



ELM341

Low Power Thermostat

Description

The ELM341 is a complete temperature measurement and control system in an 8 pin package. It automatically reverts to a very low power sleep mode between measurements, making it suitable for battery operation.

This integrated circuit is designed to compare two resistances and drive an output pin depending on the relative value of each. Typically, one of the resistors will be an NTC thermistor, and the other one will be a temperature independent resistor (whether fixed or variable). When the magnitude of the resistance connected to pin 2 exceeds the value of the resistance connected to pin 3, the output pin will be driven to a high state. Hysteresis maintains the output in that state until the relative values differ by approximately 8% (or typically 2°C for a 10KW thermistor).

To reduce the possibility of sporadic outputs, a condition must exist for three successive cycles, or 6 seconds, before the output pin can change state.

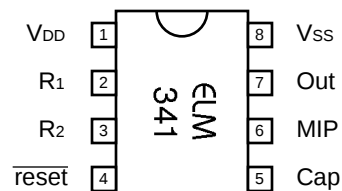
Applications

- Backup thermostats
- Under or over temperature alarm circuits

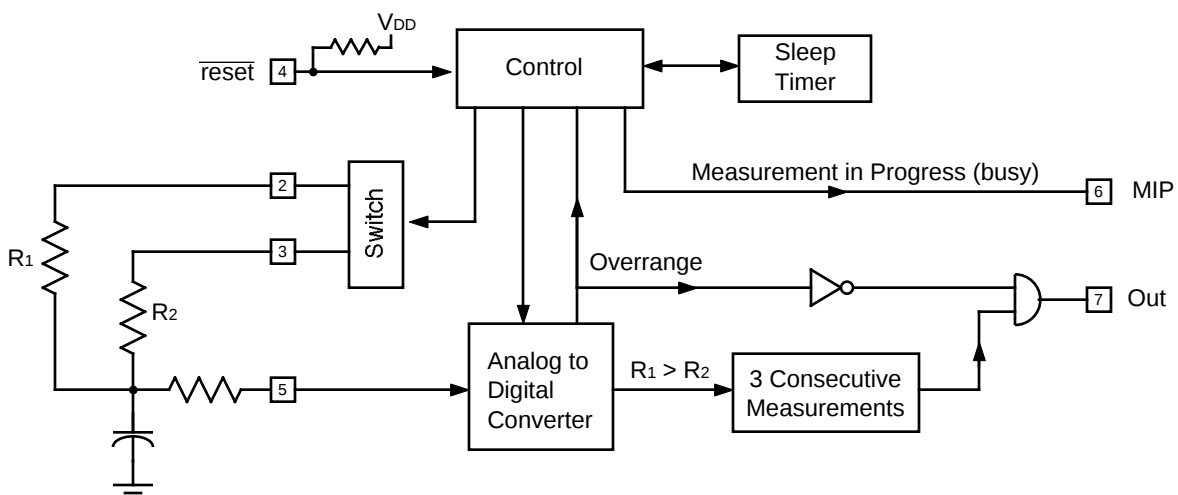
Features

- Low power CMOS design
- Wide supply range - 3.0 to 5.5 volt operation
- Built-in proportional hysteresis
- Measurement in progress output
- Time delay on operate improves noise immunity
- Internal pullup resistor on the reset input
- High current drive outputs - up to 25 mA
- Sleep mode reduces power requirements

Connection Diagram
PDIP and SOIC
(top view)



Block Diagram





Pin Descriptions

V_{DD} (pin 1)

This pin is the positive supply pin. Internal circuitry connected to this pin is used to provide power on reset of the microprocessor, so an external reset signal is normally not required. Refer to the Electrical Characteristics section for further information.

R₁ (pin 2)

One of the two resistance input pins. A temperature dependent resistance is usually connected to this input for heating or under-temperature alarm type applications. When the value of this resistor is greater than the value of the resistance connected to pin 3 (for three successive measurements) the output will be driven high.

R₂ (pin 3)

The reference resistance is connected to this pin for heating applications (and the temperature dependent resistance is connected here for cooling applications). The other end of this resistor is connected to the integrating capacitor.

reset (pin 4)

The active low reset input. An internal pullup resistor is provided for convenience. If unused, this pin may be connected to V_{DD} or left open.

Cap (pin 5)

Temperature measurements are made by determining the time to charge and discharge this

integrating capacitor. Pin 5 forces the capacitor to a known voltage for these measurements though, resulting in large current flows. To limit these capacitor currents, and protect the ELM341, a series resistor must be connected to this pin. The value of the resistance, and of the capacitance, is not critical to the measurements.

MIP (pin 6)

This pin provides a logic high level output while the ELM341 is busy (measurements are in progress). It is suitable for directly driving an LED through a current limiting resistor. As a warning, this output pulses rapidly if either resistor input is found to be open circuited.

Out (pin 7)

The output pin assumes a logic high state once the resistance of R₁ exceeds that of R₂ for three successive measurement cycles. The output is maintained until R₁ is less than R₂ by the hysteresis amount for an additional three counts.

Note: Consideration must be given to the fact that this output is in a tri-state (open circuit) mode each time the circuit wakes from sleep to take a measurement. This mode lasts for approximately 300µs, which is not generally long enough to affect a relay output, but certainly long enough to be seen by high-speed logic circuits.

V_{SS} (pin 8)

Circuit common is connected to this pin. This is the most negative point in the circuit.

Ordering Information

These integrated circuits are available in either the 300 mil plastic DIP format, or in the 200 mil SOIC surface mount type of package. To order, add the appropriate suffix to the part number:

300 mil Plastic DIP..... ELM341P

200 mil SOIC..... ELM341SM

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**Absolute Maximum Ratings**

Storage Temperature..... -65°C to +150°C
Ambient Temperature with
Power Applied..... -40°C to +85°C
Voltage on V_{DD} with respect to V_{SS}..... 0 to +7.5V
Voltage on any other pin with
respect to V_{SS}..... -0.6V to (V_{DD} + 0.6V)

Note:

Stresses beyond those listed here will likely damage the device. These values are given as a design guideline only. The ability to operate to these levels is neither inferred nor recommended.

Electrical Characteristics

All values are for operation at 25°C and a 5V supply, unless otherwise noted. For further information, refer to note 1 below.

Characteristic	Minimum	Typical	Maximum	Units	Conditions
Supply Voltage, V _{DD}	3.0	5.0	5.5	V	
V _{DD} rate of rise	0.05			V/ms	see note 2
Average Supply Current, I _{DD}	0.008	1.0	2.4	mA	V _{DD} = 5V, see note 3
	0.002	0.6	2.4	mA	V _{DD} = 3V, see note 3
Frequency of measurements		2.0		sec	see note 4
Reset pin internal pullup resistance	300	470	600	KW	see note 5
R ₁ C or R ₂ C time constant	500		500,000	µs	see note 6
Input low voltage - reset pin	V _{SS}		0.15 V _{DD}	V	
Input high voltage - reset pin	0.85 V _{DD}		V _{DD}	V	
Output low voltage			0.6	V	Current (sink) = 8.7mA
Output high voltage	V _{DD} - 0.7			V	Current (source) = 5.4mA

- Notes:
1. This integrated circuit is produced with a Microchip Technology Inc.'s PIC12C5XX as the core embedded microcontroller. For further device specifications, and possibly clarification of those given, please refer to the appropriate Microchip documentation.
 2. This spec must be met in order to ensure that a correct power on reset occurs. It is quite easily achieved using most common types of supplies, but may be violated if one uses a slowly varying supply voltage, as may be obtained through direct connection to solar cells, or some charge pump circuits.
 3. Integrated circuit only. Does not include any LED or drive currents. Minimum currents represent those which are typically found between measurements when in the low power sleep mode.
 4. If a measured resistance is determined to be out of limits, the frequency of measurements is increased to provide visual feedback as well as a faster recovery.
 5. The value of the pullup resistance is supply and temperature dependent.
 6. One should also maintain R₁ and R₂ to not less than about 5KW. When C is chosen, select the pin 5 current limiting resistance so that R_{LIM}C is less than 1msec, and R_{LIM} is greater than 1KW.

Example Application

Figure 1 shows the ELM341 in an example heating control circuit. A closed contact output occurs whenever the temperature measured by R_{TEMP} falls to a value less than that determined by R_{SET} . It is anticipated that this type of circuit could possibly be used to control temperatures over the range of -40°C to $+40^{\circ}\text{C}$.

Power for the control circuit is from a 3V battery, while the output relay is powered from a 12V supply. The output relay type is not important, as long as consideration is given to the coil drive requirements, and the capabilities of the ELM341. In this example, a relay with a 400W coil resistance was chosen so that a 2N3904 could drive it directly. For further reductions in current requirements, consideration could be given to using a power MOSFET transistor instead of this bipolar one.

Temperature measuring is performed by R_{TEMP} , which is a negative temperature coefficient type thermistor. It has a resistance of 10KW at 25°C , and this value decreases with increasing temperature. This value was chosen both because it is commonly available, and because it limits the $0.1\mu\text{F}$ integrating capacitor currents to less than 1mA over the typical range of operation (keeping the thermistor self-heating to a minimum).

If the thermistor is mounted any appreciable distance from the ELM341, consideration must be given to cabling effects such as capacitive and induced currents. Generally the integrated circuit can be adequately protected by mounting a small value (220W) resistor physically close to the ELM341 as shown

below. Take into account its value when determining the setpoint, though.

For this design, R_{SET} was selected to be equal to the resistance of R_{TEMP} at 10°C , so that the relay contact closes for any measured temperatures less than 10°C . The resistance value was determined from specs given by the manufacturer, but could have been determined experimentally as well.

An LED has been provided for visual feedback of the circuit operation. It is connected to the 'measurement in progress' output, so that it is energized each time a measurement is being made. Typically, this would be for about 25mS every 2 seconds.

Current requirements for this entire circuit have been measured to be about $2\mu\text{A}$ minimum and $23\mu\text{A}$ average, at room temperature and the relay de-energized, even with the LED blinking. Measurement times, and thus current consumption, vary with temperature, so this should only be used as a guideline. With a 5V supply, these values escalate to about $8\mu\text{A}$ and $70\mu\text{A}$, respectively.

Just a reminder that consideration must be given to the fact that the pin 7 output is in a tri-state (open circuit) mode just prior to making a measurement. This mode lasts for approximately $300\mu\text{s}$, sufficient to possibly affect some output circuits. It is generally not sufficient for an electromechanical relay to drop out, however, especially with a 'kick-back' diode across the coil.

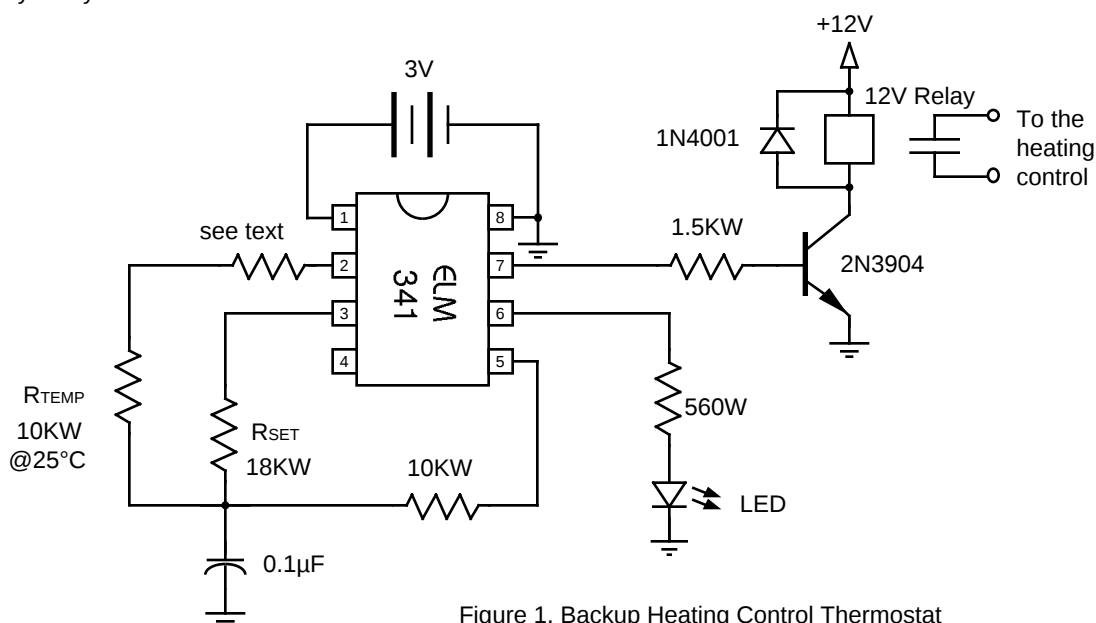


Figure 1. Backup Heating Control Thermostat