The *DATAPORT: Serial Port Data Logger*

MTM Scientific, Inc.   Website: www.mtmscientific.com

The *DATAPORT* from MTM Scientific is a project kit for building an electronic data acquisition module. The module is used to measure and record electronic data signals, such as voltage and temperature. The *DATAPORT* module acquires the data and sends the information to the computer using serial port communication. The data is graphically displayed on the computer screen during a data run for realtime monitoring. The data is also stored as a file for subsequent analysis and review. The basic layout of the *DATAPORT* is shown in Figure 1.

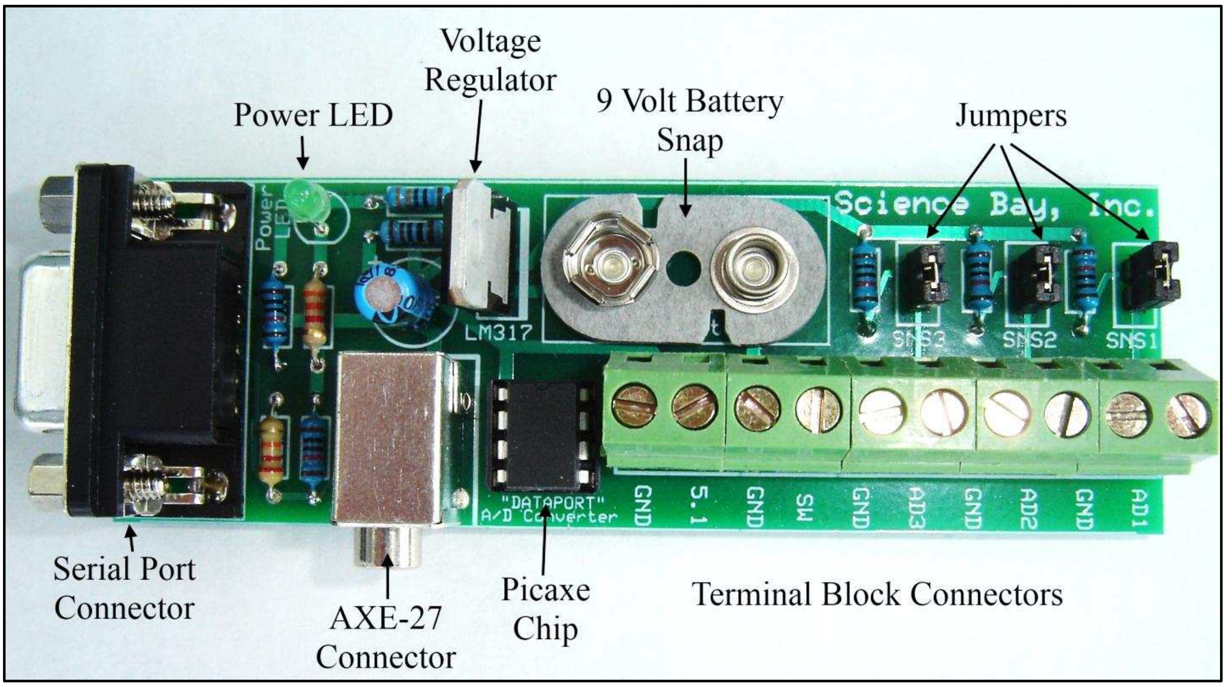

***Figure 1**: Serial Port DATAPORT by MTM Scientific, Inc.*

Kit Assembly / Hardware

Building the *DATAPORT* kit requires careful electronic assembly and soldering. A photograph of the assembled module is shown in Figure 1. All the electronic components are installed on the top side of the circuit board. Some of the electronic components must be installed with special attention to placement of the leads, as shown in Figure 2.

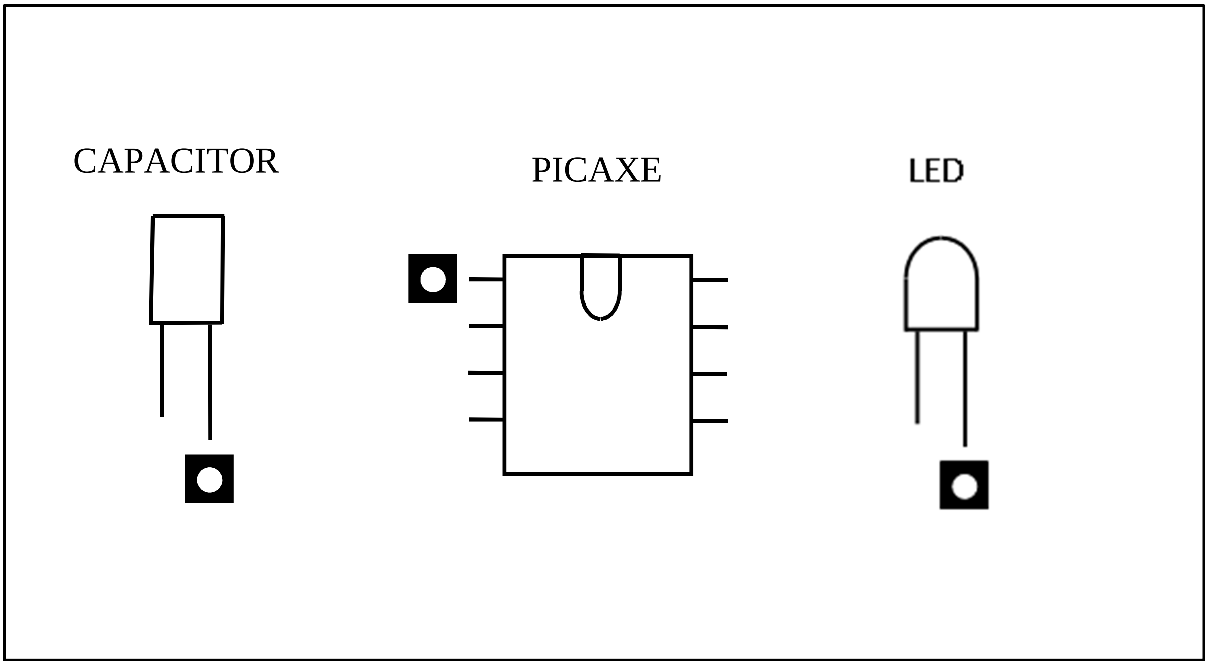

Figure 2. *The capacitor, Picaxe chip and LED have visual cues for insertion into the circuit board. Look for the square pad prints and longer leads.*

The resistors used in the kit construction can be identified using the color codes, as listed in Table 1.

Ohm	**Qty**	**Color Code**
330	1	Orange, Orange, Black, Black, Brown
1.0K	1	Brown, Black, Black, Brown, Brown
3.3K	1	Orange, Orange, Red (Beige Body)
10K	5	Brown, Black, Black, Red, Brown
22K	1	Red, Red, Orange (Beige Body)

Table 1. *Color coding of the kit resistors.*

The green electrical contact terminals should be connected together using the slide slots, before soldering them to the circuit board, as shown in Figure 3.

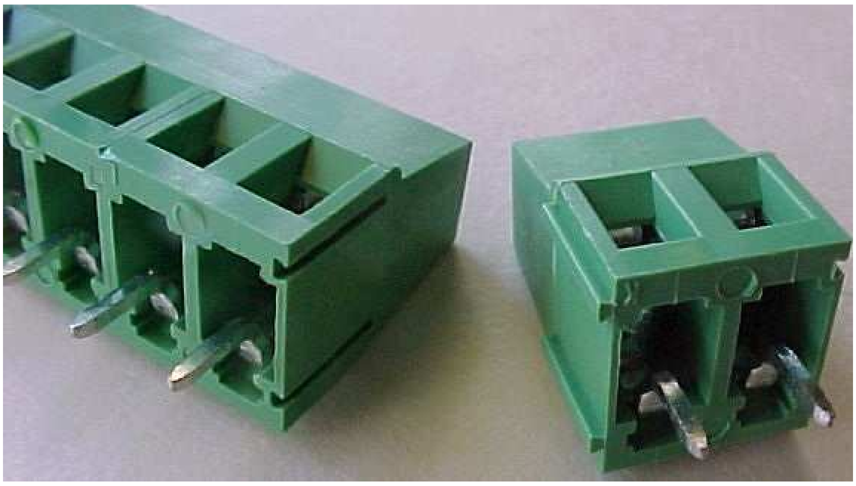

Figure 3. *Connect the terminal blocks together using the slide slots before soldering to the printed circuit board.*

Software

The *DATAPORT* computer program is written and compiled in the FreeBASIC language. The FreeBASIC language is easy to use. FreeBASIC is very similar to the original BASIC language. The language is free to download and use. The download site and documentation is available at the website here: http://www.freebasic.net

The source code for the *DATAPORT* program is contained in the compact disk that came with your kit. The code is commented to make it easier to understand. The code can be easily modified and recompiled to change the way it works.

Serial Port Connection Options

Before the *DATAPORT* can be used with your computer, serial port communication must be established. There are several options for connecting the *DATAPORT* to your computer. The 3 options are: 1) Connecting directly to a standard 9-pin serial port connector, 2) Connecting to a USB port using a converter, or 3) Connecting to the computer using an AXE-27 converter available from Revolution Education, Ltd.

Using a standard serial port on your computer is the best and least expensive option for connecting the *DATAPORT*. Examine the back of your computer to locate the serial port connector. Figure 3 shows a common connection panel on a desktop computer. The serial port for using the *DATAPORT* will have 9 male pins.

The datalogger module is designed for connection directly into a computer's serial port, without a cable. Note: In some cases it may be necessary to remove the 2 side nuts on the *DATAPORT* connector for a proper fit, as shown in Figure 4.

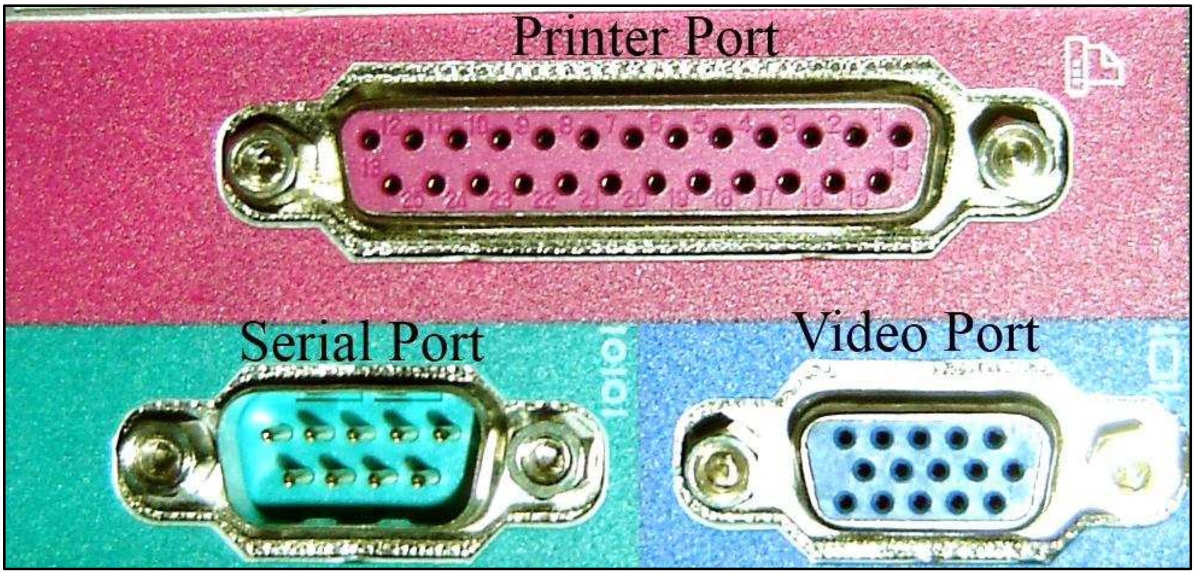

Figure 3*: The Serial Port on modern computers has 9 male pins.*

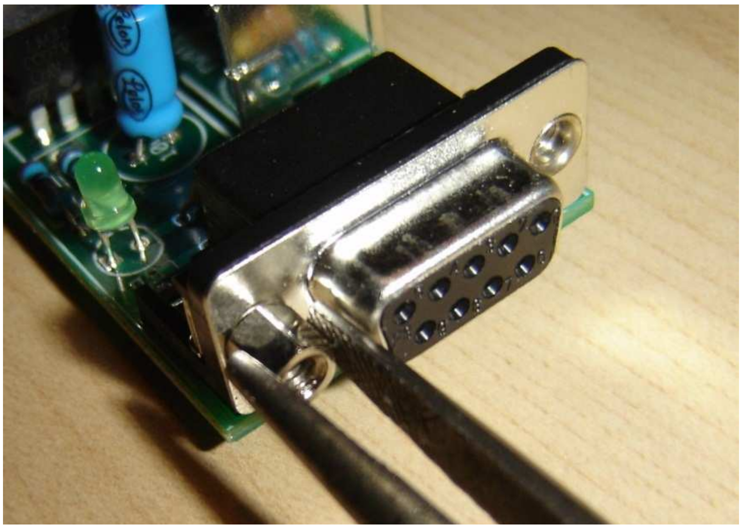

Figure 4. Remove the side nuts on the *DATAPORT* if necessary.

Analog to Digital: Channels and Jumpers

There are four input channels on the *DATAPORT*. The channels are labeled: AD1, AD2, AD3 and SW. Channel inputs are always connected with respect to ground, using the adjacent ground terminal connectors. Channels AD1, AD2 and AD3 can be used either for voltage measurements or sensor measurements.

To use channels AD1, AD2 or AD3 to measure voltage do not install the jumpers for the channels. With no jumper installed, each channel will measure voltage in the range of 0.0 to 5.0 VDC.

To use channels AD1, AD2 or AD3 with a sensor install the jumpers for the channels. With a jumper installed each channel will use a precision 10K resistor as a voltage divider to create a signal which is proportional to 10K resistance.

The switch channel does not have a jumper. The switch channel always measures a switch input: open or closed. Note that any type of switch can be used (toggle, pushbutton, limit, etc.)

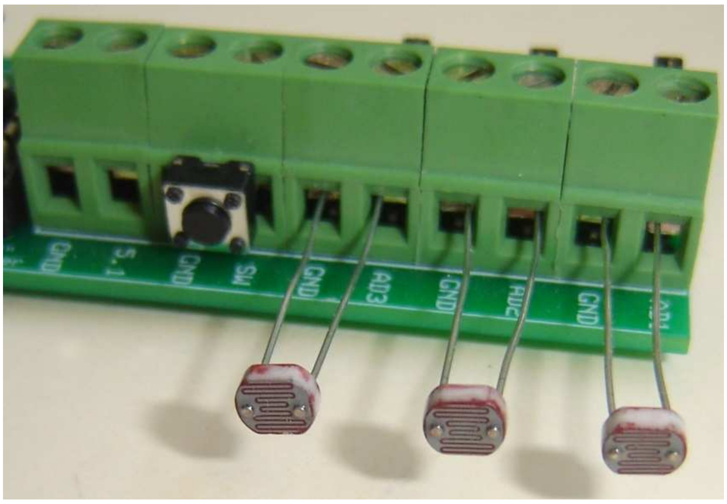

Figure 5. *DATAPORT* with photocells connected to channels AD1, AD2 and AD3. A pushbutton switch is connected to the SW channel.

Examples & Project Ideas

Several sensors are included with the kit to begin experimenting. The kit includes a 10K thermistor for measuring temperature, a photocell for detecting light, and a pushbutton switch for detecting ON/OFF signals.

Figure 6 shows a typical output graph from the *DATAPORT*. The voltage range is 0-5 Volts (Y-Axis) and the time scale is 0-60 seconds (X-Axis). While the data is being collected the ESC key can be hit at anytime to stop and save. The data is saved in a CSV format (eg. Excel) and the image is saved in BITMAP format. While the program is collecting data the voltage levels of each channel are displayed at the top of the graph with red, blue and green text. The text colors correspond to the colors of the graph lines for each channel.

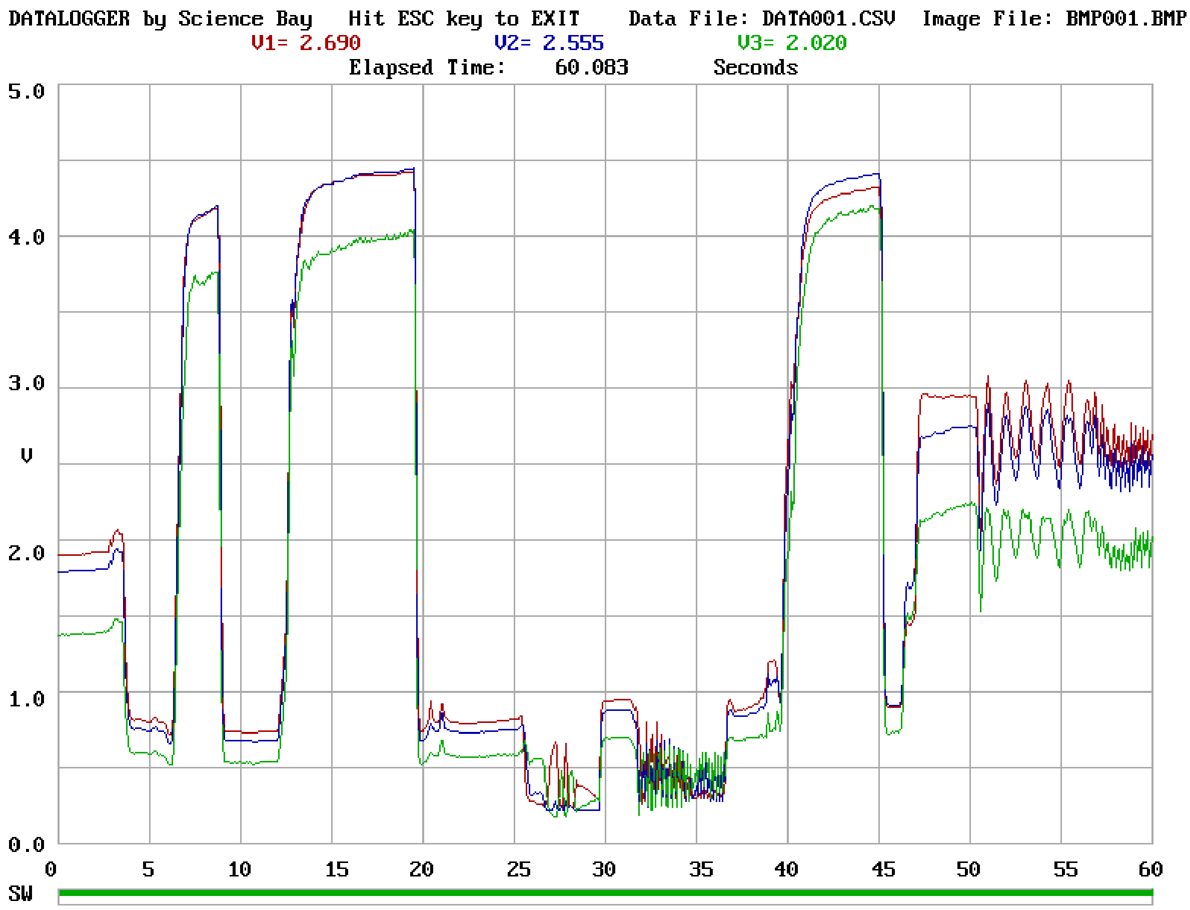

Figure 6. Example output screen from the *DATAPORT* with photocells connected to channels AD1, AD2 and AD3.

The graph in Figure 6 also displays the status of the switch channel. The switch channel is displayed at the bottom of the graph: A green line segment indicates the switch is OPEN, and a red line segment will appear on the screen if the switch is CLOSED.

Data is automically saved in a CSV file and BMP file by the *DATAPORT* program. The program will automatically update the numerical suffix (eg. 001) of the data files to create unique file names, up to a limit of 100 data sets.

Time	Seconds	Marker	Switch	AD1	AD2	AD3	Checksum	V1	V2	V3	T1	T2	T3
14:35:55	0	X	1	379	358	274	1012	1.895	1.79	1.37	98.93048	102.7794	120.1057
14:35:55	0.090327	X	1	379	358	274	1012	1.895	1.79	1.37	98.93048	102.7794	120.1057
14:35:55	0.173574	X	1	379	358	276	1014	1.895	1.79	1.38	98.93048	102.7794	119.6462
14:35:55	0.298391	X	1	379	358	276	1014	1.895	1.79	1.38	98.93048	102.7794	119.6462
14:35:55	0.340959	X	1	379	358	274	1012	1.895	1.79	1.37	98.93048	102.7794	120.1057
14:35:55	0.42403	X	1	380	358	276	1015	1.9	1.79	1.38	98.7508	102.7794	119.6462
14:35:55	0.507884	X	1	380	358	274	1013	1.9	1.79	1.37	98.7508	102.7794	120.1057
14:35:56	0.59042	X	1	380	359	274	1014	1.9	1.795	1.37	98.7508	102.5927	120.1057
14:35:56	0.715287	X	1	380	359	277	1017	1.9	1.795	1.385	98.7508	102.5927	119.4175
14:35:56	0.757825	X	1	380	359	275	1015	1.9	1.795	1.375	98.7508	102.5927	119.8756
14:35:56	0.843086	X	1	380	359	275	1015	1.9	1.795	1.375	98.7508	102.5927	119.8756

Figure 7. Example of a typical data file table from *DATAPORT*.

A typical output file from the *DATAPORT* is shown in Figure 7. The first column is the time of the data point in HH:MM:SS. The second column is the elapsed seconds from the start of the run. The third column is for the ‘Marker’ indicating a properly received data bundle. The fourth column indicates the status of the switch channel: Numeral 1 is logical high, indicating switch OPEN. The channels AD1, AD2 and AD3 indicate the actual byte reading received from the DATAPORT (Range 0-1024). The checksum column represents a total of the AD readings, and is used as a check on the data integrity.

The columns V1, V2 and V3 are software calculated conversions of the AD byte data. Each voltage reading is calculated according to the formula: Voltage = 0.005 x Byte Reading. (eg. If AD1=1000, the voltage is 5.0 Volts)

The columns T1, T2 and T3 are also software calculated conversions of the AD byte data. The T readings represent a conversion to Temperature. Note that these columns are only meaningful if a thermistor is connected to the channel input! See the software source code to understand how the temperature calculation is performed. The calculation must be modified for different types of thermistors.

Specifications

3 Analog to Digital Channels: AD1, AD2 and AD3
Analog to Digital Voltage Range: 0 to 5.0 Volts
1 Switch Input Channel: SW1 (Open or Closed)
Analog to Digital Resolution: 10 Bit (1024 Counts)
Voltage Reference for Analog to Digital Conversion: 5.12 Volts (1 Bit = 5 mV)

Maximum Speed: 20 Samples per Second
Normal Recording Durations: 1 Minute, 1 Hour, 1 Day
Software Language: Compiled FreeBASIC (Source Code Provided)
Data File Format: Spreadsheet, CSV (Comma Separated Variables)
Computer Host: Windows Operating System with an available COM port

Circuit Diagram

The circuit diagram of the *DATAPORT* is shown in the attached schematic. The constant voltage power supply for the unit is slightly unusual. The power supply regulator is set to provide a voltage of 5.12 Volts. This voltage was chosen instead of the normal 5.0 Volt supply for a specific reason. Since the Analog to Digital converter in the Picaxe chip uses the power supply voltage as the A/D reference, and also because the A/D is 10 bits (1024 levels), using a reference voltage of 5.12 Volts results in each A/D bit being equal to exactly 5 millivolts. Also, since the reference voltage is slightly greater than 5.0 Volts, the *DATAPORT* can reliably handle input signals near the 5 Volt level. (Basically an overrange buffer)

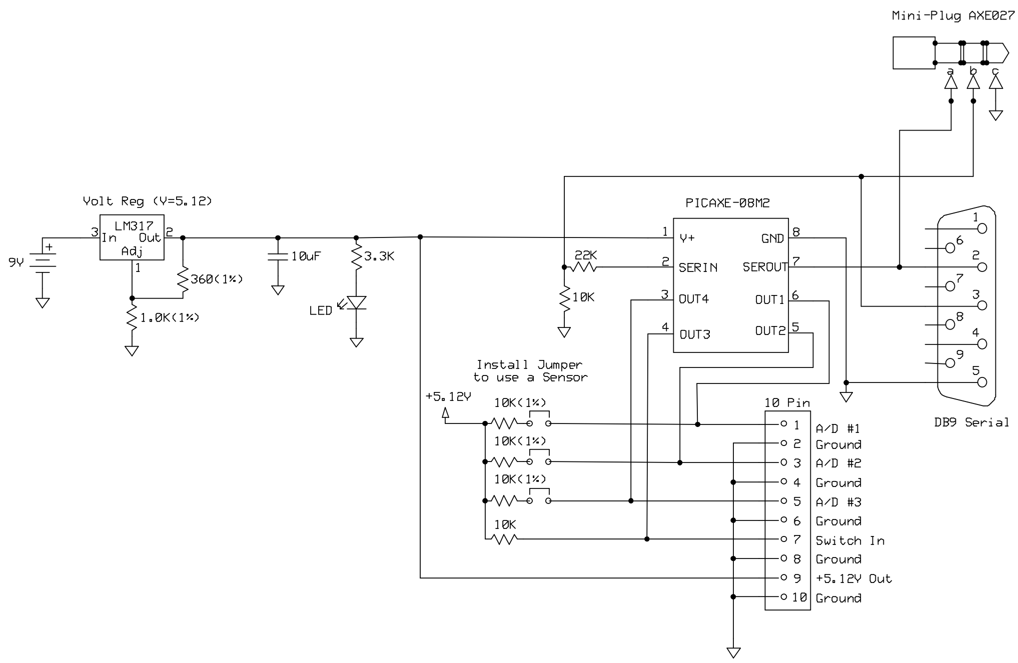

Figure 6. Circuit diagram of the DATAPORT.

Software Source Code

Please refer to the files on the CD for the source code for all the programs. The CD also contains a utility for detecting the serial ports on your computer.

The contents of the disk are as follows:

MANUAL & DOCUMENTATION

dataport.pdf	Instructions for building the hardware part of the project
dataport.jpg	Photograph of the assembled *DATPORT* module
readme.txt	CD Directory

DATAPORT PROGRAM

dataport.bas	Source code in Freebasic language for *DATAPORT* program
dataport.exe	Executable code for *DATAPORT* program (Windows)

SERIAL PORT DETECTION

spdet1.bas	Source code in Freebasic language for Serial Port detection
spdet1.exe	Executable code for Serial Port detection (Windows computers)

PICAXE

picaxe.bas Code for the PICAXE-08M2 chip located on the *DATAPORT* module

EXAMPLE DATA

DATA001.csv	Sample data output in spreadsheet format
BMP001.bmp	Sample data output in bitmap format

CIRCUIT

dataport.pcb	Circuit Board Layout in ExpressPCB
dataport.sch	Schematic Layout in ExpressPCB

Appendix A: Thermistor

The DATAPORT kit includes a thermistor for measuring temperature. A thermistor is a resistor which changes resistance relative to temperature change. The thermistor has a nominal resistance of 10,000 ohms at 25 degrees centigrade. The wire leads of the thermistor can be extended with ordinary copper wire to extend the length. The B value of the MTM provided sensor is 3488.

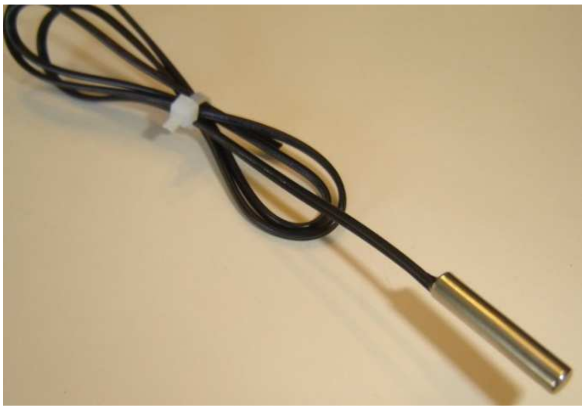

Figure 7. Thermistor sensor for measuring temperature.

Appendix B: Serial Port Detection

Most modern computers have one or more serial ports. Serial ports are identified in software by their numbers, such as COM1, COM2, COM3 or COM4. It's possible you may see a serial port connector on your computer, but not know the number. We have included a small program application on the CD for detecting serial ports on your computer called "SPDET1".

The SPDET1 program is easy to use. Double click on the program application to launch it. The program will display a DOS window and report the numbers of all the detected serial ports. The serial port information can then be used to answer the prompt when you launch the *DATAPORT* program.

Appendix C: AXE-27 Connector

Some computers do not have a serial port. At the same time, USB ports are becoming more common on new computers. It is still possible to use the *DATAPORT* in those situations by using a converter offered by the manufacturers of the Picaxe chip. The USB cable converter is called the AXE-27. We have included a miniplug connector on the board if you would like to use that communication option.

Appendix D: USB to Serial Port Converters

Another option for using a USB port is with a USB to Serial Port converter. However we have found that not all USB/Serial Port converters work in this application. If you decide to use a converter, we suggest installing the converter on your computer first, and then checking operation with the *DATAPORT*.