

2014 Edition

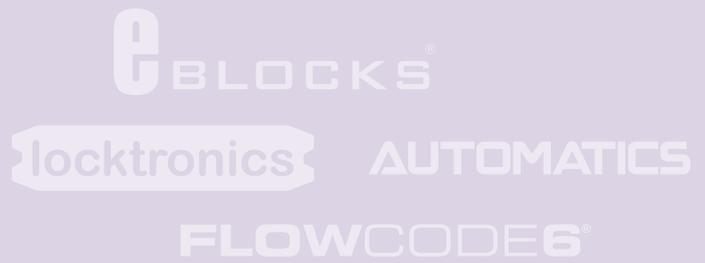
# MATRIX

Simplifying technology

[www.matrixltd.com](http://www.matrixltd.com)

 @MatrixFlowcode





## locktronics

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Cover image:  
 INSA Lyon in France use Flowcode and E-blocks to develop novel electrical vehicles as part of a combined mechanical and electronic degree course.

# Welcome to Matrix



The last 12 months has brought two significant events to Matrix:

Firstly in August we moved into a fully refurbished building in the centre of Halifax. "Olternay works" has been transformed for us from an oily-floored, leaky-roofed ruin that housed injection mouldings for Rowntree McIntosh, into an energy efficient modern facility. "The Factory", as it is now known, consists of 11,000 square feet of offices and manufacturing facilities which provides much needed space for high quality manufacturing and development of products. See photographs on the next page.

Secondly, in September we released Flowcode version 6. For nearly two years our technical team of 8 engineers have been working to develop this new version of Flowcode which allows engineers and students to develop complex electronic systems. Flowcode has been a huge success for us in both educational and industrial markets. There are more than 1,500 educational institutions across the world using Flowcode for teaching engineering in technical schools, vocational schools and universities. There are also more than 4,000 industrial users of Flowcode who vary from small one man operations to huge multinationals including Siemens, Coca-Cola, and the British Atomic Energy Authority. This new version of Flowcode is a huge step forward and it provides us with a great platform around which we can develop further products to help engineers and students design electronic systems. The first few months of 2014 will see us releasing a new version of Flowcode for the schools market – Flowcode SE.

Another significant technology development from the lab is our new 'Ghost' enabled microcontroller development board. 'Ghost' is a technology that allows learners and developers to use a PC to monitor electronic systems and interpret messages and communications between electronic devices. We believe that Ghost will enable us to deliver the World's best electronics learning and development solutions.

Thanks for taking the time to look at our 2014 catalogue and I hope that you have a great year.

**John Dobson**  
Managing Director

**Keep in touch with new developments:**

 **@MatrixFlowcode**

**[www.matrixltd.com/blog](http://www.matrixltd.com/blog)**

## New products this year include:



*Flowcode version 6*



*PIC multiprogrammer with Ghost technology*



*Low cost solutions for Design Technology*



*Lots of new curriculum packs*

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# Welcome to Matrix



*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*



## Contents

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Apprentice training at the IVECO training centre in Cheshire.

# Testimonials

*"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



## The Locktronics range includes:

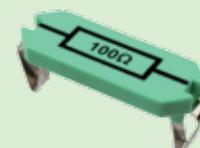


### Baseboards

To which students add...



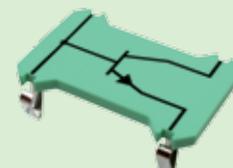
Capacitors



Resistors



Inductors



Semiconductors



Logic gates



System blocks



Electromechanical



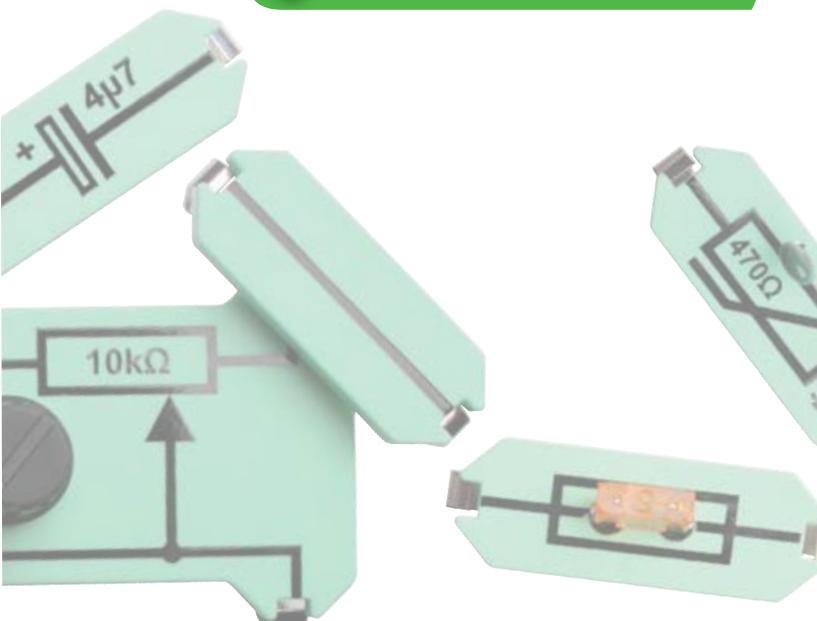
Lamps and LEDs



Curriculum packs

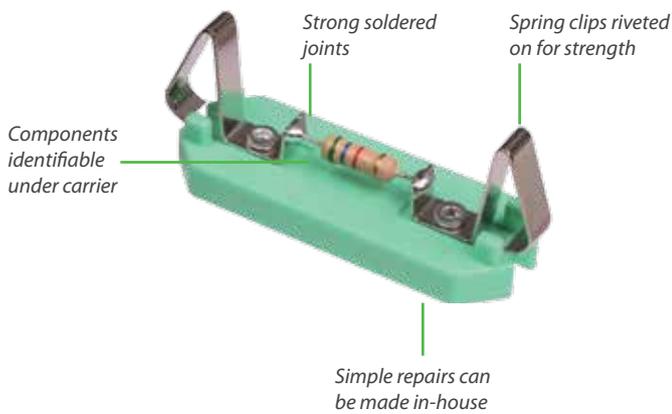
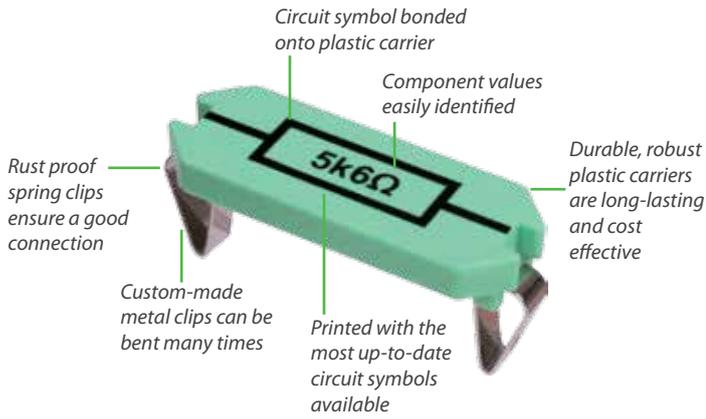


Power supplies



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# Why choose Locktronics?

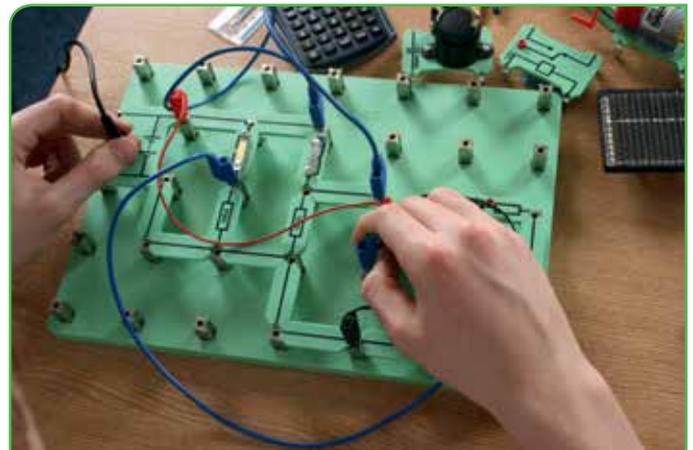


## Theory



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

## Application



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

## 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

## Understanding



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

# Choosing your Locktronics package

In 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 over 25 curriculum packs that you can see on page 10. 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 26.

## 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.

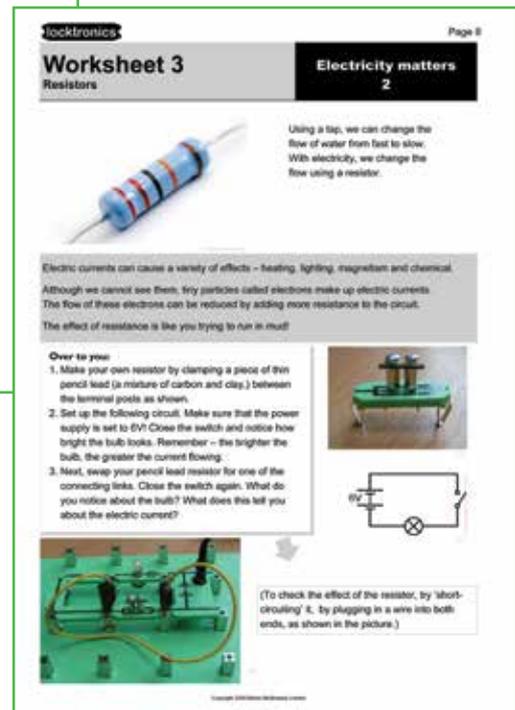
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# Curriculum packs



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

Description	Part No.	Language
Fundamentals of electricity (primary)	LK6816	
Introduction to the transistor	LK4556	
Basic and extended logic workbook	LK6920	
Operational amplifiers	LK3061	
Transistor linear applications	LK7003	
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	
Intermediate electronic engineering	LK8293	
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	LK8821	
An introduction to digital electronics	LK9392	
Operational amplifiers	LK3061	
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	
Further electrical and electronic engineering	LK4583	
PICmicro getting started guide	LK8741	



'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 25 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 available.

Most curriculum packs are provided free of charge with relevant solutions. Curriculum packs are supplied in PDF format on CD ROM.

# MIAC technology



## Features

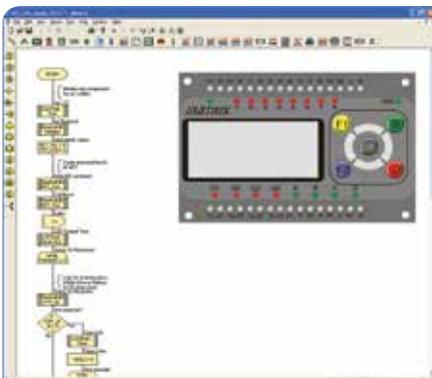
- The world's only educational Electronic Control Unit
- A flexible resource with many uses in many areas of engineering
- Physically and electrically rugged
- Compatible with Flowcode, C, Assembly, LabView and Visual Basic
- 8 digital or analogue inputs, 4 relay outputs, 4 motor outputs with speed control,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

# 2

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

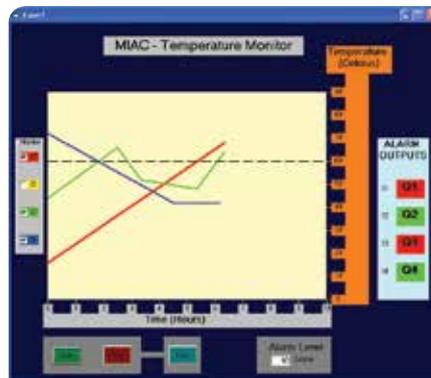
networked together. The MIAC is available in a rugged plastic case with all connections made available using 4mm shrouded 'banana' sockets. The status of all I/O lines is indicated with an individual LED. A keypad and 4 line 16 character display facilitate

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.



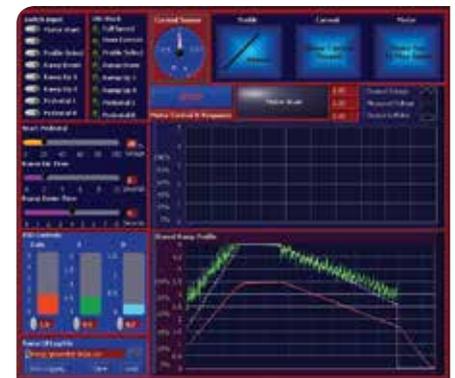
## Use with Flowcode...

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.



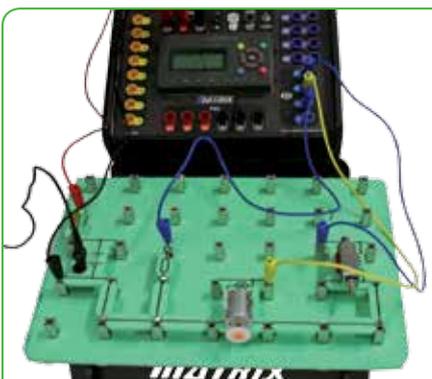
## ...Visual Basic...

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.

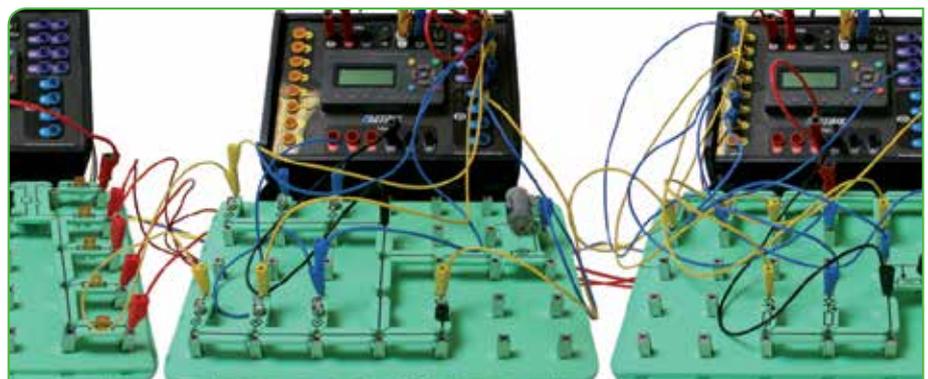


## ...or LabView

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



MIAC used to demonstrate sense and control in an industrial context.



MIAC and Locktronics used to study the role of ECUs in an automotive system.



## 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. (In the UK suitable for KS1 and KS2 Science units 2F, 4F, 6G).

### 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

Components included			
1	Curriculum CD ROM	3	MES bulb, 6.5V, 0.3A
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 holder	1	Lead, red, 500mm, 4mm to 4mm stackable
2	MES bulb, 2.5V, 0.2A	1	Lead, black, 500mm, 4mm to 4mm stackable
Ordering information		DIN	ANSI
Fundamentals of electricity with baseboard, storage tray and DC power supply.		LK6444	LK6444A
Corresponding curriculum		LK6816	



## 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. Suitable for pupils from age 11 upwards. (In the UK suitable for KS3 and KS4).

### 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	Light dependent resistor	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	Curriculum CD ROM
9	Connecting Link	1	Buzzer, 12V, 15mA
3	Lampholder, MES	1	Switch, on/off, metal strip
1	7 x 5 metric baseboard with 4mm pillars	1	Resistor, 100 ohm, 1W, 5% (DIN)
1	Ammeter, 0A to 1A	1	EMM V2 Accessories pack
Ordering information		DIN	ANSI
Electricity, magnetism and materials solution with storage, baseboard and power supply.		LK9071	LK9071A
Corresponding curriculum		LK7325 & LK7326	



## 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		
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### Components included

1	Power supply carrier with battery symbol	1	Lead, yellow, 500mm, 4mm to 4mm stackable
1	USB reprogrammable PIC carrier with power lead	2	Lead, black, 500mm, 4mm to 4mm stackable
2	Thermistor, 470 ohm, NTC (DIN)	2	Lead, red, 500mm, 4mm to 4mm stackable
1	Light dependent resistor	1	Lampholder, MES, for automotive LEDs
2	Lampholder, MES	2	Switch, push to make, metal strip
12	Connecting Link	1	Locktronics User Guide
1	Solar cell	1	MES bulb, 6.5V, 0.3A
1	Hand cranked generator	1	Potentiometer, 10k (DIN)
1	MES bulb, 6V, 0.04A	1	Resistor, 1k, 1/4W, 5% (DIN)
1	Slotted opto sensor with 2mm to 4mm lead	1	7 x 5 metric baseboard with 4mm pillars
2	Power supply	1	Energy Meter
1	Capacitor, 22,000uF, Electrolytic 16V	1	Resistor, 270 ohm, 1/2W, 5% (DIN)
1	LED, red, 5V (SB)	1	Curriculum CD ROM
1	MES bulb, 12V, LED, white		

### Ordering information

	DIN	ANSI
Energy and environment solution including storage, power supply and energy meter.	LK7345	LK7345A
Corresponding curriculum	LK7122	



## 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 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. Suitable for students of Physics aged 16 to 18.

### Note

To add PICmicro investigation to this kit see page 14.  
To add Operational amplifier investigation to this kit see page 17.

### 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, 5.6k, 1/4W, 5% (DIN)
1	1:1 transformer with retractable ferrite core	1	Transformer, 2:1 turns ratio
1	Capacitor, 22,000uF, Electrolytic 16V	1	Resistor, 3.9 ohm, 3W, 5% (DIN)
1	Light dependent resistor	1	Potentiometer, 250 ohm (DIN)
1	Thermistor, 4.7k, NTC (DIN)	1	Curriculum CD ROM
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	3	Lampholder, MES

### Ordering information

	DIN	ANSI
Electrical and electronic principles solution with storage, baseboard and power supplies.	LK9329	LK9329A
Corresponding curriculum	LK7664 & LK7773	



## 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)	1	NOT Gate with 2mm to 4mm lead - ANSI
2	MES bulb, 6.5V, 0.3A	2	Lead, red, 300mm, 4mm to 2mm stackable
2	Capacitor, 10 uF, Electrolytic, 25V	2	Lead, blue, 500mm, 4mm to 4mm stackable
1	Capacitor, 4.7uF, electrolytic, 25V	2	Lead, yellow, 500mm, 4mm to 4mm stackable
1	Capacitor, 1 uF, Polyester	1	Lead, black, 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

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



## PICmicro microcontroller systems investigation

This new kit allows students to investigate circuits and systems based on the popular PICmicro microcontroller. The kit focuses on system construction with a pre-programmed PIC carrier which includes 8 programs, selectable by hardware switches. The work can be extended to include programming of PICmicro® microcontrollers using flowcharts with our Flowcode software. A full curriculum pack is included.

### Learning objectives / experiments

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

### Components included

1	Power supply	1	LED, yellow, 5V (SB)
1	USB reprogrammable PIC carrier with power lead	1	MES bulb, 6.5V, 0.3A
1	Light dependent resistor		Locktronics User Guide
2	Resistor, 10k, 1/4W, 5% (DIN)	1	USB2 high speed A to mini B lead
16	Connecting Link	2	Lead, yellow, 500mm, 4mm to 4mm stackable
1	Lampholder, MES	1	Thermistor, 4.7k, NTC (DIN)
2	Switch, push to make, metal strip	1	Transistor RHF, NPN
2	Switch, on/off, metal strip	1	Motor 3 to 12V DC, 0.7A
1	Buzzer, 6V, 15mA	1	Resistor, 2.2k, 1/4W, 5% (DIN)
1	Curriculum CD ROM	1	7 x 5 metric baseboard with 4mm pillars
1	Potentiometer, 10k (DIN)	1	Power supply carrier with battery symbol
2	LED, red, 5V (SB)	1	Resistor, 100 ohm, 1W, 5% (DIN)
1	LED, green, 5V (SB)	1	Resistor, 1k, 1/4W, 5% (DIN)

Ordering information	DIN	ANSI
PICmicro systems solution with storage tray, baseboard and power supply	LK8922	LK8922A

### PICmicro microcontroller add-on-kit

1	Resistor, 10k, 1/4W, 5% (DIN)	1	Locktronics User Guide
1	Buzzer, 6V, 15mA	1	Thermistor, 4.7k, NTC (DIN)
2	LED, red, 5V (SB)	2	Lead, yellow, 500mm, 4mm to 4mm stackable
1	LED, yellow, 5V (SB)	1	Resistor, 2.2k, 1/4W, 5% (DIN)
1	LED, green, 5V (SB)	1	Curriculum CD ROM
1	Motor 3 to 12V DC, 0.7A	1	Transistor RHF, NPN
1	Switch, push to make, metal strip	7	Connecting Link
1	USB reprogrammable PIC carrier with power lead	2	Switch, on/off, metal strip
1	Resistor, 100 ohm, 1W, 5% (DIN)		

Ordering information	DIN	ANSI
PICmicro microcontroller add-on kit	LK5822	LK5822A
Corresponding curriculum	LK7209	



## 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



## Intermediate electronic engineering

This solution provides a broad-based introduction to electronics and provides substantial syllabus coverage of the relevant BTEC First Award (Unit 8). 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

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

# 2

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	Light dependent resistor	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 Curriculum CD ROM	
9	Connecting Link	1 Buzzer, 12V, 15mA	
3	Lampholder, MES	1 Switch, on/off, metal strip	
1	7 x 5 metric baseboard with 4mm pillars	1 Resistor, 100 ohm, 1W, 5% (DIN)	
1	Ammeter, 0A to 1A	1 EMM V2 Accessories pack	
Ordering information		DIN	ANSI
Electricity, magnetism and materials solution with storage, baseboard and power supply.		LK9071	LK9071A
Corresponding curriculum		LK7325 & LK7326	

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 Switch, on/off, metal strip	
1	7 x 5 metric baseboard with 4mm pillars	2 Resistor, 100k, 1/4W, 5% (DIN)	
2	Transistor RHF, NPN	2 Resistor, 10k, 1/4W, 5% (DIN)	
1	Transistor RHF, PNP	2 LED, red, 5V (SB)	
1	1:1 transformer with retractable ferrite core	1 Resistor, 100 ohm, 1W, 5% (DIN)	
1	Voltmeter, +/- 7.5V	18 Connecting Link	
1	Op Amp Carrier (TL081) with 2mm to 4mm Lead	1 Power supply carrier with battery symbol	
1	Speaker	2 Resistor, 1k, 1/4W, 5% (DIN)	
1	Motor 3 to 12V DC, 0.7A	1 Potentiometer, 10k (DIN)	
2	Power supply	2 Capacitor, 0.47 uF, Polyester	
2	Lead, blue, 500mm, 4mm to 4mm stackable	1 Thermistor, 4.7k, NTC (DIN)	
1	Voltmeter, 0V to 15V	1 Capacitor, 47uF, Electrolytic, 25V	
1	Curriculum CD ROM	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	Light dependent resistor	2 Capacitor, 4.7uF, electrolytic, 25V	
1	Switch, push to make, metal strip		
Ordering information		DIN	ANSI
Intermediate electronic engineering solution with storage, baseboard and power supply.		LK3889	LK3889A
Corresponding curriculum		LK8293	



## Further electrical and electronic engineering

This kit, with its accompanying workbook, is intended to reinforce the learning that takes place in the classroom or lecture room for intermediate level courses such as the BTEC National (QCF Level 3) unit in Electrical and electronic principles (J/600/0255). The 70 page workbook provides a series of practical activities and investigations that are designed to complement the BTEC syllabus 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		
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### 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	1:1 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
1	Curriculum CD ROM	3	Lampholder, MES
2	Pair of leads, red and black, 600mm, 4mm to croc clips	1	Capacitor, 150 uF, Electrolytic, 25V
2	Lead, blue, 500mm, 4mm to 4mm stackable	1	Capacitor, 100uF, Electrolytic, 25V
1	Diode, germanium	1	Resistor, 2.2k, 1/4W, 5% (DIN)
1	7 x 5 metric baseboard with 4mm pillars	1	Small bar magnet
1	Diode, power, 1A, 50V	1	Bridge rectifier

Ordering information	DIN	ANSI
Further electrical and electronic engineering solution.	LK9862	LK9862A
Corresponding curriculum	LK4583	



## Advanced electrical principles

The kit provides practical experiments that tie into electrical principles at an advanced level and allows students to marry theoretical work in AC and DC theory with practical measurements and understanding. It is suitable for those studying electrical or electronic engineering at college or university level and is modelled on the UK BTEC High National syllabus.

### Learning objectives / experiments

- Resistors in series and parallel
- Kirchoff's laws
- Superposition theorem
- Thevenin's theorem
- Max power transfer theorem
- Inductive and capacitive reactance
- RLC circuits
- Series and parallel resonance
- Q factor and bandwidth

### Instruments

To deliver this course you will also need:

LK1110	Multimeter pack	HP8279	Picoscope
HP7894	Signal generator		

### Components included

2	Power supply	1	Resistor, 2.2k, 1/4W, 5% (DIN)
3	Resistor, 10k, 1/4W, 5% (DIN)	1	Resistor, 1k, 1/4W, 5% (DIN)
1	Resistor, 270 ohm, 1/2W, 5% (DIN)	2	Power supply carrier with voltage source symbol
1	Resistor, 5.6k, 1/4W, 5% (DIN)	1	Locktronics current probe
12	Connecting Link	1	Curriculum CD ROM
1	Resistor, 330k, 1/4W, 5% (DIN)	1	General purpose lead set (LK5603 x 2, LK5604 x 2)
2	Capacitor, 1 uF, Polyester	1	Locktronics User Guide
1	Resistor, 22k, 1/4W, 5% (DIN)	1	Resistor, 10 ohm, 1W 5% (DIN)
1	Resistor, 15k, 1/4W, 5% (DIN)	1	Resistor, 47 ohm, 1/2W, 5% (DIN)
1	Choke, 47mH	1	7 x 5 metric baseboard with 4mm pillars

Ordering information	DIN	ANSI
Advanced electrical principles solution.	LK9043	LK9043A
Corresponding curriculum	LK8473 DC & LK8749 AC	



## 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

### 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 Light dependent resistor	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 Curriculum CD ROM
1 Thermistor, 4.7k, NTC (DIN)	1 MIAC Getting Started Guide
1 LED, yellow, 12V (SB)	1 7 x 5 metric baseboard with 4mm pillars
1 Lead, black, 500mm, 4mm to 4mm stackable	1 MES bulb, 14V, 0.06A

### Ordering information

	DIN	ANSI
Industrial sensor, actuator and control applications solution with storage trays, power supply and leads.	LK5783	LK5783A

### Ordering information

	DIN	ANSI
Industrial sensor, actuator and control applications with storage trays, PSU, leads and engineering panel	LK6499	LK6499A

Corresponding curriculum LK8739



## Operational amplifiers

This solution contains experiments that 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 students' 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

### Components included

1 7 x 5 metric baseboard with 4mm pillars	1 Voltmeter, +/- 7.5V
3 Resistor, 1k, 1/4W, 5% (DIN)	2 Power supply
1 LED, green, 12V (SB)	1 Locktronics User Guide
1 LED, red, 12V (SB)	1 Curriculum CD ROM
2 Lead, red, 500mm, 4mm to 4mm stackable	1 Op Amp Carrier (TL081) with 2mm to 4mm Lead
3 Lead, black, 500mm, 4mm to 4mm stackable	2 Potentiometer, 10k (DIN)
1 Lead, blue, 500mm, 4mm to 4mm stackable	1 Low power solar motor
1 Dual rail power supply carrier	1 Capacitor, 0.1 uF, Polyester
1 Thermistor, 470 ohm, NTC (DIN)	2 BNC male to dual 4mm binding post
3 Resistor, 10k, 1/4W, 5% (DIN)	1 Capacitor, 1 uF, Polyester
1 Speaker	1 Resistor, 100 ohm, 1W, 5% (DIN)
1 AC voltage source carrier	1 Light dependent resistor
1 Capacitor, 100uF, Electrolytic, 25V	18 Connecting Link

### Ordering information

	DIN	ANSI
Operational amplifiers solution, including storage, baseboard and DC power supply.	LK7148	LK7148A

The Operational amplifiers add-on kit can be added to the Electrical and Electronic principles pack:

### 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, 12V (SB)
1 Low power solar motor	1 LED, green, 12V (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



## 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.

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

### Ordering information

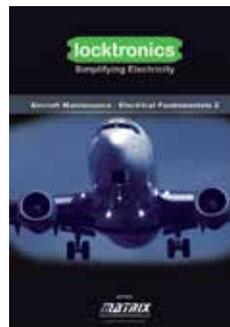
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EASA electrical fundamentals solution including storage trays, baseboard, DC (multinational) and AC (UK) power supplies.	LK9339
Corresponding curriculum	LK7378, LK7381, LK7393 & LK7415



## 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

**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.

#### 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	Curriculum CD ROM	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	LK9282
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



### 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



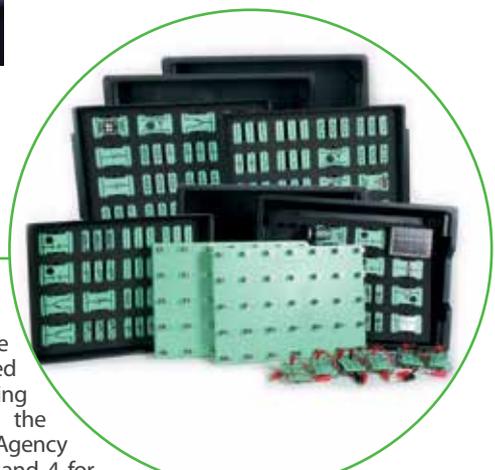
### EASA Electronic fundamentals 3

- 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



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.

# Automotive

The Locktronics automotive range has been designed to meet the training requirements of both industry and education. The range is split into three levels for basic, intermediate and advanced students. For each level Locktronics hardware solutions and curriculum packs are provided.

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 circuits and carrying out the associated experiments.

## Level 1

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

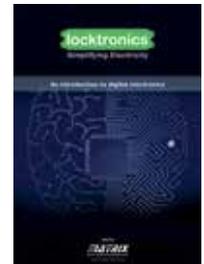
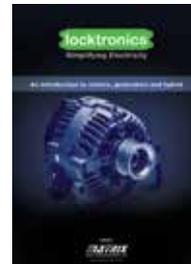
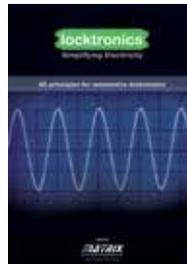
## Level 1



## 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.

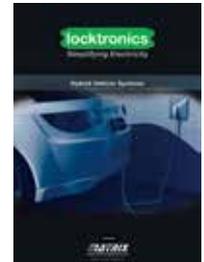
## Level 2



## 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.

## Level 3



## 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:



## Unique programmable ECU technology

Our more advanced sensors and control and CAN bus modules are based on the Matrix MIAC controller: the World's only Electronic Control Unit designed for automotive training.



## 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

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	Light dependent resistor	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	Curriculum CD ROM
9	Connecting Link	1	Buzzer, 12V, 15mA
3	Lampholder, MES	1	Switch, on/off, metal strip
1	7 x 5 metric baseboard with 4mm pillars	1	Resistor, 100 ohm, 1W, 5% (DIN)
1	Ammeter, 0A to 1A	1	EMM V2 Accessories pack
Ordering information		DIN	ANSI
Electricity, magnetism and materials solution with storage, baseboard and power supply.		LK9071	LK9071A
Corresponding curriculum		LK7325 & LK7326	



## 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	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	Curriculum CD ROM
1	Diode, power, 1A, 50V	1	Bridge rectifier
Ordering information		DIN	ANSI
AC principles for automotive technicians solution including storage trays, baseboard and power supply.		LK8222	LK8222A
Corresponding curriculum		LK8392	

# 2



## 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 conductors 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

### 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	Faraday's law kit
1	Power supply	1	Curriculum CD ROM
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	1:1 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, 2,200 uF, Electrolytic, 25V		

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



## 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		
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### Components included

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

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

If you would like a combined kit that allows you to deliver all level 2 automotive courses (AC principles, Motors and generators, and Digital electronics) then please ask us about our LK4500 combined solution.



## 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.

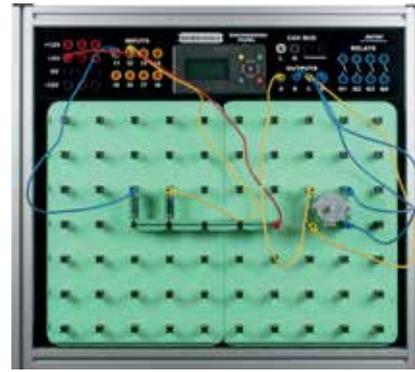
### Learning objectives / experiments

- 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	Curriculum CD ROM
2	Resistor, 1k, 1/4W, 5% (DIN)	1	Locktronics User Guide
1	Capacitor, 4,700 uF, Electrolytic, 16V	1	Hall effect switch
1	Potentiometer, 10k (DIN)	1	Buzzer, 12V, 15mA
1	Relay, 12V coil, 10A, normally open	1	Light dependent resistor
1	Solenoid	1	7 x 5 metric baseboard with 4mm pillars
1	Stepper Motor	6	Lead, yellow, 500mm, 4mm to 4mm stackable
1	LED, red, 12V (SB)	6	Lead, blue, 500mm, 4mm to 4mm stackable
1	Transistor RHF, NPN	1	Lead, black, 500mm, 4mm to 4mm stackable
1	Automotive fuse carrier	1	Lead, red, 500mm, 4mm to 4mm stackable
2	Switch, on/off, metal strip	1	Cased MIAC with Shrouded 4mm Connectors
4	Switch, push to make, metal strip	1	Small bar magnet
1	Power supply	16	Connecting Link
1	Power supply carrier with battery symbol	1	MES bulb, 14V, 0.06A
1	Resistor, 10k, 1/4W, 5% (DIN)	1	MIAC Getting Started Guide
1	Lampholder, MES	1	MES bulb, 12V, LED, white
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	



## 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

# 2



## CAN bus make-up kit

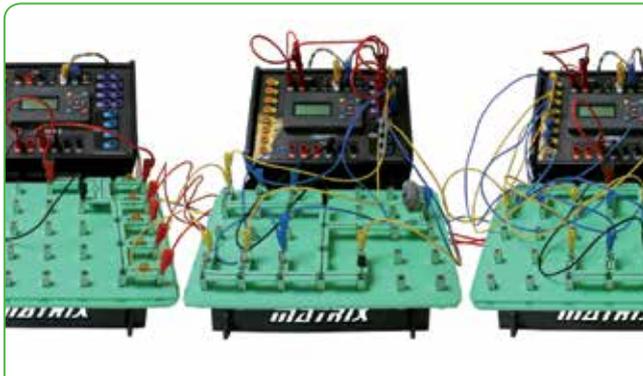
The LK9813 CAN bus make-up kit allows you to transform 5 sensors and control in automotive solutions into a CAN bus systems and operations solution.

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



## CAN bus systems and operation

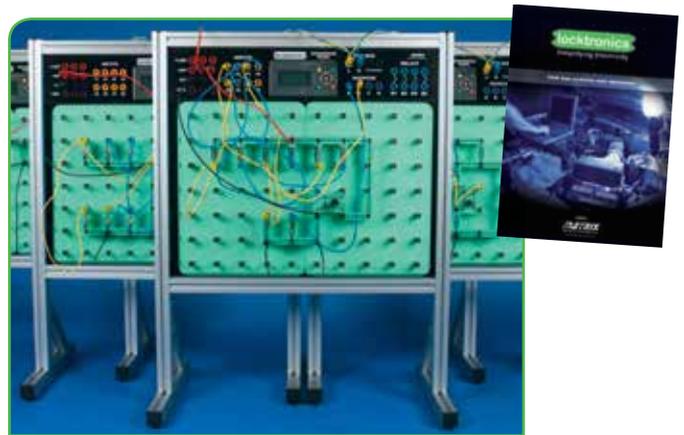
This kit allows a fully functioning CAN bus system, mimicking vehicle operation, to be set up using 5 MIAC Electronic Control Units representing Instrument Panel, Front ECU, Powertrain control, Rear ECU and system diagnosis. Students can set up a fully working CAN bus system, insert faults and use scan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



### Components included

1	MIAC Getting Started Guide	5	7 x 5 metric baseboard with 4mm pillars
5	Cased MIAC with Shrouded 4mm Connectors	1	Locktronics User Guide
1	OBD2 to 4mm Lead	53	Connecting Link
9	Lead, black, 500mm, 4mm to 4mm stackable	1	Lead, D-type to yellow and blue 4mm for CAN analyser
19	Lead, red, 500mm, 4mm to 4mm stackable	1	USB2 high speed A to mini B lead
4	Lead, red, 2000mm, 4mm to 4mm plug	1	USB CAN sniffer
24	Lead, yellow, 500mm, 4mm to 4mm stackable	6	Switch, on/off, metal strip
24	Lead, blue, 500mm, 4mm to 4mm stackable	4	MES bulb, 12V, LED, red
13	Lampholder, MES, for automotive LEDs	5	MES bulb, 12V, LED, white
3	Switch, push to make, metal strip	4	MES bulb, 12V, LED, yellow
6	Resistor, 1k, 1/4W, 5% (DIN)	1	Motor 3 to 12V DC, 0.7A
1	Relay, 12V coil, 10A, normally open	4	Potentiometer, 10k (DIN)
1	Buzzer, 12V, 15mA	4	Power supply
5	Automotive fuse carrier	1	Resistor, 560 ohm, 1/4W, 5% (DIN)
2	Resistor, 68 ohm 1/2W, 5% (DIN)	1	Zener diode, 8.2V
1	Curriculum CD ROM	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	

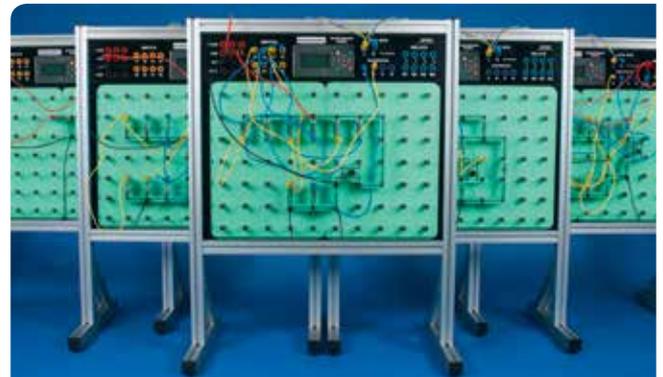


## CAN bus systems and operation solution with engineering panel

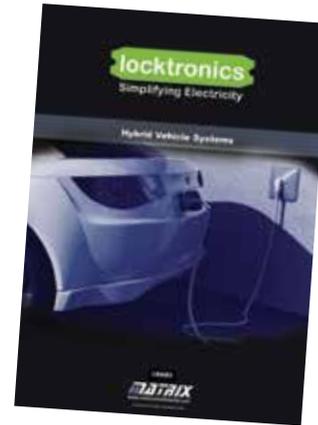
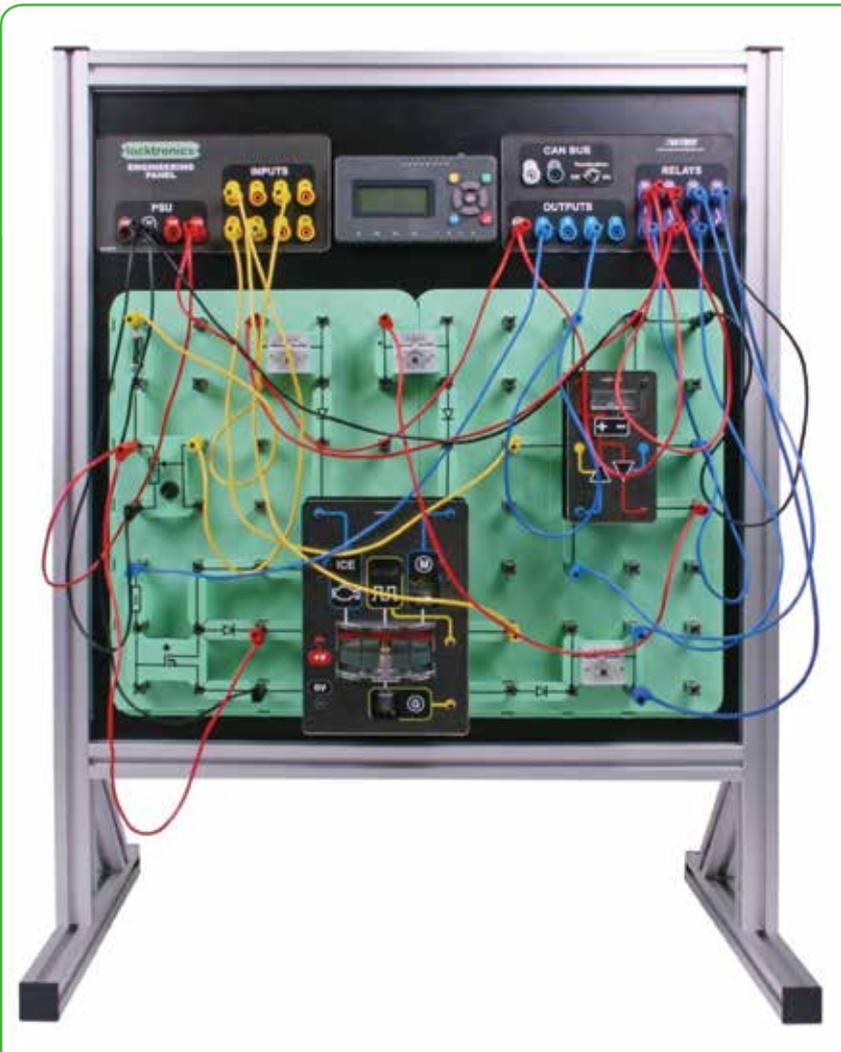
The LK2839 CAN has the same learning objectives and components as the LK7629 but is based on our engineering panel which makes it more suitable for a dedicated automotive electrical training lab.

### Learning objectives / experiments

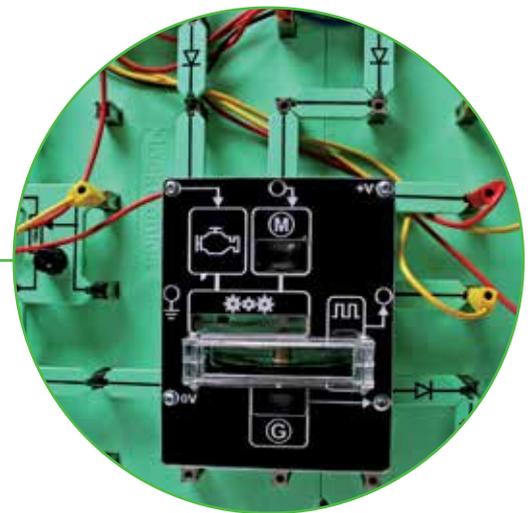
- ECU action and function
- Automotive control systems
- Wiring in CAN bus systems
- CAN bus faults
- Faults in sensors and actuators



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



# 2



## 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	Hybrid principles inlay (DIN)	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	1	Switch, push to make, metal strip

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



# Individual components



## 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



## 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
Picoscope 4223 automotive oscilloscope	HP3829



## 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
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, red, 2000mm, 4mm to 4mm stackable		LK5674
Lead, black, 300mm, 4mm to 2mm stackable	LK5556E	LK5556
General purpose lead set (LK5603 x 2, LK5604 x 2)		LK8022
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
Fuse	LK8623
Protoboard	LK4893



## 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
Locktronics current probe	LK5100
MES bulb, 12V, LED, red	LK6749
MES bulb, 12V, LED, yellow	LK6822
MES bulb, 12V, LED, white	LK6841
Earphone/microphone with leads	LK5270
400 turn induction coil	LK5299
Ferrite rod	LK3290
Curriculum CD ROM	LK6492
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
Locktronics mini prototype board	LK4839
Circuit breaker	LK8623
OBDII lead	LK5697



## Packaging and storage

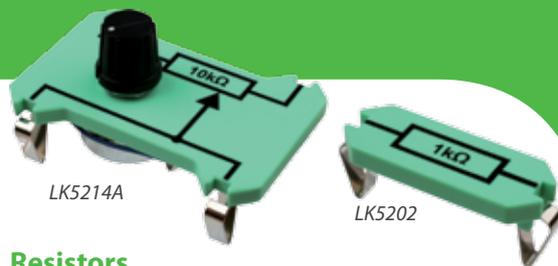
Description	Part number
Deep tray	HP5540
Tray lid	HP4039
62mm daughter tray	HP9564
Daughter tray foam insert	HP7750
18 tray trolley	HP3025N
12 tray trolley	HP2025Q

# Individual components



## Capacitors

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, 2200µF, Electrolytic, 16V	LK3662
Capacitor, 10µF, Electrolytic, 25V	LK5221
Capacitor, 47µF, Electrolytic, 25V	LK5224
Capacitor, Variable, 15-140PF	LK6214
Capacitor, 1nF, Polyester	LK6239



## Resistors

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

Description	Part no. DIN	Part No. ANSI
Resistor, 3.9Ω, 3W, 5%	LK5211	
Resistor, 10Ω, 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	
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	



## Inductors

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



## Logic gates - CMOS

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

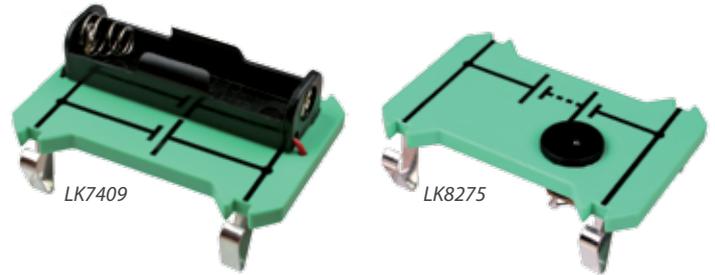
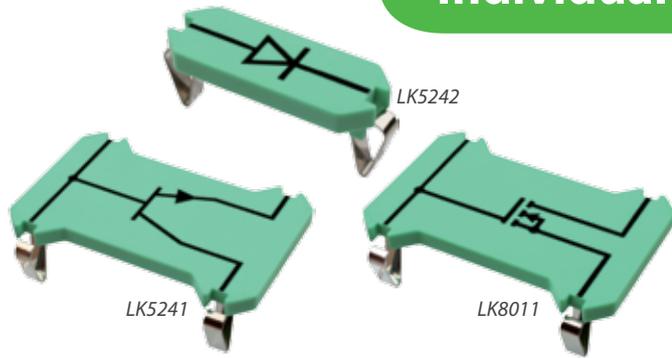
Description	Part no. SB 2mm to 2mm	Part no. ANSI 2mm to 2mm	Part no. SB 2mm to 4mm	Part no. ANSI 2mm to 4mm
AND gate with lead	LK6870LE	LK6860LE	LK6870L	LK6860L
NAND gate with lead	LK6873LE	LK6863LE	LK6873L	LK6863L
NOR gate with lead	LK6874LE	LK6864LE	LK6874L	LK6864L
NOT gate with lead	LK6872LE	LK6862LE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

## 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'. Gates are also available with 2mm to 2mm leads for use in labs where only 2mm connectors are allowed - 'LE'.

Description	Part number	
Systems block transistor switch	LK6831L	
Systems block transducer driver	LK6832L	
Description	2mm to 2mm	2mm to 4mm
555 timer	LK6300LE	LK6300L
Op Amp module (TL081)	LK6234LE	LK6234L
Voltage regulator (7805)	LK7208LE	LK7208L
Flip-flop, horizontal carrier	LK6500LE	LK6500L
Flip-flop, vertical carrier	LK6501LE	LK6501L

# Individual components



## 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	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



## Electromechanical

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

## 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

## 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	LK7889
Relay, reed, changeover	LK4103
Relay, reed, normally open	LK5405
Relay, 12V coil, 10A changeover with 2mm to 4mm lead	LK7049



## Power supplies

Description	Part number
Adjustable DC power supply, 3V to 13.5V, 1.6A, 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

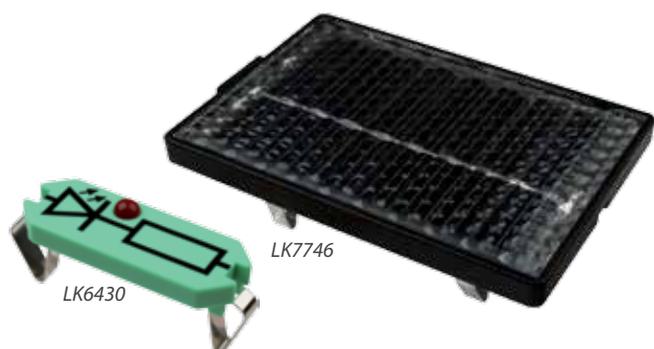
Dimensions  
W: 60cm x H: 78cm



## Engineering panel

Description	Part number
Engineering panel with built in MIAC controller, with UK power supply	HP2673

# Individual components



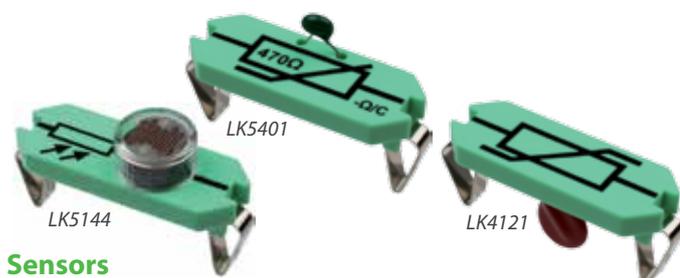
## Optoelectric and lights / lamps

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	



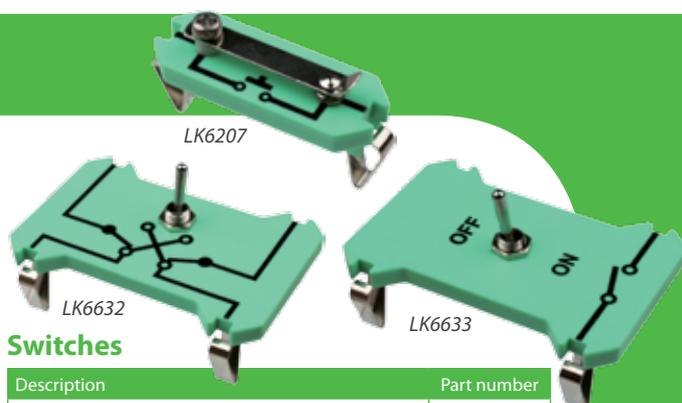
## Motors / generators

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 reductor	LK8113



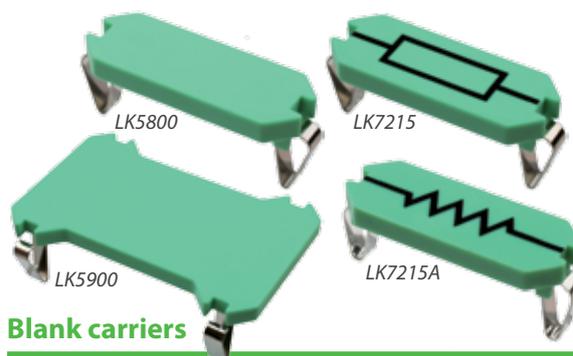
## Sensors

Description	Part no. DIN	Part no. ANSI
Hall effect switch	LK6734	
Light dependent resistor	LK5144	LK5144A
Photodiode	LK7361	
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	LK6707	
Magnetic pickup	LK8743	



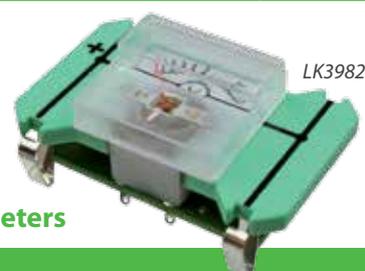
## Switches

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



## 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	



## 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



## Resistivity carriers

Description	Part number
Nichrome 0.075mm <sup>2</sup> x 500mm	LK8150
Nichrome 0.075mm <sup>2</sup> x 250mm	LK8152
Nichrome 0.21mm <sup>2</sup> x 500mm	LK8154
Constantan 0.075mm <sup>2</sup> x 500mm	LK8156

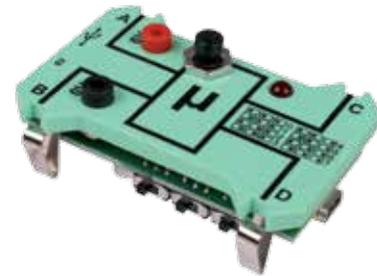
# Individual components



## 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. This product is compatible with the free (2K code limit) version of Flowcode.

Description	Part number
USB reprogrammable PICmicro MCU with 2mm to 4mm lead	LK4690L
Replacement chip for Locktronics PIC	LK8372
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



## 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

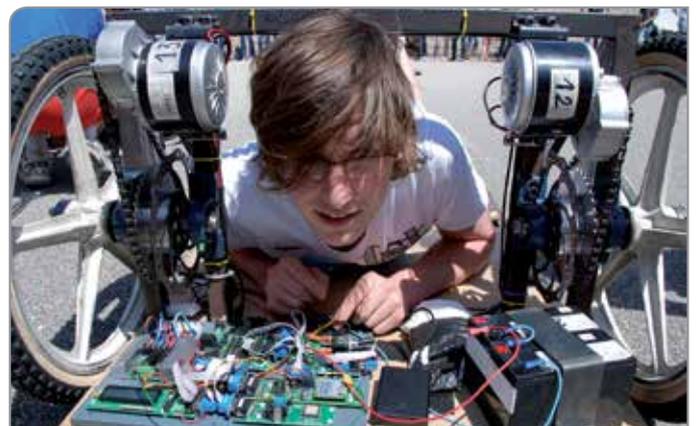
This apparatus is used to demonstrate the fact that a force is exerted on a current-carrying conductor when it is placed in a magnetic field. The apparatus consists of three parts - a large Locktronics carrier with two parallel wires, a powerful magnetic yoke with North and South poles clearly visible, 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



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A student in INSA Lyon, France, with a machine developed with E-blocks and Flowcode.

## ***Institution focus - INSA Lyon***

*The Institution of Applied Science in Lyon is one of the best Technological Higher Education Establishments in Europe graduating over 800 engineers each year in 12 fields of specialisation.*

*Over a 5 year curriculum it trains humanist multi-competent engineers who must be both*



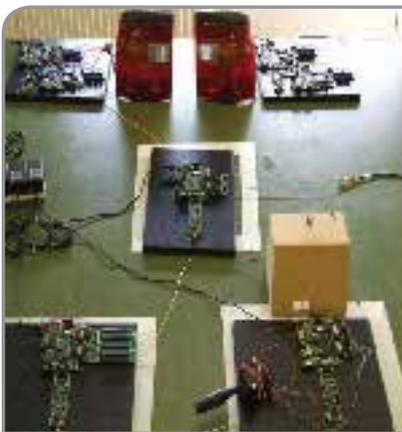
## ***INSA Lyon 2011***

*In this project students were challenged with developing a mobile robot platform which could carry one person around a building. The students were charged with designing the mechanics and the electrical systems. The students used both Flowcode and E-blocks to develop the final system. In order to debug the final design students used an E-blocks Wi-fi board to communicate to an Android tablet which was programmed to show the vehicle parameters in numerical and graphical format. The vehicle can also be driven remotely using the tilt sensor on the tablet.*

*innovative and entrepreneurial. Each year INSA Lyon challenges its engineering students with a team based electromechanical project that students must complete. Often these projects are designed to be competitive within the department.*

## ***INSA Lyon 2012***

*In this project several teams of students were challenged to make a vehicle that could carry one person around a small course with two tunnels. The four students in the team has to each drive the vehicle around one lap.*



*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.*

# What are E-blocks?

## Simplifying Technology & Electronic Systems

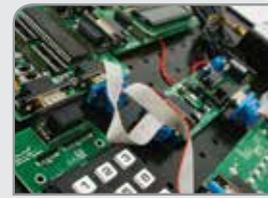
E-blocks modules provide learners and developers with a flexible suite of electronics blocks that snap together to form a wide variety of electronic systems.

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 CPLD/FPGA technologies 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

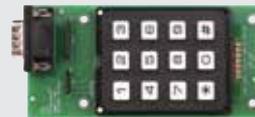


## The E-blocks range includes:



## 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

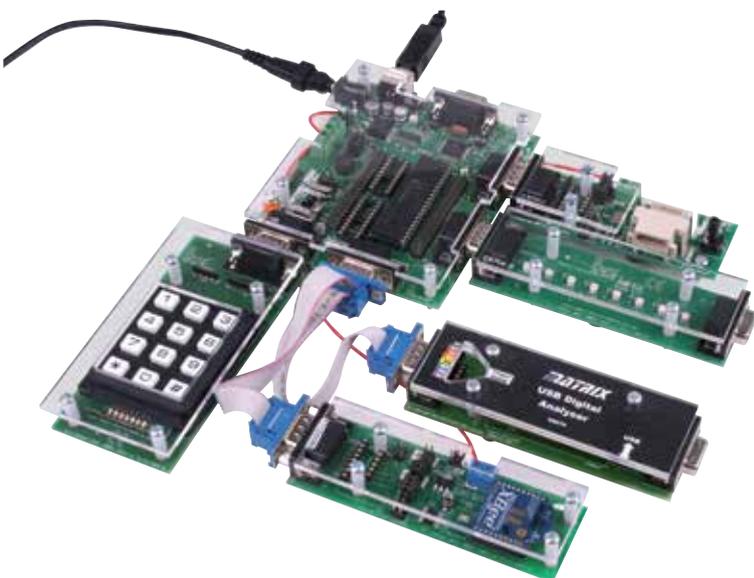


Accessories



Test instruments

# 3



# Why choose E-blocks?

## 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

## 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 compability

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

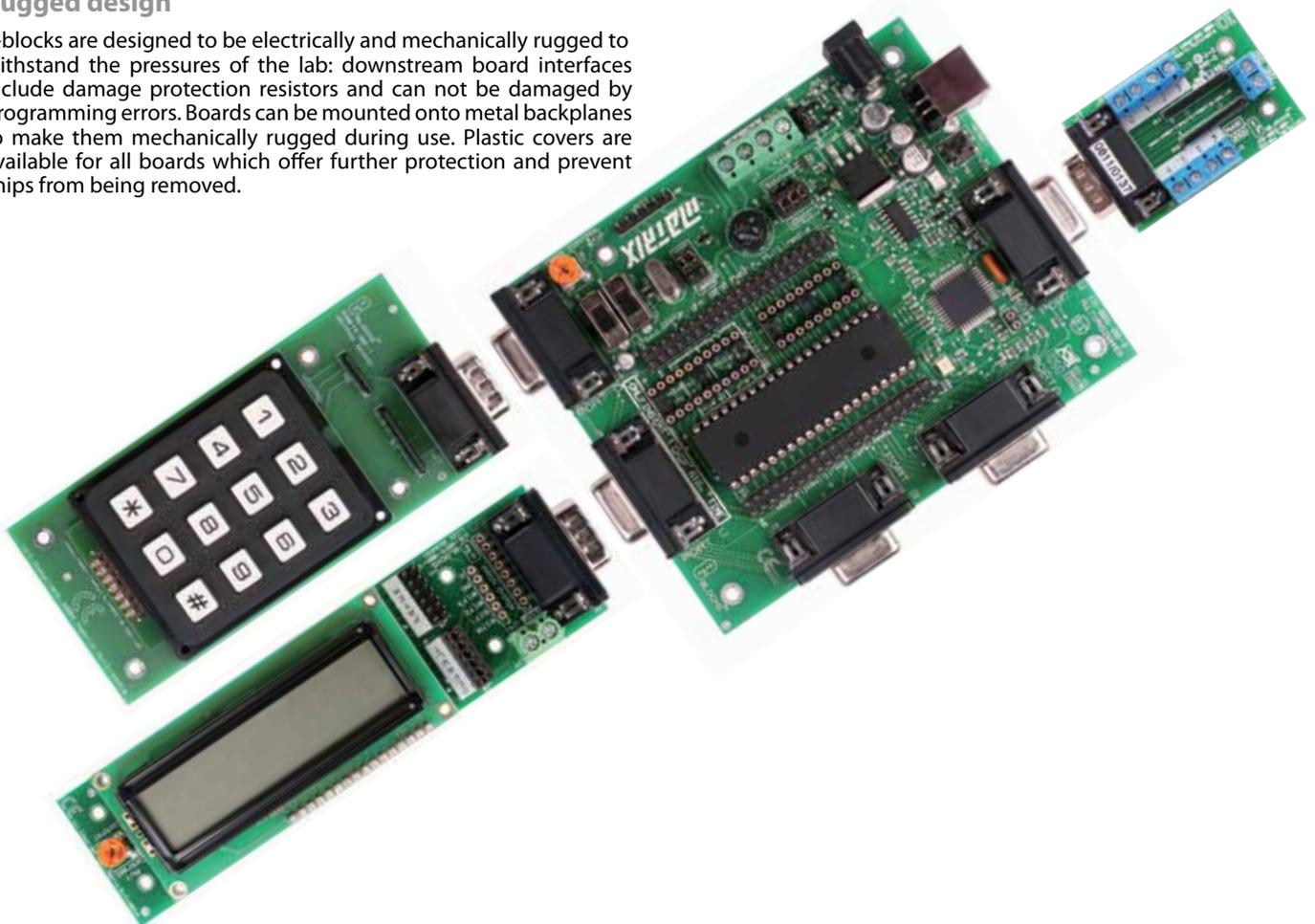
The Matrix development team provides excellent support for our products online through our very active forums. Additional support is provided by our network of valued contributors via our forums.

## Tight integration with Flowcode

E-blocks are tightly integrated with Flowcode version 6 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 is a PC-side technology which, when combined with Flowcode, 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 on the Flowcode Softscope 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'.

When this data is combined with the PC-side processing capabilities of Flowcode it provides a very powerful debugging and learning tool. As an example of this the 5 steps on the right show how a stream of GPS digital data is gathered from the E-blocks system and processed into layers of meaningful information to help the design process.

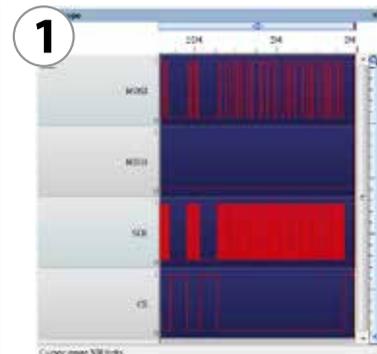
This saves huge amounts of development time - whether you are working at a pin level and getting your first program to work, or whether you are an advanced user wanting to perform a sanity check to make sure communications baud rates are set at the correct speed.

Both analogue and digital data is gathered through Ghost and displayed on the Flowcode Softscope. For 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 is watching you!



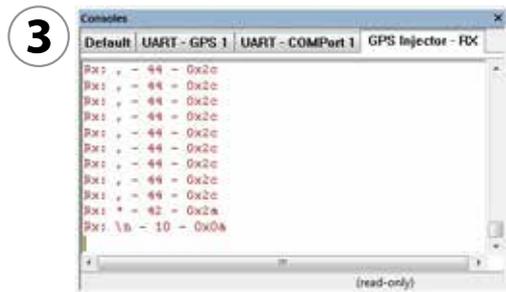
The GHOST chip on our new EB006 PICmicro Multiprogrammer enables advanced In-Circuit-Debug features.



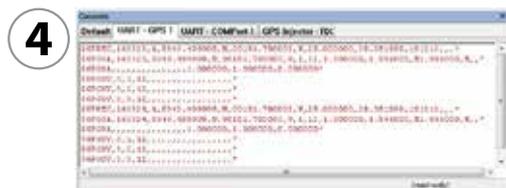
1 Real-time pin data is logged via USB and displayed on the Flowcode Softscope window...



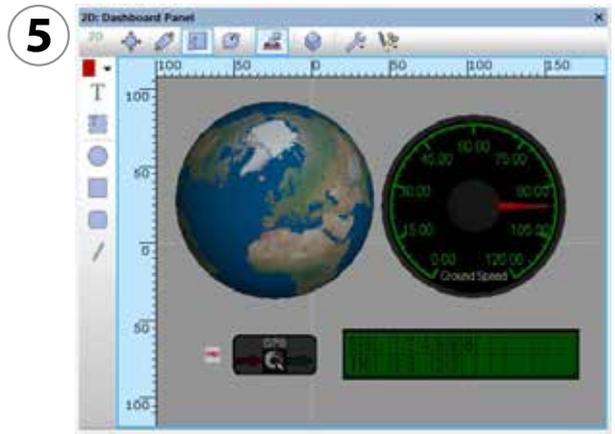
2 ...an I2C overlay is put on top of the trace by PC-side functions, so you can see the ASCII datastream...



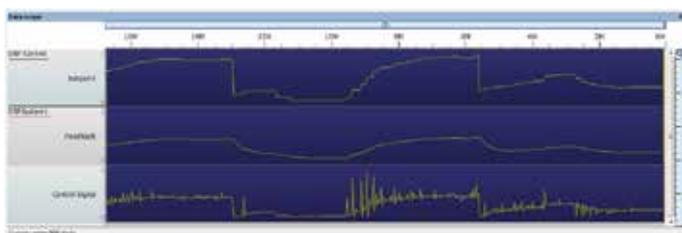
3 ...the Flowcode console displays incoming low level ASCII data on the input tab...



4 ...which is decoded to high level data and displayed on the GPS tab...



5 ... a Flowcode component, powered by PC-side software, transforms the data to show World position, location and speed of movement in human friendly format.



Analogue pin data from a PID control system based on E-blocks is gathered by Ghost and displayed on the Flowcode Softscope

3

## Starter packs

**Starter packs are designed with educational institutions in mind: they provide a cost effective way of purchasing E-blocks for general lab use.**

Each starter pack includes a device programmer board and a number of E-blocks application boards which are suitable for general lab use. The starter packs include a power supply, cables, a rugged metal backplane for mounting E-blocks on, quick snap mounting pillars, nuts and bolts, and storage trays. For each starter pack a software download utility is provided which allows you to download your program to the device.

Students can use the boards in the starter packs for learning microcontroller programming and also as a basis for project work. The packs include small plastic mounting pillars which snap into the E-blocks boards and allow them to be quickly mounted onto a metal backplane to provide a physically stable and rugged development system. The packs are compatible with a range of learning courses from Matrix and third parties.



# Starter packs



## Standard starter packs

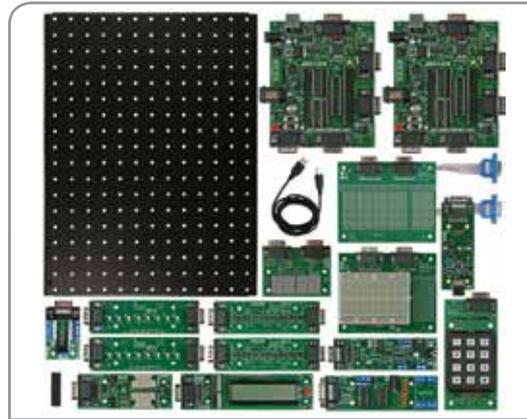
These starter packs are ideal general purpose kits which enable studying and projects in a variety of programming languages. Packs are available for PIC, AVR, ARM and dsPIC / PIC24 cores. The packs include the relevant E-blocks boards, a metal backplane, quick snap mounting pillars, leads, power supplies 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.

Components included		
1	Device programmer board	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	EB6511



## Deluxe starter packs

These packs are great for the more sophisticated learner 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. Packs are available for PIC, AVR, ARM and dsPIC / PIC24 cores. 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.

Components included		
2	Device programmer boards	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	EB2161
Deluxe AVR starter pack	EB3441
Deluxe ARM starter pack	EB1401
Deluxe dsPIC/PIC24 starter pack	EB6511

3

These ready-made learning solutions give educators everything needed to deliver hands-on courses on topics within the area of digital communications.

E-blocks solutions are designed for teachers who want a complete off-the-shelf course covering a topic in modern digital communications. Solutions are made up from our E-blocks hardware modules bolted onto strong metal backplanes. Each module has a clear plastic cover to prevent students changing link settings and removing chips. All cables and accessories are supplied, and hardware is supplied in rugged plastic trays for storage and transport.

A full copy of Flowcode is included with each solution. Flowcode allows students to concentrate on learning about protocols and data structures, without getting bogged down in the coding. In some solutions additional software for analysis is provided. Each solution has a full teacher's manual including exercises and a CD ROM with worked examples.





## LIN bus training solution

This 15 hour training solution is designed to facilitate the development and investigation of systems that use the LIN bus protocol. The solution is suitable for both automotive students and for electronics undergraduates. Four fully programmable LIN nodes are included in the solution, along with circuit boards which mimic the functions of indicator lamps, switches and sensors. A 30 page teacher's manual contains a range of exercises.

### Learning objectives /experiments

- To understand LIN transmit and receive messages and the top level LIN protocols
- To understand LIN message structure
- To understand and construct a fully operational LIN system with four nodes working at once
- To understand how LIN and CAN are able to communicate with each other in an automotive system
- Development of programs for combined LIN CAN systems based on microcontrollers

### Components included

1	LED board	2	Backplane
2	Switch boards	2	Power supplies
3	PIC Mulprogrammer boards	1	Curriculum CD ROM
1	16 x 2 LCD board	1	Flowcode V6 academic licence
3	LIN boards	1	Set of leads
1	Storage trays and packaging		

### Ordering information

LIN bus training solution	EB413
Curriculum CD ROM and manual only	EB9016



## CAN bus training solution

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.

### 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

### Components included

2	LED boards	1	Kvaser analyser
2	Switch boards	1	Curriculum CD ROM
4	CAN communication 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 Mulprogrammer boards	1	Flowcode V6 academic licence
1	CAN faults board	1	Storage trays and packaging

### Ordering information

CAN bus training solution	EB237
Curriculum CD ROM and manual only	EB9012

# 3



## Bluetooth training solution

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 and curriculum 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.

### Features include:

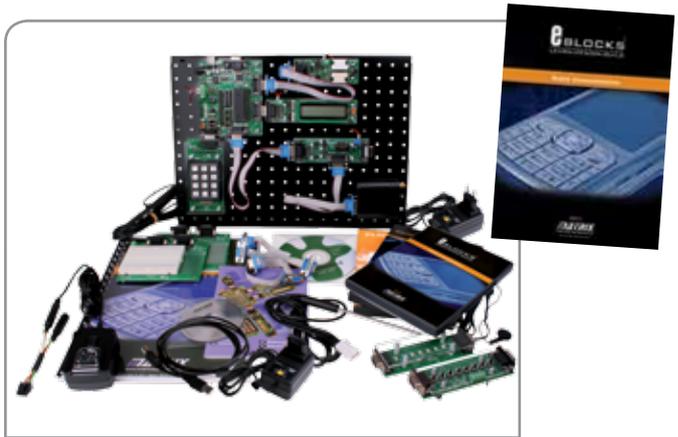
- Data communication between microcontroller and Bluetooth modules
- AT command structure and programming strategy in AT controlled systems
- Bluetooth visibility
- Device discovery, pass keys and addresses
- Responses - sequence flow and error checking
- Connecting and pairing
- Data communication
-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

### 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 Flowcode V6 academic licence
1 16 x 2 LCD board	1 Curriculum CD ROM
2 PIC Mulprogrammer boards	1 Storage trays and packaging
1 Keypad board	

### Ordering information

Bluetooth training solution	EB860
Curriculum CD ROM and manual only	EB9127



## Mobile phone technology

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 Eblocks. A 50 page teacher's manual contains a range of exercises.

### Features include:

#### 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

### 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 CD ROM
1 PIC Mulprogrammer board	1 Flowcode V6 academic licence
1 Keypad board	1 Storage trays and packaging
1 Patch board	

### Ordering information

Mobile phone solution	EB118
Curriculum CD ROM and manual only	EB9134



## Embedded internet solution

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

### Features include:

- 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

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	Flowcode V6 academic licence
1	16 x 2 LCD board	1	Curriculum CD ROM
1	PIC Mulprogrammer boards	1	Storage trays and packaging
1	Keypad board		
Ordering information			
Embedded internet solution		EB643	
Curriculum CD ROM and manual only		EB9222	



## RFID training solution

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 Icode and Mirfare mode. A 50 page teacher's manual contains a range of exercises.

### Features include:

- 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

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 CD ROM
1	PIC Mulprogrammer board	1	Flowcode V6 academic licence
1	Keypad board	1	Storage trays and packaging
2	Mifare RFID cards		
Ordering information			
RFID solution		EB699	
Curriculum CD ROM and manual only		EB9329	

# 3



## Zigbee solution

This 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.

### Features include:

- 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

### 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 Flowcode V6 academic licence
1 16 x 2 LCD board	1 Curriculum CD ROM
4 PIC Mulprogrammer boards	1 Storage trays and packaging
1 USB232 board	1 Zigbee message analyser

### Ordering information

Zigbee solution	EB284
Curriculum CD ROM and manual only	EB9457



## USB training solution

This solution allows 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.

### Features include:

- 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

### 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 CD ROM
1 16 x 2 LCD board	1 Flowcode V6 academic licence
1 PIC Mulprogrammer board	1 Storage trays and packaging
1 Keypad board	

### Ordering information

USB solution	EB479
Curriculum CD ROM and manual only	EB9538

**NEW**



### FPGA solution

This solution provides a 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 required 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 included.

#### Features include:

- 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

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 CD ROM
1 Keypad board	1 Storage trays and packaging
Ordering information	
FPGA solution	EB940
Curriculum CD ROM and manual only	EB941

**NEW**



### Audio DSP solution

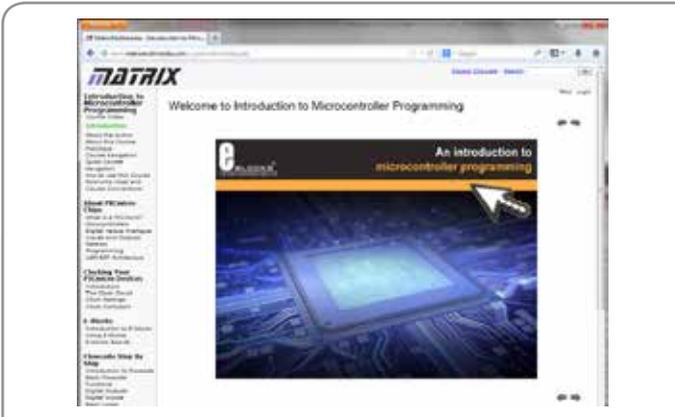
This solution provides a complete 25 hour course on the development of audio Digital Signal Processing systems based on the popular Microchip dsPIC series of processors. This highly motivating course uses systems charts made up of the DSP functional blocks contained in Flowcode and focusses on practical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

#### Features include:

- 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
- Noise cancellation systems
- Tone generation and guitar tuning
- Digital filters
- Echo and reverb techniques
- Frequency analysis and Fast Fourier Transforms

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 Mulprogrammer	1 Backplane
1 16 x 2 LCD board	1 FC6 dsPIC academic licence
1 Switch board	1 Storage trays and packaging
1 EB084 colour graphical LCD	1 Curriculum CD ROM
1 Terminal board	1 Set of leads
1 Patch board	1 Power supply
Ordering information	
Audio DSP solution	EB650
Curriculum CD ROM and manual only	EB9005

3



## Introduction to microcontroller programming course

This free online resource provides a complete course in developing microcontroller based systems using Flowcode. The course contains a suite of 13 labs each of which has an accompanying Word worksheet. Students print a worksheet and then work through the contents of the CD ROM, developing systems using Flowcode to complete each lab. Each worksheet has a number of tasks, graded to cater for mixed ability classes. Supervisors can use the accompanying Excel marking scheme to track the progress of students as they work through the material. The course is based on E-blocks but is usable on other hardware platforms.

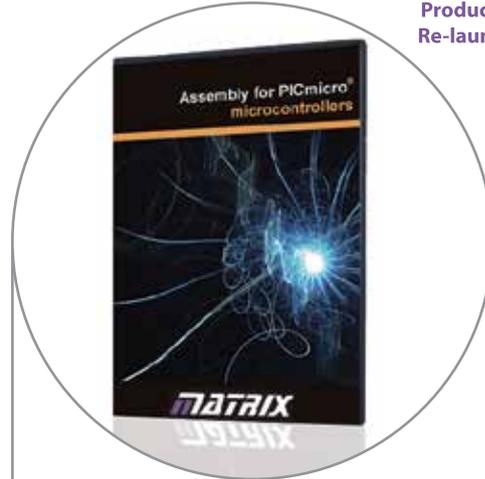
### Learning objectives /experiments

- 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

Available free online

Ordering information	
Introduction to microcontroller programming	FREE

Product under review  
Re-launch Spring 2014



## Assembly for PICmicro MCUs CD ROM V4

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	
Single user	EL629S14
10 user	EL629104
Site licence	EL629SL4

Product under review  
Re-launch Spring2014



## C programming courseware and software

These CD ROMs provide you with a complete solution to teaching and learning C programming for the PICmicro, Atmel AVR and Atmel ARM microcontrollers.

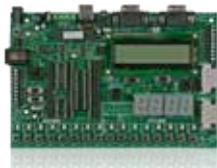
The courses are structured in two parts: firstly students are taken through the fundamentals of C programming in a series of on-screen tutorials that make use of our virtual microcontroller to explain to students how C works. This well proven methodology centres around a simulation of the microcontroller 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.



Tutorial and simulation screen

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



...and verify the program on the hardware

### Ordering information

#### C for 16 series PICmicro microcontrollers

Single user	EL543SI4
10 user	EL543I04
Site licence	EL543SL4

#### C for ARM microcontrollers

Single user	ELRMSI
10 user	ELRM10
Site licence	ELRMSL

#### C for AVR microcontrollers

Single user	ELCVRSI
10 user	ELCVR10
Site licence	ELCVRSL

Note that the C compiler on the C for 16 series PICmicro microcontrollers CD ROM is only licensed for educational use.

## PICmicro® microcontroller multiprogrammer

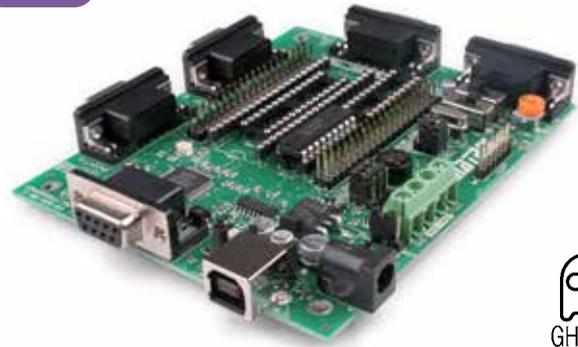
This board connects to a PC via USB to provide a high speed, low cost PICmicro MCU programmer for development and programming. This board can be used with assembly, C or Flowcode along with most third party compilers. The board programs a wide range of microcontroller devices and has 5 D-type sockets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

### Ordering information

PICmicro® microcontroller multiprogrammer

EB006

NEW



## dsPIC/PIC24 multiprogrammer board

This board can be used with MPLAB or Flowcode and most third party C compilers. The board programs a wide range of PICmicro microcontroller devices from the PIC24F, PIC24H, dsPIC30 and dsPIC33 series PICmicro ranges using the programming software provided. There are 5 D-type sockets for E-blocks connection. A Microchip PICKit socket provides alternative reprogramming and debugging techniques.

### Ordering information

dsPIC/PIC24 multiprogrammer board

EB064



## 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



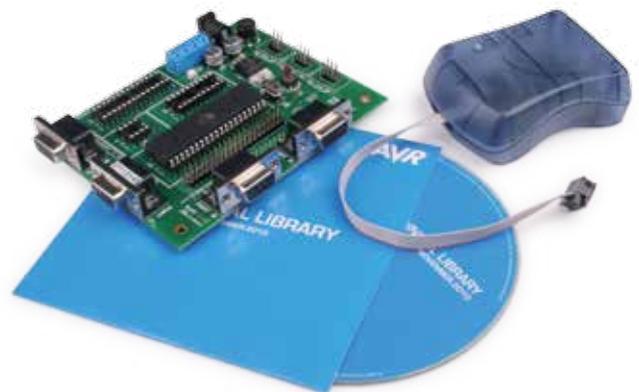
## AVR® microcontroller multiprogrammer

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



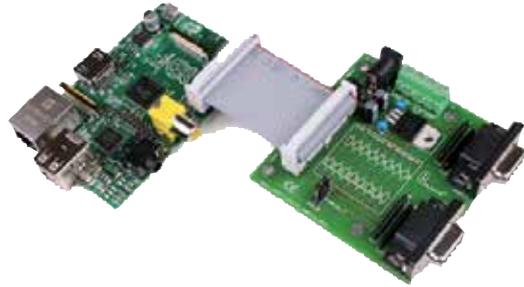
# Upstream and interface boards

## 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.

### Ordering information

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



## E-blocks interface shield for Arduino

This board allows you to connect a standard Arduino module 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 enable 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.

### Ordering information

E-blocks interface shield for Arduino	EB081
---------------------------------------	-------



## Altera FPGA board

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
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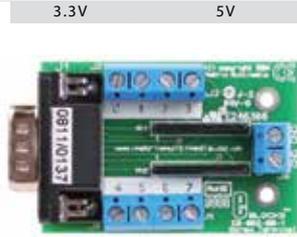


3

# Downstream boards

## Terminal board

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

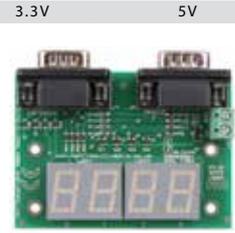


### Ordering information

Terminal board	EB002
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## Dual 7-segment display

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

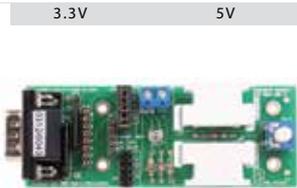


### Ordering information

Dual 7-segment display	EB008
------------------------	-------

## Sensor board

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.

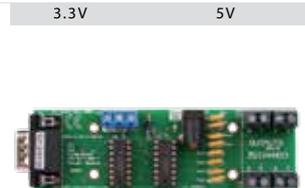


### Ordering information

Sensor board	EB003
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## Power board

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.

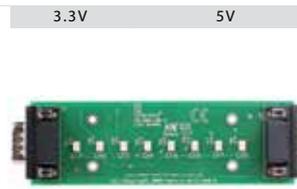


### Ordering information

Power board	EB011
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## LED board

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.

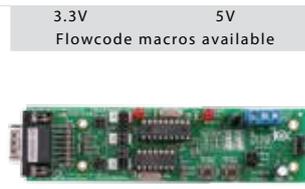


### Ordering information

LED board	EB004
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## IR/IrDA transceiver board

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

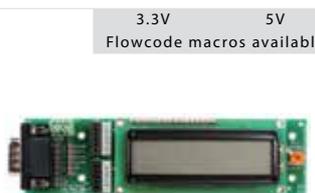


### Ordering information

IR/IrDA transceiver board	EB012
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## LCD board

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

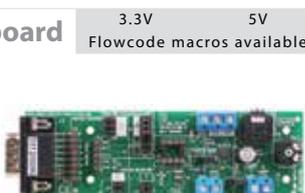


### Ordering information

LCD board	EB005
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## SPI bus D/A and memory board

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

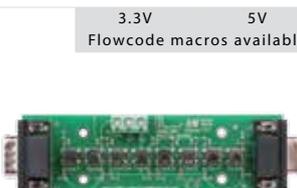


### Ordering information

SPI bus D/A and memory	EB013
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## Switch board

This board contains 8 push-to-make switches. Upstream and downstream E-blocks connectors allow this board to be used in bus configuration.

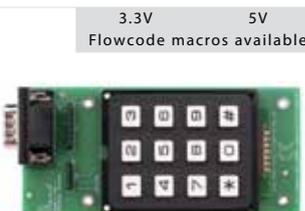


### Ordering information

Switch board	EB007
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## Keypad board

A simple 4 x 3 keypad that allows data entry into bus based systems.



### Ordering information

Keyboard board	EB014
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# 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
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## Motors board

3.3V 5V  
Flowcode macros available

This board is based on the L298 device which can drive two motors operating from up to 46V at up to 4A each. The board can be used in a variety of motor control configurations.



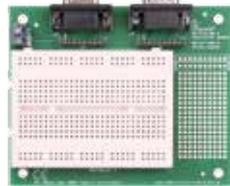
### Ordering information

Motors board	EB022
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## 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
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## 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.



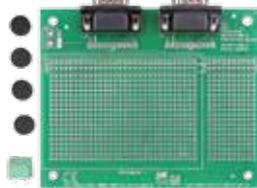
### Ordering information

Internet board	EB023
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## 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
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## 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
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## 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
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## MIDI interface board

3.3V 5V  
Flowcode macros available

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



### Ordering information

MIDI interface board	EB021
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## 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
-------------------	-------

3

# Downstream boards

## PS2 / VGA board

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



5V

### Ordering information

PS2 / VGA board	EB033
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## ZigBee coordinator board

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



3.3V 5V  
Flowcode macros available

### Ordering information

ZigBee coordinator board	EB051C
ZigBee router board	EB051R

## Opto-isolator board

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



3.3V 5V

### Ordering information

Opto-isolator board	EB035
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## RFID board

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



5V  
Flowcode macros available

### Ordering information

RFID board	EB052
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## MMC card reader board

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.



3.3V 5V  
Flowcode macros available

### Ordering information

MMC card reader board	EB037
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## Relay board

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



3.3V 5V

### Ordering information

Relay board	EB038
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## USB interface board

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



5V  
Flowcode macros available

### Ordering information

USB interface board	EB055
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## USB232 board

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.



3.3V 5V  
Flowcode macros available

### Ordering information

USB232 board	EB039
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## GPS board

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.



3.3V 5V

### Ordering information

GPS board	EB056
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## DSP input board

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.



3.3V 5V  
Flowcode macros available

### Ordering information

DSP input board	EB085
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# Downstream boards

3

## 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
-------------	-------

## 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	EB069
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## 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
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## RS485 board

3.3V 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
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## 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
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## 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

## 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
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## 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

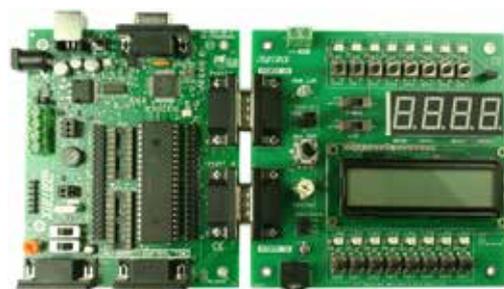
GSM module	EB066
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## Development Board and EB006 Combo

The development board consists of a EB006 PICmicro multiprogrammer and an EB083 dev combo 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
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# Downstream boards

## 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 a five separate cap-touch pads to allow you to command up, down, left, right and center button presses.



### Ordering information

Cap-touch board	EB088
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## 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
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## 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.



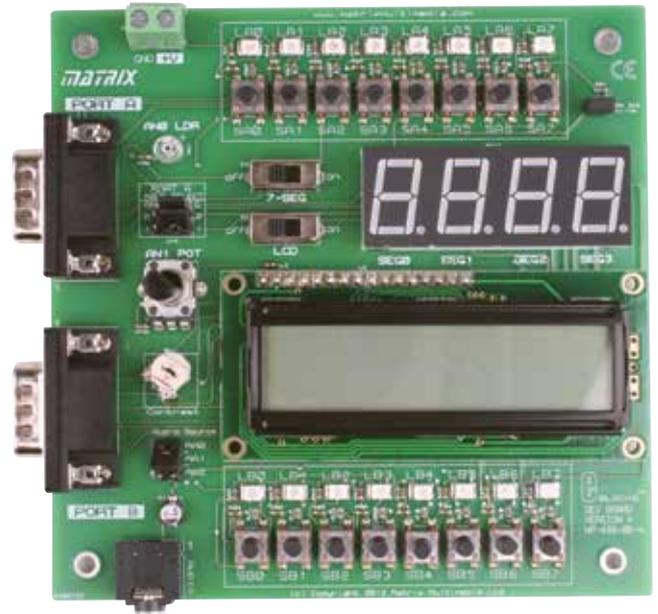
### Ordering information

DSP output board	EB086
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## Combo board

3.3V 5V  
Flowcode macros available

The new E-blocks combo 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 Combo board replaces our older HP488 Development board but also gives full In Circuit Debug facilities.



### Ordering information

Combo board	EB083
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## 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 Combo 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.



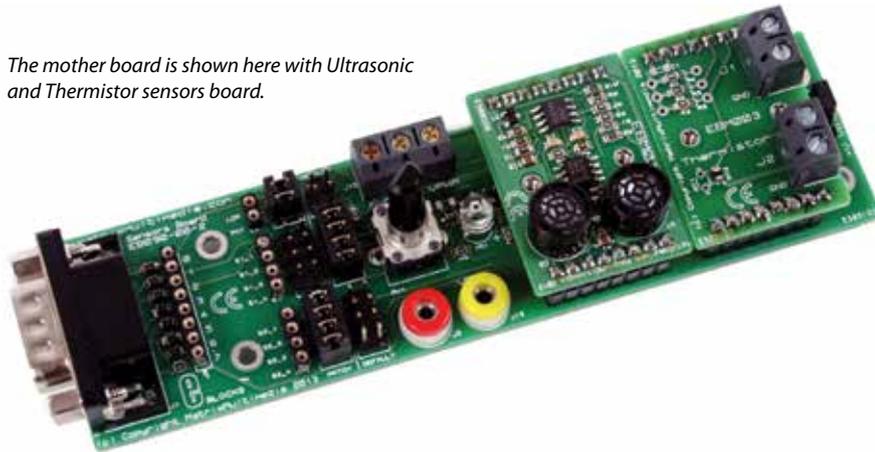
### Ordering information

PICmicro development centre kit	HP7631
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**NEW**

## E-blocks sensors mother board

The mother board is shown here with Ultrasonic and Thermistor sensors 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

## 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 converter and converted to temperature. It also has an on-board thermistor for ambient temperature compensation reading.



### Ordering information

Thermocouple

EBM008

**NEW**

## 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.



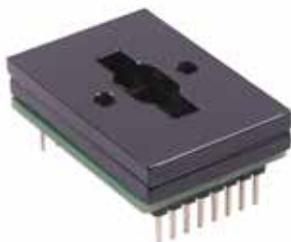
Ordering information

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

Color 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



### E-blocks test pod

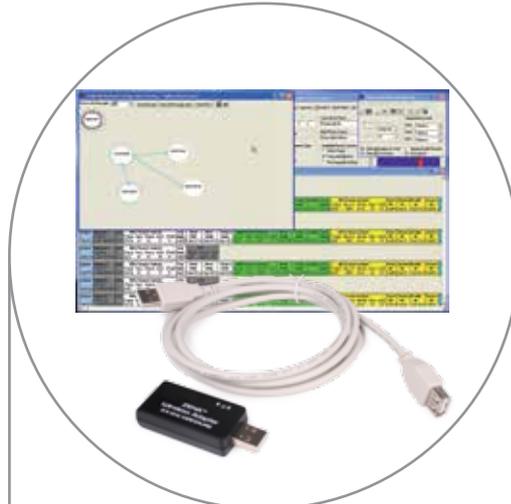
The loop through E-blocks test pod gives you a complete digital test bench in a small and affordable package. To help you debug your designs the test pod consists of two separate functions: a signal analyser and a signal generator. The signal analyser starts out as an easy-to-use Logic Analyser and Oscilloscope 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
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### 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.

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

#### Ordering information

ZigBee USB analyser	HP387
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### 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
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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
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### 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 and 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
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### 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
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### 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
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## ZIF socket programmer adaptor

By putting this adaptor board on top of your EB006 PICmicro microcontroller programmer board you can create a fully functioning PIC programmer for 8, 14, 20, 28 and 40 pin PICmicro devices with easy to use ZIF (Zero Insertion Force) sockets. For a full list of devices supported please refer to the data sheet on the EB006 (available on our web site). Note that the pins of the chip are not connected to the D-type sockets on the EB006.



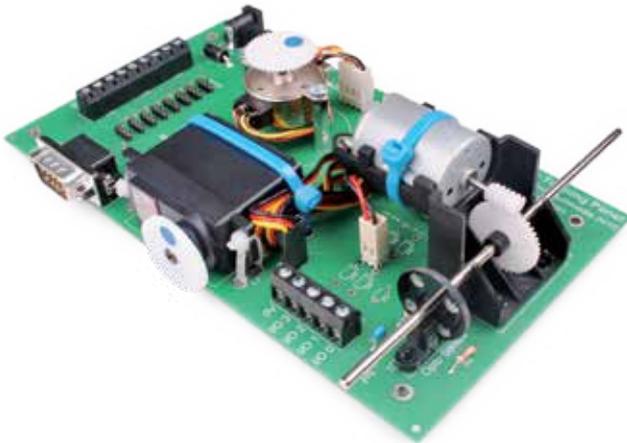
\*EB006 not included.

### Ordering information

ZIF socket programmer adaptor	EB072
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## 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
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## 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

## 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
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## 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
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## 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

## 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
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## 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
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## 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
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## Storage trays

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



### Ordering information

Plastic 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.

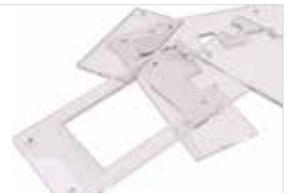


### Ordering information

Power supply	HP2666
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## 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.

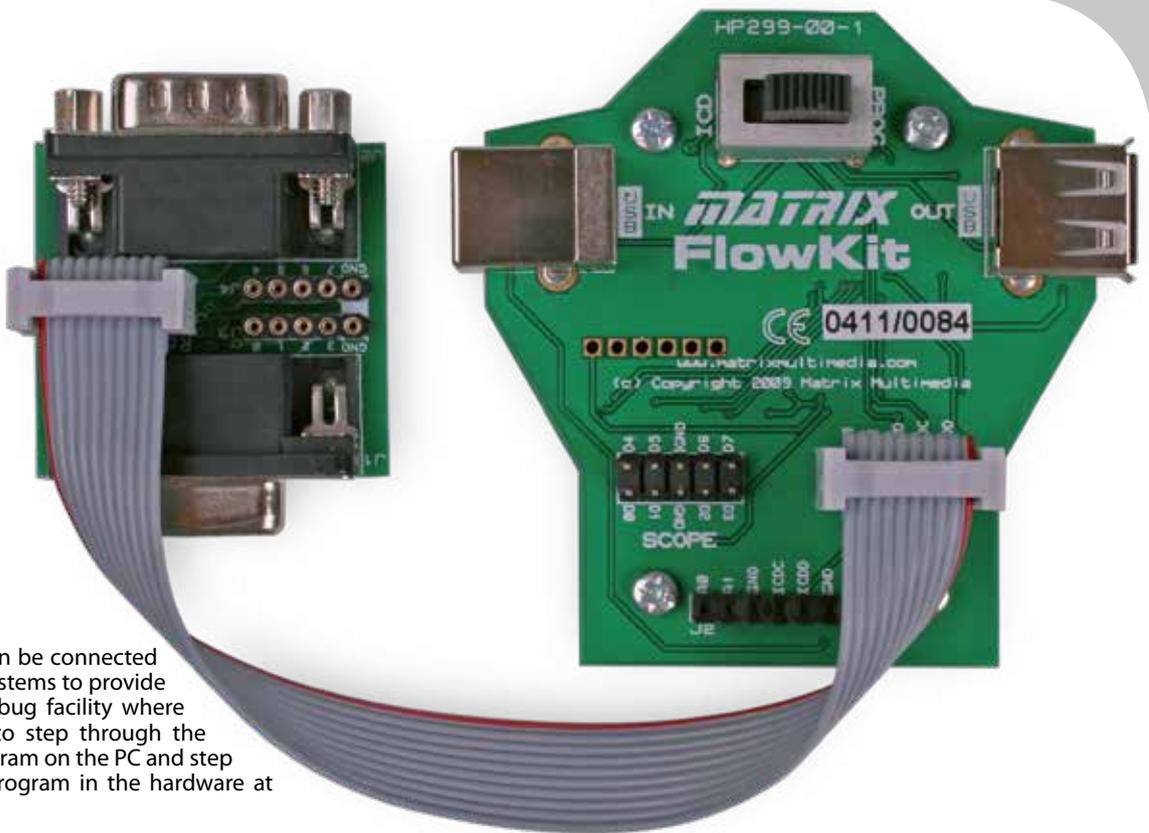
## Plastic mounting pillars

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



### Ordering information

Plastic mounting pillars x 25	HP6219
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The FlowKit can be connected to hardware systems to provide a real time debug facility where it is possible to step through the Flowcode program on the PC and step through the program in the hardware at the same time.

This function is available with Flowcode 4.2 or later.

### Benefits

- A fast way to solve programming problems
- Seamless program and debug

### Features

- Compatible with a variety of hardware systems including E-blocks
- Compatible with ECIO, MIAC and Formula Flowcode systems via the USB lead
- Allows start, step and play of programs
- Allows users to see and alter variable values

Whilst Flowcode simulation allows debug of a system to a first pass, FlowKit takes debug to a new level by running the program in the hardware and on the screen at the same time. The system is controlled from within the Flowcode environment where controls allow users to start, stop, pause and step through their program on icon at a time. Under user control the Flowcode software shows the location of the program in the flow chart, the value of all variables in the program, and allows users to alter the variable values when the program is paused.

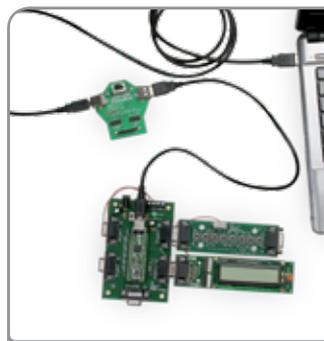
Ordering information	
FlowKit In-Circuit Test board	HP299



Using FlowKit with MIAC



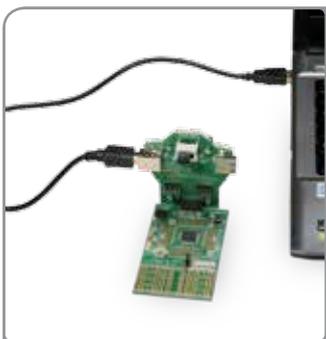
Using FlowKit with Formula Flowcode



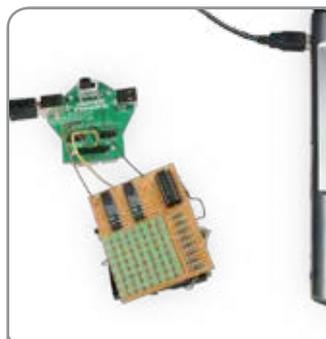
Using FlowKit with ECIO



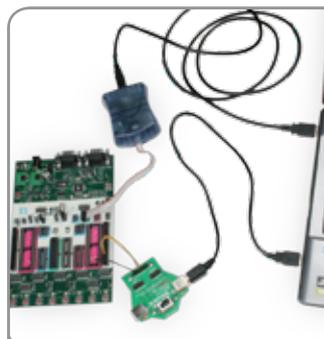
Using FlowKit with AVR E-blocks



Using FlowKit via a PICkit 2 interface



Using FlowKit with a project

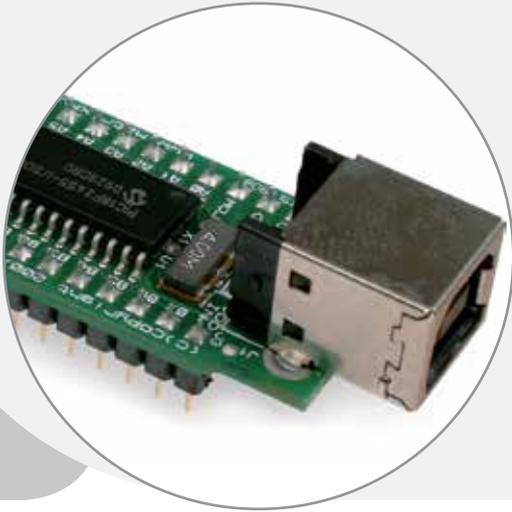


Using FlowKit with Atmel STK500



The complete FlowKit package

# ECIO single board computers



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.

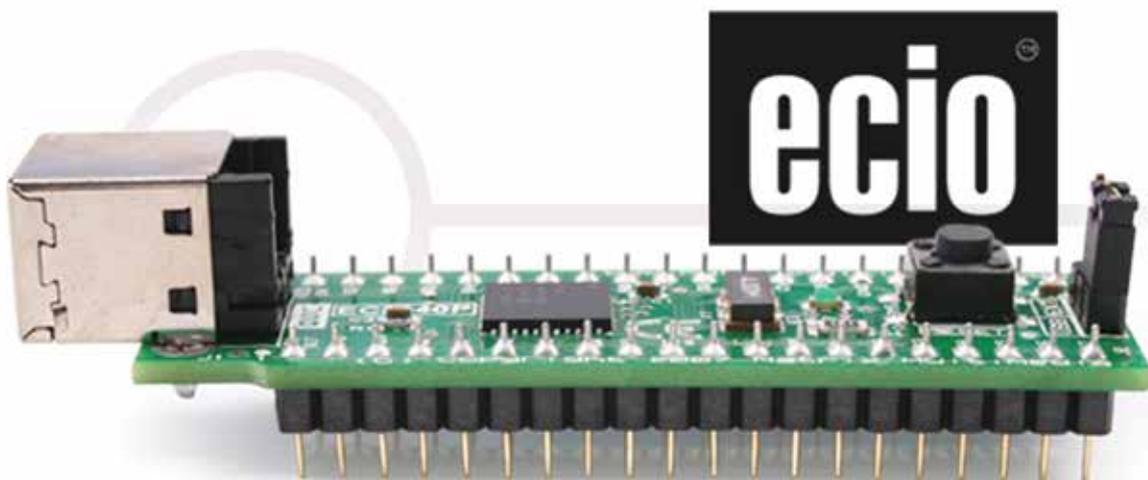
## ECIO

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 provide 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 two ECIO devices based on PIC microcontrollers. ECIO devices are compatible with hex code from a number of compilers including Flowcode, BASIC, C and assembler.



# 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	100ksp/s
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, M <sup>2</sup> C, SPI, USB2.0
Package	28 pin, 0.6", DIP compatible



ECIO28P

## 40 pin PIC 18 ECIO

Base chip	PIC18F2455
Oscillator	4MHz ext, 48MHz internal
I/O lines	30
A/D	13 x 10 bit
A/D sample rate	100ksp/s
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, M <sup>2</sup> C, SPI, USB2.0
Package	40 pin, 0.6", DIP compatible



ECIO40P

## 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 allows 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).



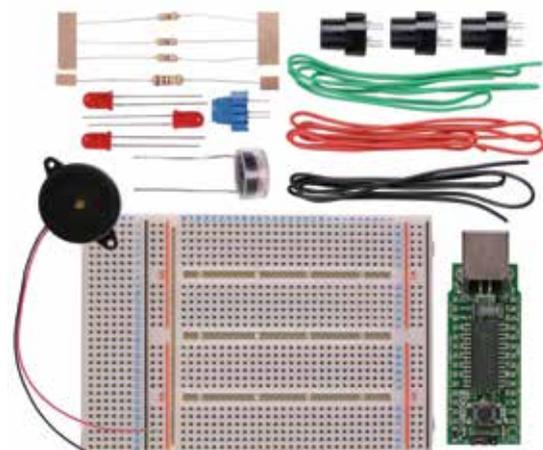
Ordering information

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

3

# Formula Flowcode

The Formula Flowcode maze solving robot vehicle can be used for a wide range of learning activities for students aged 12+.

This robot vehicle has been designed to address the requirements of the technology education curriculum between the ages of 12 to 16. It is also used up to university level for motivation, learning and project work. The robot is great for running competitions and for open days where you can motivate students to want to learn more about electronics and technology in just a few hours.

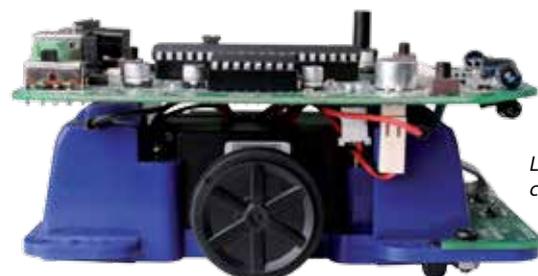
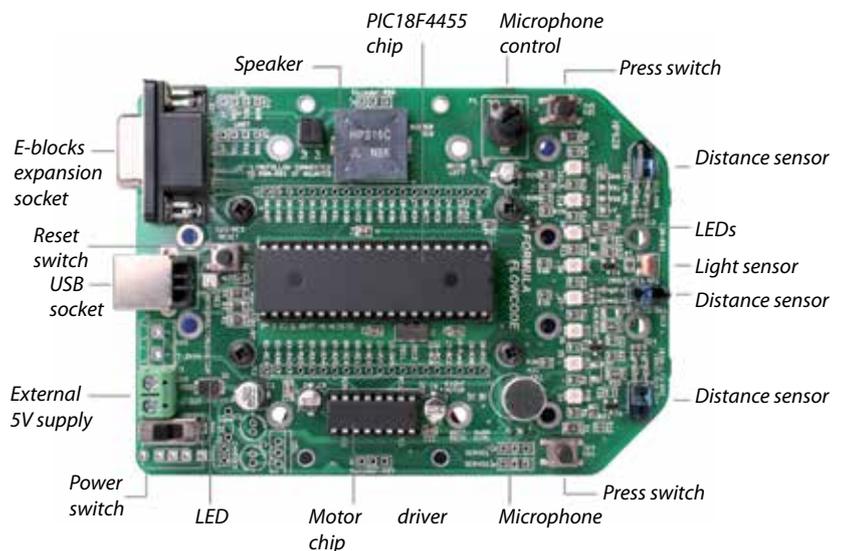
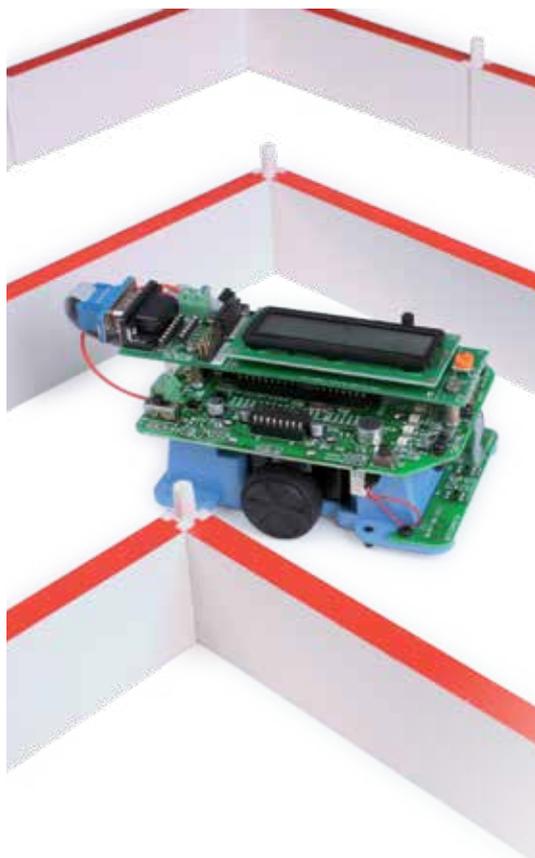
- A low cost, all-inclusive solution for technology students
- Great for motivating students to learn more
- Works with the free version of Flowcode
- Superb technical specification
- E-blocks compatible
- Micromouse competition compatible

## Hardware

The robot vehicle is based on a plastic moulded chassis with two wheels, gearboxes and motors and is powered by AA batteries. The circuit board connects directly to a PC using the USB port and provides a high specification PIC18F4455 controller with many features including 2 user switches, 8 LEDs, sound level sensor, light sensor, buzzer, motor controller (including Pulse Width Modulation), line follower sensors and distance sensors.

## Software

The robot is supplied with a reduced functionality version of Flowcode. Students develop the program, simulate its functionality on-screen and then click on a button to download the program to the robot. Flowcode is compatible with most E-blocks add-ons and a full version can be purchased separately. The buggy can also be programmed with C and Assembly.

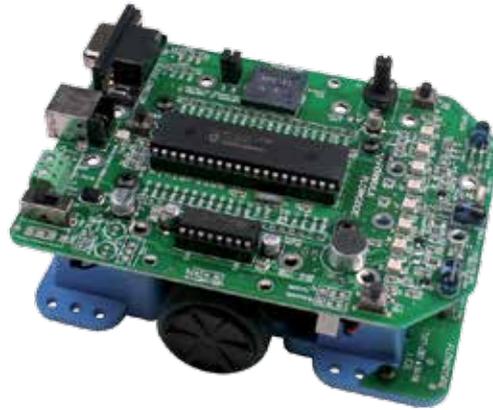


Line following circuit board

Plastic chassis with battery compartment, motors with gear boxes and 2 wheels

## Formula Flowcode buggy

The two wheel Formula Flowcode buggy is powered from rechargeable batteries and is supplied with a function limited version of Flowcode. Students develop the program, simulate its functionality on-screen and then download the program to the buggy via USB. The buggy uses an advanced PICmicro 18 series microcontroller with internal precision motor controller circuitry. It has 3 infrared distance sensors, line following sensors, a buzzer, audio level sensor, light sensor, two spare switch inputs, 8 user programmable LEDs and various expansion buses - including an E-blocks port. The buggy can be expanded with a range of additional boards including graphical LCD displays and Bluetooth.



### Ordering information

Formula Flowcode buggy	HP794
------------------------	-------

## Formula Flowcode starter class bundle

Includes 5 Formula Flowcode kits, 1 set of maze walls, a function limited version of Flowcode, a storage tray and a 10 user version of the Introduction to microcontroller programming CD ROM. Sufficient for 10 students working in pairs.

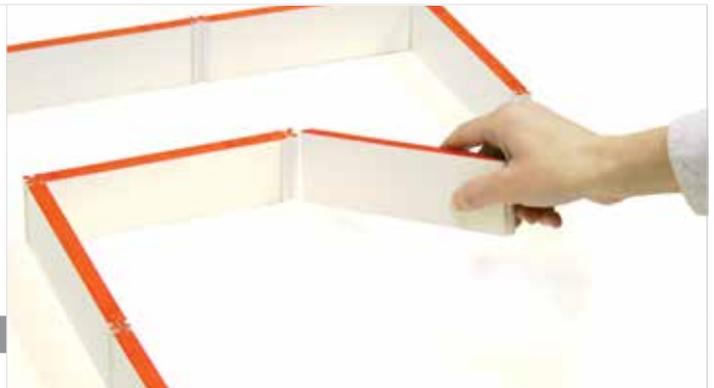


### Ordering information

Formula Flowcode starter class bundle	HP926
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## Maze walls

These walls and posts are designed to allow you to create a maze of your own. Each wall measures 168 x 12 x 50mm. 30 walls and ports are included in the pack which allows you to make a 5 x 5 cell maze.



### Ordering information

Maze walls	HP458
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## Formula Flowcode pro class bundle

Includes 10 Formula Flowcode kits, 1 set of maze walls, a site licence of Flowcode 6 pro, a site licence of the Introduction to microcontroller programming CD ROM, 5 LCD displays, 5 IDC cables and 2 storage trays. Sufficient for 20 students working in pairs.



### Ordering information

Formula Flowcode pro class bundle	HP600
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# Electronic Workstations

The Electronic Workstation meets all your power and instrumentation needs for electronics education and prototyping in one self-contained, easily portable unit.

The Electronic Workstation is a multifunction electronics workbench for electronics engineers. It combines a number of instruments that make the development and learning of electronic systems easier.

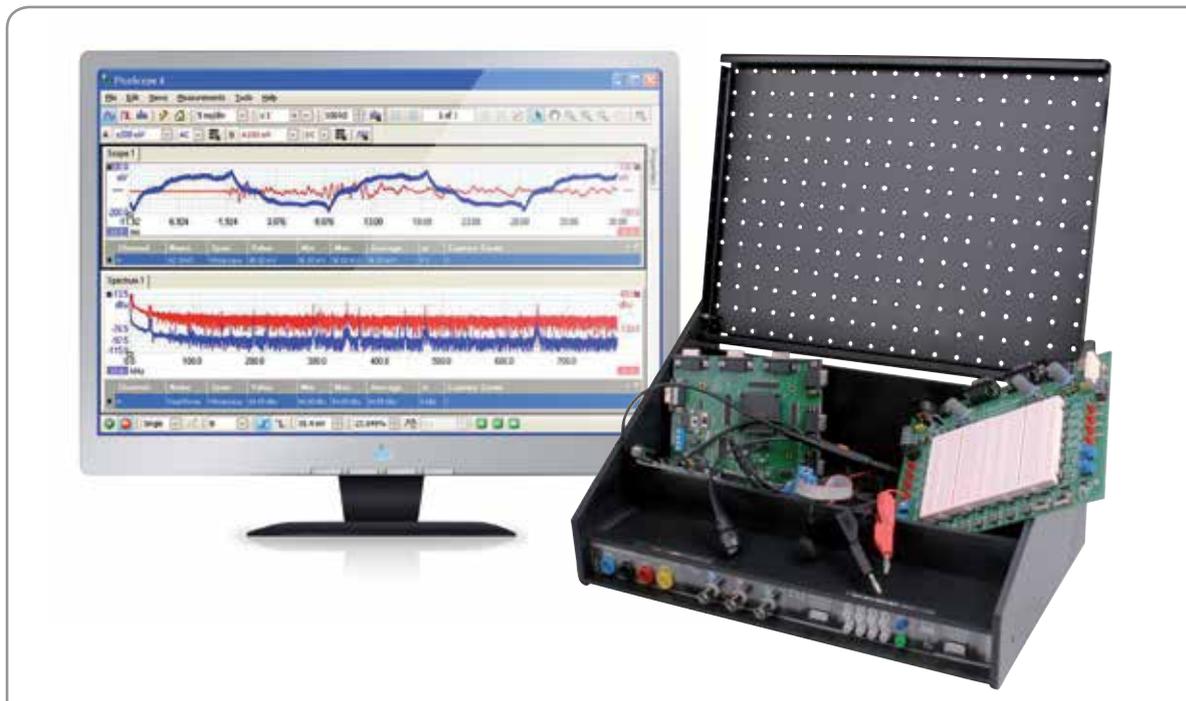
The Electronic Workstation consists of a number of virtual instruments housed in a rigid plastic case. The front panel of the Electronic Workstation has 2 analogue oscilloscope inputs, a signal generator output, 8 channel logic analyser / digital signal generator connectors, 8 channel PC interface connectors which supports use with LabView, Visual Basic, C etc. and power supply outputs. The angled top of the unit is fabricated from strong anodised black aluminium with a grid of holes that make it suitable for use with E-blocks. This lifts up to reveal a storage area for leads and accessories. The oscilloscope inputs and signal generator output are presented on standard 50ohm BNC connectors. The range of leads supplied with the Electronic Workstation includes: 1 x USB leads, 2 x 9-way D-type leads, 2 x 50ohm scope probes, 10 x 2mm micro gripper analyser probes and 25 x backplane mounting pillars and red and black 4mm 'banana' leads.

A compact version of the Electronic Workstation is available, which folds down flat and comes in a kit containing the leads and accessories (see the following page for more information).



## Features

<b>Power supply</b>	
+12V (2A) / -12V (0.8A) .5V(5A)	Yes
Digital multimeter	Yes
<b>2 channel oscilloscope</b>	
Bandwidth	25MHz
One channel sampling rate	40MHz
Scope resolution	8 bit
Signal generator	Variable
External trigger	-
Arbitrary waveform generator	Yes
<b>Spectrum analyser</b>	
Bandwidth	25MHz
<b>Logic analyser</b>	
Channels	8
Sample rate	24MHz
Digital signal generator	Yes
Bus decoder	Yes
<b>PC interface</b>	
Channels	8



# Electronic Workstations



## Electronic Workstation - desktop

The angled top of the Electronic Workstation desktop version lifts up to reveal a storage area for leads and accessories. see the previous page for a list of the leads and accessories included with this product.

Ordering information	
Electronic Workstation EU	HP886EU
Electronic Workstation UK	HP886UK
Electronic Workstation USA	HP886USA

3



## Protostation

Protostation is the perfect complement to the Electronic Workstation. Together they form a complete electronics prototyping and analysis system that needs less desk space than an open textbook. Protostation can also be used on its own for the convenience of its integral signal sources and output devices.

- Large prototyping area
- Build circuits with no soldering or tools required
- Easy access to controls and transducers
- Make your prototypes more portable
- Free your work space from clutter

The Protostation features 0.1" pitch sockets which take standard IC packages. It also contains 2 E-blocks ports, a versatile range of supply voltages, a signal generator and the following inputs and outputs:

- Inputs: Switches, potentiometers, phototransistors, thermistors, voltage source
- Outputs: LEDs, buzzer, relay

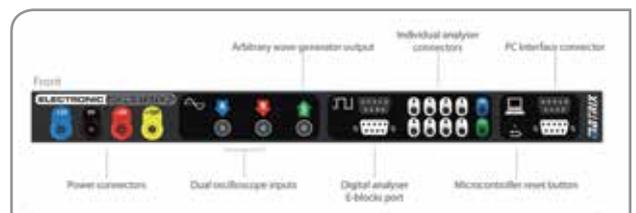
Protostation fixes to the backplane of the Electronic Workstation creating a compact, portable and extremely sturdy prototyping system.

Ordering information	
Protostation	HP512



## Electronic Workstation - compact

The compact version of the Electronic Workstation is housed in a plastic case with a folding backplane that can be angled at 45° or left flat.



Ordering information	
Electronic Workstation with case EU	HP834EU
Electronic Workstation with case UK	HP834UK
Electronic Workstation with case USA	HP834USA



**MIAC modules provide learners and developers with a flexible suite of rugged, high power, electronics blocks which quickly connect together to form a wide variety of control and data-logging systems.**

The MIAC is a general purpose controller based on PICmicro technology which is suitable for use in many areas of technical education including mechanical engineering, automotive engineering, computer science, electronics and technology. Its electrically and mechanically rugged design makes it the ideal interface for educational projects.

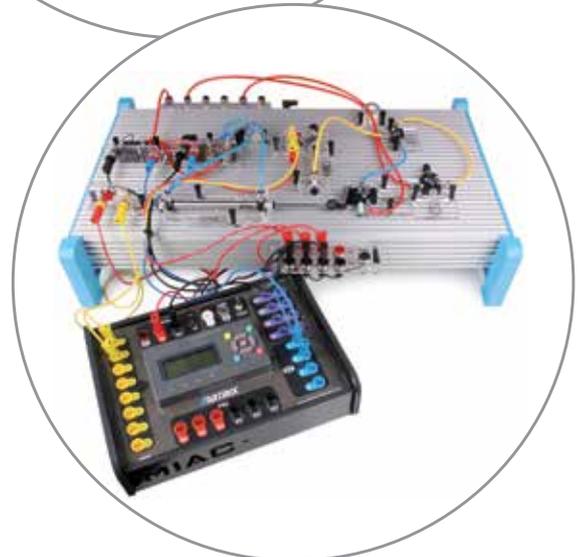
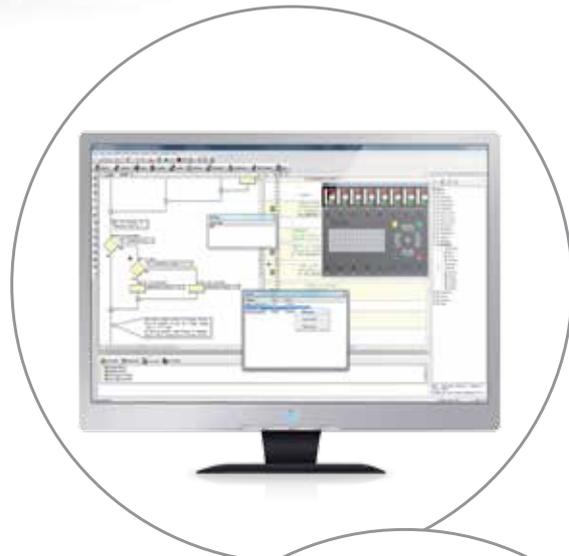
Each MIAC module contains a block of electronics which you would typically find in an industrial electronic control or data acquisition system.

The 10 modules in the range connect together using the CAN bus. The modules can be positioned next to each other or several hundred metres apart. Power is applied locally. The modules also link into a wide range of other communications systems: GSM, Bluetooth, TCP/IP, ZigBee, etc.

The system is programmed using Flowcode software. Flowcode is a graphical programming environment based on flowcharts. Flowcode includes 'drivers' for all the MIAC modules so that programming the system is easy.

Communication between modules is taken care of by Flowcode. To add a module (or second MIAC) to the system just add the module to the Flowcode simulation. Flowcode takes care of low level CAN bus commands so no understanding of CAN is needed.

MIAC modules are compatible with a vast range of industrial sensors and add-ons that sit on 25mm 'top hat' DIN rails.



# MIAC e-system design suite



**MIAC (Matrix Industrial Automotive Controller) is an industrial grade control unit which can be used to control a wide range of different electronics systems.**

The MIAC is a fully specified industrial electronic controller designed to operate off typical industrial control voltages: 0 - 10V inputs, 24V motor outputs, 240V switching relays. MIAC has 8 analogue or digital inputs, 4 high current relay outputs and 4 transistor outputs. The

MIAC is housed in an attractive, rugged, anthracite grey plastic moulding. It has two physical mounting options: it can be mounted onto a 35mm 'top hat' DIN rail, or it can be mounted directly onto any surface using the 4 screw holes provided.

The MIAC unit has screw terminal connector inputs across the top and bottom of the unit. It has several input buttons for user control and a 4 line 16 character alphanumeric display.

The unit is programmed directly from a PC's USB port and is compatible with the Flowcode graphical programming language. Users can develop a program using Flowcode, press the reset button on the back of the unit, and the program will automatically download and start. The MIAC can also be programmed in C and Assembly code, or any program that is compatible with PICmicro microcontrollers.

MIAC is equipped with a fully operational CAN bus interface so that many MIACs can be networked together to form wide area electronic systems.

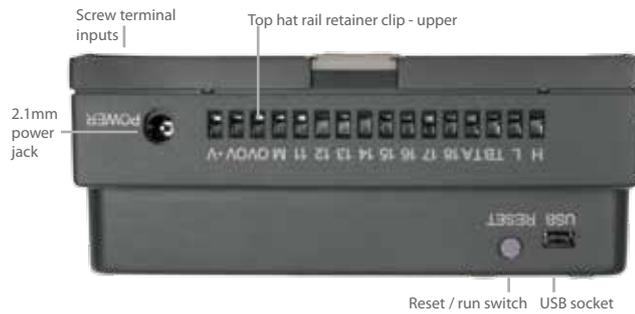
A DLL and sample programs are provided to enable MIAC to be used with PC based control programs like LabView, Visual Basic, C++ etc.

## Features

- Programmable from USB
- 8 digital or analogue inputs
- 4 relay outputs, 4 transistor outputs with PWM
- Compatible with LabView, Visual Basic and C compilers

## Benefits

- Flexible and expandable.
- Easy to program and flowcharts, C or assembly code
- Physically and electrically rugged



# 3

## Ordering information

MIAC controller	MI0235
Cased MIAC with 4mm shrouded sockets	MI0245
Power supply	HP2666
MIAC, Flowcode 6 and FlowKit bundle	HP2035
USB high speed A to mini B lead	HPUAB
MIAC and Flowcode 6 bundle	MI6100
3 MIAC units with Flowcode 6 pro	MI3487V6

# MIAC e-system design suite

## Basic

Includes I/O lines including PWM outputs for motor control, 12 bit ADC outputs for precision analogue work and several TTL level serial buses for interfacing to other serial systems at the chip level.



### Ordering information

Basic expansion module	MI1493
------------------------	--------

## Advanced

Includes I/O lines including PWM outputs, 12 bit ADC outputs, 2 x 10 bit DAC outputs and several TTL level serial buses for interfacing to other serial systems at the chip level. It also has interfaces for 2 external lab sensors and a real time clock.



### Ordering information

Industrial comms. expansion module	MI4823
Cased industrial comms. expansion module	MI9512

## Serial

Gives access to commonly used serial buses. The unit includes RS232 and RS485 bus interfaces as well as TTL level serial buses (SPI, I2C and USART). The unit also includes a number of TTL level I/O lines and a FAT16 compatible SD card.



### Ordering information

Serial expansion module	MI8447
Cased serial expansion module	MI2839

## Industrial comms.

Includes interfaces for RS485 and TCP/IP communications. TCP/IP connection is available on a standard CAT5 socket. The module is fitted with a CAN bus interface and also allows access to several 5V microcontroller I/O lines.



### Ordering information

Industrial comms. expansion module	MI4823
Cased industrial comms. expansion module	MI9512

## ZigBee

Two versions of the ZigBee expansion module are available: ZigBee coordinator and ZigBee router. Each contains a wireless ZigBee control module and access to several TTL level microcontroller I/O lines.



### Ordering information

ZigBee expansion module	MI3842C/R
Cased advanced expansion module	MI6922C/R

## Bluetooth

This module contains a TDB BLU2i module which adds Bluetooth functionality to a MIAC system. The class 1 Bluetooth module has a transmit power of 6dBm which should give a 100 yard transmission range at a transfer rate of 100Kbps.



### Ordering information

Bluetooth expansion module	MI4855
Cased bluetooth expansion module	MI5983

## GPS

Includes a highly sensitive fast access time Global Positioning System receiver which allows developers to build systems that can identify their own location. The unit also includes a FAT16 compatible SD card interface and TTL level I/O lines.



### Ordering information

GPS expansion module	MI8582
Cased GPS expansion module	MI8534

## GSM

This module is fitted with a quad band GSM unit which can be used for voice and data transmission. An internal antenna optimises the range of the module. The front of the unit has a 2mm jack socket and a SIM card socket.



### Ordering information

Advanced expansion module	MI4897
Cased advanced expansion module	MI5197



3

A cased MIAC and a cased advanced expansion module.

## MIAC bike case study

Under the guidance of teachers Osmo Lukkarila and Jyrki Tolonen, a group of ICT technician students in Oulu Vocational College in Finland took a crashed Honda CB125 motorbike and converted it to electricity. The motor they used is a permanent magnet DC motor capable of 4.8 KW continuous and 15 KW for 30 seconds. It operates from voltages of 12 to 48 VDC input and 100 amps continuous (300 amps for 30 seconds). The three batteries are 12V 20Ah LiFePO4 batteries, each with its own BMS card which balances charging and indicates if a battery is over or under charged. One of our MIAC controllers was used to control the project with all switches, lights and controls wired to it. After the MIAC was programmed and installed the bike functioned in exactly the same way as a normal bike with all the same controls.



## FLOWCODE6®

### Contents

Testimonials	71
What is Flowcode?	72
Advantages of using Flowcode	73
Flowcode design flow	74 – 75
Flowcode specification and ordering	76



*These Computer Science students in Oulu Vocational College, Finland, used Flowcode to develop a control system for an Electric motorbike and raced it against other schools*

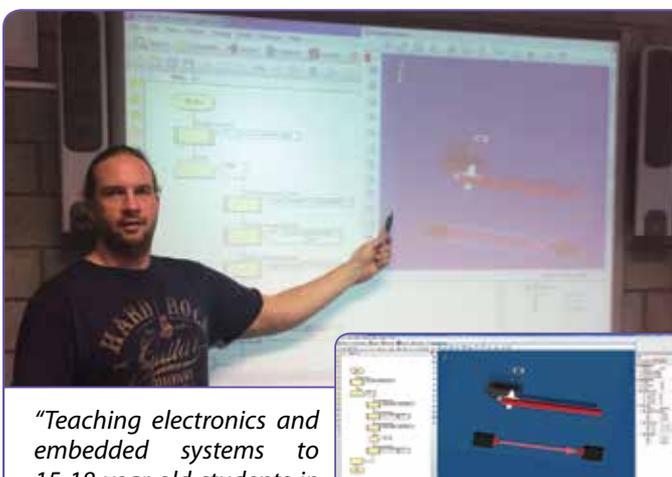
# Testimonials

"I am very new to Flowcode, but have experience of 9+ years with another PIC RAD capable program. They have a great program but unfortunately their user support has become poor over the years, so finally decided to review the market and chose to go with Flowcode V6.

I'm very much still coming to grips with Flowcode. But Flowcharting is very intuitive and the use of supplied and user generated components is a great idea. The customer and user support information being given via the forum, blog and Twitter is just so excellent - timely and constructive.

Well done Matrix on V6 and the effort that has and very obviously is still going into making V6 a great and very useable product."

**Richard Blick, Telecommunications Engineer**



"Teaching electronics and embedded systems to 15-18 year old students in a technical school near Antwerp in Belgium. 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 web servers, 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.

Our curriculum is changing from pure electronics to engineering and I was very pleased to see that Flowcode 6 also evolved in this way. Students do 'product-design' now – FC6 lets them creatively combine microcontroller circuits with their 3D mechanical drawings and lets them fully 3D-simulate their idea at home. They can download the tested code to the actual hardware the next day in classroom.

The very first small project we did with FC6 was to develop an automatic gate with a servo motor that opens automatically whenever an object breaks the beam. Something we could use with our model railtrack. The available videolessons and example programs were enough for our students to get this up and running in no time."

**Bart Huyskens – Teachers embedded systems - St.JozefinstituutSchoten, Belgium.**

"We use Flowcode and E-Blocks for the last 6 years on the second year projects. This is a great tool to do the link between mechanical engineering and computer science. Flowcode is interesting for us because there is no need to learn a new language. Students can develop very quickly the link between E-Blocks and their Android phone. Multiples of 20mm hole spacing help us to quickly integrate E-blocks in the mechanical part of the project. A ready to use electronic part can be produced in 5 weeks only( 2 hours/ week)."

**Benoit Pierret  
INSA Lyon, France**

"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**

# 4

# What is Flowcode?

**NEW**

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

Flowcode software allows you to quickly and easily develop complex electronic and electromechanical systems. The graphical programming tool allows even those with little experience to develop complex electronic systems in minutes.

Flowcode is one of the world's most advanced environments for electronic and electromechanical system development. Engineers use Flowcode to develop systems for control and measurement based on microcontrollers, on rugged industrial interfaces or on 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 PICmicro® microcontrollers, dsPIC and PIC24 microcontrollers, AVR and Arduino microcontrollers, and ARM microcontrollers.

Flowcode version 6 has a number of new developments which come together to create a software package which is amongst the best of its kind in the world. Flowcode is aimed at the 16+ market.

Development of Flowcode SE has now also given the ability for those aged 14-16 to learn about the development of complex electronic and electromechanical systems. See more on page 87.

Flowcode is available in over 20 languages and is used by thousands of engineers and educators.

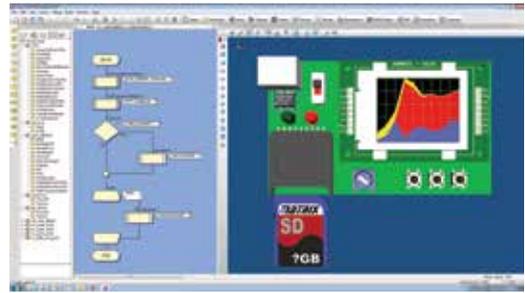


**Based on flowcharts** - minimal programming experience is required.

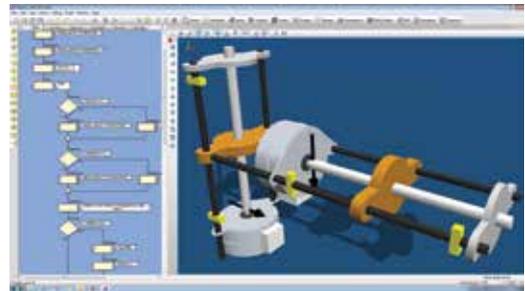
**Open architecture** - all aspects of Flowcode are fully customisable for your projects.

**Fully Supported** - with online tutorials, documentation and an active online community.

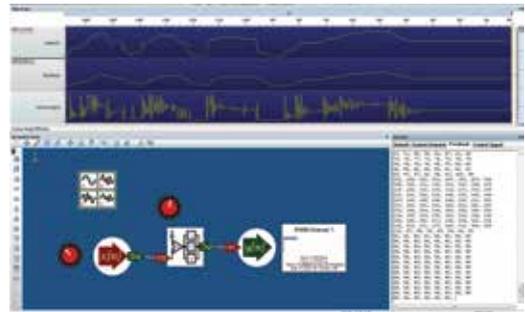
**Transfer your design** - easily between Windows, PICmicro, AVR, Arduino and ARM.



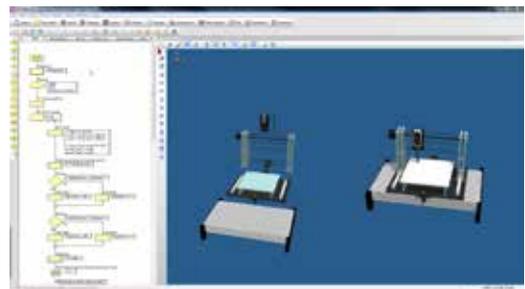
**Improved Simulation:**  
*Flowcode v6 has improved its simulation, making system design easier and faster.*



**3D Graphics Engine:**  
*Extend your design to include electromechanical components and systems.*



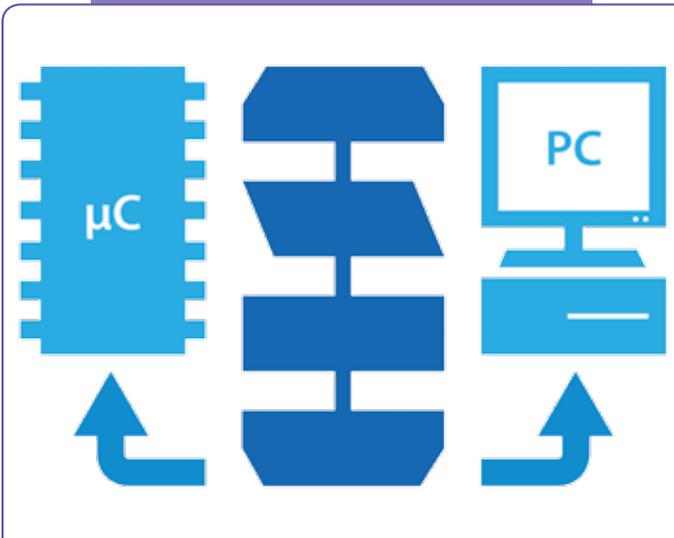
**New Test Features:**  
*The new test features in Flowcode v6 allow users to verify and record a system under test.*



**Component Creation:**  
*Users can create their own components for more realistic system design and simulation.*

# Advantages of using Flowcode

Microcontroller compiler and PC interpreter together make the design process easier.



Flowcode software is based on standard Flow charts symbols. Flow chart icons can be compiled to a microcontroller and can also be executed on a Windows PC. The PC-side software in Flowcode includes a full suite of Windows commands for mathematics, controlling graphics on the monitor, communications via Ethernet etc. In fact Flowcode 6 now includes a full Windows programming language as well as a microcontroller compiler.

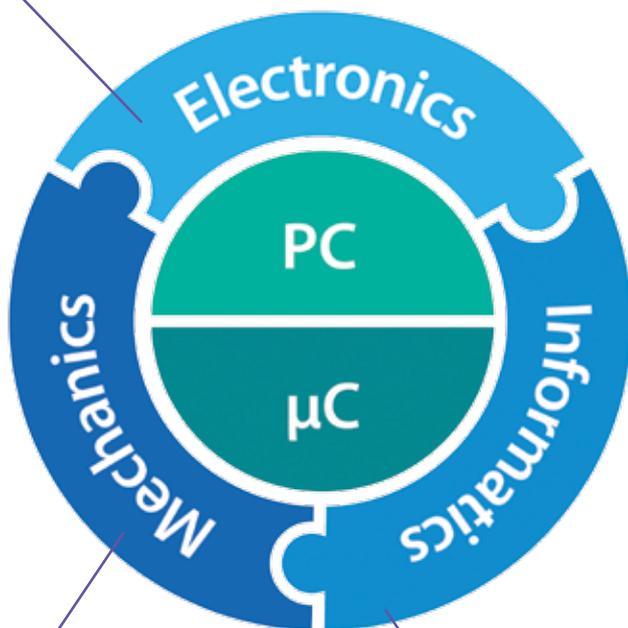
This 'PC-side' and 'chip-side' functionality makes Flowcode really powerful:

- Complex systems can be designed and simulated before chip-side compilation which saves design time
- In-Circuit-Test data can be linked to simulations to show system performance at run-time which proves designs function properly
- Programs can be deployed on a microcontroller or a Windows PC.

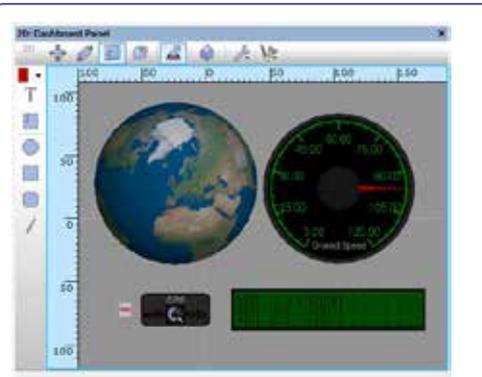
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Focus on three technologies facilitates a systems level design which makes the design process easier.

- Sensors
- Signal processing
- Drive systems



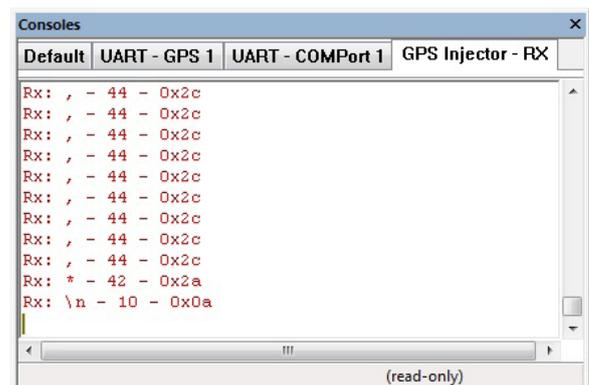
- Actuators
- Mechanisms
- Ergonomics
- Data manipulation
- Communications
- User interface



For example: GPS data from microcontroller In-Circuit-Test is processed by PC-side software into a human friendly format so that system design can be verified.

Flowcode's PC-side and chip-side features focus on Electronics, Informatics and Mechanics which gives Flowcode several advantages over other microcontroller compilers:

- Program design takes place at a systems level rather than at a chip level
- Program design time is shortened and made easier
- Programs for microcontrollers can be linked to PC side data files during design time
- Data decoding algorithms can be tested at the same time as control programs are developed



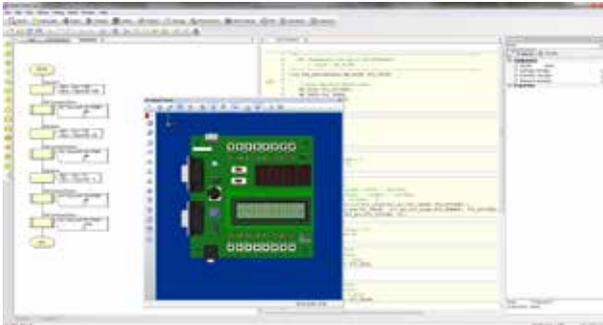
For example: During the design phase mock streams of serial digital data can be injected into a simulation so that decoding algorithms can be tested before compilation to chip.

# Flowcode design flow

## Design

## Simulate

### Circuit level

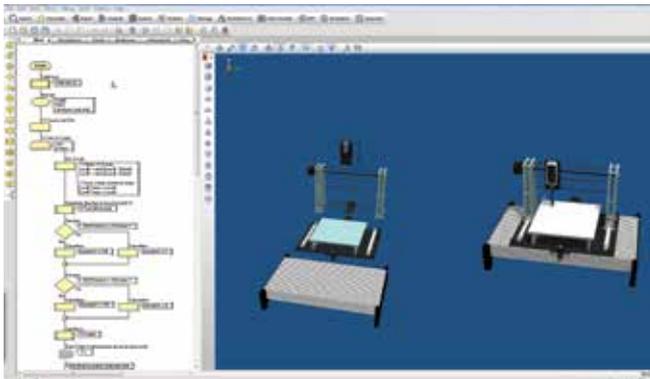


Design a virtual circuit board with PCB level components that connect to a virtual microcontroller and develop the program using flowcharts.

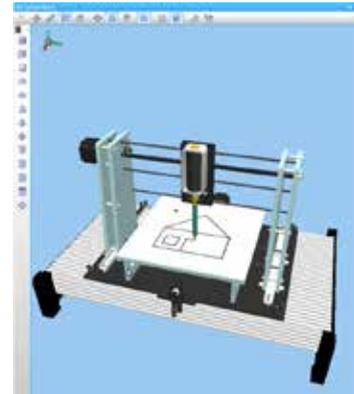


Simulate the program and circuit board components to check function using LEDs, displays to see function and interacting with virtual switches to control the system

### Electromechanical level

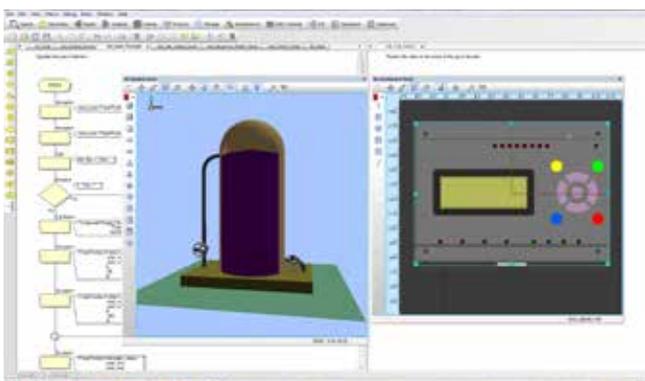


Develop a mechanical system in Solidworks and characterise it for Flowcode. Develop a flowchart program for control and operational data conditioning.

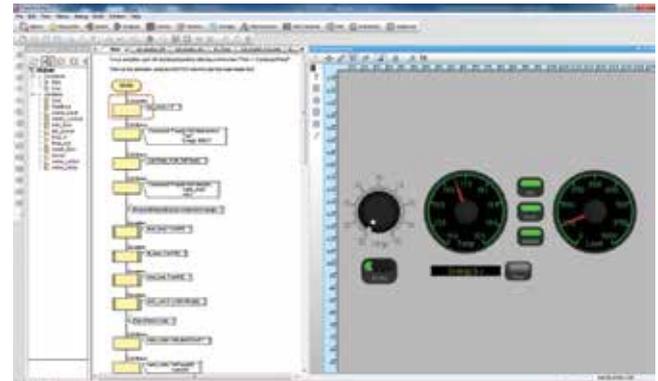


Simulate the mechanical system, the electronic system and the data decoding algorithms all in one package.

### Systems level



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



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

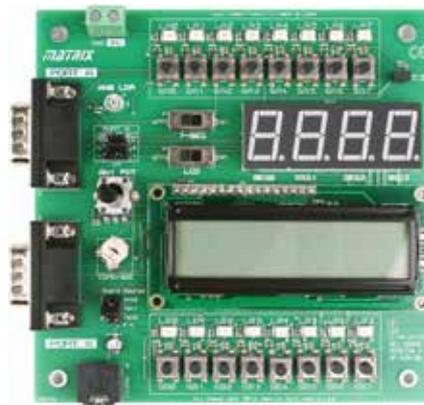
# Flowcode design flow

## Test



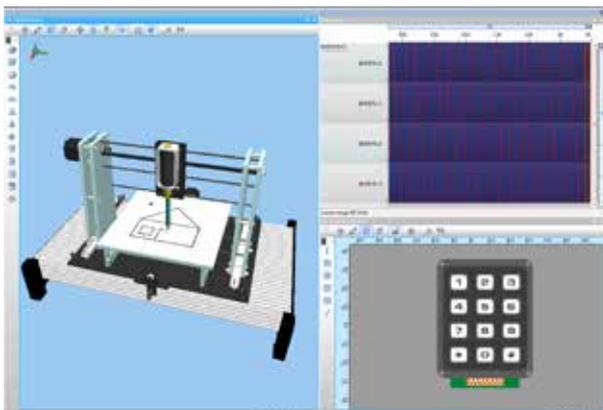
Download to the microcontroller in the E-blocks development system and use In-Circuit-Test and Softscope feature to verify operation at pin level.

## Deploy



Develop the final circuit board and release to market.

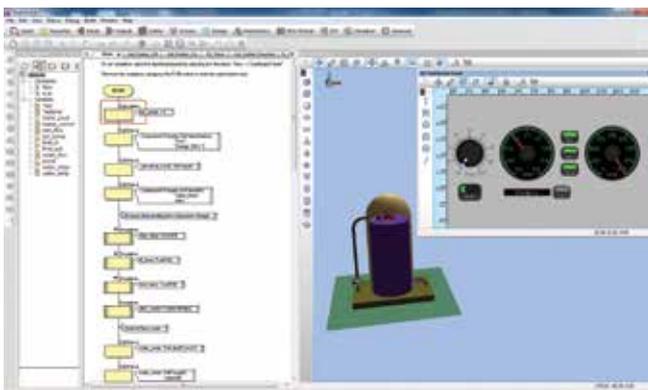
# 4



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



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



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



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

# Flowcode specification and ordering

## Specification

### OS/Processor cores

Windows XP, Vista, Windows 8, PIC10, 12, 16, 18, dsPIC/PIC24/PIC33, Atmel TINY, MEGA, Atmel AT91, SAM7, ARM, Arduino.

### Inputs

Various switches, knobs and potentiometers both PCB and panel mounted. Keypads.

### Outputs

Various LEDs and indicators, LED array, RGB LED, bar graph, single 7-seg display, quad 7-seg display, various monochrome LCDs, various colour graphic LCDs, multimedia modules. LED matrices, 4D Visi interface.

### Mechatronics

PWM, servo, stepper, DC motor, solenoid, Formula Flowcode robot.

### Media

Audio, video, MIDI, speech.

### Wired communications

CAN, CAN2, I2C master, LIN master, LIN slave, RS232, RS485, SPI, TCP/IP, web server, MIDI, USB HID, USB serial, USB slave, Modbus, One wire,

### Wireless communications

Bluetooth, GPS, GSM, RF ISM, RC5, IrDA, RFID, WLAN, Zigbee.

### Storage

FAT16 and 32, internal EEPROM, lookup tables.

### DSP

System, Kalman filter, output, inverse FFT, frequency generator, filter, FFT, control, level, scale, input, delay and sum.

### Sensors

Accelerometer, gyro, compass, photo reflector, beam breaker, reed switch, thermistor, digital temperature, quadrature encoder, thermocouple, hall effect, cap touch on/off, cap touch slider, magnetometer, humidity, colour, ultrasonic, infrared.

### MIAC

MIAC and expansion models including: MIAC slave, Basic, Advanced, Bluetooth, GPS, GSM, ZigBee router, ZigBee controller, serial, TCP/IP, RS232/485.

Expansion modules in V6.2.

### Dashboard HMI controls

Text label, value reactor, switches and buttons, control knob, slider, bargraph meter, 'analogue' style meter, vertical scale, horizontal scale.

### Injectors

CAN, GPS, Human interface, VNET, DS1307, AT.

### 3rd party instruments with DLL

ECIO, MIAC, FTDI UM232R, FTDI, UM245R, Velleman 8805 interface board, Picoscope 200 series.

## Versions

The versions and features of Flowcode are shown in the table on the right. Academic versions are designed for vocational schools, universities, and schools with highly technical curriculum content. The schools edition (SE) is designed for schools delivering a Design and Technology curriculum.

Chip packs are reduced function versions for hobbyists and also characterise Flowcode for the various microcontroller cores supported. Order a second chip pack if you need a second microcontroller core.

For ordering Substitute 'XXX' for the appropriate core: PICmicro 16 and 18 series: 'PIC' AVR/Arduino: 'AVR', dsPIC/PIC24: 'DSP', Arm 7: ARM

Proposed Version						
Feature	Version					
	Free - first 30 days	Free - post 30 days	Chip pack only	Professional	Academic	Flowcode SE
<b>1 General</b>						
Commercial Use	✗	✗	✗	✓	✗	✗
Multi-seat license available	✗	✗	✗	✓	✓	✓
Compile to Chip	✓	✗	✓	✓	✓	✓
Unrestricted Chip selection	✓	✓	✓	✓	✓	✗
<b>2 Control and measurement system design</b>	✓	✓	✓	✓	✓	✓
Import 3D objects and characterise for movement	✓	✓	✓	✓	✓	✓
Create 3D objects and characterise for movement	✓	✓	✓	✓	✓	✓
Create 'physical' and electronic components	✓	✓	✓	✓	✓	✓
Develop flowcharts for control and monitoring	✓	✓	✓	✓	✓	✓
Full access to simulation API	✓	✓	✓	✓	✓	✓
Unrestricted programme size	✓	✓	✓	✓	✓	✓
Develop Human-Machine Interface (HMI) controls	✓	✓	✓	✓	✓	✓
Simulate electromechanical systems	✓	✓	✓	✓	✓	✓
Control third party hardware using DLLs	✓	✓	✓	✓	✓	✓
Deploy your program on a PC (SCADA)	✓	✓	✓	✓	✓	✓
Ability to comment your own code	✓	✓	✓	✓	✓	✓
Auto document your program	✓	✓	✓	✓	✓	✓
Save your designs and publish as templates	✓	✓	✓	✓	✓	✓
Develop programs for MIAC controlled by PC	✓	✓	✓	✓	✓	✓
Download programs to MIAC	✓	✗	✓	✓	✓	✓
Download programs to Formula Flowcode	✓	✗	✓	✓	✓	✓
Access to Plug-ins	✓	✓	✓	✓	✓	✓
<b>3 Flowcode Components</b>						
Input / output components	✓	✓	✓	✓	✓	✓
Wired communications	✓	✗	✗	✓	✓	✗
Wireless communications	✓	✗	✗	✓	✓	✗
Wrapped wireless components	✓	✗	✓	✓	✓	✓
Mechatronics	✓	✗	✗	✓	✓	✓
MIAC expansion modules ( <i>coming soon</i> )	✓	✗	✗	✓	✓	✗
DSP	✓	✗	✗	✓	✓	✗
<b>4 SCADA support</b>						
In-Circuit-Test	✓	✗	✓	✓	✓	✓
Third party instruments	✓	✓	✓	✓	✓	✓
Consoles	✓	✗	✗	✓	✓	✓
Softscope	✓	✗	✗	✓	✓	✓

### Ordering information

Flowcode Academic single	FC6AC01NEXXX
Flowcode Academic 10 user	FC6AC10NEXXX
Flowcode academic 50 user	FC6AC50NEXXX

# AUTOMATICS

# 5

## Contents

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Why choose Automatics?	79
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Automatics courseware	81
Solutions	82 – 83
Component Guide	84 – 85



*An example of a functioning control pneumatics solution with the Matrix MIAC controller*

# 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.

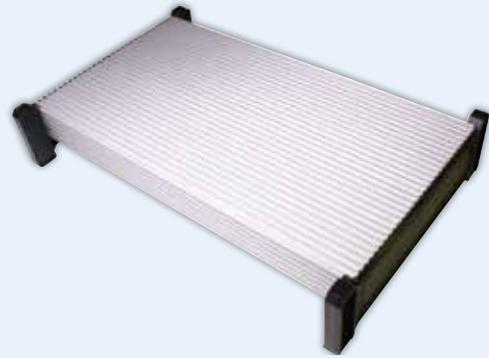
The Automatics range consists of around 100 separate rugged components that mount onto a stable aluminium platform. Components are clearly marked with the appropriate pneumatic or electrical symbol. Students take the rugged components, mount them to the platform using plastic 'tee' bolts, and connect the components together with nylon tubing to build working pneumatic circuits.

They then use the curriculum provided to carry out experiments in pneumatic and electronic control.

## Disciplines include:

- Pneumatics
- Automation
- Design technology

## The Automatics range includes:



A rugged aluminium platform

To which students add...



A compressor



A manifold



Cylinders



Mechanical valves



Electrical valves



Connectors



Switches and sensors



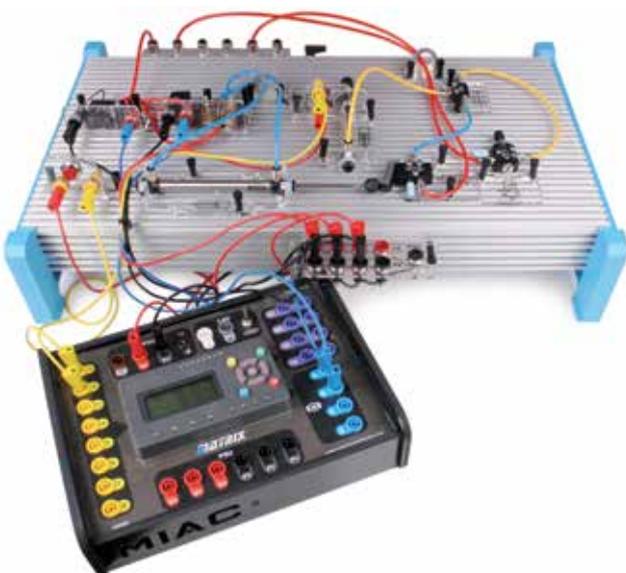
A controller



Pneumatic tubing



Electrical cables



# Why choose Automatics?

## Automatics platform

The extruded aluminium platform provides a solid foundation to which the other components are fixed. It is large enough to provide a comfortable work area for the largest of the circuits in our curriculum worksheets.

## Reliability and robustness

Automatics has been designed from the ground up to suit the classroom environment. The pneumatic components are identical to those used by real engineers, but we have cleverly adapted them so that students can construct automation systems speedily and without requiring any tools.

## Simple to connect

The compressed air supply is distributed using plastic tubing that is easily cut to length. This simply pushes into the component connectors. To release the tube, simply depress the connector collar and pull out the tube.

## Carriers and symbols

Each component is secured to a clear acrylic carrier. The carrier is printed with a product code for easy identification, and the industry standard symbol for the part. Slots in the carrier allow for easy positioning in any orientation on the platform.

## Tee-bolt fixings

Components are attached to the slots on the sturdy aluminium platform using plastic tee-bolts. These are easily secured and released without requiring any tools, allowing components to be quickly positioned and held firmly in place.

## 4mm connectors

For components which require electrical connections, we have used standard 4mm single pole connectors which are suitable for 'safety' shrouded plugs. Suitable leads are provided when you purchase any kit of components.

## Full curriculum support and courseware

Our Automatics courseware CD ROM contains a complete student centered interactive course on pneumatic system design. High quality worksheets are supplied in electronic format on CD ROM with each kit. Worksheets are all free of charge and contain clear well written instructions for each experiment. Teachers can hand students a full manual, or can print just the worksheets required.

## Software and control system support

Students learn to design control pneumatics systems using Matrix's Flowcode software which is based on flow charts. Control systems are based on our MIAC controller which is designed with education in mind.



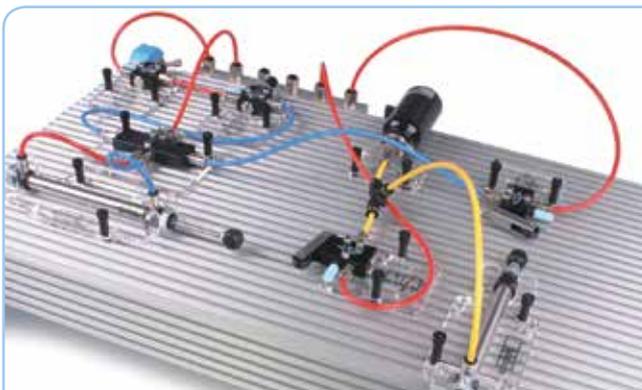
All pneumatic fittings are quick release



Circuit symbol clearly printed on each carrier



Quick release tee-bolts



A typical Automatics project



Standard 4mm cables used for all electrical connections

Automatics is more than just a range of hardware - it also offers a suite of learning resources that assist both students and educators to maximise the educational value of the equipment.

## The curriculum CD

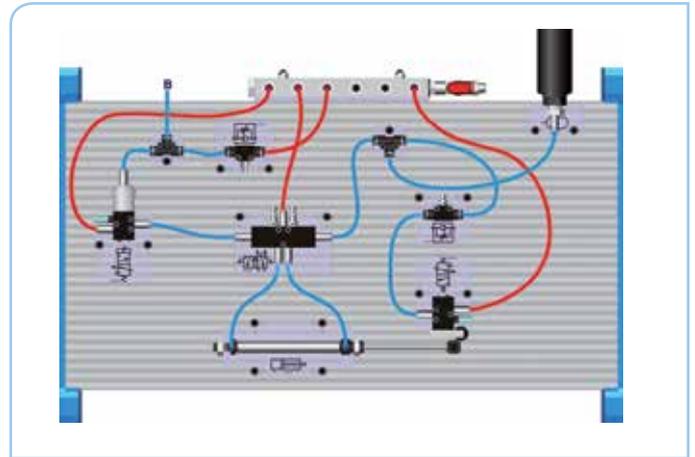


Our curriculum CD-ROM includes a set of .pdf workbooks that provide lesson plans, student worksheets and teacher's notes for a variety of courses that can be used individually or as a coherent series.

Each workbook is professionally written by experienced teachers who have used the Automatics hardware in a real learning environment.

Ordering information	
Automatics essentials	AW2080
Electro-pneumatics	AW2079
Control pneumatics	AW4956
Control pneumatics plus	AW4957

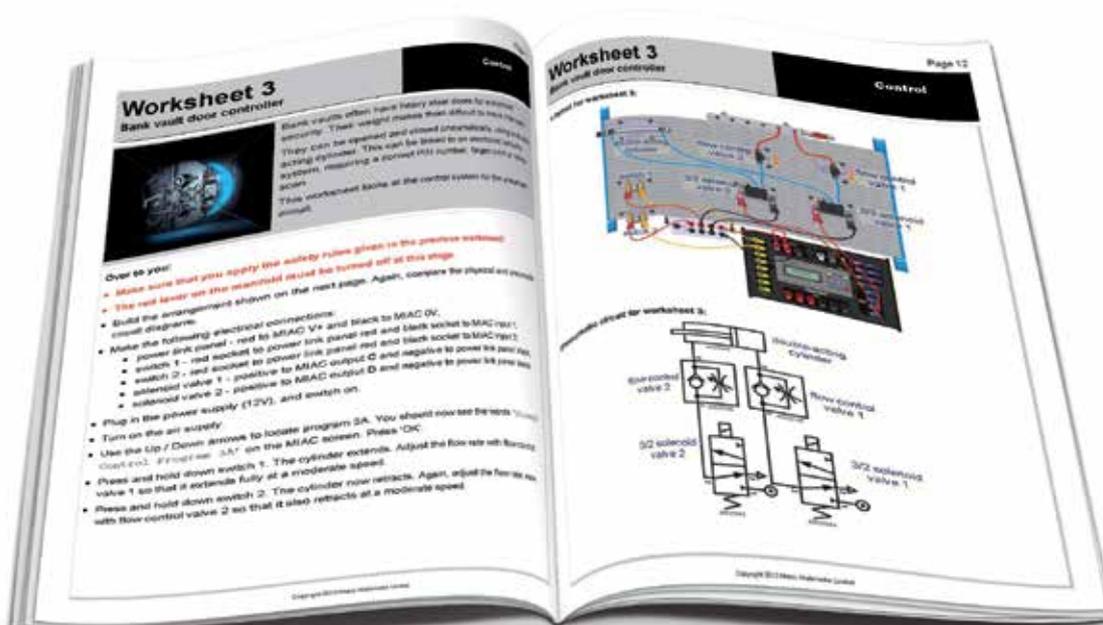
Students are guided through each subject in a logical sequence with clear, concise learning objectives at each stage, complete with quizzes and short tests by which their progress can be assessed.



For each curriculum objective, there is a worksheet designed to be printed and handed out to students, with areas set aside for them to enter the results and conclusions of their experiments.

Throughout each worksheet, pictures and diagrams of the Automatics hardware are used to make setting up the experiments easy. Examples from real world applications help students to understand the context of what they are learning, helped by our use of internationally recognised symbols for all of the components.

The curriculum CD, complete with every Automatics course, is provided free with every kit.





## Simplifying kit selection

While it is perfectly possible to assemble your own custom collection of Automatics parts, there is a much simpler way to ensure that you have everything you need.

For each of our curriculum courses, we have put together kits of parts that include almost everything that you need to be able to teach a course.

This has several advantages over buying separate components...

- It takes the hard work out of choosing the appropriate equipment.
- You will receive generous quantities of 'consumables' such as pneumatic tubing and fixings.
- Power supplies and tools are included where necessary.
- Shipped in sturdy ABS plastic storage trays.
- Programmable items, such as the MIAC controller, are pre-programmed with all of the programs that you'll need to complete our curriculum courses.

And, naturally, every curriculum and kit of components is extensively tested here at Matrix; so you can be sure that every worksheet experiment will work as intended!

## Solutions

A 'solution' is a stand-alone set of equipment that provides everything necessary to teach an associated curriculum course.

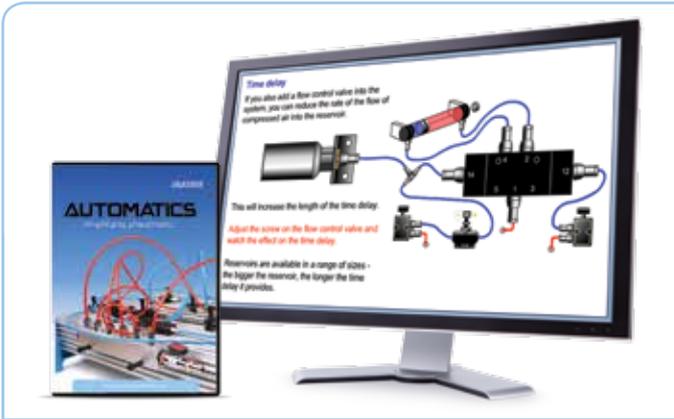
In addition, solutions can be used to provide a 'core' of essential components which can be expanded with more specialist parts once the basic principles have been mastered.

As many workshops and laboratories may already have a suitable compressed air supply, an air compressor and conditioning unit is the only item that is not supplied as standard. We do however offer a suitable unit at very reasonable cost should you require it.

## Add-on packs

Add-on packs are designed to extend the features of a core solution, to save you from having to purchase duplicate equipment if you intend to teach more than one curriculum course.

For example, the Automatics essentials solution can be extended with the Control add-on kit as your students progress from learning basic pneumatic principles to more advanced programmable control applications.



## 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.

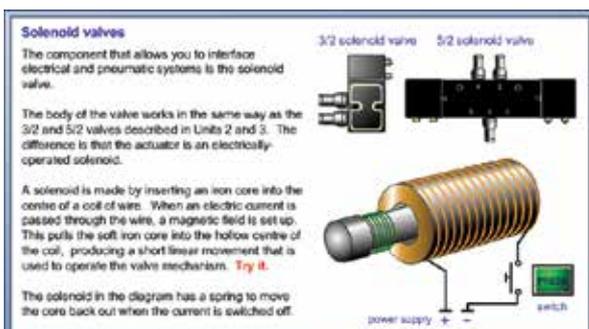
The courseware is a complete curriculum, covering everything from basic component identification and learning circuit symbols, through to the construction of complete automated systems.

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

### Ordering information

Automatics interactive courseware site licence

AW20780



## 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

### 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	Curriculum CD ROM
1	Set of storage trays		

### Ordering information

Automatics essentials solution

AW20801

### You may also need...

Compressor

AW30100



AW20792

## 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

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	1	Curriculum CD ROM

#### Ordering information

Electro-pneumatics add-on kit	AW20792
You may also need...	
Automatics essentials solution	AW20801



AW4955

## 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.

#### 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	1	Curriculum CD ROM

#### Ordering information

Automatics control add-on kit	AW4955
You may also need...	
Automatics essentials solution	AW20801
Flowcode	See page 70

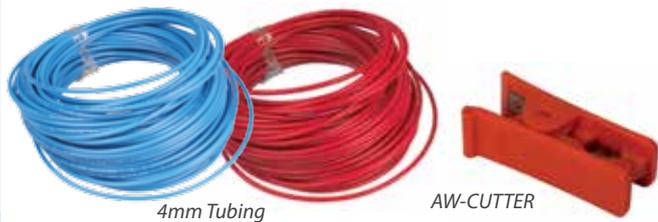
# 4



## 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 x 40 mm	AW-C1040S
Cylinder, double acting, 10 x 80 mm	AW-C1080D



## 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.

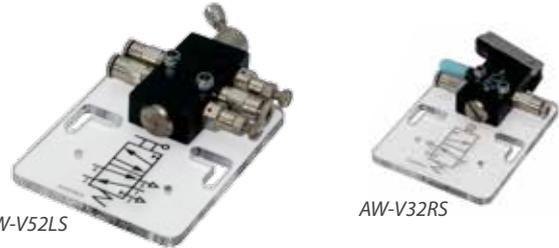
Description	Part number
Tubing, 4mm, blue, 30 m length	AW23119
Tubing, 4mm, yellow, 30 m length	AW23124
Tubing, 4mm, clear, 30 m length	AW25688
Tubing, 4mm, red, 30 m length	AW23122
Tubing, 4mm, red, 5 m length	AW23123
Tube cutting tool	AW-CUTTER
Junction, equal tee	AW-EQTEE



## 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	AW30100
Manifold	AW-MANI
Platform	AW-PLATFORM
Tee-bolts and sleeves (pack of 50)	AW22876



## 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	AW-V22FC
Valve, mini shuttle	AW-V32MS
Valve, 3/2, button-spring	AW-V32BS
Valve, 3/2, roller-spring	AW-V32RS
Valve, 3/2, lever-spring	AW-V32LS
Valve, 3/2, diaphragm-spring	AW-V32DS
Valve, 5/2, lever-spring	AW-V52LS
Valve, 5/2, pilot-pilot	AW-V52PP



## Valves - electrical

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

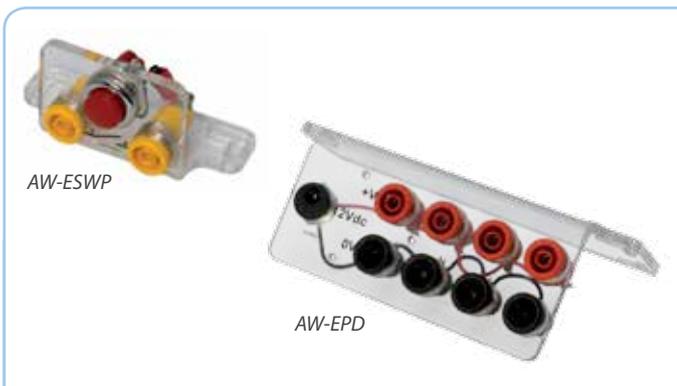
Description	Part number
Valve, 3/2 solenoid-spring	AW-V32ES
Valve, 5/2, double-solenoid	AW-V52EE



## Reservoir

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

Description	Part number
Reservoir 45cc	AW-RES45CC



## Electrical

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

Description	Part number
Reed switch and holder	AW-ERS
Switch, push to make	AW-ESWP
Microswitch	AW-EMS
Light sensor	AW-ELS
Power supply	HP2666
Power panel	AW-EPD
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. (see below)

Description	Part number
Cased MIAC with 4mm shrouded sockets	MI0245



## 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	AW20801
Automatics electro-pneumatics add-on kit	AW20792
Automatics control add-on kit	AW4955
Curriculum CD ROM	LK6492

In 2014 we are focussing on products for use in schools between the ages of 14 and 16 and you can see these products on the following pages.

## Contents

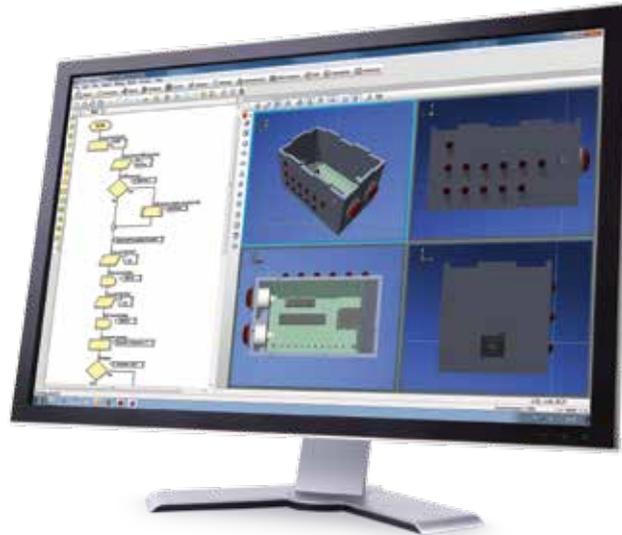
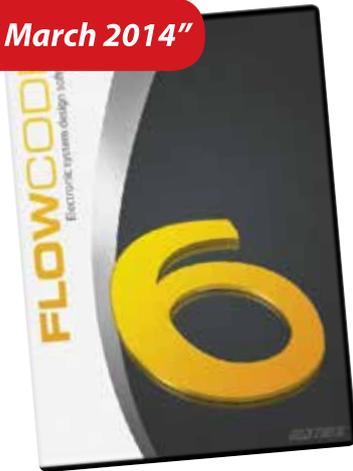
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Parts guide	93



Students at St Joseph's Institute, Schoten, Belgium, solving a simple maze using the Formula Flowcode robot and Flowcode.

NEW

"Released March 2014"



Import mechanics from Solidworks, and design and simulate the electromechanical system in Flowcode

6

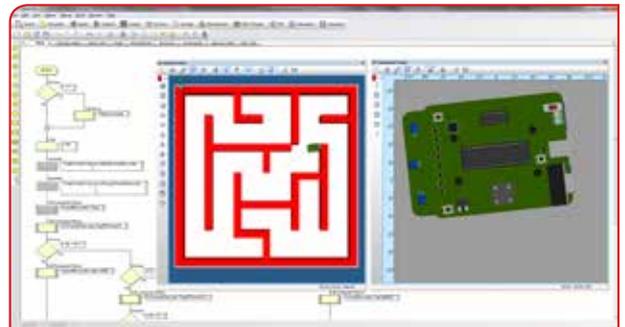
Flowcode Schools Edition (SE) is a function limited version of Flowcode 6 which allows students to develop programs for microcontrollers and Windows compatible PCs. Flowcode SE provides a great platform for learning about electronics, informatics/computer science and mechanics in a single package.

Design Technology (D&T) students can use Flowcode to learn about programming, circuit and product development based on selected PIC, AVR, and Arduino microcontrollers and on a Windows PC. D&T students can simulate their microcontroller based designs, and can also see how electromechanical systems are controlled by computers.

Computer Science students can use Flowcode SE at various levels: starting with simple program construction using Flowcharts, working up to complex programs with subroutines, interrupts, complex data structures and external files. Computer Science students can use Flowcode at a systems level to develop sophisticated programs that interface to simulations, to hardware systems and to networked computers and devices.

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

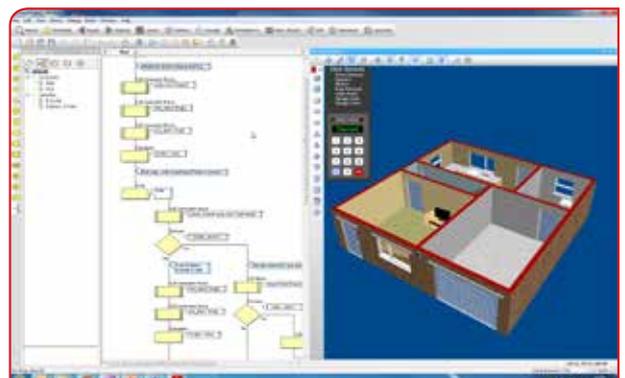
- A function limited version of Flowcode 6
- Develops code for microcontrollers and Windows PCs
- Supports selected PIC, AVR, Arduino, dsPIC microcontrollers
- Compatible with many third party microcontroller development systems
- Links to Solidworks and other 3D design packages
- Interfaces to the internet, and many other computer systems



Solve robot mazes in a virtual environment....



...and test the programs in the real world.



Control our virtual house in Flowcode

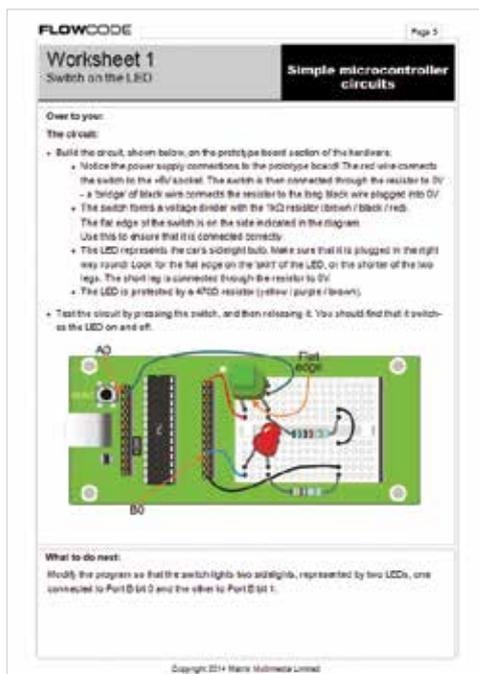
Ordering information

Flowcode SE single user	FC6SE1
Flowcode SE site licence	FC6SE50



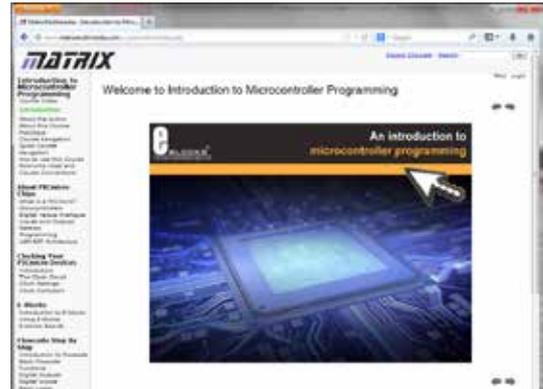
## Curriculum packs

Use of Flowcode and associated hardware is well supported in the classroom by a number of curriculum packs - all of which are free of charge and downloadable. Curriculum packs include clear instructions for students to follow to achieve the desired learning outcomes. Support for teachers is also included in the form of hints and tips in delivering learning in the classroom.



### Ordering information

Simple microcontroller circuits	SE3829
Design and make electronic products	SE4855
Introduction to microcontroller programming course	ELFCS2
Introduction to robotics	SE8832
Computer science and control 1	SE7761
Computer science and control 2	SE5690



## Introduction to microcontroller programming course

This free online resource provides a complete course in developing microcontroller based systems using Flowcode. The course contains a suite of 13 labs each of which has an accompanying Word worksheet. Students print a worksheet and then work through the contents of the CD ROM, developing systems using Flowcode to complete each lab. Each worksheet has a number of tasks, graded to cater for mixed ability classes. Supervisors can use the accompanying Excel marking scheme to track the progress of students as they work through the material. The course is based on E-blocks but is usable on other hardware platforms.

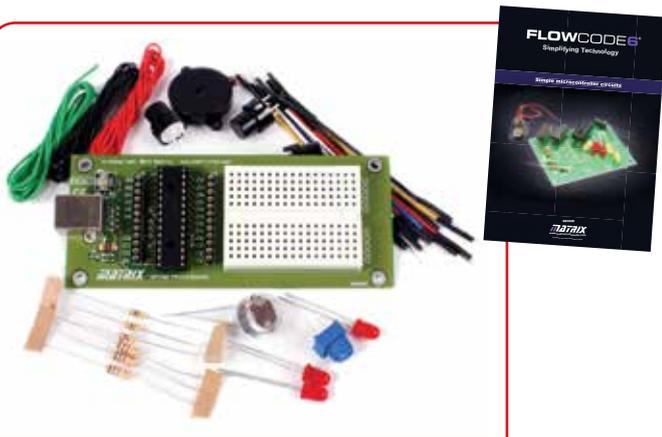
### Learning objectives /experiments

- 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

Available free online

### Ordering information

Introduction to microcontroller programming	FREE
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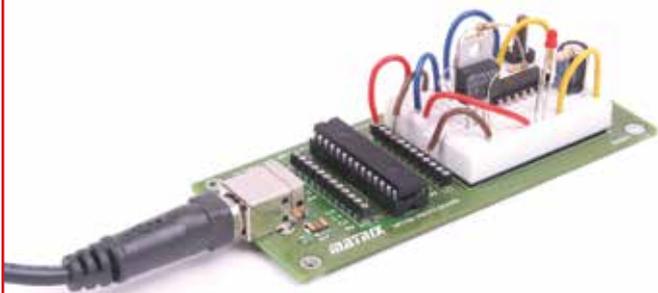
**NEW**

## Simple microcontroller circuits

This solution introduces students to the basic principles of circuit construction and prototyping using a breadboard and a few simple electronic components. The manual includes 10 simple microcontroller circuits along with guides to developing the associated control programs using Flowcode. This low cost solution is an ideal starting point for students of Design and Technology who want to understand how to incorporate microcontrollers into their projects. Needs Flowcode SE software. Requires USB cable.

### Learning objectives /experiments

- Microcontroller programming and circuits
- Microcontroller clocks, pins, inputs, outputs, ports,
- Programming using flowcharts: input, system, output, loops, decision, subroutine, go to, calculations, delays, simple variables, A/D conversion, pulse and tone generation
- Components: switches, LEDs, sensors, buzzers, resistors, potential dividers.
- Logic: AND, OR, NAND, NOR, NOT



Prototype board in use

### Components included

1 Buzzer	1 Light dependant resistor
3 470R resistors	3 LEDs (red, green, orange)
1 1K resistor	3 Push to make switches
1 4k7 trimmer	1 Lengths single core wire
1 USB prototype board	1 Pack connector leads

### Ordering information

Simple microcontroller circuits solution	SE3829
Class set of 20	SE4758
Curriculum pack	SE3829

### You may also need:

USB cable	HPUSB
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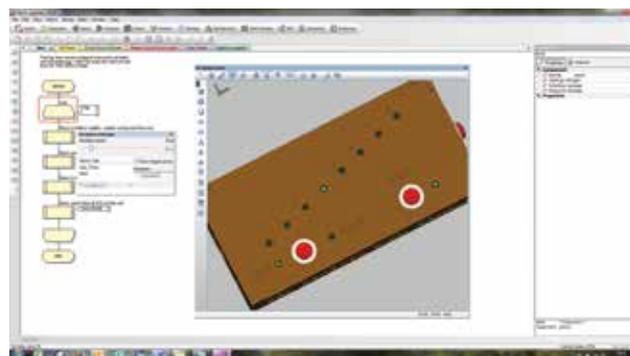
**NEW**

## Design and make electronic products solution

This solution is designed to provide a framework to allow students to first investigate the design of electronic products and then to design and manufacture a project of their own. The curriculum first guides students through a number of pre-built designs based on our PIC project board and pre-designed Solidworks projects. Students then undertake a design brief to develop an electromechanical project of their own. Needs Flowcode SE software. Requires USB cable.

### Learning objectives /experiments

- Controlling DC motors, servo motors, stepper motors, solenoids, and pneumatic systems
- Investigating electro mechanical designs
- Packaging and packaging design for electronic products using Solidworks® CAD
- Designing, making and testing electronic products using Flowcode
- Designing, making, testing and evaluating mechanical products using laser cutters, 3D printers and other CAD/CAM resources
- Writing up projects



Egg timer project with mechanics created in Solidworks

### Components included

1 Relay	3 MES lamp holder
1 DC motor	1 Red MES LED bulb
1 Stepper motor	1 Yellow MES LED bulb
1 Servo motor	1 White MES LED bulb
1 Reed switch	1 Solenoid
1 Toggle switches	1 Isonic pneumatic valve
1 USB project board	

### Ordering information

Design and make electronics products pack	SE4855
Class set of 20	SE9885
Curriculum pack	SE3844

### You may also need:

USB cable	HPUSB
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**NEW**

## Computer science and control 1

This kit of parts allows Computer Science students to develop an understanding of simple control systems and to develop programs using flow charts. The kit uses our MIAC controller as a PC slave and as an embedded microcontroller target. The kit includes switches, bulbs, motors and sensors which plug into the MIAC using 4mm connectors to allow students to cement their understanding of control using real physical parts. Requires Flowcode SE software.

### Learning objectives /experiments

- Microcontroller based systems
- Control system theory of simple systems: Input, system, output, open loop, closed loop
- Programming using flowcharts: input, system, output, loops, decision, subroutine, go to, calculations, delays, variables, strings, A/D conversion, interrupts, hardware macros, software macros, arrays.
- Control components: switch, light sensor, bulbs, motors
- Industrial controllers, Microcontroller based systems.

See MIAC section for full MIAC details

#### Components included

1	Cased MIAC	2	MES LED bulbs
1	Power supply	1	4mm Light sensor
1	USB lead	2	4mm to 4mm lead, black
2	4mm Push to make switches	2	4mm to 4mm lead, red
1	4mm DC motor	2	4mm MES bulb holders

#### Ordering information

Computer science and control 1	SE4829
Curriculum pack	SE7761



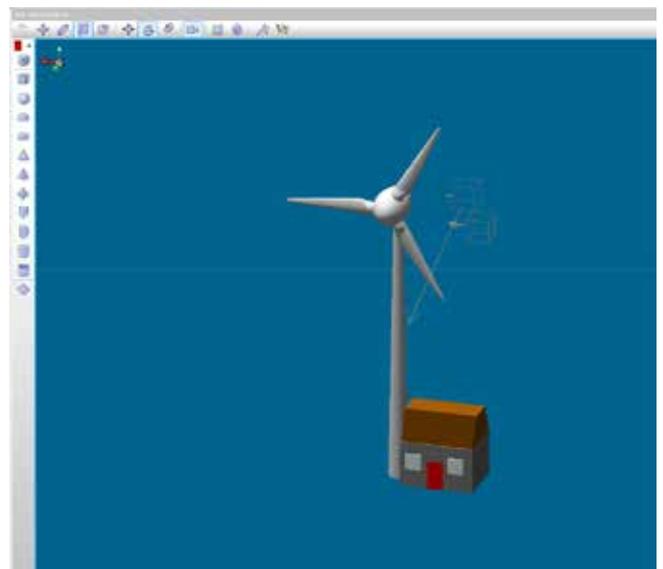
**NEW**

## Computer science and control 2

This pack of Flowcode simulations allows Computer Science students to develop more complex control projects using Flowcode. The pack covers the development of five projects: The first three projects are fully functional electronic products which include electronics and 'physical' packaging developed in Solidworks. Students are given all the elements of the design which they then need to bring together and program. These three projects, based on our USB Project board, can be built if needed. The two larger projects are based on 3D systems modelled within Flowcode. Students must use the 'Physical' model and develop programs to make the system function as required.

### Learning objectives /experiments

- Advanced programming with extensive use of macros and functions with parameters
- Development of complete electronics products in a virtual world
- Advanced egg timer
- Binary clock
- Modelling of virtual systems using software
- Windmill
- House



#### Ordering information

Computer science and control 2 curriculum pack	SE5690
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## The Automatics essentials solution

This kit provides a complete introduction to pneumatic circuit design and construction. The included 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

### 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	Curriculum CD ROM
1	Set of storage trays		

### Ordering information

Automatics essentials solution	AW20801
You may also need...	
Compressor	AW30100



AW20792

## 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

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	1	Curriculum CD ROM

### Ordering information

Electro-pneumatics add-on kit	AW20792
You may also need...	
Automatics essentials solution	AW20801

# 6



## PICmicro microcontroller systems investigation

This new kit allows students to investigate circuits and systems based on the popular PICmicro microcontroller. The kit focuses on system construction with a pre-programmed PIC carrier which includes 8 programs, selectable by hardware switches. The work can be extended to include programming of PICmicro® microcontrollers using flowcharts with our Flowcode software. A full curriculum pack is included.

### Learning objectives /experiments

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



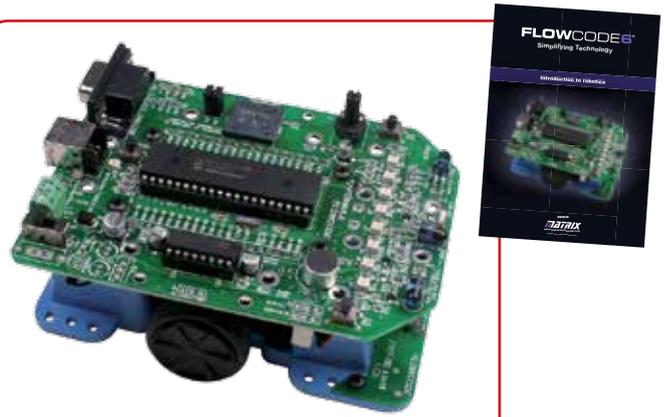
### Locktronics PICmicro microcontroller

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.

#### Components included

1	Power supply	1	LED, yellow, 5V (SB)
1	USB reprogrammable PIC carrier with power lead	1	MES bulb, 6.5V, 0.3A
1	Light dependent resistor		Locktronics User Guide
2	Resistor, 10k, 1/4W, 5% (DIN)	1	USB2 high speed A to mini B lead
16	Connecting Link	2	Lead, yellow, 500mm, 4mm to 4mm stackable
1	Lampholder, MES	1	Thermistor, 4.7k, NTC (DIN)
2	Switch, push to make, metal strip	1	Transistor RHF, NPN
2	Switch, on/off, metal strip	1	Motor 3 to 12V DC, 0.7A
1	Buzzer, 6V, 15mA	1	Resistor, 2.2k, 1/4W, 5% (DIN)
1	Curriculum CD ROM	1	7 x 5 metric baseboard with 4mm pillars
1	Potentiometer, 10k (DIN)	1	Power supply carrier with battery symbol
2	LED, red, 5V (SB)	1	Resistor, 100 ohm, 1W, 5% (DIN)
1	LED, green, 5V (SB)	1	Resistor, 1k, 1/4W, 5% (DIN)

Ordering information	DIN	ANSI
PICmicro systems solution with storage tray, baseboard and power supply	LK8922	LK8922A
Corresponding curriculum	LK7209	

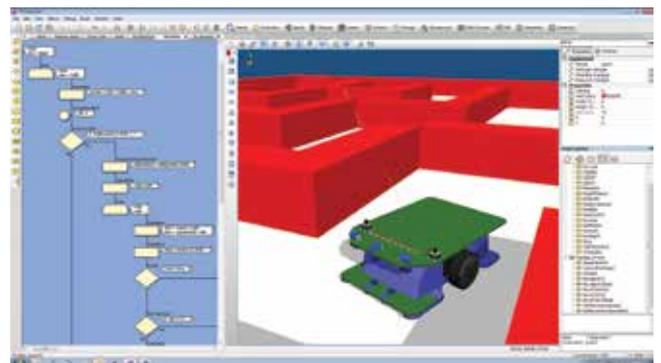


## Introduction to Robotics

The Formula Flowcode robot is a high specification, low cost microcontroller-controlled robot buggy which is great for introducing students to programming and robotics in a fun and motivating way with huge scope for further work and competitions. The buggy is supplied with new simulations in Flowcode 6/SE, a beginners' course, easy to follow circuit diagrams and information, and lots of follow on exercises and expansion options (including Bluetooth, Wifi) using E-blocks.

### Learning objectives /experiments

- Microcontroller programming and robotics
- Programming using flowcharts: 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 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



Buggy and a line following exercise

See Formula Flowcode section for full details

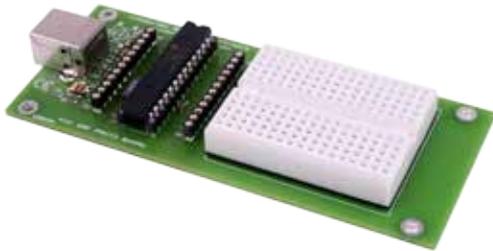
#### Ordering information

Formula Flowcode robot buggy	HP794
Maze walls	HP458
Starter class bundle	HP926
Pro class bundle	HP600
Curriculum pack	FF8832

**NEW**

## USB prototype board

The Project 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
Prototype lead pack	FLLCPK
USB lead	HPUSB

**NEW**

## USB project board

The project board includes a USB programmable 18 pin microcontroller and a ULN2003 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 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

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## 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
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## 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	SE 2995
Light dependant resistor 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





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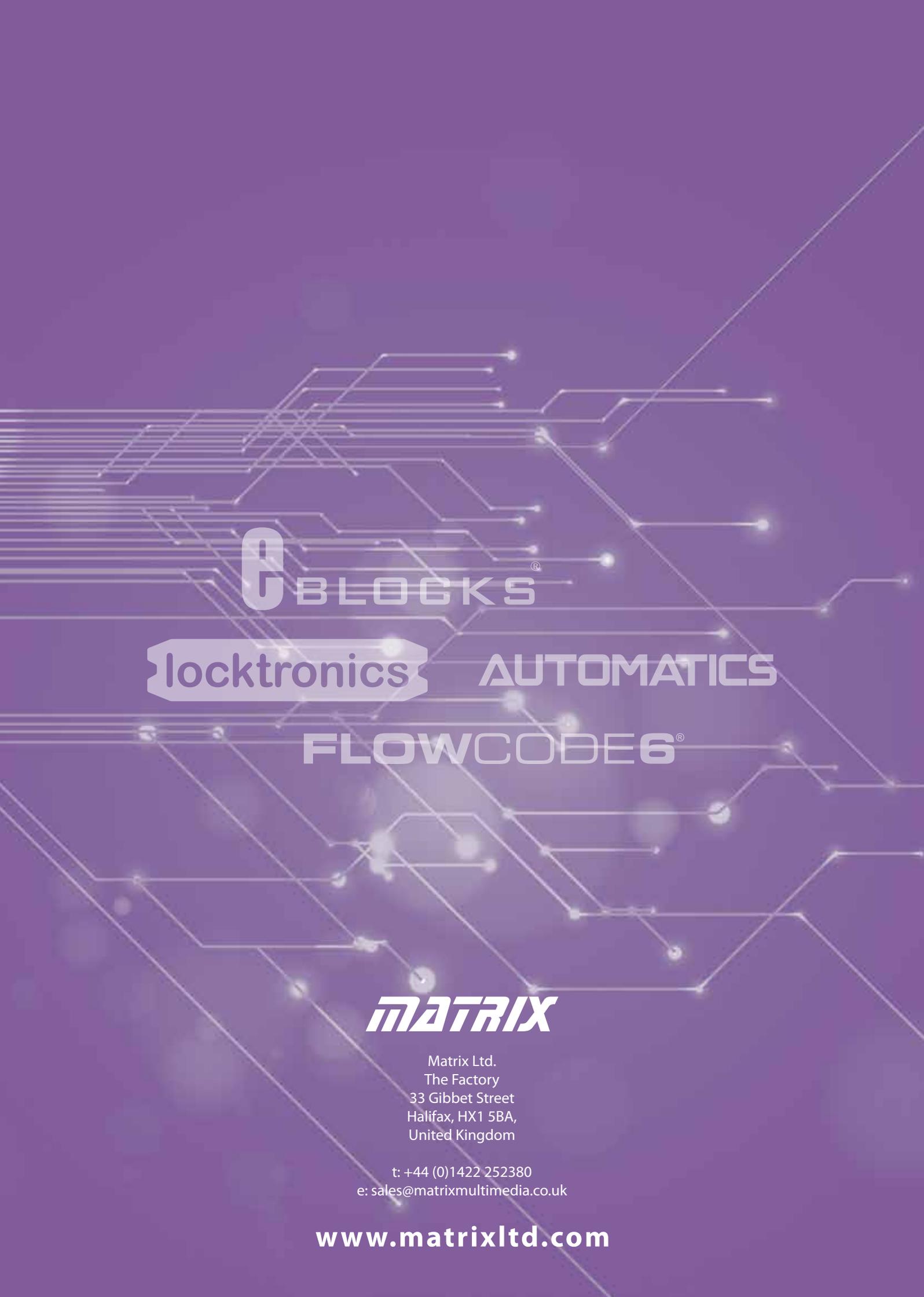
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