PICAXE-18X DATALOGGER (AXE110)

Contents:

1) Description:

The PICAXE-18X datalogger is an economical four channel datalogger based upon the PICAXE-18X microcontroller. This microcontroller can be re-programmed to perform many different types of logging experiment ("mission").

Logging can be carried out at regularly spaced intervals (typically 10 seconds to several hours), or an optional real-time-clock chip can be added to the datalogger to ensure accurate logging intervals over long periods (once a week, once a month etc.)

Data is saved in an external memory chip. If desired this memory chip can be upgraded for increased memory capacity. An optional memory expansion board can also be used to greatly increase memory capacity.

Once the mission is complete, data can be uploaded for analysis on a computer. Data can also be displayed (at the time of logging) on an optional liquid crystal display if desired.

Programming of the mission is simplified by use of automated 'Wizards', which generate the BASIC code to download to the PICAXE-18X microcontroller. Experienced users may also choose to write their own mission BASIC code (or to modify the programs generated by the automated wizard).

Features:

- Easy to use software wizards to start datalogging missions.
- Supports PICAXE-18X microcontroller and on-board EEPROM data memory.
- 4 logging channels.
- Dedicated digital temperature sensor channel.
- Small footprint - approx. same size as the power supply (3x AA cells).
- Optional real-time-clock with lithium cell backup (AXE034)
- Optional serial LCD module for on-board display of data (AXE033)
- Expandable i2c bus for additional EEPROM memory capacity (AXE111)
- Low power consumption, powered by 3x AA cells.

The datalogger is available as a self assembly kit or as a pre-assembled complete unit.
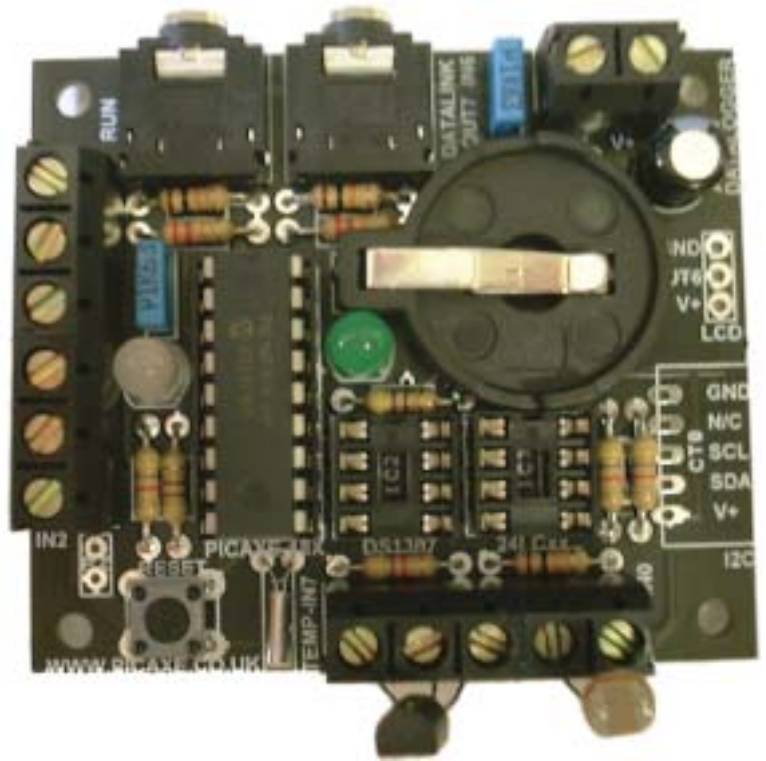
Input Channels

The datalogger has 4 input channels (labelled 0,1,2,7)

Input 0 is normally used for a miniature light sensor (LDR – light dependant resistor). The miniature LDR is connected via the two screw terminals in terminal block CT6. This input is pre-configured as a potential divider with a 10k pull-down resistor.

Input 7 is pre-configured for use with a DS18B20 digital temperature sensor. This is connected via terminal block CT5. The flat side of the sensor faces down when connecting the sensor into the terminal block.

Inputs 1 and 2 are arranged for connection of your own sensors (analogue or digital). Each input pin, and V+ and 0V, are connected to terminal blocks CT3 and CT4. No pull-down resistors are present on the board, and so should be connected externally (if required).
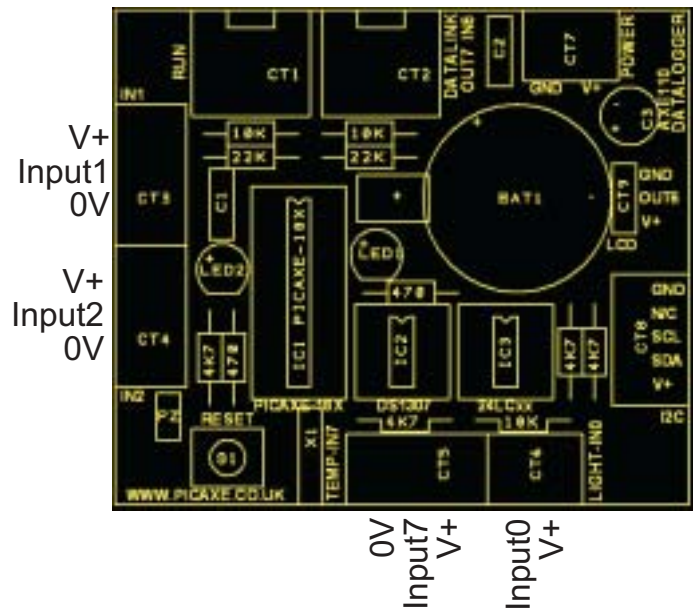
Memory

The datalogger kit is supplied with a 24LC16B EEPROM memory chip. This can store 2048 byte readings (8 blocks of 256 bytes). This usually enables 512 readings for each of the four sensors.

If desired, the memory capacity can be increased by replaced this EEPROM with a 24LC256 EEPROM (part MIC050). This can store 32768 bytes of data (128 blocks of 256 bytes).

For additional data storage capacity the optional AXE111 memory expansion board can be used. This allows an additional seven 24LC256 to be connected, giving a total of 2MB of memory (1024 blocks of 256 bytes).

Power Supply

The datalogger is designed to run from a 3xAA battery pack (3 x 1.5V = 4.5V with alkaline cells). If using rechargeable cells a 4xAA pack should be used to (4 x 1.2V = 4.8V).

The positive (red) wire should be connected to V+ on the terminal block connector CT7. The negative (black) wire should be connected to GND. When connecting the wires it is recommended that the bare wire is bent back over the insulation, and then the screw tightened on both. This gives a much stronger joint.

If a wall-plug adapter is used it must be a very high quality regulated unit. It must output exactly 4.5V or 5V DC only. Note that very cheap wall-adapters are often unregulated devices that may cause the datalogger to function incorrectly.

Connection of a higher voltage (e.g. a 9V PP3 battery), or accidentally reversing the power supply connections, will damage the ICs and digital temperature sensor on the datalogger. These will then require replacing.

Serial Cable Connections

The datalogger has two sockets for connection of the serial cable. CT1, marked 'Run' is to connect the cable when it is necessary to reprogram the PICAXE microcontroller to start a new mission. CT2, marked 'Datalink' is to connect the cable for transfer of mission data between the PICAXE chip and computer.

Optional Real Time Clock (RTC) Upgrade

The optional real time clock upgrade (part AXE034) consists of a DS1307 RTC chip and a 3V lithium CR2032 backup cell. When inserted into the datalogger sockets, this upgrade adds additional accurate clock functionality. Note that the RTC needs to be initialised (by setting the current time/date by using the time/date wizard) before it will function correctly. The lithium cell will maintain the time and date for approximately 10 years.

Additional Outputs

The datalogger has a bicolour LED (LED2) connected between outputs 2 and 3. Switching output 2 high and output 3 low will produce a green colour. Switching output 2 low and output 3 high will produce a red colour.

Note that the green LED (LED1) is connected to the square wave output of the optional DS1307 RTC chip, not the PICAXE chip. It will automatically flash on and off every second when the DS1307 chip is inserted (and initialised by the time/date wizard). This LED cannot be controlled directly by the PICAXE chip.

An optional piezo sounder (part SPE002) can be connected to output 0 via the holes marked PZ on the left hand side of the board. A 'sound' command can then be used to generate information and/or warning signals.

An optional serial LCD module (part AXE033) can be connected to output 6 via the holes marked LCD on the right hand side of the board. 'Serout' commands can then be used to display data on the serial LCD module. Note that the serial LCD module is designed to work at 6V, and so will only operate correctly at 4.5V if the diode D1 on the serial LCD module is bypassed with a piece of wire.

Using the Datalogger:
Normal Use

To program the datalogger for a mission, most users use the simple 'Wizards' which automatically generate the correct BASIC program for the PICAXE-18X microcontroller. See the 'Starting a new Datalogger mission' section on page 8 for more information.

Advanced Use

Advanced users may choose to write their own programs, to, for instance, allocate the memory to different sensors or to increase or decrease the logging period. In this case it is strongly recommended that the user carefully studies a 'wizard generated' sample program as a tutorial in how to write the BASIC for the datalogger module. It is also strongly recommended that the user has read the 'Tutorial in using the i2c bus' (AXE110_i2c.pdf), which explains how to use the 24LCxx series EEPROM memories and the DS1307 real-time-clock.

2) Self-Assembly Kit - Overview:

The PICAXE-18X datalogger board is a high quality plated through PCB and is therefore relatively straight forward to assemble. However a number of the electronic components are polarised, so please ensure these components are fitted the correct way around before soldering (see table on next page).

Note that a pre-assembled kit is also available for those with no soldering experience.

Tools required (not supplied):
- Soldering iron and solder
- Side Cutters
- Small pair of pliers

Soldering experience is assumed.

Contents:

•	PCB	1	PICAXE-18X Datalogger PCB	
•	IC1	1	18 pin IC socket	
•	IC2,3	2	8 pin IC socket	
•	R1,2	2	22k resistor (red red orange gold)	
•	R3,4,5	3	10k resistor (brown black orange gold)	
•	R6,7,8,9	4	4k7 resistor (yellow violet red gold)	
•	R10,11	2	470 resistor (yellow violet brown gold)	
•	C1,2	2	100nF (104) polyester capacitor	
•	C3	1	100uF electrolytic capacitor	*** + marked on PCB
•	LED1	1	green LED	*** flat marked on PCB
•	LED2	1	bicolour LED	*** flat marked on PCB
•	S1	1	miniature push switch	
•	X1	1	miniature watch crystal	
•	CT1,2	2	3.5mm stereo socket	
•	CT3,4,5	3	3 pin screw terminal block (may be supplied clipped together)	
•	CT6,7	2	2 pin screw terminal block (may be supplied clipped together)	
•	CT8	1	5 pin r/a connector	
•	BAT1	1	CR2032 cell holder	
•	LDR	1	miniature LDR (use in connector CT6)	
•	DS18B20	1	digital temperature sensor (use in connector CT5)	*** flat side faces solder side of pcb
•	POWER	1	4.5V battery box (use in connector CT7)	*** red wire to V+, black to GND
•	IC1	1	PICAXE-18X microcontroller	*** pin 1 faces up
•	IC3	1	24LC16B EEPROM	*** pin 1 faces up

(*** denotes components which must be soldered the correct way around. See notes above).
(IC2 & cell (AXE034) and piezo sounder PZ (SPE002) are optional upgrades not included in pack)
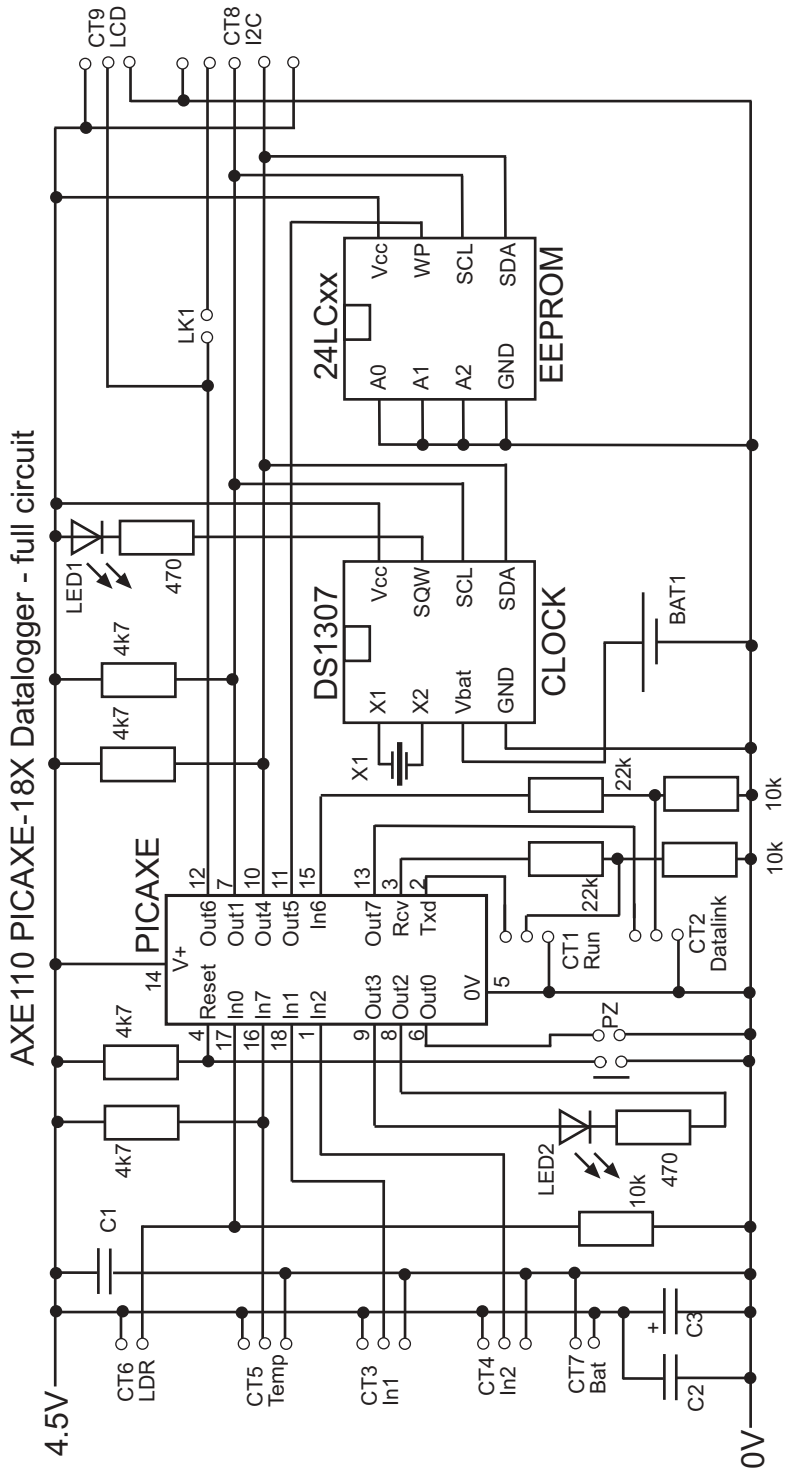
Assembly Instructions:
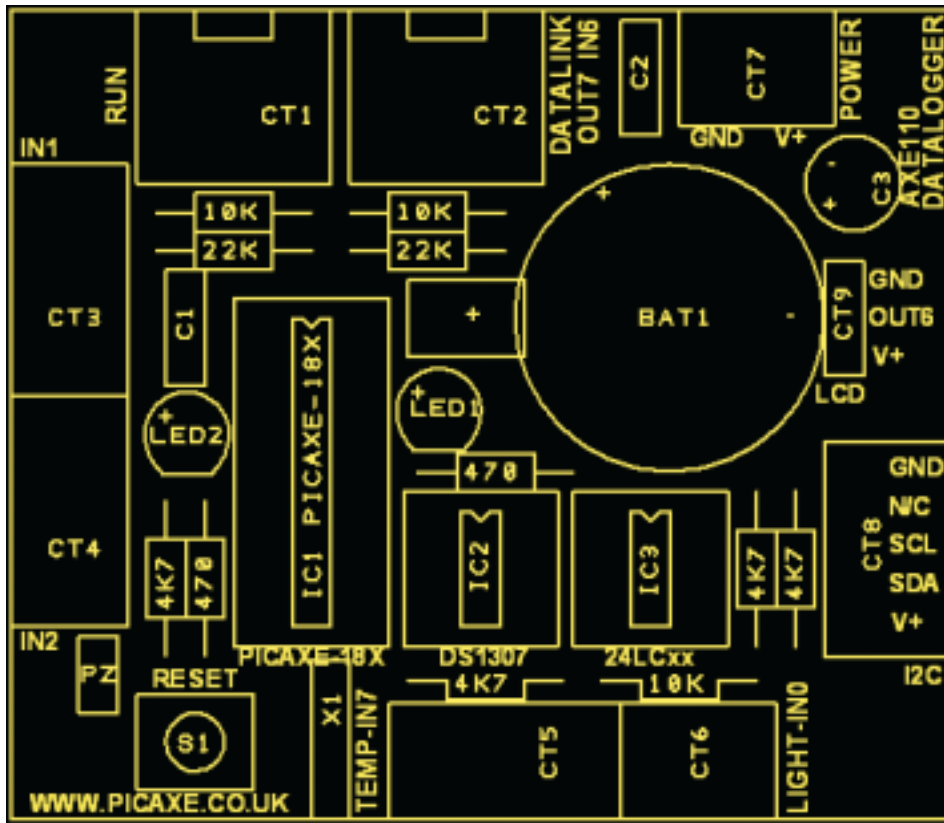
1. Solder the resistors in position. Note the pads marked LK1 under the 4k7/470 resistors are not used.

2. Solder the watch crystal in position X1. Note the can of the crystal can be soldered on top of the PCB to secure it in position.

3. Solder the three IC sockets and push switch S1 in position.

4. Solder the CT1 and CT2 connectors in place. Ensure these stereo sockets 'click' into position flat on the PCB prior to soldering.

5. Solder the capacitors and LEDs in position

6. Solder the remaining connectors in position. Note that where the screw terminals are fitted side by side they should be clipped together before soldering.

7. Solder the BAT1 battery conector in position.

8. Insert the PICAXE-18X (IC1) and 24LC16B (IC3) into their sockets.

Optional Upgrades

9. If using the optional RTC upgrade (AXE034) insert the IC into socket IC2 and the battery into it's holder.

10. If using an optional piezo sounder (SPE002) solder it in position PZ

11. If using the optional serial LCD (AXE033), connect it to the LCD header.

   Note that LED1 will not flash unless the optional RTC upgrade is fitted and the DS1307 RTC clock chip has been initialised.

3) Circuit Diagram

AXE110 PICAXE-18X Datalogger - full circuit

4) PICAXE-18X Datalogger Input/Output Pin Connections:

Analogue Input 0   - LDR light sensor (connector CT6)
Analogue Input 1   - spare sensor input 1 (CT3)
Analogue Input 2   - spare sensor input 2 (CT4)
Digital Input 6   - datalink serial input
Digital Input 7   - DS18B20 temp. sensor (CT5)

Output 0   - piezo sounder (optional - PZ)
Output 1   - i2c SDA
Output 2   - bicolour LED red
Output 3   - bicolour LED green
Output 4   - i2c SCL
Output 5   - EEPROM Write Enable
Output 6   - serial LCD (optional - LCD)
Output 7   - datalink serial output

Serial Connection

The PICAXE download 'run' connection uses ther standrad PICAXE programming pins.

The datalink connection uses input 6 for 'serin' serial commands and output 7 for 'serout' serial commands.

Default Sensors

The datalogger is supplied with two sensors, and has capacity for an additional 2 sensors (not supplied). Note the power connections and inputs are labelled on the solder side of the PCB.

LDR

A miniature LDR (light dependant resistor) can be connected into terminal block CT6, so that it is connected to input0 of the PICAXE-18X microcontroller.
The light level can then be measured by use of the 'readadc' command.

DS18B20 Digital temperature Sensor

The DS18B20 digital temperature sensor can be connected into terminal block CT5, so that it is connected to input7 of the PICAXE-18X microcontroller. The flat side of the sensor should face down as it is connected into the terminal block.

The digital temperature sensor is a very accurate device which will give readings in exact degrees celsius by use of the 'readtemp' command.

5) Starting a new Datalogging Mission.

1. Start the Programming Editor software
2. Select View>Options and select PICAXE-18X mode. Click OK.
3. Select PICAXE>Wizards>AXE110 Datalogger>Start New Datalogger Mission
4. Select the datalogging mission options and then click 'OK'.

Note that once a datalogger program is downloaded, the mission starts running automatically, and data is saved in the external memory. It is not possible to reset the mission by use of the RESET button on the datalogger, as the data is saved in the external EEPROM. Therefore to start a new mission you must download a new program.

The New Datalogging Mission wizard screen looks like this:
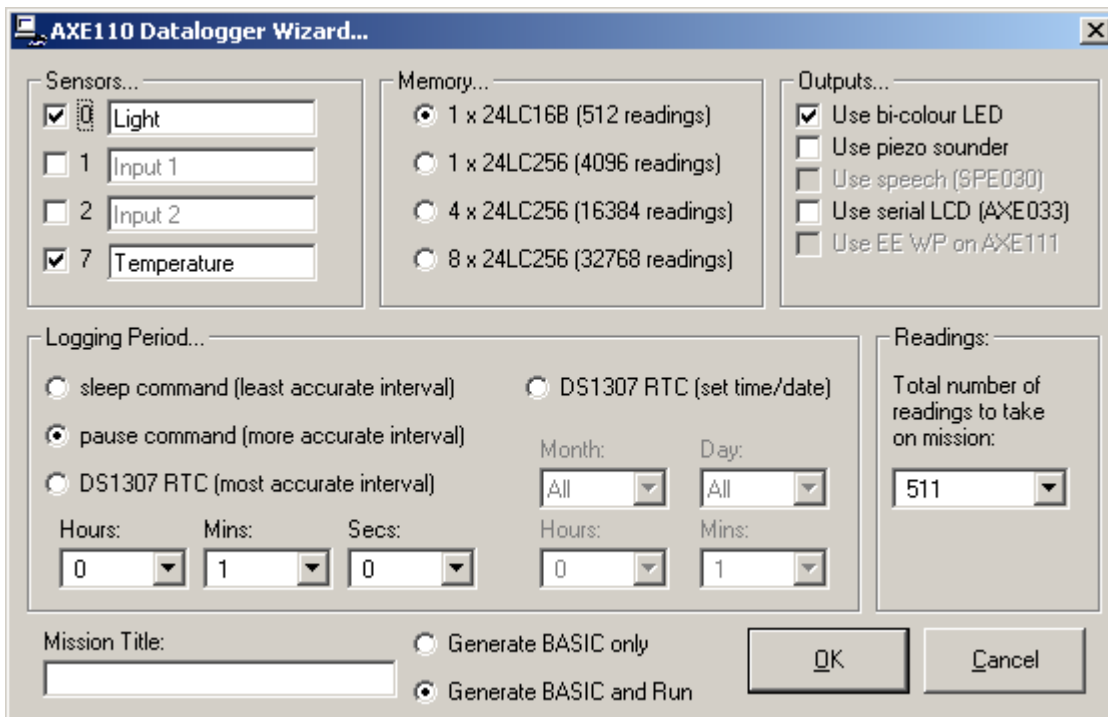
The '**Sensors**' box allows up to four sensors to be selected. Each sensor can also be named with a text string (up to 16 characters) which is saved in the PICAXE memory.

The '**Memory**' box allows the type of memory used to be selected. Note that the 4 and 8 x 24LC256 options require use of the optional memory expansion board (part AXE011).

The '**Logging Period**' box allows the interval between readings to be selected.

There are three options for general time intervals:
    sleep – uses the sleep command to reduce power consumption, but is the least accurate
    pause – more accurate, but increased power consumption than the sleep option
    DS1307 RTC – most accurate, but requires RTC upgrade

There is also a fourth option to select readings at specific time/dates using the RTC upgrade. This is generally used on much longer datalogging missions.

The '**Readings**' box allows the number of mission samples to be selected (up to the memory limit).

The '**Outputs**' box allows selection of various outputs as follows:

- Use bi-colour LED
If selected, the status LED will flash green every time a reading is taken. When the mission is complete (or the memory is full) the LED will turn red. If a memory error occurs, the LED will alternately flash red/green.

- Use piezo sounder
If selected, the optional piezo sounder (SPE002) will beep every time a reading is taken.

- Use speech
If selected, the optional speech module (SPE020) will speak the readings as they are taken.

- Use serial LCD
If selected, the optional serial LCD module (AXE033) will display the readings as they are taken.

- Use EE WP on AXE111
If selected, output6 is used as a write-enable for the AXE111 memory expansion board. Note this option cannot be used at the same time as the serial LCD option, as both options use output6. If selected, a jumper wire should be soldered across the pads marked LK1 on the bottom of the AXE110 datalogger module.

## 6) Retrieving Data from a Datalogging Mission.

The 'Datalink' communications utility is used to retrieve mission data from the AXE110 Datalogger module. The utility saves the data in CSV (comma separated variable) format files, which can be opened in all common spreadsheet applications (e.g. Microsoft Excel) for further analysis. The utility also includes the option to automatically draw a graph of the data as it is uploaded (if required).

To use the 'Datalink' communications utility, a small BASIC program must be running in the PICAXE microcontroller. This program reads the data from memory and transmits it (via the 'Datalink' connector and serial cable) to the computer, where it can be processed by the 'Datalink' utility. This BASIC program is always automatically downloaded as part of a 'New Datalogger Mission' wizard program. Note that the 'Datalink' utility uses the standard PICAXE cable to retrieve the data from the datalogger module. However this cable must be inserted into the 'Datalink' socket (not the PICAXE 'Run' socket) for the 'Datalink' utility to function correctly.

Note: If you are unsure whether the datalogger has the correct BASIC program already running, a suitable program can be downloaded by using a program wizard (use menu option PICAXE>Wizard>AXE110 Datalogger>Retrieve Unknown Data). However this wizard should only be used if a normal datalogging program is not already running (see the AXE110 datalogger manual for further information).

Instructions on how to use the Datalink Utility:

1. Wait until the datalogger mission is complete (status LED red).
2. Connect the PICAXE cable to the Datalink socket on the datalogger.
3. Start the Programming Editor software.
4. Select PICAXE>Datalink menu (or press <F9> shortcut key).
5. Select the Options menu. Make sure the options are set to

    Baud Rate   – 4800
    Sensors   – (1 to 4 as appropriate)
    Send G   – enabled

6. If you would like the software to automatically draw a graph as data is uploaded, make sure the graph is visible on screen by selecting the 'Graph…' check box.
7. Click the File>New menu, and then follow the on-screen instructions.
8. The data will then be uploaded, and is immediately visible on screen. Once the data upload is complete, click the File>Save As menu to save the data as a CSV format text file. This file can then be opened (if desired) in other applications such as Microsoft Excel.
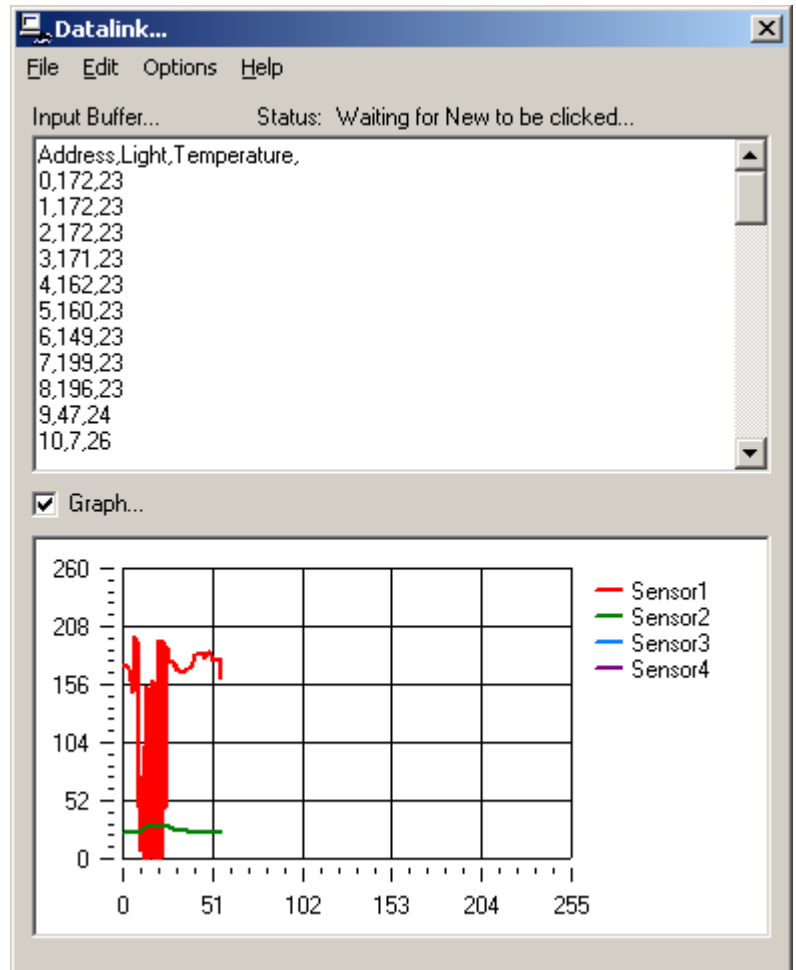
7) Using the AXE034 Real Time Clock Upgrade

The optional real time clock upgrade (part AXE034) consists of a DS1307 RTC (real-time-clock) chip and a 3V lithium CR2032 backup cell. When inserted into the datalogger, the upgrade adds additional accurate clock functionality. Note that the RTC needs to be initialised (by setting the current time/date) by the PICAXE chip before it will function correctly. The lithium backup cell will maintain the time and date for approximately 10 years.

Setting of the time and date can be completed without having to write a BASIC program by use of a Wizard.

To set the time/date:
1. Start the Programming Editor software
2. Select View>Options and select PICAXE-18X mode. Click OK.
3. Select PICAXE>Wizards>AXE110 Datalogger>Set DS1307 Time / date
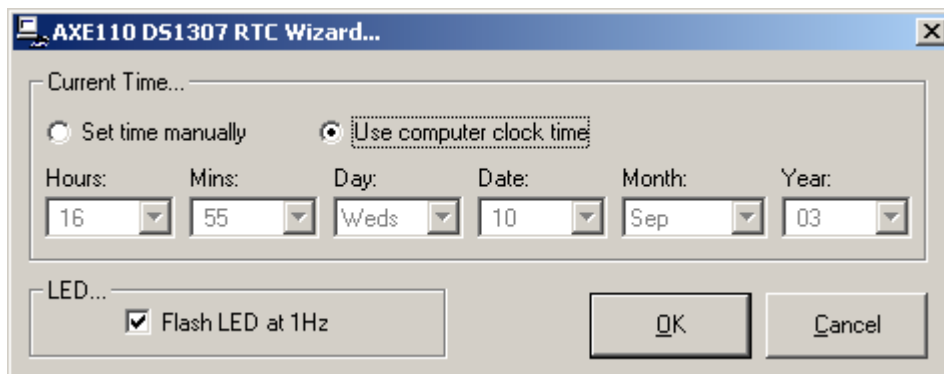
1. Set the time and date manually, or use the date from the computers clock.
2. Connect the programming cable to the 'Run' socket on the AXE110 Datalogger.
3. Connect the power supply to the AXE110 Datalogger.
4. Click 'OK' on screen.

A BASIC program to program the RTC will be generated and downloaded to the datalogger module. Once programming is complete the values are checked by the PICAXE microcontroller, and then the status LED will be lit (green for pass, red for fail).

If the 'Flash LED' option has been selected, the green LED on the datalogger should also start flashing once per second.

After the programming is complete, it is important to download an empty program to the PICAXE microcontroller to prevent the time being accidentally re-set the next time the datalogger is powered up.

8) Using the AXE033 Serial LCD Module

The optional AXE033 Serial LCD module can be used to display datalogging readings as they are taken. This module uses the serout command on output 6. To use this module connect the serial LCD module to the LCD connector on the right hand side of the datalogger. Note that the serial LCD module is designed to work at 6V, and so will only operate correctly at 4.5V if the diode D1 on the serial LCD module is bypassed with a piece of wire. See the AXE033 datasheet for more details.

9) Using the AXE111 Memory Expansion Board

The optional memory expansion board (part AXE111) allows 7 additional EEPROM chips (e.g. 24LC256) to be connected to the AXE110 Datalogger to increase its memory capacity from 1 EEPROM to 8 EEPROMs.

Kit Contents/Assembly:

PCB   PCB
IC1-7 8 pin IC sockets (x7)
C1   100nF capacitor
R1   10k resistor
CT1   5 pin r/a header
CT2   5 pin r/a socket

All parts should be soldered in position as shown in the diagram above. Note that the kit does not include EEPROM chips which must be purchase separately (e.g. 24LC256, part MIC050).

Slave Address
The PCB is arranged to give each memory IC a unique slave address as follows. (Note that the IC with address %10100000 is fitted on the AXE110 datalogger board).

IC1   %10100010
IC2   %10100100
IC3   %10100110
IC4   %10101000
IC5   %10101010
IC6   %10101100
IC7   %10101110

Write Enable
The Write Enable pin of each EEPROM is tied low by the 10k resistor, and so by default is permanently enabled. However, if desired, this can be controlled by output6 of the PICAXE-18X microcontroller on the datalogger module.

To use this option a wire link must be soldered between the two pads marked LK1 on the solder side of the AXE110 Datalogger. This connects output6 to the connector. Note that this option cannot be used if output6 is already being used to drive a serial LCD module.
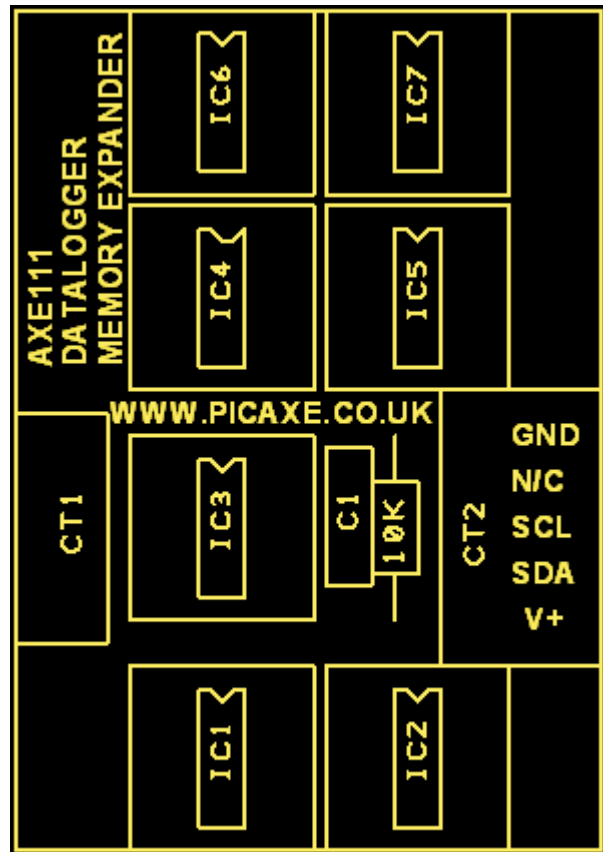
10) Using the SPE030 Speech Module.

The optional SPE030 speech module can be used to speak datalogging readings as they are taken. This module uses the i2c bus. To use this module insert the bottom 5 pins (i2c and power) of the SPE030 PL1 connector into the AXE110 i2c connector (CT8). See the SPE030 datasheet for more information on how to use this module.

11) Using the SEN008 Humidity Sensor (Honeywell HIH3610-001).

There are various humidity sensors on the market, but the recommended device for use with the PICAXE-18X datalogger is the Honeywell HIH3610-001. This sensor is a direct humidity to voltage device (with linear output), and it even has three pins which can plug straight into the datalogger terminal block connector CT4 (input1).

As with all humidity sensors, take care not to physically touch the sensing area of the device, as moisture/oils from the hand could damage the sensitive sensor element. When inserted into CT4 the small silver sensing area should be facing up.

A sample graph of the response of the humidity sensor is shown in the figure. When used with the PICAXE, the voltage output of the sensor is measured by the internal analogue-to-digital converter and stored in a variable (e.g. b1) as a number between 0 and 255. Each ADC step is 5V/256 = 0.0195V (assuming use of a regulated 5V supply).
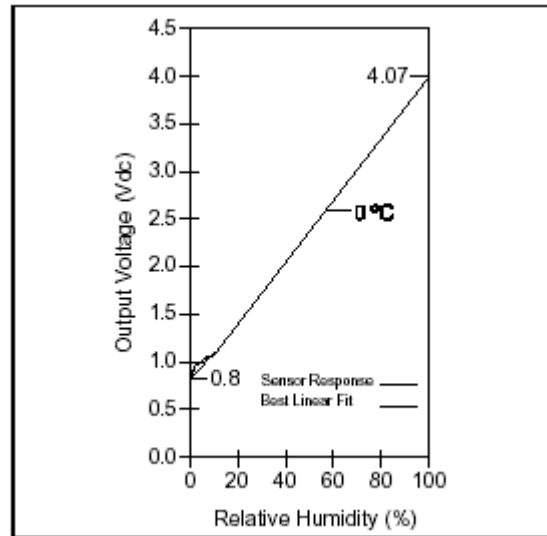
The manufacturers calibration graph shows an offset of approximately 0.8V, which equate to a ADC value of 41 (0.8 / 0.0195). The RH slope is set at about 0.0306V per %RH, or 1.57 ADC step per %RH

Therefore the actual RH% can be calculated by the following calculation.

RH = adc value – offset / (slope of graph)
RH = adc value – 41 / (1.57)

However as PICAXE cannot handle fractions, divide by 1.57 is actually calculated as a mathematical equivalent - multiply by 100 then divide by 157.

RH = adc value – 41 * 100 / 157

Checking these test values against a calibrated test probe using the test program shown below showed the resulting PICAXE system to be very accurate. However you may need to 'tweak' the offset and slope figures depending on sensor calibration, power supply voltage etc.

```
main:
    readadc 1,b1                 ' read humidity value
    let b1 = b1 - 41 * 100 / 157 ' change to %RH
    debug b1                      ' display on computer screen
    pause 500                     ' wait 0.5 second
    goto main                     ' loop
```

.