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Introduction

In this application the GreenPAK2 monitors the power on a load within the range (0.5W - 1.5W) by measuring the voltage and the current on the load. Two of the outputs drive indicator LED's to show the status.

In this design example, the voltage range to be monitored is between 3.5V - 5.5V. PIN4 is configured as Analog in, which takes its value from the output of the voltage divider Vx. ACMP0 & ACMP1 compare the value of the input against the desired limits derived from the voltage divider ratio.

We connect the analog input voltage Vx to PIN4 (configured as Analog In with floating resistor). Vx is calculated as shown using the external voltage divider circuit:

$$Vx = VDD \frac{R4}{R4 + R3}$$

When VDD = 3.5V then:

$$V_x = 3.5 \frac{100k\Omega}{100k\Omega + 400k\Omega}$$

Resulting Vx = 700mV

When VDD = 5.5V then:

$$Vx = 5.5 \frac{100k\Omega}{100k\Omega + 400k\Omega}$$

Resulting Vx = 1100mV.

The resulting level-shifted limits of 700mV and 1100mV are set as the IN- analog comparator references. ACMP0 is configured as 700mV with 12mV Hysteresis, and ACMP1 is configured as 1100mV with 12mV Hysteresis.

Symbol	Parameter	Min.	Typ.	Max.	Unit
V_{THD}	ACMP0 Voltage Threshold	694	-	706	mV
V_{THD}	ACMP1 Voltage Threshold	1094	-	1106	mV
V_{AIR}	ACMP Analog Input Voltage Range	0	-	1000	mV
$V_{REF\ ADC}$	ADC Voltage Reference	-	1000	-	mV

Table 1. Design Main Electrical Characteristics

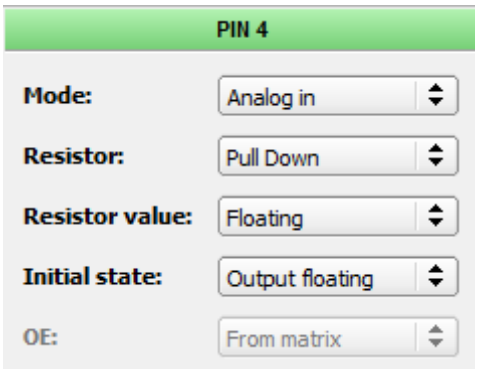

Figure 1. PIN 4 properties

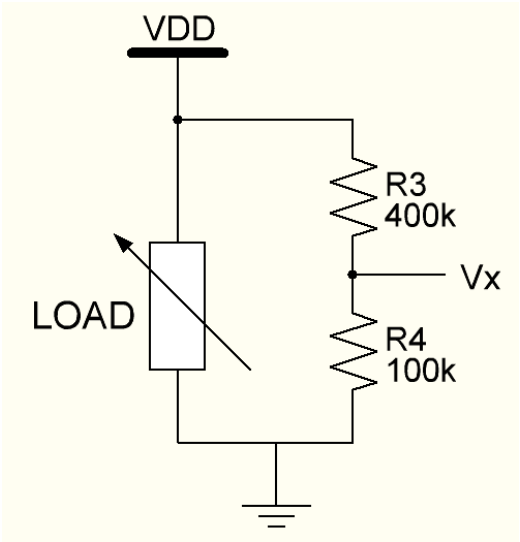

Figure 2. Circuit Design

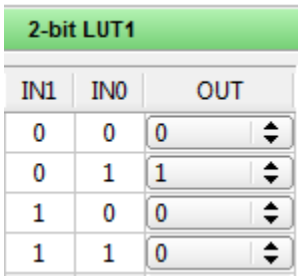

Figure 3. 2-bit LUT1

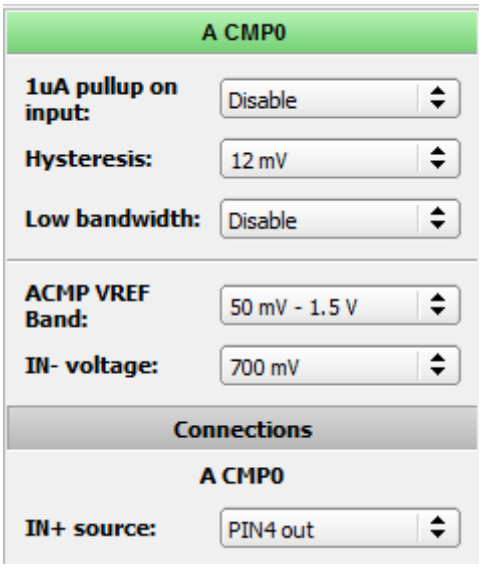

Figure 4. ACMP0 properties

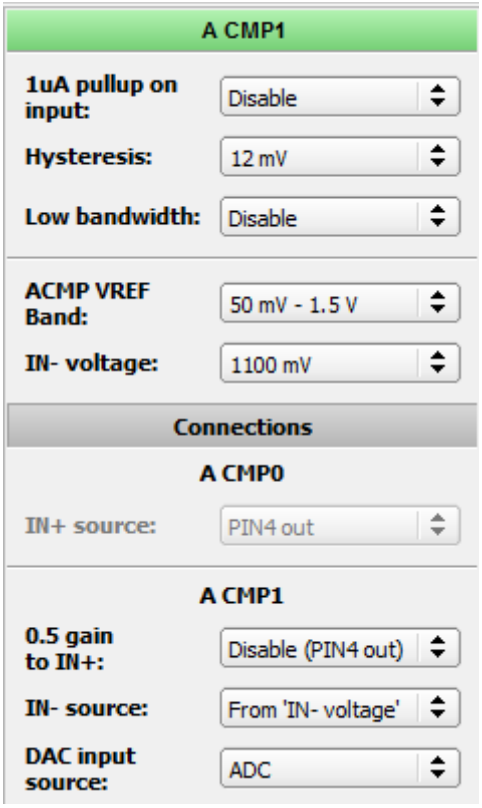

Figure 5. A CMP1 properties

Also, we use POR (configured as Auto power detect function on) for analog comparator power savings.

Connection of the POR block also ensures that the device wouldn't be influenced by external signals before all the blocks have powered up.

Next, the outputs of analog comparators go through LUT1 logic cell.

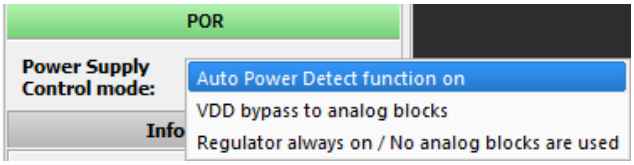

Figure 6. POR properties

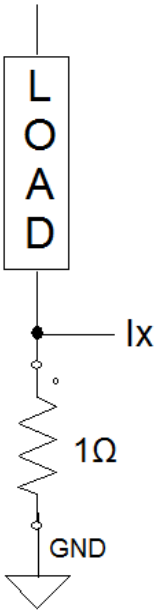

Figure 7. Circuit Design with PIN 8 configured as Analog In

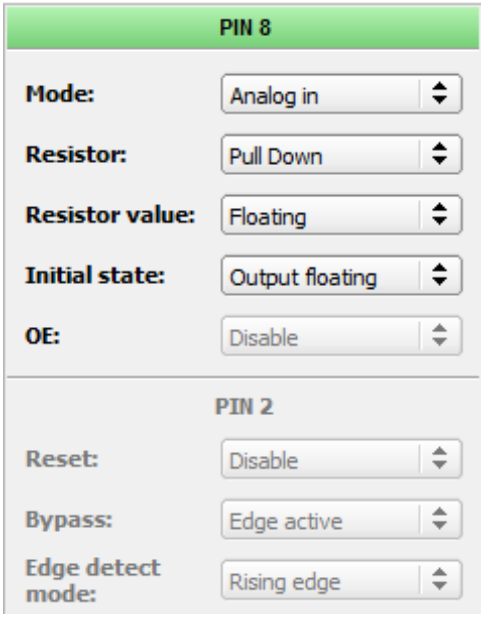

Figure 8. Pin 8 properties

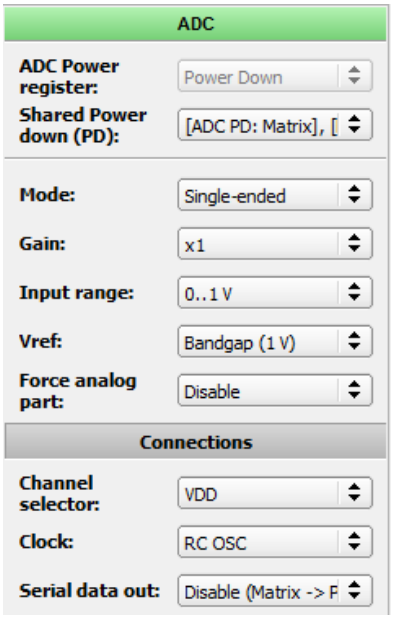

Figure 9. ADC properties

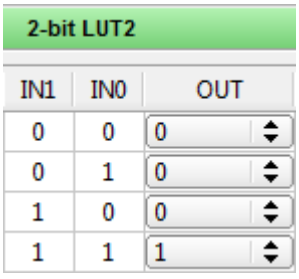

Figure 10. 2-bit LUT2 properties

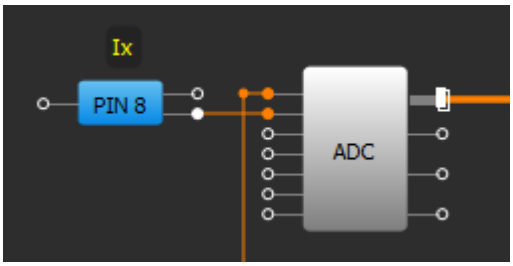

Figure 11. PIN 8 and ADC in GreenPAK2 Designer

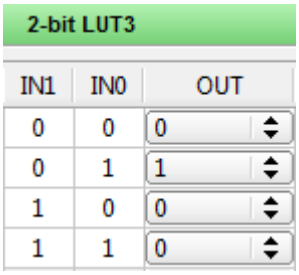

Figure 12. 2-bit LUT3 properties

Current Monitoring

The voltage range is between (3.5V - 5.5V), and the power range which we need to monitor is between (0.5W - 1.5W), so the resulting load current range is 140mA - 273mA. This current is detected by the ADC on the second channel named Ix (PIN 8: configured as Analog In with floating resistor).

DCMP0/PWM0 and DCMP1/PWM1 are used to compare the output of the ADC with the digital value that represents the threshold limits of current.

In this case:

$$Ix_{min} = \frac{36}{256} \times 1 = 140mV$$

$$Ix_{max} = \frac{70}{256} \times 1 = 273mV$$

Note that DCMP0/PWM0 IN- selector is from "Register 0", and DCMP1/PWM1 IN- selector is from "Register selected through matrix"

To indicate the required power range, we used two LEDs. One LED is Green indicating power within range of 0.5W - 1.5W, and the Red LED alerts power outside that range.

- PIN10 is an output pin which is configured as 1x Open Drain; it's connected to the Green LED.
- PIN5 is an output pin which is configured as 1x Open Drain; it's connected to the Red LED.

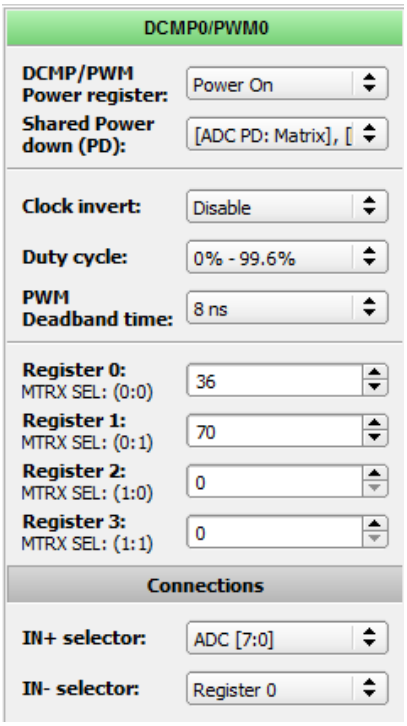

Figure 13. DCMP0/PWM0 properties

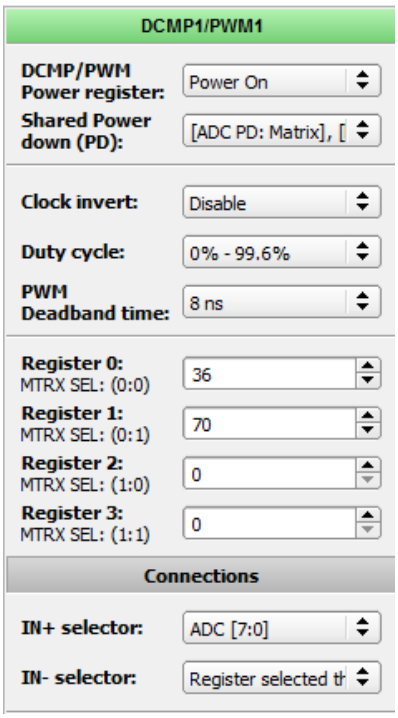

Figure 14. DCMP1/PWM1 properties

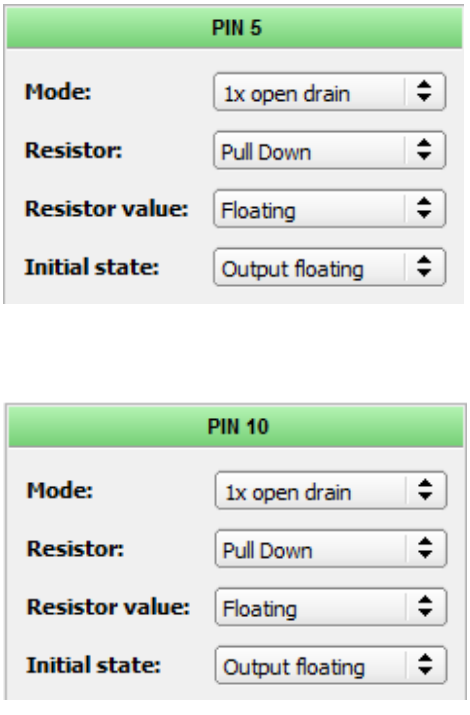

Figure 15. Pin 5 and PIN 10 properties

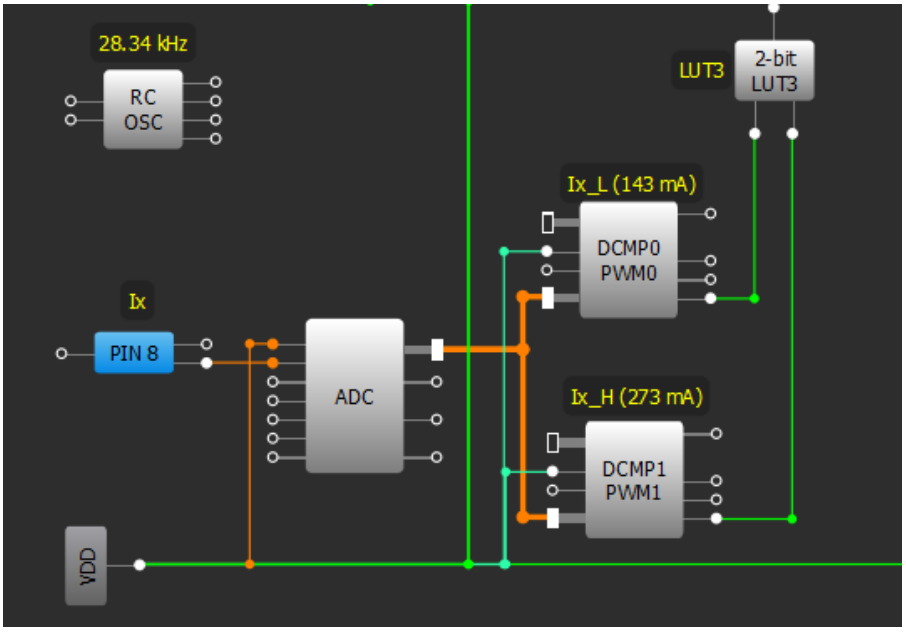

Figure 16. Design connections in GreenPAK2 Designer

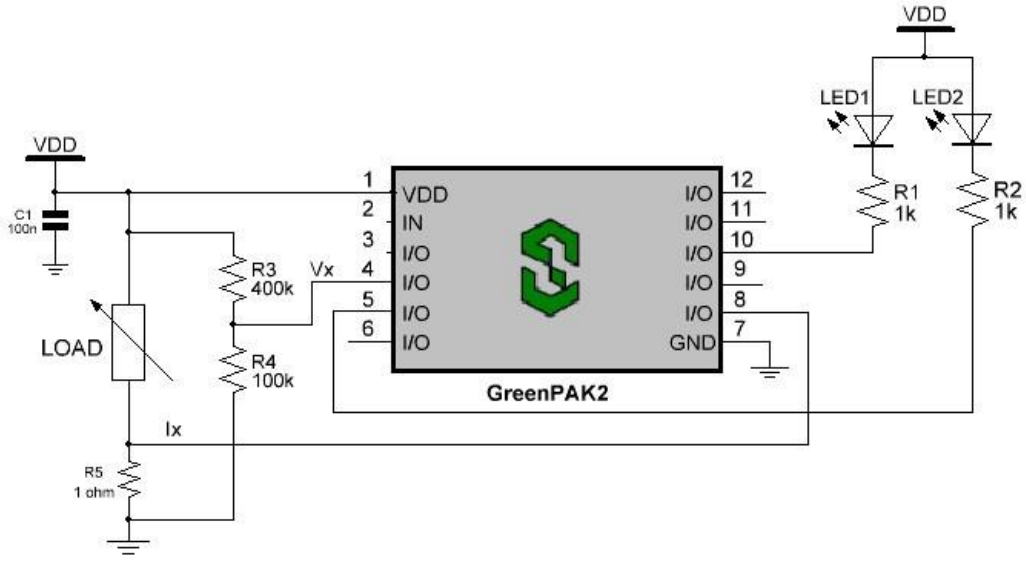

Figure 17. Typical Application Circuit

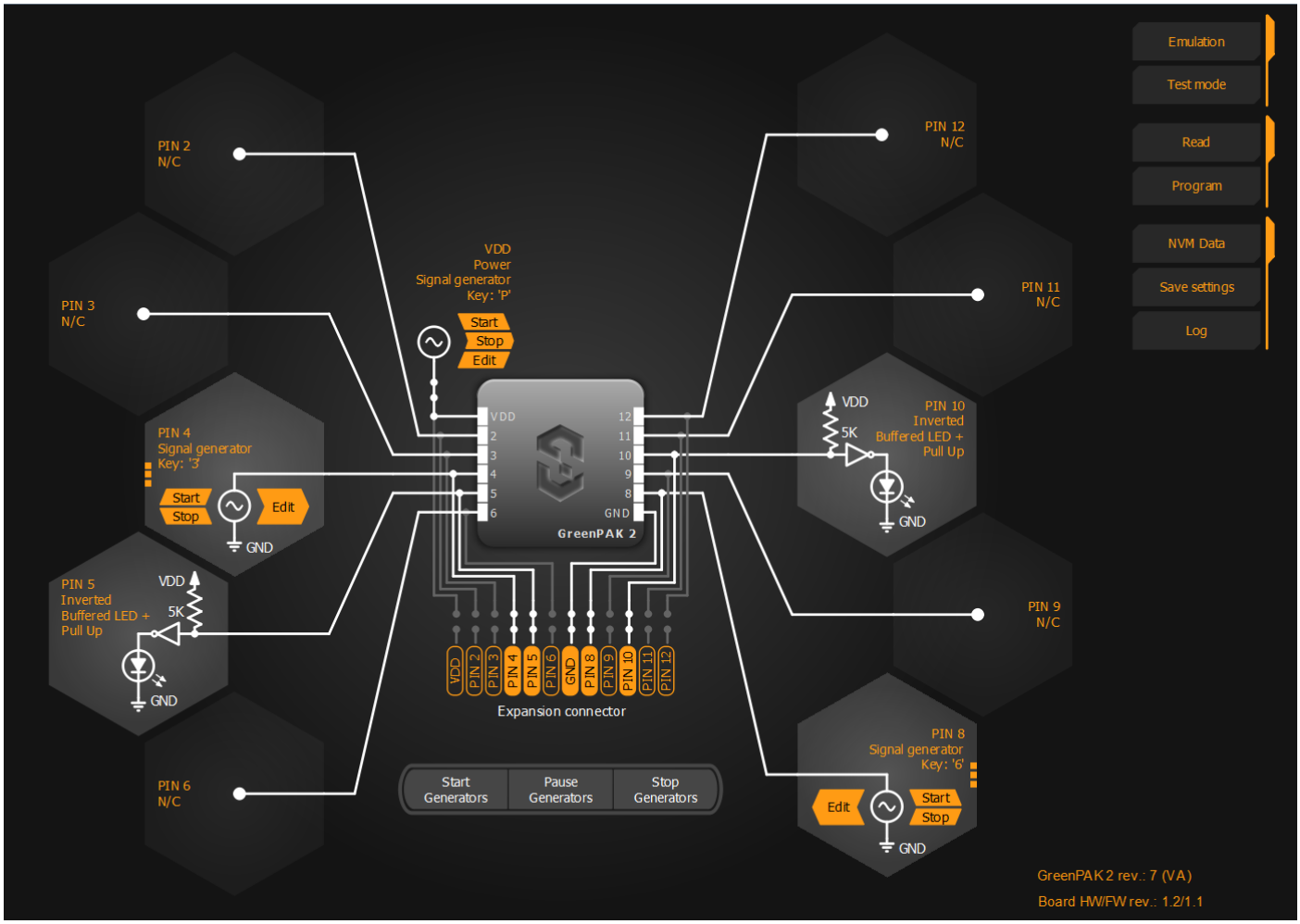

Figure 18. Configuration in GreenPAK2 Emulation Tool

Note: For proper operation of circuit, do not forget to correctly configure input and output pins. In case of schematic you see on Figure 16, PIN4 and PIN8 configured as analog input, the output PIN5 and PIN10 are configured as open drain.

For testing purposes, a custom Input Signal from PIN4 and PIN8 are generated using Signal Wizard in GreenPAK 2 emulation tool. As you can see in Figure 19 and Figure 20.

Functionality Waveforms

Generated signal from signal generator as the Input Signal from PIN4 (Vx).

Generated signal from signal generator as the input signal to PIN 8 (Ix).

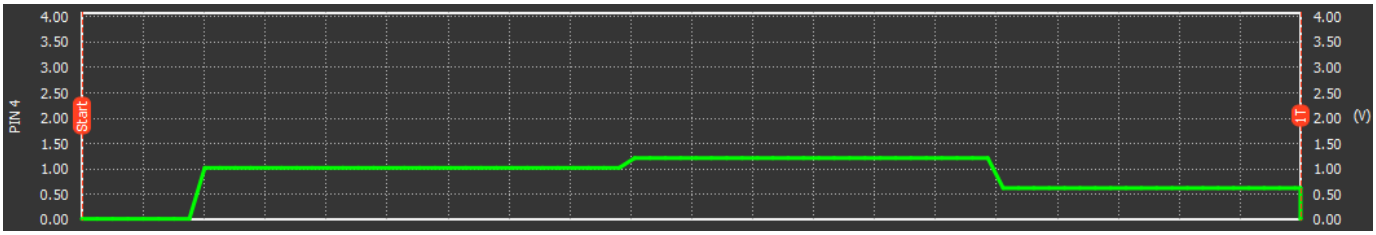

Figure 19. PIN 4 Signal Diagram

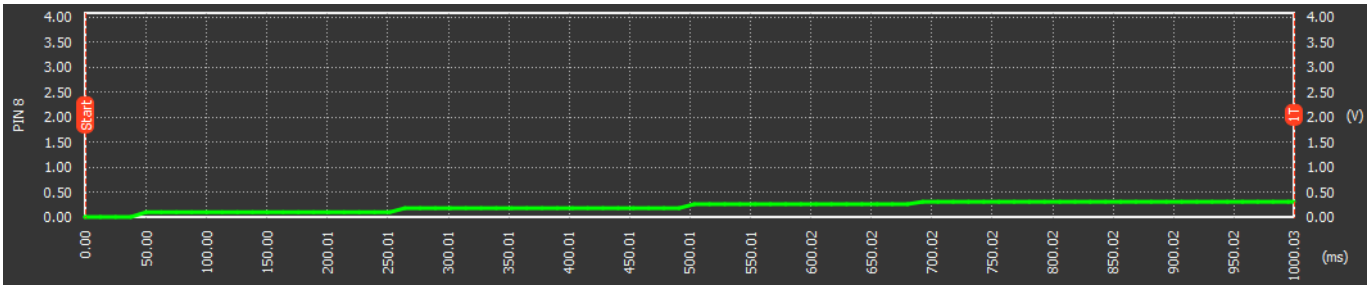

Figure 20. PIN 8 Signal Diagram

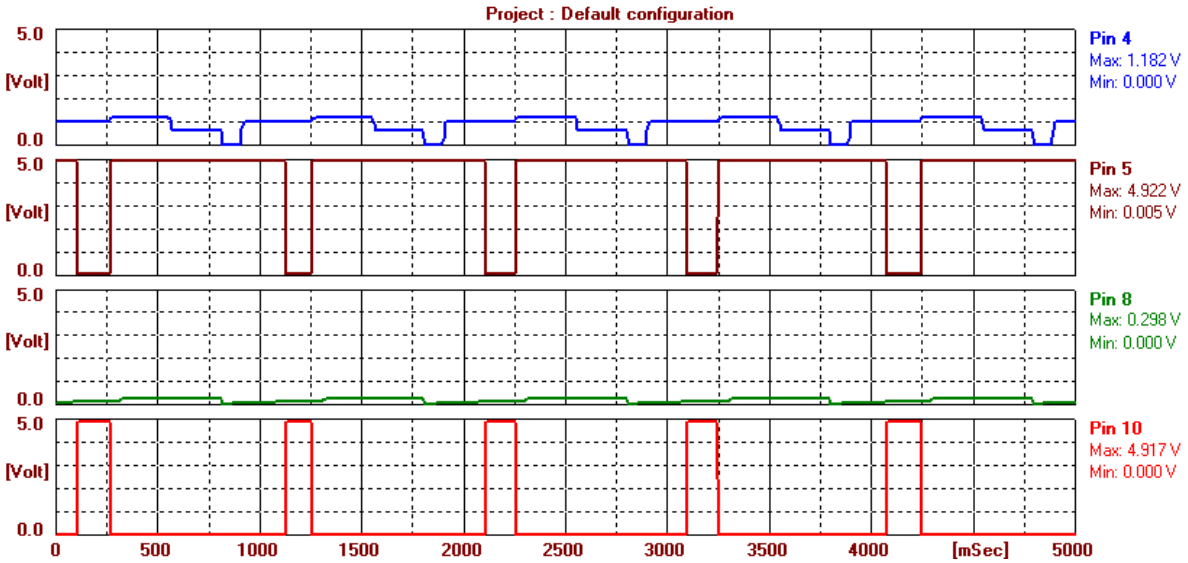

Figure 21. Timing diagram

Conclusion

The GreenPAK2 product can be configured to measure the current and voltage for a specified load, and then indicate corresponding power limits. For more sensitive applications, variants of this circuit can be constructed using monitoring resistors lower than 1 ohm.

Functionality waveforms of this Load Monitor circuit created in GreenPAK2 Designer are shown in Figure 21. Where Channel1 (blue/top line) – PIN4 (Vx), Channel2 (brown/2nd line) – PIN5 (Red_LED), Channel3 (green/3rd line) – PIN8 (Ix), Channel4 (red/ bottom line) – PIN10 (Green_LED).

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. At the moment he is an employee at Core Nano Technology-Jordan.

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Document History

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Document Number: AN-1033

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

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