INSTRUMENTATION SOFTWARE LTD

VELA

USER MANUAL FOR PHYSICS EPROM

Printed in England by W. S. Maney & Son Ltd Leeds

ERRATA

a) Prog 65 p 13

"If unscreened leads up to 4 metres long are connected to the CH1 input with the range set to ± 250mV as described then mains pickup may be excessive, and the mains period of 0.0200s will be measured. This can usually be overcome by connecting the negative side of VELA to earth. (Do not connect to the negative of the power supply and blow up your VELA!)"

b) Progs 63 and 64 Appendix A p 38

"This method is not recommended as it results in the current being measured twice (1x with school meter, and 1x with VELA) and produces wiring of unnecessary complexity. It does work for shunts up to 1A, but gives false results if a 10A shunt is used as the shunt resistance is small enough (0.01Ω) for contact resistance to become important. Use of the plug-on unit described opposite is strongly recommended".

USER MANUAL FOR PHYSICS EPROM

INSTRUMENTATION SOFTWARE LTD
7 GLEDHOW WOOD AVENUE
ROUNDHAY
LEEDS LS8 1NY

(0532) 662505

USER NOTES

INTRODUCTION

The programs available on ISL4/ISL4* are primarily aimed at the secondary school physics teacher. They were created by David Binney at Acklam 6th Form College, Cleveland as a result of experience using the basic VELA, and have evolved into their final form over a period of two years. The original impetus to provide these facilities was a desire for easier use of VELA by secondary pupils. An essential part of this was that VELA should, wherever possible, display the quantity being measured directly in the correct units. Regretfully, the 7-segment driver chip does not allow the actual units for temperature, power, energy, etc. to be displayed. During school trials this has caused no difficulty, but teachers may wish to make their own VELA overlays to eliminate possible confusion.

Where possible a numerical 'link' has been maintained between facilities available on ISL4/ISL4* and those on ISL1/ISL1*. For example, the digital thermometer is program 70 (c.f. digital voltmeter program '00'), and the 'seconds' temperature data logger is program 73 (c.f. 'seconds' voltage data logger program 03). Similarly the 100 µs timer is program 65 and the momentum timer is program 75 (c.f. 1 ms timer program 05). Even so, the teachers overworked memory is inevitably going to have difficulty keeping track of the options available; a memory jogger card will be available shortly from ISL.

Note that program 79 will only operate if you also have EPROM ISL3. If you do not possess ISL3/ISL3* you may, but should not, feel cheated. The remaining memory space in ISL4/ISL4* was insufficient for a self-contained program! A decision was taken therefore to provide an extra program by using some spare memory space in ISL3/ISL3*.

Should you require further technical information regarding the programs on ISL4/ISL4*, additional to that provided in this manual you are invited to contact David Binney via Instrumentation Software Limited.

On the next page you will find an overview of the program numbers, program description and parameter functions. Note that an additional module is required for the 4-channel temperature measurements. (If you wish to construct this module for yourself, write to ISL for circuit details - alternatively, the built and tested module + 4 sensors may be purchased from ISL for ∿ £63.)

This temperature module is manufactured for ISL by Cleveland ITEC who are prepared to give a 12 months guarantee on the module. Unfortunately, we cannot realistically give a guarantee on the individual sensors - but they may be purchased for a few pounds from RS Components (see Appendix C).

Although the insertion of this fourth EPROM presents little difficulty for Mk II users, the process is more involved for Mk I users because a fourth EPROM socket is not available in the original VELA! Therefore, a "sideways" EPROM has to be fitted and the original ISL 1 EPROM must be replaced by a new ISL 1 in order to call up the new programs '60' through to '79'. Please remember to return the original ISL 1 for reprogramming - this will help us to maintain the current price of the Mk I "list of parts".

CONTENTS

ISL4/ISL4* EPROM's

USER NOTES

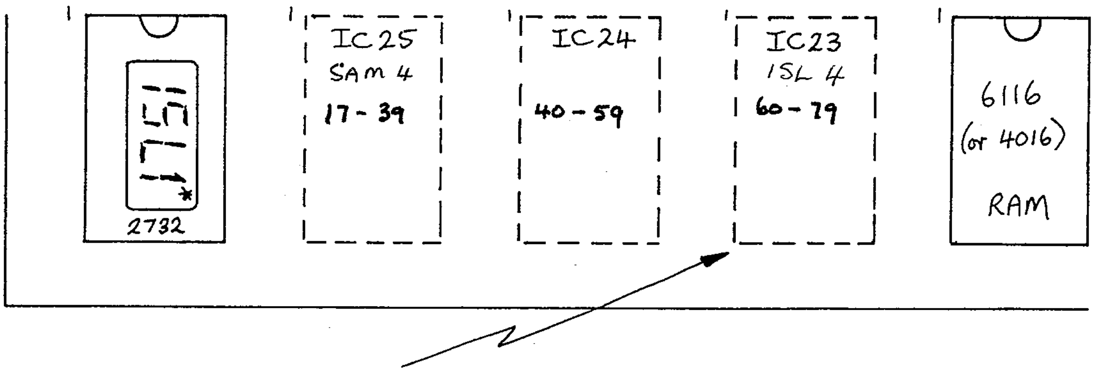
INSERTION OF ISL4* IN VELA (MK II) - *AFTER REMOVAL OF POWER*

PROCEDURE

(1) UNSCREW THE FOUR RUBBER FEET SUPPORTING VELA.

(2) LIFT OFF THE BASE PLATE TO GAIN ACCESS TO THE PRINTED CIRCUIT BOARD.

(3) LOCATE THE SPARE EPROM SOCKET (IC 23) INTO WHICH THE NEW EPROM IS TO BE INSERTED. THE POSITION OF THIS SOCKET IS INDICATED BELOW:

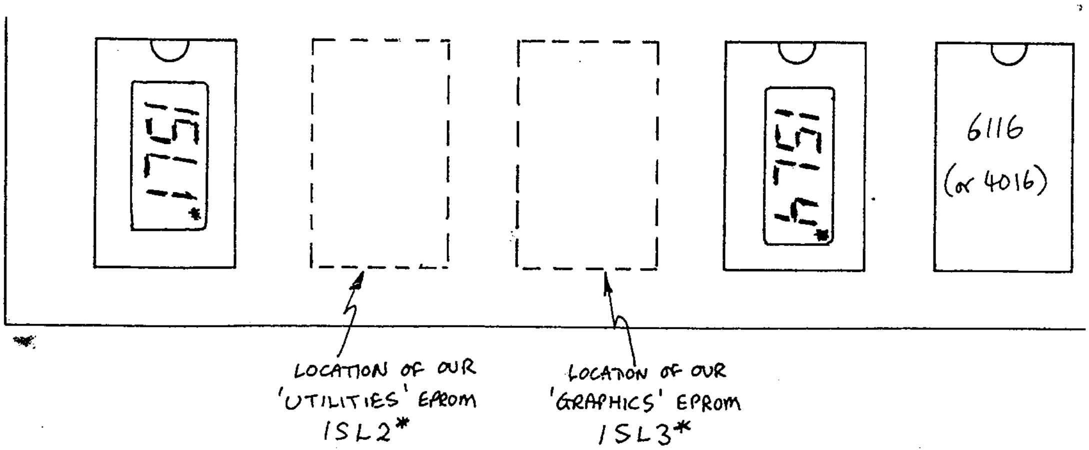


(4) PLACE THE EPROM ISL4* ONTO THE SOCKET, IC 23 AND CHECK THAT THE INDENTATION IN THE PLASTIC BODY OF THE CHIP IS POINTING THE SAME WAY AS FOR ISL1*. IF THE LEGS OF THE EPROM ARE TOO WIDE, REST THE EPROM ON ITS SIDE ON A FLAT SURFACE AND CAREFULLY BEND THE LEGS SLIGHTLY INWARDS.

(5) PRESS DOWN FIRMLY ON THE SECOND EPROM SO THAT THE LEGS ARE HELD BY THE SOCKET. I FIND IT USEFUL TO PRESS DOWN WITH MY THUMBS WHILST PUTTING A FINGER UNDERNEATH THE PCB - IN ORDER TO BOTH SUPPORT THE PCB A LITTLE AND PROVIDE REACTION TO THE THUMBS!)

(6) DO A QUICK VISUAL CHECK THAT THE EPROM IS IN THE CORRECT WAY ROUND *AND* THAT ALL OF THE EPROM LEGS ARE HELD IN THE SOCKET. (IF YOU NEED TO REMOVE EPROM's, USE A SMALL SCREWDRIVER TO GENTLY PRISE THE EPROM AWAY FROM THE SOCKET.)

(7) REFIT THE BASE PLATE AND THE FEET.



ISL4/ISL4* EPROM's

USER NOTES

Program Number	Description	Parameter
60	Digital Voltmeter (DVM) DEC. PT. ADJUST	-
61	DVM DEC. PT., OFFSET ADJUST	DETERMINES OFFSET
62	DVM OFFSET ADJUST PLUS SCALING	TWO PARAMETERS:- 1st DETERMINES OFFSET 2nd DETERMINES SCALING
63	ENERGY METER	-
64	POWER METER	-
65	100 μs TIMER	SELECTS PULSE SHAPE AS FOR PROGRAM '05'
66	SPEED MEASUREMENT	TWO PARAMETERS:- 1st SELECTS PULSE SHAPE 2nd IS THE DISTANCE BEING TIMED
67	TRIPLE 100 μs TIMER	SELECTS PULSE SHAPE
68	DUAL SPEED PLUS SINGLE TIMER	TWO PARAMETERS:- 1st SELECTS PULSE SHAPE 2nd IS THE DISTANCE BEING TIMED
69	ACCELERATION	
70†	DIGITAL THERMOMETER	-
71	CAPACITANCE METER	'0' SELECTS RANGE 50 pF TO 0.2 μF. '1' SELECTS RANGE 0.1 μF TO 1000 μF.
72	PHASE METER	-
73†	TEMPERATURE DATALOGGER	DETERMINES 'n' SECS. BETWEEN SAMPLES
74	RATEMETER	DETERMINES 'n' SECS. (255 MAX) OVER WHICH AVERAGE IS TAKEN.
75	MOMENTUM TIMER	SELECTS PULSE SHAPE
76	MOMENTUM TIME AND SPEED	TWO PARAMETERS:- 1st SELECTS PULSE SHAPE 2nd IS THE DISTANCE BEING TIMED.
77	MOMENTUM TIME AND SPEED	
78	VARIABLE SQUARE WAVE GENERATOR	'0' SELECTS 100 kHz. '1' TO '999' SELECTS 0.1 TO 99.9 Hz.
79	VARIABLE SINEWAVE OSCILLATOR	'0' SELECTS 10 kHz. '1' TO '999' SELECTS 0.1 TO 99.9 Hz.

† AN ADD-ON MODULE IS ALSO REQUIRED - SEE APPENDIX (C)

Finally - good luck with these programs. David Binney and I hope that the routines make VELA even more flexible to use in the science laboratories and that they will encourage other teachers to develop their own software. It takes a special talent and level of commitment to write 4 kbytes of machine code programs but if you have only one routine, ISL will be interested to hear about it!

A.R. Clarke
May 1985

USER NOTES

INSERTION OF ISL4 IN VELA (MK I) - AFTER REMOVAL OF POWER

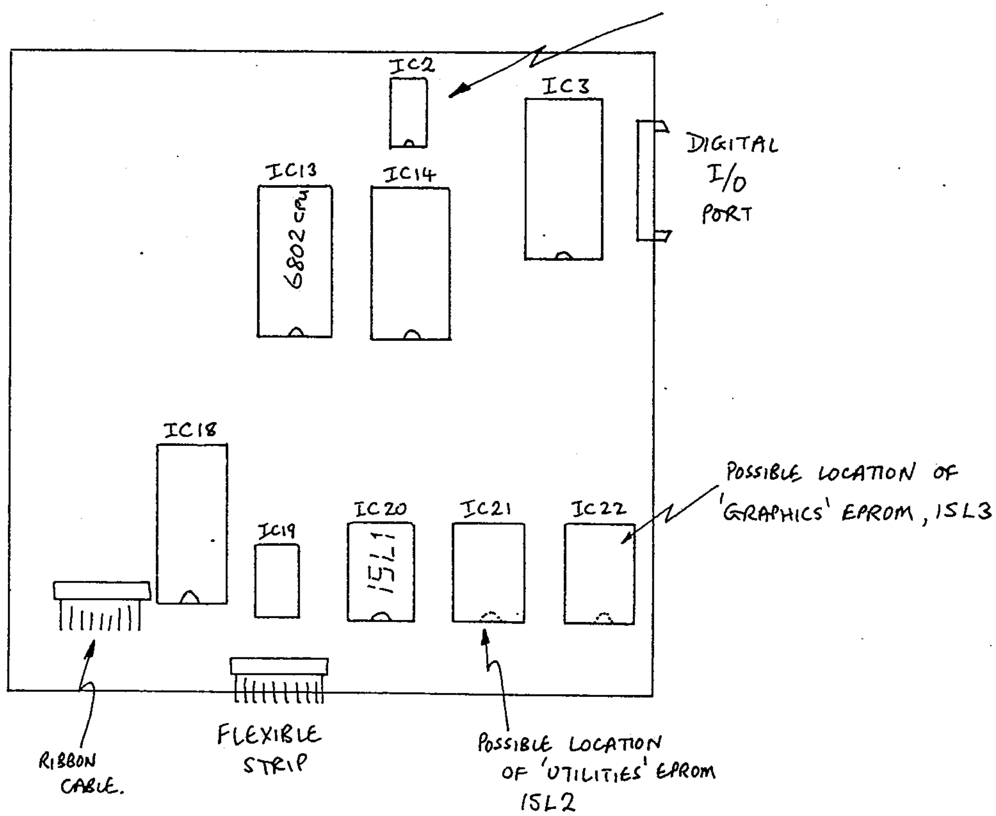
PROCEDURE

(1) UNSCREW THE SCREWS AROUND THE BASE.

(2) SEPARATE THE BASE FROM THE BOX. THIS MUST BE DONE CAREFULLY BECAUSE THE DIGITAL INPUT/OUTPUT PORT SOCKET PROTRUDES THROUGH THE SIDE OF THE BOX. (MY TECHNIQUE IS TO MOVE THE BOX SIDEWAYS A LITTLE WAY AND THEN THE BASE SHOULD SEPARATE FROM THE BOX.)

(3) YOU MAY FIND THAT YOU CANNOT OPEN OUT YOUR VELA SUFFICIENTLY TO LAY BOTH BASE AND UP-TURNED BOX ONTO A FLAT WORKING SURFACE AS THE POWER LEAD IS TOO SHORT! UNPLUG THE POWER LEAD. THERE IS NO NEED TO NOTE THE RELATIVE POSITIONING OF THE RED AND BLACK LEADS.

(4) LOCATE THE SPARE SOCKET IC22 ON THE DIGITAL PCB INTO WHICH YOU HAVE TO INSERT THE DUAL 24 PIN CONVERSION SOCKET. LOCATE ALSO THE ADDRESS DECODER 74LS138 IC2.



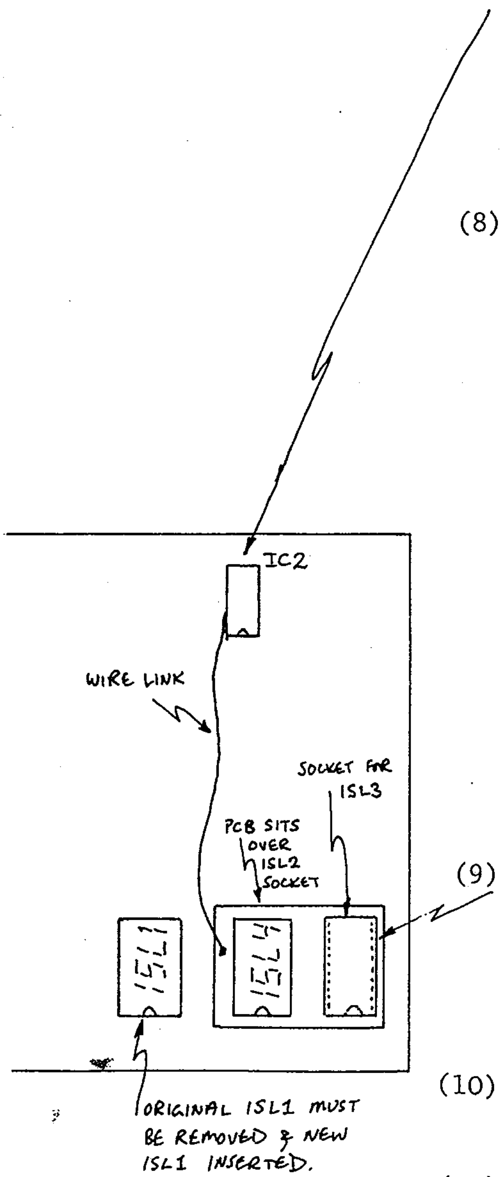
INSERTION OF ISL4 IN VELA (MK I) (continued)

(5) REMOVE THE ADDRESS DECODER 74LS138 FROM IC2 USING AN EXTRACTION TOOL OR BY GENTLY LEVERING WITH A SMALL SCREWDRIVER.

(6) SELECT THE 16 PIN SOCKET CONVERTER. ENSURE THAT THE LEAD LEAVES THE PCB FROM THE LEFT. LOCATE ALL LEGS IN THE HOLES OF THE ORIGINAL SOCKET. PRESS DOWN FIRMLY BUT CAREFULLY TO INSERT THE CONVERSION SOCKET INTO THE OLD SOCKET.

(7) ENSURE THAT THE 74LS138 HAS THE CUT OUT NOTCH FACING AWAY FROM THE EDGE OF THE BOARD. LOCATE ALL LEGS IN THE HOLES OF THE CONVERSION SOCKET. PRESS DOWN AND INSERT.

(8) SELECT THE DUAL 24 PIN CONVERSION SOCKET. ENSURE THAT THE EPROM ISL4 IS POSITIONED NEXT TO THE CONNECTING LEAD AND THAT THE CUTOUT NOTCH IS AS IN THE DRAWING. CHECK THAT ALL LEGS ARE LOCATED IN THE HOLES OF THE SOCKET, THEN PRESS DOWN AND INSERT. (IF THE LEGS OF THE EPROM ARE TOO WIDE, REST THE EPROM ON ITS SIDE ON A FLAT SURFACE AND CAREFULLY BEND THE LEGS SLIGHTLY INWARDS. IT CAN BE HELPFUL WHEN INSERTING THE EPROM TO PUT A FINGER UNDER THE PCB AND TO SQUEEZE THE EPROM BETWEEN THUMB AND FINGER.)



(9) POSITION THE LEGS OF THE CONVERSION SOCKET IN THE HOLES OF SOCKET IC22. THE EPROM ISL4 SHOULD BE POINTING THE SAME WAY AS ISL1. PRESS DOWN FIRMLY AND INSERT.

(10) IF NOT ALREADY DONE, CAREFULLY REMOVE ISL1 AND RETURN TO ISL FOR REPROGRAMMING.

(11) REASSEMBLE YOUR VELA - REMEMBERING TO PLUG IN THE POWER LEAD.

USER NOTES

PROGRAM '60' A DIGITAL VOLTMETER WITH MOVABLE DECIMAL POINT

PARAMETER VALUES NONE USED.

KEY IN [6] [0] [ENTER]

THE VOLTAGE FOR A CERTAIN CHANNEL IS DISPLAYED (AS FOR DVM PROGRAM '00').

DECIMAL POINT ADJUST

RESELECT CAUSES THE DECIMAL POINT TO FLASH

[BKWD] , [FWD] MOVES THE DECIMAL POINT TO LEFT OR RIGHT RESPECTIVELY.

[ENTER] RETAINS THE PRESENT POSITION OF THE DECIMAL POINT.

EXAMPLE 1

MK I VELA USERS CAN DISPLAY THE ACTUAL VOLTAGE BEING MEASURED WHEN THE RANGE SWITCH IS IN THE ± 250 mV POSITION BY THE KEYPRESS SEQUENCE:

[6] , [0] , [ENTER] , [RESELECT] , [BKWD] , [ENTER]

EXAMPLE 2

IF YOU PUT A WIREWOUND RESISTOR, SAY 10 Ohm ACROSS THE CHANNEL 2 INPUT TERMINALS IN ORDER TO MEASURE THE CURRENT, i THROUGH A CIRCUIT, SELECT THE ± 250 mV RANGE FOR CHANNEL 2 AND DISPLAY THE CURRENT IN AMPS BY THE KEYPRESS SEQUENCE:

MK I [6] [0] [ENTER] [CH 2] [RESELECT] [BKWD] [BKWD] [ENTER]

MK II [6] [0] [ENTER] [CH 2] [RESELECT] [BKWD] [ENTER]

CURRENT VALUES UP TO ± 0.0250 AMPS WILL BE DISPLAYED.

ISL4/ISL4* EPROM's

USER NOTES

PROGRAM '61' — DIGITAL VOLTMETER WITH MOVABLE DECIMAL POINT AND OFFSET.

PARAMETER VALUES

THE PARAMETER VALUE DETERMINES THE SIZE OF THE OFF-SET IN THE RANGE 0 TO 999.

THE OFFSET IS ADDED TO THE VOLTAGE MEASURED AT ALL FOUR INPUTS. WHEN CALCULATING THE OFFSET IGNORE THE DECIMAL POINT.

KEY IN

[6] [1] PROGRAM NUMBER AND

[N] [N] [N] [ENTER] OFFSET

THE DISPLAY SHOWS THE SELECTED INPUT, UPDATED EVERY SECOND.

DECIMAL POINT ADJUST

[RESELECT] CAUSES THE DECIMAL POINT TO FLASH

[BKWD] , [FWD] MOVES THE DECIMAL POINT LEFT OR RIGHT

[ENTER] RETAINS THE PRESENT POSITION OF THE DECIMAL POINT.

EXAMPLE

CONSIDER A TEMPERATURE UNIT WITH AN OUTPUT OF -0.250 V TO +0.250 V CORRESPONDING TO THE RANGE 0 TO 50°C. THE KEY PRESS SEQUENCE

[6] [1] PROGRAM NUMBER

[2] [5] [0] [ENTER] OFFSET

ADJUSTS THE RANGE FROM 0.000 TO 0.500.

[RESELECT] , [FWD] , [FWD] , [ENTER] MOVES THE DECIMAL POINT SO THAT THE RANGE IS NOW 0 TO 50.0.

USEFUL SUGGESTION

USE CH2 INPUT SET TO ± 250mV.(CHANNEL 1 WOULD LIGHT THE 'VOLTS' INDICATOR BUT THE OTHER CHANNELS DO NOT. THEREFORE USE OF CH2 CAUSES LESS CONFUSION IN THE UNITS.)

USER NOTES

PROGRAM '62' — DIGITAL VOLTMETER WITH OFFSET AND SCALING

PARAMETER VALUES

TWO PARAMETERS ARE USED.

PARAMETER Nº 1

A NUMBER IN THE RANGE 0 TO 999 SELECTS THE OFFSET VALUE WHICH IS ADDED TO THE VOLTAGE MEASURED AT ALL OF THE FOUR INPUTS. WHEN CALCULATING THE OFFSET, IGNORE THE DECIMAL POINT.

PARAMETER Nº 2

A NUMBER IN THE RANGE 0 TO 999 SELECTS A SCALING FACTOR IN THE RANGE 0.1 TO 99.9. THE INPUT PLUS OFFSET IS SCALED BY THIS VALUE.

KEY IN

[6] [2]	PROGRAM NUMBER
[N] [N] [N] [ENTER]	OFFSET VALUE
[N] [N] [N] [ENTER]	SCALING FACTOR

THE DISPLAY SHOWS THE SELECTED INPUT, UPDATED EVERY SECOND.

EXAMPLE 1
(MK II VELA's ONLY)

SCALING MK II REAR INPUTS (± 1.25 V)

IF THE STANDARD DVM PROGRAM ('00') IS SELECTED, VOLTAGES INPUTTED AT THE CH1, CH2 REAR SOCKETS PRODUCE A DISPLAY WHICH IS TWICE THE CORRECT VALUE. THEREFORE THE DISPLAYED VALUES MUST BE MENTALLY SCALED BY 0.5. IF YOU WANT TO DISPLAY THE CORRECT VOLTAGES ON THESE TWO REAR INPUTS, THE KEYPRESS SEQUENCE WOULD BE:

[6] [2]	
[0] [ENTER]	ADD ON ZERO
[5] [ENTER]	SCALE BY 0.5

(NOTE THAT CHANNEL 1 WILL LIGHT THE 'VOLTS' INDICATOR BUT CHANNEL 2 WILL NOT LIGHT UP THE 'VOLTS' INDICATOR.)

USER NOTES

CASE STUDY : pH METERING

A HARRIS pH UNIT GIVES AN OUTPUT OF -0.70 V TO +0.70 V CORRESPONDING TO A pH RANGE OF 0 TO 14. CONSEQUENTLY YOU NEED TO ADD 0.70 V, AND MULTIPLY BY 10. THE OFFSET PARAMETER WOULD THEN BE 70 (0.70 IGNORING DECIMAL POINT) AND THE SCALING PARAMETER 100 (i.e. 10.0).

THE KEYPRESS SEQUENCE WOULD BE

[6] [2]

[7] [0] [ENTER] ADD ON 0.70

[1] [0] [0] [ENTER] SCALE BY 10.0

USEFUL SUGGESTION

USE CH2 INPUT SET TO ± 2.5V. (CHANNEL 1 LIGHTS THE 'VOLTS' INDICATOR WHILST THE OTHERS DON'T, AND SO THE USE OF CH2 CAUSES LESS CONFUSION OF UNITS.)

VELA WILL THEN DISPLAY pH IN THE CORRECT UNITS.

CASE STUDY : MAGNETIC FIELD SENSING

THE HARRIS MAGNETIC SENSOR C 67830/5 HAS A PRECALIBRATED RANGE FROM '0' TO '100' MILLITESLA (GIVING AN OUTPUT VOLTAGE FROM -0.250 volts TO + 0.250 volts RESPECTIVELY). IN OTHER WORDS, THE OUTPUT IS MATCHED TO THE MOST SENSITIVE VELA RANGE.

FOR MK II VELA's, THE KEYPRESS SEQUENCE

[6] [2] [2] [5] [0] [ENTER]

[2] [ENTER]

WILL DISPLAY THE MAGNETIC FIELD STRENGTH IN TESLA PROVIDED THE ± 250 mV RANGE IS SELECTED.

USER NOTES

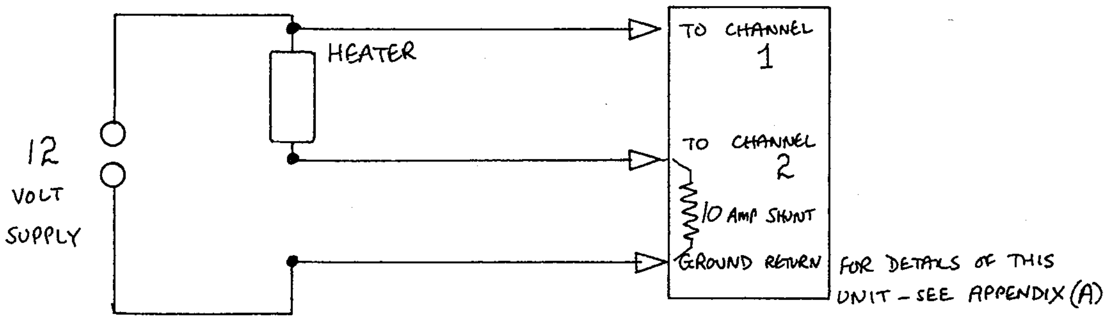
PROGRAM '63' — **AN ENERGY METER**

KEY IN [6] [3] [ENTER] (NO PARAMETER REQUIRED)

AND THE DISPLAY INDICATES THE VOLTAGE ON CHANNEL 1 INPUT.

THE PROGRAM CALCULATES THE ELECTRICAL ENERGY TRANSFORMED BY REPEATEDLY MONITORING VOLTAGE AND CURRENT AND SUMMING THE PRODUCT. IT ASSUMES THAT CHANNEL 1 WILL MONITOR VOLTAGE AND CHANNEL 2 THE CURRENT.

EXAMPLE TO MONITOR THE ENERGY TRANSFORMED BY A 12V, 3A IMMERSION HEATER (OR LIGHT BULB).



SET CH 1 INPUT TO ± 25V, CH 2 INPUT TO ± 250mV. USE A 10A SHUNT.

MK I ONLY THE DECIMAL POINT IS INITIALLY SET FOR INPUT VOLTAGES ON CHANNEL 1 OF ± 25 V, AND CURRENTS ON CHANNEL 2 OF ± 25 A. THESE DO NOT NEED ADJUSTMENTS SO WHEN READY TO MONITOR ENERGY PRESS [START].

MK II ONLY THE DECIMAL POINT IS INITIALLY SET BY THE RANGE SWITCH POSITION, AND SO CHANNEL 2 i.e. THE CURRENT RANGE MUST BE ADJUSTED. PRESS [CH 2] TO DISPLAY CHANNEL 2 INPUT e.g. .030.

[RESELECT], [FWD], [FWD], [ENTER] WILL MOVE THE DECIMAL POINT TWO PLACES RIGHT TO GIVE CORRECT DISPLAY, i.e. 3.0. PRESS [START] TO MONITOR ENERGY.

USER NOTES

PROGRAM '63' — AN ENERGY METER (continued)

ADDITIONAL NOTES

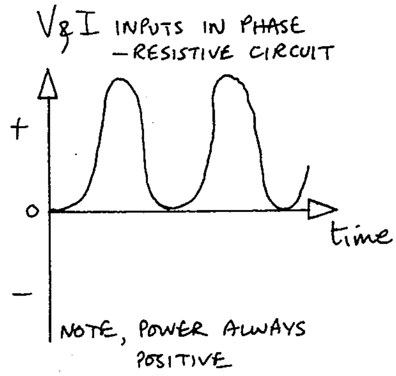
START — A [START] KEYPRESS OR A TRIGGER PULSE ON THE PULSE INPUT CAUSES VELA TO START LOGGING ENERGY. THE DISPLAY UPDATES PROVIDING A RUNNING TOTAL.

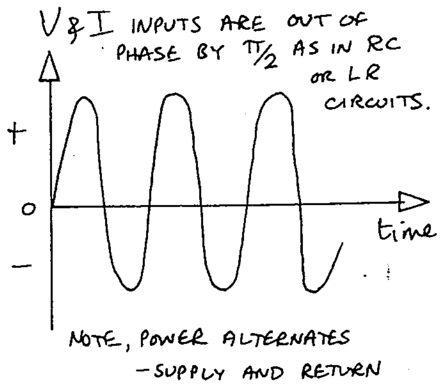
STOP — A [STOP] KEYPRESS HALTS THE ENERGY LOGGING AUTOMATICALLY IN THE UNLIKELY EVENT OF THE UPPER LIMIT OF 8.3 MJ BEING REACHED.

A.C./D.C. — THIS PROGRAM WORKS EQUALLY WELL WITH D.C. AND A.C. SUPPLIES UP TO 100 Hz APPROX. NOTE, HOWEVER, THAT IF A.C. IS USED THEN THE SHUNTS USED MUST STILL BE D.C. SHUNTS i.e. SIMPLE RESISTORS.

SLOW A.C. — NOTE ALSO THAT IF 'V' AND 'I' ARE OUT OF PHASE AS IN AN R.C. CIRCUIT, AND LOW FREQUENCY A.C. IS USED THEN THE 'SUPPLY' AND 'RETURN' OF ENERGY IS APPARENT.

CRO — CONNECTING AN OSCILLOSCOPE TO THE ANALOGUE OUTPUT PROVIDES A DISPLAY OF POWER AGAINST TIME, e.g.





DECIMAL POINT MOVEMENT — [RESELECT] CAUSES THE DECIMAL POINT TO FLASH.

[BKWD] , [FWD] CAUSES THE DECIMAL POINT TO MOVE TO LEFT OR RIGHT.

WHEN DECIMAL POINT IS IN THE CORRECT POSITION, PRESS [ENTER] .

ISL4/ISL4* EPROM's

USER NOTES

PROGRAM '64' — A POWER METER

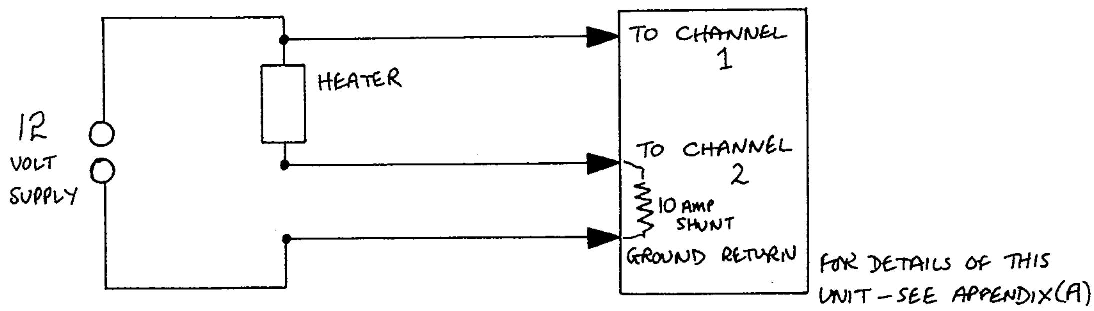
PARAMETER VALUES — NONE USED

KEY IN — [6] [4] [ENTER]

THE DISPLAY INITIALLY INDICATES THE VOLTAGE ON CHANNEL 1 INPUT.

THE POWER IS CALCULATED BY MONITORING VOLTAGE AND CURRENT AND AVERAGING THE PRODUCT. IT IS ASSUMED THAT CHANNEL 1 WILL MONITOR VOLTAGE AND CHANNEL 2 THE CURRENT AS FOLLOWS:

EXAMPLE — TO MONITOR THE POWER OF A 12V, 3A IMMERSION HEATER (OR LIGHT BULB).



SET CH 1 INPUT TO ± 25V, CH 2 INPUT TO ± 250mV. USE A 10A SHUNT.

MK 1 ONLY — THE DECIMAL POINT IS INITIALLY SET FOR INPUT VOLTAGES ON CHANNEL 1 OF ± 25V, AND CURRENTS ON CHANNEL 2 OF ± 25A. THESE DO NOT NEED ADJUSTMENTS SO WHEN READY TO MONITOR POWER PRESS [START] .

MK II ONLY — THE DECIMAL POINT IS INITIALLY SET BY THE RANGE SWITCH POSITION, AND SO CHANNEL 2 i.e. THE CURRENT RANGE MUST BE ADJUSTED. PRESS [CH 2] TO DISPLAY CHANNEL 2 INPUT e.g. .030.

[RESELECT] , [FWD] , [FWD] , [ENTER] WILL MOVE THE DECIMAL POINT TWO PLACES RIGHT TO GIVE CORRECT DISPLAY, i.e. 3.0. PRESS [START] TO MONITOR POWER.

USER NOTES

PROGRAM '64'

ADDITIONAL NOTES

POWER METER (continued)

START

A [START] KEYPRESS OR A TRIGGER PULSE ON THE PULSE INPUT CAUSES VELA TO START DISPLAYING POWER.

A.C./D.C.

THIS PROGRAM WORKS EQUALLY WELL WITH D.C. AND A.C. SUPPLIES UP TO 100 Hz APPROX. NOTE, HOWEVER, THAT IF A.C. SUPPLY IS USED THEN

(a) D.C. SHUNTS i.e. SIMPLE RESISTORS SHOULD STILL BE USED.

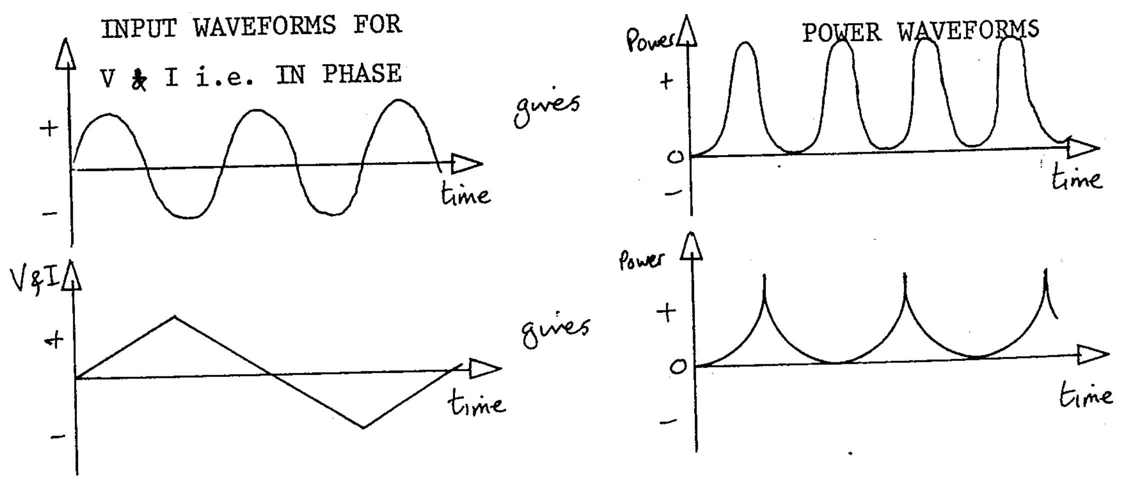
(b) THE INITIAL MONITORING ON CHANNEL 1 AND CHANNEL 2 WILL INDICATE AN AVERAGE VOLTAGE OR CURRENT OF ZERO.

SLOW A.C.

NOTE ALSO THAT IF 'V' AND 'I' ARE OUT OF PHASE AS IN AN A.C. CIRCUIT, AND LOW FREQUENCY A.C. IS USED THEN THE SUPPLY AND RETURN OF POWER MAY BE OBSERVED.

CRO

CONNECTING AN OSCILLOSCOPE TO THE ANALOGUE OUTPUT PROVIDES A DISPLAY OF POWER AGAINST TIME, e.g.



DECIMAL POINT MOVEMENT

[RESELECT] CAUSES THE DECIMAL POINT TO FLASH.

[BKWD] , [FWD] CAUSES THE DECIMAL POINT TO MOVE TO LEFT OR RIGHT.

WHEN DECIMAL POINT IS IN THE CORRECT POSITION, PRESS [ENTER] .

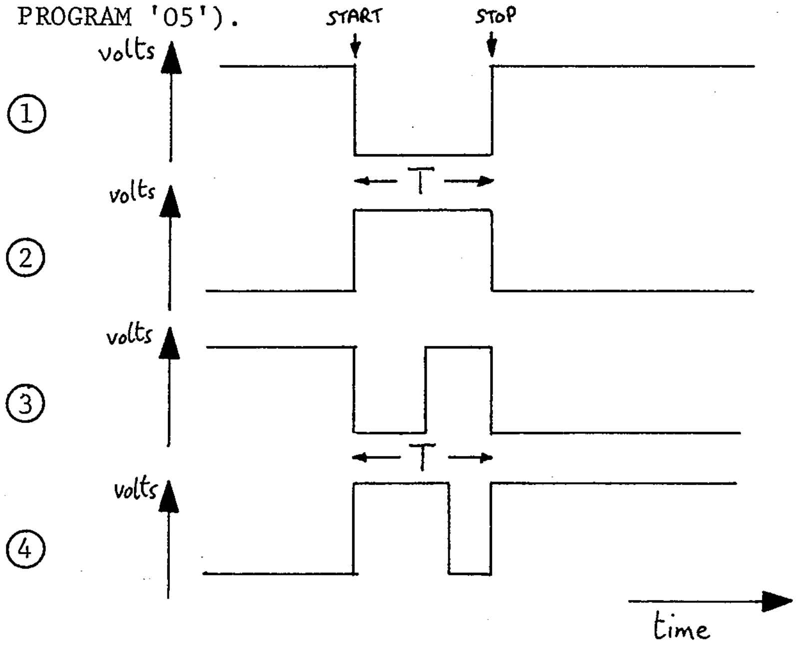
USER NOTES

PROGRAM '65'

100 µs RESOLUTION TIMER

PARAMETER VALUES

THIS DEFINES THE TRIGGERING EDGES (AS IN PROGRAM '05').



KEY IN

6 5 N ENTER

THE DISPLAY CLEARS BUT FOR THE PROGRAM NUMBER ON THE LEFT.

START CLEARS THE DISPLAY IN PREPARATION FOR TIMING. THE TIME IS DISPLAYED AUTOMATICALLY AFTER THE PULSES ARE APPLIED DIRECTLY TO THE PULSE INPUT (OR VIA CHANNEL 1 AMPLIFIER WITH THE SWITCH SET TO 'INTERNAL'). TO CARRY OUT FURTHER TIMINGS PRESS

START .

NOTE (i) THAT THE MAXIMUM TIME INTERVAL IS ∿ 6.5 SECONDS.

(ii) THAT IF A SERIES OF PULSES ARRIVE ONLY THE FIRST TIME IS RECORDED AND DISPLAYED.

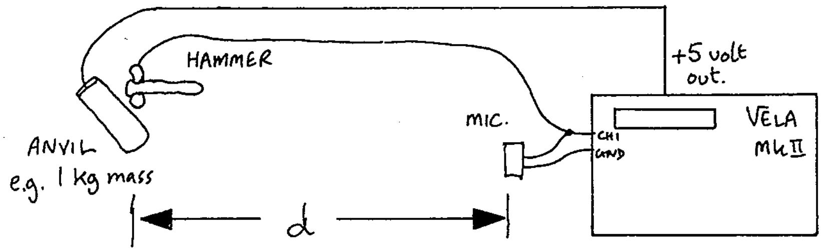
ISL4/ISL4* EPROM's

USER NOTES

CASE STUDY : SPEED OF SOUND MEASUREMENTS

THE IMPROVED RESOLUTION MAKES THIS PROGRAM IDEAL FOR THE MEASUREMENT OF THE SPEED OF SOUND. USE KEYPRESS SEQUENCE

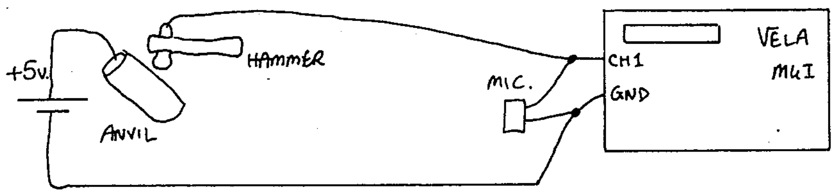
6 5 4 ENTER



SET EXTERNAL/INTERNAL SWITCH TO INTERNAL, AND CH1 TO ±250 mV.

If 'd' is ~4 metres (& microphone sensitive) then velocity of sound in air may be measured with ~1% precision – good enough to look for variations of sound speed with temperature!

TAP THE HAMMER SHARPLY ON THE ANVIL TO START TIMING. THE MICROPHONE STOPS THE TIMING. MEASUREMENT OF 'd' WOULD ALLOW THE SPEED OF SOUND TO BE CALCULATED.



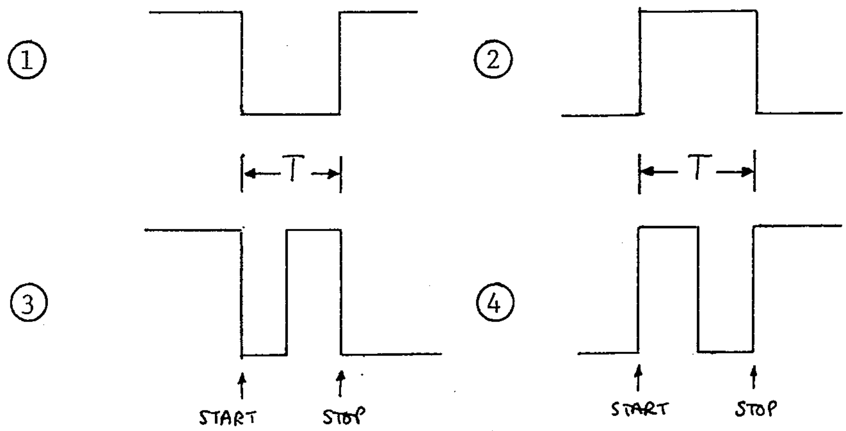
Substance	Temp.	Velocity of Sound
Air	0°C	331.3 m/sec
Water (distilled)	20°C	1482.3 m/sec
Water (sea-)	20°C	1521.9 m/sec
Milk (evap.)	20°C	1558 m/sec
Nitrous Oxide	25°C	268 m/sec

USER NOTES

PROGRAM '66' A VELOCITY METER

PARAMETER VALUES TWO PARAMETERS ARE USED.

PARAMETER Nº 1 THIS DEFINES THE TRIGGERING EDGES (AS IN PROGRAM '05')



PARAMETER Nº 2 THIS IS THE LENGTH OVER WHICH TIMING TAKES PLACE, AND ALLOWS VELA TO CALCULATE THE SPEED DIRECTLY. LENGTHS IN MILLIMETRES RESULT IN SPEEDS IN mm/s, AND LENGTHS IN METRES RESULT IN SPEEDS IN m/s.

KEY IN

[6] [6]	PROGRAM NUMBER
[N] [ENTER]	TRIGGER SELECTION
[N] [N] [N] [ENTER]	LENGTH BEING TIMED

THE DISPLAY CLEARS APART FROM THE PROGRAM NUMBER,

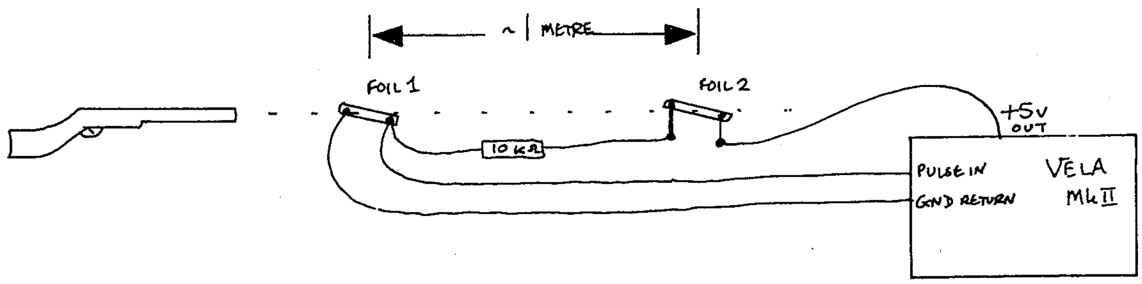
[START] CLEARS THE DISPLAY IN PREPARATION FOR TIMING. PULSES SHOULD BE INPUT DIRECTLY TO THE PULSE INPUT, OR VIA THE CHANNEL 1 AMPLIFIER WITH THE EXTERNAL/INTERNAL SWITCH SET TO INTERNAL. WHEN TIMING IS COMPLETE THE SPEED IS DISPLAYED AUTOMATICALLY. FOR FURTHER TIMINGS PRESS [START]

ISL4/ISL4* EPROM's

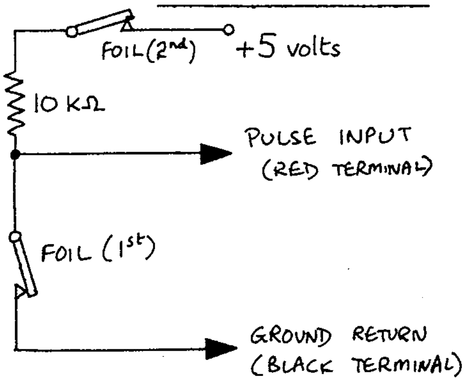
USER NOTES

CASE STUDY : DETERMINATION OF THE SPEED OF A BULLET

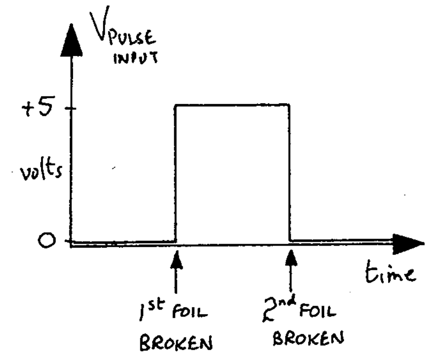
THE RESOLUTION OF THE TIMER - 100 µsecs - MAKES IT IDEAL FOR HIGH SPEED MEASUREMENT SUCH AS THE SPEED OF AN AIR RIFLE PELLET. (typically ~ 120 m/sec)



SCHEMATIC DIAGRAM



TIMING DIAGRAM



USE KEYPRESS SEQUENCE

[6] [6] [2] [ENTER]

[1] [ENTER]

MK I ONLY — AS VELA MK I IS NOT FITTED WITH A +5V OUTPUT A SEPARATE POWER SUPPLY MUST BE USED.

SAFETY — MAKE SURE A SUITABLE RECEPTACLE IS USED TO CATCH THE PELLETS. A THICK METAL WASTE BIN WITH A WOODEN BASE MIGHT BE USED WITH A SHEET OF CARD OR POLYSTYRENE TO PREVENT RICOCHETs.

ISL4/ISL4* EPROM's

USER NOTES

PROGRAMS '67', '68' and '69'   ACCELERATION MEASUREMENTS

PREAMBLE

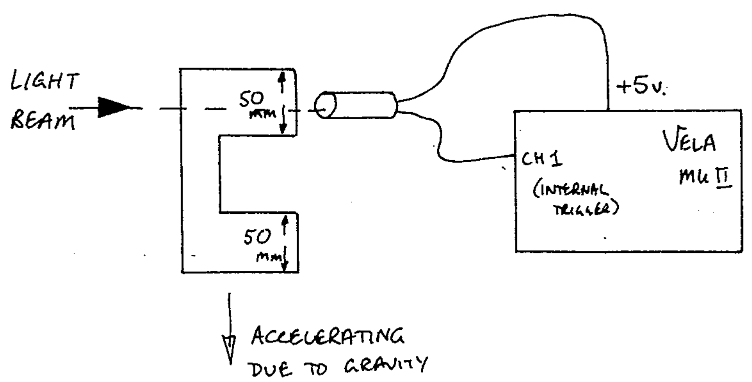
THE AIM IN WRITING THESE THREE PROGRAMS WAS TO EXTEND THE METHODS AVAILABLE TO THE PHYSICIST FOR MEASURING ACCELERATION. AS THE TIMINGS ARE DONE WITH A 100 μs RESOLUTION TIMER GOOD RESULTS CAN BE OBTAINED USING SHORT LENGTHS OF CARD etc. TO CUT THE LIGHT BEAMS. ALTHOUGH IT WAS CONSIDERED ADVANTAGEOUS TO BE ABLE TO OBTAIN A DIRECT READING OF ACCELERATION, FOR INSTANCE WHEN ILLUSTRATING FORCE AND ACCELERATION, IT WAS RECOGNIZED THAT MANY TEACHERS MAY WELL BE UNHAPPY WITH SUCH A 'BLACK BOX' APPROACH. PREPARATORY WORK WITH PROGRAMS '67' AND/OR '68' SHOULD MAKE THE METHODOLOGY OF THE ACCELERATION DETERMINATION CLEAR.

EXPERIMENTAL SUGGESTIONS

DROP THE CARD THROUGH THE LIGHT BEAMS, AND NOTE THE ACCELERATION. TRY USING MATERIALS OF DIFFERING MASS AND SHOW THAT THE ACCELERATION IS THE SAME FOR ALL. (DO ENSURE THAT ALL THE MATERIALS ARE OPAQUE.)

ALTER THE SEPARATION OF THE LIGHT BEAMS AND SHOW THAT THE AVERAGE ACCELERATION IS INDEPENDENT OF DISTANCE TRAVELLED. (BEWARE OF USING MATERIALS LIKELY TO APPROACH TERMINAL VELOCITY IN THE GIVEN DISTANCE.)
– see APPENDIX (B)

ALTERNATIVELY,



If your card is cut to these dimensions, values of "g" should lie in range
9,600 mm/sec^2 to 10,100 mm/sec^2

(see APPENDIX (B) for sensor details)

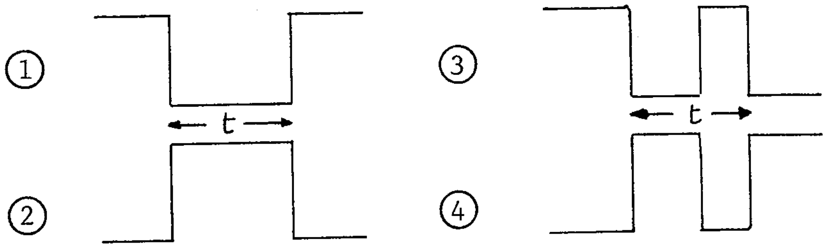
ISL4/ISL4* EPROM's

USER NOTES

PROGRAM '67' — THREE TIME MEASUREMENTS TO DETERMINE ACCELERATION

PARAMETER VALUES

DEFINES THE TRIGGERING EDGES AS IN PROGRAM '05'.



KEY IN

[6] [7] [N] [ENTER]

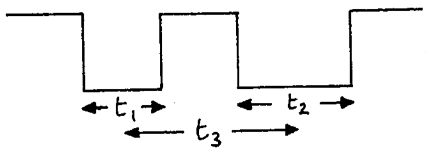
THE DISPLAY CLEARS APART FROM THE PROGRAM NUMBER.

[START] CLEARS THE DISPLAY READY FOR TIMING. PULSES SHOULD BE INPUT DIRECTLY TO PULSE INPUT (OR VIA CHANNEL 1 AMPLIFIER WITH EXTERNAL/INTERNAL SWITCH SET TO INTERNAL).

TIMING IS TRIGGERED AS DEFINED BY THE PARAMETER.

THREE TIMES ARE MEASURED: TWO VALUES OF t AS DEFINED ABOVE, AND THE TIME BETWEEN MID-PULSES.

e.g. FOR PARAMETER 1:



RESULTS

WHEN TIMING IS COMPLETE, TIME t_1 IS DISPLAYED:

[1 X.XXXX] 'seconds' led is lit.

[FWD] GIVES t_2 : [2 Y.YYYY]

[FWD] GIVES t_3 : [3 Z.ZZZZ]

'seconds' l.e.d. is lit

[BKWD] ALLOWS YOU TO STEP BACK THROUGH THE RESULTS.

RESTART

[START] CLEARS THE DISPLAY FOR FURTHER TIMING.

CONNECTIONS

SEE APPENDIX B FOR TWO OF THE POSSIBLE ARRANGEMENTS.

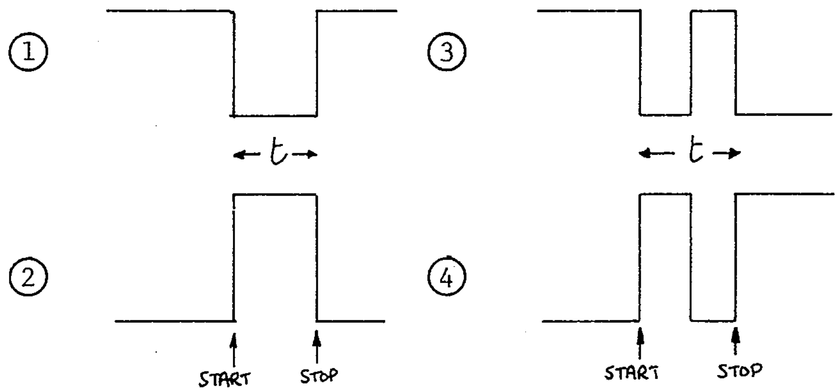
ISL4/ISL4* EPROM's

USER NOTES

PROGRAM '68' — TWO SPEEDS AND THE TIME INTERVAL TO DETERMINE ACCELERATION

PARAMETER VALUES — DEFINES THE TRIGGERING EDGES (AS IN PROGRAM '05').

PARAMETER 1



PARAMETER 2 — IS THE DISTANCE INVOLVED (e.g. LENGTH OF INTERRUPT CARD, OR DISTANCE BETWEEN DETECTORS - SEE APPENDIX B FOR SUGGESTED SENSOR ARRANGEMENTS). DISTANCES IN mm GIVE SPEEDS IN mm/s, DISTANCES IN m GIVE SPEEDS IN m/s, AND SO ON.

KEY IN

[6] [8] - PROGRAM NUMBER

[N] [ENTER] - TRIGGERING SELECTION

[N] [N] [N] [ENTER] - THE TIMING DISTANCE.

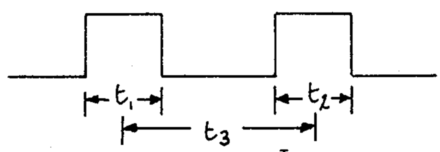
THE DISPLAY CLEARS APART FROM THE PROGRAM NUMBER.

[START] CLEARS THE DISPLAY READY FOR TIMING.

INPUT PULSES DIRECT TO PULSE INPUT (OR VIA CHANNEL 1 AMPLIFIER WITH THE EXTERNAL/INTERNAL SWITCH SET TO INTERNAL).

TIMING IS TRIGGERED AS DEFINED BY PARAMETER 1. THREE TIMES ARE MEASURED: TWO VALUES OF t AS DEFINED ABOVE, AND THE TIME BETWEEN MID-PULSES.

e.g. FOR PARAMETER 2:



VELA CALCULATES SPEEDS CORRESPONDING TO L/t_1 AND L/t_2.

RESULTS

ON COMPLETION OF TIMING VELA DISPLAYS

V_1: [1 XXX]

[FWD] GIVES V_2 [2 YYY]

[FWD] GIVES t_3 [3 Z.ZZZ] 'SECONDS' LED IS LIT.

[BKWD] ALLOWS YOU TO REINSPECT V_1, V_2.

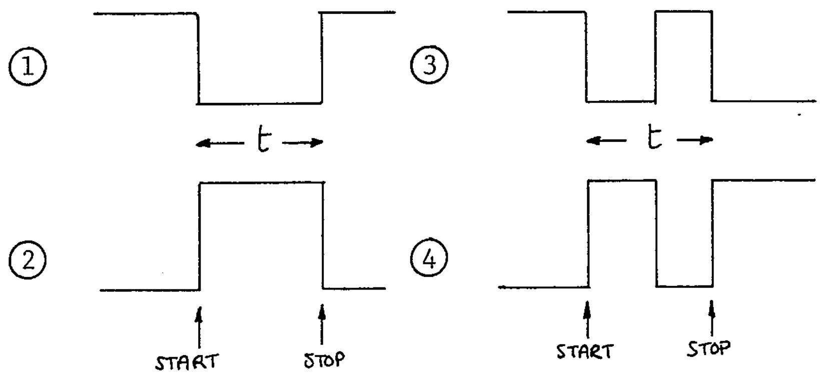
ISL4/ISL4* EPROM's

USER NOTES

PROGRAM '69' — DIRECT ACCELERATION MEASUREMENT

PARAMETER VALUES — TWO PARAMETERS ARE USED.

PARAMETER 1 — DEFINES THE TRIGGERING EDGES (AS IN PROGRAM '05').



PARAMETER 2 — A NUMBER IN THE RANGE 1 TO 999 IS THE DISTANCE INVOLVED (e.g. LENGTH OF INTERRUPT CARD OR DISTANCE BETWEEN DETECTORS - SEE APPENDIX B FOR SUGGESTED ARRANGEMENTS). DISTANCES IN mm GIVE ACCELERATION IN mm/s^2. DISTANCES IN m GIVE ACCELERATION IN m/s^2.

KEY IN

[6] [9] PROGRAM NUMBER

[N] [ENTER] TRIGGERING SELECTION

[N] [N] [N] [ENTER] LENGTH BEING TIMED.

THE DISPLAY CLEARS APART FROM THE PROGRAM NUMBER.

[START] CLEARS THE DISPLAY READY FOR TIMING. PULSES SHOULD BE INPUT DIRECT TO THE PULSE INPUT (OR VIA THE CHANNEL 1 AMPLIFIER WITH THE EXTERNAL/INTERNAL SWITCH SET TO INTERNAL).

WHEN ALL THREE TIMINGS ARE COMPLETE THE ACCELERATION IS DISPLAYED. TO CARRY OUT FURTHER MEASUREMENTS PRESS [START]

ISL4/ISL4* EPROM's

USER NOTES

PROGRAM '70' DIGITAL THERMOMETER

ESSENTIAL EQUIPMENT THE VELA TEMPERATURE MODULE MUST BE CONNECTED TO THE I/O PORT (SEE APPENDIX C).

PARAMETER VALUES NONE USED.

KEY IN $\boxed{7}$ $\boxed{0}$ $\boxed{\text{ENTER}}$

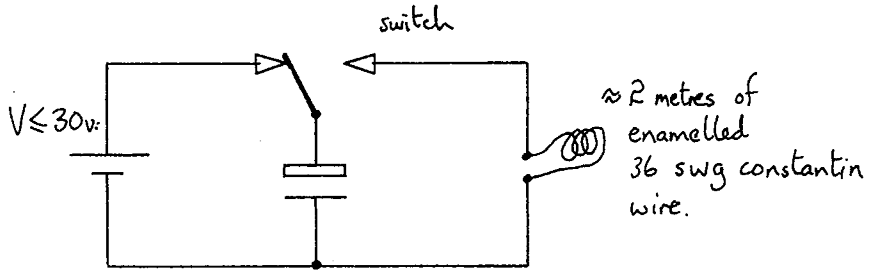
AND THE TEMPERATURE BEING SENSED ON CHANNEL 1 IS DISPLAYED IN DEGREES CELSIUS. THE DISPLAY REFRESHES EVERY $\frac{1}{4}$ SEC APPROX.

UNDER/OVER RANGE IF NO SENSOR IS CONNECTED TO CHANNEL 1, OR IF THE TEMPERATURE IS -25C OR LOWER THEN 'LO' IS OUTPUT. IF THE TEMPERATURE IS OVER 110C THEN'HI' IS DISPLAYED.

CELSIUS/KELVIN TO CONVERT THE DISPLAY TO KELVIN PRESS WHICHEVER CHANNEL IS CURRENTLY BEING DISPLAYED, IN THIS CASE $\boxed{\text{CH1}}$. A FURTHER KEYPRESS OF $\boxed{\text{CH1}}$ WOULD REVERT TO CELSIUS. ALL FOUR CHANNELS ARE DISPLAYED IN EITHER CELSIUS OR KELVIN, A MIX IS NOT POSSIBLE.

CHANNEL CHANGE TO DISPLAY THE TEMPERATURE BEING SENSED BY ANOTHER SENSOR SIMPLY PRESS THE APPROPRIATE CHANNEL KEY.

EXAMPLE THE THERMAL CAPACITY OF THE SENSOR, WHILST NOT AS LOW AS A THERMOCOUPLE IS SIGNIFICANTLY LOWER THAN A MERCURY IN GLASS THERMOMETER. IN MANY EXPERIMENTS WHERE THERMOCOUPLES HAVE PREVIOUSLY BEEN USED THE VELA TEMPERATURE SENSOR IS A SUPERIOR ALTERNATIVE GIVING A DIRECT READOUT OF TEMPERATURE, e.g.



THE CAPACITOR IS DISCHARGED THROUGH THE WIRE CAUSING HEATING OF THE WIRE. THE RESULTANT TEMPERATURE RISE CAN BE USED TO DETERMINE THE ENERGY TRANSFERRED FROM THE CAPACITOR AND THUS TO DEMONSTRATE ENERGY $\propto V^2$. THE ENERGY TRANSFER IS $\sim$ 50% EFFICIENT.

RS data

Calibrate as follows:

1 Remove link Lk A.
2 Connect battery.
3 Connect 150mm of wire (insulated) to the meter side of Lk A position. Bare the other end — this acts as a "test prod".
4 Touch "prod" on the "earthy" side of the coaxial input socket. A reading of 0.00 should be obtained.
5 Connect a shorting link to the coaxial socket and touch the "prod" on TP A. Adjust VR1 for a zero reading.
6 Touch "prod" on TP B and adjust VR2 for zero reading.
7 Touch "prod" on TP C and adjust VR4 for a reading of 7.00.
8 Remove the lead and insert Lk A. Remove the socket link and insert the pH probe.
9 Place the pH probe into a neutral solution of pH 7 and adjust VR1 for a reading of 7.00.
10 Place the probe into an acid solution of pH 4. Adjust VR3 for a reading of 4.00. Calibration is now complete.
11 Repeat 9 and 10 as necessary.

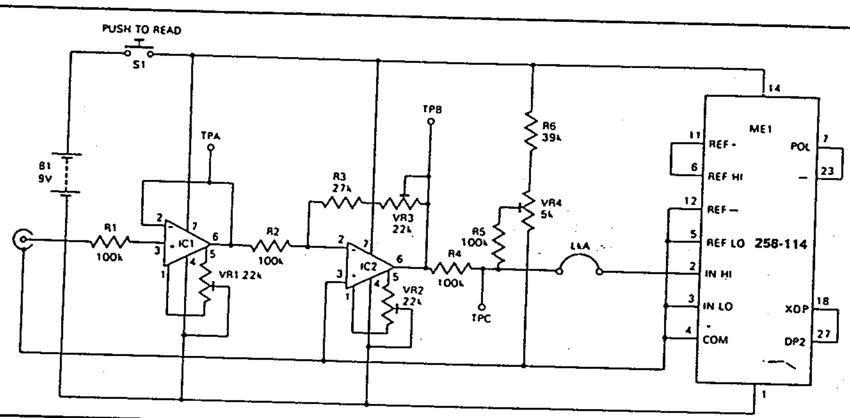
NOTE:

The chemicals contained within the probe present no specific hazard, but should not be allowed to come into contact with the mouth or food should the probe be broken or its contents become spilled.

Figure 3: **Circuit for pH Meter**

Note: this is not the circuit of the RS pH meter 610-540 – see text.

R1-6 ¼W carbon film.
VR1-4 cermet multi-turn preset.
IC1-2 071 (bifet op-amp)



pH Buffer Powders

These Buffer Powders represent an important advance in the preparation of standard solutions since they are accurate and dissolve easily. The pure dry chemicals used are sealed into a laminate of polythene and aluminium foil, which keeps out moisture and gases that can cause deterioration of the buffer powder. For best results a fresh buffer solution should be made up on the day of use.

Directions:

Before opening, the powder must be shaken down to the bottom of the sachet. This may be done conveniently by holding the sachet upright and tapping the bottom edge on a hard surface, i.e., a bench top. Alternatively, the sachet may be held upright and the top flicked with a finger nail. The corner of the sachet should then be cut off and the contents emptied into the vessel used for dissolving the powder. The sachet should be tapped to loosen any powder adhering to the inside. The water should be freshly distilled or demineralised. Distillate from hard water may be heavily contamined with carbon dioxide, which should be removed by aeration or boiling prior to use. An accuracy of 2% in the volume of water used is sufficient.

4pH type (acidic)

Each sachet makes 100 ml. of solution. The pH value is in accordance with NBS specifications i.e. 4.01 ± 0.02 pH at 25°C. pH values at other temperatures are:

°C	0	10	20	25	30	40	50
pH	4.00	4.00	4.00	4.01	4.02	4.04	4.06
°C	60	70	80	90			
pH	4.09	4.13	4.16	4.21			

The solution may be kept for up 2 weeks in a stoppered bottle.

7pH type (neutral)

Each sachet makes 200 ml of solution. The pH value is 7.00± 0.04pH at 25°C pH values at other temperatures.

°C	0	10	20	25	30	40	50
pH	7.11	7.06	7.01	7.00	6.98	6.97	6.97
°C	60	70	80	90			
pH	6.97	6.99	7.03	7.08			

The solution should not be used for calibration after the day on which it is made up, but it may still be used for probe storage.

RS data

pH Probe and pH buffer powders

Stock numbers 424—557 and 557—045

A standard combination-type pH electrode for general use in determining the acidity or alkalinity of chemical solutions. The design is of the type where the reference electrode is incorporated in the same probe as the main electrode. An electrical output proportional to pH allows its use with an amplifier/meter to form an accurate pH measuring instrument.

A hand held, digital pH meter, suitable for the probe is available, stock number 610-540.

Probe Characteristics

pH range	0 to 14pH
Response time (depending on pH)	Up to 1½ mins
Temperature range	−5 to + 100°C
Lead termination	50Ω b.n.c.
Output voltage (at 7pH)	0mV ± 18mV

IMPORTANT! The probe is despatched with a protective teat, containing 3.8M KCl solution, fitted over the glass membrane and ceramic junction, and a sleeve, sealing the filling aperture. Remove the teat prior to use, and gently shake to allow air bubbles to rise to the top of the probe. Pierce a hole in the sleeve through to the filling aperture. Always store the probe upright in a pH7 buffer solution. NEVER allow the ceramic junction to dry out.

pH Measurement

Next to temperature measurement, pH measurement is one of the most widely used in many areas of science. Essentially pH is a measure of the concentration of hydrogen ions in a solution and is effectively a measure of acidity. Absolute measurement of pH and the monitoring of its rate of change are important in chemistry, but pH measurement is also of importance to the food and drink industries, to aquarists, to prolong the life of tropical fish, and to gardeners, where lime is used to control soil acidity and improve plant growth.

pH measurement is also of value in many industrial processes and is also beginning to gain prominence in such areas as colour photography processing.

The value of pH is defined as:

$$pH = \log \frac{1}{[H^+]}$$

$[H^+]$ is the hydrogen ion concentration in the solution.

At ordinary temperatures pure water will slightly dissociate into hydrogen ions and hydroxyl ions:

$$H_2O = H^+ + OH^-$$

Now, the concentration of each type of ion is 10^{-7} gram-molecules per litre, and hence the pH value of pure water is:

$$pH = \log \frac{1}{10^{-7}} = 7$$

This figure is conventionally taken to represent neutrality on the pH scale.

Applications

- Scientific laboratories
- Educational establishments
- Processed food industry
- Drinks industry
- Aquarium monitoring and control
- Agriculture and gardening
- Colour photography processing

If acid is added to water its hydrogen ion concentration increases, and therefore its pH value decreases. Acidity is indicated by pH values below 7, alkalinity by values above 7.

Acid has the effect of liberating hydrogen ions in solution and one of the traditional tests is the use of litmus paper. Acids react with litmus to turn it red, alkalis turn it blue. However, for more accurate measurements, although more precise direct chemical indicators are available, electronic methods are now the accepted norm.

The RS pH meter, stock number 610-540, enables measurement of pH to be made to an accuracy of ±0.03pH. For those wishing to construct their own pH meter, the following circuit is offered. Please note that the following circuit is not that of the RS pH meter, neither is the calibration procedure the same.

Application

A pH probe consists of two electrodes between which a potential difference is generated when they are immersed in the solution under test. The output voltage is, however, quite small, and processing by high impedance amplifiers is necessary. The circuit given is suitable for most applications.

Operational amplifier IC1 forms a unity-gain voltage follower, with a very high input impedance. Amplification is provided by IC2 and is set by VR3. A reference voltage is adjusted by VR4, such that with zero input from the probe a reading of 7.00 is obtained on the panel meter.

Figure 1: **Probe Schematic**

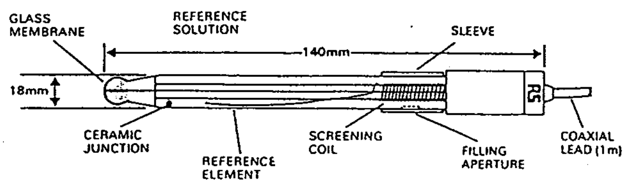
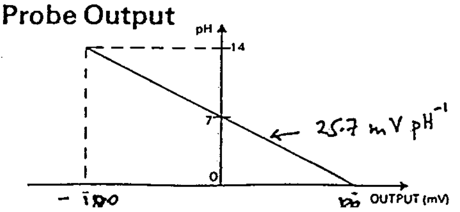


Figure 2: **Probe Output**



ISL4/ISL4* EPROM's

USER NOTES

PROGRAM '71' — **A CAPACITANCE METER**

PARAMETER VALUES

'0' SELECTS THE RANGE 50 pF TO 0.2 μF.

'1' SELECTS THE RANGE 0.1 μF TO 1000 μF.†

KEY IN

$\boxed{7}$ $\boxed{1}$ $\boxed{N}$ $\boxed{\text{ENTER}}$

THE VALUE OF THE CAPACITANCE IS DISPLAYED IN STANDARD FORM

$\boxed{\text{X.XX} \quad \text{E - X}}$

CAPACITANCE TO 3 SIG. FIGS — EXPONENT VALUE FOR BASE 10

CAPACITOR CONNECTION

THE CAPACITOR SHOULD BE CONNECTED BETWEEN SYNC. OUTPUT AND CHANNEL 1 INPUT, WITH THE RANGE SWITCH SET TO ±250 mV.

HIGH RANGE ONLY

A 1 kΩ SHOULD BE CONNECTED BETWEEN THE RED AND BLACK TERMINALS OF THE CHANNEL 1 INPUT.

ELECTROLYTIC CAPS

POLAR CAPACITORS SHOULD HAVE THE POSITIVE LEAD CONNECTED TO SYNC. OUT.

UNDER/OVER RANGE

IF NO CAPACITOR IS CONNECTED, OR IF THE CAPACITANCE IS TOO SMALL TO BE MEASURED ON THAT RANGE THEN 'LO' IS OUTPUT. IF THE CAPACITANCE IS TOO HIGH FOR THAT RANGE THEN 'HI' IS OUTPUT.

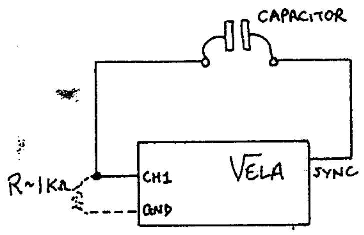
GENERAL COMMENTS

THE METHOD OF MEASUREMENT IS BASED UPON THE CAPACITOR DISCHARGE TIME. CONSEQUENTLY THE DISPLAY REFRESH TIME IS VARIABLE, AND ALTHOUGH GENERALLY IS ~1 OR 2 SECONDS IT CAN BE AS HIGH AS 8 SECS AT THE HIGH END OF THE RANGE. FLUCTUATIONS ARE EVIDENT, PARTICULARLY ON THE LOW RANGE. THIS CAN OFTEN BE IMPROVED SIGNIFICANTLY BY CONNECTING THE NEGATIVE SIDE OF VELA TO EARTH. (DO NOT CONNECT TO THE NEGATIVE OF THE POWER SUPPLY AND BLOW UP YOUR VELA!)

EXAMPLE

CHALLENGE YOUR PUPILS TO MAKE A CAPACITOR OUT OF MATERIALS AT HOME THAT WILL FIT INTO A MATCHBOX. BE NICE TO THE PUPIL WHO PRODUCES THE CAPACITOR WITH THE SMALLEST VALUE.

†



Note: Mk II users - if C ≥ 100 μfd take the first reading or short out the capacitor until the display shows 'HI' & take the next reading when the shorting wire is removed.

ISL4/ISL4* EPROM's

USER NOTES

PROGRAM ' 72' — A PHASE METER

PARAMETER VALUES — NONE USED

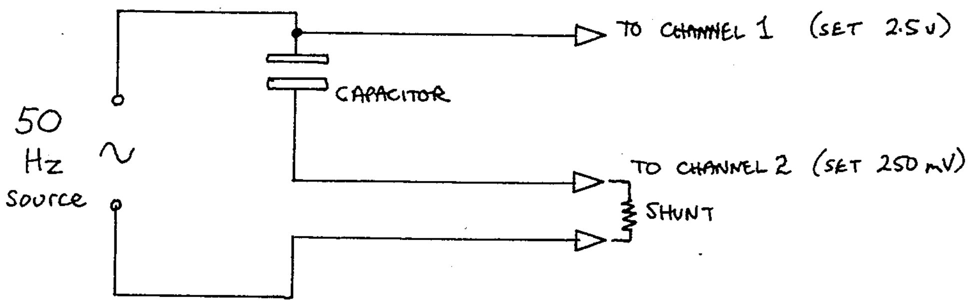
KEY IN — [7] [2] [ENTER]

CLEARS THE DISPLAY. THE PROGRAM COMPARES THE PHASE OF TWO SIGNALS APPLIED TO CHANNEL 1 AND CHANNEL 2 INPUTS. THE RESULT IS DISPLAYED IN DEGREES IN THE RANGE 0 TO 359, A PHASE SHIFT OF 360 DEGREES BEING RESET TO ZERO. A RESULT OF 90 DEGREES MEANS THAT CHANNEL 2 INPUT IS A QUARTER OSCILLATION BEHIND CHANNEL 1. THE WAVEFORM MUST CROSS ZERO VOLTS.

THE 7-SEGMENT DISPLAY REFRESHES EVERY 1½ SECONDS BUT REMAINS BLANK IF NO INPUT IS DETECTED.

RESOLUTION — 1 DEGREE UP TO ∿100 Hz, DETERIORATING TO 10 DEGREES ∿1 kHz. MINIMUM FREQUENCY ∿2 Hz.

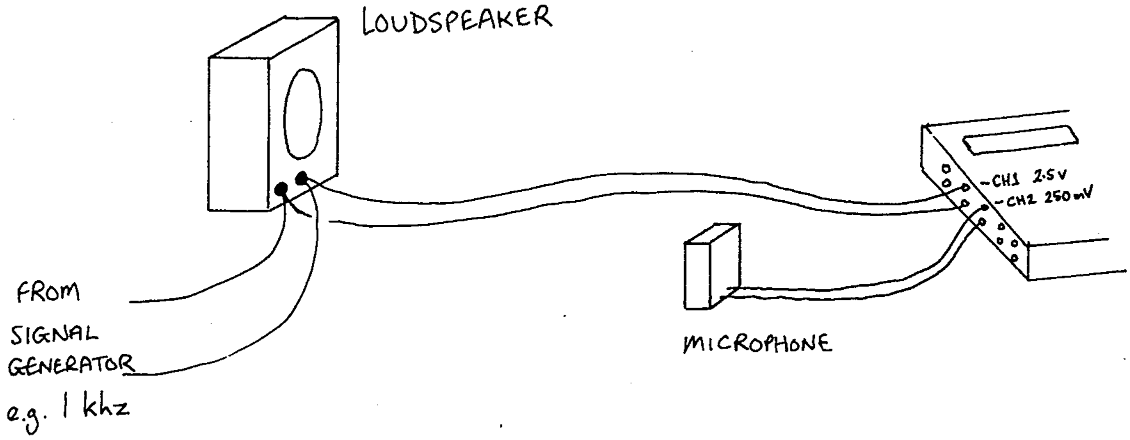
EXAMPLE 1



CHANNEL 1 MEASURES VOLTAGE, CH2 MEASURES CURRENT (SEE APPENDIX A). A SHUNT OF 1mA IS SUITABLE AND VELA INDICATES THE PHASE LAG OF CURRENT COMPARED TO VOLTAGE, i.e. 270 DEGREES (EQUIVALENT TO CURRENT LEADING VOLTAGE BY 90 DEGREES). USE OF A TWIN BEAM OSCILLOSCOPE PROVIDES VISUAL SUPPORT FOR THE MEASUREMENT.

USER NOTES

CASE STUDY : MEASUREMENT OF WAVELENGTH OF SOUND



PLACE THE MICROPHONE NEXT TO THE LOUDSPEAKER, THEN MOVE IT AWAY UNTIL A POSITION OF ZERO PHASE SHIFT BETWEEN THE LOUD-SPEAKER SIGNAL AND THE MICROPHONE SIGNAL IS FOUND. (BEWARE OF DOPPLER EFFECTS!) CONTINUE MOVING THE LOUDSPEAKER AWAY UNTIL THE NEXT POSITION OF ZERO PHASE SHIFT IS FOUND. THE MICROPHONE HAS MOVED THROUGH ONE WAVELENGTH. USE OF PROGRAM '04' TO MEASURE FREQUENCY WOULD ALLOW A THEORETICAL VALUE FOR THE WAVELENGTH TO BE FOUND ASSUMING THE SPEED OF SOUND IS KNOWN, AND THIS COULD BE COMPARED TO THE EXPERIMENTAL VALUE.

$$c = f\lambda$$

VELOCITY (SPEED) FREQUENCY WAVELENGTH

ISL4/ISL4* EPROM's

USER NOTES

PROGRAM '73' — A 4-CHANNEL TEMPERATURE DATALOGGER

ESSENTIAL EQUIPMENT — THE VELA TEMPERATURE MODULE AND SENSORS† MUST BE CONNECTED TO THE I/O PORT (SEE APPENDIX C).

PARAMETER VALUES — ANY VALUE IN THE RANGE 1 TO 999 TO DEFINE THE NUMBER OF SECONDS BETWEEN SAMPLES.

KEY IN

7 3 PROGRAM NUMBER

N N N ENTER TIME INTERVAL IN SECS.

AND THE TEMPERATURE BEING SENSED ON CHANNEL 1 IS DISPLAYED IN CELSIUS. THE DISPLAY REFRESHES EVERY 1/4 SECS APPROX.

CHANNEL CHANGE — TO DISPLAY THE TEMPERATURE BEING SENSED BY ANOTHER SENSOR SIMPLY PRESS THE APPROPRIATE CHANNEL KEY.

START DATALOGGING — MANUALLY - PRESS START

AUTOMATICALLY - SEND A PULSE TO THE PULSE INPUT. DATALOGGING STARTS ON THE POSITIVE EDGE.

STOP DATALOGGING — MANUALLY - PRESS STOP

AUTOMATICALLY - WHEN 512 RESULTS HAVE BEEN STORED FROM EACH OF THE FOUR INPUTS.

CELSIUS/KELVIN — CHANGE SCALE BY PRESSING THE KEY FOR THE CHANNEL CURRENTLY BEING DISPLAYED. A FURTHER KEYPRESS CHANGES SCALE AGAIN. ALL FOUR CHANNELS ARE DISPLAYED IN EITHER CELSIUS OR KELVIN, A MIX IS NOT POSSIBLE.

DURING DATALOGGING — THE LAST RESULT TAKEN ON EACH CHANNEL IS SHOWN ON THE DISPLAY. ALL THE RESULTS FOR THE CHANNEL ON DISPLAY ARE OUTPUT TO OSCILLOSCOPE VIA ANALOGUE OUT, SO THAT YOU CAN SEE THE DATA RECORDED.

† **WARNING** — THE SENSORS DISSOLVE IN ORGANIC SOLVENTS SUCH AS NAPHTHALENE.

Recovery of data to display.

After $\boxed{\text{STOP}}$ is pressed

the display flashes

O - P

press the channel you want

eg #2

press $\boxed{\text{SCOPE}}$

2	1	21.9
channel	reading #	value either °C or Kelvin

the arrows then work through memory

and channel selection is possible by pushing the channel buttons

USER NOTES

PROGRAM '73' — **TEMPERATURE DATA LOGGER** (continued)

RECOVERY OF DATA

THE OUTPUT OPTIONS FOR THIS PROGRAM ARE ALMOST THE SAME AS FOR THE FOUR CHANNEL VOLTAGE DATA LOGGING PROGRAMS '02' AND '03', BUT USERS SHOULD NOTE THE FOLLOWING DIFFERENCES:

CHART RECORDER

VOLTAGE RANGE IS −2.5V TO +2.5V   −2.5V ≡ −25C, 0V ≡ 40C AND +2.5V ≡ 110C. TO OUTPUT ALL 512 RESULTS TAKES ∿ 5 mins.

OSCILLOSCOPE/ DISPLAY

1) [FAST] ADVANCES/REVERSES BY 20 DATA ITEMS RATHER THAN 16.

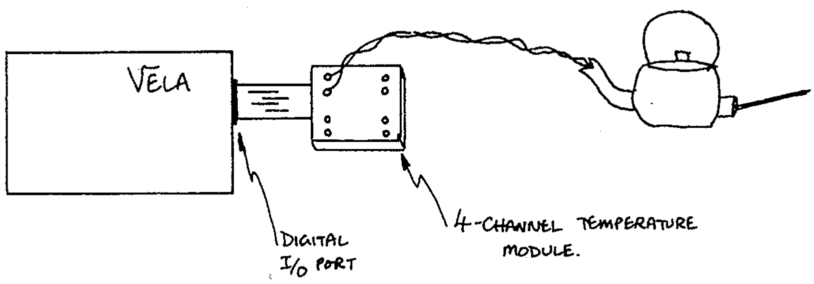
2) IT IS POSSIBLE TO TRANSFER FROM ONE CHANNEL TO ANOTHER WITHOUT HAVING TO RESELECT AND START AGAIN.

3) IF FEWER THAN 512 ITEMS OF DATA ARE RECORDED THEN THE PROGRAM IGNORES UNUSED MEMORY SPACE IN ORDER TO READOUT THE DATA RECORDED AS QUICKLY AS POSSIBLE.

MICROCOMPUTER

THE PREAMBLE SENDS ACROSS THE ACTUAL NUMBER OF DATA ITEMS RECORDED. INFORMATION ON HOW TO DECODE THE DATA SENT ACROSS TO MICROCOMPUTER IS GIVEN ON PAGE 27.

EXAMPLE 1



FILL A KETTLE WITH COLD WATER. POP SENSOR INTO KETTLE VIA SPOUT, BUT DO NOT REST ON ELECTRIC HEATING ELEMENT. KEYPRESS SEQUENCE

[7] [3] [1] [ENTER]

PRESS [START] AND SWITCH ON KETTLE.

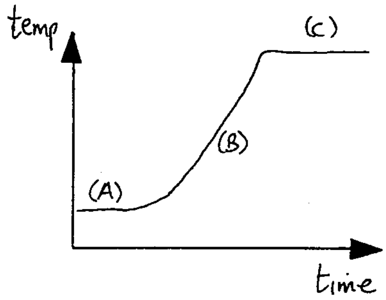
WHEN KETTLE BOILS PRESS [STOP] • [CH 1] [SCOPE]

USER NOTES

PROGRAM '73'

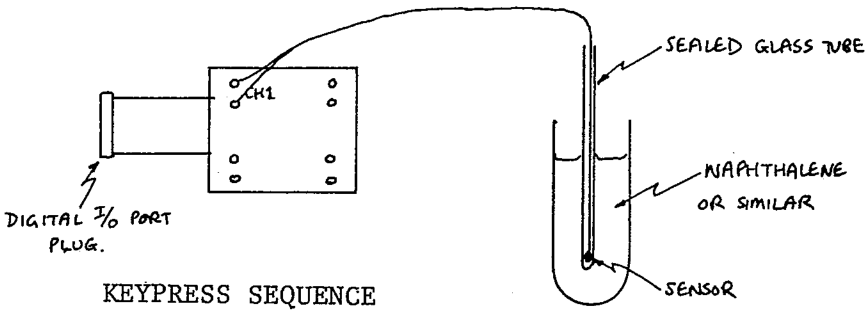
TEMPERATURE DATA LOGGER (continued)

PRODUCES AN OSCILLOSCOPE TRACE LIKE THIS WITH THREE REGIONS OF INTEREST: (A), (B) AND (C).



EXAMPLE 2

NAPHTHALENE COOLING CURVE

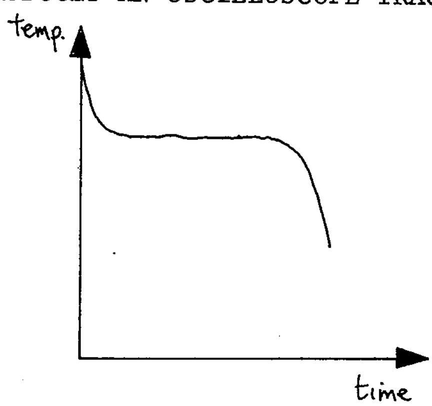


KEYPRESS SEQUENCE

[7] [3] [3] [ENTER]

PRESS [START] AND LEAVE NAPHTHALENE TO COOL IN FREE AIR. DATALOGGING WILL STOP AFTER ∿ 25 mins.

[CH 1], [SCOPE] PRODUCES AN OSCILLOSCOPE TRACE LIKE THIS.



PUPILS CAN EXTRACT RESULTS AT 1 min INTERVALS TO PLOT THEIR OWN GRAPHS BY PRESSING

[FAST] [FWD]

TO ADVANCE 20 DATA ITEMS.

SAFETY

CHECK YOUR LOCAL REGULATIONS TO SEE WHETHER YOU ARE ALLOWED TO USE NAPHTHALENE.

- ALTERNATIVES ARE HEXADECAN-1-OL 49.3°C m.pt.
  OR OCTADECANOL ACID 28→29°C m.pt.

NOTE THAT 4 CHANNEL DATALOGGING ALLOWS MEASUREMENTS OF DIFFUSION, CONDUCTION, CONVECTION AND RADIATION PROCESSES.

USER NOTES

PROGRAM '73' — TRANSFER DATA TO MICROCOMPUTERS

THIS ROUTINE HANDSHAKES DATA FROM VELA TO THE MICRO-COMPUTER IN THE SAME WAY AS THE OTHER DATALOGGING PROGRAMS - SEE THE TECHNICAL MANUAL AND/OR VELA APPLICATIONS BOOK.

THE VALID DATA IS PRECEDED BY 6 PREAMBLE BYTES FOR MK I VELA's AND 7 PREAMBLE BYTES FOR MK II VELA's.

Mk I

HI BYTE	LO BYTE	PROGRAM NUMBER	HI BYTE	LO BYTE	CHANNEL NUMBER	HI BYTE	LO BYTE	HI BYTE	LO BYTE	etc.
TOTAL NUMBER OF DATA BYTES SENT AFTER 6 PREAMBLE			PARAMETER CHOSEN		(1, 2, 3 or 4)	FIRST DATA VALUE		SECOND DATA VALUE		

time →

Mk II

HI BYTE	LO BYTE	PROGRAM NUMBER	HI BYTE	LO BYTE	CHANNEL NUMBER	THIS BYTE IS TO BE IGNORED	HI BYTE	LO BYTE	HI BYTE	etc.
TOTAL NUMBER OF DATA BYTES AFTER 7 PREAMBLE BYTES			PARAMETER CHOSEN		(1,2,3 or 4)		FIRST DATA ITEM		2ND DATA	

NOTE THAT THE FORM OF THE DATA IS DIFFERENT. UP TO 1024 DATA BYTES ARE TRANSFERRED. 2 DATA BYTES ARE NEEDED FOR EACH RESULT. THE TEMPERATURE RESULT IS OBTAINED AS FOLLOWS:-

1) DECODE THE 2 DATA BYTES THUS:

   X=(1st data byte x256)+2nd data byte

2) CONVERT TO CELSIUS THUS $T=\frac{X-250}{10}$

or 3) CONVERT TO KELVIN THUS $T=\frac{X+2482}{10}$

CAUTIONARY NOTES

(a) EXTENDING THE SENSOR LEADS CAUSES VELA TO GIVE A LOWER TEMPERATURE READING THAN EXPECTED. THIS IS DUE TO STRAY CAPACITANCE BETWEEN THE LEADS AND THE EARTH AND IS UNAVOIDABLE. IT IS THEREFORE PREFERABLE TO EXTEND THE LOW VOLTAGE POWER LEADS IN ORDER TO MAKE ENVIRONMENTAL MEASUREMENTS AWAY FROM A POWER SOURCE RATHER THAN EXTEND THE SENSOR LEADS.

(b) LEAVING THE TEMPERATURE MODULE CONNECTED PREVENTS VELA FROM CORRECTLY SELECTING CH 1 TO CH 4 INPUTS, SO IF YOU WISH TO USE ANOTHER PROGRAM NUMBER REMEMBER TO DISCONNECT THE TEMPERATURE MODULE.

ISL4/ISL4* EPROM's

USER NOTES

PROGRAM '74'

A RATEMETER

PARAMETER VALUES

ANY VALUE IN THE RANGE 1 TO 255 TO DEFINE THE NUMBER OF SECONDS OVER WHICH THE COUNT RATE IS DETERMINED. WHATEVER TIME INTERVAL IS CHOSEN THE MAXIMUM PERMITTED COUNT IS 6553 COUNTS. (NOTE THAT THIS PROGRAM IS NOT PROTECTED AGAINST ENTRIES OUTSIDE THE RANGE QUOTED AND THAT NON-SENSICAL RESULTS WILL BE OBTAINED IF FALSE ENTRY IS MADE.)

KEY IN

[7] [4] PROGRAM NUMBER

[N] [N] [N] [ENTER] TIME INTERVAL

CLEARS THE DISPLAY. VELA TAKES AN INITIAL READING DURING THE FIRST SECOND, AND PUTS THIS ON THE DISPLAY. THE DISPLAY IS THEN UPDATED EVERY N N N SECONDS, WHERE N N N IS THE CHOSEN TIME INTERVAL. THE RESULT IS ROUNDED TO THE NEAREST 0.1 Hz.

USES

THIS PROGRAM EXTENDS THE RANGE OF FREQUENCY MEASUREMENT BELOW THAT POSSIBLE WITH PROGRAM '04'. i.e. WITH WEAK RADIOACTIVE SOURCES OR FOR MEASUREMENT OF MECHANICAL ROTATION FREQUENCIES USING A PHOTODIODE AND INTERRUPT CARD.

EXAMPLE

DECAY OF PROTACTINIUM 235.
FEED PULSES FROM THE GM. UNIT INTO THE PULSE INPUT.
PRESS [7] [4] [5] [ENTER]
THE DISPLAY WILL UPDATE EVERY 5 SECONDS GIVING THE USER TIME TO READ AND RECORD THE DISPLAY - ENABLING VARIATION OF COUNT RATE WITH TIME TO BE MEASURED. ALTERNATIVELY, INVESTIGATE VARIATION OF COUNT RATE WITH SOURCE-GM TUBE SEPARATION FOR A γ-RAY EMITTER.

USER NOTES

PROGRAMS '75','76' & '77' DUAL TIMER AND SPEED MEASUREMENT FOR DYNAMICS EXPERIMENTS

PREAMBLE

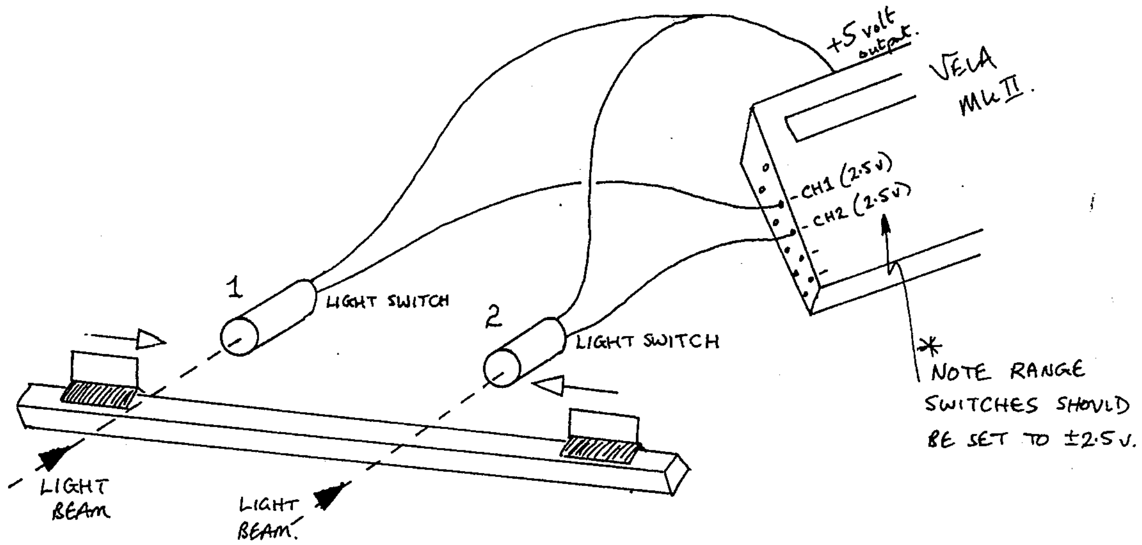
THESE PROGRAMS WERE WRITTEN TO EXTEND AND SIMPLIFY DYNAMICS EXPERIMENTS INVOLVING ELASTIC AND IN-ELASTIC COLLISION OF VEHICLES ON AN AIR TRACK. A SINGLE VELA CAN MONITOR AN ELASTIC COLLISION THAT PREVIOUSLY WOULD HAVE REQUIRED FOUR SCALER/TIMERS AND CAN ADDITIONALLY RETURN A DIRECT READING OF SPEED IF REQUIRED. WHEN CALCULATING MOMENTUM PUPILS WILL NEED TO PAY DUE ATTENTION TO THE DIRECTION OF TRAVEL. THREE VERSIONS OF THE PROGRAM ARE AVAILABLE, viz:-

(a) TIMES ONLY
(b) SPEEDS ONLY
(c) TIMES AND SPEEDS.

THIS GIVES THE TEACHER THE MAXIMUM CHOICE WHEN IT COMES TO DECIDING WHETHER OR NOT THE MATHEMATICS OF SPEED CALCULATION IS AN INTEGRAL PART OF THE EXPERIMENT.

EXPERIMENTAL DESIGN

ONE POSSIBLE EXPERIMENTAL ARRANGEMENT IS AS FOLLOWS:



SEE APPENDIX B FOR ADDITIONAL INFORMATION ON LIGHT SWITCHES.

THE DESIGN OF LIGHT SWITCH USED WILL OBVIOUSLY BE A MATTER OF PERSONAL CHOICE.

MK 1 ONLY

AS VELA MK 1 HAS NO 5V OUTPUT A SEPARATE POWER SUPPLY MUST BE USED (SEE APPENDIX B).

ISL4/ISL4* EPROM's

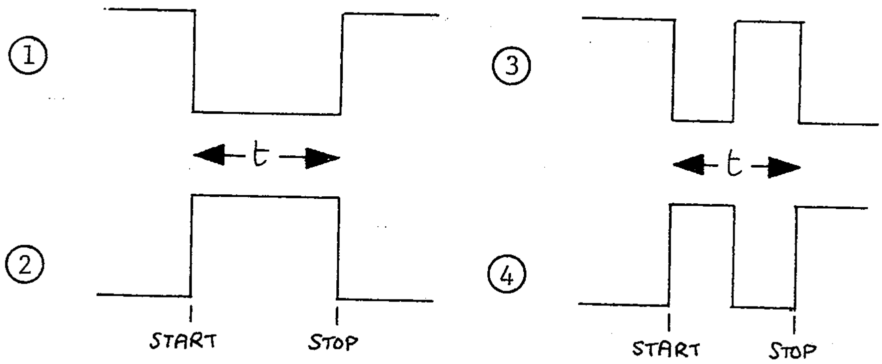
USER NOTES

PROGRAM '75'

DUAL TIMER FOR DYNAMICS

PARAMETER VALUES

THIS DEFINES THE TRIGGERING EDGES (AS IN PROGRAM '05').



KEY IN

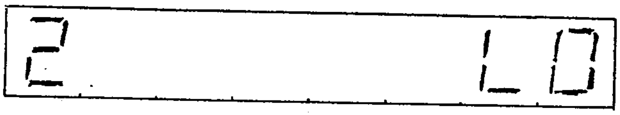
[7] [4] PROGRAM NUMBER

[N] [ENTER] TRIGGER SELECTION

PULSES IN

TIMING RESOLUTION IS 1 ms; MAXIMUM TIME INTERVAL IS ∿ 65 SECONDS.

THE PROGRAM WILL LOOK FOR PULSES ARRIVING AT CH 1 INPUT AND CH 2 INPUT. INITIALLY THE DISPLAY INDICATES WHETHER CH 1 INPUT IS LO(W) OR HI(GH). A [CH 2] KEYPRESS CAUSES THE DISPLAY TO INDICATE WHETHER CH 2 IS LO(W) OR HI(CH).

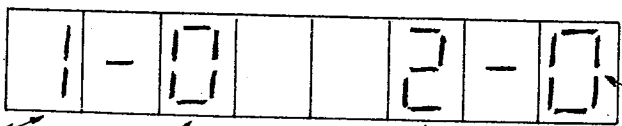


CH 2 INPUT CURRENTLY LOW

(BOTH CH 1 INPUT AND CH 2 INPUT ARE PROGRAMMED TO BEHAVE AS SCHMITT TRIGGER INPUTS TO IMPROVE PERFORMANCE RELIABILITY.)

PREPARE FOR DATALOGGING

PRESS [START], THE DISPLAY CHANGES TO



NO RESULTS ON CH 2 EITHER

CH 1 INPUT

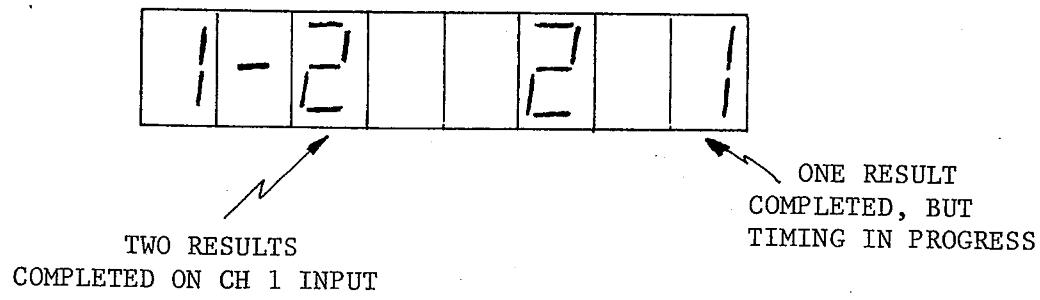
CH 2 INPUT

NO RESULTS YET

PROGRAM '75'

DUAL TIMER (continued)

WHEN A LIGHT BEAM IS INTERRUPTED THE HYPHEN IS CLEARED. WHEN THE LIGHT BEAM IS RESTORED THE HYPHEN RETURNS AND THE RESULT TOTAL IS INCREMENTED e.g.



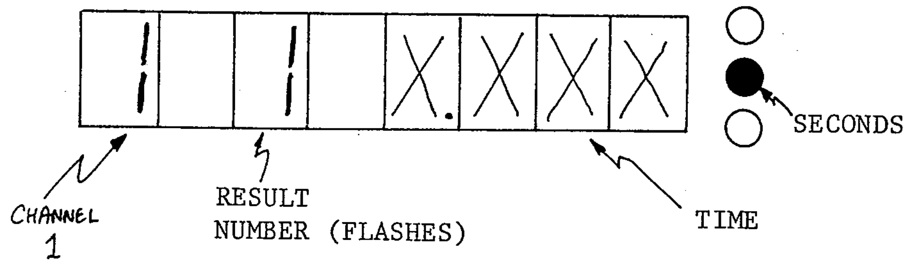
STOP DATALOGGING

MANUALLY - PRESS [STOP]

AUTOMATICALLY - WHEN NINE RESULTS HAVE BEEN TAKEN ON EITHER CH 1 OR CH 2.

AFTER DATALOGGING

WHEN DATALOGGING STOPS VELA's DISPLAY SHOWS:



[FWD] ADVANCES TO THE NEXT DATA ITEM,

[BKWD] REVERSES TO THE LAST DATA ITEM,

[CH 2] WOULD SELECT TIMINGS RECORDED ON CH 2 INPUT.

UNDER/OVER RANGE

IF THE RESULT RECORDED WAS ZERO THEN THE DISPLAYS SHOWS 'LO'. IF THE TIME WAS OVER 65 SECONDS THE DISPLAY SHOWS 'HI'.

ISL4/ISL4* EPROM's

USER NOTES

PROGRAM '76'

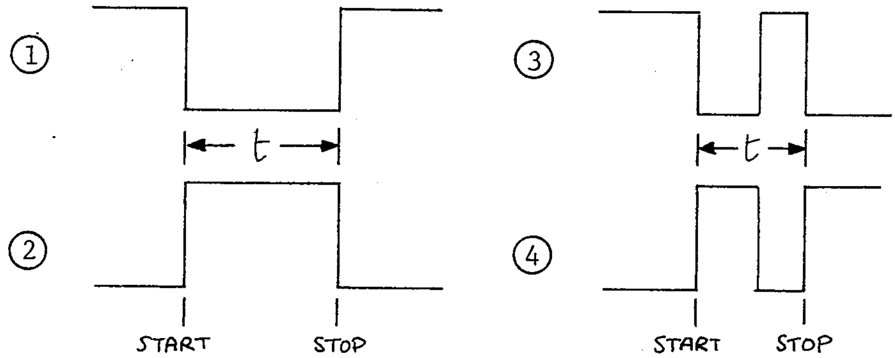
DUAL SPEED MEASUREMENT FOR DYNAMICS

PARAMETER VALUES

TWO PARAMETERS ARE USED.

PARAMETER No 1

THIS DEFINES THE TRIGGERING EDGES (AS IN PROGRAM '05').



PARAMETER No 2

THIS IS THE LENGTH OVER WHICH TIMING TAKES PLACE, AND ALLOWS VELA TO CALCULATE THE SPEED DIRECTLY. IF THE LENGTH OF THE CARD IS MEASURED IN MILLIMETRES THEN THE SPEED WILL BE IN mm/s.

KEY IN

[7] [6] PROGRAM NUMBER

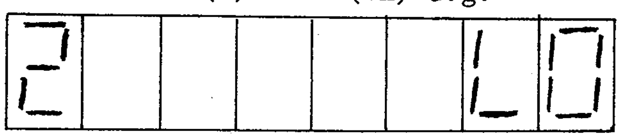
[N] [ENTER] TRIGGER SELECTION

[N] [N] [N] [ENTER] LENGTH OF CARD

PULSES IN

PULSES FROM THE LIGHT BEAMS SHOULD BE INPUT TO CH 1 INPUT AND CH 2 INPUT. INITIALLY THE DISPLAY INDICATES WHETHER CH 1 INPUT IS LO(W) OR HI(GH). A [CH 2] KEYPRESS CAUSES THE DISPLAY TO INDICATE WHETHER CH 2 INPUT IS LO(W) OR HI(GH) e.g.

CH 2 INPUT



CURRENTLY LOW

(BOTH CH 1 INPUT AND CH 2 INPUT ARE PROGRAMMED TO BEHAVE AS SCHMITT TRIGGER INPUTS TO IMPROVE PERFORMANCE RELIABILITY.)

PREPARE FOR DATALOGGING

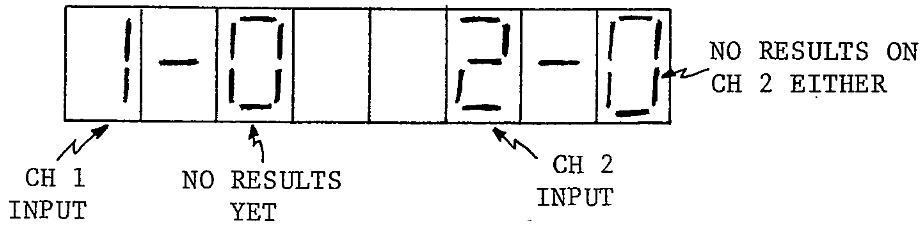
PRESS [START], THE DISPLAY CHANGES TO

ISL4/ISL4* EPROM's

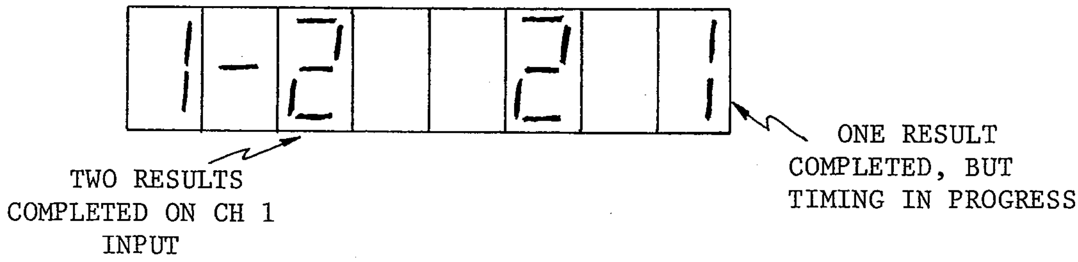
USER NOTES

PROGRAM '76'

DUAL SPEED (continued)



WHEN ONE OF THE LIGHT BEAMS IS INTERRUPTED THE HYPHEN IS CLEARED. WHEN THE LIGHT BEAM IS RESTORED THE HYPHEN RETURNS AND THE RESULT TOTAL FOR THAT INPUT IS INCREMENTED e.g.



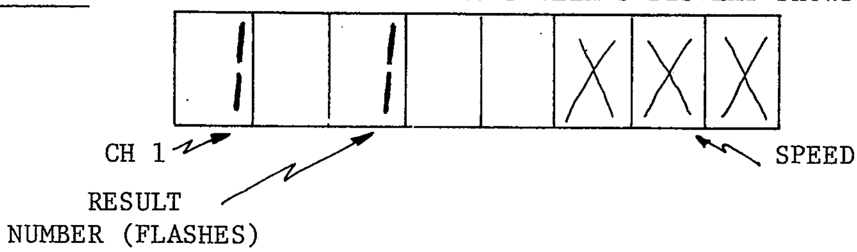
STOP DATALOGGING

MANUALLY - PRESS STOP

AUTOMATICALLY - WHEN NINE RESULTS HAVE BEEN RECORDED ON EITHER CH 1 OR CH 2.

AFTER DATALOGGING

WHEN DATALOGGING STOPS VELA's DISPLAY SHOWS:



FWD ADVANCES TO THE NEXT DATA ITEM

BKWD REVERSES TO THE LAST DATA ITEM

CH 2 SELECTS SPEEDS RECORDED ON CH 2

UNDER/OVER RANGE

IF THE TIME RECORDED WAS ZERO THE CORRESPONDING SPEED SHOWN ON THE DISPLAY IS 'HI'. TIMES IN EXCESS OF THE MAXIMUM OF 65 SECS RETURN A SPEED OF 'LO'.

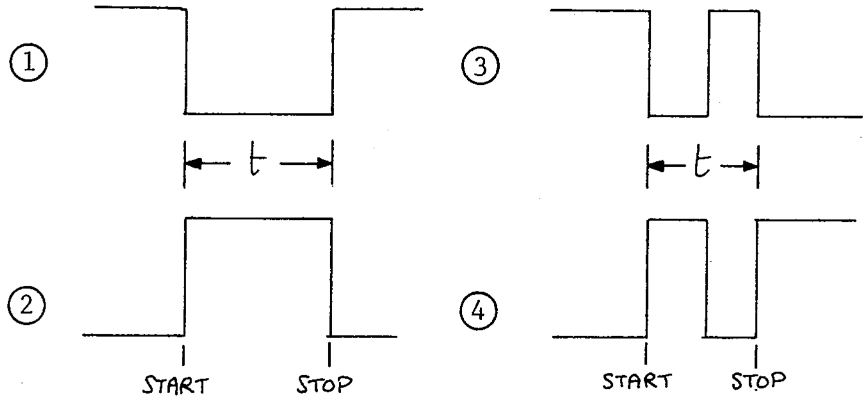
ISL4/ISL4* EPROM's

USER NOTES

PROGRAM '77' — DUAL TIMER AND SPEED MEASUREMENT FOR DYNAMICS

PARAMETER VALUES — TWO PARAMETERS ARE USED

PARAMETER No 1 — THIS DEFINES THE TRIGGERING EDGES (AS IN PROGRAM '05')



PARAMETER No 2 — THIS IS THE LENGTH OVER WHICH TIMING TAKES PLACE, AND ALLOWS VELA TO CALCULATE THE SPEED DIRECTLY. IF THE LENGTH OF THE CARD IS MEASURED IN MILLIMETRES THEN THE SPEED WILL BE IN mm/s.

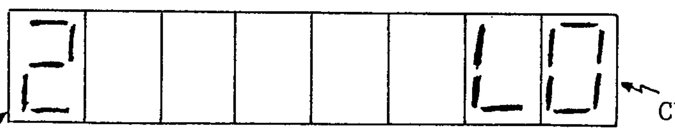
KEY IN

[7] [7] PROGRAM NUMBER

[N] [ENTER] TRIGGER SELECTION

[N] [N] [N] [ENTER] LENGTH OF CARD

PHOTODIODES — PULSES FROM THE PHOTODIODE LIGHT SWITCHES SHOULD BE INPUT TO CH 1 INPUT AND CH 2 INPUT. INITIALLY THE DISPLAY INDICATES WHETHER CH 1 INPUT IS LO(W) OR HI(GH). A [CH 2] KEYPRESS CAUSES THE DISPLAY TO INDICATE WHETHER CH 2 INPUT IS LO(W) OR HI(GH) e.g.



CH 2
INPUT

CURRENTLY
LOW

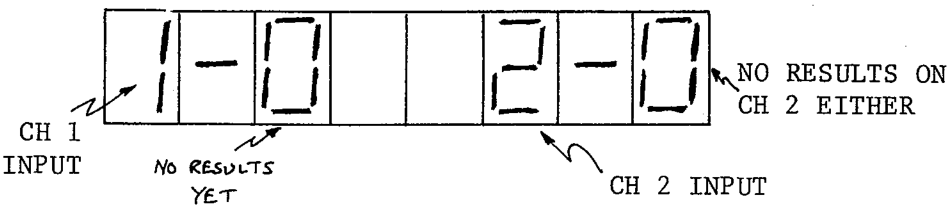
(BOTH CH 1 INPUT AND CH 2 INPUT ARE PROGRAMMED TO BEHAVE AS SCHMITT TRIGGER INPUTS TO IMPROVE PERFORMANCE RELIABILITY.)

PREPARE FOR DATALOGGING — PRESS [START], THE DISPLAY CHANGES TO

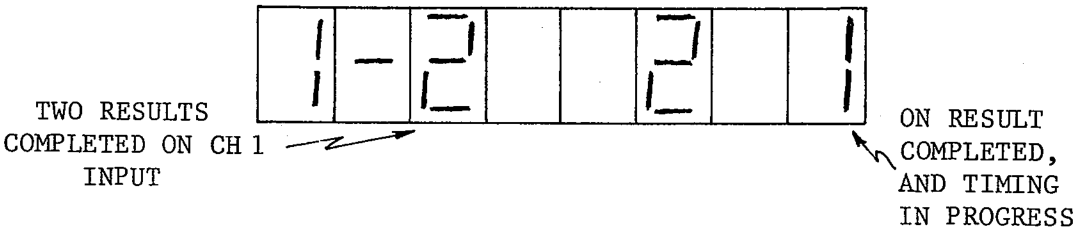
ISL4/ISL4* EPROM's

USER NOTES

PROGRAM '77' DUAL TIMER AND SPEED MEASUREMENT (continued)



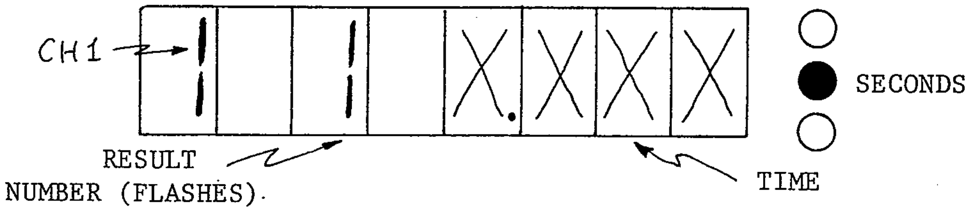
WHEN ONE OF THE LIGHT BEAMS IS INTERRUPTED THE HYPHEN IS CLEARED. WHEN THE LIGHT BEAM IS RESTORED THE HYPHEN RETURNS AND THE RESULT TOTAL FOR THAT INPUT IS INCREMENTED, e.g.



STOP DATALOGGING MANUALLY - PRESS STOP

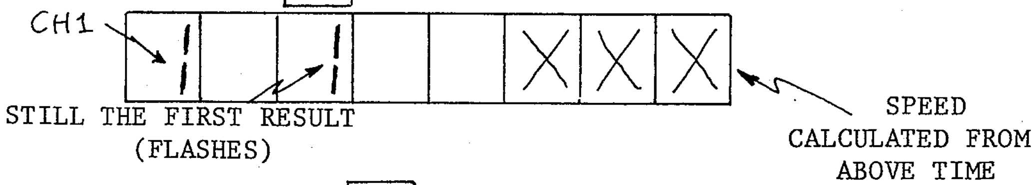
AUTOMATICALLY - WHEN NINE RESULTS HAVE BEEN RECORDED ON EITHER CH 1 OR CH 2.

AFTER DATALOGGING WHEN DATALOGGING STOPS VELA's DISPLAY SHOWS:



THIS PROGRAM OUTPUTS BOTH THE TIMES RECORDED AS SHOWN ABOVE, AND THE SPEED CALCULATED THUS:

PRESS FWD AND THE DISPLAY CHANGES TO



PRESSING FWD AGAIN ADVANCES TO THE NEXT DATA ITEM, TIMES FIRST AND THEN SPEED

BKWD REVERSES TO THE LAST DATA ITEM

CH 2 SELECTS TIMES AND SPEEDS RECORDED ON CH 2 INPUT.

UNDER/OVER RANGE IF THE TIME RECORDED WAS ZERO THE DISPLAY SHOWS 'LO' FOR THE TIME, AND 'HI' FOR THE SPEED. IF THE TIME WAS OVER 65 SECONDS THE DISPLAY SHOWS 'HI' FOR THE TIME, AND 'LO' FOR THE SPEED.

ISL4/ISL4* EPROM's

USER NOTES

PROGRAM '78' — **SQUARE WAVE GENERATION**

PARAMETER VALUES

'0' SELECTS A PRECISION 100 kHz PULSE GENERATOR. A SQUARE WAVE OUTPUT '1 TO 999' SELECTS IN THE RANGE 0.1 Hz TO 99.9 Hz.

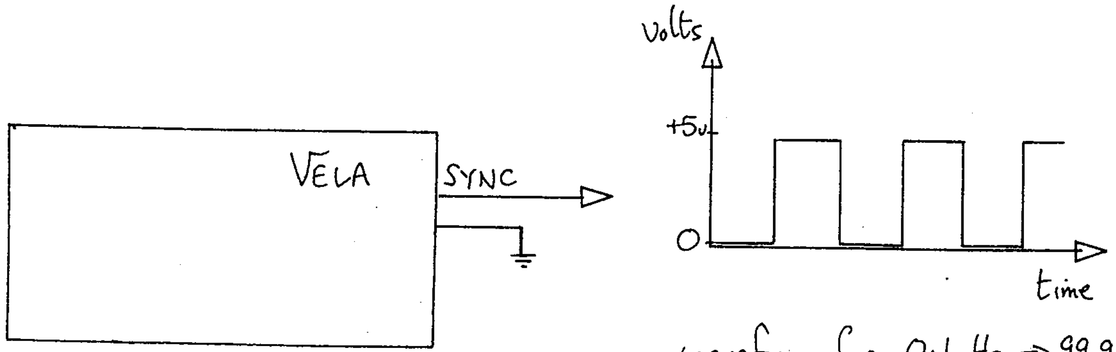
KEY IN

7 8 N N N ENTER

THE DISPLAY SHOWS THE FREQUENCY SELECTED, AND THE OUTPUT IS AVAILABLE AT THE SYNC. OUTPUT. NOTE THAT THE OUTPUT IMPEDANCE IS ∿ 10 kΩ FOR VELA MARK II, AND ∿ 560 Ω FOR VELA MK I. A POWER AMPLIFIER MUST BE USED IF THE OUTPUT IS TO BE CONNECTED TO A LOW IMPEDANCE CIRCUIT.

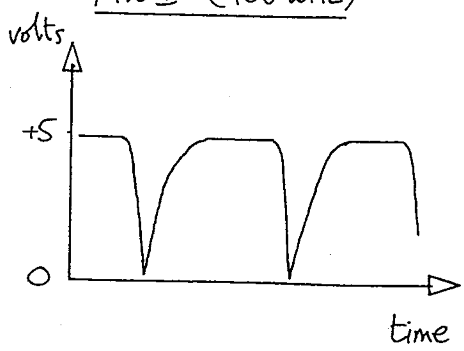
ACCURACY

USERS SHOULD NOTE THAT WHILST THE RESOLUTION IN THE SELECTED FREQUENCY IS < 1% BELOW 10 Hz, AT THE TOP END OF THE RANGE THE RESOLUTION INCREASES TO ∿ 2% AND SO THE LAST DIGIT HAS NO SIGNIFICANCE.

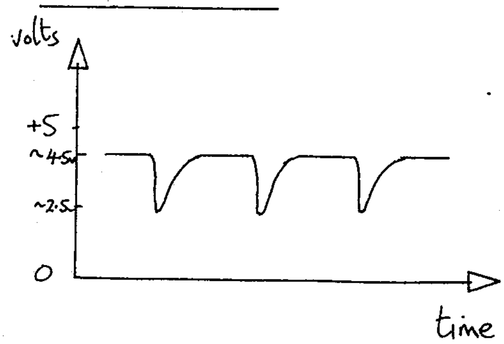


waveform for 0.1 Hz → 99.9 Hz.

Mk I (100 kHz)



Mk II (100 kHz)



ISL4/ISL4* EPROM's

USER NOTES

PROGRAM '79' — **SINE WAVE GENERATION**

(ONLY WORKS IF ISL3/ISL3* EPROM IS INSERTED IN YOUR VELA)

PARAMETER VALUES

'0' SELECTS A 10 kHz SINE WAVE OUTPUT.

'1 TO 999' SELECTS A SINE WAVE OUTPUT IN THE RANGE 0.1 Hz TO 99.9 Hz.

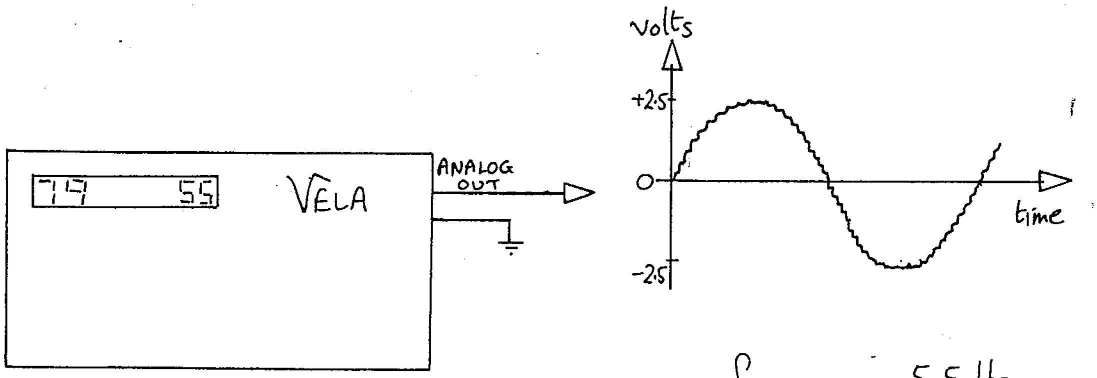
KEY IN

[7] [9] [N] [N] [N] [ENTER]

THE DISPLAY SHOWS THE FREQUENCY SELECTED, AND THE OUTPUT IS AVAILABLE AT THE ANALOGUE OUTPUT. NOTE THAT THE OUTPUT IMPEDANCE IS ∿ 10kΩ FOR VELA MK II, AND ∿ 560 Ω FOR VELA MK I. A POWER AMPLIFIER IS ESSENTIAL IF THE OUTPUT IS TO BE USED TO DRIVE LOW IMPEDANCE CIRCUITS SUCH AS VIBRATION GENERATORS.

ACCURACY

USERS SHOULD NOTE THAT WHILST THE RESOLUTION IN THE SELECTED FREQUENCY IS ∿ 1% BELOW 6 Hz, THIS DETERIORATES PROGRESSIVELY TO A WORST CASE OF ∿ 15% AT THE TOP END OF THE RANGE. CONSEQUENTLY THE LAST DIGIT AT HIGHER FREQUENCIES IS MEANINGLESS.



frequency ~ 5.5 Hz

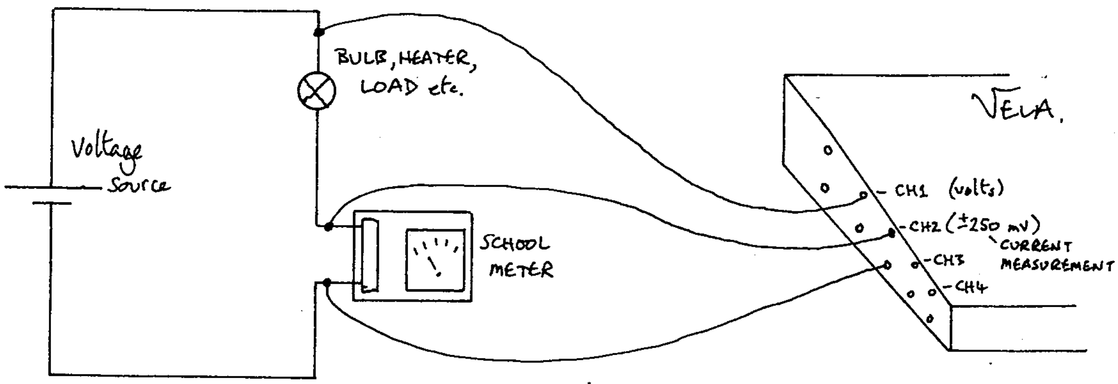
ISL4/ISL4* EPROM's

User Notes

APPENDIX A

CURRENT MEASUREMENT

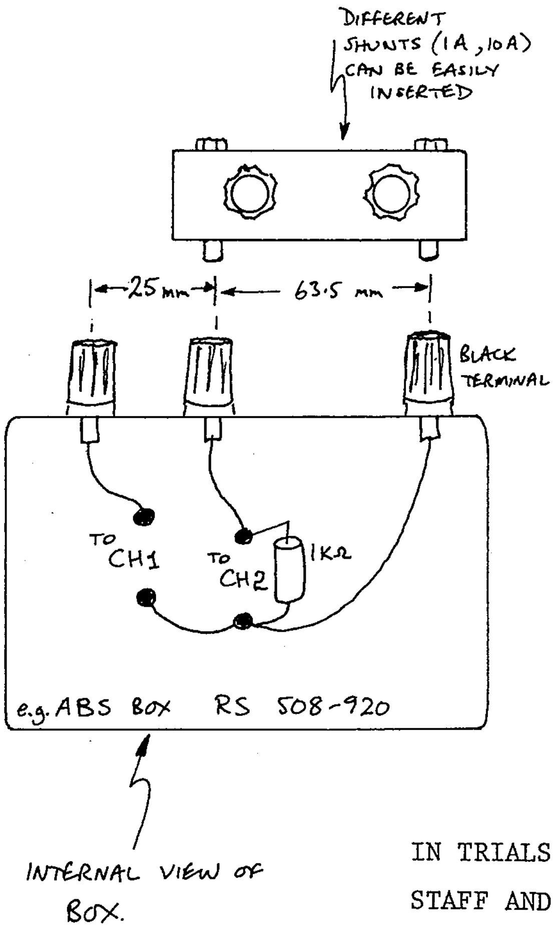
A TYPICAL SCHOOL METER HAS f.s.d. OF 100 mV, e.g. UNILAB METER 1000 Ω, 100 μA f.s.d., AND OF COURSE THIS VOLTAGE IS CONSTANT WHEN CURRENT SHUNTS ARE ADDED. IF THE VELA INPUT RANGE SWITCH IS SET TO ± 250 mV, AND THE VOLTAGE ACROSS THE AMMETER IS MEASURED THEN VELA's DISPLAY WILL BE PROPORTIONAL TO THE CURRENT BEING MEASURED BY THE AMMETER AND THE CONSTANT OF PROPORTIONALITY WILL BE A SIMPLE POWER OF TEN. IN OTHER WORDS FOR VELA's DISPLAY TO INDICATE THE CURRENT CORRECTLY, THE DECIMAL POINT MUST BE ADJUSTED WHILE LEAVING THE RANGE SWITCH SET TO ± 250 mV. THIS IS WHAT IS DONE IN THE SCALED D.V.M. AND ENERGY/POWER PROGRAMS.

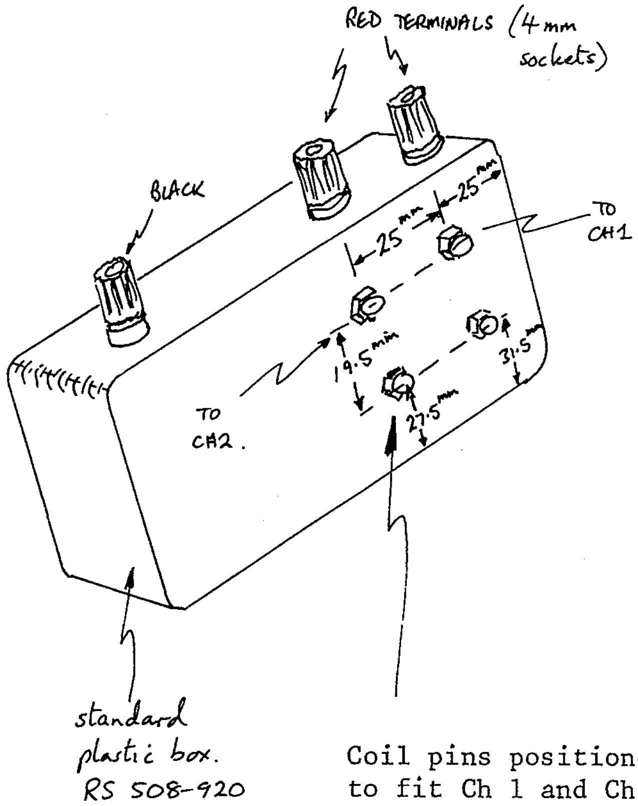


THIS SIMPLE APPROACH OF LITERALLY MEASURING THE VOLTAGE ACROSS THE METER RESULTS IN COMPLICATED WIRING AND IT IS SUGGESTED THAT A SIMPLE PLUG-ON UNIT BE CONSTRUCTED FOR VELA, e.g. IF YOU USE A UNILAB 1000 Ω METER.

USER NOTES

APPENDIX A (continued)





Coil pins positioned to fit Ch 1 and Ch 2 Inputs. Check dimensions before drilling

IN TRIALS THIS ARRANGEMENT MADE IT MUCH EASIER FOR STAFF AND PUPILS TO SIMPLY VIEW CH 2 AS A CURRENT RANGE. THE 1 kΩ RESISTOR REPLACES THE 1000 Ω METER. THE BASIC BOX WITHOUT ADDITIONAL SHUNTS CORRESPONDS TO A CURRENT OF 100 μA. YOU ARE ADVISED TO AVOID USE OF DUAL RANGE SHUNTS, AS THESE CAN GIVE FALSE RESULTS BECAUSE OF THE COMMON NEGATIVE USED BY CH 1 AND CH 2 INPUTS.

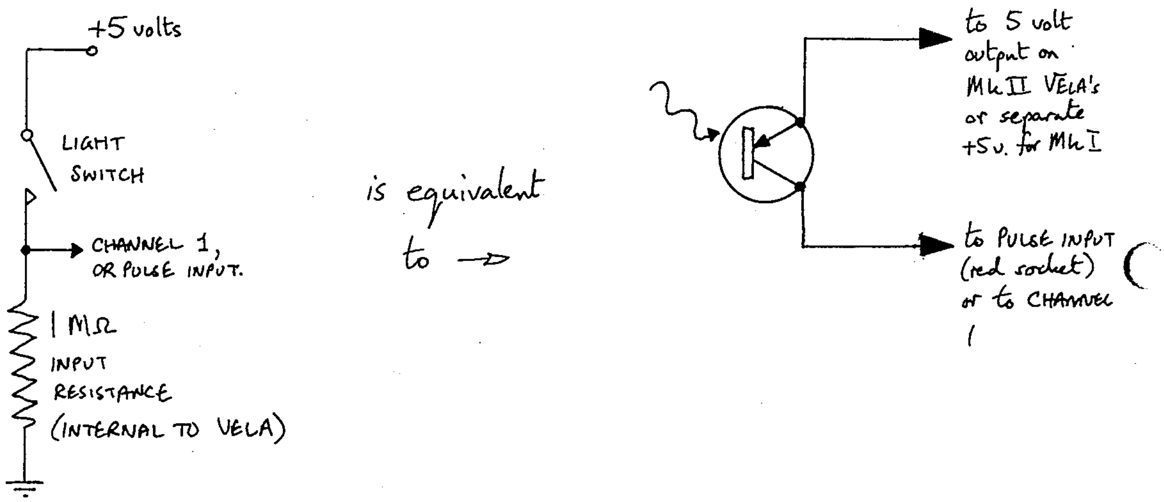
NOTE THAT THIS ARRANGEMENT EXTENDS THE RANGE OF THE SHUNT, e.g. 1 mA UP TO 2.5 mA, BUT BEWARE OF OVERHEATING YOUR SHUNTS.

ISL4/ISL4* EPROMs

USER NOTES

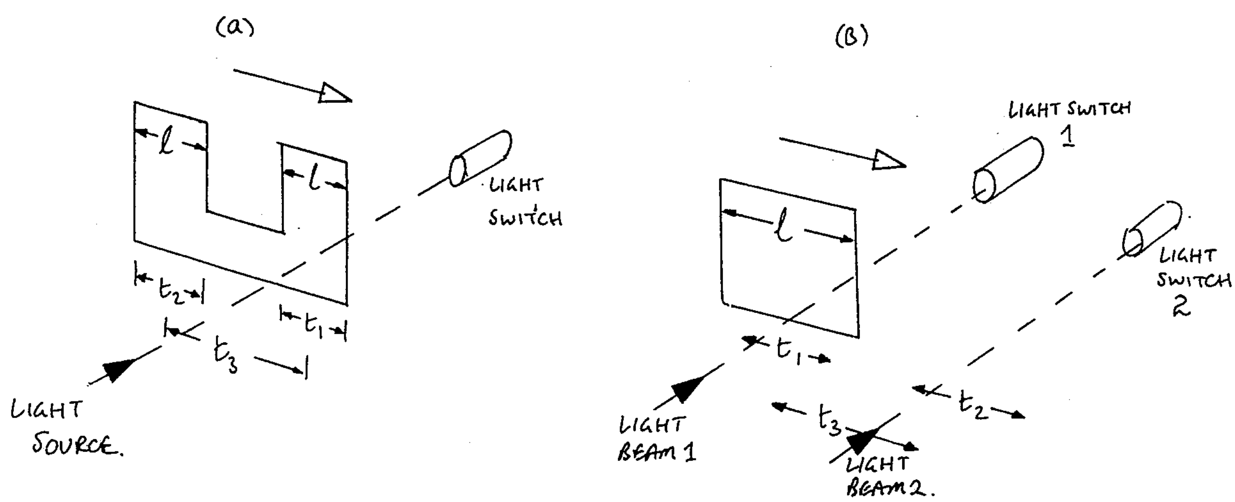
APPENDIX B

THE ORIGINAL USER MANUAL FOR YOUR VELA OUTLINES THREE DESIGNS OF LIGHT SWITCH USED BY COMMERCIAL SUPPLIERS AND SUITABLE FOR USE BY THE D.I.Y. TEACHER. A FOURTH, AND SIMPLER, ALTERNATIVE IN TERMS OF WIRING IS THIS:



THIS WORKS RELIABLY FOR PHOTODIODE R.S. 305 - 462 † AND I.R. DETECTOR R.S. 306 - 083 † PROVIDED THEY ARE WELL SHIELDED FROM EXTRANEOUS LIGHT AND THAT THE CARD, etc. USED TO CUT THE LIGHT BEAM IS TRULY OPAQUE.

ACCELERATION MEASUREMENT (TWO TECHNIQUES)

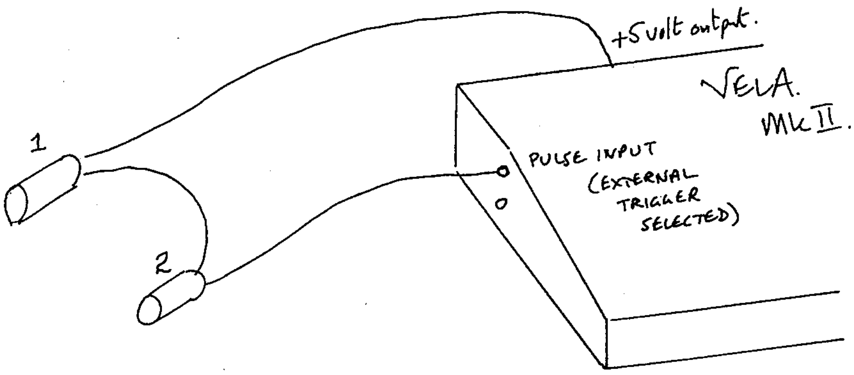


† AVAILABLE FROM RS COMPONENTS LTD, P.O. BOX 99 CORBY, NORTHANTS. ENGLAND.

APPENDIX B (continued)

TWO EXPERIMENTAL METHODS ARE POSSIBLE. IN (a) TWO SUCCESSIVE LENGTHS 'ℓ' CUT A LIGHT BEAM ENABLING THE SPEED OF EACH TO BE CALCULATED AND THEN THE ACCELERATION. IN (b) ONE CARD LENGTH 'ℓ' CUTS TWO LIGHT BEAMS. AGAIN THE SPEED THROUGH EACH LIGHT BEAM CAN BE CALCULATED, AND THEN THE ACCELERATION.

IN BOTH (a) AND (b) $v_1 = \frac{\ell}{t_1}$; $v_2 = \frac{\ell}{t_2}$; $a = \frac{v_2 - v_1}{t_3}$



this arrangement is equivalent to:

DO ENSURE THAT THE LIGHT BEAMS ARE CUT BY AN OPAQUE (BEWARE OF THIN CARD OR CARDBOARD !!) MATERIAL AND THAT THE PHOTODIODES/PHOTO-TRANSISTORS ARE SHIELDED FROM UNWANTED LIGHT.

THE APPROPRIATE PARAMETER FOR METHOD (a) AND (b) WOULD BE $\boxed{1}$

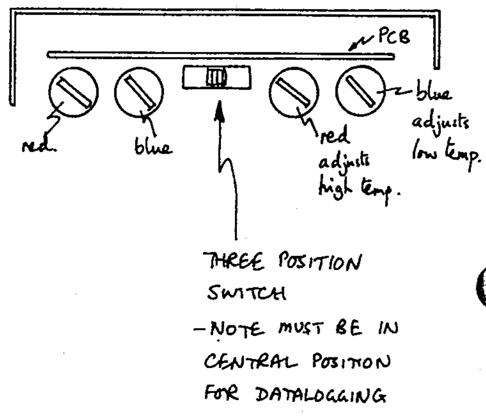
APPENDIX C

TEMPERATURE MODULE AND SENSORS

THE SENSORS USED ARE CALIBRATED EPOXY COATED THERMISTOR BEADS. THESE ARE EMBEDDED IN A LENGTH OF p.t.f.e. SLEEVING FOR CHEMICAL AND HEATING PROTECTION, AND ARE SEALED WITH EPOXY. THE TWO MOST LIKELY FAULTS ARE (1) CHEMICAL ATTACK, THIS DESTROYS THE CALIBRATION AND CANNOT BE RECTIFIED. (2) ELECTRICAL BREAK, THIS CAN BE REPAIRED. THE p.t.f.e. SLEEVING CAN BE REMOVED WITH CARE AND RESEALED WITH ARALDITE.

THE SENSOR FORMS PART OF AN R-C TIMING CIRCUIT FOR A 555 TIMER BASED ASTABLE CIRCUIT. VELA MEASURES THE FREQUENCY OUTPUT AND CONVERTS THIS TO TEMPERATURE.

THE CIRCUIT IS CALIBRATED USING TWO INTERNAL RESISTORS WHICH HAPPEN TO CORRESPOND TO TEMPERATURES 1.3°C AND 100.3°C. CALIBRATION CAN BE CHECKED AS FOLLOWS:-



(1) REMOVE THE BASE OF THE MODULE.

(2) SLIDE SWITCHES TO THE RIGHT.

(3) CHECK DISPLAYS SHOWS 1.3°C. IF NOT, ADJUST RIGHT PRESET OF EACH PAIR. ONCE SET THIS END OF THE RANGE SHOULD NEED ONLY OCCASIONAL ADJUSTMENT UNLESS EXPOSED TO EXTREMES OF TEMPERATURE.

(4) SLIDE SWITCHES TO THE LEFT.

(5) CHECK DISPLAY SHOWS 100.3°C. IF NOT, ADJUST LEFT PRESET OF EACH PAIR. THIS END OF THE RANGE DOES TEND TO DRIFT. IT IS NOT WORTH ADJUSTING IF IT IS LESS THAN 0.2°C OUT.

ACCURACY: ± 0.5°C IN RANGE 0°C TO 70°C, ± 1°C EITHER END OF RANGE.

RESOLUTION: 0.1°C FROM +110°C → -13.9°C
0.2°C FROM -13.9°C → -24.9°C

EXTRA SENSORS CAN EASILY BE MADE IN-HOUSE USING THE FOLLOWING

PARTS: THERMISTOR BEAD (R.S. 151-243) CABLE (R.S. 357-435)
p.t.f.e. SLEEVING (R.S. 399-833) BANANA PLUGS + ARALDITE.

A SET OF WORKSHEETS AND TEACHERS GUIDE — ONLY £20

Experiment with VELA

his publication is intended to help teachers get the best out of their VELA.
t includes 62 detailed worksheets split into 4 groups.

ntroductory worksheets (up to 14 yrs.)
Measuring temperature *◊
How hot are you? *◊
Changing the temperature *◊
Observing water boil *◊
Making clouds *◊
Thermal conduction along solid rods *◊
Does 'huddling together' keep animals warm? *◊
Transfer of energy through a solid *◊
Transfer of energy through a liquid *◊
0 Transfer of energy through a gas *◊
1 Monitoring animal activity or road traffic activity

econdary worksheets (13 yrs. to 16 yrs.)
2 Muscle fatigue
3 Measuring speed *
4 Do clothes keep you warm? *◊
5 Testing double glazing *◊
6 Energy - 'save it' *
7 Heating curves for aluminium *◊
8 Heating curves for aluminium and water *◊
9 Specific heating energies *§
20 Absorption of infra-red radiation *◊
21 The strange behaviour of freezing water *◊
22 Cooling curves for hexadecan-1-ol and water *◊
23 Investigating a heating system *◊
24 Monitoring soil or pond temperatures *◊
25 Monitoring solar radiation *◊
26 Conservation of energy *◊
Gravitational potential energy to internal energy
27 Measuring the velocity of sound *
28 Voice patterns and musical notes
29 Interference of sound waves
30 Conservation of energy *
Gravitational potential energy to kinetic energy
31 Measuring velocity and acceleration *
32 Determination of 'g' *
33 Force, mass and acceleration F = ma *
34 Force, mass and acceleration F = ma *

Intermediate worksheets (15 yrs. to 17 yrs.)
35 Force, mass and acceleration F = ma *
36 Conservation of momentum *
Elastic collisions
37 Conservation of momentum *
Inelastic collisions
38 Measuring the force between a snooker cue and ball *
39 Measuring the velocity of an air rifle pellet *
40 Measuring the efficiency of a d.c.generator/motor *
41 Comparing visible light emissions *
Fluorescent, tungsten filament and quartz halogen bulb
42 Range of radioactive emissions
43 Monitoring background radioactivity
44 Half-life of protactinium
45 Decay of radon gas

Advanced worksheets (16 yrs. to 18 yrs.)
46 Deflection of ß-particles by a magnetic field
47 Capacitor charge and discharge
48 Power dissipation in d.c. and a.c. circuits *
49 Specific energy of fusion for water *
50 Specific energy of vaporisation for water *
51 Making a position transducer
52 Motion of an oscillator
53 Measuring the wavelength of sound waves *
54 Diffraction and interference of light
55 Energy dissipated by a discharging capacitor *
(direct method)
56 Energy dissipated by a discharging capacitor *◊
(indirect method)
57 Factors affecting capacitance *
58 Electrical potential around a charged sphere
59 Entropy changes of a gas *◊
60 Measuring the self-inductance of a coil
61 Power dissipation in resistive and reactive circuits *
62 Power dissipation in an inductive circuit *

* These worksheets require VELA to be fitted with the physics eprom.
◊ These worksheets make use of the temperature module and sensors.
§ Use of the temperature module and sensor is optional.