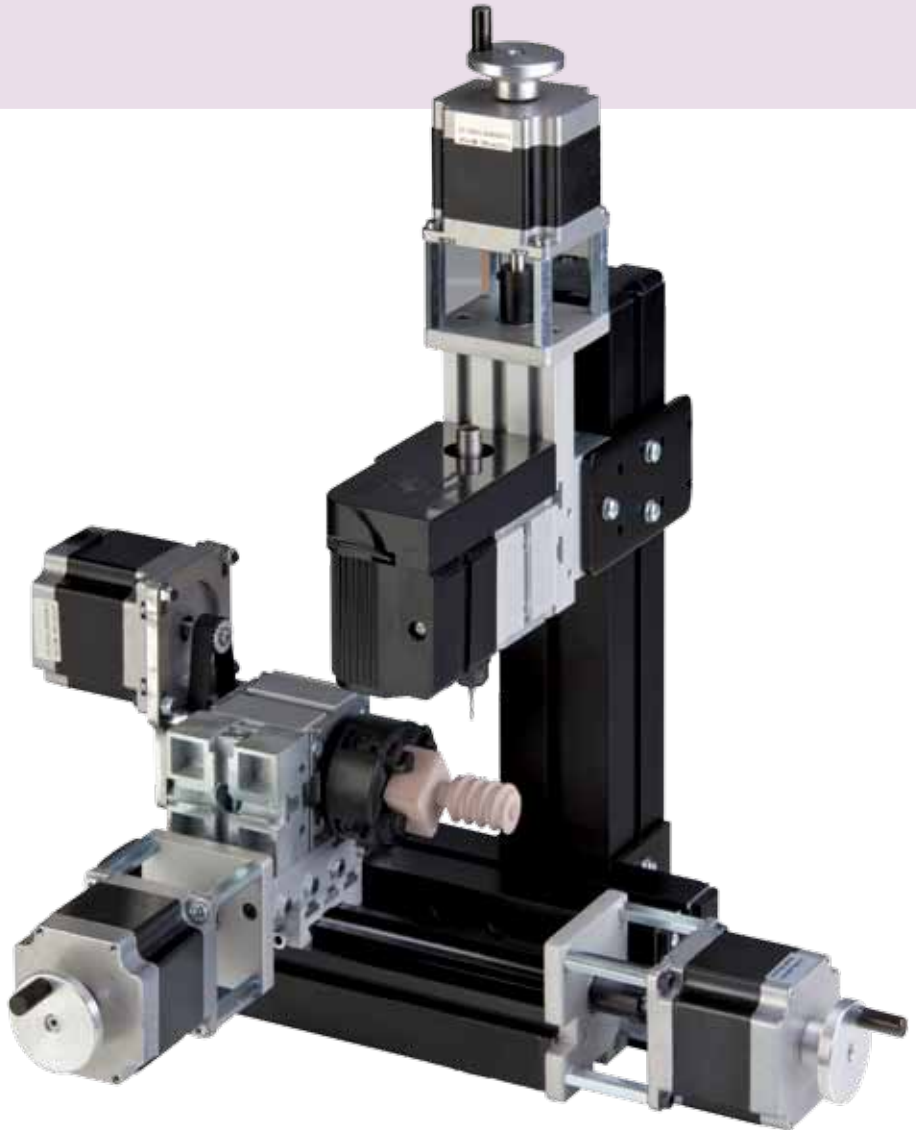
We have developed an impressive staged learning process for students in this section

1. First students can use our CAD CAM simulator to learn G code programming using a variety of CNC machines in simulation mode

2. Then students can use one of our real MicroCNC machines with a Windows based G code editor to manufacture real parts.

3. Then students can work in a 'high level' package like DesignSpark Mechanical or Solidworks to design real parts, convert them to G code programs and use the Micro CNC machines to manufacture them.

This low cost route to teaching design and manufacture using CNC technology gives students a great introduction to Manufacturing engineering.

 Matrix

COMING SOON

Unit 43 of the BTEC National award in Engineering : Manufacturing CNC machine processes

Suitable for unit 23 of BTEC Higher National: CAD/CAM

Unit 40 of the BTEC National award in Engineering : Computer Aided Manufacturing

COMING SOON
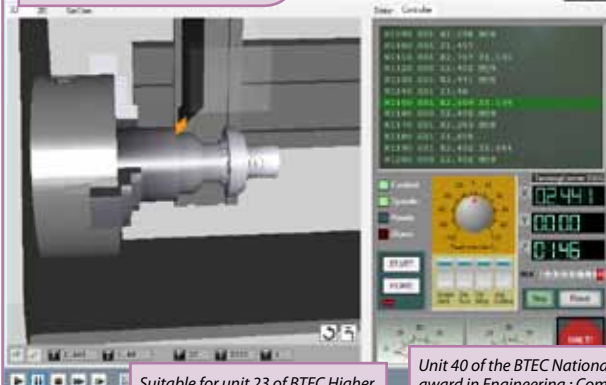
Suitable for unit 23 of BTEC Higher National: CAD/CAM

Unit 43 of the BTEC National award in Engineering : Manufacturing CNC machine processes

CNC CAD/CAM and simulation software

The CNC CAD/CAM and simulation software provides students with a complete learning platform for understanding how CNC machines are programmed and operate. The Software has three modules: firstly the package includes models of more than 20 CNC machines: lathes, milling machines, laser cutters, plasma cutters, 3D printers etc. Students can use the text and conversational editor to enter G codes and see programmes running for all machines using a variety of tools and materials. Secondly the CAM editor allows students to import models in DXF/STL format from third party packages like Solidworks and Designspark Mechanical to simulate students' own designs. Thirdly the CAD editor allows students to export G code programmes for students' designs for use in our range of micro CNC machines. Windows compatible.

Learning objectives / experiments

- Includes models of more than 20 CNC machines
- G and M code editor and simulator
- Simulate designs using different cutting algorithms
- Includes editor hints, tutorials and online help
- Produce simple G code programs from STL files

MicroCNC system controller and base plate

This Micro CNC system controller and base plate allows you to control 4 axis CNC 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 bolted to the plate using quick snap connectors to provide a solid and tidy machine which can easily be put away for storage. Windows compatible.
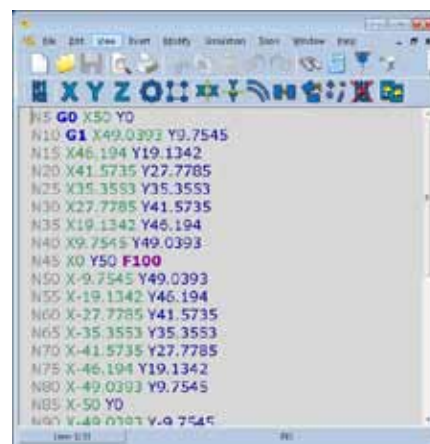
Software showing G code editor

Ordering information	
CNC CAD/CAM and simulation software - site licence	MB6809

Ordering information	
MicroCNC system controller and base plate	CN4079

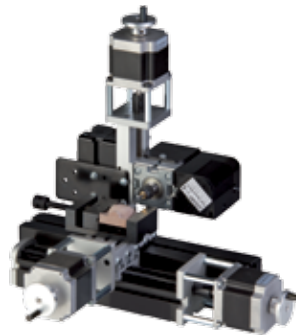## COMING SOON

Suitable for unit 23 of BTEC Higher National: CAD/CAM

Unit 43 of the BTEC National award in Engineering : Manufacturing CNC machine processes
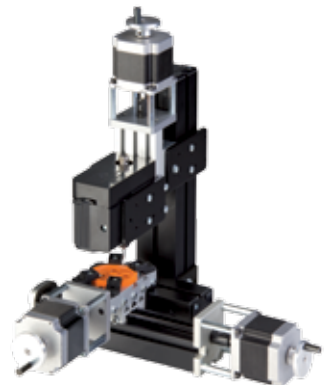
2 axis MicroCNC lathe

This 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 using wood, acrylic, wax or aluminium. This is supplied in kit form. Once assembled it can be stored in our standard plastic storage tray. Windows compatible. Supplied as a kit which needs modest assembly.

Learning objectives / experiments
- Lathe construction and operation
- Simple G and M code protocol
- CNC machine operation using G codes
- Creation of turned parts using CNC technology

COMING SOON

Suitable for unit 23 of BTEC Higher National: CAD/CAM

Unit 43 of the BTEC National award in Engineering : Manufacturing CNC machine processes

3 axis MicroCNC milling machine

This 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 they can create complex work pieces using wood, acrylic, wax or aluminium. Two models can be made with this kit: a vertical milling machine and a horizontal milling machine. This is supplied in kit form. Once assembled it can be stored in our standard plastic storage tray. Windows compatible.

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

Horizontal milling machine

Vertical milling machine

Ordering information	
MicroCNC lathe pack	CN2668
MicroCNC system controller and base plate	CN4079

Ordering information	
Micro CNC milling machine pack	CN4234
MicroCNC system controller and base plate	CN4079

matrix

Manufacturing engineering

Suitable for unit 23 of BTEC Higher National: CAD/CAM

Unit 40 of the BTEC National award in Engineering : Computer Aided Manufacturing

Suitable for unit 23 of BTEC Higher National: CAD/CAM

Unit 43 of the BTEC National award in Engineering : Manufacturing CNC machine processes

4 axis MicroCNC milling machine

This 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 they can create complex work pieces using wood, acrylic, wax or aluminium. Three models can be made with this kit: a vertical milling machine, a horizontal milling machine and a vertical milling machine with rotating chuck. Supplied as a kit which needs modest assembly.

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

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 aluminium, wood or plastic using the G code editor supplied.

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

Ordering information	
4 axis MicroCNC milling machine	CN8285
MicroCNC system controller and base plate	CN4079

Ordering information	
Complete MicroCNC set	CN3885
MicroCNC system controller and base plate	CN4079

COMING SOON
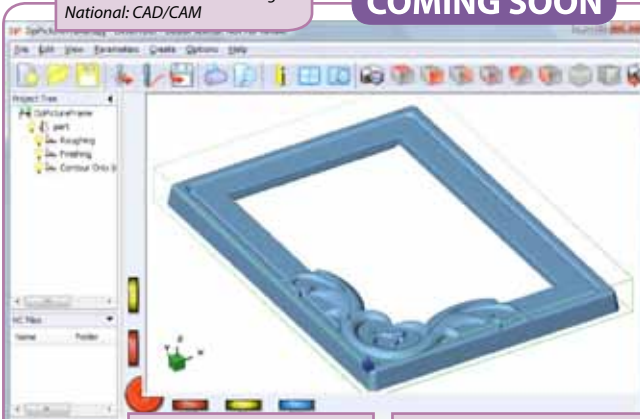
Deskproto CAM software

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 DesignSpark Mechanical, Solidworks and AutoCAD.
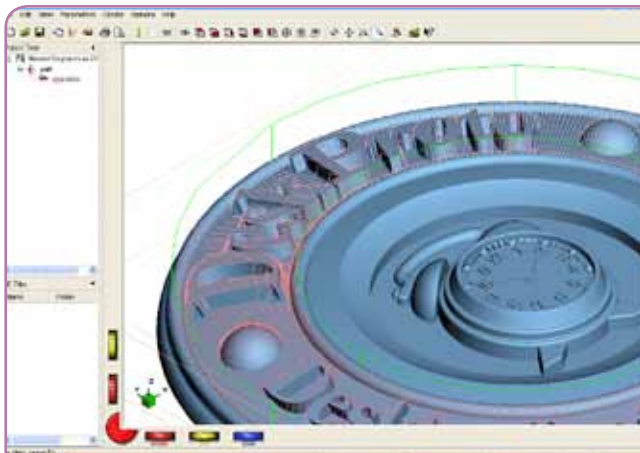
Ordering information	
Deskproto site licence	CN2498

MATRIX

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:

- Designed around the requirements of modules 3 and 4
- 8 sets of full colour PDF worksheets with thorough topic coverage and teacher's notes
- Meet RoHS compliancy
- Rugged and durable to stand up to the rigours of technical labs
- 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 both as demonstration equipment on short courses and apprentices conducting their own experiments, construction of circuits, testing and understanding of 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.

EASA Electrical fundamentals 1
- Series and parallel circuits
- Measuring voltage and current
- Cells and batteries
- Thermocouples
- Photocells
- Ohm's law

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

EASA Electrical fundamentals 3
- Capacitors and electrostatics
- Inductors and inductance
- DC motors
- Generator principles
- Transformers and their construction
- Transformer losses

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

Instruments			
To deliver this course you will also need:			
LK1110	Multimeter pack	HP8279	Picoscope
HP7894	Signal generator		

Components included			
1	Resistor, 10 ohm, 1W 5% (DIN)	1	Resistor, variable, 10k (DIN)
1	Resistor, 5.6k, 1/4W, 5% (DIN)	1	Faraday's law kit
1	Resistor, 12 ohm, 1W, 5% (DIN)	1	Lenz's law kit
1	Switch, on/off, metal strip	1	Resistor, 2.2k, 1/4W, 5% (DIN)
1	Diode, germanium	3	Resistor, 10k, 1/4W, 5% (DIN)
1	1:1 transformer with retractable ferrite core	1	Capacitor, 1 uF, Polyester
2	Lead, yellow, 500mm, 4mm to 4mm stackable	1	Resistor, 15k, 1/4W, 5% (DIN)
1	Transformer, 2:1 turns ratio	3	MES bulb, 6V, 0.04A
1	Resistor, 270 ohm, 1/2W, 5% (DIN)	1	Potentiometer, 250 ohm (DIN)
1	Fleming's motor rule apparatus	1	7 x 5 metric baseboard with 4mm pillars
1	Resistor, 22k, 1/4W, 5% (DIN)	3	MES bulb, 6.5V, 0.3A
1	Resistor, 47 ohm, 1/2W, 5% (DIN)	2	Lead, blue, 500mm, 4mm to 4mm stackable
1	Switch, push to make, metal strip	2	Power supply
1	Choke, 47mH	14	Connecting Link
3	Choke, 10mH	1	AC voltage source carrier
1	Choke, 5mH	2	Power supply carrier with battery symbol
3	Capacitor, 10 uF, Electrolytic, 25V	1	Ammeter, 0mA to 100mA
2	Capacitor, 4.7uF, electrolytic, 25V	1	Motor, 6V, open frame
2	Capacitor, 2.2 uF, Polyester	1	Fuse/universal component carrier
1	Resistor, 1k, 1/4W, 5% (DIN)	3	AA battery holder carrier
1	Alnico Rod Magnet	1	Solar cell
1	AC power supply, 12VAC, 1.5A, UK	1	Thermocouple and carrier
1	Locktronics User Guide	3	Lampholder, MES
1	Resistor, 100 ohm, 1W, 5% (DIN)		

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

Note: These packs are delivered with an international DC power supply and a UK style (3 square pin) 220V AC power supply. If you are ordering outside the UK please let us know which kind of mains plug you require on the AC supply.

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.

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

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

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

EASA Electronic fundamentals 4
- Open and closed loop systems
- Analogue transducers
- Damping in feedback systems

Instruments			
To deliver this course you will also need:			
LK1110	Multimeter pack	HP8279	Picoscope
HP7894	Signal generator		

Components included			
1	Resistor, 100 ohm, 1W, 5% (DIN)	1	Transistor LHF, NPN
1	Potentiometer, 250 ohm (DIN)	1	Transistor RHF, NPN
1	Capacitor, 1,000 uF, Electrolytic 30V	1	Thyristor
2	Capacitor, 47uF, Electrolytic, 25V	3	Diode, power, 1A, 50V
4	Capacitor. 4.7uF, electrolytic, 25V	2	Switch, push to make, metal strip
3	Capacitor, 0.47 uF, Polyester	1	Transformer, 2:1 turns ratio
2	Resistor, 100k, 1/4W, 5% (DIN)	1	Zener diode, 8.2V
3	Resistor, 10k, 1/4W, 5% (DIN)	1	Transistor RHF, PNP
3	Resistor, 1k, 1/4W, 5% (DIN)	2	Power supply carrier with battery symbol
2	Resistor, 180 ohm, 1/2W, 5% (DIN)	1	Dual rail power supply carrier
1	Resistor, 500k, 1/4W, 5% (DIN)	12	Connecting Link
2	7 x 5 metric baseboard with 4mm pillars	1	Diode, germanium
2	Power supply	1	AA battery holder carrier
2	Lead, blue, 500mm, 4mm to 4mm stackable	2	LED, red, 5V (SB)
2	Lead, yellow, 500mm, 4mm to 4mm stackable	1	Switch, on/off, metal strip
2	Lead, black, 500mm, 4mm to 4mm stackable	2	Ammeter, 0mA to 100mA
2	Lead, red. 500mm, 4mm to 4mm stackable	1	Voltmeter, 0V to 15V
1	Resistor, 270 ohm, 1/2W, 5% (DIN)	1	OR gate carrier (ANSI)
1	AC power supply, 12VAC, 1.5A, UK	1	Zener diode, 4.7V
1	Resistor, 200k, 1/4W, 5% (DIN)	2	NOT gate carrier (ANSI)
1	Capacitor, 1nF, Polyester	1	Transistor LHF, PNP
1	Capacitor, variable, 15-140pF	1	Op Amp Carrier (TL081) with 2mm to 4mm Lead
1	Thermistor, 4.7k, NTC (DIN)	1	1:1 transformer with retractable ferrite core
2	Potentiometer, 10k (DIN)	1	Switch, changeover, toggle
1	Capacitor, 100uF, Electrolytic, 25V	1	Low power solar motor
1	Resistor, 2.2k, 1/4W, 5% (DIN)	1	AC voltage source carrier
1	Capacitor, 1 uF, Polyester	1	Bridge rectifier
1	Locktronics User Guide	1	Motor 3 to 12V DC, 0.7A
1	AND gate carrier (ANSI)		

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	

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

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 see our website.

NEW

NEW

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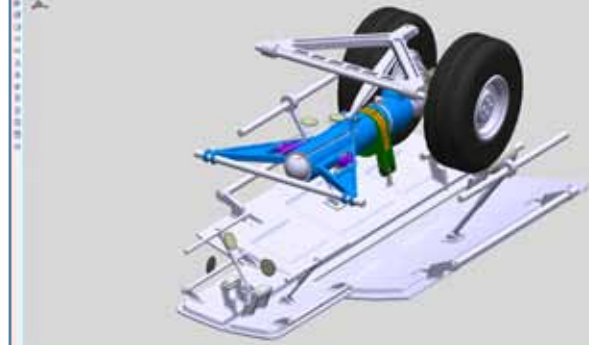
Two models are available: standard model and a model with high pressure compressor.

Learning objectives
- Jet engine operation
- Combustion
- Fuel injection
- Compression

Aviation engineering simulation pack

This Flowcode add-on pack has been developed for Aerospace engineering students who want to study programming of microcontroller or PLC based systems in a motivating context. The pack includes a 3D model of pneumatically powered landing gear controlled by three pneumatic pistons and position sensors. Students study this system in three separate stages: piston control, safety, system control. The pack includes a site licence for all simulations and a set of worksheets.

Learning objectives / experiments
- Full 3D simulation of A320 landing gear
- Staged design introduces students to topics one at a time
- Motivating context for studying microcontroller use in Aerospace

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

Ordering information	
Aviation engineering simulation pack	FC2316

matrix

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.

Locktronics automotive customers

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

Level 1

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

Level 2

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

Level 3

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

Suitable for IMI and City and Guilds level 1 courses.

Electricity, magnetism and materials V2

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

Suitable for IMI and City and Guilds level 2 courses.

AC principles for automotive technicians

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

Learning objectives / experiments

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

Instruments

To deliver this course you will also need:

LK1110	Multimeter pack		

Components included

1	Switch, push to make, metal strip	1	400 Turn coil carrier
1	Power supply	1	Thermistor, 4.7k, NTC (DIN)
1	Resistor, 12 ohm, 1W, 5% (DIN)	1	LED, red, 12V (SB)
1	Motor, 6V, open frame	1	Voltmeter, 0V to 15V
1	Phototransistor	1	Relay, reed, normally open
2	Resistor, 1k, 1/4W, 5% (DIN)	1	Pair of leads, red and black, 600mm, 4mm to croc clip
1	Resistor, 10k, 1/4W, 5% (DIN)	1	Power supply carrier with battery symbol
1	Potentiometer, 10k (DIN)	1	Fuse/universal component carrier
1	Diode, power, 1A, 50V	1	Buzzer, 12V, 15mA
9	Connecting Link	1	Switch, on/off, metal strip
3	Lampholder, MES	1	Resistor, 100 ohm, 1W, 5% (DIN)
1	7 x 5 metric baseboard with 4mm pillars	1	EMM V2 Accessories pack
1	Ammeter, 0A to 1A	1	Resistor, 50K, 1/4W, 5%

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

Instruments

To deliver this course you will also need:

LK1110	Multimeter pack	HP8279	Picoscope
HP7894	Signal generator		

Components included

12	Connecting Link	1	7 x 5 metric baseboard with 4mm pillars
1	Resistor, 1k, 1/4W, 5% (DIN)	2	Switch, on/off, metal strip
1	Potentiometer, 10k (DIN)	1	AC voltage source carrier
1	Potentiometer, 250 ohm (DIN)	1	Power supply carrier with battery symbol
1	Capacitor, 100uF, Electrolytic, 25V	1	Power supply
1	Capacitor, 2,200 uF, Electrolytic, 25V	2	Lead, red. 500mm, 4mm to 4mm stackable
1	Capacitor, 1 uF, Polyester	2	Lead, black, 500mm, 4mm to 4mm stackable
1	Choke, 47mH	1	Locktronics User Guide
3	MES bulb, 6V, 0.04A	1	BNC male to dual 4mm binding post
3	Lampholder, MES	1	Bridge rectifier
1	Diode, power, 1A, 50V		

Ordering information		DIN	ANSI
AC principles for automotive technicians solution including storage trays, baseboard and power supply.		LK8222	LK8222A
Corresponding curriculum		LK8392	

matrix

Suitable for IMI and City and Guilds level 2 courses.

An introduction to motors, generators and hybrid

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

Learning objectives / experiments

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

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

Instruments

To deliver this course you will also need:

LK1110	Multimeter pack	HP8279	Picoscope
HP7894	Signal generator		

Components included

1	Resistor, 1k, 1/4W, 5% (DIN)	1	Capacitor, 2,200 uF, Electrolytic, 25V
1	Power supply	1	Faraday's law kit
1	Zener diode, 4.7V	1	BNC male to dual 4mm binding post
1	Switch, push to make, metal strip	1	Pair of leads, red and black, 600mm, 4mm to croc clip
1	Bridge rectifier	1	Lead, black, 500mm, 4mm to 4mm stackable
1	Diode, power, 1A, 50V	1	Lead, red. 500mm, 4mm to 4mm stackable
1	7 x 5 metric baseboard with 4mm pillars	1	AC voltage source carrier
1	Potentiometer, 250 ohm (DIN)	1	Power supply carrier with battery symbol
1	Resistor, 270 ohm, 1/2W, 5% (DIN)	1	Lenz's law kit
1	Transformer, 2:1 turns ratio	1	Alnico Rod Magnet
1	Motor 3 to 12V DC, 0.7A	1	2:1 transformer with retractable ferrite core
1	Ammeter, 0A to 1A	1	Locktronics User Guide
1	Ammeter, 0mA to 100mA	1	400 Turn coil carrier
5	Connecting Link	1	Fleming's motor rule apparatus
1	Capacitor, 22,000uF, Electrolytic 16V	1	Hand cranked generator
1	Voltmeter, 0V to 15V		

Ordering information		DIN	ANSI
An introduction to motors, generators and hybrid		LK7444	LK7444A
Corresponding curriculum		LK8822	

Instruments

To deliver this course you will also need:

LK1110	Multimeter pack		

Components included

1	Power supply	2	LED, red, 5V (SB)
1	Locktronics User Guide	1	AND Gate with 2mm to 4mm lead - ANSI
1	USB reprogrammable PIC carrier with power lead	1	OR Gate with 2mm to 4mm lead - ANSI
1	Resistor, 50k, 1/4W, 5% (DIN)	1	NOT Gate with 2mm to 4mm lead - ANSI
2	Resistor, 10k, 1/4W, 5% (DIN)	1	NAND Gate with 2mm to 4mm lead - ANSI
16	Connecting Link	1	NOR Gate with 2mm to 4mm lead - ANSI
1	Lead, yellow, 500mm, 4mm to 4mm stackable	1	Power supply carrier with battery symbol
1	Lead, blue, 500mm, 4mm to 4mm stackable	1	7 x 5 metric baseboard with 4mm pillars
2	Switch, on/off, metal strip	1	Phototransistor Carrier

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

Suitable for IMI and City and Guilds level 2 courses.

Combined level 2 Automotive pack

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

Learning objectives / experiments

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

Components included
The LK4500CUS includes the components necessary for delivery of learning objectives from the LK8222, LK7444 and LK4221 kits.

Instruments			
To deliver this course you will also need:			
LK1110	Multimeter pack	HP8279	Picoscope
HP7894	Signal generator		

Ordering information	
Combined level 2 automotive pack	LK4500CUS
Corresponding curriculum	LK8822, LK9392, LK8392

Suitable for IMI and City and Guilds level 3 courses.

Sensors and control in automotive applications

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

Learning objectives / experiments

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

Components included			
1	Microswitch	1	Motor 3 to 12V DC, 0.7A
1	Thermistor, 4.7k, NTC (DIN)	1	USB2 high speed A to mini B lead
1	Resistor, 10 ohm, 1W 5% (DIN)	1	Locktronics User Guide
2	Resistor, 1k, 1/4W, 5% (DIN)	1	Hall effect switch
1	Capacitor, 4,700 uF, Electrolytic, 16V	1	Buzzer, 12V, 15mA
1	Potentiometer, 10k (DIN)	1	Phototransitor
1	Relay, 12V coil, 10A, normally open	1	7 x 5 metric baseboard with 4mm pillars
1	Solenoid	6	Lead, yellow, 500mm, 4mm to 4mm stackable
1	Stepper Motor	6	Lead, blue, 500mm, 4mm to 4mm stackable
1	LED, red, 12V (SB)	1	Lead, black, 500mm, 4mm to 4mm stackable
1	Transistor RHF, NPN	1	Lead, red. 500mm, 4mm to 4mm stackable
1	Automotive fuse carrier	1	Cased MIAC with Shrouded 4mm Connectors
2	Switch, on/off, metal strip	1	Small bar magnet
4	Switch, push to make, metal strip	16	Connecting Link
1	Power supply	1	MES bulb, 14V, 0.06A
1	Power supply carrier with battery symbol	1	MIAC Getting Started Guide
1	Resistor, 10k, 1/4W, 5% (DIN)	1	MES bulb, 12V, LED, white
1	Lampholder, MES	1	Resistor, 47K, 1/4W, 5%
1	Lampholder, MES, for automotive LEDs		

Ordering information	DIN	ANSI
Sensors and control solution with baseboard, storage trays, power supply and leads.	LK9834	LK9834A
Corresponding curriculum	LK8849	

Matrix

Sensors and control with Engineering panel

The LK6491 sensors and control solution includes an Engineering panel that allows you to set up a more permanent lab for automotive electrical training.

| Ordering information	DIN	ANSI
Sensors and control solution on Engineering panel	LK6491	LK6491A

CAN bus make-up kit

The LK9813 CAN bus make-up kit allows you to transform 5 sensors and control in automotive solutions into a CAN bus systems and operations solution.

Ordering information	DIN	ANSI
CAN bus make-up kit	LK9813	LK9813A

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.

Components included			
1	MIAC Getting Started Guide	1	Locktronics User Guide
5	Cased MIAC with Shrouded 4mm Connectors	53	Connecting Link
1	OBD2 to 4mm Lead	1	Lead, D-type to yellow and blue 4mm for CAN analyser
9	Lead, black, 500mm, 4mm to 4mm stackable	1	USB2 high speed A to mini B lead
19	Lead, red. 500mm, 4mm to 4mm stackable	1	USB CAN sniffer
4	Lead, red, 2000mm, 4mm to 4mm plug	6	Switch, on/off, metal strip
24	Lead, yellow, 500mm, 4mm to 4mm stackable	4	MES bulb, 12V, LED, red
24	Lead, blue, 500mm, 4mm to 4mm stackable	5	MES bulb, 12V, LED, white
13	Lampholder, MES, for automotive LEDs	4	MES bulb, 12V, LED, yellow
3	Switch, push to make, metal strip	1	Motor 3 to 12V DC, 0.7A
6	Resistor, 1k, 1/4W, 5% (DIN)	4	Potentiometer, 10k (DIN)
1	Relay, 12V coil, 10A, normally open	4	Power supply
1	Buzzer, 12V, 15mA	1	Resistor, 560 ohm, 1/4W, 5% (DIN)
5	Automotive fuse carrier	1	Zener diode, 8.2V
5	7 x 5 metric baseboard with 4mm pillars	2	LED, red, 12V (SB)

Ordering information	DIN	ANSI
CAN bus systems and operation solution with storage trays, power supply, leads and Kvaser analyser.	LK7629	LK7629A
CAN bus systems and operations solution with storage trays, power supply, leads and PICOscope 4000.	LK8391	LK8391A
Corresponding curriculum	LK9893	
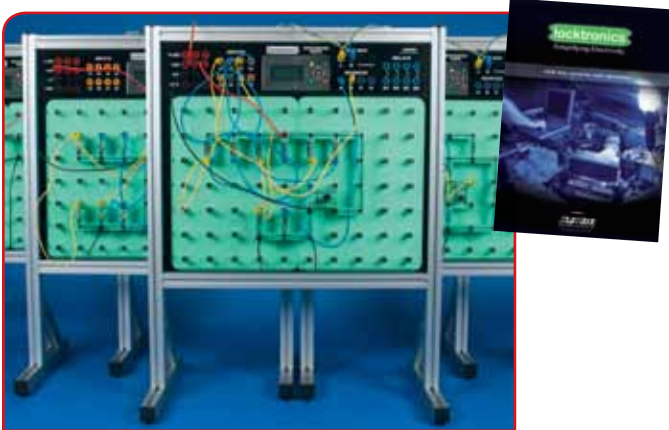
CAN bus systems and operation solution with engineering panel

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

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
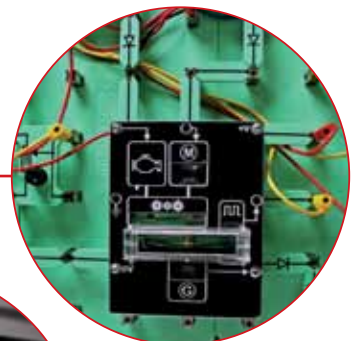
Components included			
1	Resistor, 1k, 1/4W, 5% (DIN)	7	Lead, red. 500mm, 4mm to 4mm stackable
1	Locktronics engineering panel	4	Lead, yellow, 500mm, 4mm to 4mm stackable
4	Diode, power, 1A, 50V	6	Lead, blue, 500mm, 4mm to 4mm stackable
1	Switch, push to make, metal strip	1	Hybrid Car Motor Unit
1	Power MOSFET transistor	1	Hybrid Car Battery Unit
18	Connecting Link	1	Hybrid Car Power Output Meter
1	Potentiometer, 10k (DIN)	2	Hybrid Car Input Power Meter
4	Lead, black, 500mm, 4mm to 4mm stackable		

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

Ordering information	DIN	ANSI
CAN bus systems and operation solution with the Engineering panel	LK2839	LK2839A

matrix

Suitable for unit 6 of the BTEC National: Microcontroller systems for engineers

NEW

Unit 6 of the BTEC national award in Engineering: Microcontroller systems

Microcontrollers for Automotive engineers

This solution provides a suite of equipment suitable for studying microcontroller system development in an automotive context. The solution consists of two development centres with either PICmicro or Arduino microcontroller boards. To these students can add one of our power boards, a relay board and a CAN bus board to form a basic Automotive network. Two fully functioning vehicle light clusters are included for experiments.

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 debounce, Schmitt trigger, prototyping with E-blocks strip board
- Automotive control using CAN bus

Mechanical / Automotive engineering simulation pack

This Flowcode add-on pack has been developed for mechanical engineering students who want to study programming of microcontroller or PLC based systems in a motivating context. The pack includes a simulation of a fully working car seat controlled by 3 motors with linear actuators. Students study this system in four separate stages: rotational to linear conversion, encoders and end stops, 3D control with 3 motors, position and memory control. The pack includes a site licence for all simulations and a set of worksheets.

Learning objectives /experiments

- Motor speed control
- Linear control of mechanical systems using motors
- Electromechanical system design and control

For an explanation of icons please see page 6

Ordering information	QTY	
Either: Arduino development centre with printed base plate	2	HP9769
Or: PIC development centre with printed base plate	2	HP4988
E-blocks CAN bus board	2	EB018
E-blocks relay board	2	EB038
Power supply	1	HP2666
Rear light cluster - Aspock Minipoint square 4-F. lamp, non plug-in	2	HP7478
USB lead	1	HPUSB

Ordering information	
Mechanical engineering simulation pack	FC4037

NEW

All automotive courses

NEW

All automotive 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. We can also offer a service to section your own engines.

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

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 included our most popular products—please contact us for a full list of products.

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

More models available—please call us for details

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

More models available—please call us for details

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

matrix

Electrical installation

This new 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:
- Designed around City and Guilds syllabuses
- Accompanied by detailed colour workbooks
- Hands on equipment and activities
- Supplied in rugged storage trays
- Also suitable for EAL

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

Bill Crawford, Department of Engineering, Forth Valley College, Scotland

Investigating voltage and current phase relationship in a circuit.
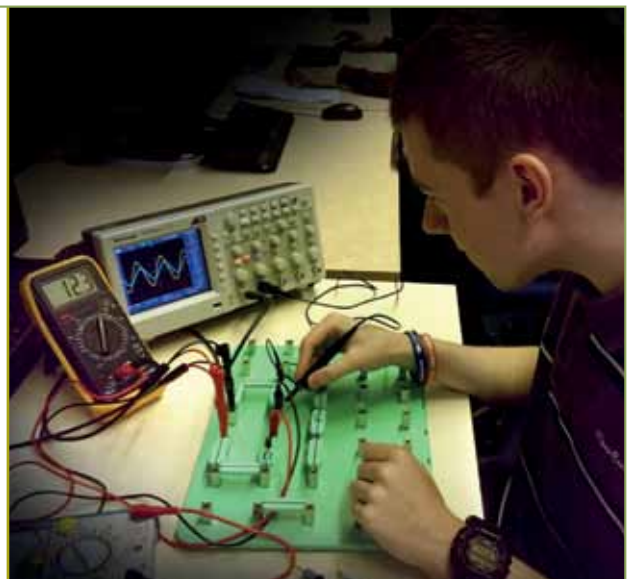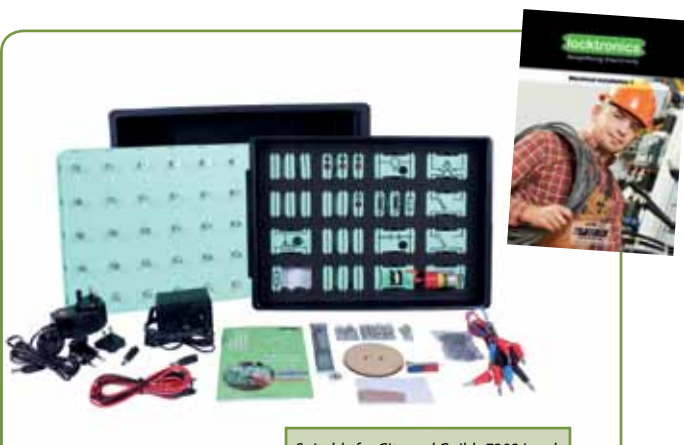
Suitable for City and Guilds 7202 Level 1 diploma in electrical installation

Suitable for unit 31 of BTEC Higher National: Electrical systems and fault finding

Suitable for BTEC National in Engineering unit 14: Electrical installation of hardware and cables

Suitable for much of 8202 Unit 202 of the City and Guilds level 2 Diploma in Electrical Installations

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

Electrical installation level 2

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

Learning objectives / experiments

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

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

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

Instruments	
LK1110	Multimeter

Components included			
1	7 x 5 metric baseboard with 4mm pillars	1	Fuse/universal component carrier
1	Resistor, 12 ohm, 1W, 5% (DIN)	1	Power supply carrier with battery symbol
1	Potentiometer, 250 ohm (DIN)	1	AC voltage source carrier
14	Connecting Link	1	EMM V2 Accessories pack
3	Lampholder, MES	1	Power supply
3	MES bulb, 12V, 0.1A	1	AC power supply, 12VAC, 1.5A, UK
1	400 Turn coil carrier	1	Hand cranked generator
2	Lead, red. 500mm, 4mm to 4mm stackable	1	Switch, changover, metal strip
2	Lead, black, 500mm, 4mm to 4mm stackable	1	Switch, reversing, toggle
1	Lead, blue, 500mm, 4mm to 4mm stackable	1	Pair of leads, red and black, 1000mm, 4mm to croc clip
1	Switch, push to make, metal strip	1	Lampholder, MES, for automotive LEDs
1	Switch, on/off, metal strip		

Ordering information	
Electrical installation level 1	LK5000
Corresponding curriculum	LK4098

Instruments	
LK1110	Multimeter

Components included			
1	7 x 5 metric baseboard with 4mm pillars	1	Power diode
1	2,200 capacitor	1	Pair of leads, red and black, 1000mm, 4mm to croc clip
1	Potentiometer, 250 ohm (DIN)	1	Resistor, 12 ohm, 1W, 5% (DIN)
14	Connecting Link	1	Resistor, 1k, 1/2W, 5% (DIN)
3	Lampholder, MES	1	Resistor, 10k, 1/4W, 5% (DIN)
3	MES bulb, 12V, 0.1A	1	Hand cranked generator
1	400 Turn coil carrier	2	Switch, changeover, metal strip
1	Lead, blue, 500mm, 4mm to 4mm stackable	1	Switch, reversing, toggle
1	Switch, push to make, metal strip	1	Nichrome Wire Carrier, 0.075 x 500mm
1	Switch, on/off, metal strip	1	Nichrome Wire Carrier, 0.075 x 250mm
1	Power supply carrier with battery symbol	1	Nichrome Wire Carrier, 0.21 x 500mm
1	Circuit breaker	1	Constantan Wire Carrier, 0.075 x 500mm
1	AC voltage source carrier	1	Transformer, 2:1 turns ratio
1	Power supply	1	Fuse/universal component carrier
1	AC power supply, 12VAC, 1.5A, UK	1	Lead, red. 500mm, 4mm to 4mm stackable
1	RCD block (new component)	1	Lead, black, 500mm, 4mm to 4mm stackable
1	Flemings law kit	1	MES bulb, 12V, LED, white
1	2: 1 transformer		

Ordering information	
Electrical installation level 2	LK4063
Corresponding curriculum	CP8475

Matrix

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

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

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

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

Suitable for City and Guilds 8202 level 3

Transformer construction and operation

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

Learning objectives / experiments

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

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

Instruments	
To deliver this you will also need:	
LK1110	Mutimeter x 2
HP3728	AC power supply (240V: 12V @5amps)
Ordering information	
Transformer construction and operation pack	LK1989

COMING SOON

Suitable for City and Guilds 8202 level 2

COMING SOON

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

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

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

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

Instruments	
To deliver this you will also need:	
LK1110	Multimeter

Components included				
1	7 x 5 metric baseboard with 4mm pillars	1	AC power supply, 12VAC, 1.5A, UK
1	AC voltage source carrier	1	4v& Zener diode
14	Connecting link	1	Power diode
3	Lampholder, MES	1	Potentiometer 10K ohm
1	Switch, push to make, metal strip	1	DC power supply
1	Switch, on/off, metal strip	1	Power supply carrier with battery symbol
1	Thermistor, 4k7, NTC	1	MES power LED
1	Triac	2	Transistor RHF, NPN
1	Phototransistor	1	Resistor, 4k7, 1/4W 5%

Ordering information	
8202 level 2 - Electronic components and circuits pack	LK2901

Instruments	
To deliver this you will also need:	
LK1110	Multimeter
HP7894	Signal generator

Components included				
1	7 x 5 metric baseboard with 4mm pillars	1	AC power supply, 12VAC, 1.5A, UK
1	AC voltage source carrier	1	RCD block
14	Connecting link	1	Relay
3	Lampholder, MES	1	Solenoid
1	Switch, push to make, metal strip	1	DC power supply
1	Switch, on/off, metal strip	1	Power supply carrier with battery symbol
1	Cirtuit breaker	1	MES power LED
1	Inductor, 47mH	2	MES bulb, 12V, 0.1A
1	Capacitor, 1uF	1	Resistor, 270ohm

Ordering information	
8202 level 3 Electrical installation circuit principles	LK4562

MATRIX

COMING SOON

Suitable for City and Guilds 8202 level 3

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

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

Instruments			
Further instruments may be required, please contact us			
Components included			
4	7 x 5 metric baseboard with 4mm pillars	1	Lead set
1	Power supply carrier with battery symbol	1	Switch, push to make, metal strip
28	Connecting link	16	MES power LED
16	Lampholder, MES		
Ordering information			
Principles of lighting pack			LK2285

COMING SOON

Suitable for City and Guilds 8202 level 3

8202 Level 3 Electrical machines

This pack allows students to investigate the main types of motors used in industrial installations: DC machines, AC machines, and three phase AC machines. This pack contains a combination of our Electrical machines starter system, AC machines add-on pack and our three phase add-on pack with associated meters and power supplies. Students can construct a wide variety of electrical machines and attach them to our dynamometer load machine to measure power and torque. Students can understand why different machines are used in different industrial circumstances.

Learning objectives / experiments
- DC machine construction
- Basic DC machines, DC machines with wound stators
- Simple DC machine speed control with voltage
- Compound DC machines, Universal motors
- DC machines as dynamos
- The link between HP, watts and joules in motor systems
- AC induction motors, synchronous speed and slip
- Start up and run circuits
- Three phase AC machine construction and operation
- Star and Delta circuits
- Operating three phase motors from a single phase
- Three phase speed control with variable frequency power supply.

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

Components included			
1	Machines base plate	1	24V DC power supply
1	Power Rheostat	1	Lead pack
1	Swinging arm dynamometer machine	4	V I meter pairs
1	DC machine	1	Energy meter
1	Balance	1	Tacho meter
1	AC machine	1	24V AC power supply
1	Three phase machine	1	Phase shift capacitor
Ordering information			
8202 level 3 electrical machines			EM5066

FLOWCODE 7
Smarter programming

Contents

professional users of the latest version

3,000

academic users of the Flowcode

20,000

38% of users programming Arduino

20 top UK Universities are using Flowcode

300+ French institutions using Flowcode

MATRIX

Testimonials

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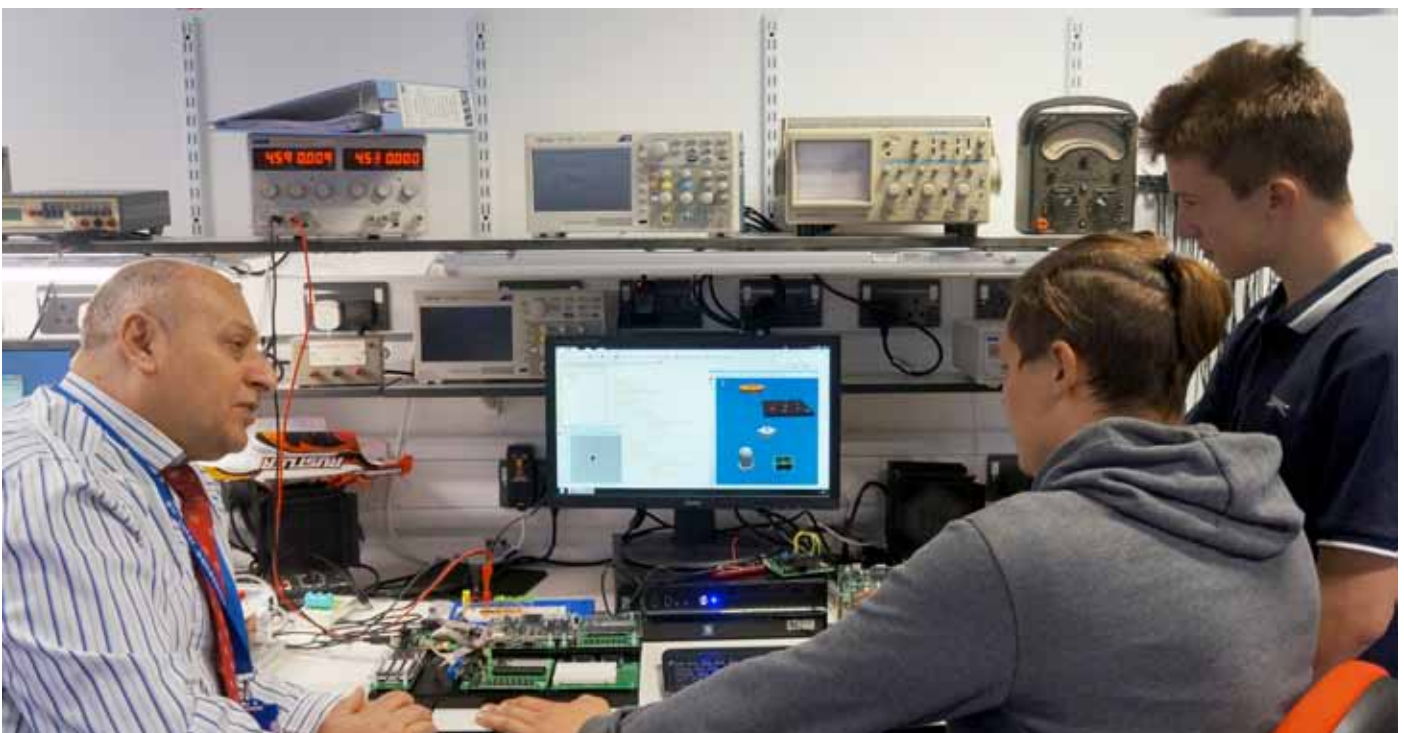
Flowcode software allows you to develop complex electronic and electromechanical systems with ease.

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 or on rugged industrial interfaces using Windows compatible personal computers.

A 2D and 3D graphical development interface allows students 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 Microchip's PIC MCU; 8bit, 16bit and 32 bit, as well as Atmel AVR, Arduino and ARM devices.

- **Based on flowcharts** - minimal programming experience required

- **Open architecture** - all aspects of Flowcode are fully customisable for your projects

- **Fully supported** - with online tutorials, documentation and active online community

- **Transfer your design** - easily between Windows, PICmicro, AVR, Arduino and ARM

MATRIX

Flowcode exposed

The new version 7 user interface allows students to design simulate and test a wide variety of microcontroller based systems with ease.
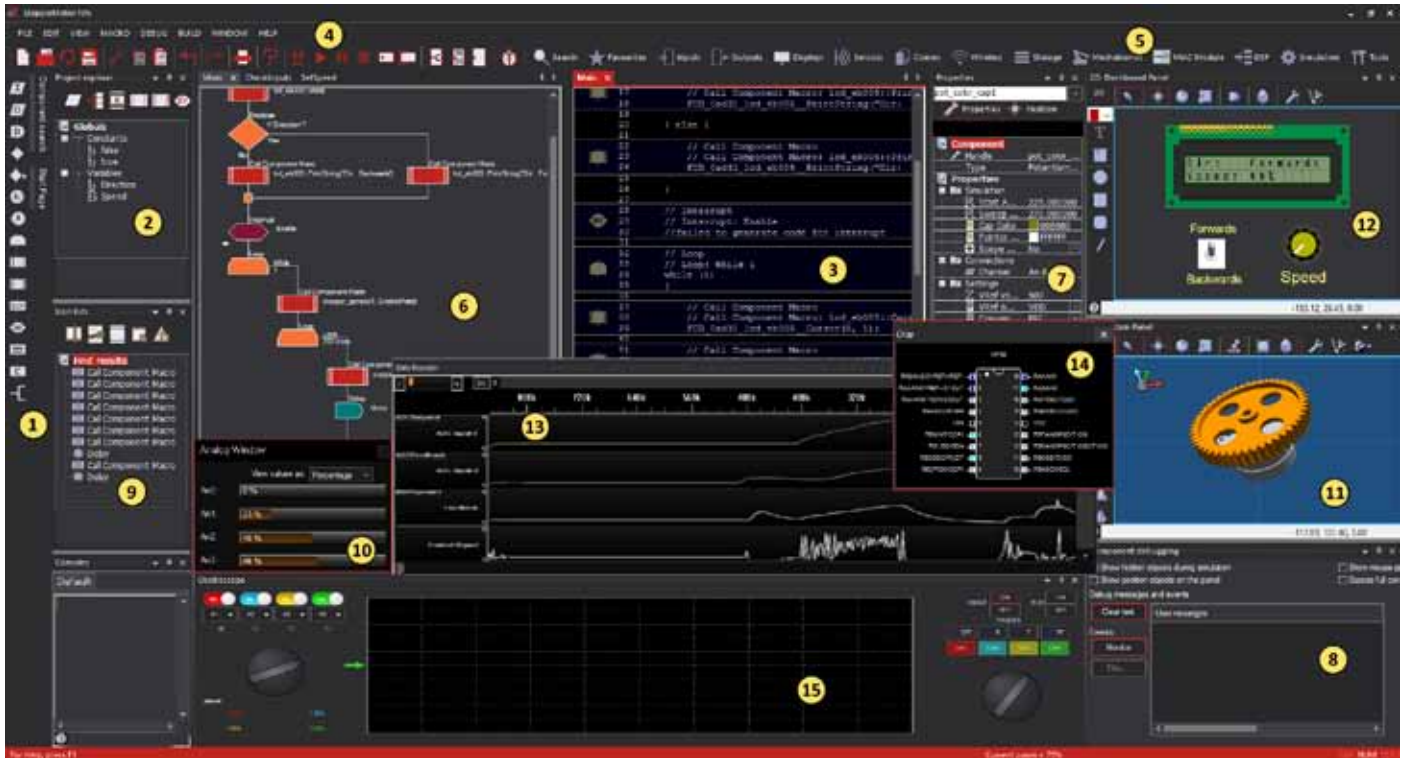
1. **Icon tool bar** - drag and drop standard flowchart icons onto your flowchart. Click to edit properties for a syntax-correct program.

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 stimulating 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.

Design

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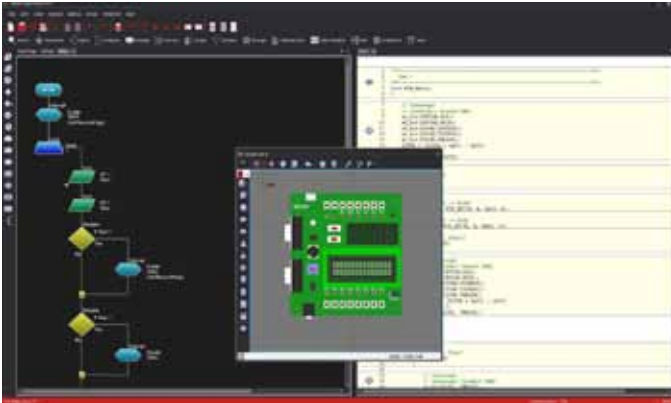
Design a virtual circuit board with PCB level components that connect to a virtual microcontroller and develop the program using flowcharts.

Electromechanical engineer

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

System engineer

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

Simulate

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

Simulate the mechanical system, the electronic system and the data decoding algorithms all in one package.
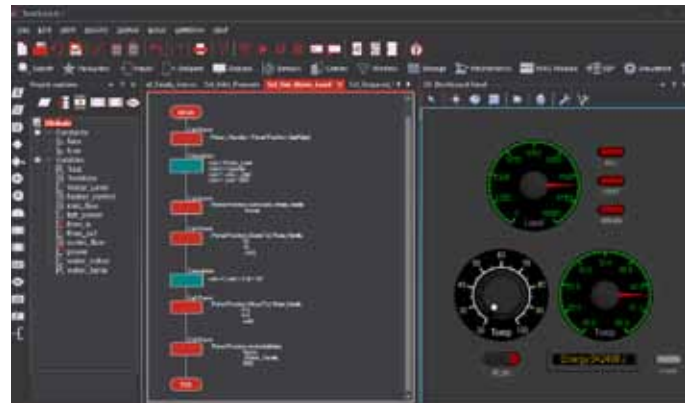
Use Flowcode Dashboard objects to simulate system performance in human friendly graphical format.

MATRIX

Flowcode design flow

Test
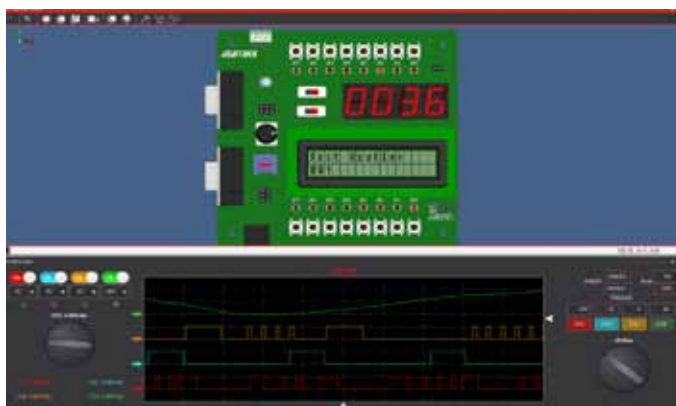
Download to the microcontroller in the E-blocks development system and use In-Circuit-Test and Softscope feature to verify operation at pin level.
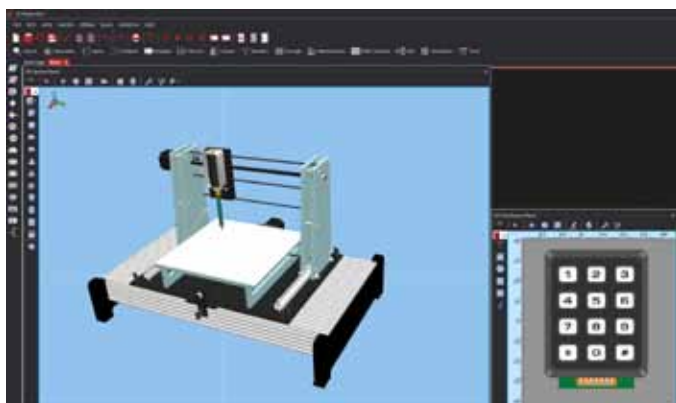
Use In-Circuit-Test to test and debug at a pin level.
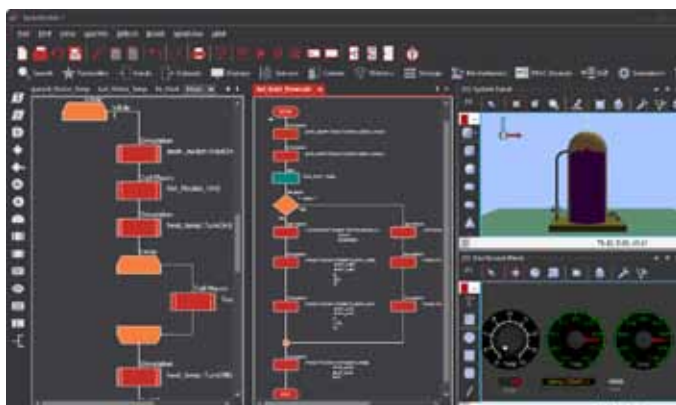
Link Dashboard objects, Softscope and Console to third party instruments using DLLs in SCADA fashion to verify performance in real time.

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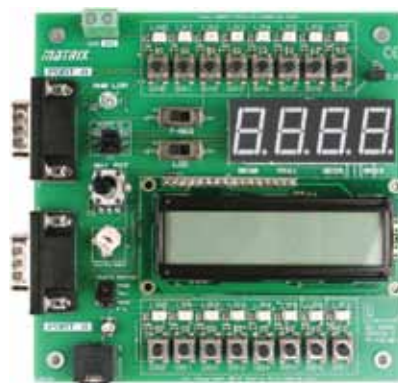
Develop the final circuit board and release to market.
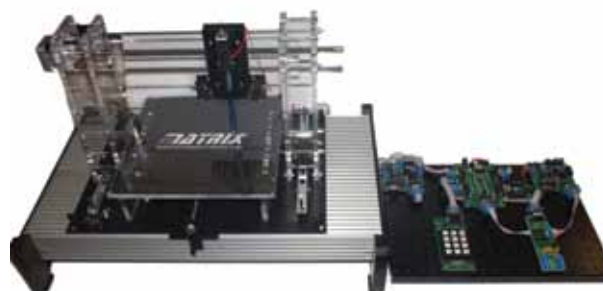
Develop the final product, verify operation and release to market.

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

Supported devices

E-blocks

Use Flowcode to program Matrix´s electronic modules; the perfect platform for learners, engineers and electronic system developers to quickly 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.

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 **NEW**

New for version 7 is Flowcode's ability to support the PIC32 range from Microchip. The PIC32 family delivers 32bit performance and more memory to solve increasing complex embedded system design challenges.

Microchip templates **NEW**

Another new feature of Flowcode 7 is the inclusion of templates for a number of popular Microchip development boards including the Curiosity and Xpress boards.

AVR & ARM

Atmel's AVR devices including the popular Arduino, plus a range of ARM MCU's are also supported in Flowcode 7.

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 and DesignSpark Mechanical 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.

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 bases.

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

W	?	📚	7
Wiki	Forum	Course	Examples

 MATRIX

locktronics

Simplifying electricity

Contents

Apprentice training at the UK Jaguar Land Rover Training Centre.

"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 both as demonstration equipment on short courses and apprentices conducting their own experiments, construction of circuits, testing and understanding of electrics, electronics and digital techniques".

Tony Russell, British Airways.

"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.

What is Locktronics?

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

The Locktronics range includes:

Baseboards
To which students add...

Capacitors
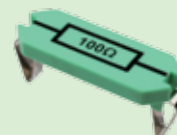
Resistors

Inductors
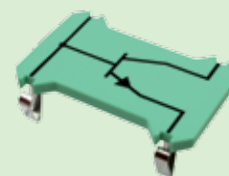
Semiconductors

Logic gates
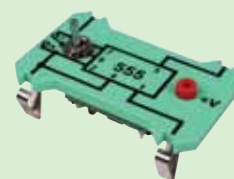
System blocks
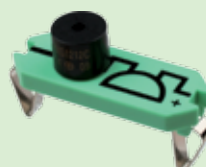
Electromechanical

Lamps and LEDs

Curriculum packs

Power supplies

Circuit symbol bonded onto plastic carrier

Component values easily identified

Rust proof spring clips ensure a good connection

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

5k6Ω

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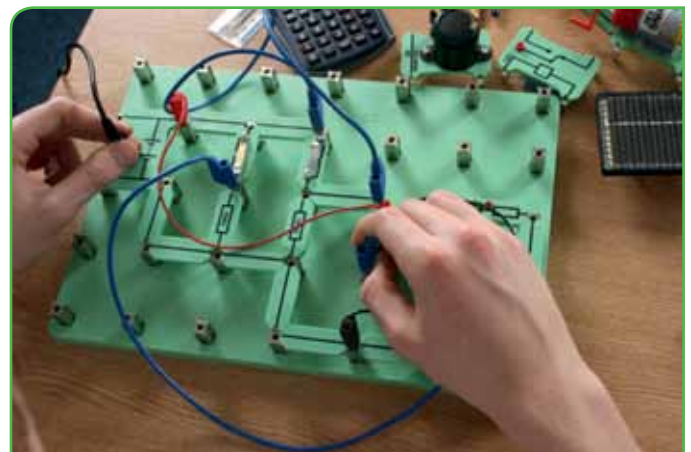
...students apply theory to practice using Locktronics kits...
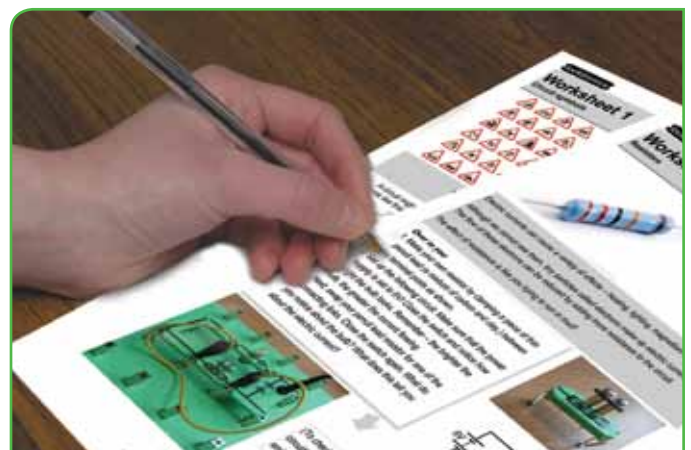
Understanding

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

MATRIX

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

Choosing the right solution

Take a look at our range of curriculum packs that you can see on page 63. 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 online. 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 92 - 96.

Choosing additional manuals and parts

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

Take a look at our curriculum packs online...

...choose one of our solutions...

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

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

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

...and our active MIAC control unit.

Curriculum packs

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
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

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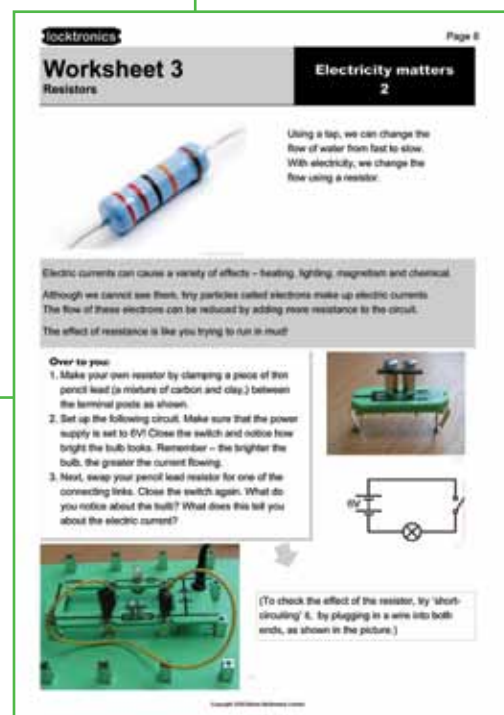
'Over to you' allows students to experiment based on what they have learnt and allows teachers to assess their understanding through a series of exercises.

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 on the left shows the complete list of products currently available.

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

MATRIX

8 analogue or digital inputs

CAN bus connectors

Input status LEDs

4 x 10A relay outputs

2 line 16 character LCD display

Output status LEDs

Code: MI0245

Power (up to 26V) and ground connectors

User keypad

4 x motor outputs

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.
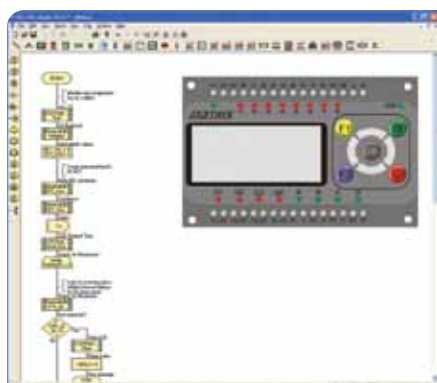
Use with Flowcode...

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.
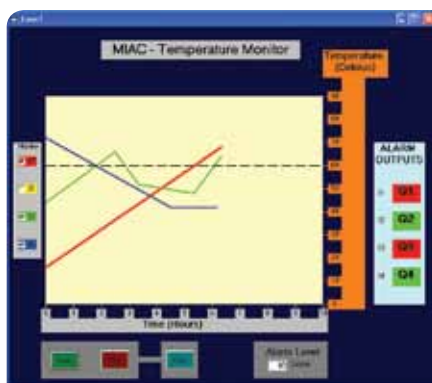
...Visual Basic®...

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.
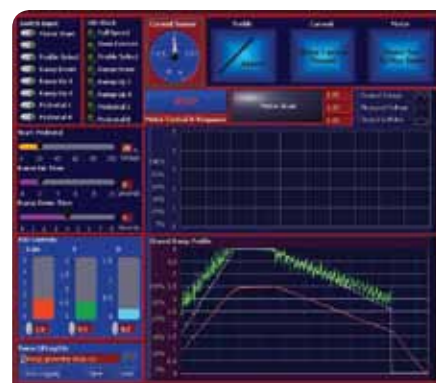
...or LabView®

- 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 4 versions:

Standard cased MIAC

dsPIC cased MIAC

Arduino cased MIAC

Raspberry Pi cased MIAC

LK8900

LK3000

LK3293

LK7936

LK5250

LK4786
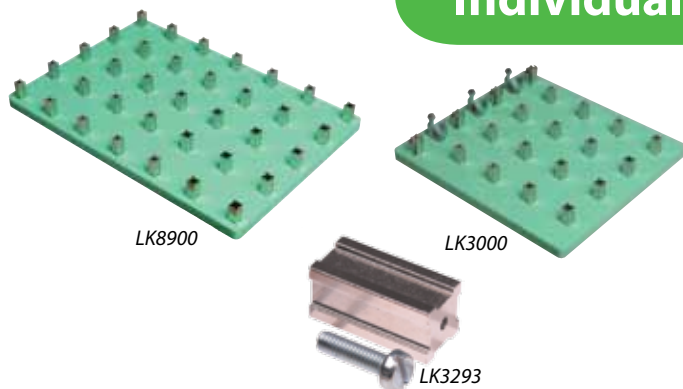
Baseboards and spares

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
7 x 5 baseboard with 2mm pillars	LK7302
4 x 4 baseboard with 2mm pillars and battery holders	LK5940
Spare 2mm pillar and bolt	LK5939

HP7894

LK1110

Instruments

Description	Part number
Multimeter	LK1110
Energy meter	LK8591
25MHz Pico 2205 oscilloscope with free lead set	HP8279
3MHz TTI signal generator with free lead set	HP7894
AC/DC current clamp	HP5561
Three phase power supply	HP9390

LK5298

LK5607

Leads

Description	2mm option	Standard part
Lead, black, 320mm, 4mm stackable to croc clip	LK5297E	LK5297
Lead, red, 300mm, 4mm to 2mm stackable	LK5555E	LK5555
Pair of 4mm to croc clip leads		LK5570
Lead, red, 320mm, 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 Kvaser 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

Need more information?

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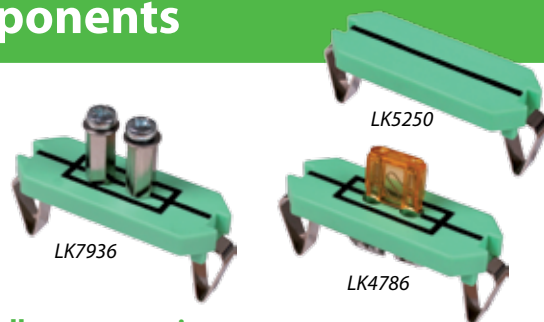
Miscellaneous carriers

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

LK4839

LK8623
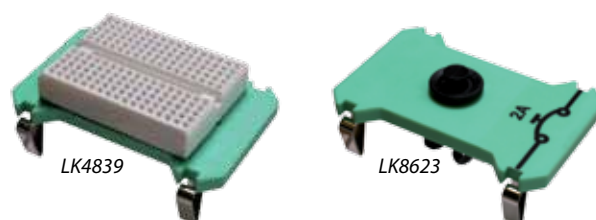
Non-carrier products

Description	Part number
MES bulb, 2.5V, 0.2A	LK2341
MES bulb, 6V, 0.04A	LK2347
MES bulb, 6.5V, 0.3A	LK2350
MES bulb, 14V, 0.06A	LK2363
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
Locktronics user guide	LK4000
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
OBDII lead	LK5697
Three phase motor	HP3920

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

matrix

Individual components
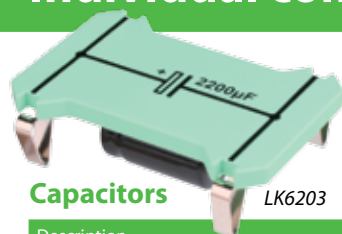
Capacitors

LK6206
LK6205
LK6203

Description	Part number
Capacitor, 100pF, Ceramic	LK6283
Capacitor, 0.1µF, Polyester	LK5222
Capacitor, 0.47µF	LK6216
Capacitor, 1µF, Polyester	LK6205
Capacitor, 2.2µF, Polyester	LK6217
Capacitor, 4.7µF, 25V	LK6206
Capacitor, 4.7µF, Ceramic	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

LK6214R3
LK4021
LK4123

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
2:1 transformer	LK7483
Dual 400 turn coil	LK9998
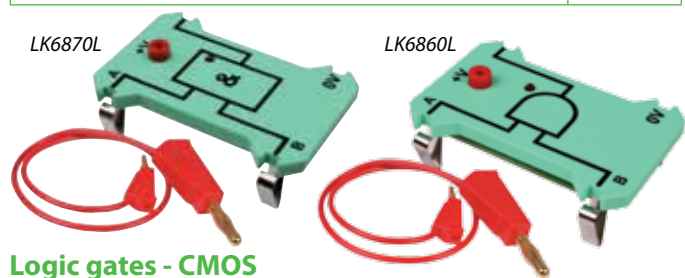
Logic gates - CMOS

LK6870L
LK6860L

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

LK5202
LK5214A

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, 1W, 5%	LK4025	LK4025A
Resistor, 12Ω, 1W, 5%	LK4100	LK4100A
Resistor, 47Ω, 0.5W, 5%	LK4065	LK4065A
Resistor, 68Ω, 0.5W, 5%	LK5217	LK5217A
Resistor, 100Ω, 1W, 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, 0.25W, 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'.

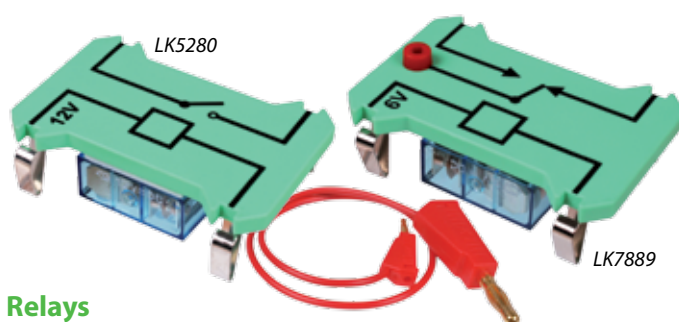| Description	Part number	
Systems block transistor switch	LK6831	
Systems block transducer driver	LK6832	
Residual Current Device (RCD)	LK7928	
Description	2mm to 2mm	2mm to 4mm
555 timer	LK6300LE	LK6300L
Op Amp module (TL081)	LK6234LE	LK6234L
Voltage regulator (7805)	LK7208	LK7208
Flip-flop, horizontal carrier	LK6500LE	LK6500L
Flip-flop, vertical carrier	LK6501LE	LK6501L

Individual components

LK5242

LK5241

LK8011

LK7409

LK8275
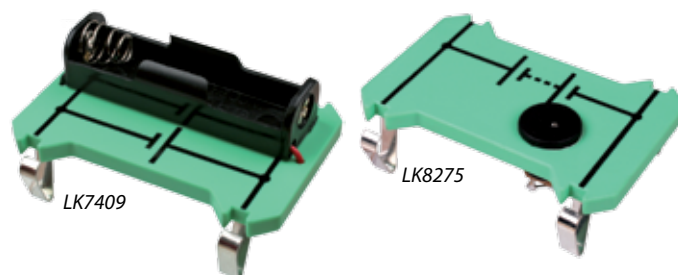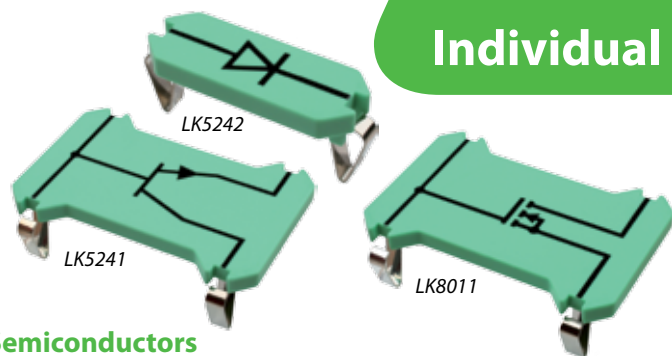
Semiconductors

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

Power / battery carriers

Description	Part number
Power supply carrier	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

LK5280

LK7889

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
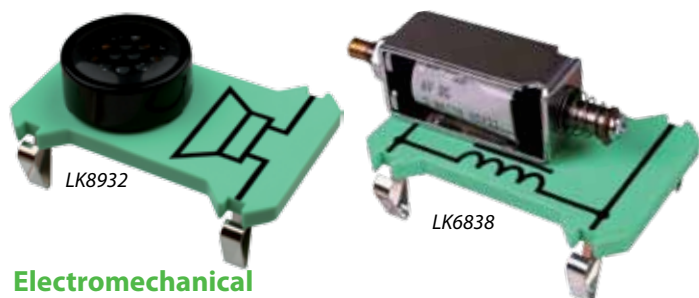
LK8932

LK6838

Electromechanical

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

HP2666

HP3728

HP8405

HP2673

HP6320

Dimensions W: 60cm x H: 78cm

Engineering panel

Description	Part number
Engineering panel	HP2673
Demonstration panel	HP6320

Power supplies

Description	Part number
Adjustable DC power supply, 3V to 12V, 1A, no carrier	HP2666
AC power supply, 12VAC, 1A, UK	HP3728
AC power supply, 12VAC, 1A Europe	HP4429
AC power supply, 12VAC, 1A, USA	HP4688
+/-12VDC power supply, 5 pin DIN, inc UK mains lead	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

matrix

LK6207

LK6632

LK6633

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	

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

LK4663

LK6706

LK5800

LK7215

LK5900

LK7215A

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
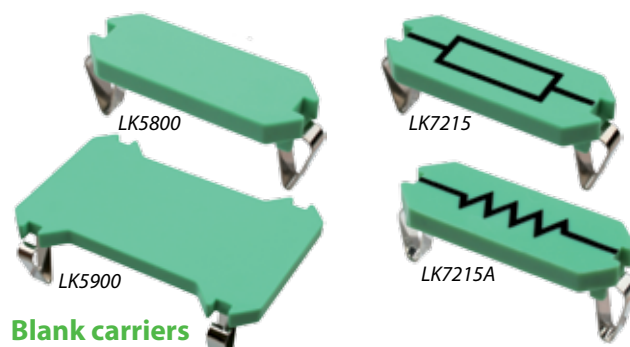
Blank carriers

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

LK5401

LK4121

LK8150

LK8154

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	

Resistivity carriers

Description	Part number
Nichrome 0.075mm^2 x 500mm	LK8150
Nichrome 0.075mm^2 x 250mm	LK8152
Nichrome 0.21mm^2 x 500mm	LK8154
Constantan 0.075mm^2 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 PICmicro microcontroller

This carrier includes a reprogrammable PICmicro 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 PICmicro 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

ⓔBLOCKS®

Simplifying electronics & rapid prototyping

Contents

The School of Electronic and Aeronautical Engineering (SEAE), one of the British Army's key training establishments in the United Kingdom, has reacted to the need to dominate the Digital Battlefield by equipping a number of classrooms and project rooms with a comprehensive range of E-Block modules and Flowcode. The E-blocks system has enabled SEAE to develop courses to teach the students fault-finding procedures applicable to microprocessor and/or embedded microcontroller systems.

This means that the students can develop practical experience of designing, programming and building systems similar to what they will encounter during an operational tour of duty.

A particular success has been the student project work on CAN bus which is a communications system used to link sub systems together in military vehicles. Students are split into groups, given real automotive components and tasked with developing a functional vehicle electronic control system.

Simplifying Technology & Electronic Systems

E-blocks modules provide learners and developers with a flexible suite of electronics blocks that snap together to form a wide variety of electronic systems.

E-blocks are small circuit boards each of which contains a block of electronics that you would typically find in an electronic system. The 50 circuit boards in the E-blocks range use rugged 9-way D-type connectors as connection busses for 8 signal lines and earth. Power (3.3V or 5V) is wired separately. This allows a complete system to be assembled in a matter of minutes.

Systems based on microcontrollers can be programmed using flowcharts, C, assembly, or anything else that generates an appropriate HEX file. Systems based on FPGA technology can be programmed in block diagrams, VHDL or Verilog. A range of CD ROM tutorials, which include compilers, development tools and manuals, provide support to students who are new to any of these technologies.

Disciplines include:

- Electronic engineering
- Mechanical engineering
- Computer Science
- Design Technology

The E-blocks range includes:

A range of upstream programmer boards
To which students add:

Input /output boards

Communications boards

Wireless comms boards

Graphical displays

Prototype boards

Motor driver boards

A/D and D/A boards

Sensors

Accessories

Test instruments

MATRIX

Flexibility

The modular nature of E-blocks 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 E-blocks.

Supported programmable devices

To give you flexibility in the courses you can deliver with E-blocks, we support a wide range of programmable devices which includes 8, 16 and 32 bit microcontrollers and Altera FPGAs:

PICmicro® microcontroller
ARM® microcontroller
Atmel AVR® microcontroller
dsPIC/PIC24® microcontroller
Altera Cyclone IV FPGA
Arduino

Supported programming languages

E-blocks microcontroller boards are 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 continues to grow and includes:

CAN, LIN, Bluetooth, GSM, RS232, RS485, IrDA, PS2, VGA, TCP/IP, MIDI, SPI, I2C, ZigBee, RFID, VGA, USB, GPS, SD/FAT16/FAT32, RS485, RF(ISM), RC5, WiFi

Curriculum support

E-blocks are 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-blocks are designed to be electrically and mechanically rugged to withstand the pressures of the lab: downstream board interfaces include damage protection resistors and can not be damaged by programming errors. Boards can be mounted onto metal backplanes to make them mechanically rugged during use. Plastic covers are available for all boards which offer further protection and prevent chips from being removed.

Product information

All E-blocks are provided with full datasheets - including circuit diagrams - which can be downloaded from our web site. Up to date drivers for all boards are also available free of charge.

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-blocks are tightly integrated with Flowcode and Flowcode components are available for all E-blocks as they are released.

Industry standard technology

E-blocks are used as much by engineers in industry as they are used by students and teachers in education. The technology is real, up to date and provides a great base for training the next generation of engineers.
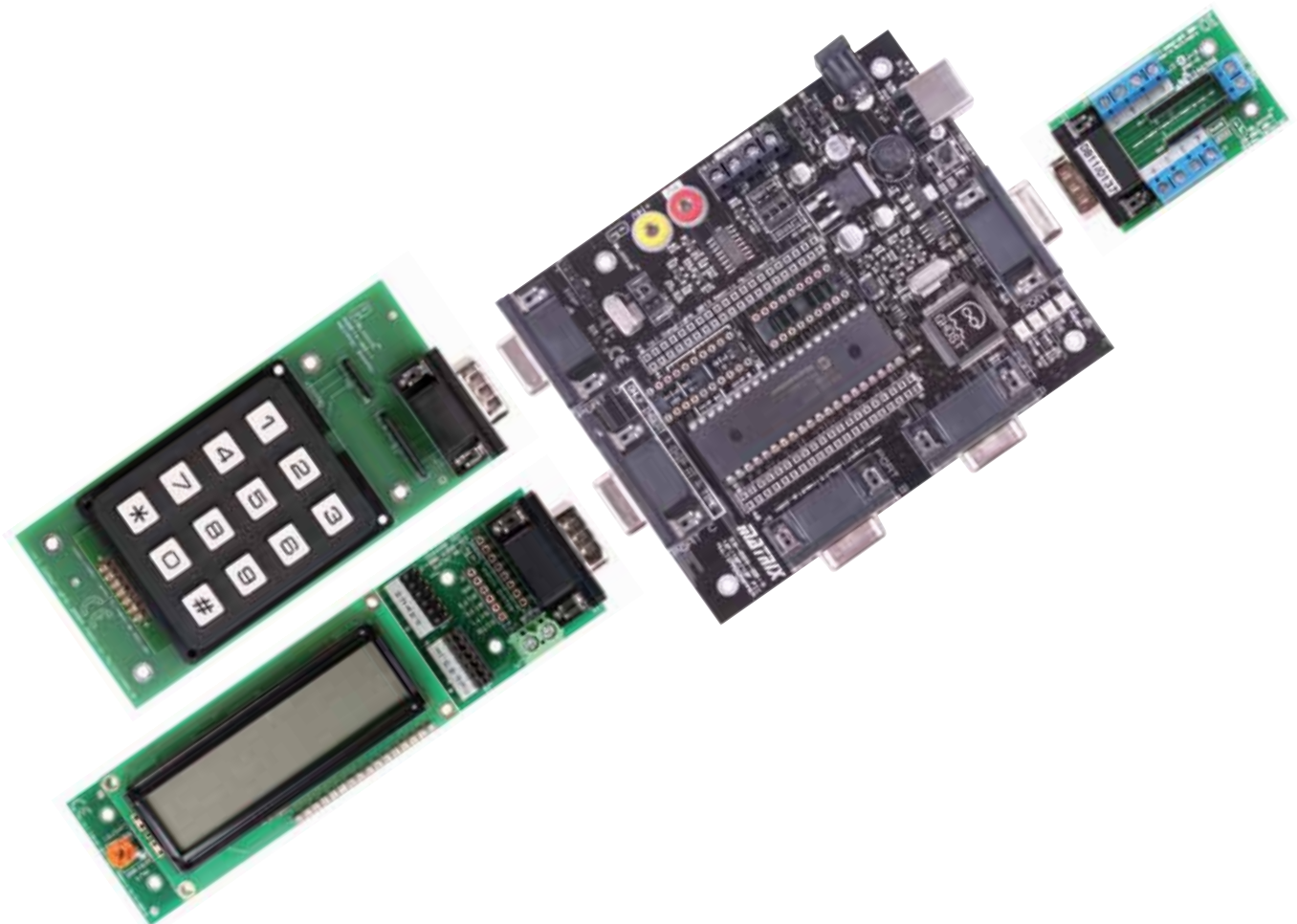
GHOST™

Ghost is a PC-side technology which, when combined with Flow-code, provides a new 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 in Flowcode at the same time as the flow chart simulation. You can run, pause, and step through, your program and view real-time data at the same time and view variables, registers and other memory locations. We call this 'In-Circuit-Test' (ICT).

Ghost also includes an 'In-Circuit Debug' mode (ICD) which allows your flowchart to be executed step-by-step on the actual hardware. Variable values can be inspected and changed.

When this data is combined with the PC-side processing capabilities of Flowcode it provides a very powerful debugging and learning tool.

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 and displayed on the oscilloscope or the data recorder. On the data recorder, communications busses decoding overlays for SPI, I2C, and other comms standards are available.

Ghost data can also be passed to simulation / SCADA components in Flowcode to provide Human Machine Interface style debug features.

Ghost technology is available on a range of Matrix hardware including the 8bit and dsPIC multiprogrammer boards, EB006v9 and EB091 (above), and now with the new FlowKit v2 for Matrix hardware plus your own hardware including Arduino (below).

Below is an example of the new oscilloscope, developed for Flowcode 7. You can also see below how the new feature can be used for test and debug of electronic systems.

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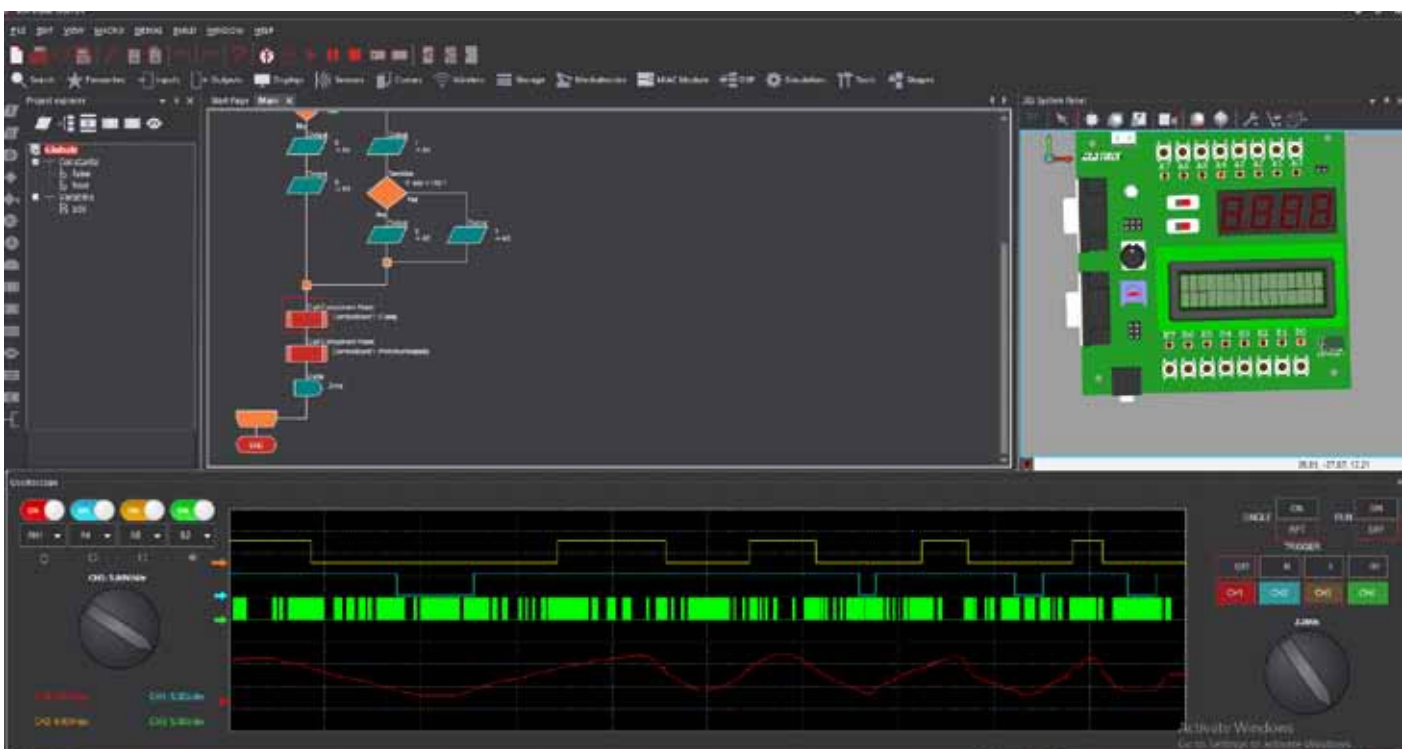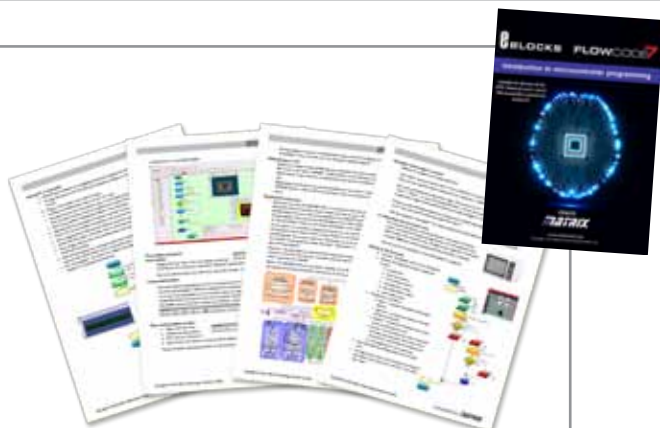
Unit 6 of the BTEC National award in Engineering: Microcontroller systems.

Introduction to microcontroller programming

This free course is designed to give students a thorough understanding of programming microcontrollers using Flowcode. It can be used with either PIC or Arduino microcontrollers. The course includes a wealth of written material, examples, and a suite of labs for self test and assessment. The structure for the course is based on Pearson's BTEC national unit 6 and is a complete student-centred solution for delivering this unit. The PDF based course is available as a free download from our web site.

Learning objectives /experiments

- Microcontroller hardware
- Input devices including switches, potentiometers, sensors
- Output devices including LED, 7-segment displays, LCD displays, relays, speakers, motors with PWM
- System development techniques including modules and breadboards
- Coding constructs and programming techniques
- I2C chip to chip communications

Assembly for PICmicro MCUs CD ROM

This CD ROM contains a complete 50 hour course in programming the PICmicro 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 PICmicro microcontroller

Ordering information	
Introduction to microcontroller programming	CP4375

Ordering information	
Single user	EL629SI6
Site licence	EL629SL6

C programming courseware and software

This CD ROM provides you with a complete solution to teaching and learning C programming for the PICmicro 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 PICmicro microcontrollers	
Single user	EL543SI5
Site licence	EL543SL5
Note that the C compiler is only licensed for educational use.	

PICmicro® microcontroller multiprogrammer

This board connects to a PC via USB to provide a high speed, low cost PICmicro 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	
PICmicro® microcontroller multiprogrammer	EB006V9

Extended functionality dsPIC board

Our dsPIC board provides a high speed processor, tons of memory and plenty of peripheral inputs and outputs. It is also fitted with Ghost technology which, when used with Flowcode, provides in-circuit debugging and instrumentation including multi channel oscilloscope, multi channel logic analyser, packet decoder and data console. The board is shipped with a powerful 16bit dsPIC processor – the dsPIC33EP256MU806 with 256K ROM and 28K RAM - which provides a huge assortment of functionality including remappable peripherals, 4x UART, 4 x SPI, 12-bit ADC, 16 x PWM, 2 x I2C and 2 x Internal CAN and USB.

Ordering information	
Extended functionality dsPIC board	EB091

ARM® microcontroller multiprogrammer

This board is a development tool for the Atmel AT91 SAM 7 microcontroller. The SAM 7 is a 32 bit RISC device running at an internal frequency of 80MHz with 128k ROM and 32K static RAM as well as 2 USARTs, 4 x 10 bit A/D converters and a native USB bus. The board has 5 D-type sockets for E-blocks. The processor is housed on a removable daughter board so that the ARM can be incorporated into custom PCBs.

Ordering information	
ARM® microcontroller multiprogrammer	EB185

AVR® microcontroller multiprogrammer

This board includes everything you need to program an AVR microcontroller and develop AVR projects. The board comes with a CD ROM containing development tools (including an Integrated Development Environment for code writing) and an in-system programmer. The board programs a wide range of AVR devices and has 4 D-type sockets for E-blocks.

Ordering information	
AVR® microcontroller multiprogrammer	EB194

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

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. CD ROM courses and compilers for this board are available.

Ordering information	
FPGA board	EB089

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

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

MATRIX

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

Arduino uno	*Cypress*	*Nucleo*	*Freescale ARM*

Arduino compatibility

These shields make E-blocks compatible with several Arduino boards including:

1. Uno	*2. Leonardo*	*3. Mega*
4. Micro	*5. Mini*	*6. Nano*

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 to our range of 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.

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

Dual 7-segment display

3.3V 5V

Has a quad 7-segment common anode display with anodes controlled via one port and cathodes controlled by the other.

Ordering information

Dual 7-segment display	EB008

Power board

3.3V 5V

Contains two L293 quad push pull driver chips which provide power outputs for driving lamps or motors. The board supplies 8 outputs which sink or source 500mA at up to 36V.

Ordering information

Power board	EB011

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

matrix

Downstream boards

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.
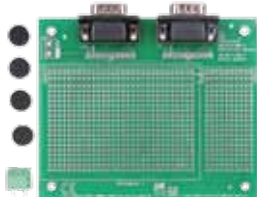
Ordering information	
Patch board kit	EB017

CAN bus board

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

MIDI interface board

v3.3V   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

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

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

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

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

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

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

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

MATRIX

Downstream boards

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

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

GSM board

3.3V 5V
Flowcode macros available

Comes complete with a SIM card socket and a small antenna. It is fitted with 2.5mm jack sockets for microphone and headphone use.

Ordering information

GSM module	EB066

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

Rotary encoder board

3.3V 5V
Flowcode macros available

Has two rotary encoders, an LED and a push switch. It does not have a start and end position so keeps turning in either direction to allow a continually turning potentiometer.

Ordering information

Rotary encoder board	EB073

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

Slide switch board

3.3V 5V
Flowcode macros available

This board contains 8 slide switches with upstream and downstream D-type connector.

Ordering information

Slide switch board	EB074

LCD board

3.3V   5V
Flowcode macros available

The new graphical display board features a new low cost 128 x 160 pixel, 16-bit colour, 1.77 inch graphical TFT display. The display features a LED backlight with microcontroller based brightness control as well as compatibility with 3V3 and 5V E-block systems.

Ordering information

LCD board	EB084
Graphical display module only	EBM001

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

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 LED array board

3.3V

The LED array board offers an array of 8 x 5 high brightness red LEDs which can be easily controlled to create visual animations, pointers and signs. The boards plug together in a way to allow large message boards to be created by cascading data through from one board to the next.
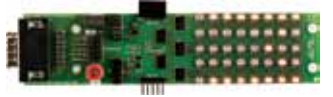
Ordering information

E-blocks LED array board	EB087

Cap-touch board

3.3V   5V
Flowcode macros available

The cap-touch board allows easy investigation and implementation of cap touch technology. The board features five separate cap-touch pads to allow you to command up, down, left, right and center button presses.

Ordering information

Cap-touch board	EB088

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

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.
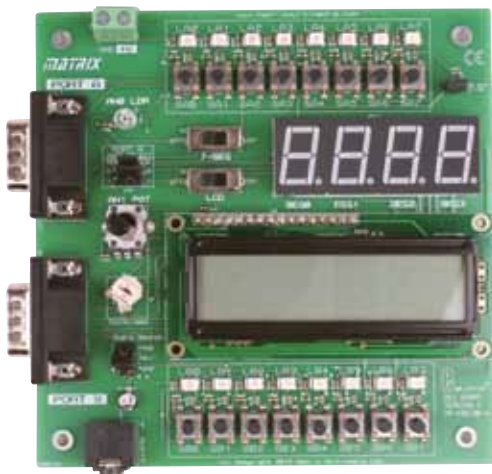
Ordering information

DC Motor Servo Trainer E-block	EB097

Matrix

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 PICmicro 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 PICmicro 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

PICmicro development centre kit

3.3V   5V
Flowcode macros available

If you are looking for a protected and physically compact and rugged development environment for PICmicro projects then the HP7631 is ideal for you. The HP7631 Development Centre consists of a EB006 PICmicro 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 PICmicro 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.
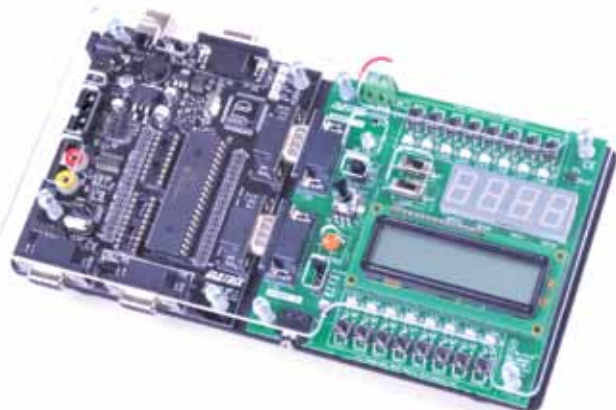
Ordering information	
PICmicro development centre kit	HP7631

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 interface board for learning and development with switches, sensors, LEDs and displays. A power supply and USB cable are included. Arduino board not included.
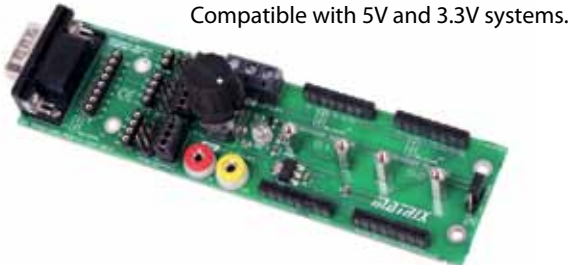

Ordering information	
Development board and Arduino shield combo	HP7745

E-blocks sensors mother board

This new 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 sensor boards can then be screwed down into the mother boards to prevent easy removal when used in open labs. The mother board also includes a light sensor and a general purpose potentiometer.

Compatible with 5V and 3.3V systems.

Ordering information	
E-blocks sensors mother board	EB090

E-blocks Sensors Bundle

The E-blocks Sensors bundle includes our most popular sensor modules neatly packaged into one container making it ideal for a learning environment. It also comes complete with one EB090 sensors motherboard.
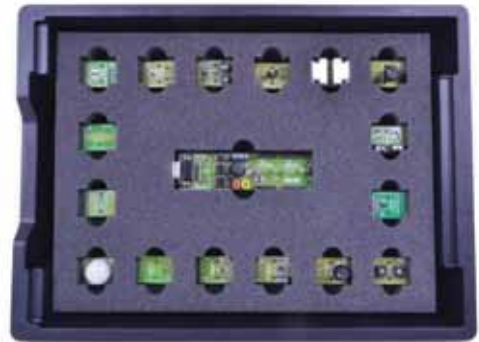
Ordering information	
E-blocks Sensors Bundle	EBM1000

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

Thermocouple sensor board

This board houses a 2 way screw terminal block for attaching a Type K Thermocouple. The output can be used with an Analogue to Digital convertor and converted to temperature. It also has an on-board thermistor for ambient temperature compensation reading.

Ordering information	
Thermocouple	EBM008

MATRIX

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.
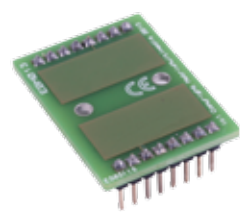
Ordering information

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.
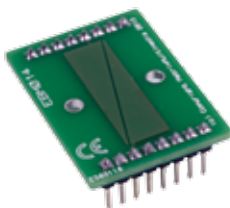
Ordering information

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.
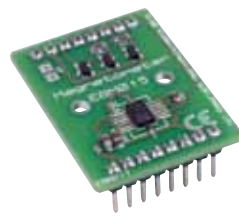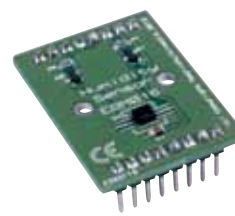
Ordering information

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.
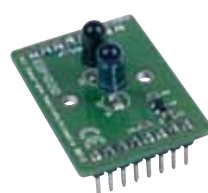
Ordering information

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 with this pack: 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

MATRIX

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 with this pack: 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.

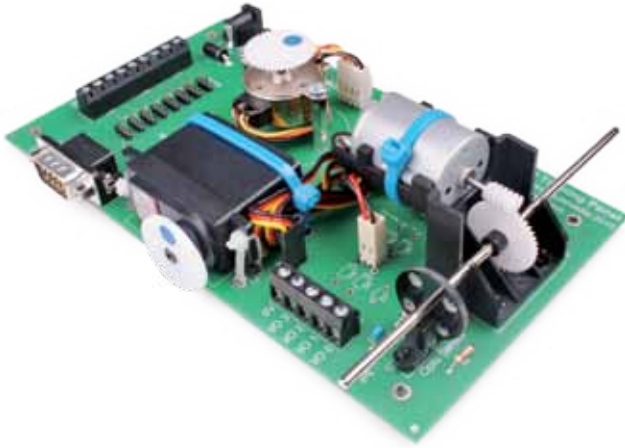| Ordering information	
SCADA power supply	HP4449

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

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	EB635S

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

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 and ECIO ARM.

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

MATRIX

E-blocks accessories

PIC programmer with ZIF sockets

This PICmicro microcontroller programmer will program any 8, 14, 18, 28 and 40 pin PICmicro device from the 16 or 18 series of PICmicro 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	
PICmicro microcontroller programmer with ZIF sockets	HP6339

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

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

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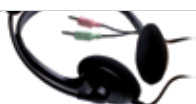
Ordering information
Covers are available for most E-blocks. The product code is the same as the code of the board the cover is for, with a '7' replacing the first '0' in the code. For example, the code for the EB003 sensor board cover is an EB703. See the Matrix website for a complete list of available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

Communication busses being decoded
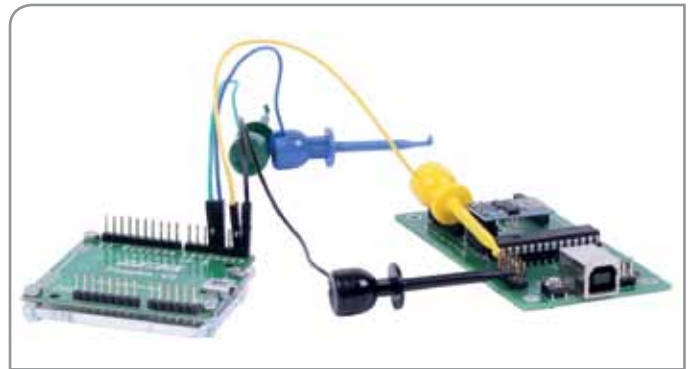
Attaching FlowKit to your own circuit board using the probes provided

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

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

MATRIX

USB prototype board

The prototype board has been created to allow students to take designs from schematic concept to realisation very quickly. It achieves this through a small section of breadboard which allows students to create simple electronic circuits. This breadboard is simple to interface with the microcontroller through two SIL connectors providing access to all ports of the device. Breadboard also allows flexibility at a design stage with students easily able to modify designs until they have a working system. The system is powered and programmed via USB - cable not included.

Ordering information	
USB prototype board	HP4829
USB prototype board x 20	HP4820
Component kit only for SE3829-2	HP4800
USB lead	HPUSB

USB project board

The project board includes a USB programmable 18 pin microcontroller and a ULN2803 power output chip which give students a rugged miniature input output board that can be embedded in a wide variety of projects that include motors, lamps and solenoids. The system can be powered from the USB lead (not included) or from batteries. The chip is based on open source Microchip code.

Ordering information	
USB project board	HP1110
USB project board x 20	HP9954
USB lead	HPUSB

Cased MIAC

The Cased MIAC with 4mm shrouded sockets is internally connected to all of the input outputs of the MIAC (except CAN bus terminations). This allows rapid development of circuits based on the MIAC up to mains voltages.
Power supply and USB lead included.

Ordering information	
Cased MIAC	MI0245

MIAC components with 4mm leads

This range of add -on components are fitted with 4mm connectors which plug into the MIAC to allow fast development of simple control systems

| Ordering information	
Motor with 4mm leadset	SE3945
Push to make switch with 4mm leadset	SE2995
Light sensor with 4mm leadset	SE7045
MES bulb holder with 4mm leadset	SE3400
4mm to 4mm lead, black	LK5604
4mm to 4mm lead, red	LK5603
4mm to 4mm lead, blue	LK5609
4mm to 4mm lead, yellow	LK5607

FORMULA
//ALLCODE™

Formula AllCode is host independent and can be used with:

- Raspberry Pi
- Android
- iPhone
- Windows & MacOS
- And many more…
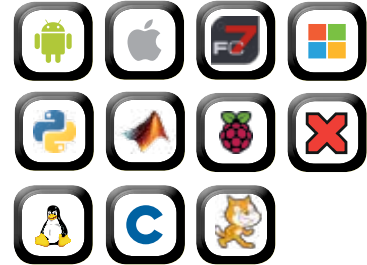
For an explanation of icons please see page 6
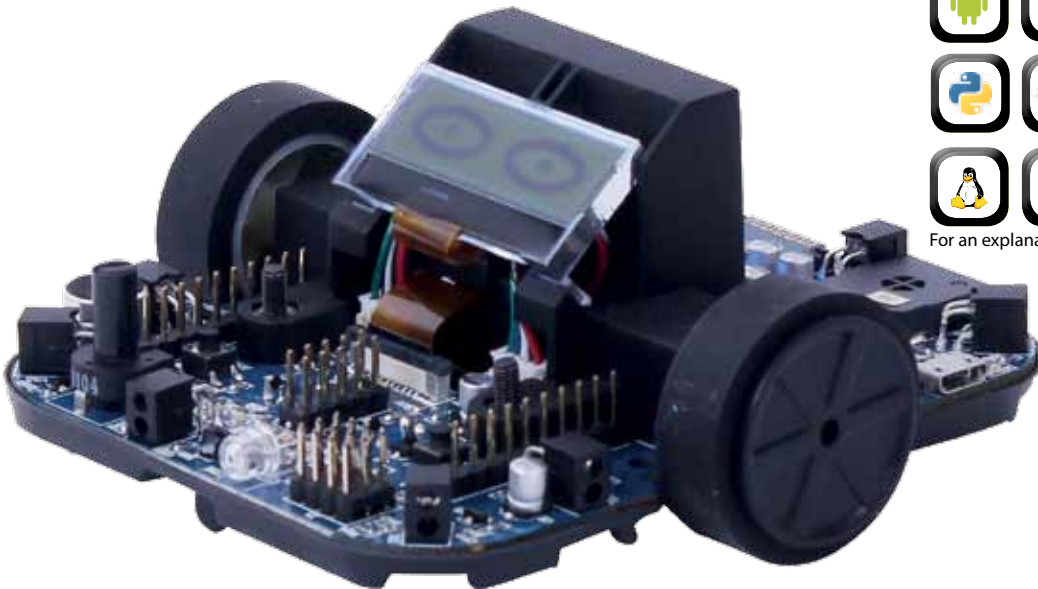
Learn robotics your way

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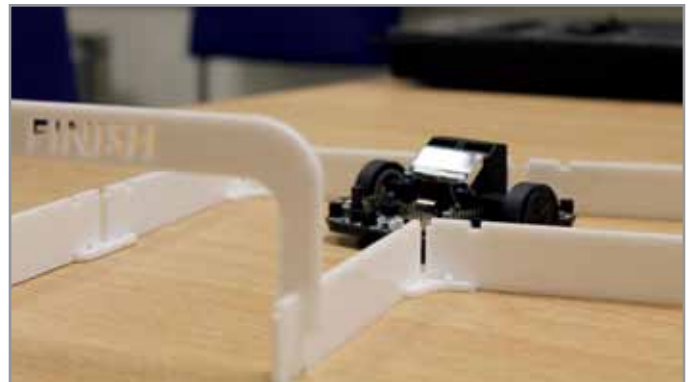
Formula AllCode uses it's high specification of sensors to follow lines and can even solve complex mazes. We are offering maze walls and maze mat with full examples to enhance your learning experience.
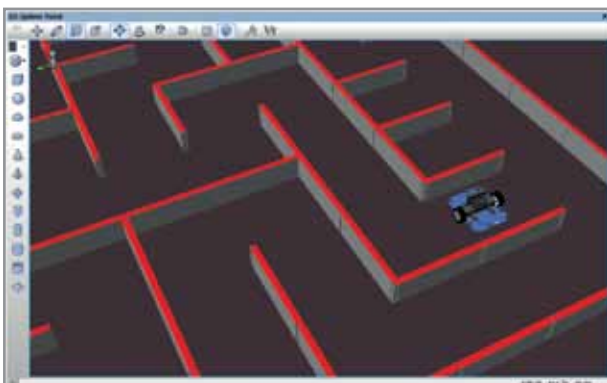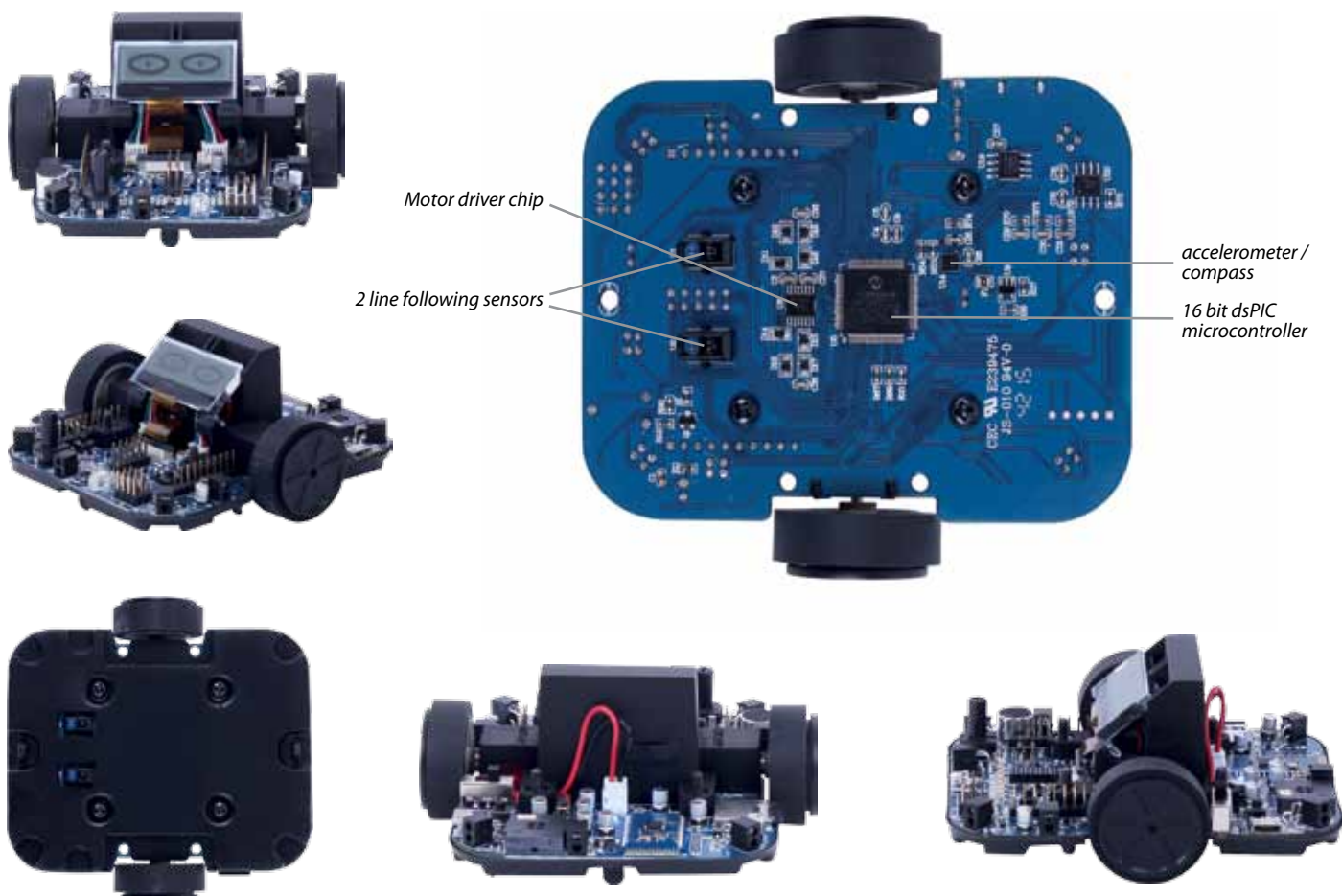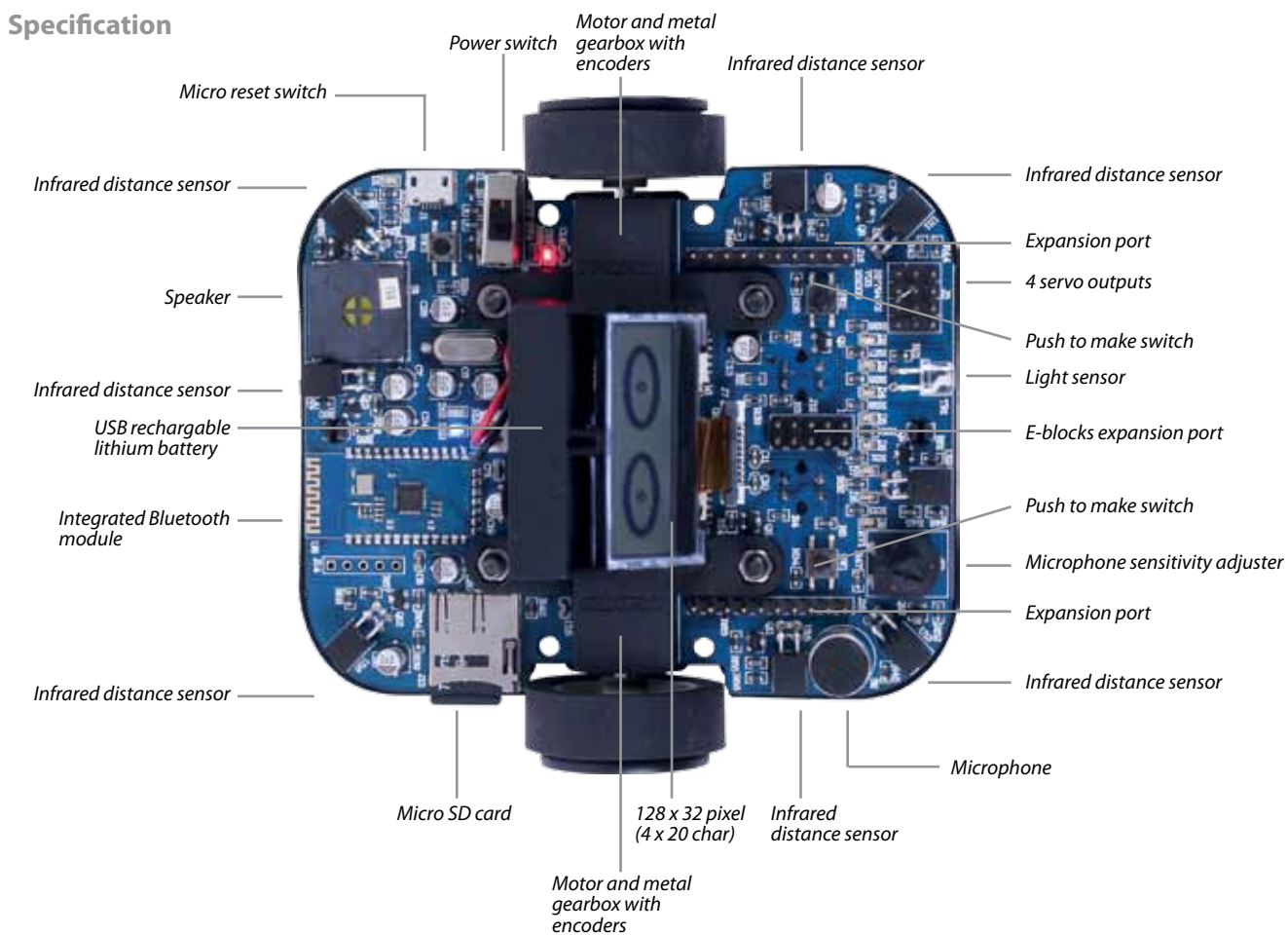

Simulating the AllCode in a maze using Flowcode

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.

MATRIX

Specification

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

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

Formula AllCode

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.

RoboIO	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'.

Naviagtion	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 C 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.

Move forward 10cm. Read front distance sensor. LCDprint "Hello world"

MATRIX

Formula AllCode

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).
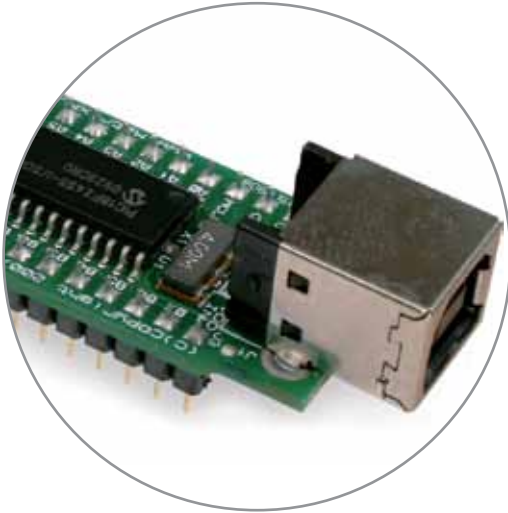
COMING SOON

Ordering information	
Formula AllCode football mat add-on	RB3068

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.

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.

MATRIX
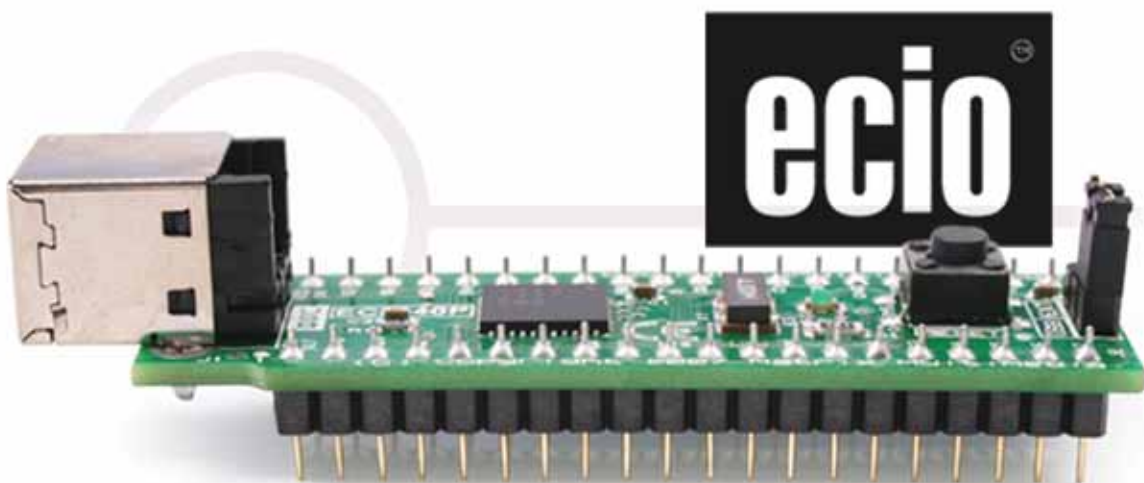
ECIO single board computers

The ECIO family of USB programmable microcontroller modules behave just like a normal microcontroller - but when you plug the USB lead in and press the reset switch you can send a new program to the device. This, along with the low cost, makes ECIO ideal for student work at home and for incorporating into student circuit boards. ECIO microcontrollers are pre-programmed with a bootloader program which allows you to send a new program to the microcontroller via USB. ECIO is compatible with hex code from any appropriate compiler including Flowcode, C compilers and MPLAB.

Flowcode programs and Windows drivers are available for ECIO devices making them suitable for use with LabView, Visual Basic, C++ etc.

28 pin PIC 18 ECIO

Base chip	PIC18F2455
Oscillator	4MHz ext, 48MHz internal
I/O lines	19
A/D	10 x 10 bit
A/D sample rate	100ksps
Program memory	24K bytes
RAM	2K bytes
EEPROM	256 bytes
Power	5V, USB or external
PWM channels	2
Timers	1 x 8 bit, 3 x 16 bit
Interfaces	EUSART, MI²C, SPI, USB2.0
Package	28 pin, 0.6", DIP compatible

ECIO28P

40 pin PIC 18 ECIO

Base chip	PIC18F4455
Oscillator	4MHz ext, 48MHz internal
I/O lines	30
A/D	13 x 10 bit
A/D sample rate	100ksps
Program memory	24K bytes
RAM	2K bytes
EEPROM	256 bytes
Power	5V, USB or external
PWM channels	5
Timers	1 x 8 bit, 3 x 16 bit
Interfaces	EUSART, MI²C, SPI, USB2.0
Package	40 pin, 0.6", DIP compatible

ECIO40P

40 pin dsPIC ECIO

Base chip	dsPIC33EP256MU806
Oscillator	8MHz ext., 70MHz internal
I/O lines	34
A/D	20 x 12 bit
A/D sample rate	1.1 Msps
Program memory	256K bytes
RAM	28K bytes
EEPROM	0 (internal ROM overwrite)
Power	5V, USB or external
PWM channels	16
Timers	9 x 16 bit
Interfaces	4 x UART, 2 x MI2C, 4 x SPI, 2 x CAN, USB2.0
Package	40 pin DIP, 0.6" compatible

ECIO40P16

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).
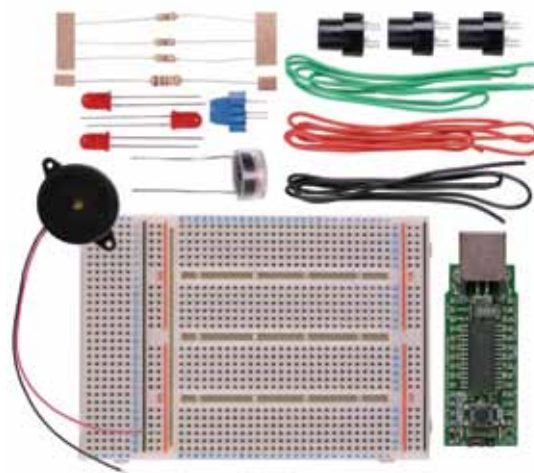
Ordering information	
E-blocks application board	EB061

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

MIAC

MIAC is now available in 5 models:

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

For an explanation of icons please see page 6

MIACs have a wide range of uses:

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 (PICmicro, 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.
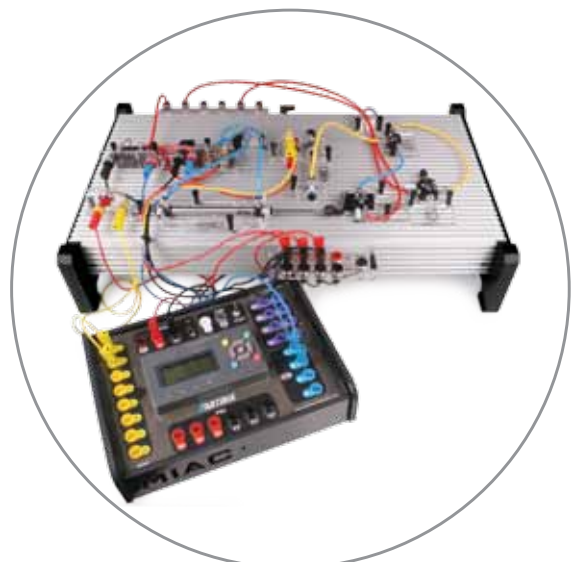
The range of inputs and outputs of the MIAC are well specified with analogue/digital inputs, motor control outputs, internal relays, and a number of communications interfaces including CAN, RS232, and RS485. Optional Bluetooth and Wi-Fi interfaces make MIAC perfect for Internet Of Things applications.

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

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

matrix

Features				
PIC	**Arduino**	**dsPIC**	**RPi**	**AllCode** COMING SOON
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: MI9335	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	Call us

AUTOMATICS
Simplifying pneumatics

Contents

An example of a functioning control pneumatics solution with PLC adaptors.

matrix

What is Automatics?
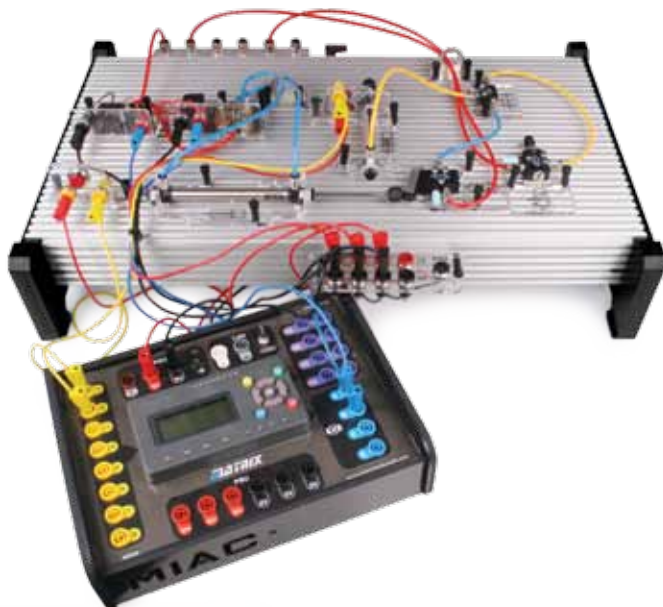
Simplifying pneumatics and automation

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.

The Automatics range includes:
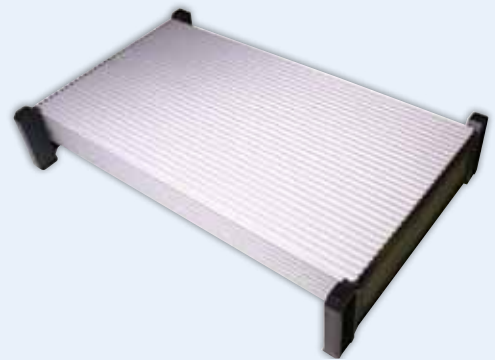
A rugged aluminium platform

To which students add...

Disciplines include:

- Pneumatics
- Automation
- Design technology
- PLC programming

A compressor
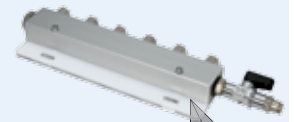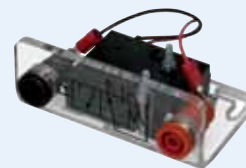
A manifold
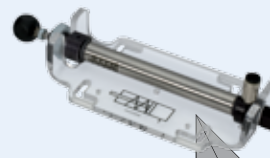
Cylinders
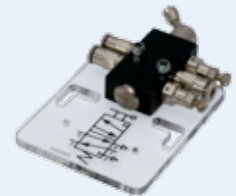
Mechanical valves

Electrical valves

Connectors

Switches and sensors

A controller

Pneumatic tubing

Electrical cables

AU2140

AU2280

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.
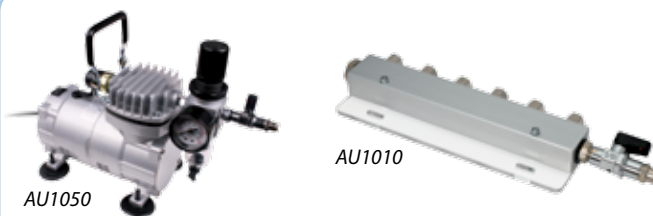
Description	Part number
Cylinder, single acting, 10 × 40 mm	AU2140
Cylinder, double acting, 10 × 80 mm	AU2280

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

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

AU5200

AU3204
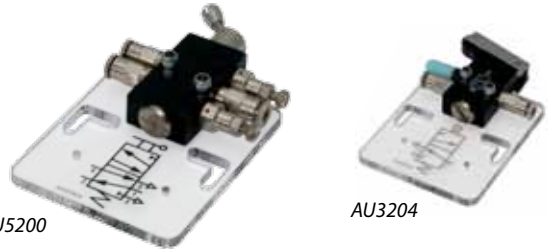
Valves - mechanical

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

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

AU1020

Reservoir

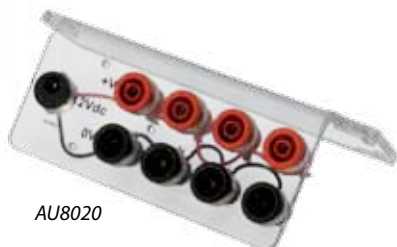Create time delays in your pneumatic circuits by allowing pressure to gradually build up inside the reservoir.

Description	Part number
Reservoir 45cc	AU1020

matrix

Automatics component guide

AU8030

AU8020

MI0245

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

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

HP6700

HP6785

Platform not included

AU9020

AU9010

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

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

The south side of building

The Matrix team

The north side of building

The product development team

The training room

The production hall

The kitting and despatch hall

Goods out

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BLOCKS

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FLOWCODE7

AUTOMATICS

MIAC

FORMULA //ALLCODE

Keep in touch with new developments:

Huddersfield University School of Engineering E-Blocks lab.
"Using E-Blocks has allowed us to simplify the teaching of complex topics to undergraduate and postgraduate students. Matrix's E-Blocks has inspired our students to design innovative systems and products of their own. Learners can use E-Blocks to create an unlimited number of systems by mixing and matching various E-Block boards.

Flowcode 6 development software makes programming complex systems by novices and learners possible. We use Flowcode for PIC and dsPIC family of microcontrollers to teach various topics starting from blinking LEDs to advanced digital signal processing (DSP) applications."

Bruce Mehrdadi, University of Huddersfield School of Engineering

MATRIX

MATRIX

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