Temperature monitor with External Sensor IC's

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Introduction

Silego GreenPAK2 is a low power and small form factor device. It is housed in a 2.5mm x 2.5mm TDFN package which is ideal when space saving is important.

In this application the GreenPAK2 is configured as a temperature monitor along with an external solid state temperature sensor. The GreenPAK2 monitors the temperature to indicate within a desired range. Two of the outputs drive indicator LED's to show the status.

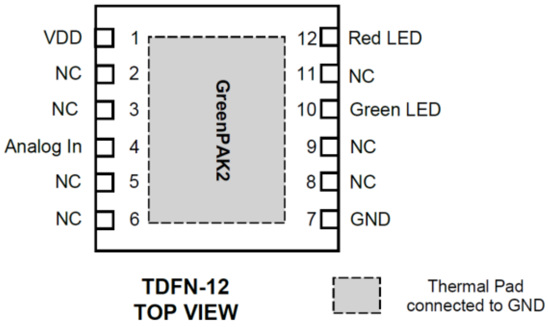

Figure 1. Pin configuration

Description

As external devices, we can choose the LM35 series. These are precision integrated circuit temperature sensors that feature: linear output voltage at 10mV/°C - 0.5°C accuracy from (-55°C to 150°C), don't require calibration, and are well suited for low power applications.

The solid state temperature sensor that we used is LM35 as shown in figure 2.

At 20°C the output of LM35 is 200mV:

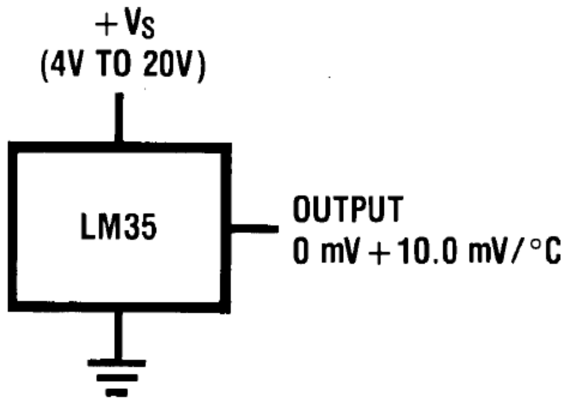

Figure 2. LM35 Temp sensor

$$V_{out} = 10mV/°C \times X \times 20°C$$

And at 30°C the output is 300mV:

$$V_{out} = 10mV/°C \times X \times 30°C$$

In this design example of temperature monitoring, the GreenPAK2 uses Pin5 to power up the LM15 during a sample period to save power. Pin4 is used to measure the analog output from the LM15.

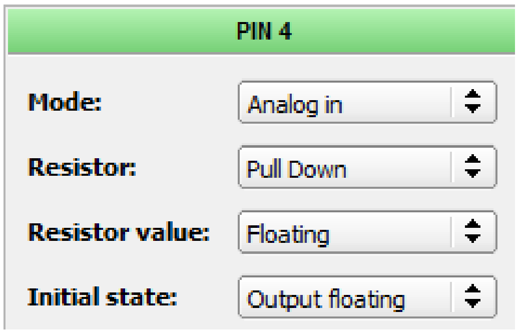

Figure 3. PIN 4 properties

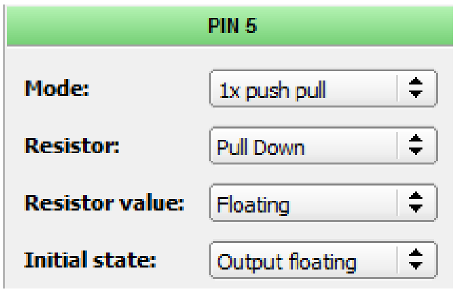

Figure 4. PIN 5 properties

The ACMP0&1 compare the analog input voltage V_{In} with a reference value 300mV for ACMP1 and 200mV for ACMP0 (see figure 5 and 6).

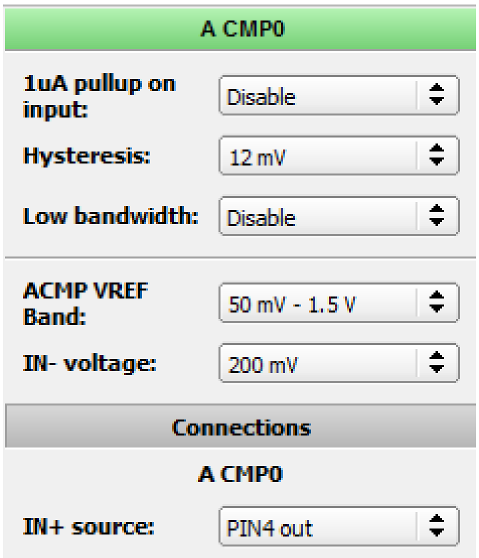

Figure 5. A CMP0 properties

The sampling period is determined by CNT0/DLY0 and is configured for 1.7ms ON and 170ms OFF to conserve power. The CNT0 input clock is generated by RC OSC signal/12, then divided by 4 using two DFFs.

ACMP0 and ACMP1 are also powered on only when needed for additional power savings. DLY1 is a 0.75ms delay that is used for sensor settling time.

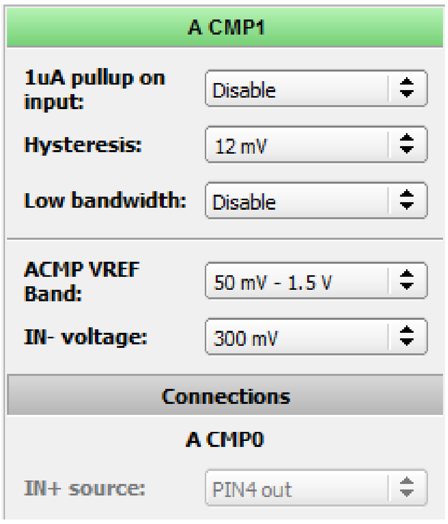

Figure 6. A CMP1 properties

The outputs of the two comparators go to LUT1 as pulses as shown Then the LUT1's output goes to a latch to hold the value between sample periods.

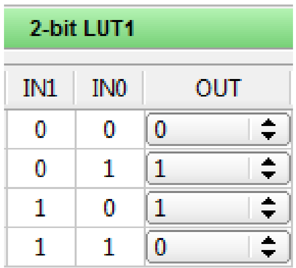

Figure 7. 2-bit LUT1 properties

CNT2/Dly2 is a delay used as a glitch filter to reject the glitches when ACMP's are switching.

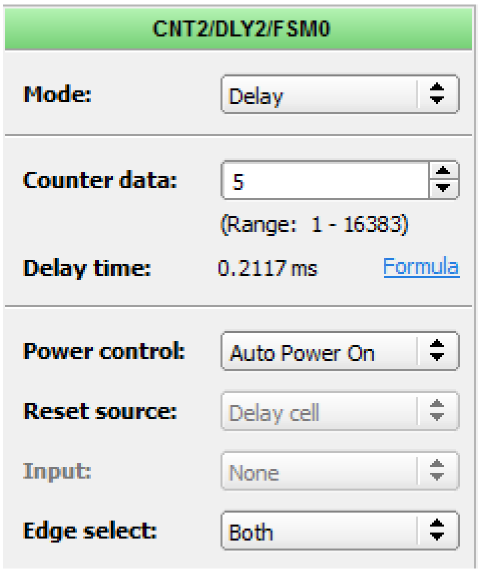

Figure 8. CNT2/DLY2/FSM0 properties

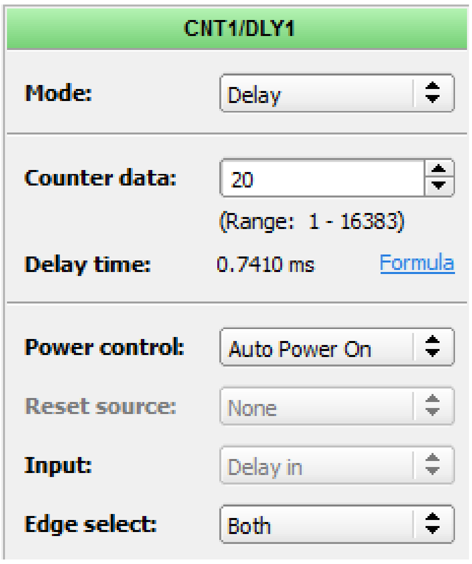

Figure 10. CNT1/DLY1 properties

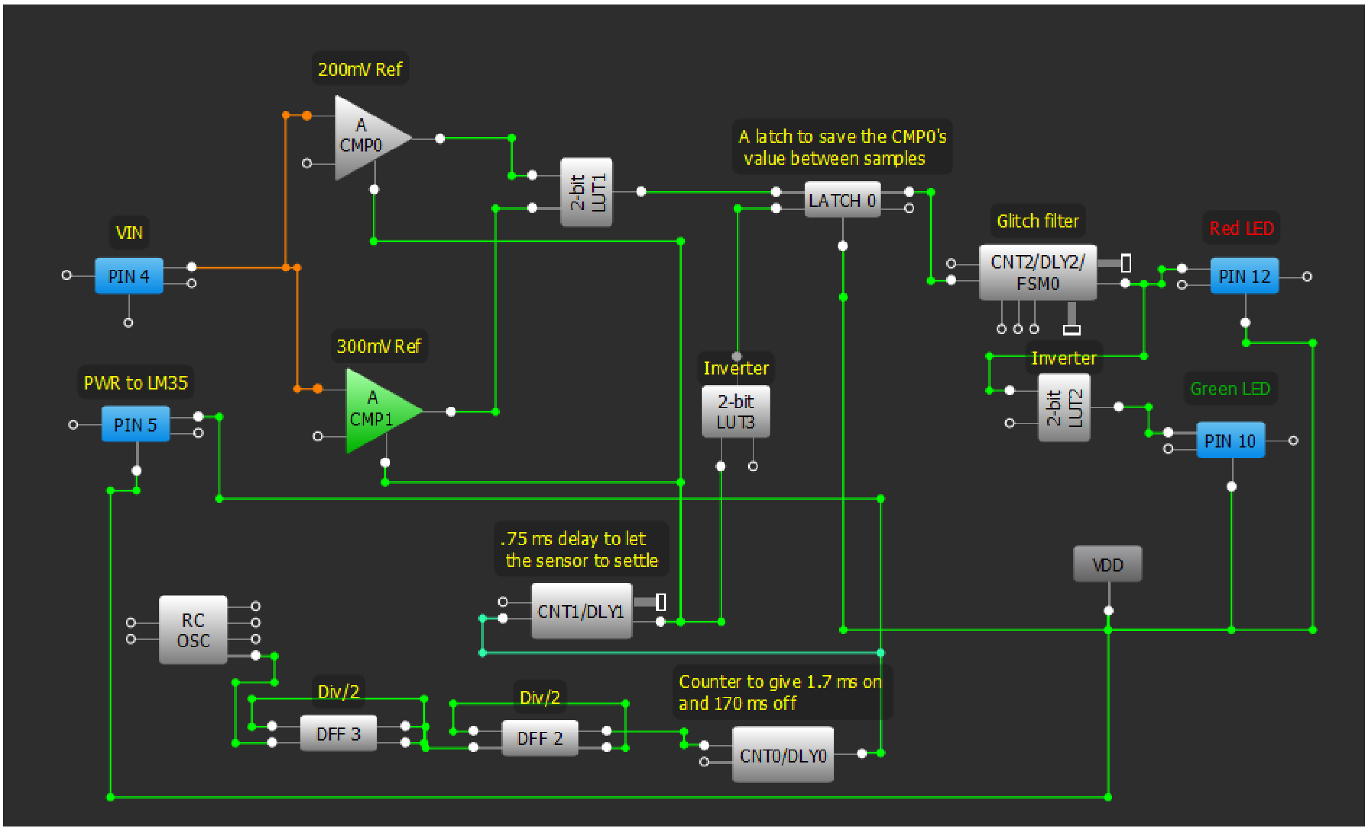

Figure 9. Design connections inside GPAK

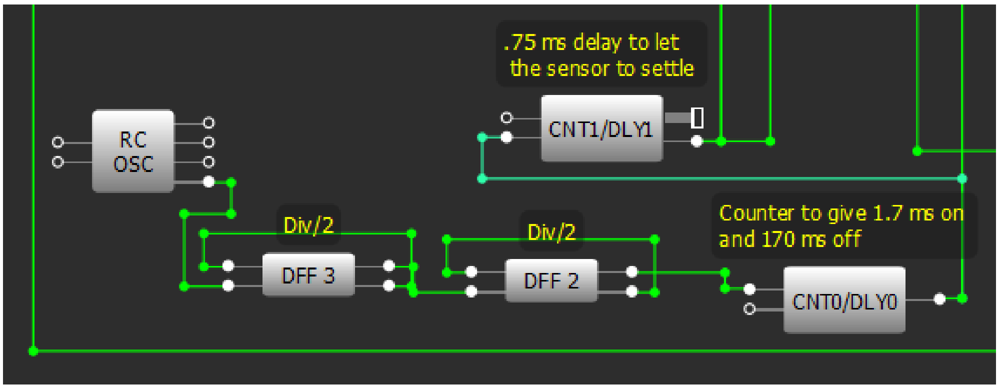

Figure 11. CNT0/DLY1 and CNT0/DLY0 configuration in GreenPAK2 Designer

Pin #	Pin Name	Type	Pin Description
1	VDD	Power	Supply Voltage
2	NC	--	Keep floating or connect to GND
3	NC	--	Keep floating or connect to GND
4	Analog in	Analog input	Analog input from external circuit
5	NC	--	Keep floating or connect to GND
6	NC	--	Keep floating or connect to GND
7	GND	GND	Ground
8	NC	--	Keep floating or connect to GND
9	NC	--	Keep floating or connect to GND
10	Green LED	1x Push Pull	Output to Green LED
11	NC	--	Keep floating or connect to GND
12	Red LED	1x Push Pull	Output to Red LED
Exposed Bottom Pad	Exposed Bottom Pad	GND	Ground

Table 1. Pin configuration

The outputs are configured as open drain to drive two LED’s. PIN10 is connected to a green LED which indicates that the temperature is within limits. And PIN 12 is connected to a red LED to indicate that the temperature is outside the limits (see figure 12 and 13).

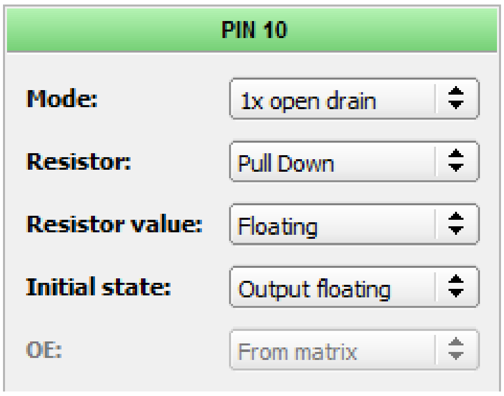

Figure 12. PIN 10 properties

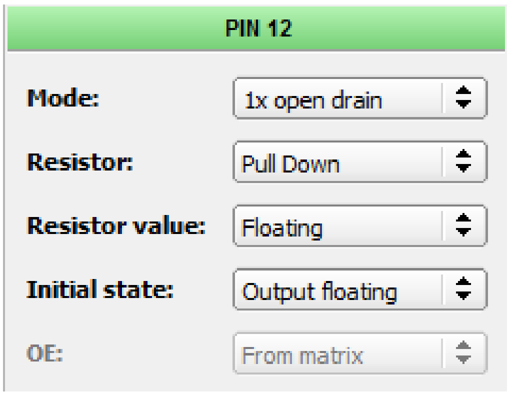

Figure 13. PIN 12 properties

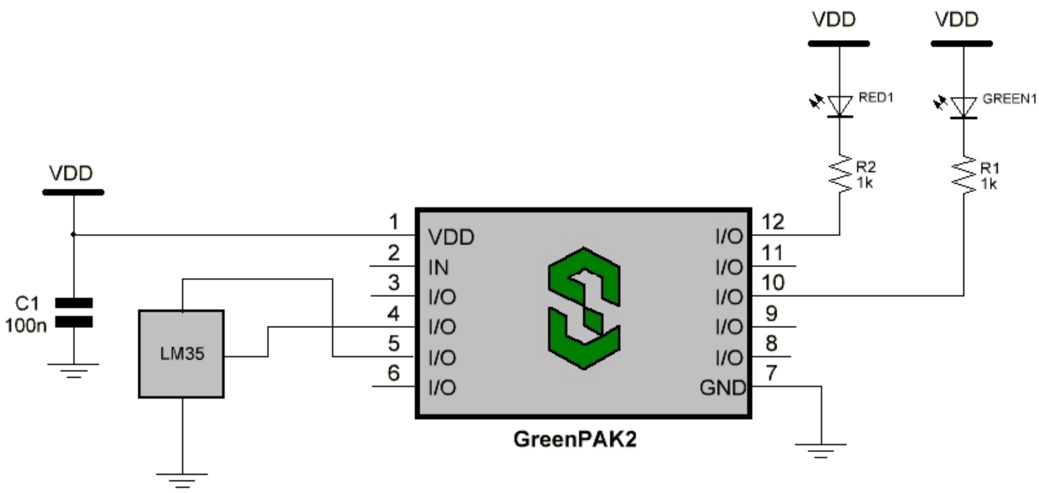

Figure 14. Typical Application Circuit

Symbol	Parameter	Condition/Note	Min.	Typ.	Max.	Unit
V_{ref}	Reference Voltage	ACMP0	--	200	--	mV
V_{ref}	Reference Voltage	ACMP1	--	300	--	mV
V_{HYST}	Analog Comparator Hysteresis	ACMP0,ACMP1	--	12	--	mV
T_{CNT0}	Counter	CNT0/DLY0	--	170	--	ms
T_{Delay1}	Delay	CNT1/DLY1	--	0.75	--	ms
T_{Delay2}	Glitch filter	CNT2/DLY2/FSM0	--	0.21	--	ms
F_{RCOSC}	Oscillator	RCOSC	--	3.54	--	Hz

Table 2. Electrical characteristics

Figure 15. PIN 4 Signal Diagram

- Pins 10, 12 are configured as Inverted buffered LED+Pull up.
- Pin 5 is configured as Buffered LED.
- Pin 4 is configured as Signal generator as shown in figure 16.

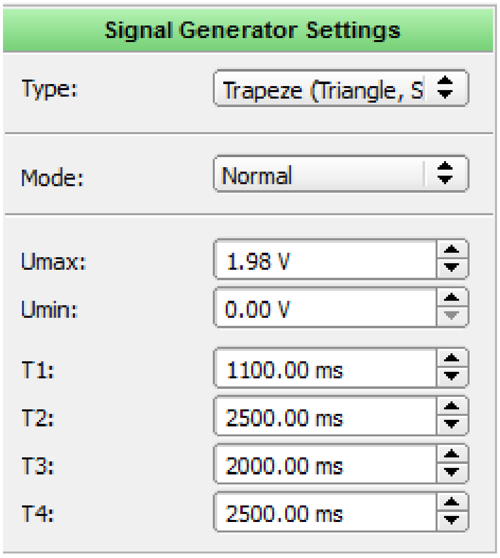

Figure 16. Signal Generator Settings

Functionality waveforms

Functionality waveforms are shown in figure 17.

The blue signal is the input analog test signal, the green signal is the Green LEDs output where it's ON at low and the red signal is the red LEDs output where it's ON at low.

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

As can be seen from Figure 17 the real waveform coincides with the theoretical one shown on Figure 18.

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

In case of schematic you see on Figure 9 inputs are configured as digital input with Schmitt trigger, and output as push-pull.

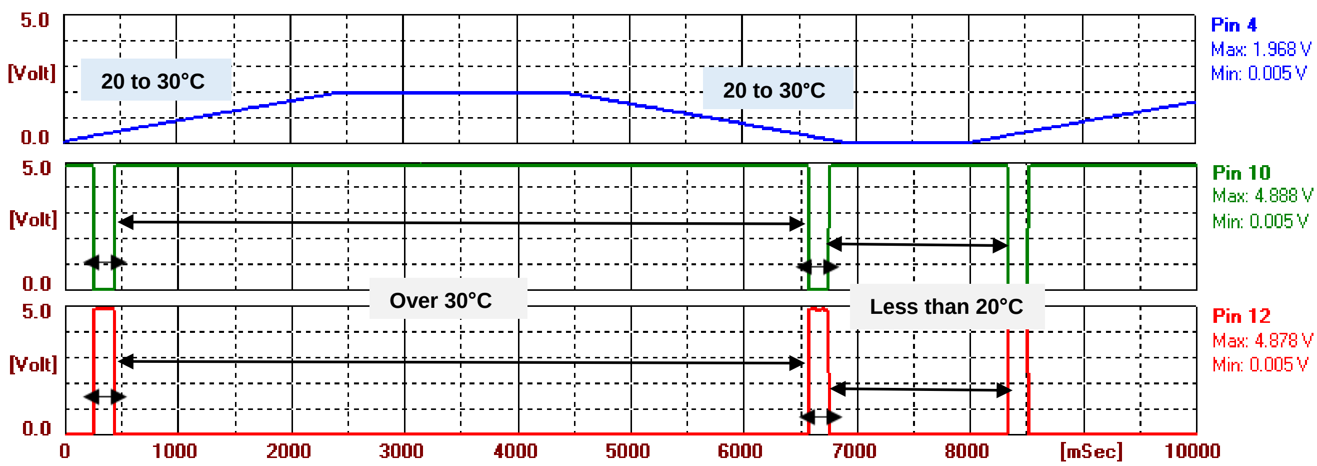

Figure 17. Input and outputs behavior

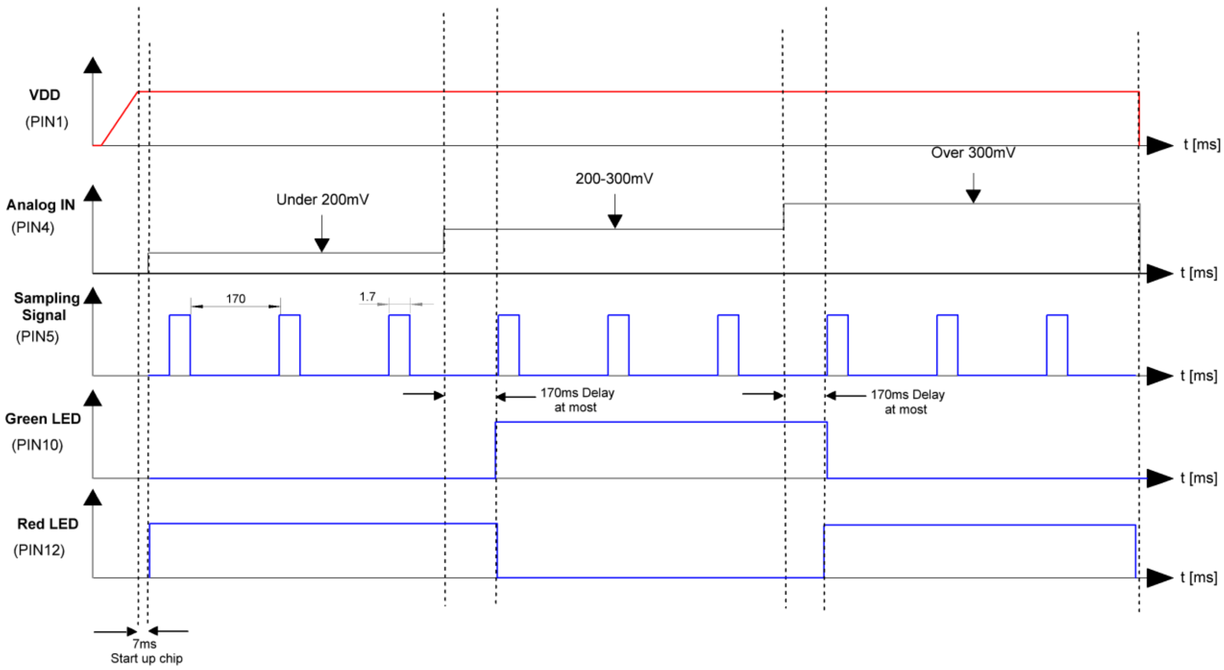

Figure 18. The Timing diagram

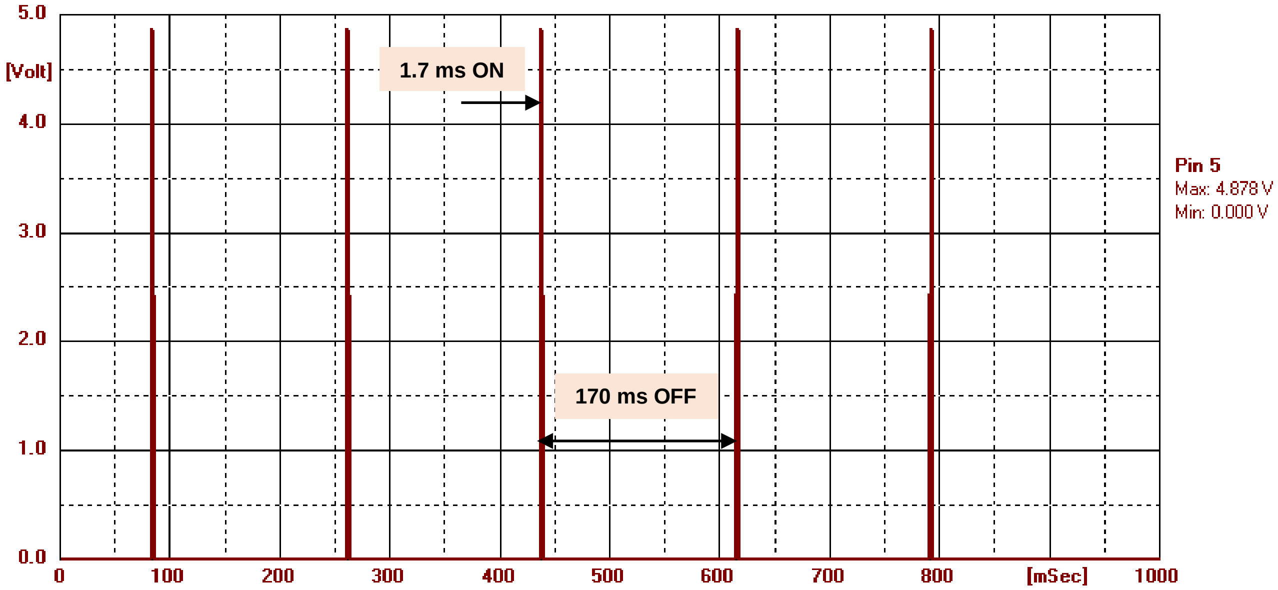

Figure 19. Sampling signal at PIN5 where this signal wake the circuit at high and to sleep at low

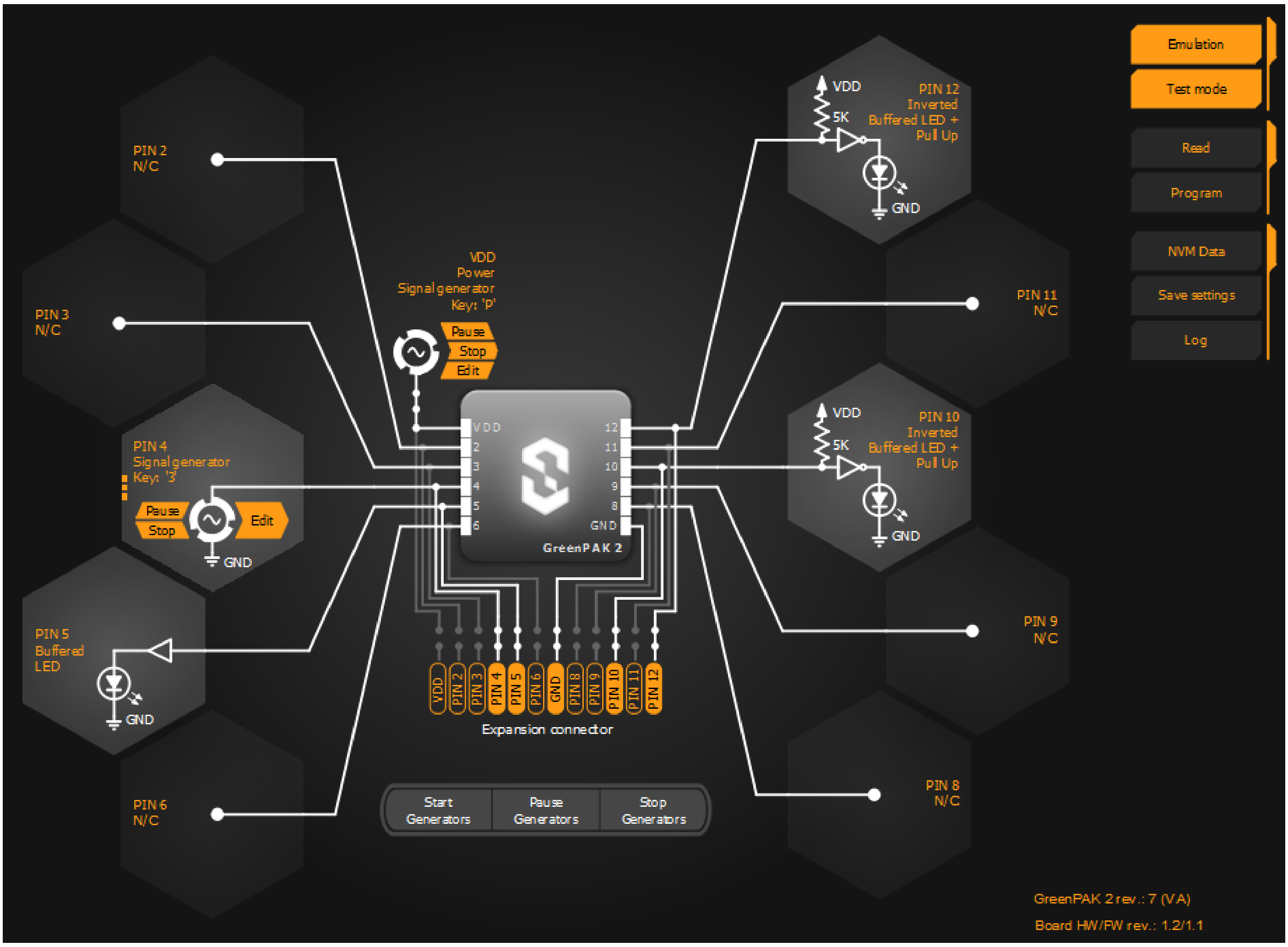

Figure 20. Emulation Tool Configuration

Conclusion

Temperature monitoring using GPAK is very easy and very efficient where the GPAK can take samples for the surrounding environment which increase the designs efficiency.

About the Author

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Revision	Orig. of Change	Submission Date	Description of Change
A	Ahmad Al Shari	3/12/2014	New application note

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