Self Diagnostics and Environmental Sensing in IP Network Cameras

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Introduction to IP Network Cameras

An Internet Protocol camera, or IP Network Camera (IPNC), is a type of digital video camera that receives control data and sends image data via the internet or network link. These cameras are commonly used in IP surveillance, closed-circuit television (CCTV) and digital videography.

IP Network Cameras are widely replacing analog cameras due to their digital zoom, remote surveillance options over the internet, and software updates that add functionality. IPNCs can either be wired or wireless, the latter has increased in popularity due to the inherent lower cost and maintenance required over cameras used in CCTV surveillance circuit. Mechanically, IP Network Cameras can either come fixed or with PTZ (Pan, Tilt, Zoom) functionality. Fixed IP Network Cameras do not allow for mechanical movement, while PTZ cameras extend the flexibility of remotely controlling the camera during on camera events.

System problems found in IP Network Cameras

There are two main functions for temperature sensors in IP Network Cameras: Self-Diagnostics and Environmental Sensing. For this reason, thermal monitoring and protection of the system is important.

There are multiple components within the camera that need to have temperature monitored for overall camera function. In regards to self-diagnostics, under-/over-temperature protection is needed to prevent damage to motors and the imaging sensor.

Some dome covered cameras need protection as temperatures decrease to prevent condensation from building on the dome, thereby blocking vision of the camera. This issue is commonly handled by using a humidity sensor to monitor the dew point and turn on a heater to remove the moisture that has developed. As far as environmental sensing, in several systems it is critical to continuously monitor temperature for compensation. The imaging sensor, is often times placed on its own PCB and can reach temperatures above 80°C. Overheating can distort the image quality to an unusable point or cause permanent damage.

For PTZ cameras, the motor can be damaged if it is too cold outside. Often times there will be a heater that needs to be turned on at a certain temperature threshold in order to avoid this. Redundancy can also be used in these systems to ensure that the sensor is not turned on at low temperatures.

Figure 1. IP Network Camera

Design Considerations for IP Network Cameras

There are three major considerations when designing IPNCs: package size, thermal conditions, and enclosure type. Today's design requirements for IPNC have an emphasis on package size due to the form factor of the IPNCs. Although the demand for compact cameras is great there are functional tradeoffs that occur because of this. All outdoor IPNCs require thermal trip detection for lower temperature trip points. Typically, –20°C is a common trip point used for Power On of main processor and 0°C for shutting down the heater. At higher temperatures a fan may need to be turned on or the system will shut off at around 70°C.

The trip points specs vary from 1°C to 5°C while hysteresis of 5°C to 10°C is optimal. Thermistor's and Analog temperature sensors are used along with the MCU's integrated ADC as a hardware solution to continuously monitor thermal conditions. Additionally, the type of enclosure used plays an important role for preventing condensation since many cameras do not have a seal to prevent water vapors from entering. In this instance a need for monitoring the environment is critical so the system can autonomously protect itself.

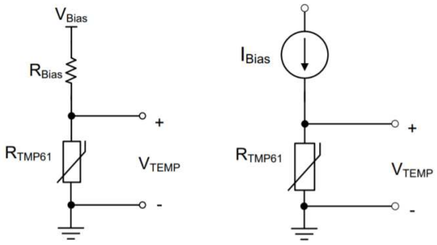

Figure 2. Thermistor Current and Voltage Biasing Circuits

Thermistor Solutions

Thermistors are passive components that change resistance with a change in temperature. Typically, thermistors are either placed on the bottom of the voltage divider or biased by a constant current source as shown in Figure 2.

There are two types of thermistors that can be used for this application: Negative Temperature Coefficient (NTC) and Positive Temperature Coefficient (PTC). NTCs are inherently nonlinear, making it difficult to achieve high accuracy over the whole temperature range. Such effects of non-linearity are often managed through the use of hardware and software-based linearization methods.

Unlike NTCs, silicon-based PTCs have a positive linear slope in resistance with an increase in temperature. Thermistors can be used to measure ambient temperature in order to provide diagnostics to the system. If higher accuracy across temperature is required, an analog IC temperature sensor such as the TMP235 is a fitting choice.

Temperature Switch Solutions

In IPNCs, temperature switches are a great solution to overall system redundancy. In order to implement a switch functionality at set temperature thresholds a thermistor needs to be placed in a circuit along with a comparator and additional resistors as shown in Figure 3. These resistors set the trip thresholds and drive the comparator either high or low depending on the input from the thermistor. With this solution, you have a total of 8 discrete components for a single temperature point, and up to 16 if implementing both over and under temperature protection.

When designing a temperature-monitoring circuit, the system must account for errors like the tolerance of the components, system complexity, and the analog-to-digital converter (ADC) resolution. These errors can greatly influence the thermistor output and compromise the safety of the system.

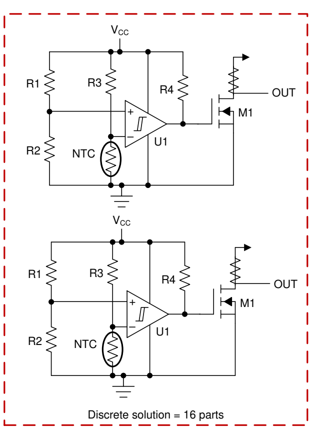

Figure 3. Discrete Temperature Switch Solution

Another thermal protection solution for dual temperature threshold detection in IP Network Cameras is the integrated temperature switch/thermostat. Typically, these devices have a temperature sensor, comparator, and voltage reference fully integrated in a single chip.

These temperature switches are smart sensors that autonomously make decisions to provide real-time thermal protection without interrupting the control processing system. For a dual channel temperature threshold configuration, a temperature switch offers up to 60% PCB area savings, as highlighted in Figure 4.

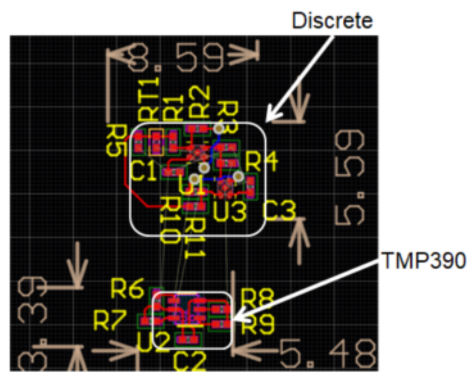

Figure 4. Solution Size TMP390 vs Discrete

Device Recommendations

The TMP61 is a silicon-based thermistor designed for temperature measurement, protection, compensation, and control systems. The TMP61 has a wide operating range of –65°C to 150°C, enhanced linearity and consistent sensitivity across the full temperature range.

The TMP390 device is a part of a family of ultra-low power, dual channel, resistor programmable temperature switches that enable protection and detection of system thermal events from –50°C to 130°C. The TMP390 offers independent over temperature (hot) and under temperature (cold) detection with hysteresis options of 5°C and 10°C.

The TMP235 is a high accuracy analog output temperature sensor. The TMP235 provides 0.5°C accuracy from temperature ranges of 0°C to 70°C.

The HDC2010 is a 2%RH/0.2°C, ultra-low-power digital humidity sensor. This device is the smallest WCSP humidity sensor with trip point functionality.

Table 1. Related Documentation

COLLATERAL	DESCRIPTION
Data Sheet	*TMP390 Ultra-small, dual-channel, 0.5-µA, resistor - programmable temperature switch*
Data Sheet	*TMP61 Small Silicon-Based Linear Thermistor for Temperature Sensing*
Application Report	*Optimizing Placement and Routing for Humidity Sensors*