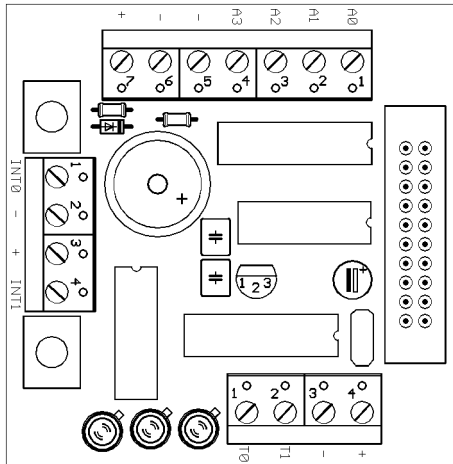## Voltage measurements with MINI-MAX/51-C and TB-1 Training Board

Overview

MINI-MAX/51-C can measure voltage values using the TB-1 Training Board. TB-1 Training has a type ADC0834 4-channel, 8-bit Analog/Digital Converter (ADC) from National Semiconductor. 4 voltage inputs to the ADC0834 are available on X1 terminal block of TB-1:
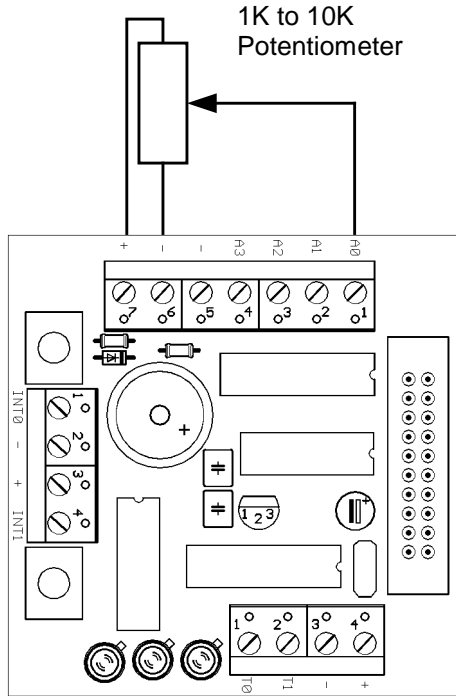
Analog Inputs

Theory of Operation

Analog/Digital Converter is controlled by the micro-controller through 4 port lines. Chip Select (CS) is an input to the ADC. Chip Select enables data conversion when it is logic low and disables data conversion when it is logic high. Clock is an input to the ADC. Mode of operation (single-ended versus differential) and channel number is entered through the DI pin one bit at a time (on every transition of the Clock input). The 8-bit data that corresponds to the voltage on the selected channel is output on DO one bit at a time (on every transition of the Clock input).

Installation

Turn the power off to MINI-MAX/51-C by unplugging the power jack Plug the TB-1 board on top of MINI-MAX/51-C. Use the SPACER-1 plastic spacer set.

Example 1: Measuring voltage with TB-1

Apply a varying voltage source to one of the inputs of TB-1. This can be achieved using a 1K to 10K potentiometer as shown in the figure below.

One side of the potentiometer is connected to +5 Volts. The other side of the potentiometer is connected to – (Ground). The middle position (wiper) of the potentiometer is connected to A0 (short for Analog 0) input of TB-1 board. By rotating the potentiometer wiper, voltages from 0 to 5 Volts can be applied to A0 input.

WARNING: Never connect one side of the potentiometer to – and the middle point to +. Similarly, never connect one side of the potentiometer to + and the middle point to -. In both cases, the potentiometer and TB-1 may be damaged.

Start Micro-IDE and open the project TB1 under BASCOM51\Examples. Build the project and download to MINI-MAX/51-C. Open the Terminal window in Micro-IDE and open the COM port by clicking the Connect button on the Terminal toolbar. Run the program tb1.hex on the MINI-MAX/51-C board by clicking the Set Mode button on the toolbar.

TB1 project first tests the LED's and the buzzer. It then tests the switches on the TB-1 board. Skip these tests by pressing a key in the terminal window. MINI-MAX/51-C will now display the voltage values from channels A0 through A3 on the TB-1 board.

Example 2: Measuring and displaying room temperature

This is similar to Example 1 except that instead of a potentiometer as the voltage source, we will use an LM35 type temperature sensor from National Semiconductor. LM35 is a semiconductor temperature sensor that provides a voltage output that is directly proportional to the temperature in Fahrenheit. This is given by the formula:
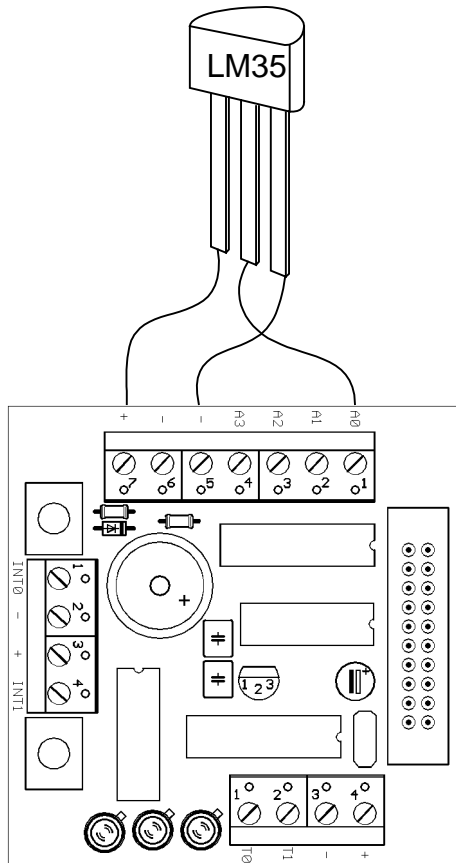
LM35 Voltage Output in millivolts = 10 X Temperature in Fahrenheit.

This means that every 1 degree Fahrenheit change in temperature results in 10 millivolts of change at the voltage output.

For more information on the LM35 Temperature Sensor, please visit **www.bipom.com**

Turn the power off to MINI-MAX/51-C by unplugging the power jack. Connect the LM35 temperature sensor to TB-1 using wires as shown.

WARNING: Incorrect connection may damage TB-1 or LM35.

Apply power to MINI-MAX/51-C by plugging the power jack. The program **tb1.hex** should start running and display the voltage values on the terminal window in Micro-IDE. Watch Ch0: (Channel 0). This should show the temperature readings.

Now touch the LM35 with your finger and see if the temperature reading on the terminal changes.

Appendix A: Measuring voltage with TB-1 in your BASIC programs.

To add the capability to measure voltage using TB-1 to your BASIC programs:

1- Include a reference to bipom library and TB1 conversion routine TB1_ADC at the beginning of your BASIC program:

Bipom library is a pre-packaged collection of useful subroutines

$LIB "bipom.lib"
$external _TB1_ADC

_TB1_ADC is the Analog/Digital conversion subroutine

2- Add the following Analog/Digital Conversion subroutine to the end of your BASIC program:

```
Sub Convert ( Adc As Byte)
        Acc = Adc                    ' assign the desired analog channel
        Call _TB1_ADC                ' make an Analog/Digital conversion
        Adc = Acc                    ' get the result of Analog/Digital conversion
End Sub
```

Accumulator which is used for returning the result from **TB1_ADC**

3- Place a Subroutine Call to **Convert()** subroutine in your program where you want to measure the voltage. Example:

```
…
< your program >

' We want to read the voltage from Channel 1 here:

Call Convert(1)
Print " Ch1:";Adc;

…
```