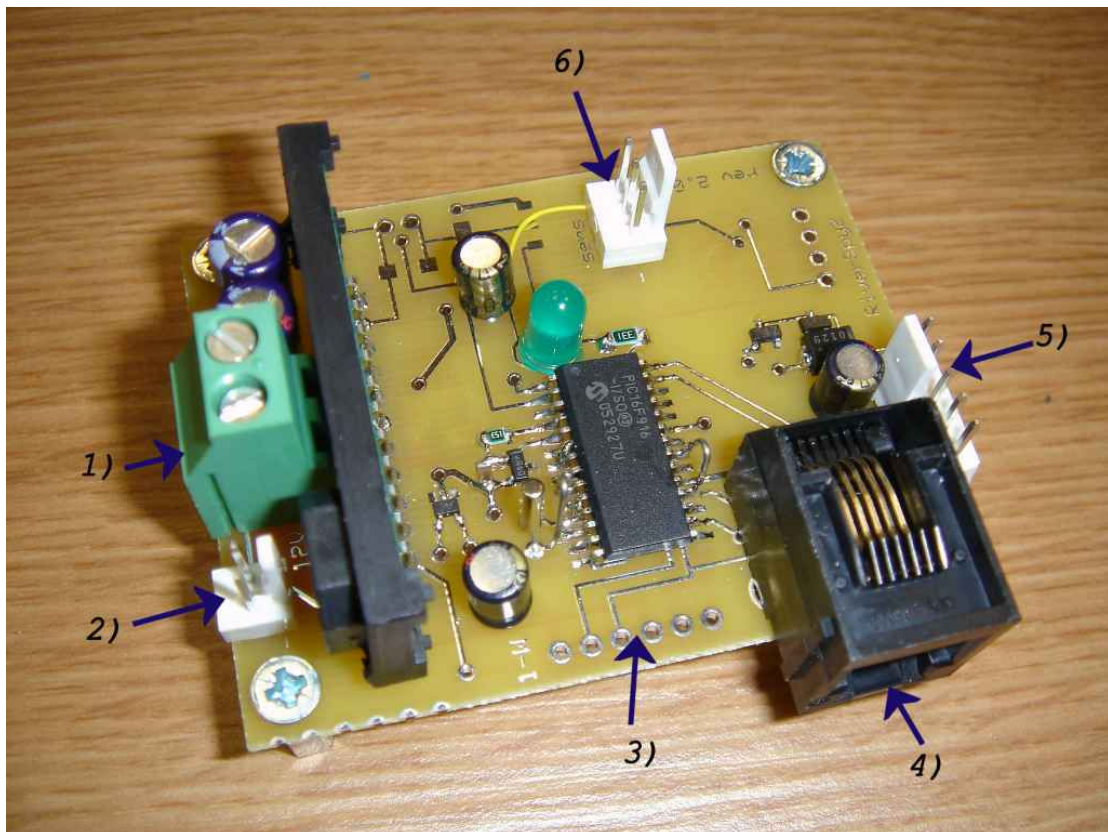# RiverSpy2

Overview

RiverSpy2 measures the depth of a river using a differential pressure gauge and logs the measurements every 15 minutes. If the system has been configured with an email address, then once a day it will send a compressed report to the email address specified. If the system receives a phone call, it examines the caller id received. If the number is contained in the administrator list, the phone call will be rejected and an sms containing recent river levels will be sent. If the number is not recognised, the phone call will be answered and a number of beeps will be given to indicate the current river level. If no number is received (caller id barred), the system will just hang up. The system can also accept sms messages to configure system settings.

Layout

The picture below shows the control board of the RiverSpy2 system.

1. 12V connector for solar panel
2. 12V connector for battery (1 and 2 are connected in parallel and can be swapped)
3. Debugging connector, can be used to snoop RS232 communications
4. Programming connector for PIC. (see microchip ICD2)
5. Connector to phone
6. Connector to sensor

Powering the system

The system operates from a 12V supply. A 1.2Ah 12V battery charged either by a solar panel or by a mains charger is suggested. When used with a Siemens M35i, the system draws 25mA when the phone is turned on and 3mA with the phone powered off. Extra current (approx 100mA) is drawn whenever a phone call is answered. If the battery voltage drops to between 12V and 11V, the length of time that the phone is turned on each day is reduced in proportion to the battery voltage. If the battery voltage drops below 11V, the phone is turned on just long enough to send the daily report and then switched off. A 5W solar panel was used in the first prototype, giving 6 hours/day operation during bad weather in mid-winter and continuous operation from March to September. (see Farnell part no 109-6176)

Connecting the phone

The original system used a Siemens M35i. Although untested, the system should work with anything from a C25 to an S45. The phone battery should be removed. The phone is connected by 5 wires to a connector on the right hand side of the board. The pinout is as follows. Pin 1 is closest to the bottom right corner of the board.

Pin No	Function
1	+4V : provides power to the phone
2	ON : pulling this line to ground turns on the phone
3	TX : serial data transmitted from the controller to the phone
4	RX : serial data received from the phone
5	GND : system ground

Pins 1 and 5 are soldered either to the battery contacts of the phone or directly to the phone printed circuit board where the contacts attach. Pin 2 is soldered to the printed circuit board directly below the ON button. Pins 3 and 4 connect to other pins on the flat connector at the bottom of the phone. Pin 4 goes to the 5th pin in from the left on the phone. Pin 3 goes to the 6th pin in from the left.
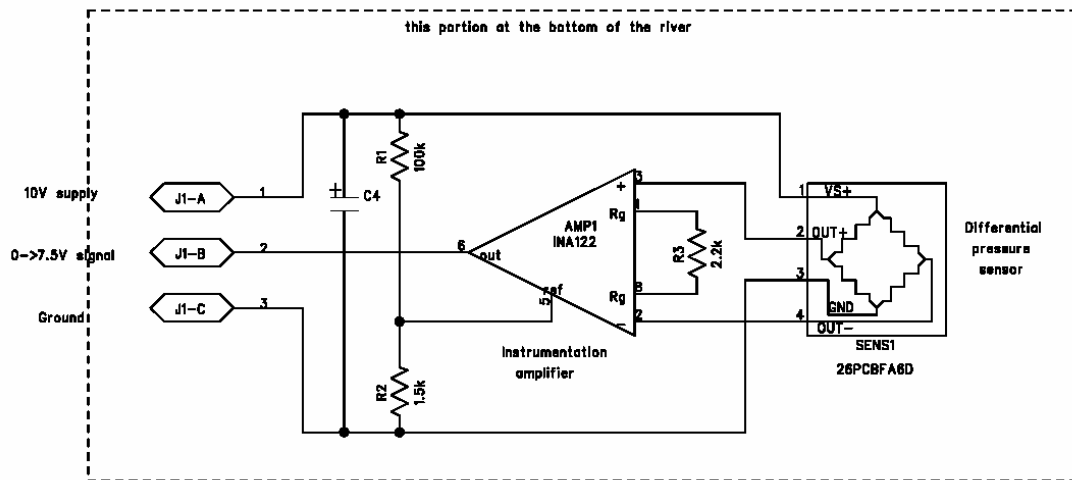
When the phone is turned on, it is powered by a 4V supply provided by the PT6102 dc-dc converter. When the system turns off the phone, it also shuts down the 4V supply to save power. The phone still receives a 3.3V trickle supply to keep the real-time clock going.
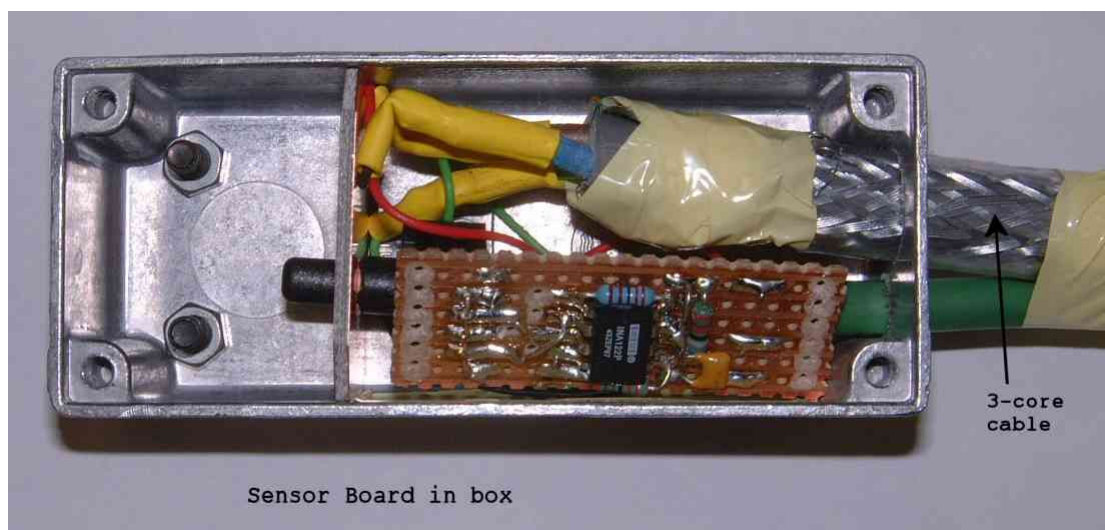
SIM card

An O2 Speakeasy card was used in the original system. The email gateway is an O2 number and speakeasy top-ups do not expire, so go for a Speakeasy if buying a new card for the system (cost €10). If you already have a spare SIM card from another provider it should work anyway. **Very important: Set the SIM PIN to match the PIN in the source code**. The source code on the web has the PIN set to 0000. It might be easier to use another phone to change the code on the SIM.

Sensor

The system measures the river level by sensing the pressure differential between the atmosphere and the bottom of the river using a 26PCBFA6D pressure sensor. The output of the sensor is amplified using an INA122 instrumentation amplifier. The schematic below shows the layout of the sensor module. For clarity, the schematic editor has hidden the power and ground pins of AMP1. Pin 4 must be connected to ground and pin 7 connected to the 10V supply. Round dots initiate junctions. Where lines cross without a dot, no connection is made. The value of C4 is not critical. A 100nF ceramic capacitor would be typical.

The sensor circuit must be mounted at the bottom of the river so the electronics must be potted in epoxy resin for protection from the water. A small aluminium box is sufficient. Holes should be drilled for a 3-core cable carrying the signals to the controller board and a breather tube to the surface. A divider was made from printed circuit board material to split the box in two. The larger right hand section was filled with epoxy resin. The left section was an empty cavity. Holes were drilled in the left side of the box (after this pic was taken) to let in the surrounding water to the sensor. The cavity on the left should be filled with a piece of sponge to prevent debris getting into the sensor inlet.

Sensor Board in box

The top end of the cable connects to the 3-pin connector marked (6) in the picture of the control board. The resolution of the sensor should be approximately 1V per metre of water. This can be fine tuned later as a software variable. A dummy connector with a simple potential divider can be connected to provide a constant 1V signal when testing the controller board in the absence of a sensor module.

The exact construction is really up to you and the materials you have handy. The second sensor module I made up was done using a 2-inch pipe rather than a rectangular box. Also, even though the current system uses a sponge filter, a better option might be to attach a rubber pipette bulb filled with clean water to the sensor. This would allow the pressure to be sensed without actually allowing river water into the sensor.

Switching On

1. Use any normal mobile phone to set the PIN code of the sim card to **2603**. (this is my extension in UCC by the way)

2. Insert the sim card into the system phone and connect to the controller board

3. Connect 12V to the controller board. The LED should flash twice, then switch off for two seconds at which point the phone will turn on. If the phone turns immediately on power-up and turns off after a few seconds, remove the power for a second and reconnect.

4. The system takes approximately 60 seconds to boot. At this point, the LED will stop flashing.

5. The level is initialised to 40cm until the first reading is taken. Try phoning the sim card number. The system should answer and give 4 beeps. (or send you a txt if you call from a number in the administrator list)

6. Set the time on the phone. The back button on the phone keypad may not be working as it has a wire soldered underneath it. If you go into the wrong menu, you may have to reboot to get out. Once the time and date have been set, reboot so that the system can read the correct time from the phone. The time and date can also be set using a text message.

7. The system will take readings every 15 minutes at hh:00, hh:15, hh:30 and hh:45. The plus line on the sensor connector will be brought to 10V for approximately 35 seconds. At the end of this time, the voltage will return to zero and the LED will flash once to indicate that the level had been updated. After the initial turn-on the 10V line will remain high until the first reading is taken.

SMS commands

The default system settings can be modified by sending the unit sms messages. The command interpreter is very simple so the spacing and number format must be correct. The general format of a command is

PPPP C AAA

where the first 4 chars are a PIN code, char 5 is a space, char 6 is the command, char 7 is a space and the subsequent chars are an argument to the command. The following table gives a summary of the command set.

Pneumonic	Example	Description
P	1234 P 1234	Change PIN code
T	1234 T +CCLK=06/05/23,14:05	Set system time
U	1234 U styxspy	Set user part of email address
D	1234 D yahoo.ie	Set domain of email address
O	1234 O 025	Explicitly set level offset
C	1234 C 075	Calibrate current level
R	1234 R 035	Explicitly set scaling factor
S	1234 S 036	Set start-up time
A	1234 A	Add next caller to admin list
W	1234 W	Wipe admin list
L	1234 L	List current settings

To send a command to the system, send the txt and the wait until either you get a delivery report or you see the new message notification arrive at the phone. At this point ring the system. *After the system responds to your call,* it will check for new messages and process the command.

Pass Code: This command simply changes the security code used to filter texts to stop others messing with your system. This need not be the same as the PIN code of the SIM card. It is initially set to 1234 unless modified in the source code.

Time: The micro-controller communicates with the phone using an "AT" command set. (Do a search for *Siemens AT command set* for more info). This T pneumonic causes the micro-controller to put an "AT" in front of the argument and sends it directly out the serial line to the phone. The example above would set the time. Always use GMT time, even during the summer. This command could also be used to change other phone settings.

U and D: An email address can be specified using a user and domain combination. The commands above would set the email address to styxspy@yahoo.ie If a user and domain have been set, a daily report is sent to that email address. The maximum length email address is 11 chars followed by @ followed by 11 chars.

O,R and C: If the gauge is to be calibrated to correspond with an existing stick gauge, the offset and scaling factor can be set. O stands for offset. R stands for readings. Increasing the number of readings increased the scaling factor and can be used to fine-tune the gain of the system. The easiest way to calibrate the system is to install it, wait until it takes its first reading, visibly read the level from a stick gauge

and then calibrate the current level using the C command. Eg, if the stick gauge read 75cm, sending the above example (*C 075*) would modify the offsets to set the system level also to 75cm. **It is very important to use 3-digit numbers with these commands. Use a leading zero if necessary.**

Start time: Use S to set the start time. The start-time will be set to (arg / 4). In the example above, arg is 036 so the start time is 9am. Daily reports are sent immediately after start-up. Assuming a healthy battery, the system will shut down 15 minutes before start time. If (arg) is greater than 095, the system will never shutdown. **Again, use a leading zero to form a 3-digit number**

A and W: The system can hold up to 14 admin numbers that will get text reports instead of a number of beeps to indicate the river level. To add a phone number to the list, send the PIN code followed by 'A' and then ring the system from the phone that you want to add to the admin list. 'W' will wipe all admin numbers. These commands are still a little experimental.

List Status: Send an 'L' to the system to get a text back of what the system variables are currently set to. The message will be of the form.

23-5-6 9:15 S36 R35 O25 A14 V1244 styxspy@yahoo.ie

where the information represents the date, current time, start time, scaling, offset, number of available admin slots, battery voltage and email address. The time format could be a little strange, eg five past nine would display as 9:5. (chip resources are tight so no room for exact formatting).

Debugging interface

When debugging, the connector at J4 can be used to monitor the serial communications between the micro-controller the phone using a pc. A MAX232 chip is needed to convert the 5V logic level signal to the −10V/+10V required by a pc's com port. A datasheet for the MAX232 can be downloaded from http://focus.ti.com/lit/ds/symlink/max232.pdf. On the pc, run Start->Accessories->Communications->HyperTerminal and set COM1 to Baud rate 9600, N,8,1.