FLITE ELECTRONICS INTERNATIONAL LIMITED

Multi-Applications Board

User Manual

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CE

APPROVED

1994 NO. 3080
ELECTROMAGNETIC COMPATABILITY
The Electromagnetic Compatibility (Amendment) Regulations 1994

EDUCATION, TRAINING AND EVALUATION EQUIPMENT

Section 8-(1)
This regulation applies only to education and training equipment which would not, except for the provisions of this regulation, conform with the protection requirements under normal conditions of use in its usual electromagnetic environment.

! WARNING !

The use of this apparatus outside the classroom, laboratory, or similar area invalidates conformity with the protection requirements of the Electromagnetic Compatibility Directive (89/336/EEC) and could lead to prosecution.

Electromagnetic Compatibility – Further Notes

From 1st January 1995 it is a legal requirement that we comply with the EEC directive (89/336/EEC). As members of BESA (British Education Suppliers Association) and ETEMA (Engineering Teaching Equipment Manufactures Association) EMC 1944 No 3080 (as amended) Section 8.1 is our lobbied contribution to this statutory instrument enabling us to legally comply.

By using equipment within the confines of an electromagnetically safe environment i.e. a Faraday Cage, or using the PCB in a completely sealed, earthed metal box, with correctly de-coupled and screened leads, EMC radiation will be negligible and well within the wider remit of this directive. However, this makes education training and evaluation equipment either impractical or impossible to use. Therefore Section 8.1 is one of the necessary recent amendments.

In short, use this product sensibly and not in an electromagnetic sensitive area and only within the confines of a classroom, laboratory, study area or similar place. If in doubt, consult a professional electronics engineer to review the electro-magnetic environment.

Flite Electronics International Limited and its staff are not liable for misuse o fits equipment or breaches of this EEC Directive.

ELECTROMAGNETIC COMPATIBILITY

What is EMC?

EMC, Electromagnetic Compatibility, is achieved when two pieces of electrical or electronic equipment can work as intended in the same environment without causing each other problems. Standards have been set up which lay down the requirements for equipment to operate in this way.

The first of these standards, the European Council Directive (89/336/EEC), was introduced on 3 May 1989 and states that:

1. The electromagnetic disturbance it generates does not exceed a level allowing radio and telecommunications equipment and other apparatus to operate as intended;
2. The apparatus has an adequate level of intrinsic immunity of electromagnetic disturbance to enable it to operate as intended.

However, educational electronics equipment was not mentioned at any stage within this Directive. Whilst 'standard' equipment must obviously comply, there are special issues for some equipment and it is in relation to such equipment which cannot comply, usually by reason of its objectives, that these routes apply.

Educational equipment and EMC

Some member companies wish to pass equipment through the system which is open in construction. The equipment could be electronic boards which are connected by electrical leads to other sections of apparatus or large test rigs which the student has to look at from the inside. One of the features of this type of approach is that it is not easy to provide electrical screening in the way that the Directive suggests.

Realising the effect that these Directives would have on member companies BESA set up a working group with members who had like products to look at how the application of the Directive could be modified to suit education - the Working Group began to lobby the DTI in 1990.

In 1994 an amendment to the Statutory UK Regulation Directive regarding EMC was brought into operation. A section relating to educational electronic equipment was included within it.

This regulation applies to education and training equipment which would not except for the provisions of this regulation, conform with the protection requirements under normal conditions of use in its usual electromagnetic environment.

1. Education and training equipment to which this regulation applies shall be deemed to conform with the protection requirements if it satisfies the following conditions:

   a. in relation to supply, the apparatus is accompanied by a written declaration in English stating that the use of the apparatus outside the classroom, laboratory, study area or similar such place invalidates conformity with the protection requirement of the Electromagnetic Compatibility Directive (891336/EE) and could lead to prosecution; and
   b. the equipment when operating does not cause electromagnetic disturbance to apparatus situated outside its immediate electromagnetic environment.

2. In these Regulations, "education and training equipment" mean any relevant apparatus, including a kit:

   a. supplied or possessed for supply to education or training establishments or manufactured in such an establishment for the purposes of experimentation, learning or practical training and
   b. the usual electromagnetic environment of which is a classroom, laboratory, study areas or similar such place.

   This amended regulation now gives BESA members the opportunity to place the CE mark on their products in relation to EMC providing that all other standards and directives that relate to the product carrying the mark are complied with.

GETTING STARTED

The Flite Electronics Internationals Multi-Applications Board provides the user with an introduction to computer control, as well as some of the electronic components associated with such control.

The board is primarily intended for use with the wide range of Flite Electronics International Microprocessor Training Boards,

These include the following:-

MPF-1B and MPF1P Z80 based boards

FLT-68K (68000, 68020 EVM and 68EC020 EVM

FLT-86 (8086)

FLT-32 (8086)

Transputer (T414, T425, T805)

The Multi Applications Board may also be used with the BBC Micro using a special cable and can be interfaced to any IBM compatible PC via Flite 48 line I/O board.

Indeed the board can be used with any processor system which can provide one 8 bit input port and one 8 bit output port.

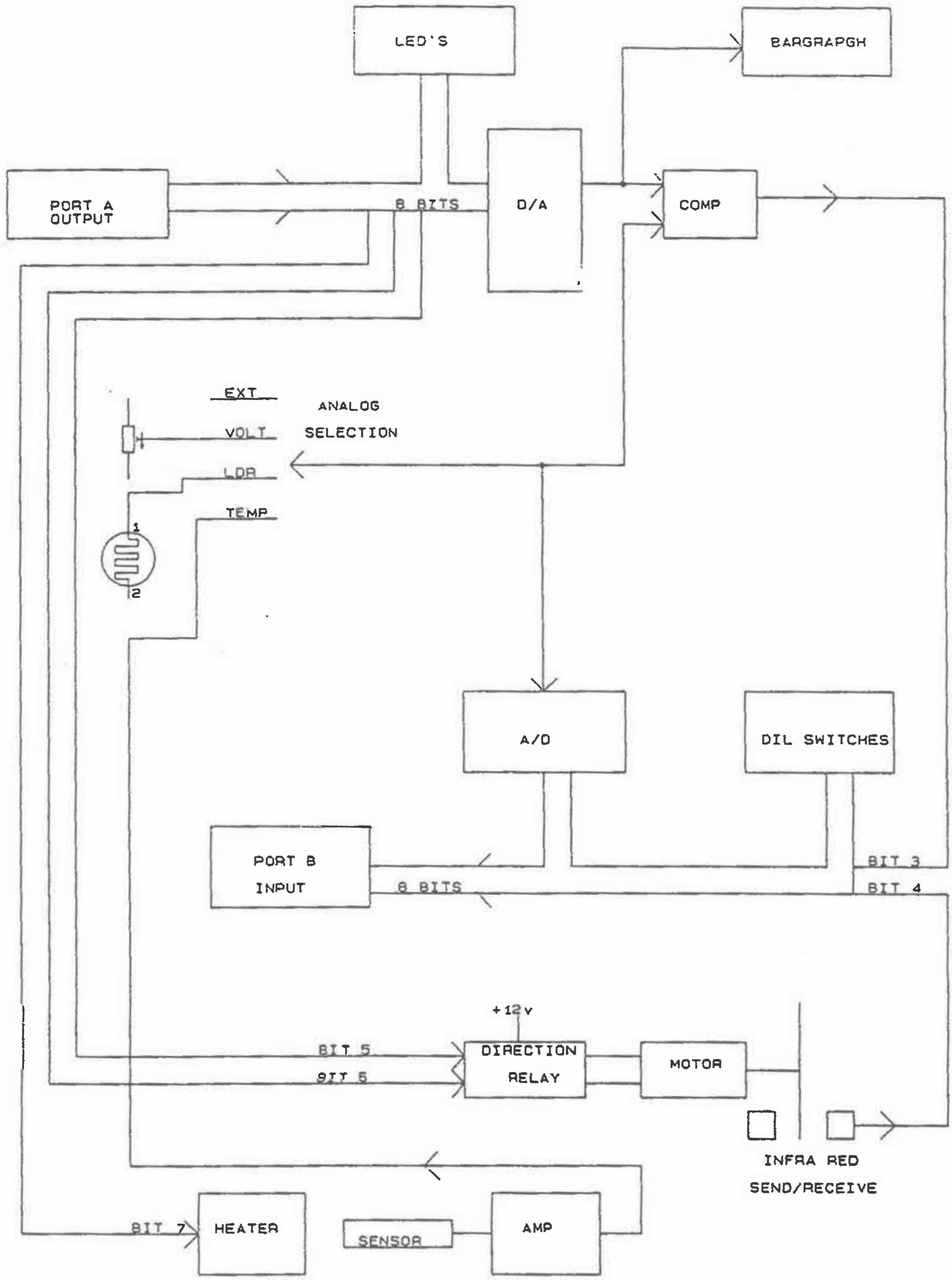
It will provide the user with experience in reading switches, Analogue to Digital Conversion, Digital to Analogue conversion, motor speed control, temperature control and provide the basis for many allied experiments.

CONNECTION

For the Flite range of Microprocessor Training Boards, connection is by means of the 40 way ribbon cable supplied. Power is provided by the 240v mains adapter supplied. (Optionally a 110v is available)

BOARD FACILITIES

The features of the board are shown in the following block diagram and fully described in the following paragraphs.



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OUTPUT PORT

The Processor output port connects to Port A on the Multi Applications Board, and the state of the 8 lines will always be displayed on the 8 coloured LED's.

By means of on board mode switches, this port can be used to control the motor (forward and reverse) and/or the heater.

When not in use for these functions, the output port can be used to drive the Digital to Analogue Convertor (D/A).

The board is carefully laid out so that each item is clearly marked, and enclosed in an area with its associated components.

INPUT PORT

The processor input port connects to Port B on the Multi Applications Board, and by selection via mode switches can be used to read the 8 bit DIL switch, or the output of the Analogue to Digital Convertor (A/D), or the output of the D/A comparator, and/or the output of the speed sensing infra-red detector.

ANALOGUE SOURCE

By means of a four position switch, the analogue source to the A/D can be provided externally, or from the output of a light dependant resistor, or from the temperature sensor, or from an on board variable voltage.

The output of the D/A can be displayed in graphical form by means of the ten segment Bargraph.

BOARD DESCRIPTION.

Power

Power from the unregulated mains adaptor is provided at nominally 9V 1A, to connector J1. In this section of the board it is regulated to 5V by U12, and associated smoothing capacitors, and also via the dc to dc convertor U13 the +5V provides a low current supply of -5V albeit from a relatively high source impedance. This -5V is required by some of the analogue circuitry. The +5V regulator U12 is mounted on a heat sink, and care should be taken in handling the board, as this heatsink may reach 70C.

Mode Switches

These two banks of switches control the functions on the board, and their settings will be described later. In the 'OFF' position, (all switches pushed in the direction of the heat sink) all functions are switched off , with the exception of the 8 bit DIL switch which is selected.

The three jumper links in this section are unlikely to be required, but link 0V, Port A bits 3 & 4 to alternative pins on the connector, for compatibility with some older products.

Output Switches

When selected the state of the 8 bits on this DIL switch are read into the processor via Port A. Each switch is connected to an input on U1, this input is also pulled up by a resistor on RP1 resistor network. However when the switch is in the 'ON' position (pushed down), it grounds its respective input on U1. UI inverts the input signal and drives the Port A bus. Setting mode switch SW2A to 'ADC', disables U1, and prevents it driving Port A.

For correct use in reading the state of SW1, SW2A must be 'SWITCH' and SW4A 'OFF' and SW4B 'OFF'. These latter two switch data bits 3 & 4 to other uses if not in the OFF position.

ADC

U2 is an 8 bit A/D, free running at a clock rate of approx 400KHz determined by the values of R4 and C2. This produces a conversion time of 180uS. As the device has no internal reset circuit on power up, it may sometimes be necessary to press PB1 to ensure that the A/D starts up.

The resistor chain R2, VR1 and R3 set the reference voltage to the A/D, and is nominally set at 2.50V, hence scaling the A/D to 0 to +5V full scale. i.e reference = half full scale.

To use the A/D, SW2A must be set to 'ADC', this removes the ground from U5 pin 3, which is pulled up by R1. U5 being an invertor now drives the ADC pin 2 to a logic '0' (this is the RD pin), enabling the digital output of the ADC onto the bus to Port A. As with the switches above, SW4A and SW4B must be 'OFF' if data bits 3 & 4 are not to be lost.

As the A/D is free running it is completely asynchronous with any 'read' from the microprocessor training board, which means if read just as the output of the A/D is being updated, false readings could be obtained. This can be overcome by reading twice or more times, only accepting a value when it is unchanged over two consecutive readings. For most microprocessors this should provide no problem in taking two readings in between conversions of the A/D.

The analogue input source to the A/D is selected by the four position slider switch SW3, Posn 1 'VOLTS' selects the variable voltage source, which can be varied by VR6, between 0V and approx 2.5V. Posn 2 'EXT' selects an external analogue source via IN on screw tag connector P2, this should be between 0V and 2.5V, voltages above +5V may damage U2. Posn 3 'LDR' selects the output of the potential divider formed by the light dependant resistor LDR1 and R29, by varying the incident light falling on LDR1, this voltage will vary between 0V and approx 2.5V. Lastly Posn 4 will select the output of the temperature sensing circuit U6, which will be fully described later.

Motor

The small dc motor with 3 bladed propeller is limited to approx 8000 RPM by the two 27R current limiting resistors connecting it to the board. The polarity of the voltage applied to the motor and hence forward and reverse is selected by the relay K1. The motor is driven from the unregulated supply obtained from the mains adaptor (approx 9V), this minimises the noise introduced into the 5V regulated supply, and hence the noise induced in the logic circuits.

Motor ON forward/reverse selection is by output bits 6 & 7 on Port B, their value is decoded by U4, such that 'bit 6 and not bit 7' will produce forward motion, and 'not bit 6 and bit 7' produces reverse motion. The other two combinations will cause the motor to stop. To decode and drive any output of U4 to a logic '0' first U4 must be enabled by placing SW2B in 'MOTOR' placing a logic '0' on U4 pin 1, which is otherwise pulled up by R8.

Either of the valid combinations of bit 6 and bit 7 will create a logic '0' at U4 pin 9, which via the high current driver U3 pin 15, and relay K1 will ground one side of the motor causing it to operate.

One of these valid combinations (bit 6) will also produce a logic '0' on U4 pin 5, which via driver U3 pin 16 will energise relay K1 (also powered from the unregulated supply), the contacts of K1 reversing the polarity of the motor supply, hence changing its direction.

As the motor rotates the propeller blades pass between D1 an infra-red source, and D2 an infra-red detector, the change in current through the detector is sufficient to pass the schmitt trigger threshold of U5 pin 1, thus providing a signal 3 times per revolution back to Port A bit 4. However for this to function SW4A must be set to 'SPEED', connecting the output of U5 pin 2 to the A bus.

Heater

The heating element is R12 a wire wound resistor, when SW4C is set to 'HEAT' an output on Port B bit 5 via the high current driver U3 pin 13 will draw current through this resistor from the unregulated supply. Via R11 the Heater LED will illuminate to indicate the heater is on. R12 will get too hot to touch if left on for long periods.

Q1 an LM335 is a special temperature sensing element, the voltage across it providing an exact measure of temperature in degrees Kelvin (10mV/K). Hence if VR2 is set to 2.73V (273K) then at 0C the differential input to U6 pins 2 & 3 will be zero. Any change in temperature will produce a differential input of 10mV per degree C. This is amplified by U6, and can be sampled and measured by the A/D U2. VR3 adjusts the gain of U6, and is nominally set to provide 40mV/C output to the A/D.

Bargraph

When SW4D is set to 'BARGR' the output of the D/A (U8) is routed to U11, this device is a 10 level detector, and as each level is reached will drive an output to U10 causing successive segments of the bargraph to illuminate. VR5 sets the full scale of U11, and is nominally set up so that a voltage of 2.55V from the D/A will just cause the tenth segment of the bargraph to illuminate.

DAC

U8 is a D/A device which produces an analogue voltage output proportional to the digital input. The digital input is provided by Port A. VR4 sets the analogue ouput to 0.00V when the digital input is 00, and circuit values are chosen so that a digital input of 255 (FF hex) will produce an analogue output of approx 2.55V.

The output of the D/A is fed to pin 3 of U9, which is a comparator, comparing the voltage on pin 3 with that on pin 2. The voltage on pin 2 will come from one of the analogue sources, as selected by SW3. When the voltage on pin 3 exceeds that on pin 2, the output pin 7 will change from a logic '1' to a logic '0'. The LM311 is an open collector device, hence R30 provides the necessary pull up. Comparators are very high gain devices, and prone to oscillation, hence careful component layout, screening, and C9 to alleviate this. The output of U9 can be read on bit 3 of Port A provided switch SW4B is set to 'DAC'.

LED Output

Port A output is buffered by U7, which drives the 8 coloured LED's D4 to D11, giving a constant indication of the state of the eight bits of Port B. LED on indicates a logic '1'.

The experiment manual for the respective Processor Training Board will show how these various elements can be used in conjunction for a variety of experiments in computer control.

Conclusion

This board is not intended to provide the last word in accuracy from D/A and A/D, to do so would add considerably to the cost, nevertheless the user will obtain good results with a little care typically +- 1 bit.

CONNECTORS

PIN NO	SIGNAL	PIN NO	SIGNAL
1		21	Port B Bit 0
2		22	Port B Bit 1
3		23	Port B Bit 2
4		24	Port B Bit 3
5		25	Port B Bit 4
6		26	Port B Bit 5
7	Port A Bit 7	27	Port B Bit 6
8	Port A Bit 6	28	Port B Bit 7
9	Port A Bit 5	29	
10	Port A Bit 4	30	0V (LK1)
11	0V	31	Port A Bit 4 (LK2)
12	Port A Bit 3	32	Port A Bit 3 (LK3)
13	Port A Bit 2	33	
14	Port A Bit 1	34	
15	Port A Bit 0	35	
16		36	
17		37	
18		38	
19		39	
20		40	

Those connections shown with a link number (LK) are only available with the respective jumper link in place.

Port A is the Output Port from the Applications Board to the Processor Board.

Port B is the Input Port to the Applications Board from the Processor Board

SIGNALS

The Ports carry the following signals from/to the various devices on the board, appropriate to the devices currently enabled i.e. MOTOR, SPEED etc.

PORT	SIGNALS			
	SW2A 'SWITCH'	SW2A 'ADC'	SW4B 'DAC'	SW4A 'SPEED'
A Bit 0	DIL Sw Bit 0	A/D Bit 0		
A Bit 1	DIL Sw Bit 1	A/D Bit 1		
A Bit 2	DIL Sw Bit 2	A/D Bit 2		
A Bit 3	DIL Sw Bit 3	A/D Bit 3	Comparator O/P	
A Bit 4	DIL Sw Bit 4	A/D Bit 4		Infra Red Diode
A Bit 5	DIL Sw Bit 5	A/D Bit 5		
A Bit 6	DIL Sw Bit 6	A/D Bit 6		
A Bit 7	DIL Sw Bit 7	A/D Bit 7		
	Always	Always	SW4C 'HEAT'	SW2B 'MOTOR'
B Bit 0	LED Bit 0	A/D Bit 0		
B Bit 1	LED Bit 1	A/D Bit 1		
B Bit 2	LED Bit 2	A/D Bit 2		
B Bit 3	LED Bit 3	A/D Bit 3		
B Bit 4	LED Bit 4	A/D Bit 4		
B BIt 5	LED Bit 5	A/D Bit 5	Heater On	
B Bit 6	LED Bit 6	A/D Bit 6		Motor Control
B Bit 7	LED Bit 7	A/D Bit 7		Motor Control

Specification

DIL 8 bit switch

TTL Logic levels to bus.

LED's

indicate a logic '1' on the bus when lit.

D/A Convertor, type DAC0800

digital input 00 hex, analogue output 0.00V

digital input 80 hex, analogue output 1.28V

digital input FF hex, analogue output 2.55V

settling time approx 100nS

Bargraph

Full scale 2.55 V = approx 0.25V per segment.

DC Motor

Speed 0 to approx 8000 RPM

Current no load approx 180mA

Heater

Temperature Range nominally 0 to 70C

Temperature sensor nominally 40mV/C (adjustable 1mV/C to 90mV/C)

Light Sensor

output 0V to approx 2.5V

Potentiometer

0 to approx 2.55V linear

Infra-Red beam

Logic ‘1’ no obstruction

Logic ‘0’ obstructed

A/D type ADC0804

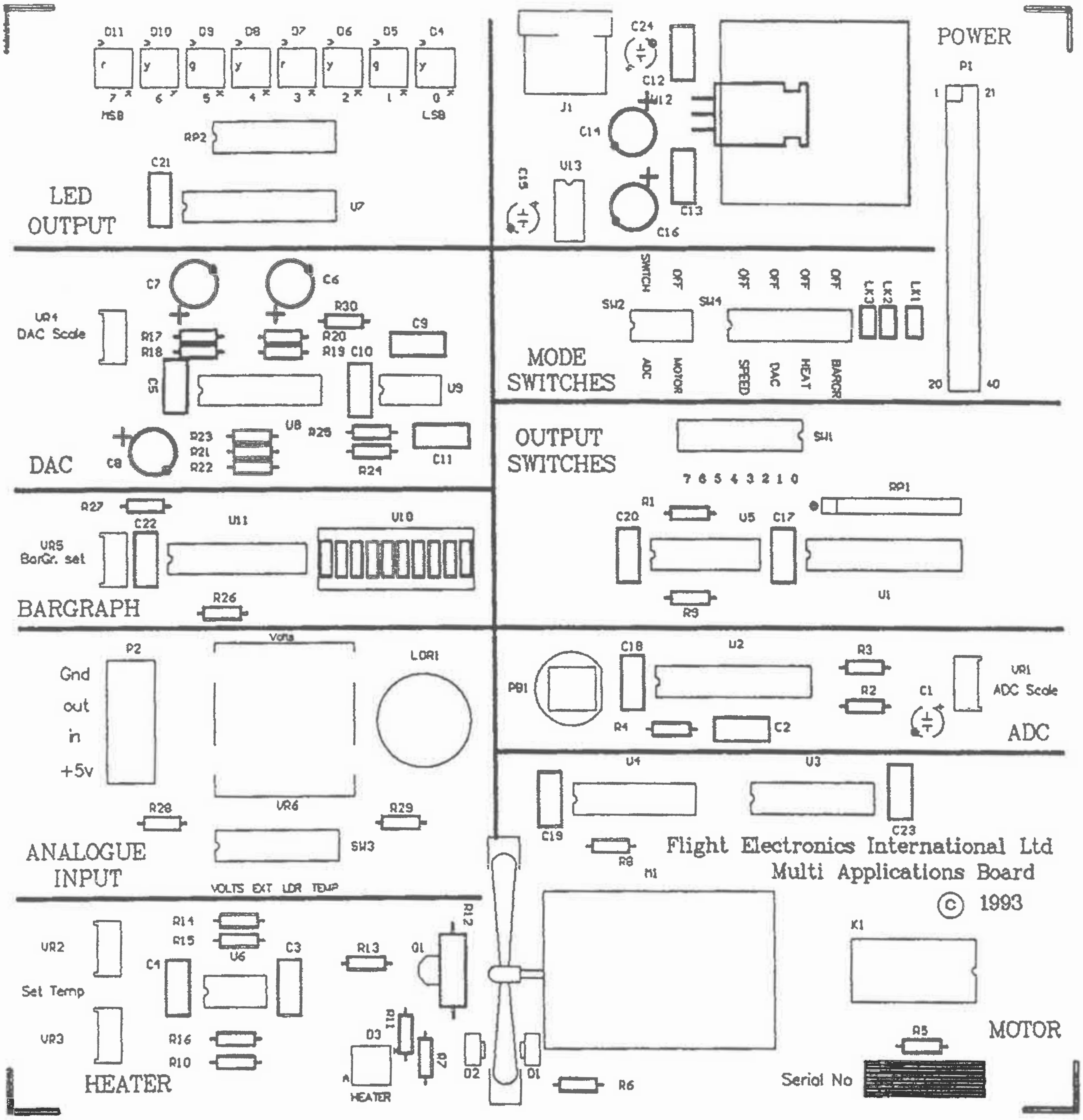
Clock rate 400KHz

Conversion time 180uS

Input 0.00V for 00 hex output

Input 2.50V for 80 hex output

Input 5.00V for FF hex output


LED OUTPUT
MSB
LSB
POWER
MODE SWITCHES
SWITCH OFF OFF OFF OFF OFF
ADC MOTOR SPEED DAC HEAT BARGR
DAC
DAC Scale
OUTPUT SWITCHES
7 6 5 4 3 2 1 0
BARGRAPH
BarGr. set
Gnd
out
in
+5v
Volts
ANALOGUE INPUT
VOLTS EXT LDR TEMP
ADC
ADC Scale
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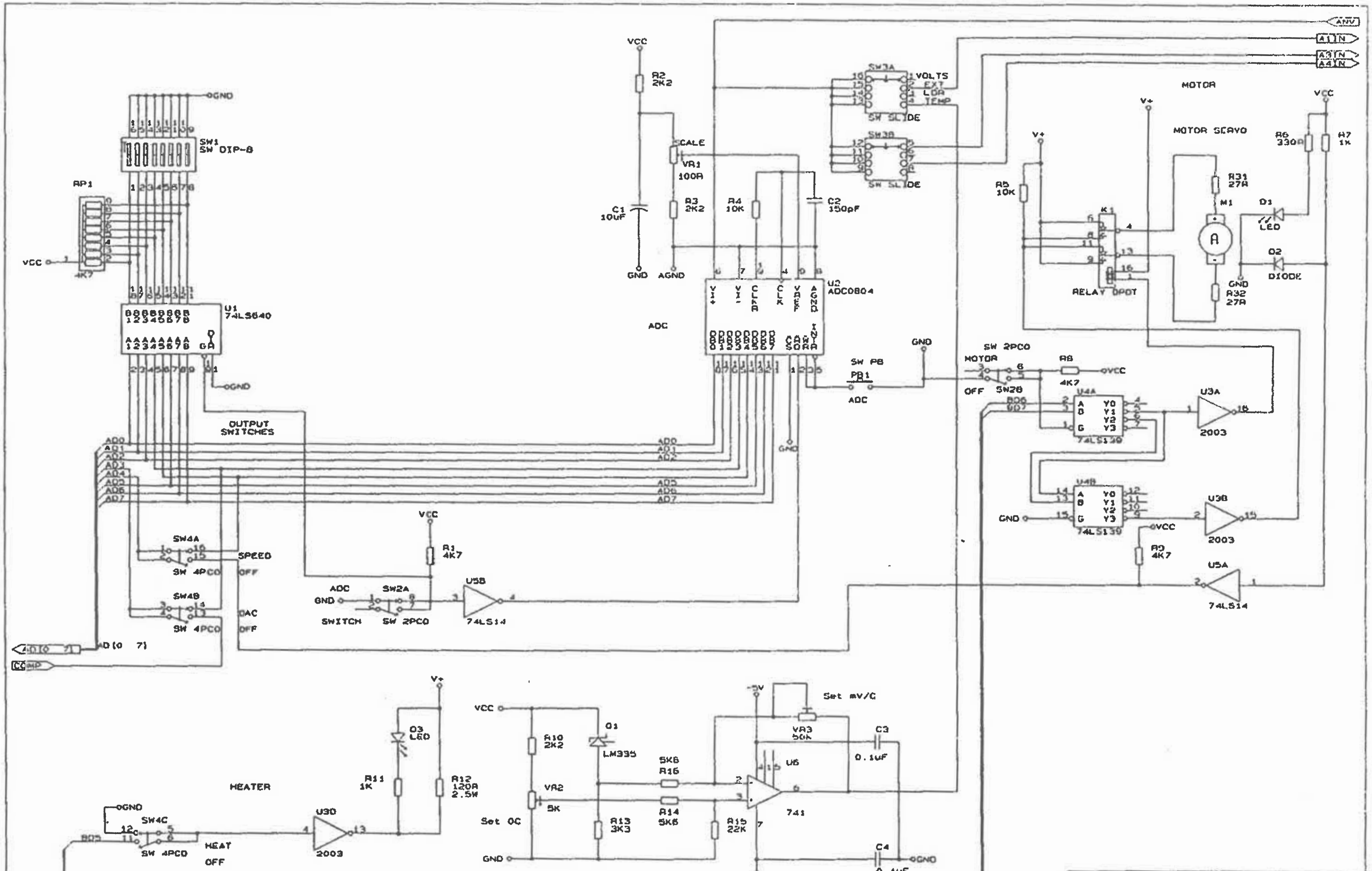
Multi Applications Board
© 1993
Set Temp
HEATER
MOTOR
Serial No [redacted]



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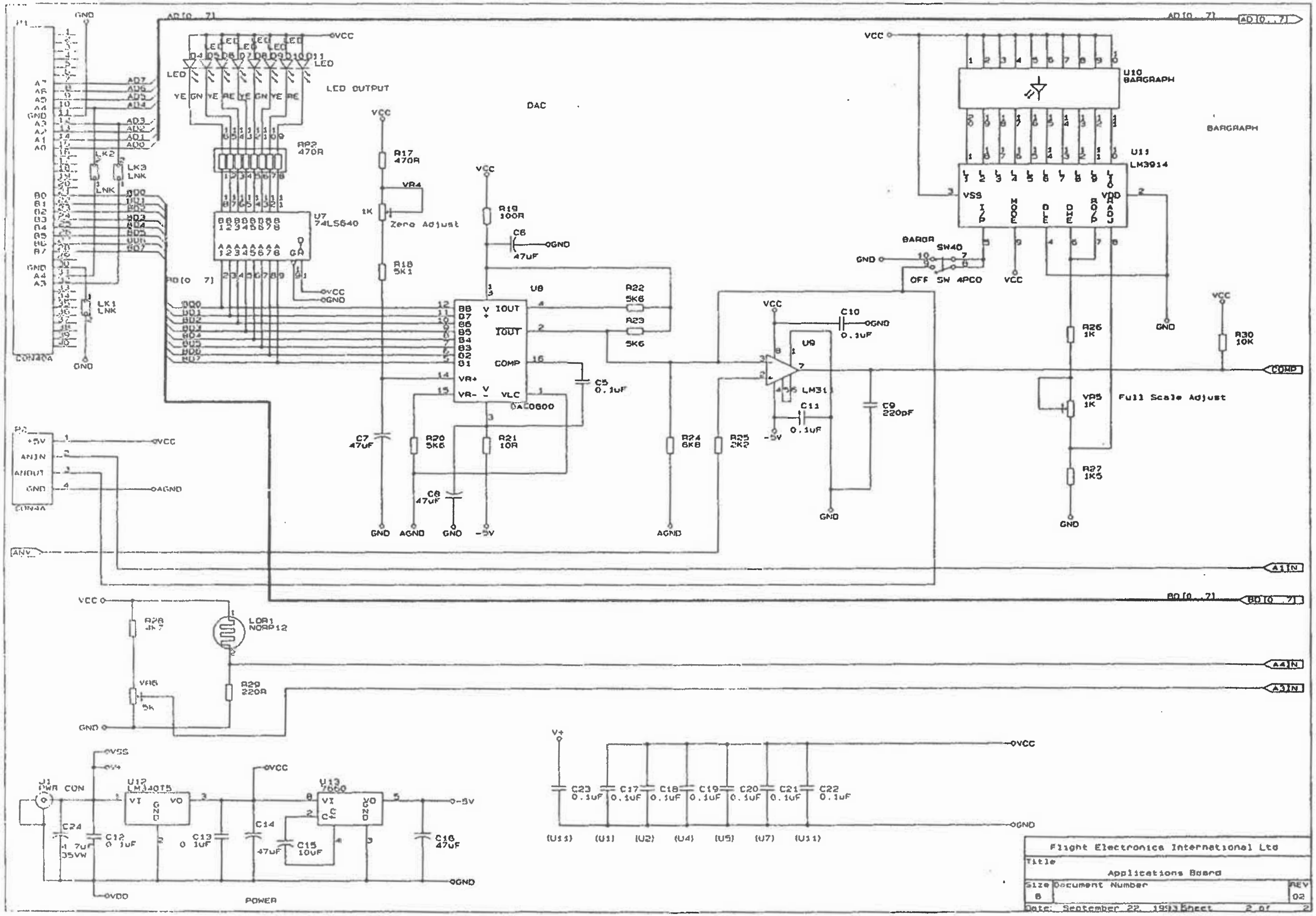
LED OUTPUT
DAC
BARGRAPH
U10 BARGRAPH
U11 LM3914
U7 74LS640
U8 DAC0800
U9 LM311
RP2 470R
R17 470R
VR4 1K Zero Adjust
R18 5K1
R19 100R
R20 5K6
R21 10R
R22 5K6
R23 5K6
R24 6K8
R25 2K2
R26 1K
VR5 1K Full Scale Adjust
R27 1K5
R30 10K
R28 4K7
VR6 5K
R29 220R
LDR1 NORP12
SW40 SW 4PCO
BARGR
OFF
C5 0.1uF
C6 47uF
C7 47uF
C8 47uF
C9 220pF
C10 0.1uF
C11 0.1uF
P1 CON40A
P2 CON4A
LK1 LNK
LK2 LNK
LK3 LNK
AD[0..7]
BD[0..7]
COMP
A1IN
A4IN
A3IN
ANV
J1 PWR CON
U12 LM340T5
U13 7660
C24 4.7uF 35VW
C12 0.1uF
C13 0.1uF
C14 47uF
C15 10uF
C16 47uF
POWER
C23 0.1uF
C17 0.1uF
C18 0.1uF
C19 0.1uF
C20 0.1uF
C21 0.1uF
C22 0.1uF
(U11) (U1) (U2) (U4) (U5) (U7) (U11)
Flight Electronics International Ltd
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Applications Board
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Document Number
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Flite Electronics International Limited are members of BESA and ETEMA

We subscribe to the BESA code of practice

We offer:-

- **Value for Money**
- **Quality**
- **Safety**
- **Service**

1. Our products are of proper quality, safety and suitable for educational use.
2. Our products comply with current British safety regulations. Except: Where toxic and hazardous substances are required to achieve the purpose of the product, then all products will be marked with the full safety instructions or symbols.
3. Our products and services are fairly and properly described in catalogues and advertising materials.
4. Where advisory or consultancy services are offered, they will be performed with reasonable skill and care
5. We value our customers and promise a high standard of customer service and any complaints will be dealt with promptly
6. We carry public liability insurance at a level appropriate to the range and value of our products and services
7. Our representatives abide by the BESA Representative's Code of Practice and will present their BESA members Representatives card on any visit