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ENGINEERING
EDITION 2020

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“Tullos Training Ltd have been looking for training equipment to enhance our apprentices training for a number of years. We were looking for training materials that would cover us from our Foundation Apprentices to our HNC students. We came across Matrix and enquired about a demonstration. Matrix were more than happy to travel up to Aberdeen to demonstrate the equipment to my Lecturing staff.

We were all impressed by the equipment and the professional demonstration, so much so, the lecturers would have purchased all of the equipment shown, given half a chance. In the end, it was decided that we would purchase Engineering equipment, which have proven to be invaluable teaching aids.

The whole process has been easy and quickly dealt with, I would have no hesitation in recommending Matrix, to anyone looking to enhance their teaching methods/student engagement.”

Jim Booth
Training Executive, Tullos Training Ltd, United Kingdom

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



Electrical & Electronic

Our learning solutions:

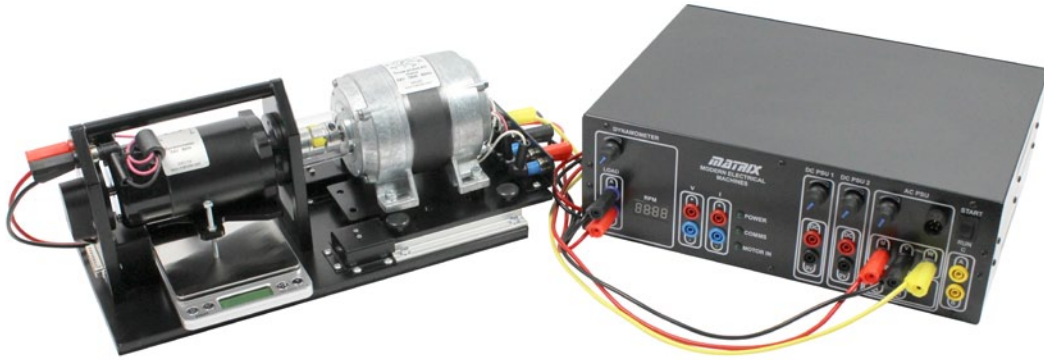
- Meet RoHS compliancy stipulations
- Are rugged and long-lasting, in order to stand up to the demands of engineering lab requirements
- Include relevant and in-depth curriculum guides throughout
- Are often compatible with our microcontroller programming software, Flowcode.

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



Joe Robinson
Joe Robinson Training, United Kingdom

Modern electrical machines



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

Learning objectives / experiments:

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

This kit includes:

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

Control box features

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

Control box

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



Control box features

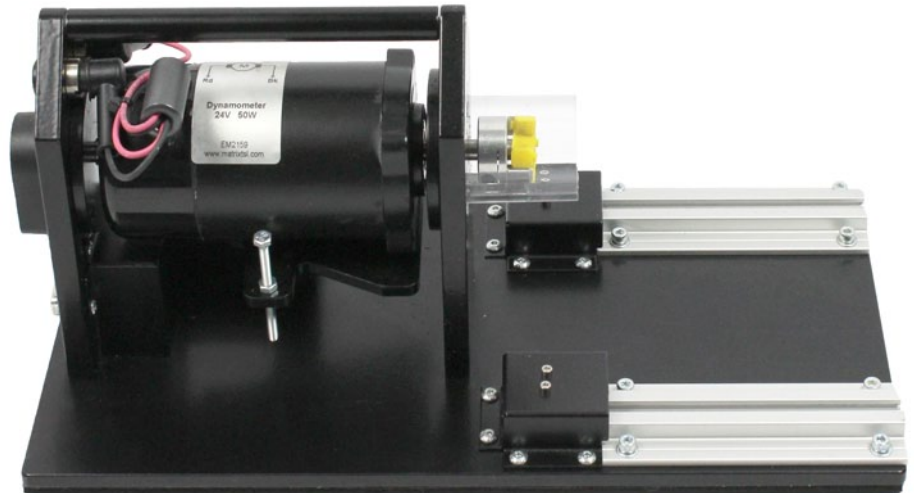
- 14 different instruments embedded within it
- A unique API, allowing connection to be made to the MATLAB environment
- A small size, around the size of a laptop, making it small enough to sit on a desk along with the rest of the kit and PC

Modern electrical machines (continued)

Motors

DC Dynamometer / motor and cradle

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



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

Three phase induction motor

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



Shunt motor

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



Single phase induction motor

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



Universal / Series motor

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



DC motor

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



Brushless DC motor / 3 phase generator

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

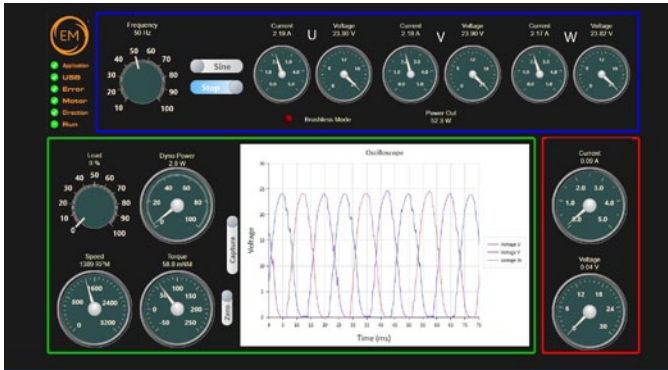


Modern electrical machines (continued)

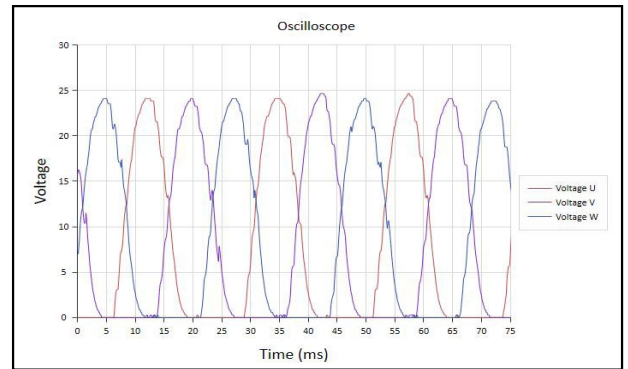
PC Software

The system is designed to be used manually or via connection to a laptop or PC. When utilising the PC control option, the user should download the app from the Resources page on the website. Above are a range of screenshots showcasing the ways the proprietary software can be used to control each type of machine in the range.

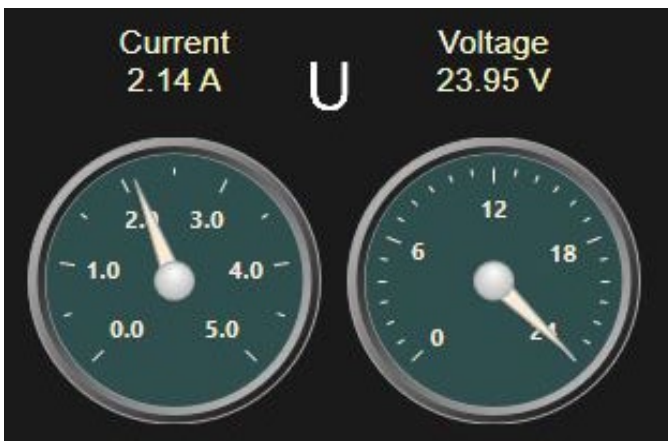
Through experimentation, users can review the results of altering the voltage, load etc of each machine and the subsequent effect this has on each machine's current, torque etc. over time.



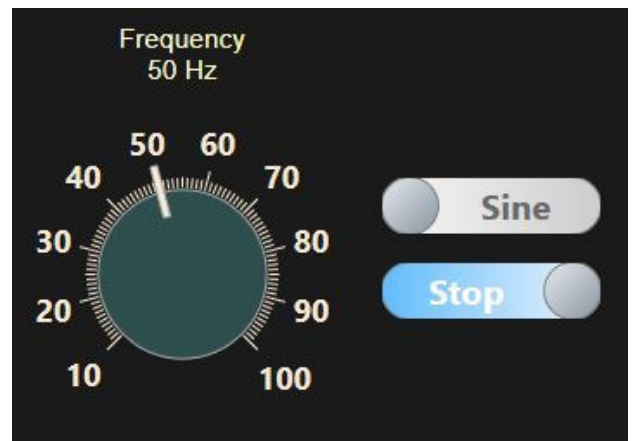
Three phase control software with integrated oscilloscope.



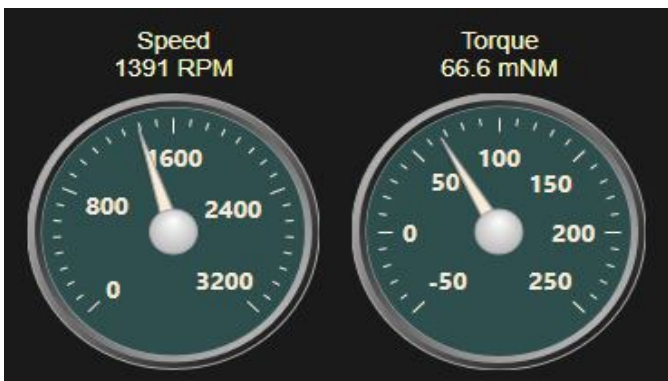
Close up of oscilloscope plot – users can select from one of 14 on-board instruments.



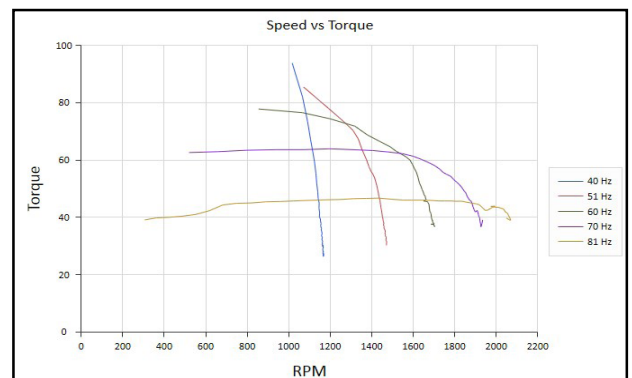
Gauges show key values such as current and voltage.



Set output frequency and waveform type – in this case digital or pseudo-sine.



Software allows you to monitor RPM and torque in real time.



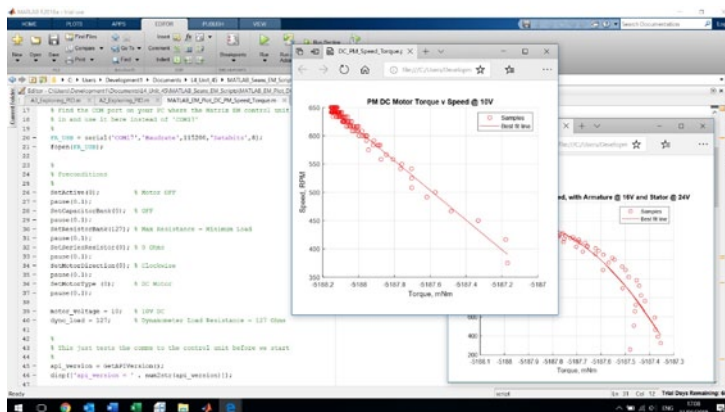
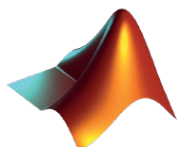
Automatic speed torque graph for any of the machines can be generated by the software.

Modern electrical machines (continued)

MATLAB and LABVIEW compatibility

A suite of API calls are provided which allows the system to be used with both MATLAB and LabVIEW software.

This allows students to understand the characterisation of electromechanical systems using mathematical formulae and to compare simulated results with real world values.



Curriculum

We have created 4 curriculum to go with our range of modern electrical machines. They follow the learning required within different courses and come complete with learning instructions, worksheets and a teachers section. They come equipped with all the learning required for the course, along with the software required.



Curriculum mapping

- Teaches students the basics of electrical machine operation, their speed / torque characteristics, relevant mathematical relationships including torque, power, and slip, and details of the circuits and power supplies needed to drive them.



Curriculum mapping

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



Curriculum mapping

- Teaches students how to use MATLAB to measure the characteristics of electrical machines, how to define the characteristics using a mathematical model and to verify that model using test results.



Curriculum mapping

- Introduces students to more advanced concepts and models of electrical machines and focuses particularly on building equivalent circuits of machines.



"As with all Matrix solutions, our electrical machines kit is provided with storage trays, to ensure minimal lab space is taken up."

Ordering information	
Modern electrical machines	EM6637
Corresponding curriculum	CP6490, CP4160, CP8385, CP9989
You will also need	
Fluke 115 True RMS Digital Multimeter	HP1324
Tektronix Digital Oscilloscope	HP8067
COMING SOON	
Electrical machines servo & pendulum add-on	EM3967
Electrical machines locked-rotor add-on	EM2551

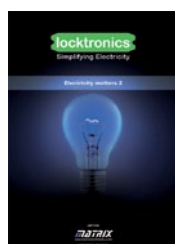
Electricity, magnetism and materials



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

Learning objectives / experiments:

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



Curriculum mapping

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

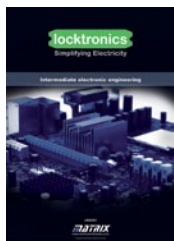
Ordering information	DIN	ANSI
Electricity, magnetism and materials solution with storage, baseboard and power supply	LK9071-2	LK9071-2A
Corresponding curriculum	LK7325 & LK7326	
You will also need		
Multimeter pack	LK1110	
Components - See page 64		

Electronic devices and communication applications

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

Learning objectives / experiments:

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



Curriculum mapping

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



Ordering information	DIN	ANSI
Intermediate electronic engineering solution with storage, baseboard and power supply	LK3889-2	LK3889-2A
Corresponding curriculum	LK8293	
You will also need		
Multimeter pack	LK1110	
Components See page 64		

PIC systems solution

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

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

Learning objectives / experiments:

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

Ordering information	
PIC systems solution	LK8922-2
Corresponding curriculum	LK7209
Components - See page 65	



Curriculum mapping

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

Intermediate electronic engineering solution

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

Learning objectives / experiments:

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



Curriculum mapping

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

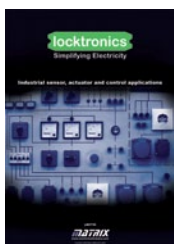
Ordering information	DIN	ANSI
Intermediate electronic engineering solution	LK9862	LK9862A
Corresponding curriculum	LK4583	
You will also need		
Multimeter pack	LK1110	
Components - See page 65		

Industrial sensors, actuator and control application

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

Learning objectives / experiments:

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



Curriculum mapping

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

Ordering information	DIN	ANSI
Industrial sensor, actuator and control solution	LK5783-2	LK5783-2A
Industrial sensor, actuator and control solution on engineering panel	LK6499-2	LK6499-2A
Corresponding curriculum	LK8739	
You will also need		
Multimeter pack	LK1110	
Components - See page 66		

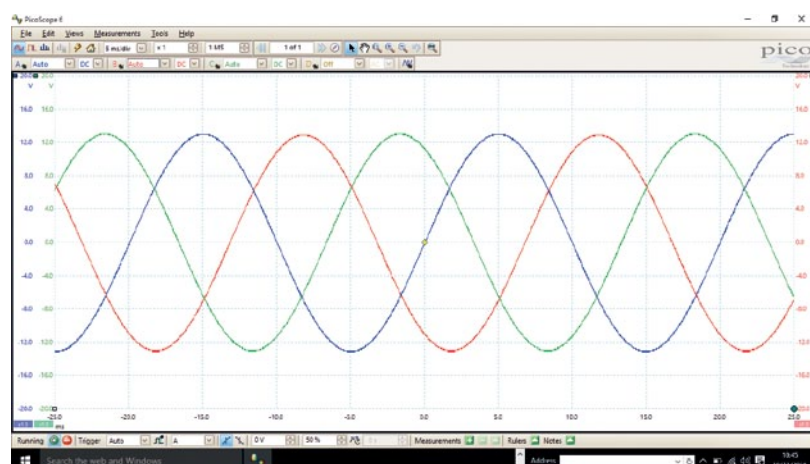
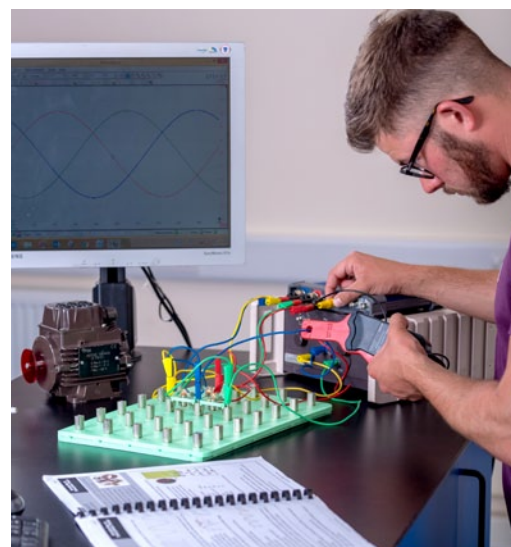
Three phase systems



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

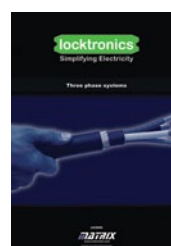
Learning objectives / experiments:

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



Curriculum mapping

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



Ordering information

Three phase systems	LK4961
Corresponding curriculum	LK2686

Recommended

Pico 4 phase oscilloscope	HP5834
AC/DC current clamp	HP5561

Components - See page 66

Operational amplifiers add-on pack

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

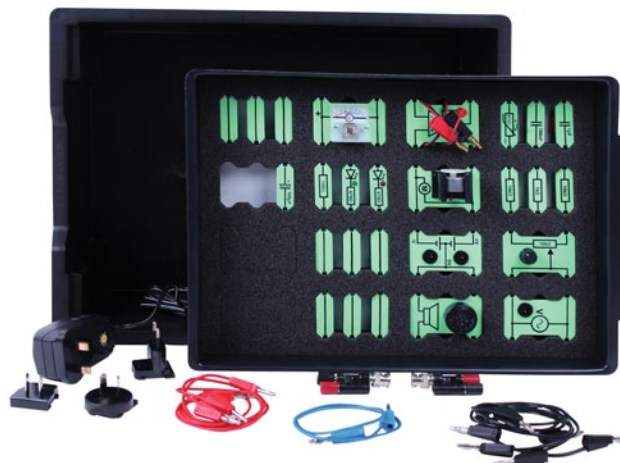
Learning objectives / experiments:

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



Curriculum mapping

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



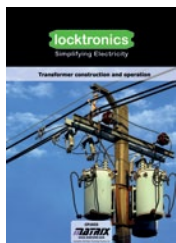
Ordering information	DIN	ANSI
Operational amplifiers add-on-kit	LK6906	LK6906A
Corresponding curriculum	LK3061	
You will also need		
Source - DC PSU, AC PSU and signal generator	LK6999/LK2975	
Components - See page 67		

Transformer construction and operation

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

Learning objectives / experiments:

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



Curriculum mapping

- Suitable for City and Guilds 8202 level 3



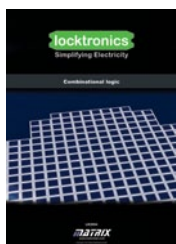
Ordering information	DIN	ANSI
Transformer construction and operation pack	LK1989	
Corresponding curriculum	CP1933	
You will also need		
Source - DC PSU, AC PSU and signal generator	LK6999/LK2975	
Components - See page 67		

Combinational logic add-on pack

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

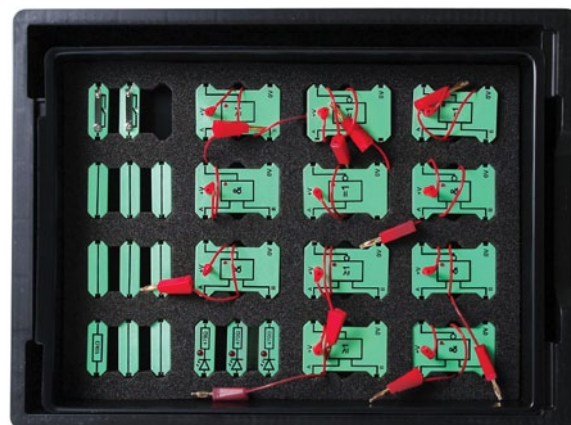
Learning objectives / experiments:

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



Curriculum mapping

- Suitable for use in a wide range of syllabuses



Ordering information

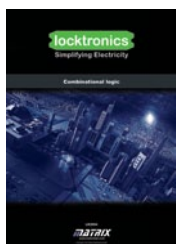
Combinational logic add-on pack	LK6904
Corresponding curriculum	LK2094
Components - See page 67	

Sequential logic add-on pack

The worksheets used with this kit assume a customer has bought one of our basic kits, like LK9071-2, as well as the Combinational logic add-on pack, LK6904. Together these kits allow students to do extended work in understanding sequential logic circuits and systems. The pack starts by allowing students to understand basic flip flop operation and builds up to the design of circuits and systems with three flip flops. A full colour workbook with teacher's notes is included.

Learning objectives / experiments:

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



Curriculum mapping

- Suitable for use in a wide range of syllabuses



Ordering information

Sequential logic add-on pack	LK6905
Corresponding curriculum	LK9945
Components - See page 68	

Transistor amplifiers add-on pack

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

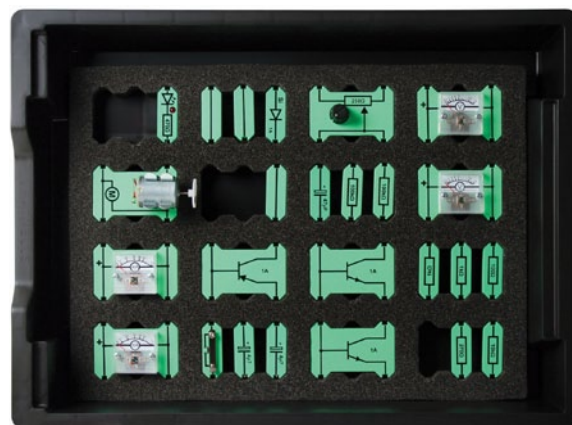
Learning objectives / experiments:

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



Curriculum mapping

- Suitable for use in a wide range of syllabuses



Ordering information

Transistor amplifiers add-on pack	LK9435
Corresponding curriculum	LK4403

Components - See page 68

Principles and applications of electronic devices and circuits

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

Learning objectives / experiments:

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



Curriculum mapping

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



Ordering information

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

You will also need

Source - DC PSU, AC PSU and signal generator	LK6999/LK2975
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Components - See page 68

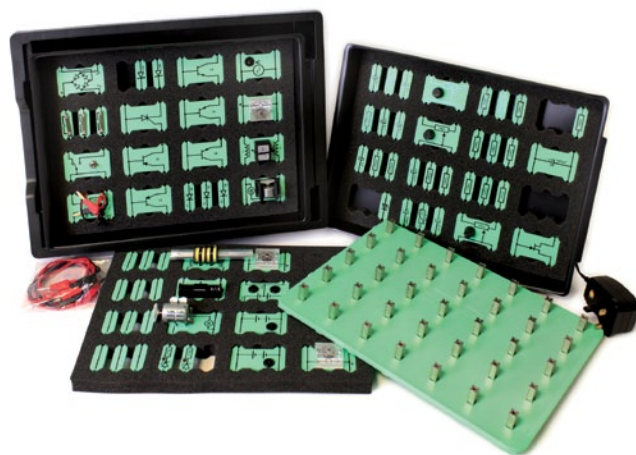
Advanced electronic principles

The experiments in this pack are designed for the more advanced students of electronics who need to understand the theory and practice of a wide range of electronic components and circuits: from basic diode circuits through to feedback and oscillator design.

The 42 experiments are guided by a 100 page book and full instructor notes are included.

Learning objectives / experiments:

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



Curriculum mapping

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

Ordering information	DIN	ANSI
Advanced electronic principles	LK6804	LK6804A
Corresponding curriculum	LK3008	
You will also need		
Source - DC PSU, AC PSU and signal generator	LK6999/LK2975	
Components See page 69		

Advanced electrical, electronic and digital principles

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



Learning objectives / experiments:

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



Curriculum mapping

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

Ordering information	DIN	ANSI
Advanced electrical, electronic and digital principles	LK9044	LK9044A
Corresponding curriculum	LK8473, LK8749	
You will also need		
Multimeter pack	LK1110	
Picoscope	HP8279	
Source - DC PSU, AC PSU and signal generator	LK6999/LK2975	
Components - See page 70		

Fault finding in electronic circuits

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

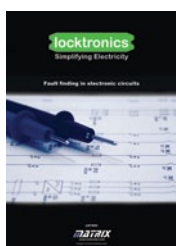
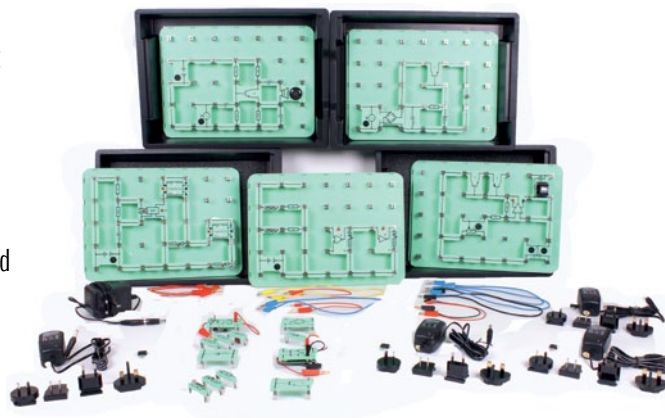
Faulty components are clearly marked underneath the carrier. Five fully tested and assembled circuits supplied.

Learning objectives / experiments:

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

Fault finding circuits:

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



Curriculum mapping

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

Ordering information

Fault finding in electronic circuits	LK3566
Corresponding curriculum	LK9333

You will also need

Multimeter pack	LK1110
Picoscope	HP8279

Components - See page 71

Power and energy electronics

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



Learning objectives / experiments:

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



Curriculum mapping

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

Ordering information

Power and energy electronics	LK3568
Corresponding curriculum	CP3666

You will also need

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

Components - See page 71

Source - DC PSU, AC PSU and signal generator

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

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

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

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



Functions:

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



Ordering information

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

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

TINA

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

Learning objectives / experiments:

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



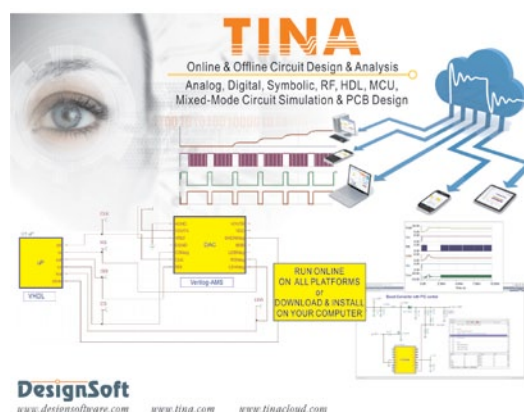
Curriculum mapping

BTEC National:

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

BTEC Higher National:

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



Ordering information

Please call us for pricing and versions



FLOWCODE

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

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

Hongying Meng,

Brunel University, United Kingdom



UNIVERSITY OF LEEDS

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

Matthew Buckley,

Leeds University, United Kingdom

"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 webserver, Bluetooth and USB. The excellent and fast support of the Matrix team gives teachers the necessary confidence to take their projects to the next level."

Bart Huyskens,

St.Jozefinstituut, Schoten, Belgium.

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

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

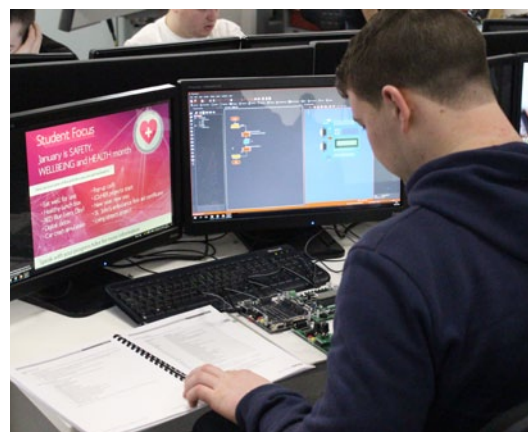
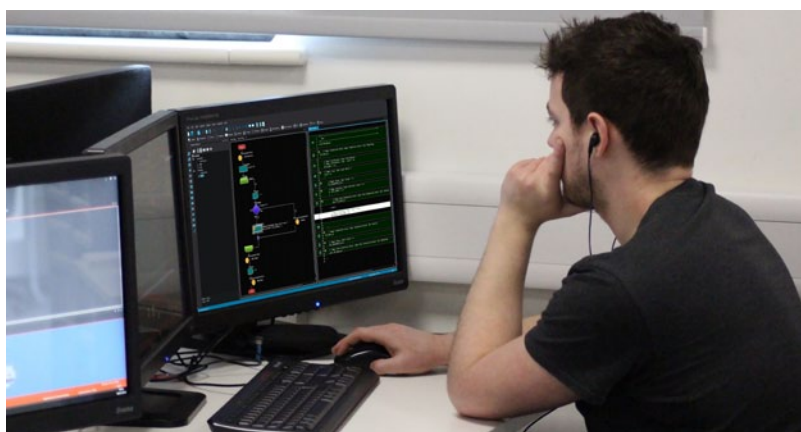
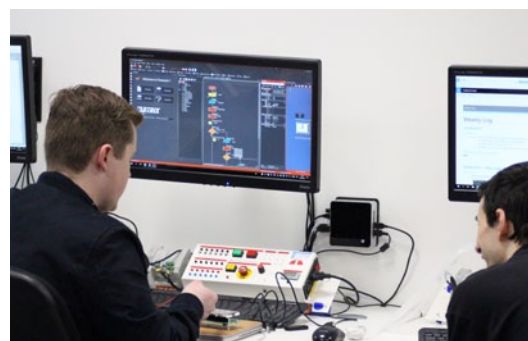
The software is unique in the educational workspace and creates an almost limitless new learning environment.

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

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

Steve Collins,

Cambridge Regional College, United Kingdom



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

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

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

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

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

As with previous versions, a 2D and 3D graphical development interface allows users to construct a complete electronic system on-screen, develop a program based on standard flowcharts, simulate the system and then produce hex code for programming a range of devices including Arduino, Microchip's PIC MCU: 8-bit, 16-bit and 32-bit, as well as Atmel AVR, ARM, Raspberry Pi and ESP32 devices.

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

What's new in the latest version of Flowcode?

- C code to flowchart converter
- C code simulation
- SCADA mode
- Raspberry Pi compatibility
- Improved test, debug and Ghost Technology
- Display builder (COMING 2020)
- ESP32 and ESP8266 support (COMING 2020)
- IOT components (COMING 2020)
- State machines (COMING 2020)



Did you know?

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

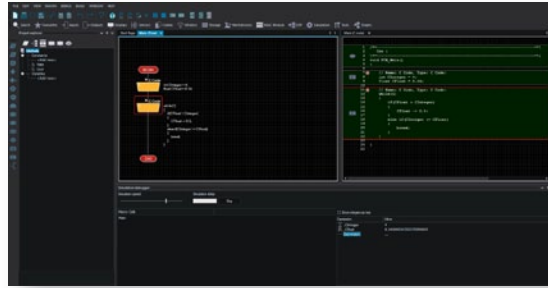
Test environment

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



C code editor

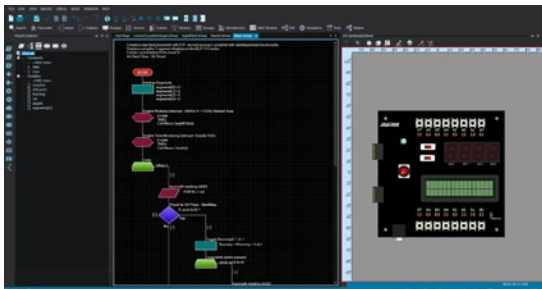
- Full C code editor
- Simulate your C code
- Convert between C and flowcharts etc.



What is
FLOWCODE

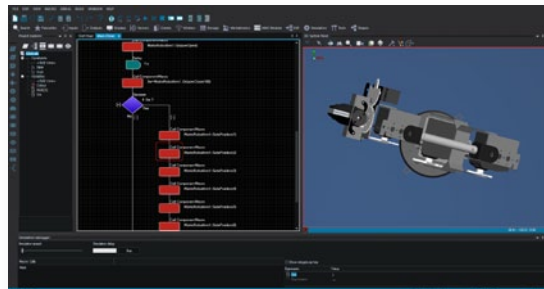
MCU programming

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



Wired & wireless communications

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



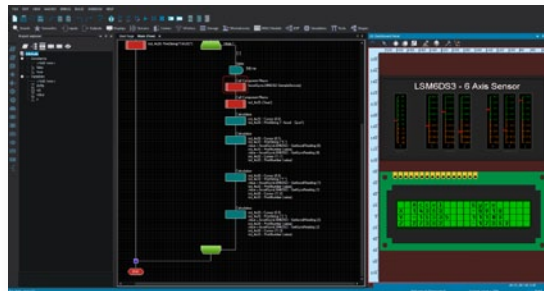
SCADA IDE

- Hardware support
- Separate SCADA runtime mode



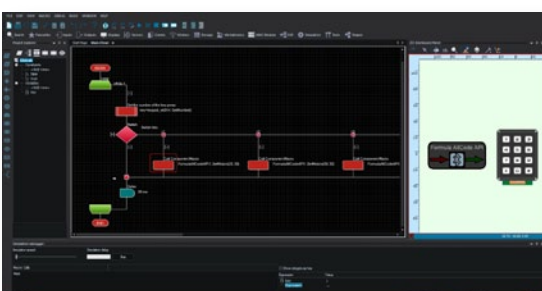
Sensor interface

- Sensor module support
- Grove sensor compatibility



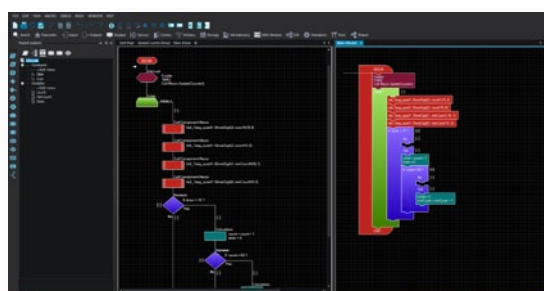
Mechatronic system development

- Robotics
- AllCode technology
- MIAC PLC



Multiple programming languages

- Flowcharts
- Blocks
- Pseudocode
- C code



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

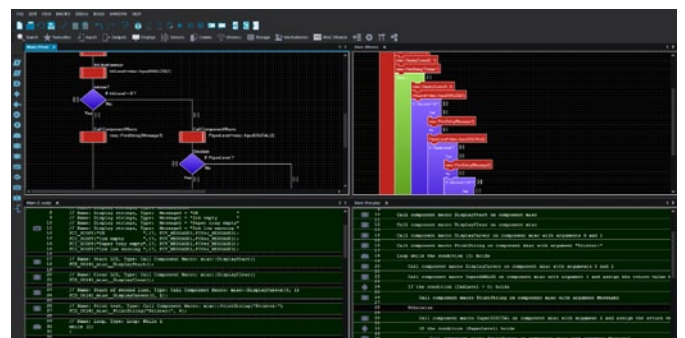


1. **Icon tool bar** - drag and drop standard flowchart icons onto your flowchart. Click to edit properties for a syntax-correct program.
2. **Project explorer** - instantly see all the ports, macros, variables, constants and components in your project.
3. **C code program** - monitor the C code equivalent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

Did you know?

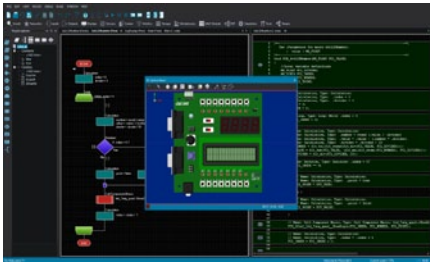
Flowcode now allows you to embrace multiple programming languages including:

- Flowcharts
- Blocks
- C code
- Pseudocode



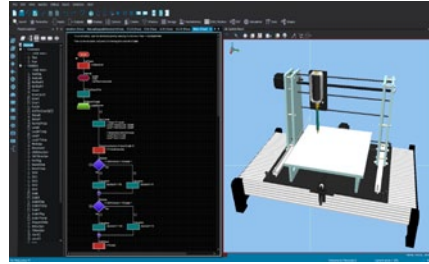
Design

Electronic engineer



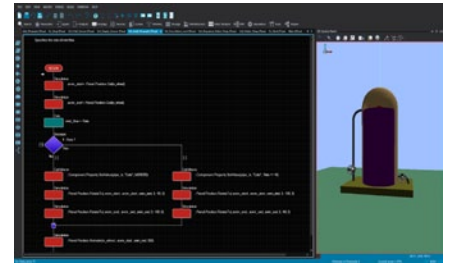
Design a virtual circuit board with PCB level components that connect to a virtual microcontroller and develop the program using flowcharts.

Electromechanical engineer



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

System engineer

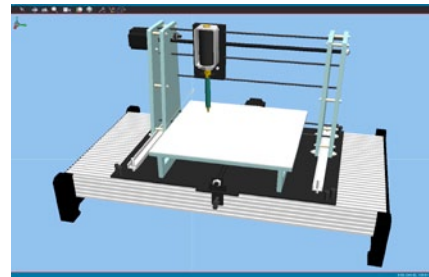


Develop a mathematical and/or physical model of your system, and develop a flowchart control program using Flowcode.

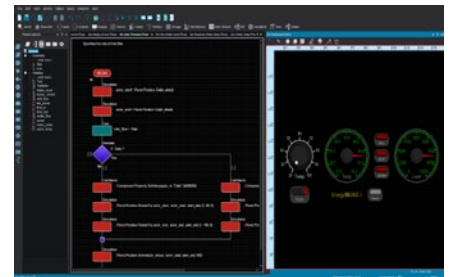
Simulate



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

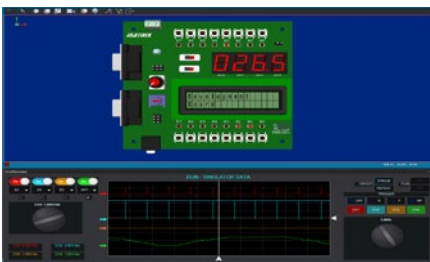


Simulate the mechanical system, the electronic system and the data decoding algorithms all in one package.



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

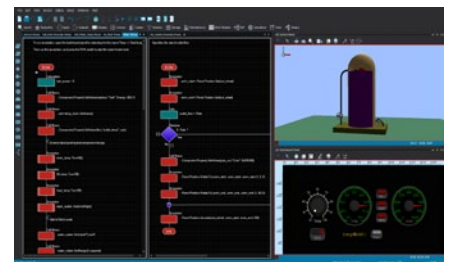
Test



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

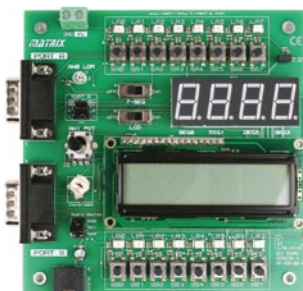


Use In-Circuit-Test to test and debug at a pin level.

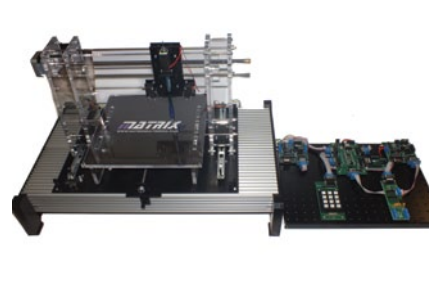


Link Dashboard objects, Oscilloscope and Console to third party instruments using DLLs in SCADA fashion to verify performance in real time.

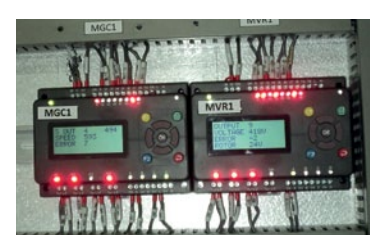
Deploy



Develop the final circuit board and release to market.



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



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

Supported devices

E-blocks2

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

MIAC

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

Arduino

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

8bit PIC

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

16bit PIC

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

32bit PIC

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

Raspberry Pi

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

AVR & ARM

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

ESP32

In 2020, we will begin supporting ESP32 devices from Espressif Systems for the first time. This low-cost chip with integrated Wi-Fi and Bluetooth is becoming extremely popular amongst developers and academics alike.

Did you know?

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

Academic support and support for learners

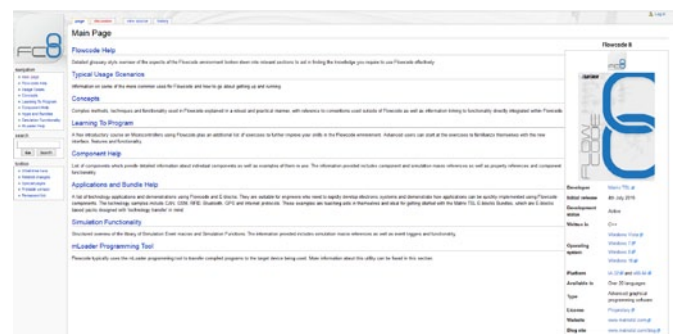
Flowcode delivers outcomes not only in professional, and industrial businesses but also at a number of levels of education. For many years Flowcode has delivered at further and higher education levels.

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

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

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

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



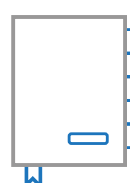
The Flowcode Wiki site provides you with a detailed glossary style overview of the aspects of the Flowcode environment. The Matrix forum is a great place to share ideas and solve problems with our well established community of long term as well as new users. It's attended to and updated by our own engineers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



Wiki



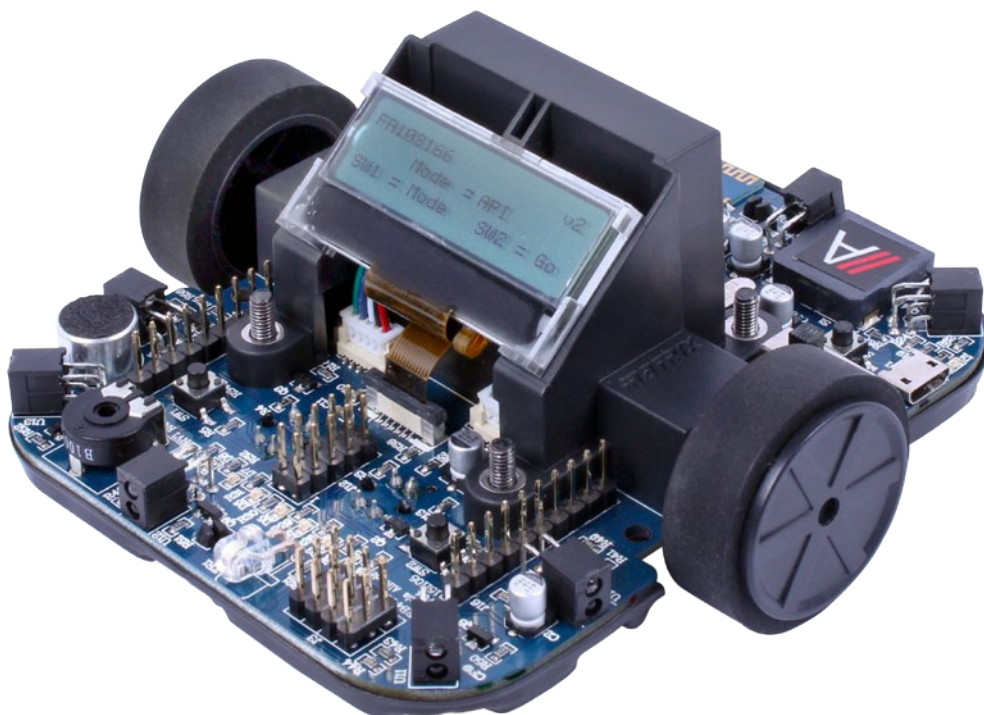
Forum



Course



Examples



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

Learning objectives /experiments:

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



Curriculum mapping

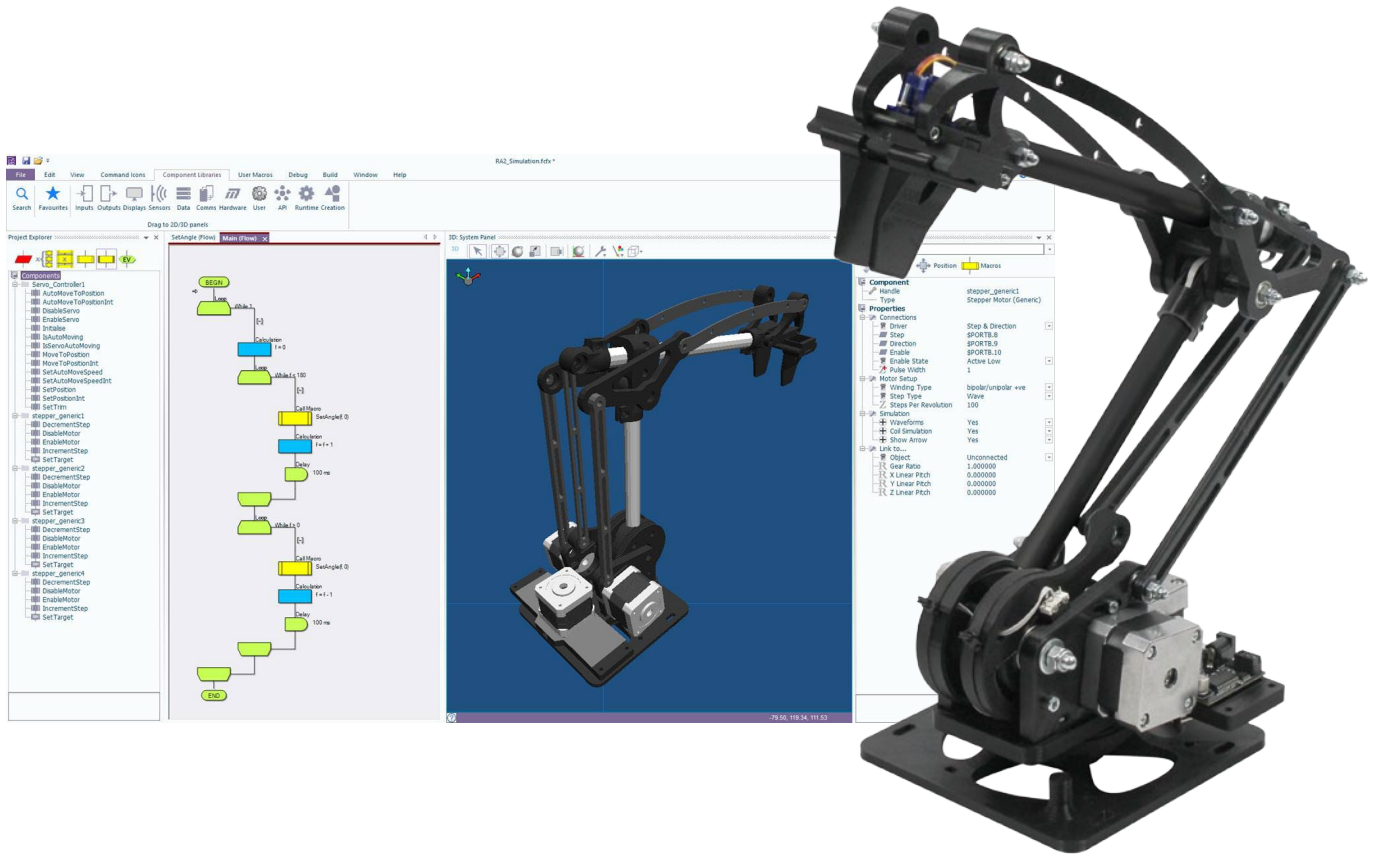
- Suitable for Design Technology and STEM related courses aged 11-18.
- Suitable for unit 10 BTEC National in Computer Science - Human-computer interface
- Suitable for various City & Guilds qualifications at Level 2 and beyond



Ordering information

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

AllCode robot arm



Our new robot arm production cell consists of a rugged stepper controlled 6 degrees of freedom arm bolted to a base plate and a mat that provides a range of exercises mimicking industrial robot arm production cells. The arm itself delivers accurate and repeatable movement with base rotation, single plane shoulder, elbow, wrist motion, a functional gripper, and a wrist rotator.

The Bluetooth and Wi-Fi enabled host controller board can be programmed directly from Flowcode, or Microchip's MPLAB. A full 3D Flowcode simulation is available. The control system is also shipped with a full Application Program Interface so that the robot can be controlled using any Bluetooth enabled device such as a PC,

Android, or Apple MAC device using a range of software applications including C++, LabView, Python, and App Inventor as well as remote applications over the web. The kit is supplied with several coloured counters which can be moved by the arm into different locations in the work cell. A teacher's guide is available for download from our web site.

Learning objectives /experiments:

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



Curriculum mapping

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



Ordering information

AllCode robot arm production cell	RB6231-2
Corresponding curriculum	CP8656

Internet of Things solution



This Internet of Things solution is designed to allow students to give consideration to current trends in technology, including the future of industrial systems (with Industry 4.0 in mind), the impact of digital developments, the increase of wireless and remote control and the Internet of Things.

Our IoT kit comes with a basic guide, to using our Raspberry Pi based MIAC(s) with Node-RED - a flow-based IDE for visual programming for wiring together hardware devices, APIs and online services as part of the Internet of Things. Users of this kit send and receive data remotely via Wi-Fi using pre-built internet communication services.

The IoT solution also includes a small selection of Locktronics parts for example work, the pre-written guide is available through the resources in our online learning centre.

Learning objectives / experiments:

- Development of Raspberry Pi based IoT applications
- Development of cloud-based IoT applications
- Exchanging data between IoT devices and cloud-based applications
- Utilising Node-RED as an IoT platform for learning and development
- Security implications for IoT
- Remote datalogging, sensing and control

This kit assumes prior understanding of the Node-RED environment from the user.

Curriculum mapping

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



Ordering information

Internet of Things solution	MI0899
Flowcode	

Programming Arduino microcontrollers



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

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

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



Learning objectives / experiments:

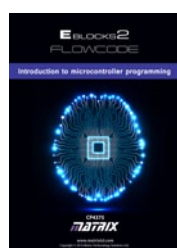
- Programming microcontrollers with flowcharts, or C (using Arduino IDE)
- Control hardware and specifications for Arduino microcontrollers
- Input and output devices
- Assembling and operating a microcontroller system
- Programming/coding constructs and techniques

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



Ghost & Flowcode provide:

- In-Circuit-Test
- In-Circuit-Debug
- Software oscilloscope
- Packet decoder
- Auto-ID



Curriculum mapping

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

Ordering information

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

Programming PIC microcontrollers



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

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

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

Learning objectives / experiments:

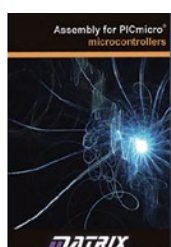
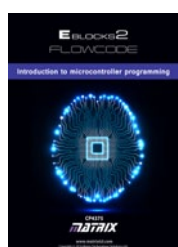
- Programming microcontrollers with flowcharts, C or assembler
- Control hardware and specifications for PIC microcontrollers
- Input and output devices
- Assembling and operating a microcontroller system
- Programming/coding constructs and techniques

Ghost & Flowcode provide:

- In-Circuit-Test
- In-Circuit-Debug
- Software oscilloscope
- Packet decoder
- Auto-ID

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

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



Curriculum mapping

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

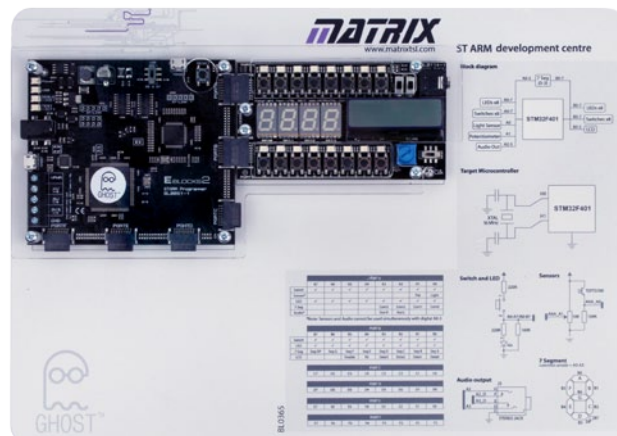
Programming ARM microcontrollers

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

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

Learning objectives / experiments:

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



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

Curriculum mapping

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



Ghost & Flowcode provide:

- In-Circuit-Test
- In-Circuit-Debug
- Software oscilloscope
- Packet decoder
- Auto-ID

Ordering information

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

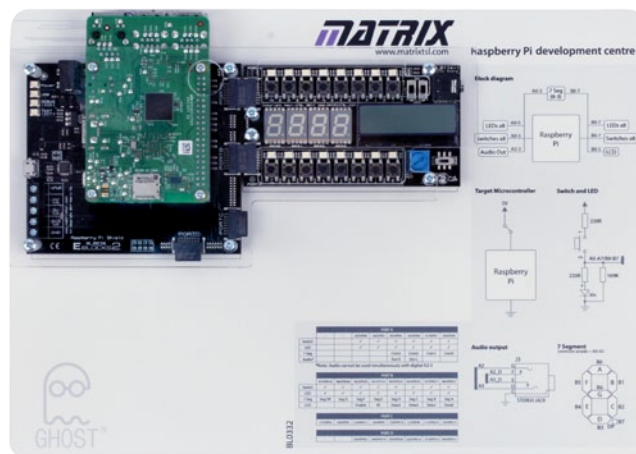
Raspberry Pi development kit

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

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

Learning objectives / experiments:

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



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

Curriculum mapping

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



Ghost & Flowcode provide:

- In-Circuit-Test
- In-Circuit-Debug
- Software oscilloscope
- Packet decoder
- Auto-ID

Ordering information

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

Programming dsPIC microcontrollers

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

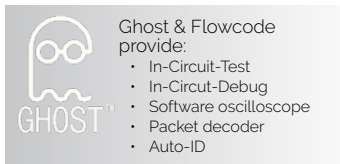
This product is available as a development kit in Gratnell's tray with all necessary boards included. The programmer board and combo board can also be purchased separately either with or without the printed panel.

Learning objectives / experiments:

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

Curriculum mapping

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



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

Ordering information

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

Programming AVR microcontrollers

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

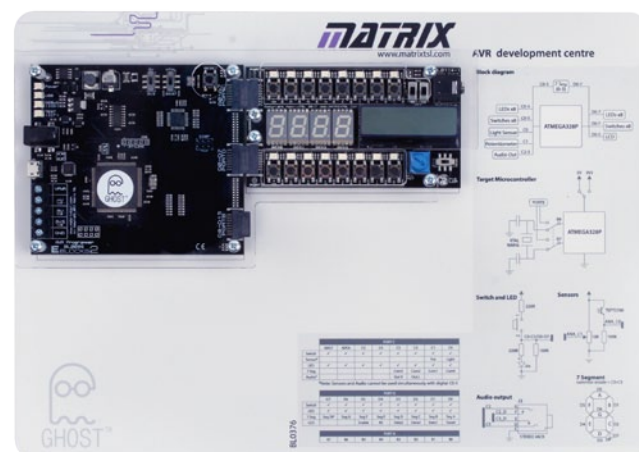
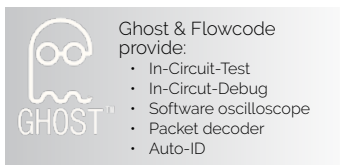
This product is available as a development kit in Gratnell's tray with all necessary boards included. The programmer board and combo board can also be purchased separately either with or without the printed panel.

Learning objectives / experiments:

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

Curriculum mapping

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



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

Ordering information

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

Arduino GSM training course

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

Learning objectives / experiments:

Programming:

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

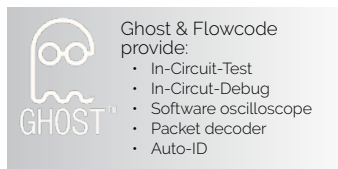
Communications:

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



Curriculum mapping

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



Ordering information

Arduino GSM training course	BL0521
PIC GSM training course	BL0579
Requires Flowcode, which must be ordered separately	

FPGA training course

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

Learning objectives / experiments:

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



Curriculum mapping

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



Ordering information

FPGA training course	EB940-2
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Arduino Bluetooth training course

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

Learning objectives / experiments:

- Data communication between microcontroller and Bluetooth modules
- Bluetooth visibility
- Device discovery, pass keys and addresses
- Responses - sequence flow and error checking
- Connecting and pairing
- Data communication
- Using Bluetooth for control applications



Curriculum mapping

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



Ghost & Flowcode provide:

- In-Circuit-Test
- In-Circuit-Debug
- Software oscilloscope
- Packet decoder
- Auto-ID

Ordering information

Arduino Bluetooth training course	BL0563
PIC Bluetooth training course	BL0506
Requires Flowcode, which must be ordered separately	

Arduino embedded internet training course

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

Learning objectives / experiments:

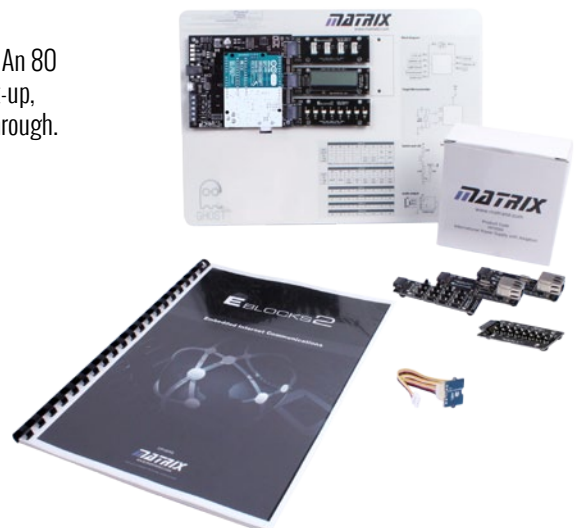
- OSI model and layers
- Ethernet, DLC, MAC, ARP, TCP, IP, UDP, ICMP, HTTP and POP3 protocols
- MAC packet structure and message creation using microcontrollers
- Communication strategy and information flow
- Packet injectors and debuggers

Labs include:

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

Advanced tasks include:

- Custom messaging using UDP
- A firewall application



Curriculum mapping

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



Ghost & Flowcode provide:

- In-Circuit-Test
- In-Circuit-Debug
- Software oscilloscope
- Packet decoder
- Auto-ID

Ordering information

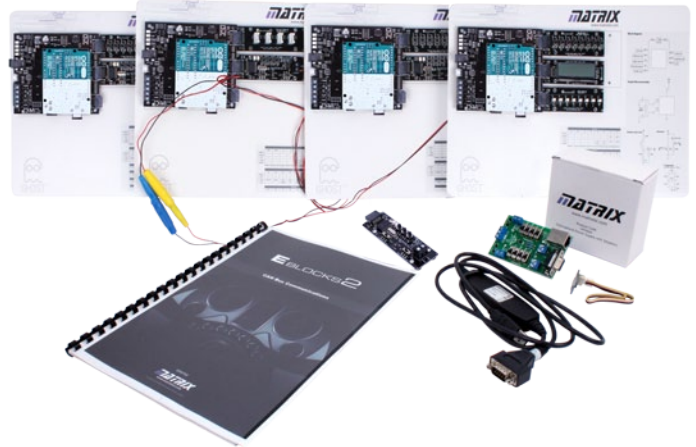
Arduino embedded internet training course	BL0535
PIC embedded internet training course	BL0531
Requires Flowcode, which must be ordered separately	

Arduino CAN bus training course

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

Learning objectives / experiments:

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



Curriculum mapping

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

FC



Ghost & Flowcode provide:

- In-Circuit-Test
- In-Circuit-Debug
- Software oscilloscope
- Packet decoder
- Auto-ID

Ordering information

Arduino CAN bus training course	BL0587
PIC CAN bus training course	BL0589
Requires Flowcode, which must be ordered separately	

Arduino ZigBee training course

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

Learning objectives / experiments:

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



Curriculum mapping

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



Ghost & Flowcode provide:

- In-Circuit-Test
- In-Circuit-Debug
- Software oscilloscope
- Packet decoder
- Auto-ID

FC

Ordering information

Arduino ZigBee training course	BL0536
PIC ZigBee training course	BL0516
Requires Flowcode, which must be ordered separately	

Arduino RFID training course

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

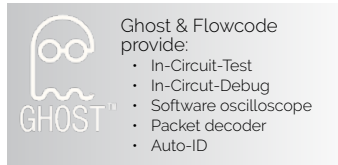
Learning objectives / experiments:

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



Curriculum mapping

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



Ordering information

Arduino RFID training course	BL0548
PIC RFID training course	BL0510
Requires Flowcode, which must be ordered separately	

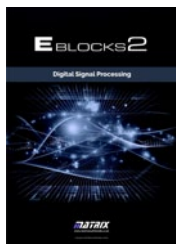
Audio DSP training course

This solution allows students to carry out a number of practical exercises in audio DSP technology. Students learn about DSP by developing 7 different system developments: Audio pass-through, Echo effect, Reverb effect, Sine wave generator, Waveform generator, Low pass filter, and High pass filter.

Working through the exercises students build a good understanding of the various types of DSP operation including Inputs, Outputs, Sum, Level, Filter and Delay. The solution can also be used as a motivating platform for learning general microcontroller programming and project work. The course is provided along with a 20 hour course.

Learning objectives / experiments:

- Fundamentals of audio digital processing
- Functionality of the Matrix dsPIC hardware
- Techniques to program the dsPIC microcontroller to process audio signals
- Commands and syntax used to input, process and output audio signals



Curriculum mapping

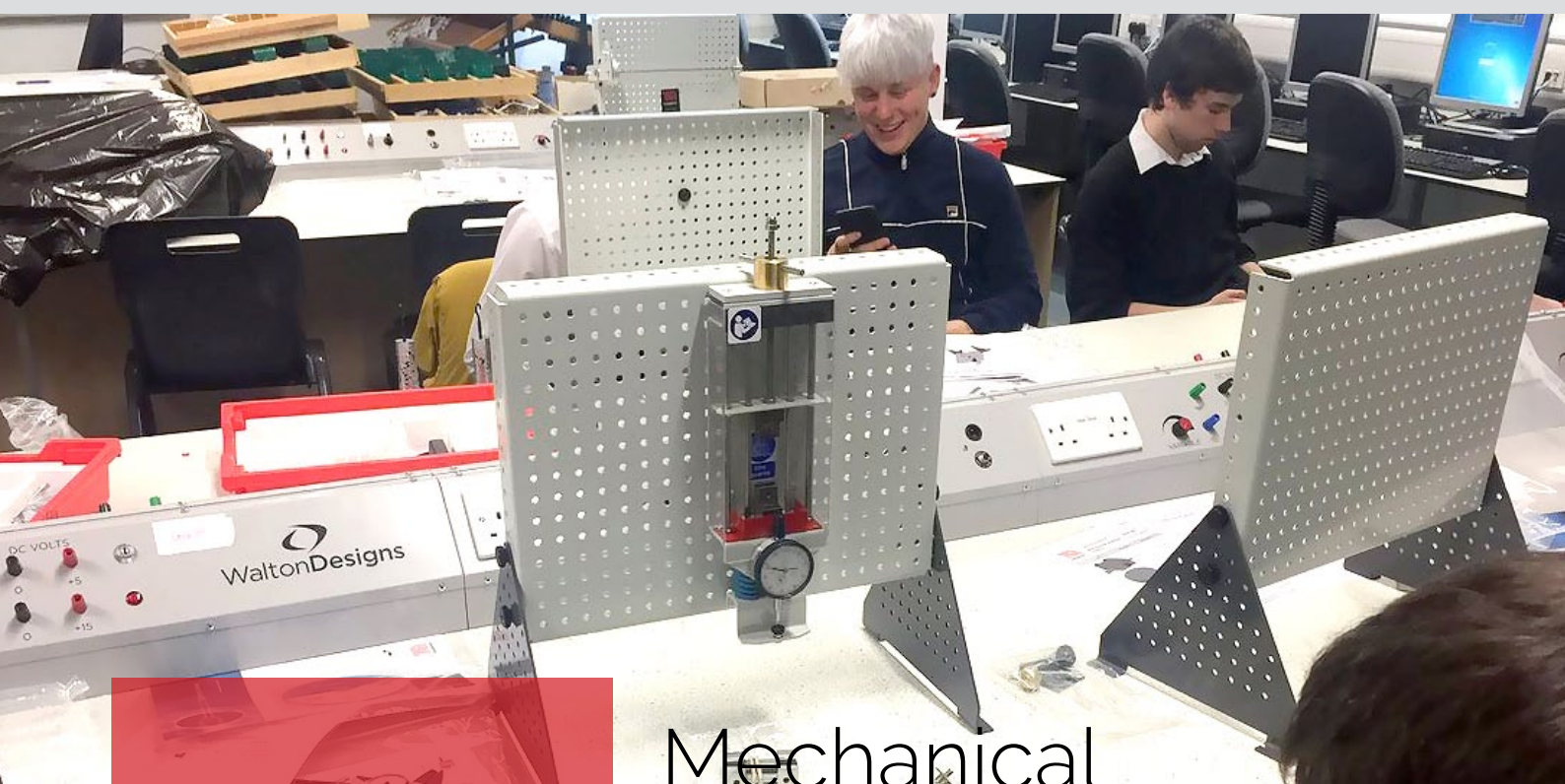
- Suitable for courses in microcontrollers and digital communications at undergraduate level



Ordering information

Audio DSP training course	BL0573
Requires Flowcode, which must be ordered separately	

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



Mechanical

Our learning solutions:

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

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

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

Engineering Department,
Reaseheath College

Essential base unit HP5000

The work panel is for use with any of the kits from the Mechanical engineering range and fits on any standard desk or bench top. Students, teachers or lecturers fit the parts of their kit to the work panel to study or demonstrate an engineering science topic. The work panel has its main panel and two supports, all made from thick perforated metal to allow students, teachers or lecturers to fit the parts of the kits and the work panel in any position suitable for the experiments. A CD Rom is included with the unit which includes worksheets, guidance notes and lecturer notes (with answers). The selection of parts in the kits and the choice of fixing points on the work panel means that teachers or lecturers may extend the experiments to an even greater range.



Ordering information

Essential base unit	HP5000
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Forces Kit

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

Learning objectives / experiments:

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



Curriculum mapping

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

Ordering information

Forces kit	HP5005
Essential base unit	HP5000

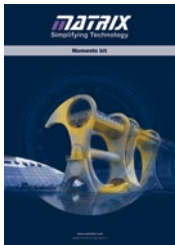


Moments Kit

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

Learning objectives / experiments:

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



Curriculum mapping

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

Ordering information	
Moments kit	HP5010
Essential base unit	HP5000

Deflection of beams and cantilevers Kit

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

Learning objectives / experiments:

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



Curriculum mapping

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

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

Torsion of circular sections kit

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



Learning objectives / experiments:

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



Curriculum mapping

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

Ordering information

Torsion of circular sections kit	HP5020
Essential base unit	HP5000

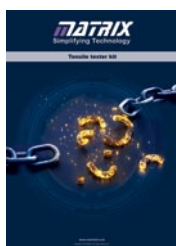
Tensile tester kit

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



Learning objectives / experiments:

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



Curriculum mapping

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

Ordering information

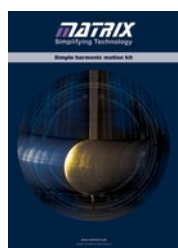
Tensile tester kit	HP5025
Essential base unit	HP5000

Simple harmonic motion kit

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

Learning objectives / experiments:

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



Curriculum mapping

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

Ordering information

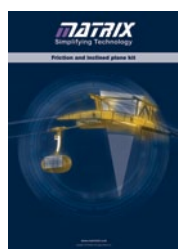
Simple harmonic motion kit	HP5030
Essential base unit	HP5000

Friction and inclined plane kit

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

Learning objectives / experiments:

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



Curriculum mapping

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

Ordering information

Friction and inclined plane kit	HP5035
Essential base unit	HP5000

Potential and kinetic energy kit

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

Learning objectives / experiments:

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



Curriculum mapping

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



Ordering information

Potential and kinetic energy kit	HP5040
Essential base unit	HP5000

Drive systems kit

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

Learning objectives / experiments:

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

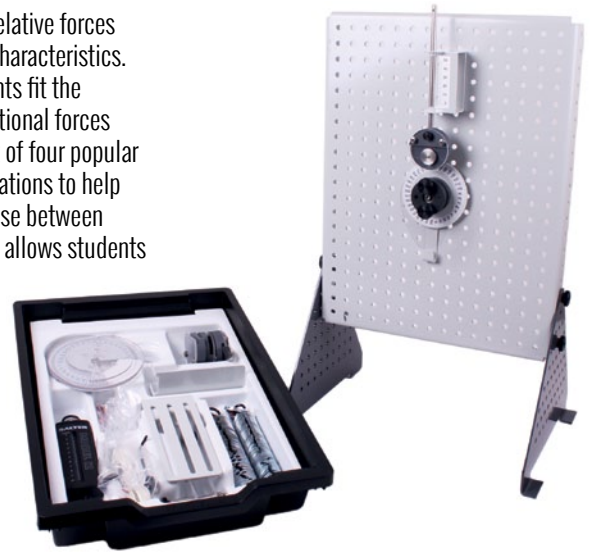


Ordering information

Drive systems kit	HP5045
Essential base unit	HP5000

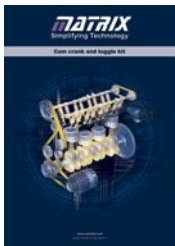
Cam, crank and toggle kit

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



Learning objectives / experiments:

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



Curriculum mapping

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

Ordering information

Cam, crank and toggle kit	HP5050
Essential base unit	HP5000

Gear trains kit

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



Learning objectives / experiments:

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



Curriculum mapping

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

Ordering information

Gear trains kit	HP5055
Essential base unit	HP5000

Simple mechanisms kit

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

Learning objectives / experiments:

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



Ordering information

Simple mechanisms Kit	HP5060
Essential base unit	HP5000



Spring tester kit

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

Learning objectives / experiments:

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



Curriculum mapping

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

Ordering information

Spring tester kit	HP1282
Essential base unit	HP5000

Centrifugal force kit

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



Learning objectives / experiments:

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



Ordering information

Centrifugal force kit	HP0232
Essential base unit	HP5000

Bar linkages kit

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



Learning objectives / experiments:

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



Ordering information

Bar linkages kit	HP7622
Essential base unit	HP5000

Additional mechanisms kit

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

Learning objectives / experiments:

- Ratchet mechanisms
- Geneva mechanisms



Ordering information

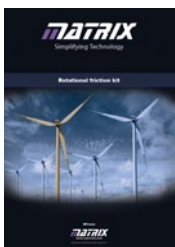
Additional mechanisms kit	HP6207
Essential base unit	HP5000

Rotational friction kit

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

Learning objectives / experiments:

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



Ordering information

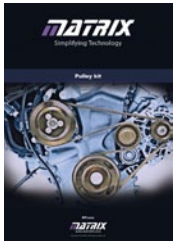
Rotational friction kit	HP8604
Essential base unit	HP5000

Pulley kit

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

Learning objectives / experiments:

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



Ordering information	
Pulley kit	HP9771
Essential base unit	HP5000

Complete mechanics

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

Learning objectives / experiments:

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



Curriculum mapping

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



Ordering information	
Complete mechanics	HP8797

Linear and rotational dynamics

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

Learning objectives / experiments:

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



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



Curriculum mapping

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

Ordering information

Linear and rotational dynamics

HP5099

Thermodynamics kit

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

Learning objectives / experiments:

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



Curriculum mapping

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

Ordering information

Thermodynamics kit

HP4159

Corresponding curriculum

CP4261

You will also need

Source - DC PSU, AC PSU and signal generator

LK6999/LK2975

The manufacturing engineering offering from Matrix, comprises of a range of products that cover key principles of manufacturing in a learning and industrial environment. From automation and pneumatics to robotics and machining, through our revolutionary MicroCNC product range, we have low voltage, storable solutions to teach key principles or more advanced learning outcomes for your students.



Manufacturing

Our learning solutions:

- Are rugged, reusable and stand up to the demands of the learning environment
- Are low-voltage (12 - 24V in most cases)
- Can be stored away to ensure they stay safe and can be moved lab to lab
- Can be used to prepare student for bigger industrial systems
- Can also be used for in-depth study of complex engineering principles

“We have used the MicroCNC equipment, primarily for level 2 Engineering (Technical Diploma) in a unit that focuses on the introduction and basics of CNC. Most of the students have no prior experience or knowledge of the subject and we were hesitant to invest in more expensive (and thus fewer) kits.

As expected, the materials that can be machined are limited to softer types, and within smaller dimensional constraints, but this is sufficient at this level to show the progression from idea through computer aided drafting to machined product. It also means that there is more inherent safety due to the types of materials and speeds of machining. The packaged software (CamBam and Deskproto) come with tutorials which allow beginners to follow step by step.

Our students have enjoyed working with the kits, and some ventured into the more advanced coding, while others were happy with the basic competencies gained in following the tutorials and ending up with machined products.”

Ghulam Solker,
Suffolk One Sixth Form College, United Kingdom.

Automatics essentials solution



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

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

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

Learning objectives / experiments:

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



Curriculum mapping

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

Ordering information	
Automatics essentials solution	AU9020
Corresponding curriculum	AW2080
You will also need	
Compressor	AU1050
Components - See page 72	

Electro-pneumatics add-on kit

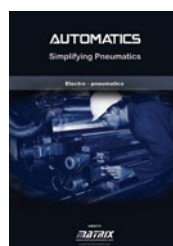
This kit supplements the Automatics essentials solution by adding a selection of electrically operated valves and a range of sensors. By following the curriculum, students will learn how to use these new components to create systems in which pneumatics and electrical circuits are combined into complete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

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

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

Learning objectives / experiments:

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



Curriculum mapping

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

Ordering information

Electro-pneumatics add-on kit	AU9015
Corresponding curriculum	AW2079
Components - See page 72	

Pneumatics control add-on kit

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

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

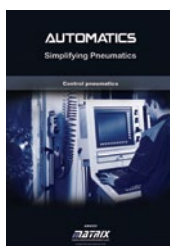
Students will learn how to establish the state of a pneumatic machine using sensors, the use of logic to process that data and the issuing of commands to the included solenoid valves.

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

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

Learning objectives / experiments:

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



Also available with Rpi
MIAC and Arduino MIAC

Curriculum mapping

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

Ordering information

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

You will also need

Automatics essentials solution	AU9020
Flowcode	

Components - See page 72

Pneumatics with your own PLC

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

Learning objectives / experiments:

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



Curriculum mapping

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



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

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

Ordering information	
PLC Adaptor - input module	HP6700
PLC Adaptor - power module	HP6711
PLC Adaptor - motor module	HP6723
PLC Adaptor - relay module	HP6752
PLC adaptor - mounting bracket	HP6785
You will also need	
Automatics essential solution	AU9020
Automatics control add-on kit (24V) no MIAC	AU9030

Automatics interactive courseware

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

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

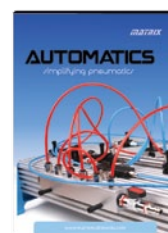
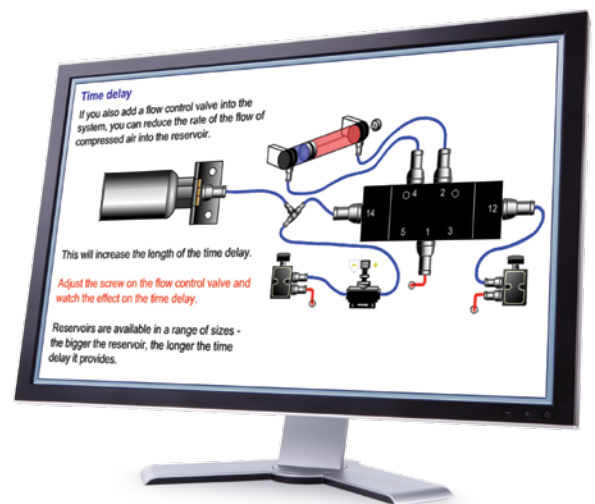
The courseware is a complete curriculum, covering everything from basic component identification and learning circuit symbols, through to the construction of complete automated systems.

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

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

Learning objectives / experiments:

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



Curriculum mapping

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

Ordering information	
Automatics interactive courseware site licence	AW20780

Pneumatics control with S7-1200 Siemens PLC add-on



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

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

Learning objectives / experiments:

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

Curriculum mapping

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



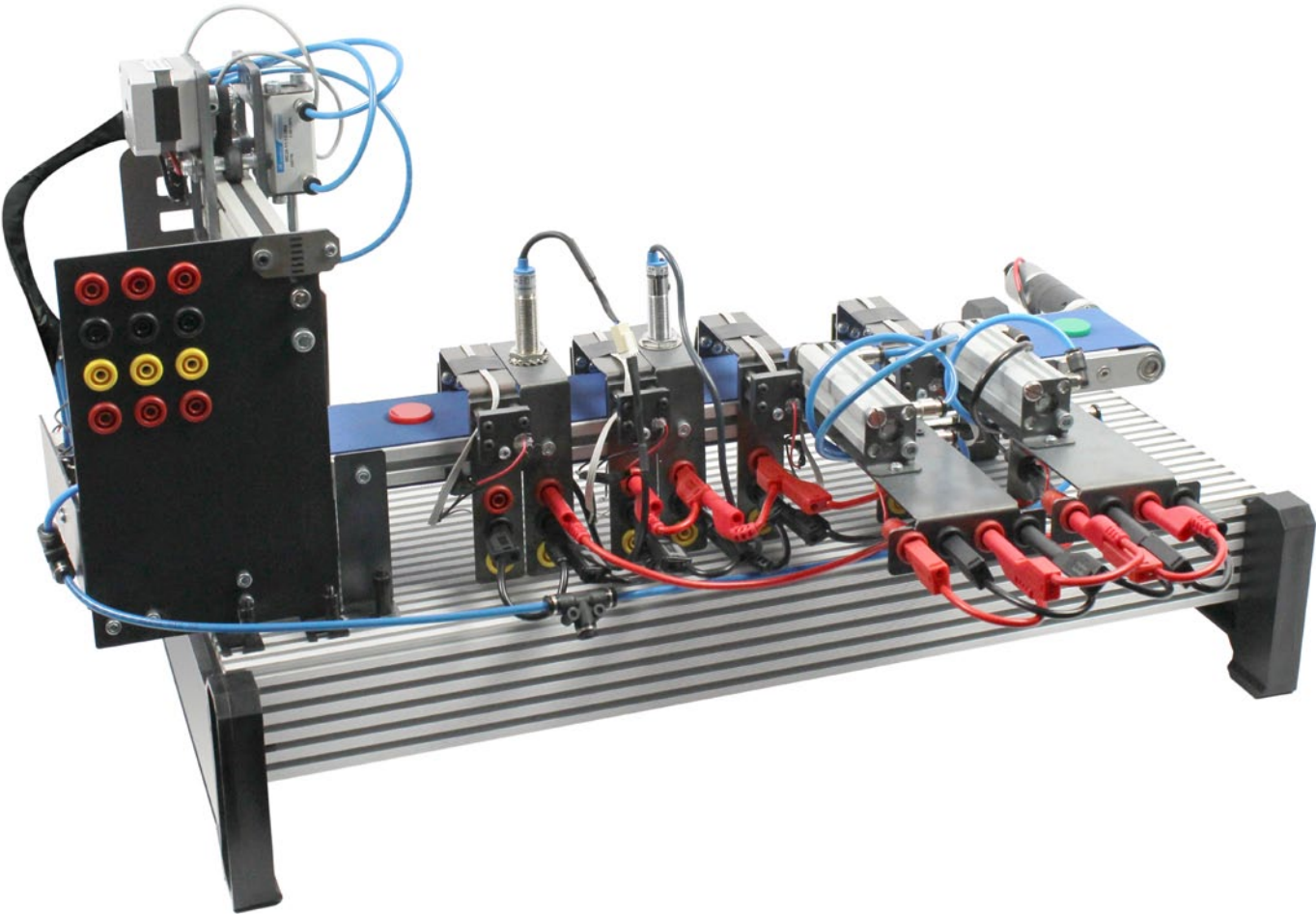
SIEMENS

Ordering information

Pneumatics control with S7-1200 Siemens PLC add-on

AU9077

Components - See page 73



The Automatics smart factory allows students to get experience of a number of processes/technologies that are commonly used in manufacturing and modern-day Industry 4.0 principles. This includes conveyor systems, sensing systems, pneumatic pick and place technology, DC motor drives, and stepper motor drives. The factory includes a number of coloured components—plastic (and other material) discs. A conveyor belt moves these pieces into the factory, where user programmed sensors sort the discs into rejection bins etc. Some are picked off the conveyor by a suction device and a stepper motor-controlled gantry sorts the discs into appropriately coloured containers. The smart factory is completely self-contained and can be stored away in one of our standard trays. The smart factory can be used with Siemens (or other brand) 12V or 24V PLC and is also compatible with our AIICode MIAC. Various order codes apply.

Learning objectives / experiments:

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



Curriculum mapping

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

SMART FACTORY

The smart factory is compatible with the AIICode robot arm, which can be added to provide a powerful and interesting Industry 4.0 learning solution.



Ordering information	
Automatics smart factory with AIICode MIAC	AU4956
Automatics smart factory with Siemens S7-1200	AU3686
Compressor	AU1050

Mechatronic systems



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

Learning objectives / experiments:

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



Curriculum mapping

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



Ordering information

Mechatronic systems	HP4550-2
Corresponding curriculum	LK8739, CP4375, AW4956, AW2080

MicroCNC system controller and base plate

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

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



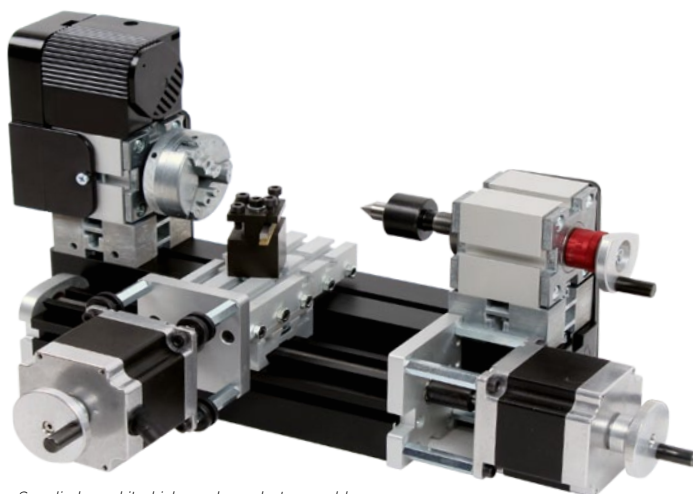
Ordering information

MicroCNC system controller and base plate	CN4079
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2-axis MicroCNC lathe

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

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



Supplied as a kit which needs modest assembly.

You will also need: MicroCNC system controller and base plate

Learning objectives / experiments:

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



Curriculum mapping

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

Ordering information

2-axis MicroCNC lathe	CN2668
MicroCNC system controller and base plate	CN4079
Corresponding curriculum	CP7449
You will also need	
CamBam software	CN8332/CN2171

3-axis MicroCNC milling machine

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

Learning objectives / experiments:

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

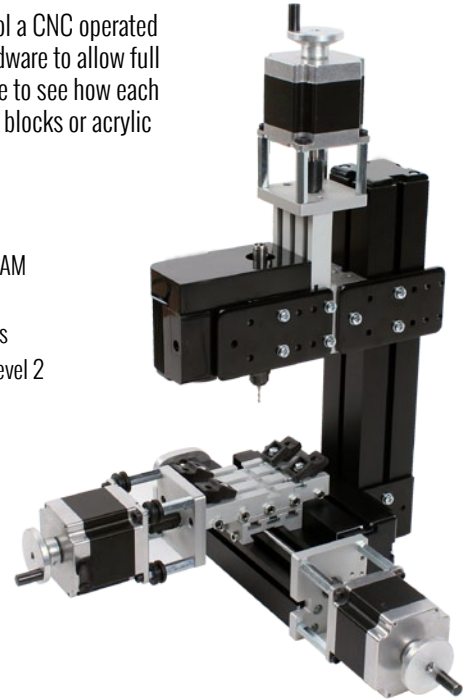
Curriculum mapping

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



Ordering information

3-axis MicroCNC milling machine	CN4234
MicroCNC system controller and base plate	CN4079
Corresponding curriculum	CP7449
You will also need	
Deskproto CAM software	CN2498/CN3075



4-axis MicroCNC milling machine

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

Learning objectives / experiments:

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

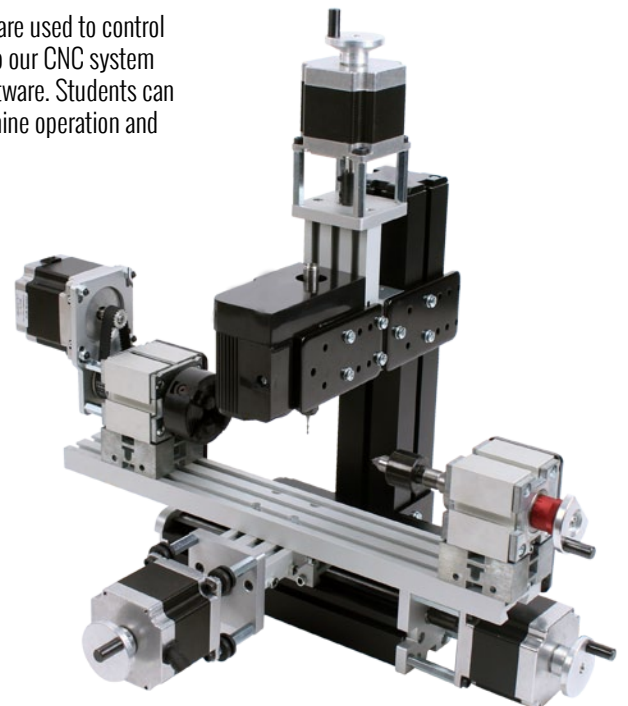
Supplied as a kit which needs modest assembly.

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



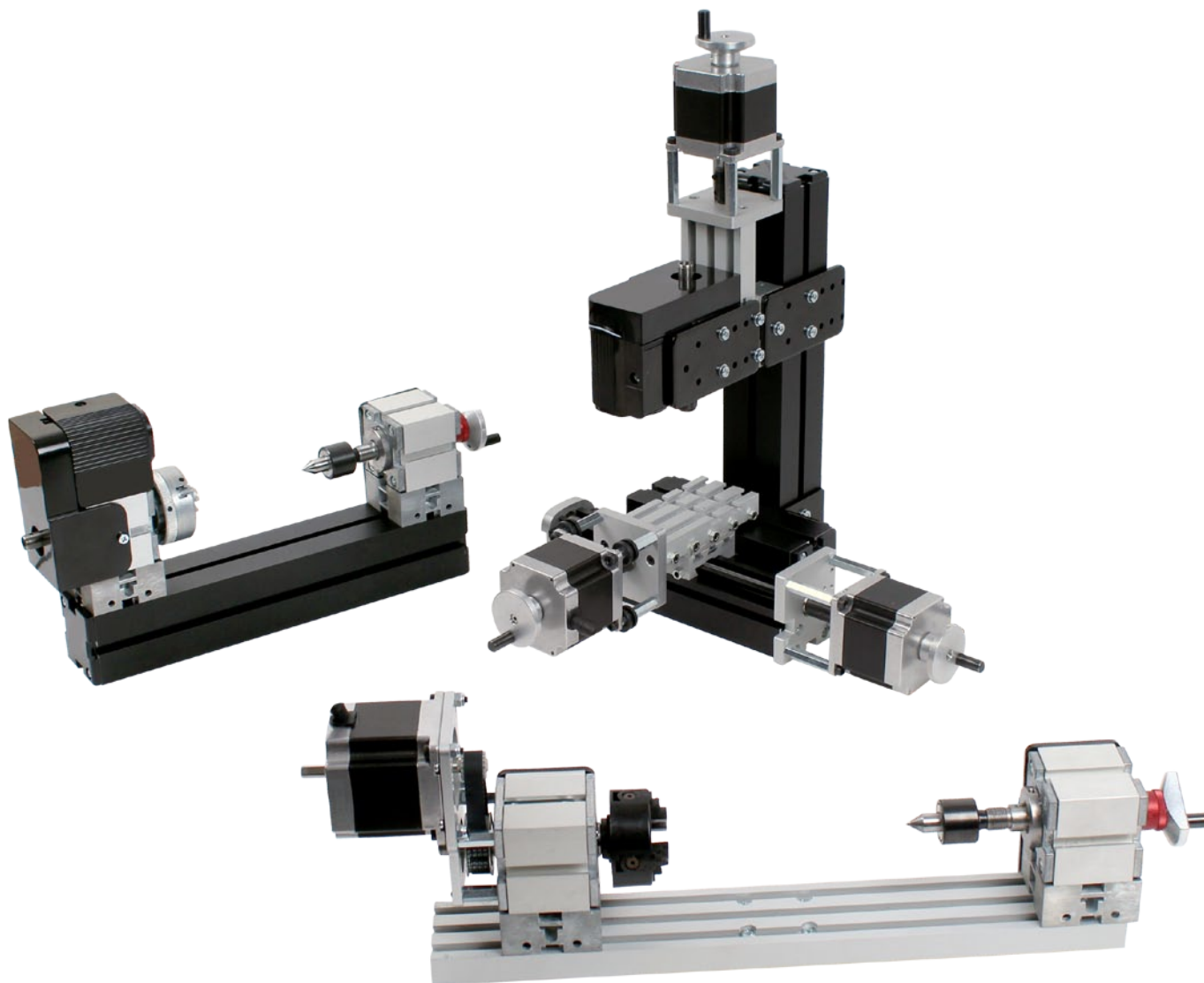
Curriculum mapping

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



Ordering information

4-axis MicroCNC milling machine	CN8285
MicroCNC system controller and base plate	CN4079
Corresponding curriculum	CP7449
You will also need	
Deskproto CAM software	CN2498/CN3075



Complete MicroCNC set

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

Learning objectives / experiments:

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



Curriculum mapping

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

Ordering information

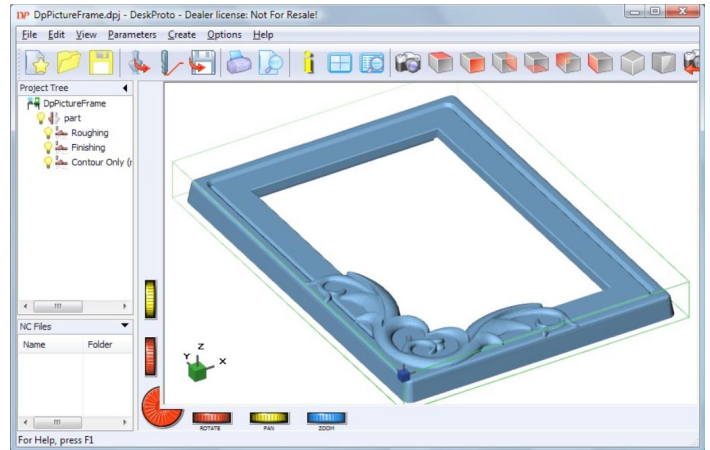
Complete MicroCNC set	CN3885
MicroCNC system controller and base plate	CN4079
Corresponding curriculum	CP7449
You will also need	
Deskproto CAM software	CN2498/CN3075
CamBam software	CN8332/CN2171

Deskproto CAM software

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

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

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



Curriculum mapping

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

Ordering information

Deskproto single license	CN3075
Deskproto site license	CN2498

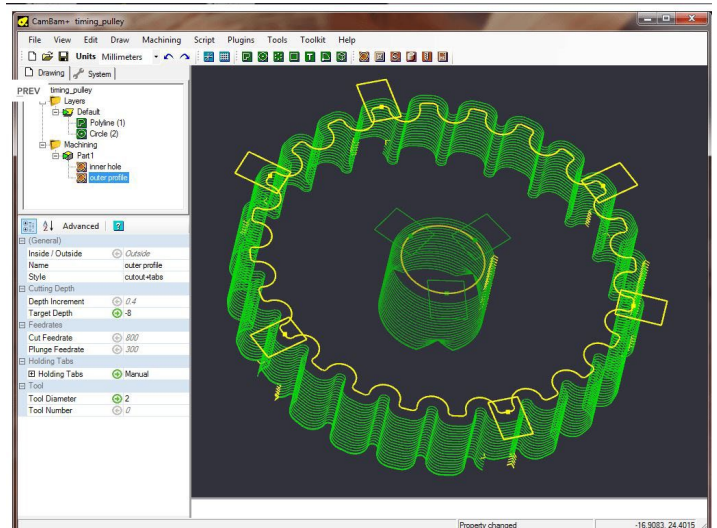
CamBam software

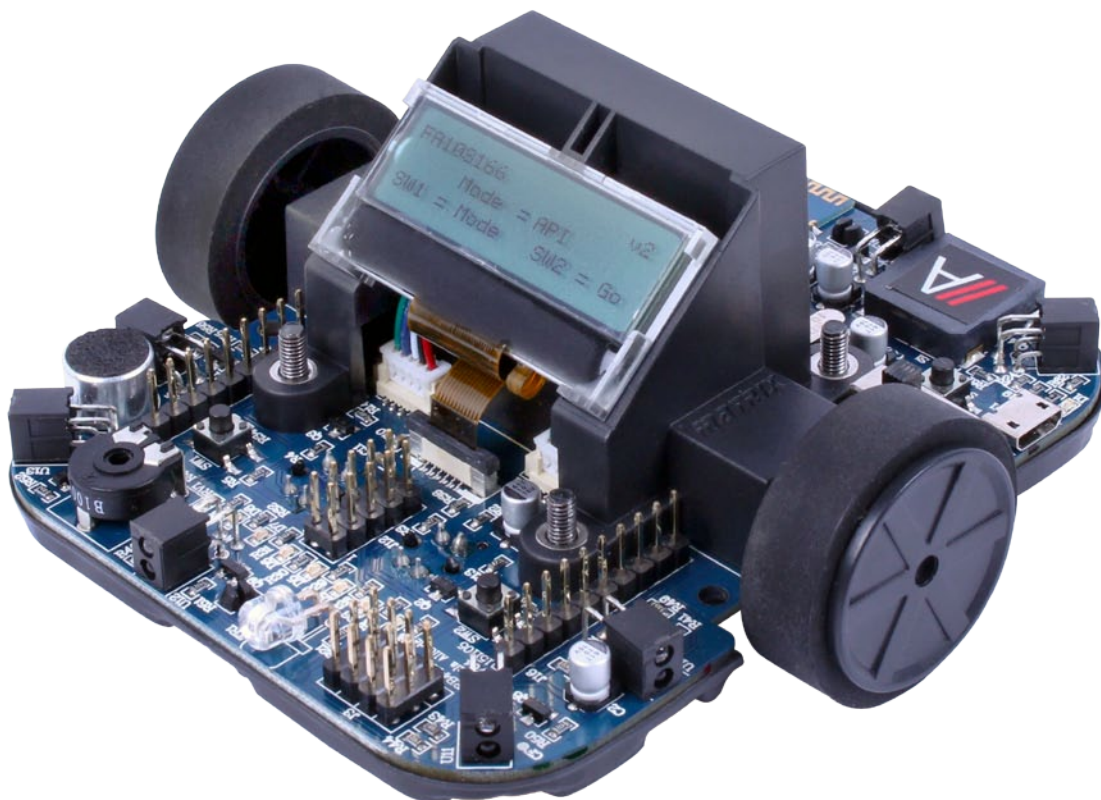
CamBam is an application to create CAM files, G code, from CAD source files or its own internal geometry editor and has many users worldwide from CNC hobbyists to professional machinists and engineers.

CamBam currently supports:

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

Compatible with 2-axis lathe and the complete MicroCNC

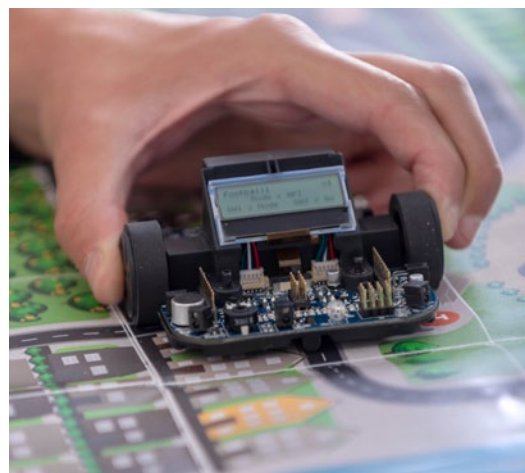




This training solution provides a course in robotics with a sequence of staged exercises including line following and maze solving. The course makes use of the high specification Formula AllCode robot which can be programmed with a number of languages on various operating systems including Flowcode,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

Learning objectives /experiments:

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



Curriculum mapping

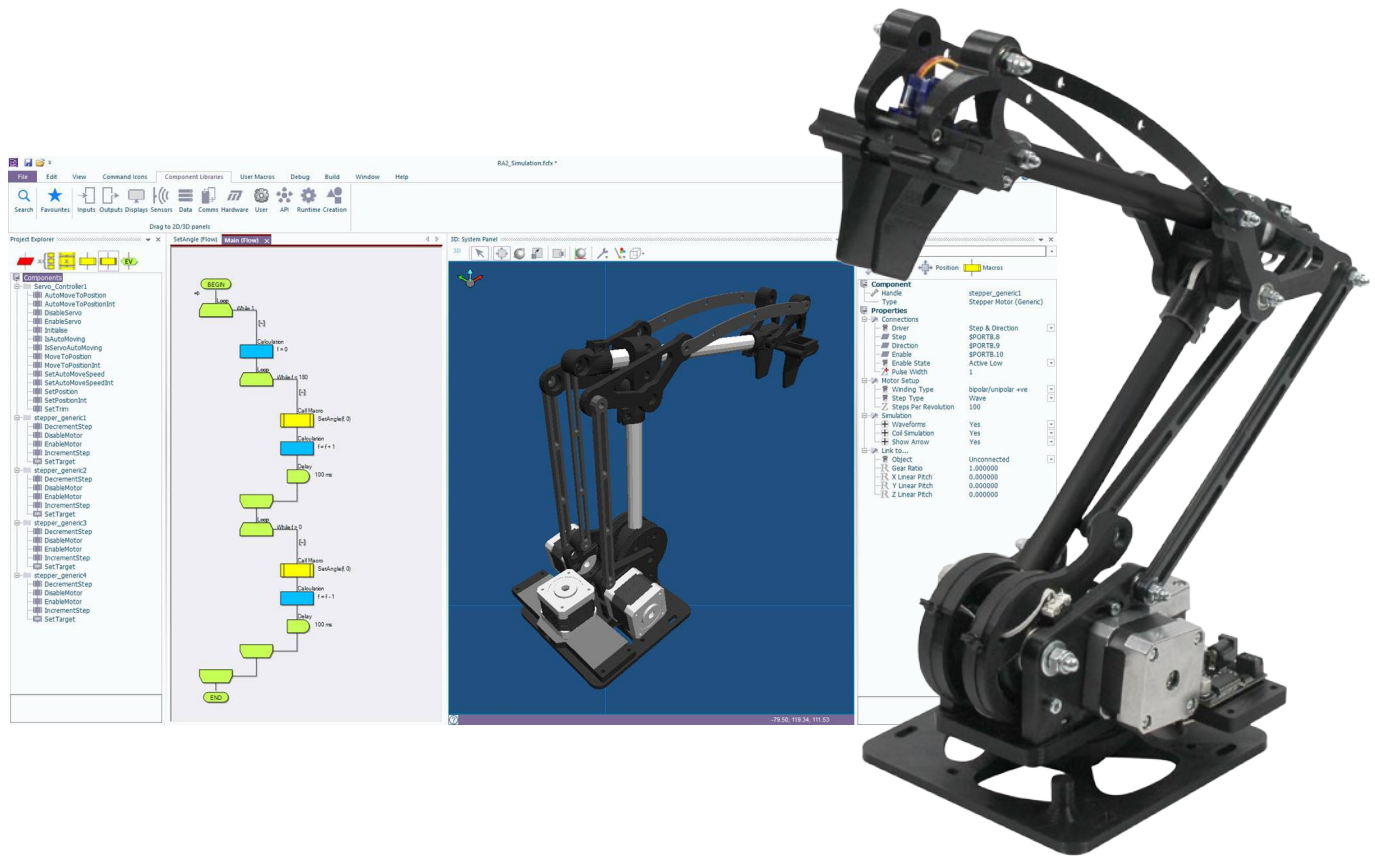
- Suitable for Design Technology and STEM related courses aged 11-18.
- Suitable for unit 10 BTEC National in Computer Science - Human-computer interface
- Suitable for various City & Guilds qualifications at Level 2 and beyond



Ordering information

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

AllCode robot arm



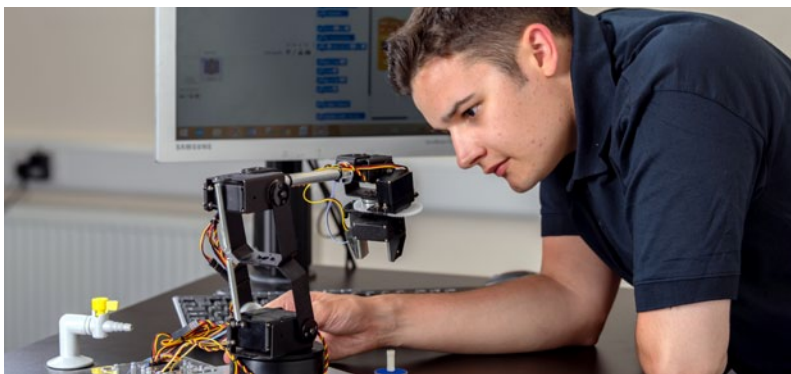
Our new robot arm production cell consists of a rugged stepper controlled 6 degrees of freedom arm bolted to a base plate and a mat that provides a range of exercises mimicking industrial robot arm production cells. The arm itself delivers accurate and repeatable movement with base rotation, single plane shoulder, elbow, wrist motion, a functional gripper, and a wrist rotator.

The Bluetooth and Wi-Fi enabled host controller board can be programmed directly from Flowcode, or Microchip's MPLAB. A full 3D Flowcode simulation is available. The control system is also shipped with a full Application Program Interface so that the robot can be controlled using any Bluetooth enabled device such as a PC,

Android, or Apple MAC device using a range of software applications including C++, LabView, Python, and App Inventor as well as remote applications over the web. The kit is supplied with several coloured counters which can be moved by the arm into different locations in the work cell. A teacher's guide is available for download from our web site.

Learning objectives /experiments:

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



Curriculum mapping

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



Ordering information

AllCode robot arm production cell	RB6231-2
Corresponding curriculum	CP8656

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



Aeronautical

Our learning solutions:

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

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

Tony Russell, British Airways.

EASA electrical fundamentals (module 3)



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

Ordering information	DIN	ANSI
EASA electrical fundamentals solution including storage trays, baseboard, DC (multinational) and AC (UK) power supplies.	LK9339	LK9339A
Corresponding curriculum	LK7378, LK7381, LK7393 & LK7415	
You will also need		
Multimeter pack	LK1110	
Picoscope	HP8279	
Signal generator	HP7894	
Source - DC PSU, AC PSU and signal generator	LK6999/LK2975	
Components - See page 73		

EASA electronic fundamentals (module 4)



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

Ordering information	DIN	ANSI
EASA electronic fundamentals solution including storage trays, baseboard, DC (multinational) and AC (UK) power supplies.	LK9282	LK9282A
Corresponding curriculum	LK7419, LK7422, LK7426 & LK7430	
You will also need		
Multimeter pack	LK1110	
Picoscope	HP8279	
Signal generator	HP7894	
Source - DC PSU, AC PSU and signal generator	LK6999/LK2975	
Components - See page 74		



Module 3 EASA Electrical fundamentals 1

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



Module 3 EASA Electrical fundamentals 2

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



Module 3 EASA Electrical fundamentals 3

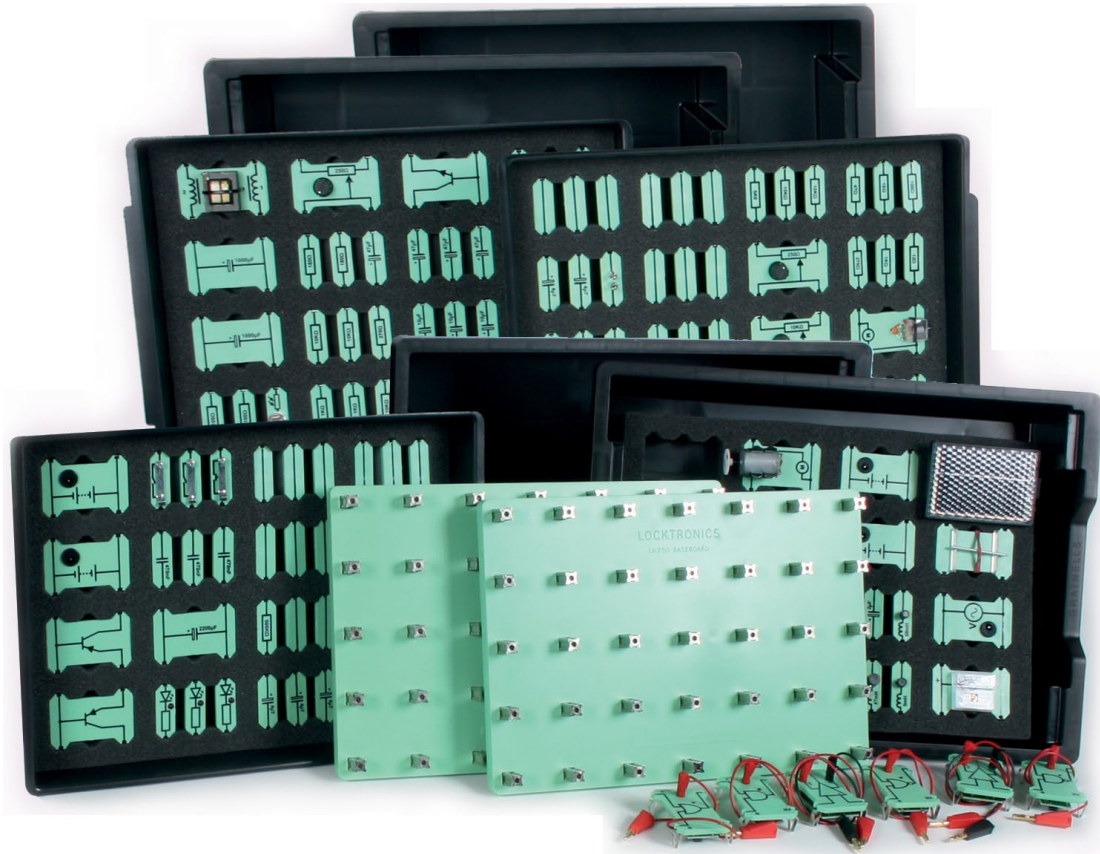
- Capacitors and electrostatics
- Inductors and inductance
- DC motors
- Generator principles
- Transformers and their construction
- Transformer losses



Module 3 EASA Electrical fundamentals 4

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

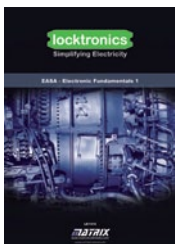
EASA electrical and electronic fundamentals (modules 3 and 4)



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

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

Ordering information	DIN	ANSI
EASA electronic fundamentals solution including storage trays, baseboard, DC (multinational) and AC (UK) power supplies.	LK9672	LK9672A
Components - See page 75		



Module 4 EASA Electronic fundamentals 1

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



Module 4 EASA Electronic fundamentals 2

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



Module 4 EASA Electronic fundamentals 3

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



Module 4 EASA Electronic fundamentals 4

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

COMPONENTS

Electricity, magnetism and materials

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

Electronic devices and communication applications

Components LK3889-2	
555 timer carrier	Choke, 10mH
2:1 transformer with retractable ferrite core	Capacitor, 0.47 uF, Polyester
7 x 5 metric baseboard with 4mm pillars	Resistor, 50k, 1/4W, 5% (DIN)
Speaker	Lampholder, MES
Ammeter, 0mA to 100mA	Thermistor, 4.7k, NTC (DIN)
Voltmeter, +/- 7.5V	MES bulb, 12V, 0.1A
Op Amp Carrier (TL081) with 2mm to 4mm Leads	Diode, germanium
Motor 3 to 12V DC, 0.7A	Diode, power, 1A, 50V
AND Gate with 2mm to 4mm lead - ANSI	Connecting Link
OR Gate with 2mm to 4mm lead - ANSI	Resistor, 100 ohm, 1W, 5% (DIN)
NOT Gate with 2mm to 4mm lead - ANSI	Resistor, 1k, 1/2W, 5% (DIN)
NAND Gate with 2mm to 4mm lead - ANSI	Resistor, 10k, 1/4W, 5% (DIN)
NOR Gate with 2mm to 4mm lead - ANSI	Potentiometer, 10k (DIN)
Power supply	Resistor, 100k, 1/4W, 5% (DIN)
Voltmeter, 0V to 15V	Capacitor, 47uF, Electrolytic, 25V
Transistor RHF, NPN	Phototransistor Carrier

Transistor RHF,	Capacitor, 100pF, Ceramic
PNP	Capacitor, 4n7, Ceramic
Lead, yellow, 500mm, 4mm to 4mm stackable	Buzzer, 6V, 15mA
Lead, blue, 500mm, 4mm to 4mm stackable	LED, Red
Capacitor, 4.7uF, electrolytic, 25V	Power supply carrier with battery symbol
Switch, push to make, metal strip	Dual rail power supply carrier
Switch, on/off, metal strip	

PIC systems solution

Components LK8922-2	
Lead, red, 500mm, 4mm to 4mm stackable	PICmicro systems solution inlay
Lead, yellow, 500mm, 4mm to 4mm stackable	Power supply
Switch, push to make, metal strip	USB2 high speed A to mini B lead
Switch, on/off, metal strip	MES bulb, 6.5V, 0.3A
Resistor, 2.2k, 1/4W, 5%	Resistor, 100 ohm, 1W, 5%
Resistor, 50k, 1/4W, 5%	USB reprogrammable PIC carrier with power leads
Buzzer, 6V, 15mA	Resistor, 1k, 1/2W, 5%
LED, Red	Resistor, 10k, 1/4W, 5%
LED, Green	LK5214 Potentiometer, 10k
LED, Yellow	Resistor, 100k, 1/4W, 5%
Motor 3 to 12V DC, 0.7A	Transistor RHF, NPN
Phototransistor Carrier	Connecting Link
Power supply carrier with battery symbol	Lampholder, MES
7 x 5 metric baseboard with 4mm pillars	Thermistor, 4.7k, NTC

Intermediate electronic engineering solution

Components LK9862	
Capacitor, 1,000 uF, Electrolytic 30V	Ammeter, 0mA to 100mA
Transformer, 2:1 turns ratio	400 Turn coil carrier
Resistor, 1k, 1/2W, 5% (DIN)	Resistor, 100 ohm, 1W, 5% (DIN)
Resistor, 10k, 1/4W, 5% (DIN)	Voltmeter, 0V to 15V
Resistor, 270 ohm, 1/2W, 5% (DIN)	Capacitor, 100uF, Electrolytic, 25V
Resistor, 180 ohm, 1/2W, 5% (DIN)	Capacitor, 2,200 uF, Electrolytic, 25V
Potentiometer, 250 ohm (DIN)	Capacitor, 1 uF, Polyester
Capacitor, 47uF, Electrolytic, 25V	Switch, push to make, metal strip
Diode, germanium	Resistor, 22k, 1/4W, 5% (DIN)
Diode, power, 1A, 50V	Choke, 47mH
Connecting Link	Resistor, 2.2k, 1/4W, 5% (DIN)
Pair of leads, red and black, 1000mm, 4mm to croc clip	Capacitor, 150 uF, Electrolytic, 25V
Lead, yellow, 500mm, 4mm to 4mm stackable	AA battery holder carrier
Lead, blue, 500mm, 4mm to 4mm stackable	2:1 transformer with retractable ferrite core
Small bar magnet	Power supply carrier with battery symbol
AC voltage source carrier	Bridge rectifier
MES bulb, 12V, 0.1A	Lampholder, MES
7 x 5 metric baseboard with 4mm pillars	

Industrial sensors, actuator and control application

Components LK5783-2	
Resistor, 10 ohm, 1W 5% (ANSI)	Motor 3 to 12V DC, 0.7A
Potentiometer, 1k (ANSI)	Solenoid
Stepper Motor	Phototransistor Carrier
Resistor, 1k, 1/2W, 5% (ANSI)	Power supply carrier with battery symbol
Resistor, 10k, 1/4W, 5% (ANSI)	Cased MIAC with Shrouded 4mm Connectors
Potentiometer, 10k (ANSI)	7 x 5 metric baseboard with 4mm pillars
Transistor RHF, NPN	MES bulb, 12V, LED, white
Diode, power, 1A, 50V	Lead, red. 500mm, 4mm to 4mm stackable
Relay, 12V coil, 10A, normally open	Lead, black, 500mm, 4mm to 4mm stackable
Lampholder, MES	Lead, yellow, 500mm, 4mm to 4mm stackable
Thermistor, 4.7k, NTC (ANSI)	Lead, blue, 500mm, 4mm to 4mm stackable
Switch, reed, normally open	Connecting Link
Switch, push to make, metal strip	USB2 high speed A to mini B lead
Switch, on/off, metal strip	Small bar magnet
Microswitch	12V 200mA miniature mes lamp
LED, Red (ANSI)	Buzzer, 12V, 15mA
LED, Green (ANSI)	Power supply
LED, Yellow (ANSI)	

Industrial sensors, actuator and control application on engineering panel

Components LK6499-2	
Locktronics engineering panel	Lampholder, MES
USB2 high speed A to mini B lead	Thermistor, 4.7k, NTC (DIN)
Small bar magnet	Switch, reed, normally open
12v 200mA miniature mes lamp	Lead, red. 500mm, 4mm to 4mm stackable
Buzzer, 12v, 15mA	Lead, black. 500mm, 4mm to 4mm stackable
Resistor, 10ohm, 1W 5% (DIN)	Lead, yellow. 500mm, 4mm to 4mm stackable
Potentiometer, 1k (DIN)	Lead, blue. 500mm, 4mm to 4mm stackable
Stepper motor	Switch, push to make, metal strip
Resistor, 1k, 1/2W, 5% (DIN)	Switch, on/off, metal strip
Resistor, 10k, 1/4W, 5% (DIN)	Microswitch
Potentiometer, 10k (DIN)	LED, red
Transistor RHF, NPN	LED, green
Diode, germanium	LED, yellow
Diode, power, 1A, 50V	Motor 3 to 12V DC, 0.7A
Connecting link	Solenoid
Relay, 12v coil, 10A, normally open	

Three phase systems

Components LK4961	
Three phase motor	Lampholder, MES
BNC male to dual 4mm Binding post	Lead - green - 320mm, 4mm to 4mm stackable
Three phase power supply	Lead, red. 500mm, 4mm to 4mm stackable
MES bulb 12V, 0.1A	Lead, black, 500mm, 4mm to 4mm stackable

Resistor, 10 ohm, 1W 5% (IN)	Lead, yellow, 500mm, 4mm to 4mm stackable
Resistor, 1k, 1/2W, 5% (DIN)	Lead, blue, 500mm, 4mm to 4mm stackable
Diode, power, 1A, 50V	33uF non-electrolytic capacitor
Connecting Link	Resistor, 2.2k, 1/4W, 5% (DIN)

Operational amplifiers add-on pack

Components LK6906	
BNC male to dual 4mm Binding post	Lead, black, 500mm, 4mm to 4mm stackable
AC voltage source carrier	Lead, blue, 500mm, 4mm to 4mm stackable
Resistor, 100 ohm, 1W, 5% (DIN)	Capacitor, 100uF, Electrolytic, 25V
Low power solar motor	Capacitor 1 uF, Polyester
Resistor, 1k, 1/2W, 5% (DIN)	Op Amp Carrier (TL081) with 2mm to 4mm Leads
Resistor, 10k, 1/4W, 5% (DIN)	LED, Red
Potentiometer, 10k (DIN)	LED, Green
Capacitor, 0.1 uF, Polyester	Dual rail power supply carrier
Connecting Link	Speaker
Thermistor, 470 ohm, NTC (DIN)	Voltmeter, +/- 7.5V
Lead, red, 500mm, 4mm to 4mm stackable	

Transformer construction and operation

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

Combinational logic add-on pack

Components LK6904	
Voltmeter, 0V to 15V	LED, Green
Resistor, 10k, 1/4W, 5% (DIN)	AND Gate with 2mm to 4mm lead - ANSI
Connecting Link	OR Gate with 2mm to 4mm lead - ANSI
Lead, red, 500mm, 4mm to 4mm stackable	NOT Gate with 2mm to 4mm lead - ANSI
Lead, black, 500mm, 4mm to 4mm stackable	NAND Gate with 2mm to 4mm lead - ANSI
Lead, yellow, 500mm, 4mm to 4mm stackable	NOR Gate with 2mm to 4mm lead - ANSI
Switch, push to make, metal strip	XOR Gate with 2mm to 4mm lead - ANSI
LED, Red	7 x 5 metric baseboard with 4mm pillars

Sequential logic add-on pack

Components LK6905	
Resistor, 100k, 1/4W, 5% (DIN)	Resistor, 5k, 1/4W, 5% (DIN)
Capacitor, 47uF, Electrolytic, 25V	555 timer carrier
Connecting Link	D-Type Flip-Flop (horizontal) with 2mm to 4mm lead
Capacitor, 100uF, Electrolytic, 25V	Systems Block display decoder - 7-segment
Switch, changeover, toggle	LED, Yellow

Transistor amplifiers add-on pack

Components LK9435	
Connecting Link	Voltmeter, 0V to 15V
Resistor, 200k, 1/4W, 5% (DIN)	Transformer, 2:1 turns ratio
Power MOSFET transistor	Transistor, JGFET
Speaker	Resistor, 1k, 1/2W, 5% (DIN)
Ammeter, 0mA to 100mA	Resistor, 10k, 1/4W, 5% (DIN)
Transistor RHF, NPN	Resistor, 270 ohm, 1/2W, 5% (DIN)
Transistor LHF, PNP	Potentiometer, 250 ohm (DIN)
Capacitor, 4.7uF, electrolytic, 25V	Resistor, 100k, 1/4W, 5% (DIN)
Resistor, 560 ohm, 1/4W, 5% (DIN)	Capacitor, 47uF, Electrolytic, 25V
Resistor, 5k, 1/4W, 5% (DIN)	Diode, power, 1A, 50V

Principles and applications of electronic devices and circuits

Components LK9422	
Voltmeter, 0V to 15V	Potentiometer, 10k (DIN)
Resistor, 10k, 1/4W, 5% (DIN)	Capacitor, 0.1 uF, Polyester
Connecting Link	Connecting Link
Lead, red, 500mm, 4mm to 4mm stackable	Thermistor, 470 ohm, NTC (DIN)
Lead, black, 500mm, 4mm to 4mm stackable	Capacitor, 100uF, Electrolytic, 25V
Lead, yellow, 500mm, 4mm to 4mm stackable	Capacitor 1 uF, Polyester
Switch, push to make, metal strip	Op Amp Carrier (TL081) with 2mm to 4mm Leads
LED, Red	LED, Red
LED, Green	LED, Green
AND Gate with 2mm to 4mm lead - ANSI	Dual rail power supply carrier
OR Gate with 2mm to 4mm lead - ANSI	Speaker
NOT Gate with 2mm to 4mm lead - ANSI	Voltmeter, +/- 7.5V
NAND Gate with 2mm to 4mm lead - ANSI	Connecting Link
NOR Gate with 2mm to 4mm lead - ANSI	Resistor, 200k, 1/4W, 5% (DIN)
XOR Gate with 2mm to 4mm lead - ANSI	Power MOSFET transistor
7 x 5 metric baseboard with 4mm pillars	Speaker
Resistor, 100k, 1/4W, 5% (DIN)	Ammeter, 0mA to 100mA
Capacitor, 47uF, Electrolytic, 25V	Transistor RHF, NPN
Connecting Link	Transistor LHF, PNP
Capacitor, 100uF, Electrolytic, 25V	Capacitor, 4.7uF, electrolytic, 25V

Switch, changeover, toggle	Resistor, 560 ohm, 1/4W, 5% (DIN)
Resistor, 5k, 1/4W, 5% (DIN)	Resistor, 5k, 1/4W, 5% (DIN)
555 timer carrier	Voltmeter, 0V to 15V
D-Type Flip-Flop (horizontal) with 2mm to 4mm lead	Transformer, 2:1 turns ratio
Systems Block display decoder - 7-segment	Transistor, JGFET
LED, Yellow	Resistor, 1k, 1/2W, 5% (DIN)
BNC male to dual 4mm Binding post	Resistor, 10k, 1/4W, 5% (DIN)
AC voltage source carrier	Resistor, 270 ohm, 1/2W, 5% (DIN)
Resistor, 100 ohm, 1W, 5% (DIN)	Potentiometer, 250 ohm (DIN)
Low power solar motor	Resistor, 100k, 1/4W, 5% (DIN)
Resistor, 1k, 1/2W, 5% (DIN)	Capacitor, 47uF, Electrolytic, 25V
Resistor, 10k, 1/4W, 5% (DIN)	Diode, power, 1A, 50V

Advanced electronic principles

Components LK6804	
Power supply	Photodiode
Resistor, 100 ohm, 1W, 5% (DIN)	Switch, changeover, toggle
Capacitor, 1,000 uF, Electrolytic 30V	Resistor, 500k, 1/4W, 5% (DIN)
Triac - TIC206M	Zener diode, 8.2V
Transistor, JGFET	Transistor RHF, PNP
Resistor, 1k, 1/2W, 5% (DIN)	Transistor LHF, PNP
Resistor, 10k, 1/4W, 5% (DIN)	Bridge rectifier
Resistor, 270 ohm, 1/2W, 5% (DIN)	Switch, push to make, metal strip
Resistor, 180 ohm, 1/2W, 5% (DIN)	Switch, on/off, metal strip
Potentiometer, 250 ohm (DIN)	Transistor RHF, NPN
Potentiometer, 10k (DIN)	Transistor LHF, NPN
Resistor, 100k, 1/4W, 5% (DIN)	Diode, germanium
Capacitor, 47uF, Electrolytic, 25V	Diode, power, 1A, 50V
Thermistor, 4.7k, NTC (DIN)	Zener diode, 4.7V
Lead, red, 500mm, 4mm to 4mm stackable	Thyristor
Lead, black, 500mm, 4mm to 4mm stackable	Transformer, 2:1 turns ratio
Lead, yellow, 500mm, 4mm to 4mm stackable	Low power solar motor
Lead, blue, 500mm, 4mm to 4mm stackable	AC voltage source carrier
Capacitor, 100uF, Electrolytic, 25V	Voltmeter, 0V to 15V
Capacitor, 1 uF, Polyester	Connecting Link
Capacitor, 4.7uF, electrolytic, 25V	Op Amp Carrier (TL081) with 2mm to 4mm Leads
Capacitor, variable, 15-140pF	AA battery holder carrier
Capacitor, 0.47 uF, Polyester	2:1 transformer with retractable ferrite core
Resistor, 2.2k, 1/4W, 5% (DIN)	Power supply carrier with battery symbol
7 x 5 metric baseboard with 4mm pillars	Dual rail power supply carrier
7 x 5 metric baseboard with 4mm pillars	LED, Red
Resistor, 200k, 1/4W, 5% (DIN)	Motor 3 to 12V DC, 0.7A
Capacitor, 1nF, Polyester	Ammeter, 0mA to 100mA
Phototransistor Carrier	

Advanced electrical, electronic and digital principles

Components LK9044	
Voltmeter, 0V to 15V	Resistor, 500k, 1/4W, 5% (DIN)
Resistor, 10k, 1/4W, 5% (DIN)	Zener diode, 8.2V
Connecting Link	Transistor RHF, PNP
Lead, red, 500mm, 4mm to 4mm stackable	Transistor LHF, PNP
Lead, black, 500mm, 4mm to 4mm stackable	Bridge rectifier
Lead, yellow, 500mm, 4mm to 4mm stackable	Switch, push to make, metal strip
Switch, push to make, metal strip	Switch, on/off, metal strip
LED, Red	Transistor RHF, NPN
LED, Green	Transistor LHF, NPN
AND Gate with 2mm to 4mm lead - ANSI	Diode, germanium
OR Gate with 2mm to 4mm lead - ANSI	Diode, power, 1A, 50V
NOT Gate with 2mm to 4mm lead - ANSI	Zener diode, 4.7V
NAND Gate with 2mm to 4mm lead - ANSI	Thyristor
NOR Gate with 2mm to 4mm lead - ANSI	Transformer, 2:1 turns ratio
XOR Gate with 2mm to 4mm lead - ANSI	Low power solar motor
7 x 5 metric baseboard with 4mm pillars	AC voltage source carrier
Resistor, 100 ohm, 1W, 5% (DIN)	Voltmeter, 0V to 15V
Capacitor, 1,000 uF, Electrolytic 30V	Connecting Link
Triac - TIC206M	Op Amp Carrier (TL081) with 2mm to 4mm Leads
Transistor, JGFET	AA battery holder carrier
Resistor, 1k, 1/2W, 5% (DIN)	2:1 transformer with retractable ferrite core
Resistor, 10k, 1/4W, 5% (DIN)	Power supply carrier with battery symbol
Resistor, 270 ohm, 1/2W, 5% (DIN)	Dual rail power supply carrier
Resistor, 180 ohm, 1/2W, 5% (DIN)	LED, Red
Potentiometer, 250 ohm (DIN)	Motor 3 to 12V DC, 0.7A
Potentiometer, 10k (DIN)	Ammeter, 0mA to 100mA
Resistor, 100k, 1/4W, 5% (DIN)	Connecting Link
Capacitor, 47uF, Electrolytic, 25V	Resistor, 200k, 1/4W, 5% (DIN)
Thermistor, 4.7k, NTC (DIN)	Power MOSFET transistor
Lead, red, 500mm, 4mm to 4mm stackable	Speaker
Lead, black, 500mm, 4mm to 4mm stackable	Ammeter, 0mA to 100mA
Lead, yellow, 500mm, 4mm to 4mm stackable	Transistor RHF, NPN
Lead, blue, 500mm, 4mm to 4mm stackable	Transistor LHF, PNP
Capacitor, 100uF, Electrolytic, 25V	Capacitor, 4.7uF, electrolytic, 25V
Capacitor, 1 uF, Polyester	Resistor, 560 ohm, 1/4W, 5% (DIN)
Capacitor, 4.7uF, electrolytic, 25V	Resistor, 5k, 1/4W, 5% (DIN)
Capacitor, variable, 15-140pF	Voltmeter, 0V to 15V
Capacitor, 0.47 uF, Polyester	Transformer, 2:1 turns ratio
Resistor, 2.2k, 1/4W, 5% (DIN)	Transistor, JGFET
7 x 5 metric baseboard with 4mm pillars	Resistor, 1k, 1/2W, 5% (DIN)
7 x 5 metric baseboard with 4mm pillars	Resistor, 10k, 1/4W, 5% (DIN)
Resistor, 200k, 1/4W, 5% (DIN)	Resistor, 270 ohm, 1/2W, 5% (DIN)
Capacitor, 1nF, Polyester	Potentiometer, 250 ohm (DIN)
Phototransistor Carrier	Resistor, 100k, 1/4W, 5% (DIN)
Photodiode	Capacitor, 47uF, Electrolytic, 25V
Switch, changeover, toggle	Diode, power, 1A, 50V

Fault finding in electronic circuits

Components LK3566	
Power supply	Capacitor 47uF, Electrolytic, 25V
AC Power supply, 12VAC, 1.5A, UK	Power supply carrier with battery symbol
Low power solar motor	Speaker
AC voltage source carrier	555 carrier
MES bulb, 12V, 0.1A	Flip flop, horizontal carrier
Resistor , 1k, 1/2W, 5% (DIN)	LED, red
Resistor, 10k, 1/4W, 5% (DIN)	NOT Gate with 2mm to 4mm lead - ANSI
Resistor, 270 ohm, 1/2W, 5% (DIN)	NOR Gate with 2mm to 4mm lead - ANSI
Resistor 100k, 1/4W, 5% (DIN)	7x5 metric baseboard with pillars (made up)
Resistor 22k, 1/4W, 5% (DIN)	Faulty bridge rectifier (reverse diode)
Potentiometer, 10k (DIN)	Faulty Zener diode (short circuit)
Lead, black, 500mm, 4mm to 4mm stackable	Faulty op-amp (pin 6 open circuit)
Lead, blue, 500mm, 4mm to 4mm stackable	Faulty NPN transistor (open base)
Lead, red, 300mm, 4mm to 2mm stackable	Faulty 555 timer IC (pin 8 open circuit)
Lead, black, 300mm, 4mm to 2mm stackable	Faulty 47uF capacitor (4.4uf)
Lead, yellow, 500mm, 4mm to 4mm stackable	Faulty 100k ohm resistor (1kohm)
Switch on/off metal strip	Faulty 220uF capacitor (4.7uF)
Op Amp Carrier (TL081) with 2mm to 4mm Leads	Faulty 10k resistor (10ohm)
Dual rail power supply carrier	Faulty 1k resistor (open circuit)
Transistor RHF, NPN	Faulty LED (reverse bias)
Connecting link	Faulty switch (short circuit)
Zener diode, 6.8V	Faulty NPN transistor (short between base-emitter)
Bridge rectifier	Faulty link carrier (open circuit)
Lampholder, MES	Faulty blue cable (open circuit)
Capacitor, 2,200 uF, Electrolytic, 25V	Faulty Zener diode (reverse bias)

Power and energy electronics

Components LK3568	
Resistor, 33k, 1/4W, 5% (DIN)	Lead, red, 500mm, 4mm to 4mm stackable
Resistor, 100k, 1/4W, 5% (DIN)	Lead, black, 500mm, 4mm to 4mm stackable
Capacitor, 47uF, Electrolytic, 25V	Capacitor, 100pF, Ceramic
Resistor, 10 ohm, 1W 5% (DIN)	555 carrier
Resistor, 220 ohm, 1/2W, 5% (DIN)	Lead, blue, 500mm, 4mm to 4mm stackable
Resistor, 10k, 1/4W, 5% (DIN)	Power supply
7 x 5 metric baseboard with 4mm pillars	AC power supply, 12VAC, 1.5A, UK
Potentiometer, 10k (DIN)	Lampholder, MES
Diode, power, 1A, 50V	Thyristor
Transistor RHF, NPN	Zener diode, 8.2V
Resistor, 100 ohm, 1W, 5% (DIN)	Capacitor, 100uF, Electrolytic, 25V
Resistor, 1k, 1/2W, 5% (DIN)	Voltage regulator (7805)
Triac - TIC206M	Switch, changover, metal strip
AC voltage source carrier	Switch, push to make, metal strip
Resistor, 120 ohm, 1/2W, 5% (DIN)	Resistor, 22k, 1/4W, 5% (DIN)

Resistor, 180 ohm, 1/2W, 5% (DIN)	MES bulb, 12V, 0.1A
Resistor, 270 ohm, 1/2W, 5% (DIN)	Fuse/universal component carrier
Resistor, 5.6k, 1/4W, 5% (DIN)	Capacitor, 2,200 uF, Electrolytic, 25V
Potentiometer, 100k (DIN)	Zener diode, 12V
Capacitor, 10 uF, Electrolytic, 25V	Bridge rectifier
Potentiometer, 250 ohm (DIN)	Phototransistor Carrier
Capacitor, 0.1 uF, Polyester	Transistor, unijunction
Capacitor, 0.47 uF, Polyester	Resistor, 1M, 1/4W, 5% (DIN)
Resistor, 2.2k, 1/4W, 5% (DIN)	Motor 3 to 12V DC, 0.7A
Choke, 5mH	Connecting Link
LED, Red	Power MOSFET transistor
BNC male to dual 4mm Binding post	Power supply carrier with battery symbol

Automatics essentials solution

Components AU9020	
Platform System Controller & Base Plate	Valve, 3/2, lever-spring
Valve 5/2, pilot-pilot (x3)	Valve, mini shuttle
Manifold	Valve, 3/2, roller-spring (x4)
Reservoir 45cc	Valve, 5/2, lever-spring
Junction, equal tee (x4)	Valve, 3/2, button-spring
Tube Cutting Tool	Tee-bolts and sleeves (pack of 50)
Cylinder, single acting, 10 * 40 mm	Permanent Fixing Kit
Cylinder, double acting, 10 * 80 mm (x2)	Tubing, 4mm, yellow, 30m length
Valve, flow control (x2)	Tubing, 4mm, blue, 30m length
Valve, 3/2, diaphragm-spring	Tubing, red, 5m length

Electro-pneumatics add-on kit

Components AU9015	
Valve, 3/2, solenoid - spring (x2)	Switch, push to make (x2)
Valve, 5/2, double - spring	Power Supply
Microswitch (x2)	Lead, red, 500mm, 4mm to 4mm stackable (x6)
Power Panel	Lead, black, 500mm, 4mm to 4mm stackable (x6)
Reed Switch & Holder (x2)	

Pneumatics control add-on kit

Components AU9010	
Cased MIAC with Shrouded 4mm Connectors	Automatics Safety Sheet
Valve, flow control (x2)	Power Supply
Valve, 3/2, solenoid - spring (x4)	USB2 High Speed A to mini B Lead
Light Sensor	Lead, red, 500mm, 4mm to 4mm stackable (x6)
Power Panel	Lead, black, 500mm, 4mm to 4mm stackable (x6)
Reed Switch & Holder	Lead, yellow, 500mm, 4mm to 4mm stackable (x2)
Switch, push to make (x2)	

Pneumatics control with S7-1200 Siemens PLC add-on

Components AU9077	
Switch, push to make	Lead, blue, 500mm, 4mm to 4mm stackable
Reed switch and holder	PLC adaptor - mounting bracket
Valve, flow control	PLC adaptor - relay module (Siemens)
Light sensor	PLC adaptor - input module (Siemens)
Valve, 3/2, solenoid-spring 24V	PLC adaptor - power module
Lead, red, 500mm, 4mm to 4mm stackable	Wire pack
Lead, black, 500mm, 4mm to 4mm stackable	24V 1A DC plug top mains PSU
Lead, yellow, 500mm, 4mm to 4mm stackable	Siemens S7-1211C PLC

EASA electrical fundamentals (module 3)

Components LK9339	
Potentiometer, 10k (DIN)	Lead, blue, 500mm, 4mm to 4mm stackable
Choke, 68 mH	Capacitor, 1 uF, Polyester
2:1 transformer with retractable ferrite core	Capacitor, 4.7uF, electrolytic, 25V
Alnico rod magnet	Switch, push to make, metal strip
Lenz's law kit	Switch, on/off, metal strip
Faraday's law kit	Resistor, 22k, 1/4W, 5% (DIN)
7 x 5 metric baseboard with 4mm pillars	Resistor, 15k, 1/4W, 5% (DIN)
Power supply	Choke, 10mH
MES bulb, 6V, 0.04A	Choke, 47mH
MES bulb, 6.5V, 0.3A	Choke, 5mH
Resistor, 100 ohm, 1W, 5% (DIN)	Capacitor, 2.2 uF, Polyester
Resistor, 10 ohm, 1W 5% (DIN)	Resistor, 2.2k, 1/4W, 5% (DIN)
Resistor, 47 ohm, 1/2W, 5% (DIN)	Fleming's motor rule apparatus
Resistor, 12 ohm, 1W, 5% (DIN)	AA battery holder carrier
Transformer, 2:1 turns ratio	Connecting Link
Resistor, 1k, 1/2W, 5% (DIN)	Lampholder, MES
Resistor, 10k, 1/4W, 5% (DIN)	Motor, 6V, open frame
Resistor, 270 ohm, 1/2W, 5% (DIN)	AC voltage source carrier
Potentiometer, 250 ohm (DIN)	Thermocouple and carrier
Resistor, 5.6k, 1/4W, 5% (DIN)	Solar cell
Capacitor, 10 uF, Electrolytic, 25V	Fuse/universal component carrier
Diode, germanium	Power supply carrier with battery symbol
Lead, yellow, 500mm, 4mm to 4mm stackable	Ammeter, 0mA to 100mA

EASA electronic fundamentals (module 4)

Components LK9282	
Resistor, 1k, 1/2W, 5% (DIN)	Op Amp Carrier (TL081) with 2mm to 4mm Leads
Resistor, 10k, 1/4W, 5% (DIN)	AC voltage source carrier
Resistor, 270 ohm, 1/2W, 5% (DIN)	Voltmeter, 0V to 15V
Resistor, 180 ohm, 1/2W, 5% (DIN)	LED, Red
Potentiometer, 250 ohm (DIN)	Motor 3 to 12V DC, 0.7A
Potentiometer, 10k (DIN)	AND Gate with 2mm to 4mm lead - ANSI
Resistor, 100k, 1/4W, 5% (DIN)	OR Gate with 2mm to 4mm lead - ANSI
Capacitor, 47uF, Electrolytic, 25V	NOT Gate with 2mm to 4mm lead - ANSI
Power supply	AA battery holder carrier
Thermistor, 4.7k, NTC (DIN)	2:1 transformer with retractable ferrite core
Lead, red, 500mm, 4mm to 4mm stackable	Power supply carrier with battery symbol
Lead, black, 500mm, 4mm to 4mm stackable	Dual rail power supply carrier
Lead, yellow, 500mm, 4mm to 4mm stackable	Switch, changeover, toggle
Lead, blue, 500mm, 4mm to 4mm stackable	Transformer, 2:1 turns ratio
Capacitor, 100uF, Electrolytic, 25V	Low power solar motor
Capacitor, 1 uF, Polyester	Switch, push to make, metal strip
Capacitor, 4.7uF, electrolytic, 25V	Switch, on/off, metal strip
Resistor, 100 ohm, 1W, 5% (DIN)	Transistor RHF, NPN
Capacitor, 1,000 uF, Electrolytic 30V	Transistor LHF, NPN
Capacitor, variable, 15-140pF	Diode, germanium
Capacitor, 0.47 uF, Polyester	Diode, power, 1A, 50V
Resistor, 2.2k, 1/4W, 5% (DIN)	Zener diode, 4.7V
Resistor, 200k, 1/4W, 5% (DIN)	Thyristor
Capacitor, 1nF, Polyester	Connecting Link
Resistor, 500k, 1/4W, 5% (DIN)	Zener diode, 8.2V
7 x 5 metric baseboard with 4mm pillars	Transistor RHF, PNP
Ammeter, 0mA to 100mA	Transistor LHF, PNP
7 x 5 metric baseboard with 4mm pillars	Bridge rectifier

EASA electrical and electronic fundamentals (modules 3 and 4)

Components LK9672	
LED, Red (ANSI)	Capacitor, 100uF, Electrolytic, 25V
Alnico rod magnet	Capacitor, 1 uF, Polyester
Fuse/universal component carrier	Capacitor, 4.7uF, electrolytic, 25V
7 x 5 metric baseboard with 4mm pillars	Capacitor, 1,000 uF, Electrolytic 30V
Resistor, 1k, 1/2W, 5% (ANSI)	Capacitor, 10 uF, Electrolytic, 25V
Resistor, 10k, 1/4W, 5% (ANSI)	Capacitor, 47uF, Electrolytic, 25V
Resistor, 270 ohm, 1/2W, 5% (ANSI)	Power supply
Resistor, 180 ohm, 1/2W, 5% (ANSI)	Thermocouple and carrier
Potentiometer, 250 ohm (ANSI)	Lenz's law kit
Resistor, 5.6k, 1/4W, 5% (ANSI)	Faraday's law kit
Potentiometer, 10k (ANSI)	2:1 transformer with retractable ferrite core
Resistor, 100k, 1/4W, 5% (ANSI)	AND Gate with 2mm to 4mm lead - ANSI
Resistor, 100 ohm, 1W, 5% (ANSI)	OR Gate with 2mm to 4mm lead - ANSI
Resistor, 10 ohm, 1W 5% (ANSI)	NOT Gate with 2mm to 4mm lead - ANSI
Resistor, 47 ohm, 1/2W, 5% (ANSI)	Solar cell
Resistor, 12 ohm, 1W, 5% (ANSI)	Transistor RHF, NPN
Lampholder, MES	Transistor LHF, NPN
Thermistor, 4.7k, NTC (ANSI)	Diode, germanium
Lead, red, 500mm, 4mm to 4mm stackable	Diode, power, 1A, 50V
Lead, black, 500mm, 4mm to 4mm stackable	Zener diode, 4.7V
Lead, yellow, 500mm, 4mm to 4mm stackable	Thyristor
Lead, blue, 500mm, 4mm to 4mm stackable	Connecting Link
Switch, push to make, metal strip	Zener diode, 8.2V
Switch, on/off, metal strip	Transistor RHF, PNP
Resistor, 22k, 1/4W, 5% (ANSI)	Transistor LHF, PNP
Resistor, 15k, 1/4W, 5% (ANSI)	Bridge rectifier
Resistor, 2.2k, 1/4W, 5% (ANSI)	Fleming's motor rule apparatus
Switch, changeover, toggle	Op Amp Carrier (TL081) with 2mm to 4mm Leads
Resistor, 500k, 1/4W, 5% (ANSI)	Low power solar motor
Resistor, 200k, 1/4W, 5% (ANSI)	Motor, 6V, open frame
Capacitor, 1nF, Polyester	AC voltage source carrier
Transformer, 2:1 turns ratio	MES bulb, 6V, 0.04A
Capacitor, variable, 15-140pF	MES bulb, 6.5V, 0.3A
Choke, 10mH	Voltmeter, 0V to 15V
Choke, 47mH	Ammeter, 0mA to 100mA
Choke, 5mH	Power supply carrier with battery symbol
Choke, 68 mH	Dual rail power supply carrier
Capacitor, 470nF, Polyester	AA battery holder carrier
Capacitor, 2.2 uF, Polyester	Motor 3 to 12V DC, 0.7A



www.matrixtsl.com



Matrix Technology Solutions

The Factory, 33 Gibbet Street, Halifax, HX1 5BA, United Kingdom

t: +44 (0) 1422 252380 e: sales@matrixtsl.com