Application Note

Temperature Sensing Using the PV88080

AN-PV-003

Abstract

In many applications there is a need to monitor temperature and take action should the temperature of the system exceed the point of safe or reliable operation. This application note describes how to use the temperature sensing function of the PV88080 to alert the application's processor to an over-temperature condition.

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1 Terms and Definitions

NTC	Negative temperature coefficient
OTP	One time programable memory
PCB	Printed circuit board

2 References

[1] PV88080 Datasheet, Dialog Semiconductor Revision 2.2

[2] Thermistor Datasheet, NCP03XH103J05R 8/29/2016, reference data used with permission and courtesy of Murata Corp

3 Introduction

This application note describes how to setup and use the temperature sensing function on the PV88080.

4 Temperature Sense Function

When using the temperature sense function, the PV88080 provides a 10 µA source current from the GPIO2 pin. Add the external components as shown below in Figure 1 to connect an NTC thermistor mounted on the PCB. The output of this external network will be compared to the internal 1.2 V reference. When the voltage level on GPIO2 is less than the internal reference, as a consequence of the NTC resistance dropping with increased temperature, an alert will be sent to the host processor via the nIRQ pin.

If the temperature on the PCB decreases, the SOC system can clear the event signal sourced by the PV88080 via an I^{2}C command. Clearing the event returns the nIRQ pin to a low state.

NOTE
An external inverter is needed for low active nIRQ signals.

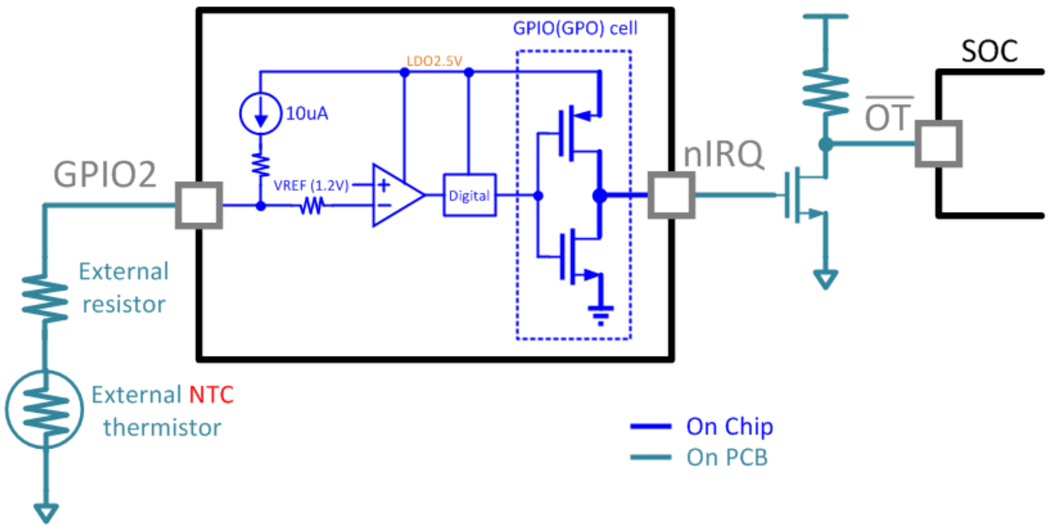

Figure 1: Temperature Sense Block Diagram

Resistance Temperature Characteristic

The NTC thermistors' resistance decreases exponentially as the temperature rises, as shown in Figure 2. The NTC thermistors' resistance can be expressed by the following formula:

Rx＝R0expB (1/T1/T0)

In this formula, Rx is the resistance at a given temperature. T1 is the highest temperature of interest, or the detection temperature, for the application. T0 is the ambient temperature. R0 is the ambient temperature resistance, and B is the constant related to the specific NTC type. All temperatures are given in degrees Kelvin.

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In addition, the B constant indicates a slope of the change in resistance of the thermistor due to a temperature change, and is the basic characteristic of an NTC thermistor.

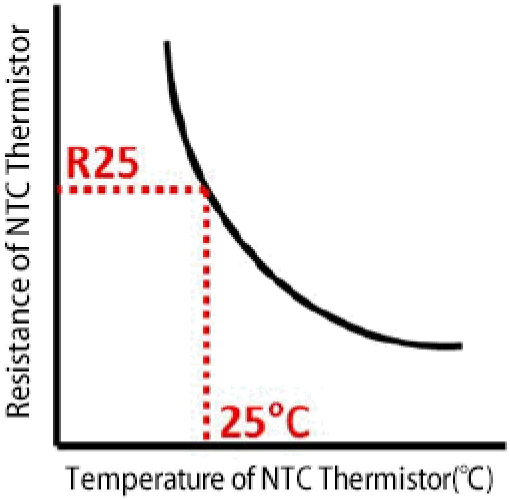

Figure 2: Temperature of NTC Thermistor

4.1 Over-Temperature Design Example (100 °C Trigger Point)

This example uses a thermistor with an R0 of 10 kΩ and a B value of 3455 in the temperature range of 25 °C to 100 °C. First, the thermistor's resistive value at 100 °C is calculated. Next, the series resistor value is calculated, such that at 100 °C the voltage generated by the 10 µA current source is less than 1.2 V.

Data given: B = 3455, R0 = 10k Ω at 25 °C. To convert the temperature from Celsius to Kelvin, add the mathematical constant 273.15.

Step 1:

$$B_{(25/100)} = \frac{(100+273.15)\times(25+273.15)}{(100+273.15)-(25+273.15)} \times \ln\left(\frac{10000}{R_X}\right)$$

$$3455 = \frac{111254.6725}{75} \times \ln\left(\frac{10000}{R_X}\right)$$

$$3455 = 1483.4 \times \ln\left(\frac{10000}{R_X}\right)$$

$$e^{\left[\frac{3455}{1483.4}\right]} = \frac{10000}{R_X}$$

$$\therefore R_X = \frac{10000}{e^{2.33}} = 973\Omega$$

Figure 3: Thermistor Resistive Calculation

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Plotting the above data gives the following two-point characteristics graph.

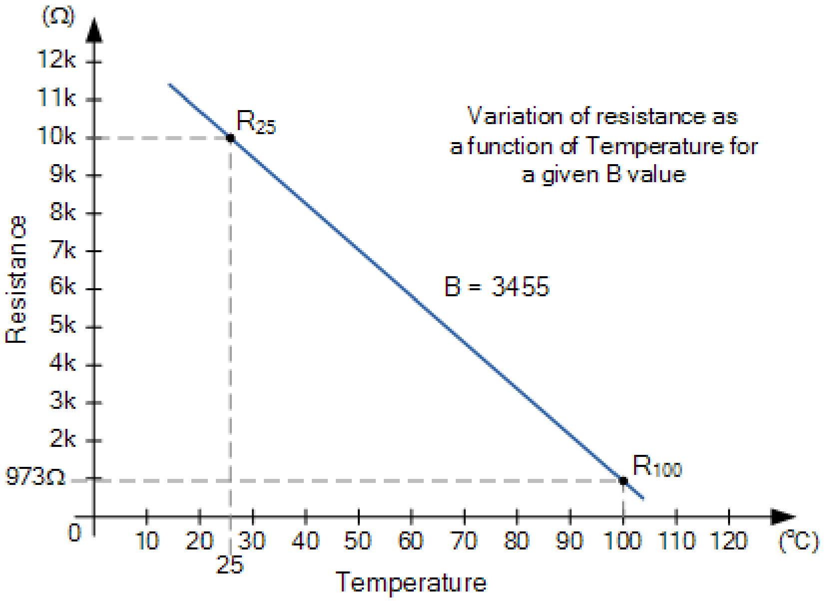

Figure 4: Resistance Variation

Note that in this simple example, only two points are found, but generally thermistors change their resistance exponentially with changes in temperature so their characteristic curve is non-linear. Therefore, the more temperature points calculated, the more accurate the curve.

Table 1: Resistance Variation

Temperature (°C)	10	20	25	30	40	50	60	70	80	90	100	110	120
Resistance (Ω)	18476	12185	10000	8260	5740	4080	2960	2188	1645	1257	973	765	608

Plotting the more complete data points gives a more accurate characteristics curve for the 10 kΩ NTC thermistor with a B-value of 3455.

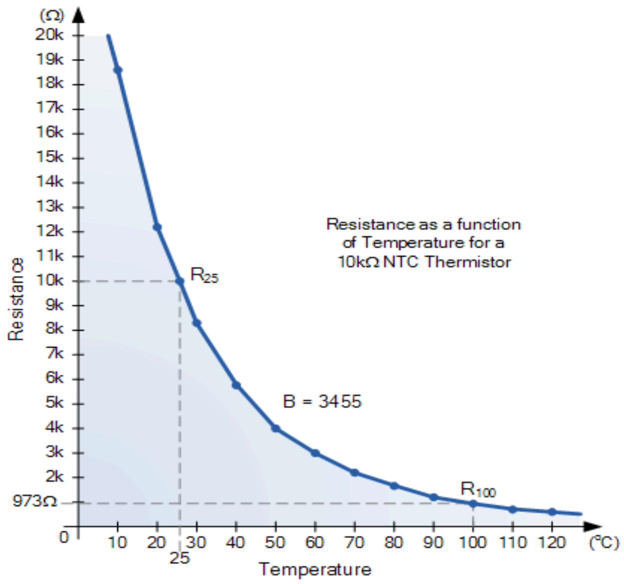

Figure 5: Temperature vs Resistance

Step 2

The value of the series resistor for PV88080 is calculated using the total resistance needed to generate 1.19 V at 100 °C and subtracting the resistance of the NTC at this temperature:

- 10 µA = 1.19 V / (R_{NTC} + R_{SERIES})
- 10 µA = 1.19 V / (10000 Ω+ R_{SERIES}) at 25 °C
- 10 µA = 1.19 V / (973 Ω+ R_{SERIES}) at 100 °C
- R_{SERIES} = 119 kΩ

Table 2: Resistance Variation

Temperature (°C)	10	20	25	30	40	50	60	70	80	90	100	110	120
Resistance (Ω)	18476	12185	10000	8260	5740	4080	2960	2188	1645	1257	973	765	608

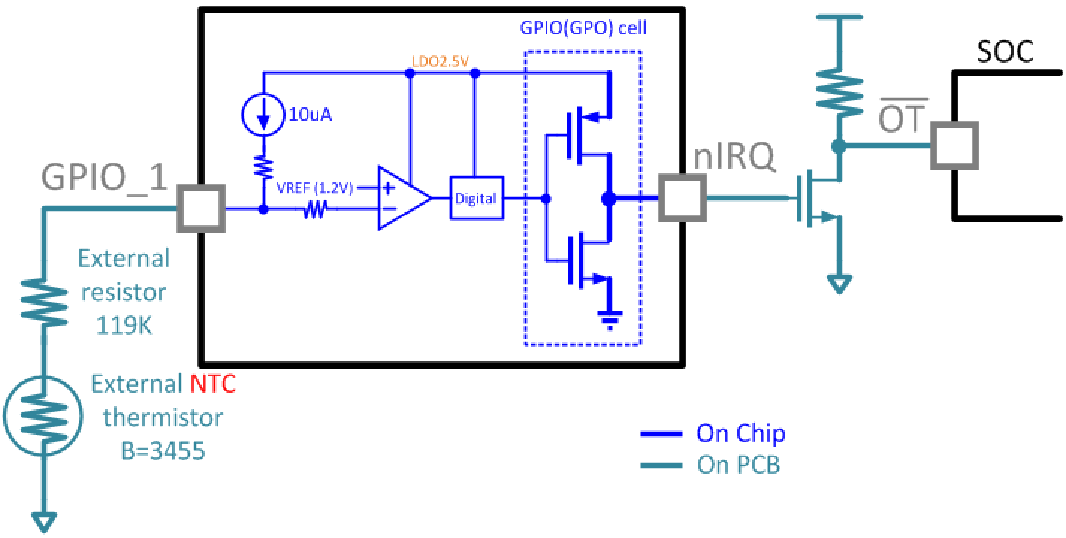

Figure 6: Temperature vs Resistance

Thermal Sense Test Result

GPIO2 Threshold = 1.20 V from high to low as shown in Figure 6.

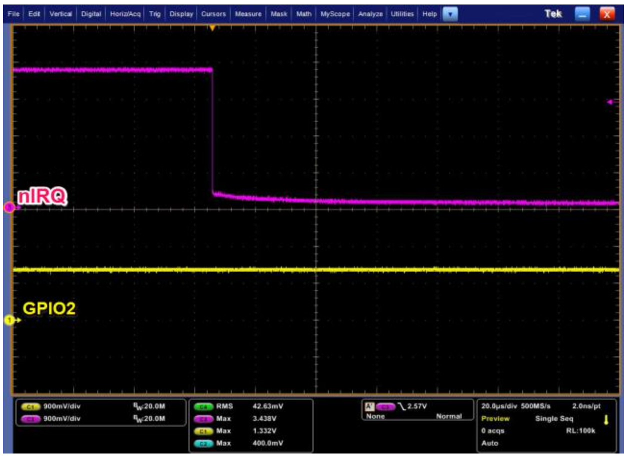

Figure 7: GPIO2 Triggering nIRQ for High Temperature

5 Conclusions

The comparator in the PV88080 can be used for a variety of functions. Described in this application note is a temperature sensing function which can be easily implemented to alert a host processor so that appropriate action can be taken.

Appendix A

NOTE
The thermistor is a special type of variable resistive element that changes its physical resistance when exposed to changes in temperature These heat-dependent resistors can operate in one of two ways, either increasing or decreasing their resistive value with changes in temperature. There are two types of thermistors: negative temperature coefficient (NTC) of resistance and positive temperature coefficient (PTC) of resistance.

With NTC thermistors, the resistance drops as the temperature increases.

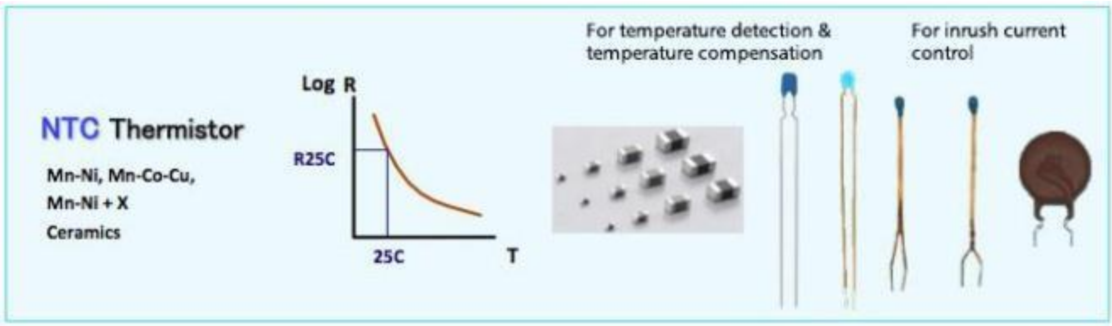

Figure 8: Temperature vs Resistance

Revision History

Revision	Date	Description
1.0	23-July-2017	Initial version
1.5	29-Aug-2017	Added reference title for thermistor

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Contacting Dialog Semiconductor

United Kingdom (Headquarters)
Dialog Semiconductor (UK) LTD
Phone: +44 1793 757700

Germany
Dialog Semiconductor GmbH
Phone: +49 7021 805-0

The Netherlands
Dialog Semiconductor B.V.
Phone: +31 73 640 8822

Email:
enquiry@diasemi.com

North America
Dialog Semiconductor Inc.
Phone: +1 408 845 8500

Japan
Dialog Semiconductor K. K.
Phone: +81 3 5425 4567

Taiwan
Dialog Semiconductor Taiwan
Phone: +886 281 786 222

Web site:
www.dialog-semiconductor.com

Singapore
Dialog Semiconductor Singapore
Phone: +65 64 8499 29

Hong Kong
Dialog Semiconductor Hong Kong
Phone: +852 3769 5200

Korea
Dialog Semiconductor Korea
Phone: +82 2 3469 8200

China (Shenzhen)
Dialog Semiconductor China
Phone: +86 755 2981 3669

China (Shanghai)
Dialog Semiconductor China
Phone: +86 21 5424 9058

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Koto-ku, Tokyo 135-0061, Japan
www.renesas.com

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