Solar Powered Field Weather Station

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Hardware Description
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Introduction
The Solar Powered Field Weather Station is an electronic system designed to perform and store measurements of temperature, absolute pressure, relative humidity, and wind speed in a simple and energy conscious way. Being solar powered, the design of my project is focused on low power consumption and an efficient use of peripherals. The hardware portion of my project can be separated into three sections; the solar supplemented battery power supply, the user interface, and the sensor block. Each section interacts with the microcontroller to perform the required functions.

Microcontroller
I chose the 9S08QE128 microcontroller for my project because of its low power consumption and appropriate IO capabilities. The two SPI ports will be utilized as well as the A/D convertor and external peripheral ports. A crystal oscillator circuit will act as the clock for the microcontroller running at 8 MHz. Since this project is designed more for professional use than consumer, a universal six pin BDM port is included to allow for updates to the software.

Power Supply
The power supply for my projects consists of a solar panel, a 12V battery, charge protection circuitry, and two switching voltage regulators. The solar panel and battery are placed in parallel allowing the battery to be charged when the solar panel voltage it greater than 12V. In order to prevent overcharging and to protect the battery and solar panel, charge regulation circuitry is placed between the two. A diode located with the cathode at the positive terminal of the battery is reverse biased when the solar panel voltage is less than that of the battery preventing current from flowing the wrong way through the solar panel. A 13V zener diode in series with the base of a power NPN transistor makes up the charge protection. When solar panel voltage is large enough, the 13V drop across the zener and the 0.7V drop from base to emitter of the transistor enables the battery to be charged at about 14V. This voltage is ideal for charging the battery as well as powering the weather station system. Thus, the output of the power sources varies from 12V to 14V. This voltage is then regulated to 5V and 3.3V though the means of two separate switching regulators. The 3.3V is required by the microcontroller and the user interface circuitry and the 5V powers the humidity/temperature sensor.

User Interface
Included in the user interface section of the hardware design are a keypad, an LCD display, three indicator LEDs, and a Flash Memory SD-card module for storing the data.
Keypad
I am using a 3x4 keypad for user input into the weather station. The keypad pin out is in matrix format meaning each row and column is connected to a pin. The three column pins are connected to 10kΩ pull-up resistors to 3.3V and every pin is connected to the MCU through PORTB.

LCD Display
The LCD Display is 20x4 characters and shows the user all of the current values of the sensors and the date and time. The LCD is run in 8-bit mode meaning all of the instructions are communicated in full binary words. Pins 7 through 14 on the LCD make up the 8-bit data line and are connected to PORTD and PORTA on the MCU. Pin 6, the operation enable, and Pin 4, the register select are connected to the MCU through PORTE. Pin 5, the read/write signal select, is connected to ground because only the write function is required for the application. A voltage divider applies 0.76V to Pin 3 applying the correct contrast to the display.

LED Array
Three LEDs are included to indicate to the user the current state of the system. The weather station is either displaying live sensor readings, previously recorded data, or is currently recording data. Each LED corresponds to one of these states and is connected from PORTC through a current limiting resistor to 3.3V.

Flash SD-Card SPI Module
To allow the user to remove stored data from the weather station, an SD-Card module is included. This module communicates with the MCU through SPI2 and can write new data or read previously recorded information. This module allows for communication through SPI or IIC. For this application the IIC output Pins are not connected.

Sensor Block
Three sensors are used to measure the weather information required by the project.

Relative Humidity/Temperature Sensor
The HTM1735LF sensor module measures relative humidity and temperature. The module is powered by 5V through Pin 3 and is connected to ground at Pin 2. At Pin 4, a voltage with a linear relationship to humidity varies between 0V and 5V. This voltage is placed across a two-thirds voltage divider to convert this to 0V to 3.3V required by the A/D convertor on the MCU.
The resistance between Pin 4 and ground is related to the ambient temperature. The resistance ranges from 144 kΩ to 1.4 kΩ. In order to convert the varying resistance to a voltage that can be used by the A/D convertor, it is placed in a voltage divider with a 75 kΩ resistor to 5V. With this, the maximum resistance results in 3.3V across the thermistor and 10 mV at the minimum resistance.

To reduce the load on the A/D convertor, both analog voltages are first sent through op-amp voltage followers.

**Absolute Pressure Sensor Module**

The SPC1000 Sensor Module is used to measure the Absolute Pressure of the atmosphere. This module simply communicated the pressure measurement with the MCU through SPI1. Pin 7 on the module is used to send an interrupt signal to the MCU to tell it when the data is ready. This is necessary because the module generates a new reading once a second.

**Anemometer**

An Anemometer is used to measure wind speed. The anemometer itself it only a reed switch so it is connected with a pull-up resistor to 3.3V in order to generate a pulse each rotation. The wind speed is determined by multiplying 2.5 by the number of cycles per second (Hz) results in Miles per Hour.