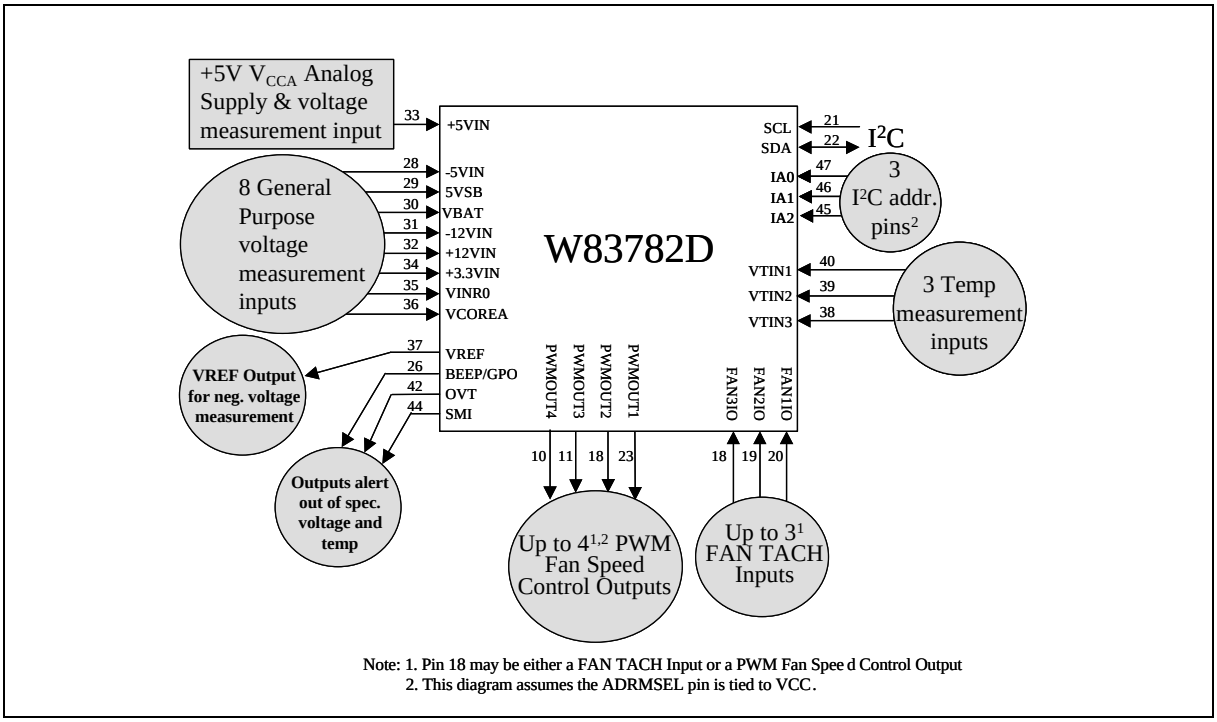
Using the W83782D Hardware Monitor IC in non-PC Applications

The Winbond W83782D was designed to monitor the internal voltages and temperatures in a platform for a PC or a server. It also can be used to monitor and vary the speed of one or more fans to regulate those temperatures. This device may be controlled via an industry standard I^2C bus. This allows it to be easily used in non-PC applications. For example, a solar power system is composed of solar cells, batteries, power converters and other components. Temperature and voltage monitoring would be very important in such a system. A large HVAC system requires the monitoring of environmental and power subsystems to maintain peak performance and efficiency. A complex power supply with multiple output voltages needs voltage monitoring and sampling of heat-sink temperatures for system failure protection.



Note: 1. Pin 18 may be either a FAN TACH Input or a PWM Fan Spee d Control Output
2. This diagram assumes the ADRMSEL pin is tied to VCC.

Figure 1. Functional I/O Diagram for the W83782D

The ***W83782D Hardware Monitor IC*** may be used in general purpose, voltage and temperature monitoring applications. The IC has the ability to monitor up to 9 voltages and 3 temperatures plus the speed of as many as 3 fans. Trip points can be set inside the chip to detect voltages that are too high or too low. Temperatures above a set limit can be detected. Fan speeds below a set limit can also be detected. An out-of-range value causes an interrupt flag to be set. Also, there are as many as 4 Pulse Width Modulation output pins that may be used to control fan speed.

Measurements are made using an on-chip 8-bit A-D converter. This gives +/- 1% voltage monitoring accuracy over its native measurement range of 0 to 4.096 volts. External resistors and an on-chip VREF output enable the user to measure both negative and positive voltages over a wide range. The temperature measurement range is -40°C to +120°C. It has an accuracy of +/-3°C using inexpensive thermistors.

All of the General Purpose voltage measurement pins identified in Figure 1, above, have identical input circuitry regardless of their labels. That is, the input called -5VIN may be used to measure a positive voltage and the +12VIN pin may be used to measure a negative voltage. Examples of each type of measurement are found below. The exception to this is the +5VIN pin, which is both a voltage measurement pin and the Analog VCC supply for the chip. It must be connected to +5 volts.[1]

This device may be completely controlled through an industry standard I^2C port. Low-cost microcontrollers can easily perform this task. Systems without an already existing I2C bus can add the capabilities of the W83782D by using just two controller port pins.".

Control Registers

The W83782D is controlled and monitored through a group of 8-bit registers. These registers may be loaded or (in most cases) read through the I^2C port. The 9 monitored voltages all may be read via individual registers. Each voltage has 2 corresponding registers for a low limit and high limit setting. When a voltage goes above or below the limits, an interrupt is generated as a warning.

The temperature measurement section of the chip has the ability to either monitor for a temperature over a set limit, or to monitor for temperatures between an upper and lower limit. In this case, the chip provides an interrupt when the temperature exceeds the upper limit. It also provides a second interrupt when the temperature goes below the lower limit. Additionally, there is an output specifically to show an over temperature event has occurred separate from the voltage monitors.

Other control registers allow the programmer to individually select which events cause the interrupt. This makes for a very flexible chip.

Several of the control registers listed in the W83782D data sheet (http://www.winbond-usa.com/products/winbond_products/pdfs/PCIC/w83782d.pdf) are for ISA bus use only. The data sheet, however, does not always make this clear.

The following registers are for ISA bus use only and are not used when I^2C is used to control the device: Address Register (Port x5h), Data Register (Port x6h), Serial Bus Address Register (48h)[2], and Register 50h~5Fh Bank Select – Index 4Eh.

Measuring Positive Voltages

Voltages between 0.400 millivolts and 3.9 volts may be measured directly. Just connect the voltage source to the input pin. Voltages higher than 3.9 volts should be scaled using a resistor network to bring them into the proper range. Voltages between 0 and 400 millivolts will be read with limited accuracy. Figure 2 shows the desired resistor network. Suggested values for a 5 volt source are: R1 = 5.1KΩ and R2 = 7.5KΩ. Suggested values for a 12 volt source are: R1 = 28KΩ and R2 = 10KΩ.

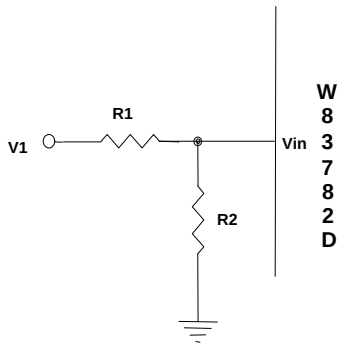


Figure 2. Measuring Positive Voltages

[1] The W83782D also has a 5-volt VCC power input located on pin 13. This is not a voltage measurement pin and it must be connected to +5 volts.

[2] The Serial Buss Address Register is used to set the I^2C slave address when both the ISA bus and I2C bus are used simultaneously. It is not used when the I^2C bus is used by itself.

Measuring Negative Voltages

The W83782D uses the VREF output to enable the programmer to monitor negative voltages. The example circuit in Figure 3 shows how this is accomplished. The values R1 = 232KΩ and R2 = 56KΩ is recommended for a -12-volt measurement. The two resistors form a voltage divider between the voltage being measured and the 3.6-volt VREF output. If you are measuring a -12-volt input, then we have a differential of 15.6 volts across the total resistance of 288KΩ. This results in a current of 54 microamperes. The voltage drop across R1 is therefore 12.566 volts. This results in a +0.566 volts being applied to the voltage measurement pin. One percent resistors should be used in this application to increase the accuracy of the voltage measurement.

Suggested values for a -5 volt source are R1 = 120KΩ and R2 = 56KΩ.

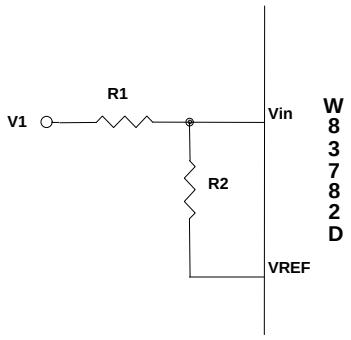


Figure 3. Measuring Negative Voltages

Estimating Measurement Accuracy

The voltage monitoring accuracy of the A/D converter is specified at +/- 1% max. This implies the accuracy of the A/D is +/- 2.5LSB (1/256 = 0.39% per LSB, 2.5 LSB ≈ 1%/0.39%). For a direct reading voltage, the accuracy is (4.096V/256) x 2.5 ≈ +/- 40 millivolts. For voltages higher than 4 volts using a 1% accurate resistor network, the accuracy of the scaled reading would decrease by an additional 1%.

The input leakage current to the VIN measurement pin is typically under 1 microampere. This means that this factor can be ignored in the measurements.

The W83782D data sheet contains some interesting equations to determine what accuracy can be obtained for negative voltage readings. When you work through the numbers and assume +/- 2.5 bit of accuracy in the A-D converter, you find that at -12 volts, the accuracy is approximately +/- 205 millivolts.

Measuring Temperatures

Temperature measurements may be made using a thermistor with a resistance of 10 KΩ @25 °C and a ß of 3435.[3] A 2N3904 V_{Tin} connected as a diode (base shorted to the collector) may also be used to read temperature but the accuracy may be reduced. A third method allows you to measure the temperature of the internal thermal diode in a Pentium II CPU. Note that bits 1, 2 or 3 in register 5Dh (Bank 0) are set to a "0" to enable the thermistor mode and set to a "1" to enable the Pentium II diode or 2N3904 bipolar sensor. If the thermistor mode is not used, then register 59h (Bank 0) is used to select the Pentium diode or 2N3904 and the corresponding bits in register 5Dh (Bank 0) must be a "1".

Figure 4 shows the Thermistor connection.

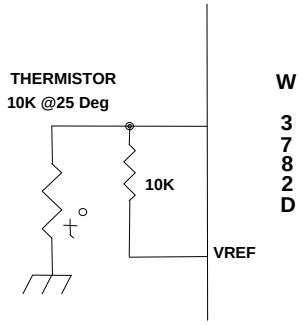


Figure 4. Measuring Temperatures

[3] Radio Shack part number 271-110A meets this specification.

Fan Controls

Many fans today have tachometer outputs. The fan speed input pins of the W83782D are designed to accept TTL level fan tachometer signals. If the tachometer signals are more than TTL levels, they must be limited in some manner. The data sheet has examples of several methods of doing this. Two of the tachometer input pins may be programmed to be TTL logic outputs.

The W83782D has up to 4 PWM fan speed control outputs that may be used to precisely control fan speeds. Or these outputs may be used to just turn a fan on (program to FFh) or off (program to 0h).

I²C Bus Port[4]

An industry standard I²C bus or a PC ISA bus may be used to control the W83782D. To lock the chip into I²C bus control mode, pin 43, the ADRMSEL pin must be tied to VCC. The chip has up to 3 different I²C slave addresses. The first slave address allows access to all of the registers in the device except Temperature 2 and Temperature 3 registers. This address is <0101> plus 3 bits defined by the logic levels on pins 45 through 47. For example, if pin 45 = "1", pin 46 = "1" and pin 47 = "0", then the complete slave address would be <0101110>.

When reading or writing Temperature 2 or Temperature 3 registers, the slave address is <1001> plus 3 bits as defined by control register 4Ah. Three bits in this register (2,1 and 0) define the address for the Temperature 2 register access. For example, if Bit2 = "1", Bit1 = "0" and Bit0 = "1", then the complete slave address would be <1001101>. Three other bits in this register (6, 5 and 4) define the address for the Temperature 3 register access. Bits 3 and 7 of register 4Ah are used to turn on or off access to Temperature 2 and Temperature 3 data.

Example Application

Figure 5 (on the following page) shows an example application that could make use of the W83782D. High-power broadcast transmitters are often located at remote locations. A tall radio tower requiring aircraft warning beacons may also be associated with this transmitter. Safety considerations require that the tower beacon current be monitored to detect when one or more bulbs have burned out. Measurement of the current going to the warning beacons will show if one or more bulbs have burned out.

It is necessary to monitor the operation of the transmitter to make sure it isn't damaged by overheating or out of tolerance voltage conditions. Some components will age or wear out. This may cause the output power to decrease below acceptable wattage levels. The ambient air inside the transmitter building may need to be cooled or heated to insure proper operation of the transmitter.

The W83782D plus a simple microcontroller and a modem connected to a phone line, would allow the monitoring of the transmitter site. The microcontroller could be programmed to automatically dial a phone number and send warning data when any of the voltages or temperatures got outside specified limits.

[4] It is assumed that the reader is familiar with the I²C bus.

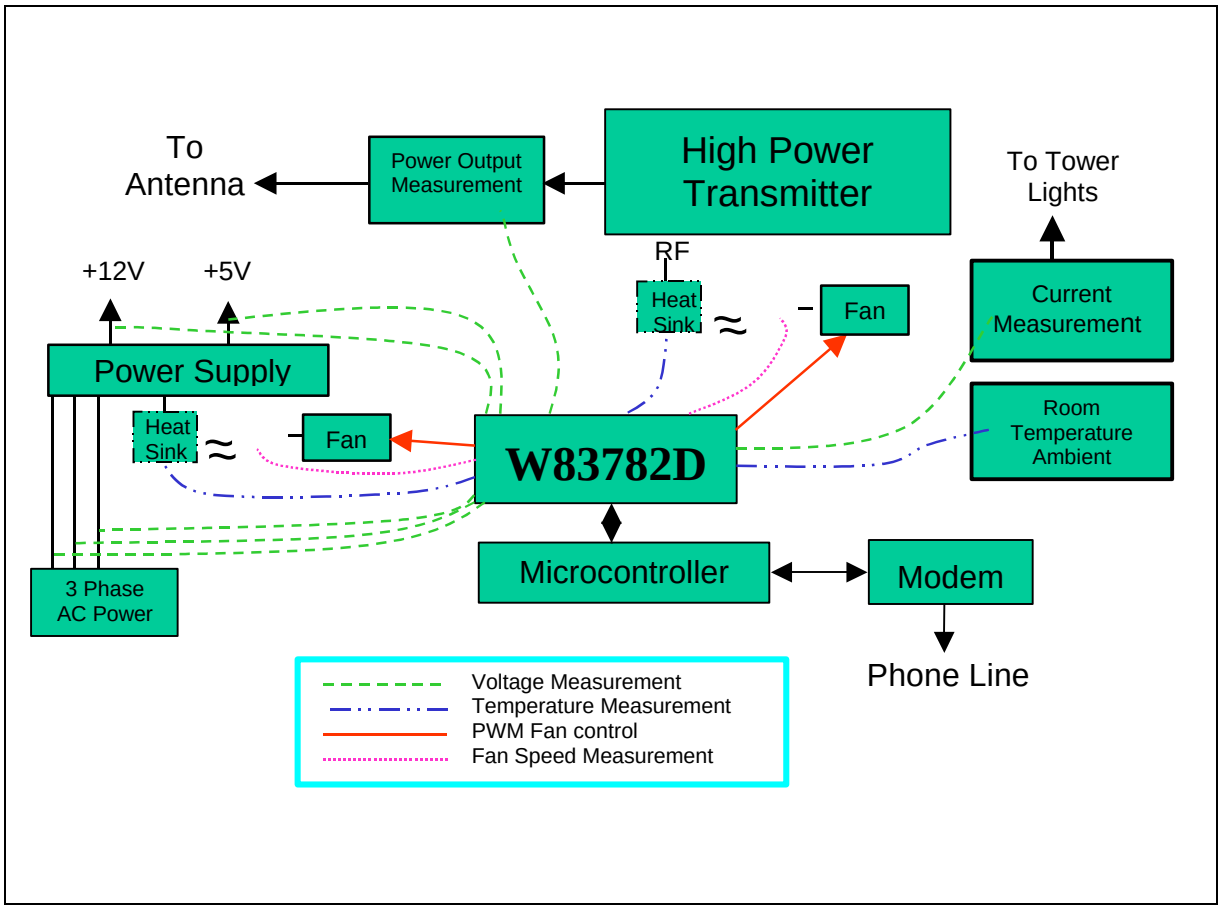


Figure 5. Remote Transmitter Site Monitor

Conclusion:

This Application Note has shown a general-purpose voltage and temperature measurement device using an integrated circuit originally designed for use inside a personal computer. The W83782D Hardware Monitor IC satisfies a requirement that many non-PC products may have for this application.

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