

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.

Temperature Sensing Using the PV88080

Contents

Abstract	1
Contents	2
Figures	2
Tables	2
1 Terms and Definitions	3
2 References	3
3 Introduction	4
4 Temperature Sense function	4
Over Temperature Design Example (100 degree C trigger point)	5
Thermal Sense Test Result	7
5 Conclusions	8
Appendix A	9
Revision History	10

Figures

Figure 1: Temperature Sense block diagram	4
Figure 2: Temperature of NTC Thermistor	5
Figure 3: Variation of Resistance	6
Figure 5: Temperature vs Resistance	6
Figure 4: Temperature vs Resistance	7
Figure 6: GPIO2 triggering nIRQ indicating high temperature	8
Figure 7: Temperature vs Resistance	9

Tables

No table of figures entries found.

Temperature Sensing Using the PV88080

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

Temperature Sensing Using the PV88080

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 I²C command. Clearing the event returns the nIRQ pin to a low state.

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

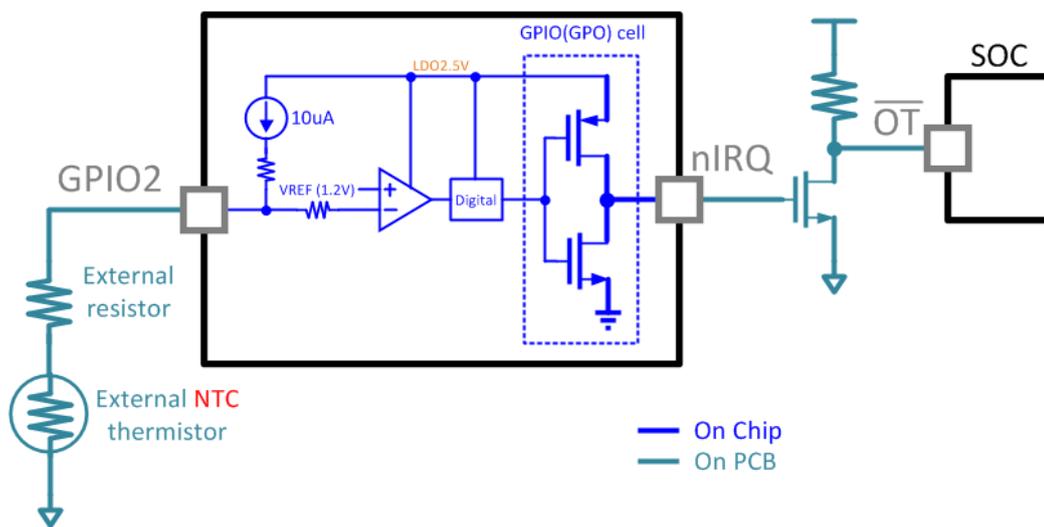


Figure 1: Temperature Sense Block Diagram

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:

$$R_x = R_0 \exp B (1/T_1 - 1/T_0)$$

In this formula, R_x is the resistance at a given temperature. T_1 is the highest temperature of interest, or the detection temperature, for the application. T_0 is the ambient temperature. R_0 is the ambient temperature resistance, and B is the constant related to the specific NTC type. All temperatures are given in degrees Kelvin.

Temperature Sensing Using the PV88080

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.

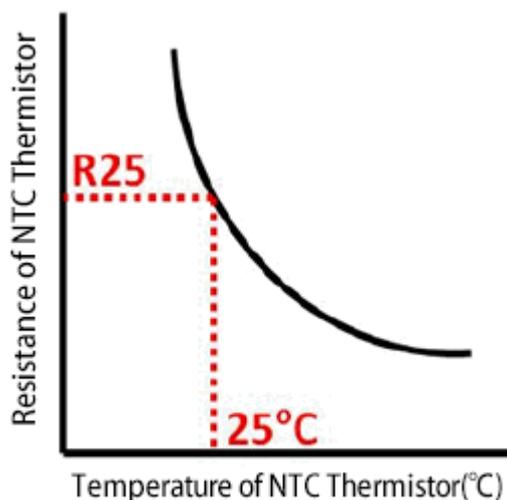


Figure 2: Temperature of NTC Thermistor

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

This example uses a thermistor with an R_0 of 10 k Ω 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 μ A current source is less than 1.2 V.

Data given: $B = 3455$, $R_0 = 10\text{k } \Omega$ 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

Temperature Sensing Using the PV88080

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

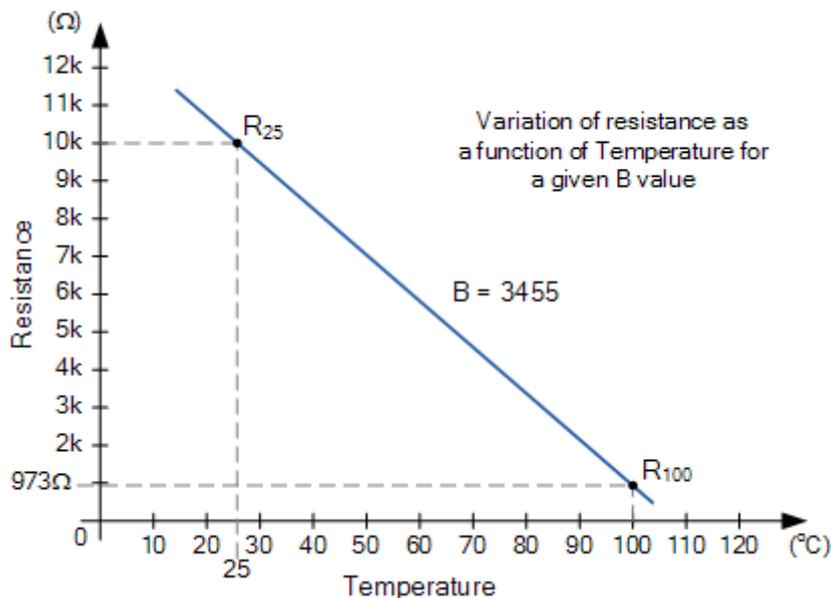


Figure 4: Resistance Variation

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.

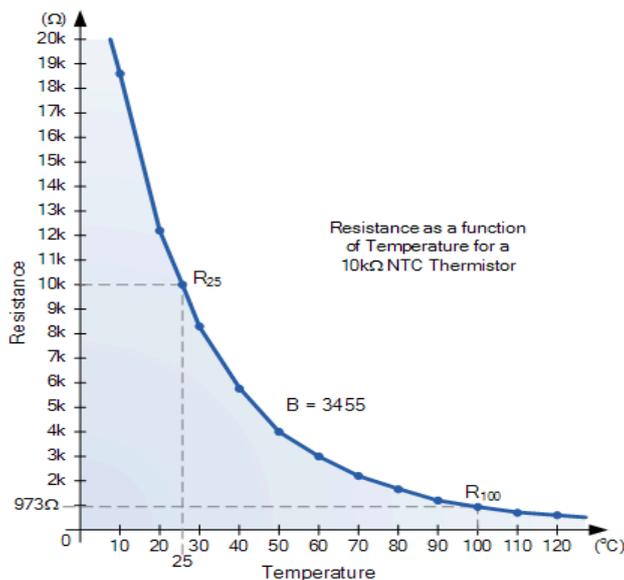


Figure 5: Temperature vs Resistance

Temperature Sensing Using the PV88080

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:

- $10 \mu A = 1.19 V / (R_{NTC} + R_{SERIES})$
- $10 \mu A = 1.19 V / (10000 \Omega + R_{SERIES})$ at 25 °C
- $10 \mu A = 1.19 V / (973 \Omega + R_{SERIES})$ at 100 °C
- $R_{SERIES} = 119 k\Omega$

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

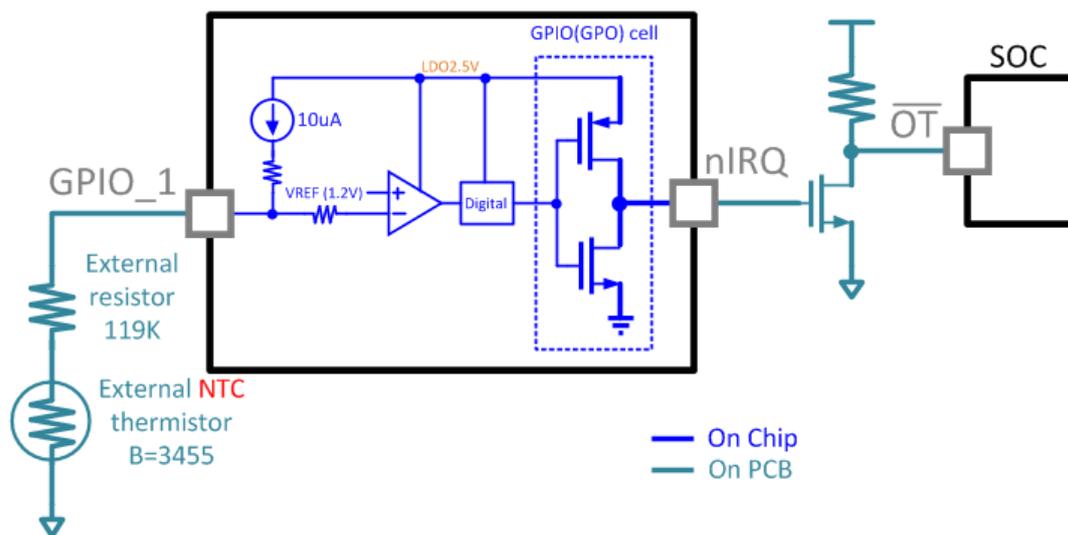


Figure 6: Temperature vs Resistance

Thermal Sense Test Result

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

Temperature Sensing Using the PV88080



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.

Temperature Sensing Using the PV88080

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.

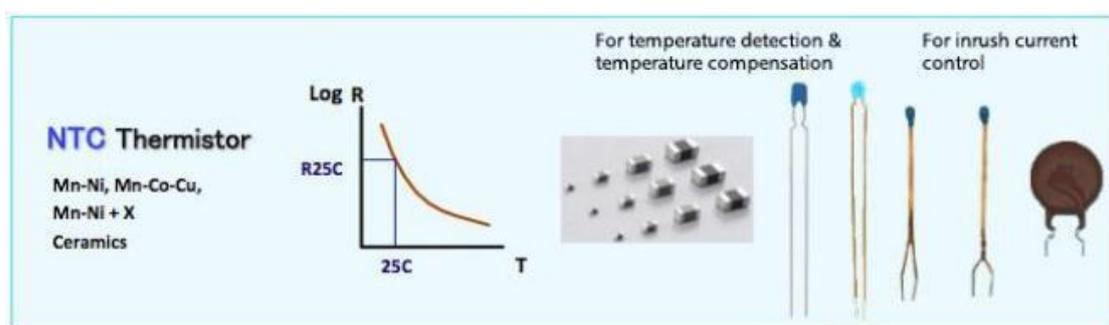


Figure 8: Temperature vs Resistance

Temperature Sensing Using the PV88080

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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