Temperature Sensor with Thermistor

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General Description

In this application the GreenPAK2 is configured as a temperature monitor along with an external thermistor type temperature sensor. The GreenPAK2 monitors the temperature to indicate when a desired value (27°C) has been reached. Two of the outputs drive indicator LED's to show the status.

Description

Thermistors are temperature sensitive resistors. All resistors vary with temperature, but thermistors are constructed of semiconductor material with a resistivity that is especially sensitive to temperature. However, unlike most other resistive devices, the resistance of a thermistor decreases with increasing temperature.

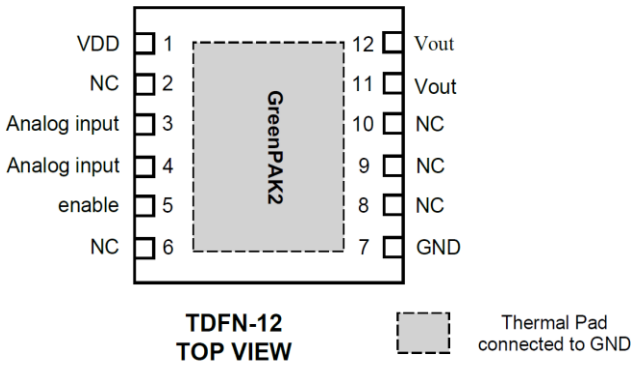

Figure 1. Pin configuration

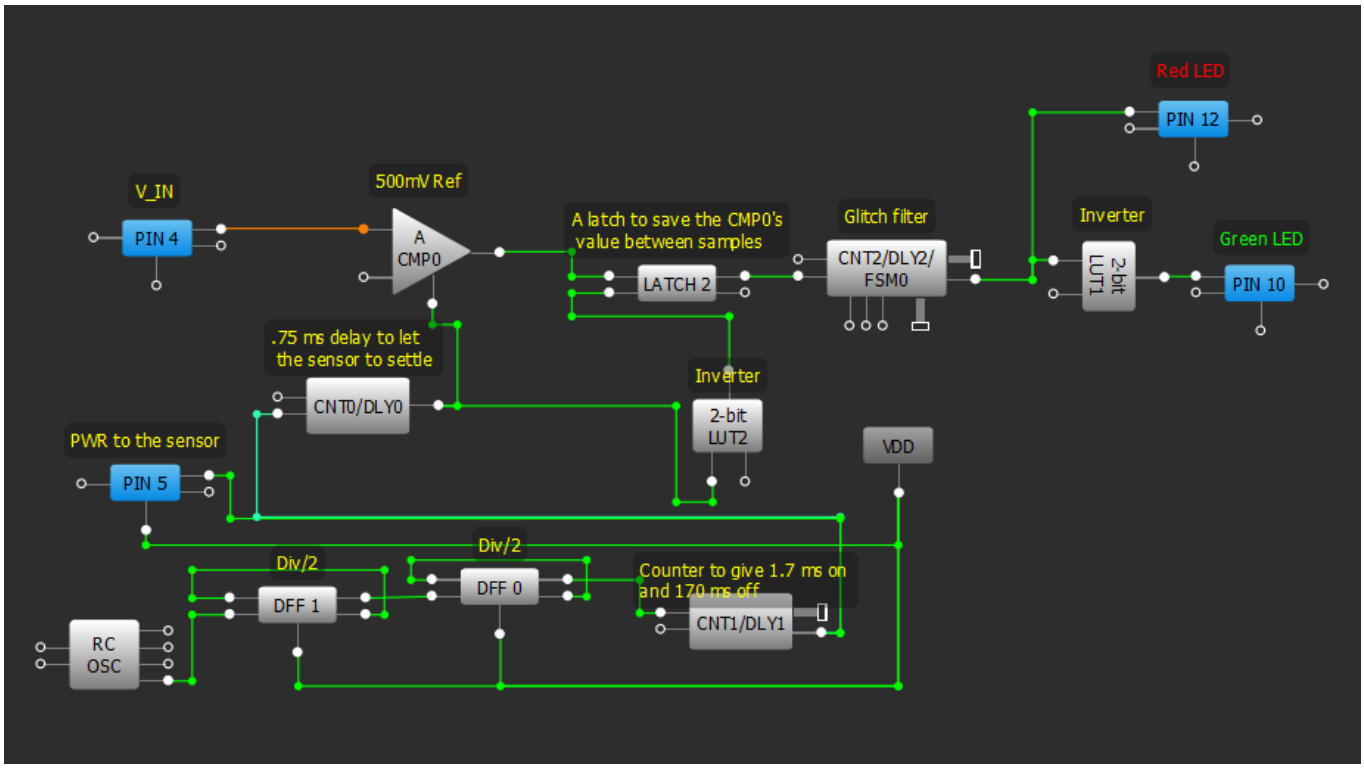

Figure 2. Design connections in GreenPAK2 Designer

Symbol	Parameter	Min.	Typ.	Max.	Unit
V_{THD}	ACMP0 Voltage Threshold	494	-	506	mV
V_{AIR}	ACMP Analog Input Voltage Range	0	-	1000	mV
T_{DLY0}	DLY0 Time Delay	-	0.7410	-	ms
T_{CNT1}	CNT1 Period Time	-	14.25	-	ms
T_{DLY2}	DLY2 Period Time	-	0.0706	-	ms

Table 1. Design Main Electrical Characteristics

This is due to the properties of the semiconductor material that the thermistor is made from.

$$V_{IN} = +5\frac{10k\Omega}{10k\Omega + R_{Th}}$$

At 27°C the resistance value of a Thermistor is 90kΩ (from data sheet of 100kΩ Thermistor)

Using voltage division:

$$V_{IN} = +5\frac{10k\Omega}{10k\Omega + R_{Th}}$$

At 27°C the resistance value of a Thermistor is 90kΩ (from data sheet of 100kΩ Thermistor)

Using voltage division:

$$V_{IN} = +5\frac{10k\Omega}{10k\Omega + 90k\Omega}$$

So, V_{IN} = 500mV

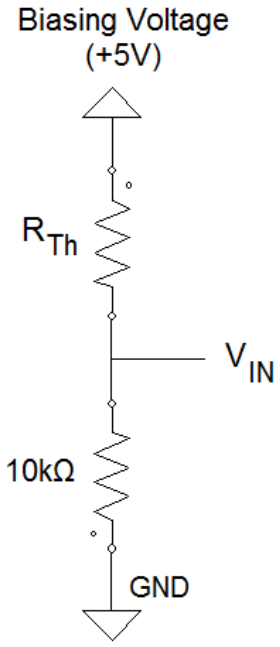

Figure 3. Circuit Design

Now we want to compare the input voltage value (representing measured temperature) with a 500mV voltage reference (representing 27°C target). ACMP0 configured as 500mV with 12mV hysteresis compares the analog input voltage V_{IN} with the reference value 500mV.

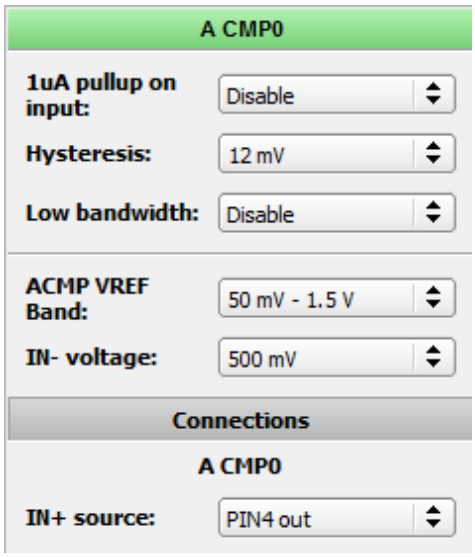

Figure 4. A CMP0 properties

In this design example, the GreenPAK2 uses Pin5 to bias the thermistor, and uses Pin4 to measure the analog output from the resistor divider during each sample period.

The sampling (determined by CNT1/DLY1) is configured for 1.7ms ON and 170ms OFF, which conserves power. CNT1's input clock is generated by RC OSC signal/12, then divided by 4 using two DFFs.

The ACMP power is gated by the pulse signal coming from the frequency generator to reduce the power consumption. DLY0 creates .75ms delay for sensor settling time. The output goes to a latch to hold the state between sample periods.

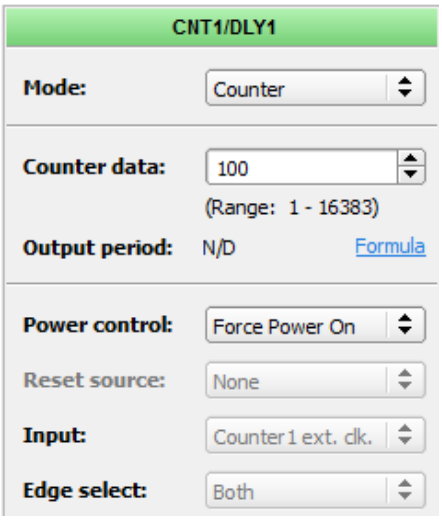

Figure 5. CNT1/DLY1 properties

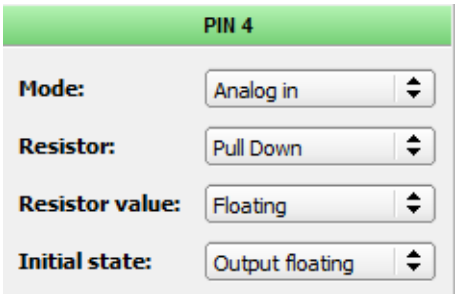

Figure 6. PIN 4 properties

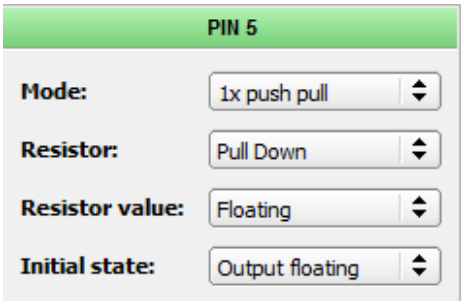

Figure 7. PIN 5 properties

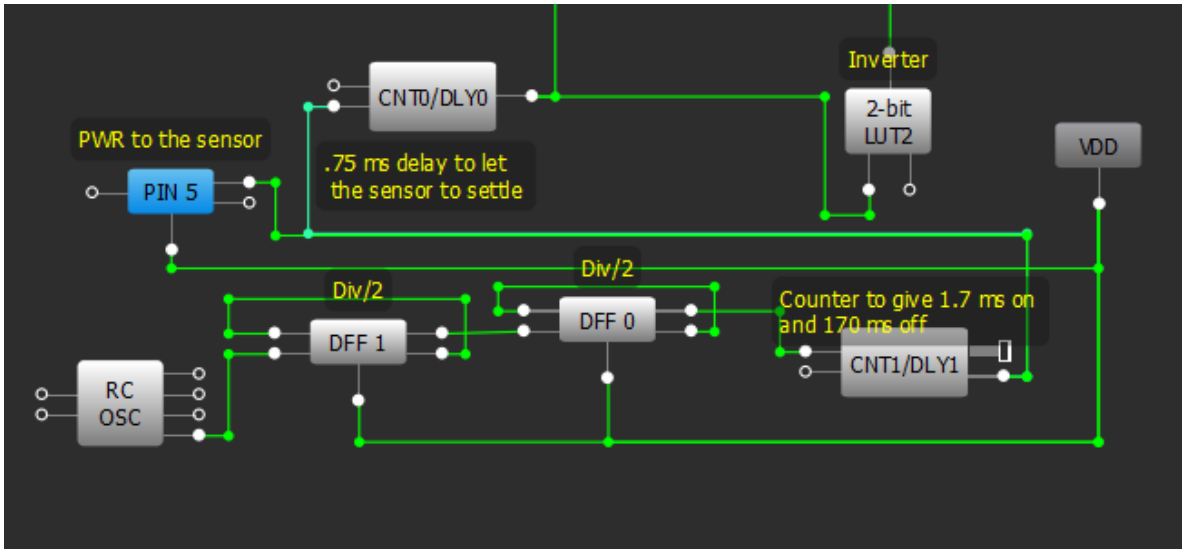

Figure 8. CNT1/DLY1, DFF0 and DFF1 in GreenPAK2 Designer

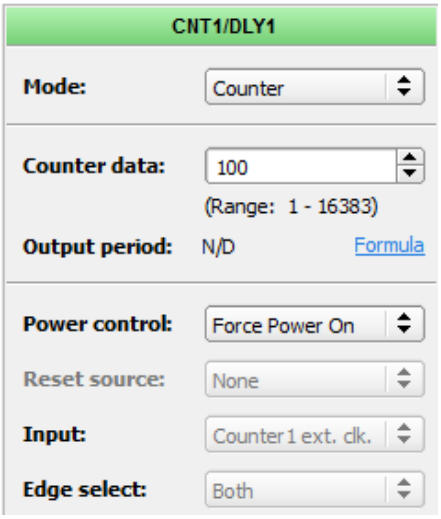

Figure 9. CNT1/DLY1 properties

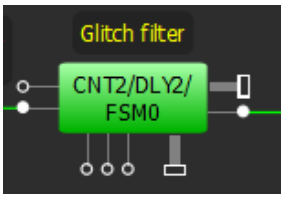

Figure 10. Glitch filter in GreenPak2 Designer

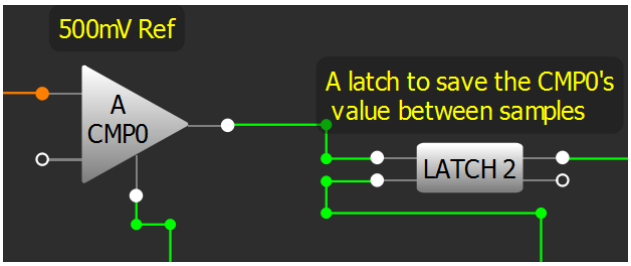

Figure 11. A CMP0 and Latch2 in GreenPAK2 Designer

The CNT2/DLY2 is a delay used as a Glitch filter to reject the glitches by ACMP's switching.

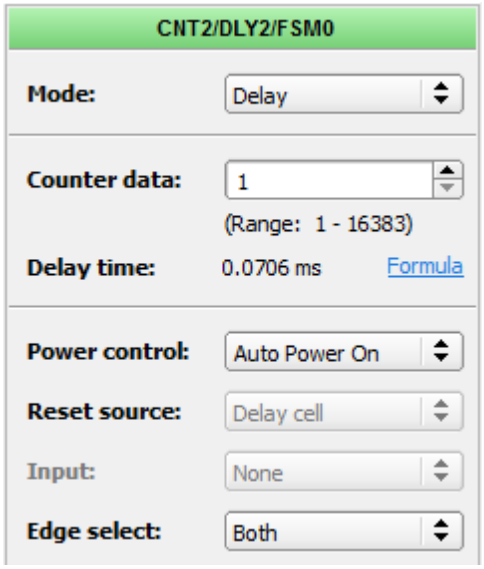

Figure 12. CNT2/DLY2/FSM0 properties

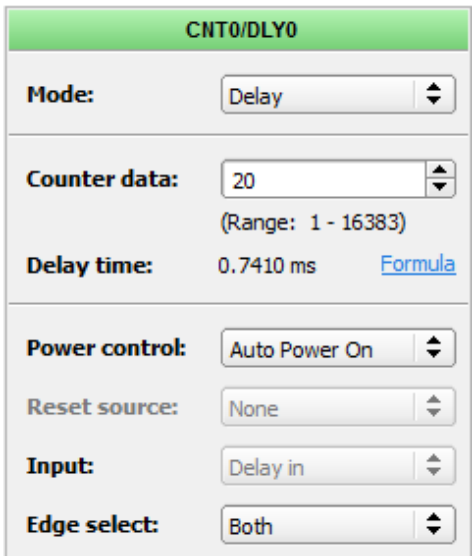

Figure 13. CNT0/DLY0 properties

The outputs are configured as Open Drain which drive two LEDs. PIN10 is connected to a green LED, which indicates that the temperature is within limit, and PIN 12 is connected to a red LED, which indicates that the temperature is outside the limit.

PINs 10 & 12 are configured as Inverted buffered LED+Pull up.

Pin 5 is configured as Buffered LED.

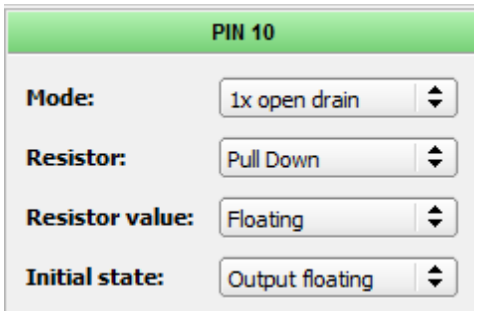

Figure 14. PIN 10 properties

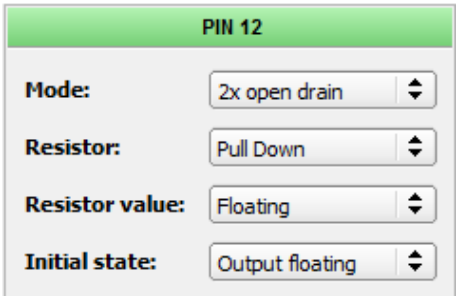

Figure 15. PIN 12 properties

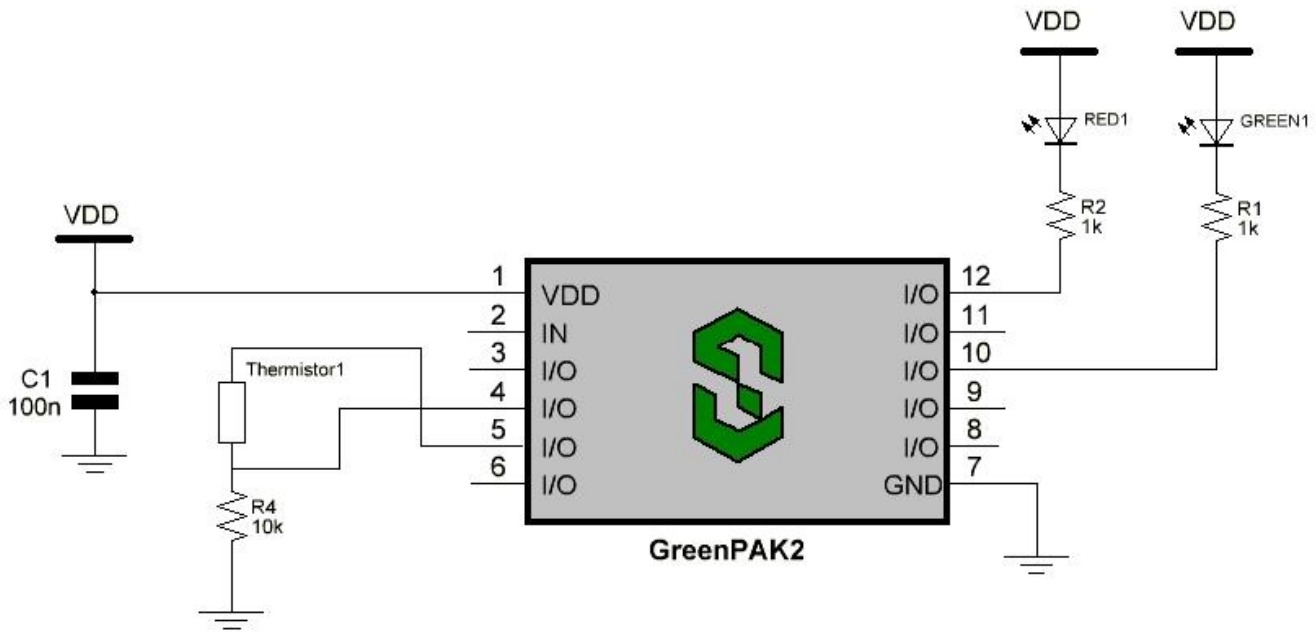

Figure 16. Typical Application Circuit

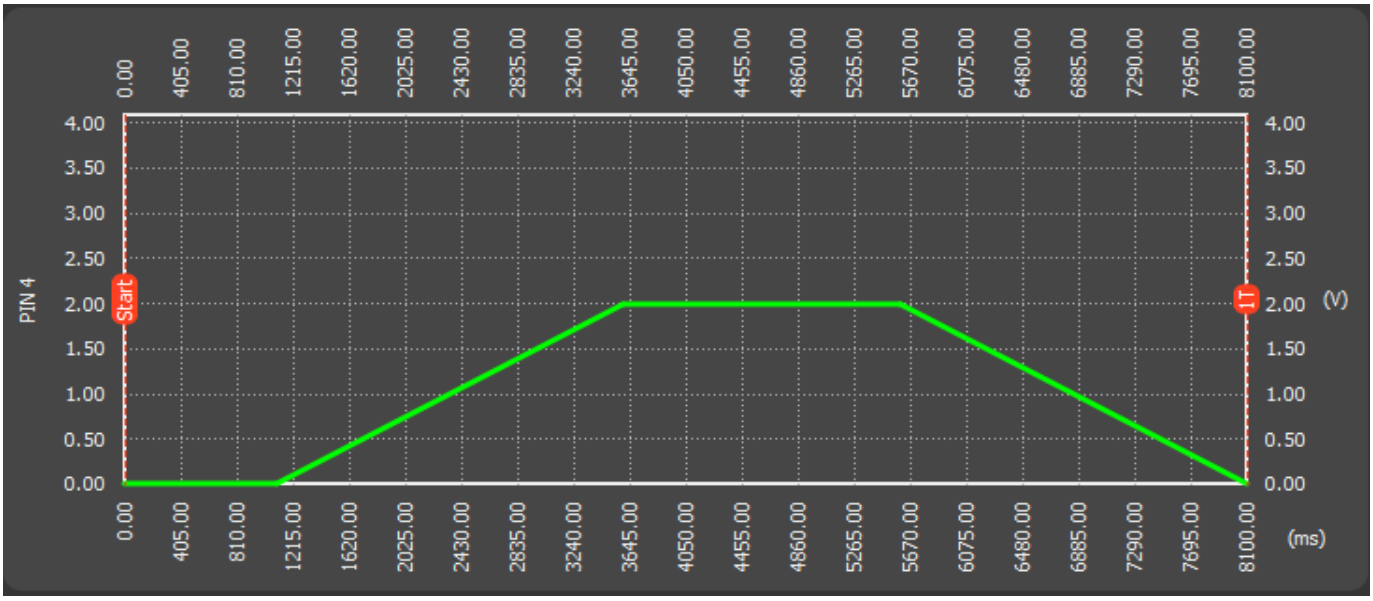

Figure 17. PIN 4 Signal Diagram

Pin 4 is configured as Signal generator as shown:

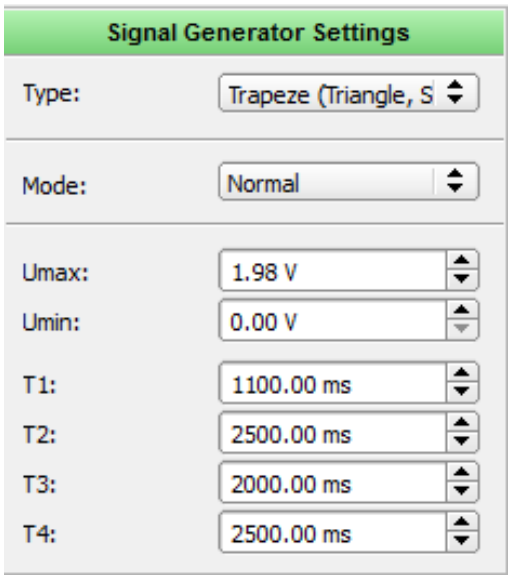

Figure 18. Signal Generator Settings

Note: For proper operation of circuit don't forget to correctly configure input and output pins.

In case of schematic you see on Figure 2 inputs are configured as digital input with Schmitt trigger, and output as push-pull.

Functionality Waveforms

Pins 10&12 are configured as open drain so that the LED will be ON at low and be OFF at high.

The sampling signal at PIN 5 is shown in figure 22.

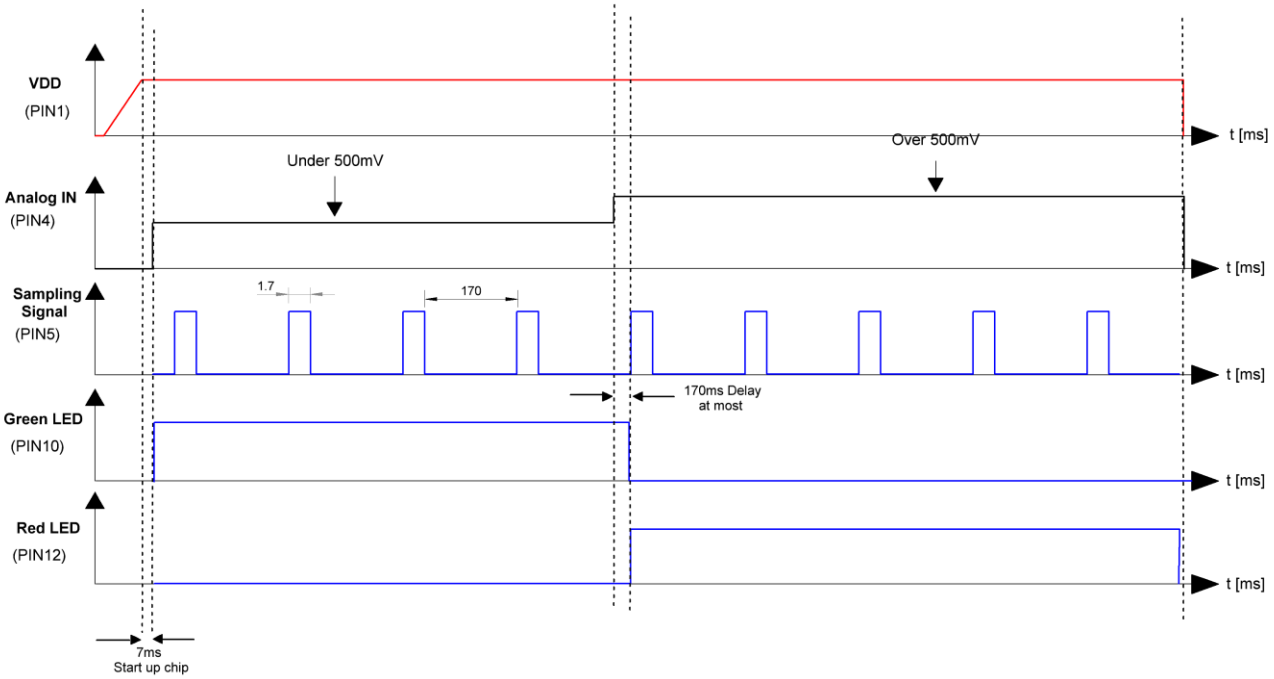

Figure 19. Timing Diagram

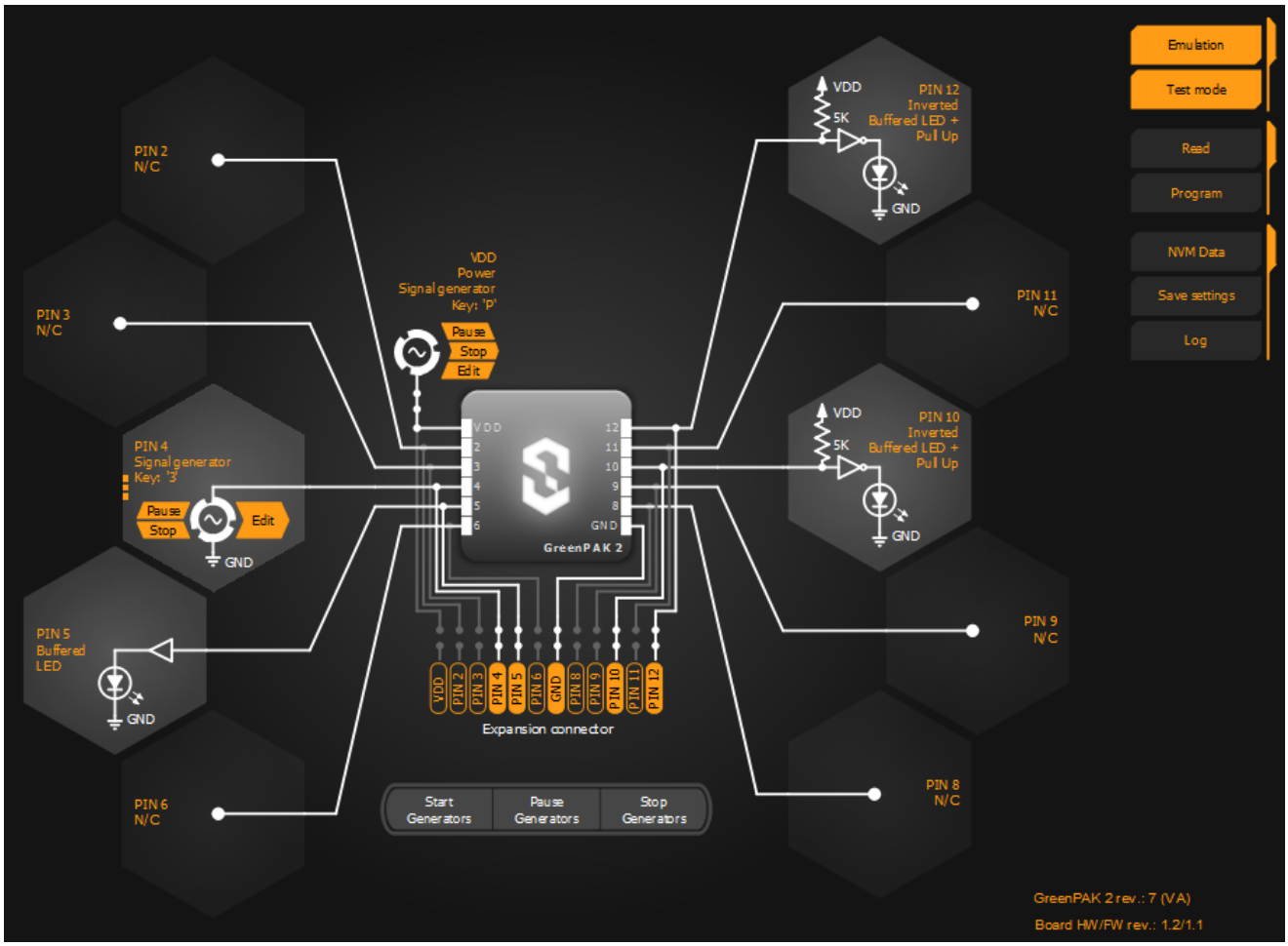

Figure 20. Configuration of GreenPAK2 Emulation Tool

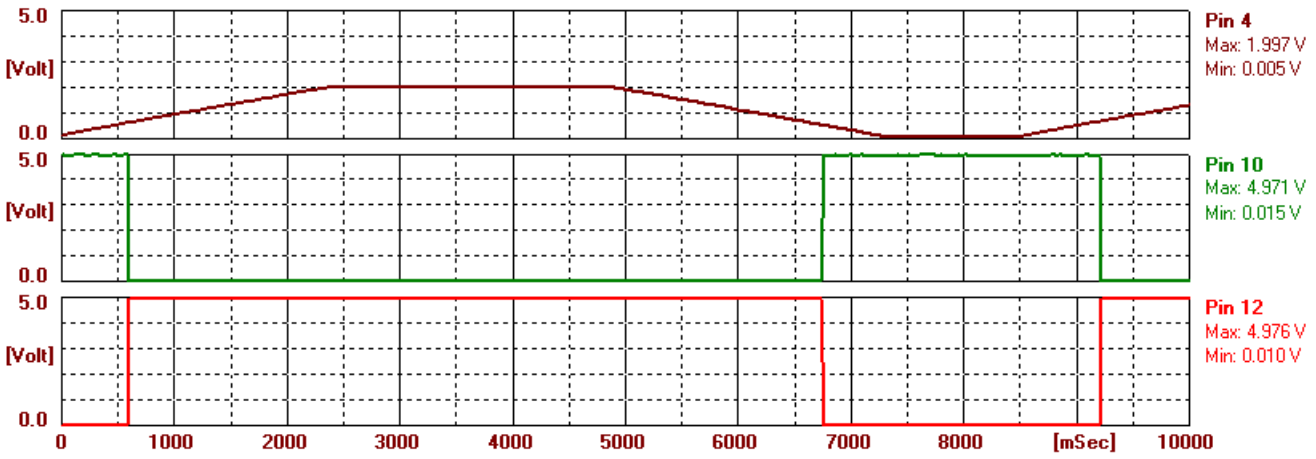

Figure 21. Functionality waveforms

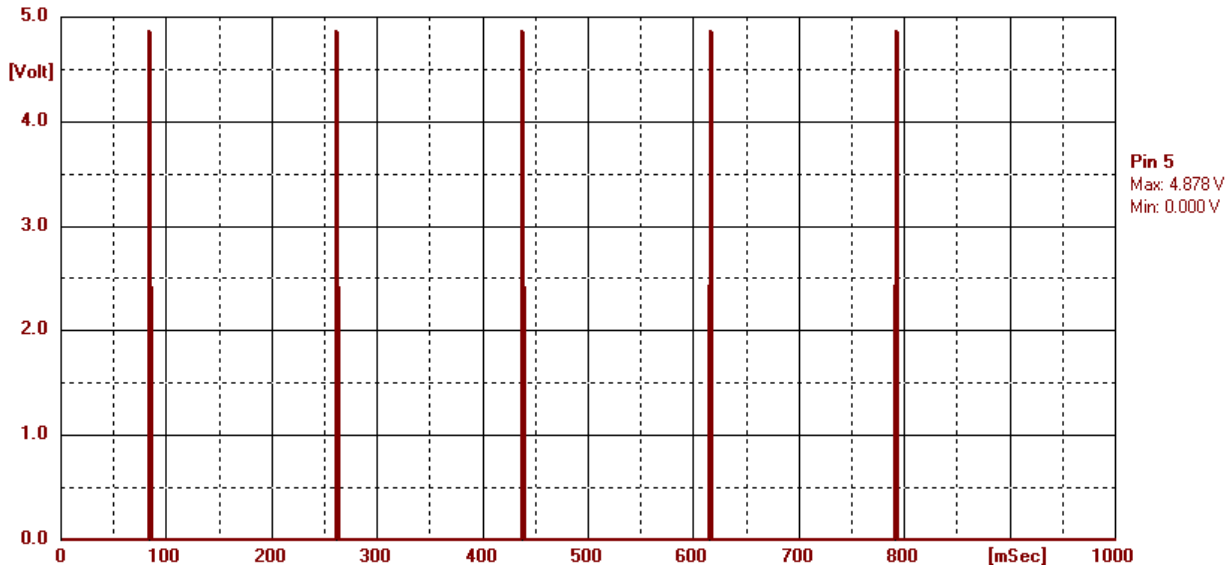

Figure 22. Sampling signal at PIN 5

Conclusion

Temperature was successfully monitored using a thermistor, with a GreenPAK2 providing analog conversion, alarm limits setting, and driving the external indicators.

About the Author

Name: Ahmad Al Shari

Background: Ahmad Al Shari graduated from Jordan University of Science and Technology -Jordan in 2013, studying at the Department of Electrical Power Engineering. Presently he is working with Configurable Mixed Signal ICs (CMICs) and their application notes.

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Document History

Document Title: Temperature Sensor with Thermistor

Document Number: AN-1036

Revision	Orig. of Change	Submission Date	Description of Change
A	Ahmad Al Shari	3/20/2014	New application note

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