Application Brief

How to Protect Displays With the Latest Temperature Sensing Technology

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Introduction

Take a look around you… how many displays do you see? Think about your computer, phone, tablet, television (TV), and so forth. Now think about how these displays have been constantly improving over the past couple of decades with requirements for larger dimensions, finer resolutions and greater brightness levels. As the complexity in regards to form factor and performance increases, so do the concerns for thermal management.

If displays like the one shown in Figure 1 overheat and cause thermal damage, their performance and lifetime can be severely affected. One reason displays get hot is because of their power consumption which ends up dissipating as heat. Another reason is the environment in which they operate. While your TV might sit in an air-conditioned room, some automotive and industrial displays may be under direct sunlight for the majority of their lifetime.

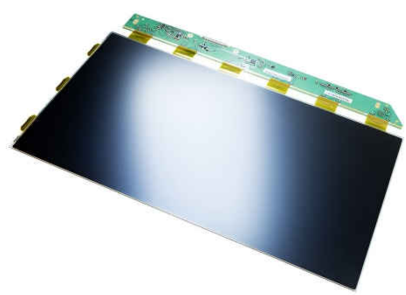

Figure 1. Display Panel

Regardless of the type of display you are designing, it is important to protect it from thermal damage by properly using temperature sensors. The ability of a sensor to accurately measure temperature of the display panel itself (LED backlighting) and onboard subsystems enables reliable data capture so that your controller can make better decisions. With this accurate data, you can precisely modify the temperature-dependent current profile of the LEDs (known as thermal foldback), adjust picture quality, and protect components from thermal damage by throttling or shutting down only when necessary.

Recent temperature sensor advancements have enabled much simpler and efficient designs than what an NTC thermistor could ever offer, especially when it comes down to accuracy and long-term reliability. Searching for the right sensor; however, can be time consuming since there are so many options. To save you time, here are four temperature sensing technologies you may not have been aware of that are designed to help simplify and optimize display designs.

Sensor Type #1: Linear Thermistors

Silicon-based thermistors are discrete devices that have a linear change in their effective resistance as temperature rises. Because they are made from silicon, they have many advantages over NTC thermistors like response time, drift, accuracy, tolerance and more. See the *Temperature sensing with thermistors white paper* to learn about their advantages. What is great about these devices for displays is their small size which enables them to be embedded in the backlight panel. Their linearity and consistent accuracy allow for a very precise thermal foldback profile whenever used with an LED driver or connected directly to an MCU as seen in Figure 2.

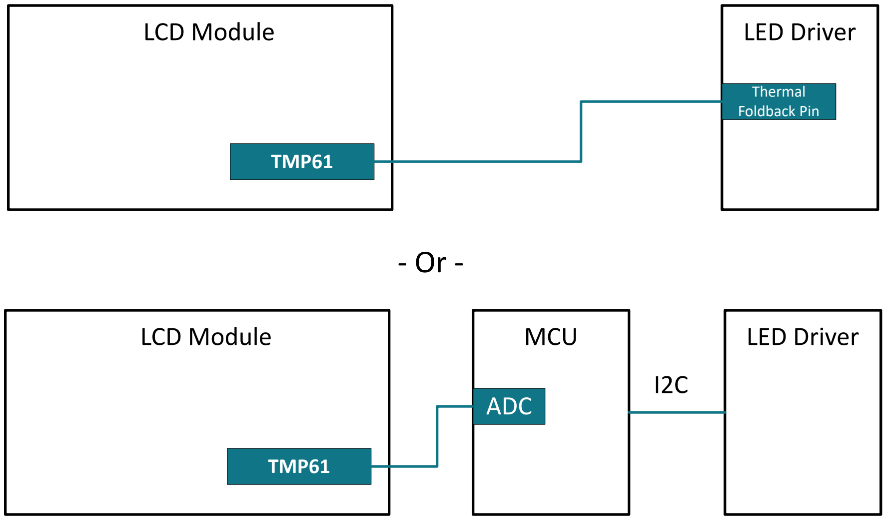

Figure 2. Using a Thermistor for Display Temperature Sensing

Linear thermistors like the TMP61-Q1 offer very low long-term drift and are available at the same low cost as NTC thermistors. To learn more about how to use the TMP61 with an LED driver like the LP8863 in displays, see the *Implementing Analog Thermal Foldback with the LP8867- Q1 and TMP61-Q1 application report*.

Sensor Type #2: Analog Temperature ICs

An analog temperature integrated circuit (IC) sensor has an output voltage proportional to temperature and is a cost-effective alternative to thermistors. Since thermistors are discrete, their solution accuracy can be influenced by the tolerances and drift of external components in the signal chain, especially if you do not do any sort of calibration. Analog temperature ICs like the TMP235-Q1 do not require any resistors and are much less affected by variations of the voltage reference thanks to their integrated class-AB output driver. Place them in the same locations within the display as you would with a thermistor, and connect the IC directly to an ADC as Figure 3 shows. The *Automotive 144-Zone Local Dimming Backlight Reference Design* is an example of how to use analog temperature ICs to measure display temperature.

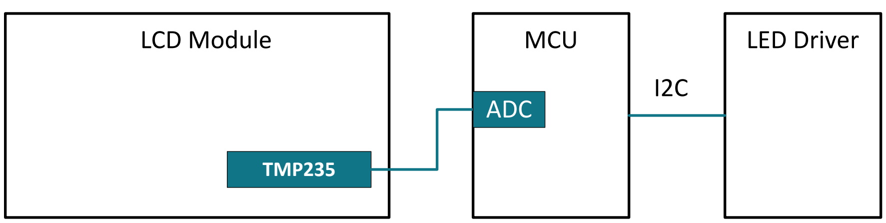

Figure 3. Using Analog Temperature ICs for Display Temperature Sensing

Sensor Type #3: Digital Temperature ICs

What if you run out of ADC inputs on your MCU or do not even have an onboard MCU? In this case, and especially if using a local dimming backlight technique with many LED drivers, an accurate temperature sensor with a digital interface is needed. In displays, this digital temperature sensor typically uses the I2C protocol as it is plug and play with your MCU or FPD-Link (for automotive if no MCU is present) as seen in Figure 4.

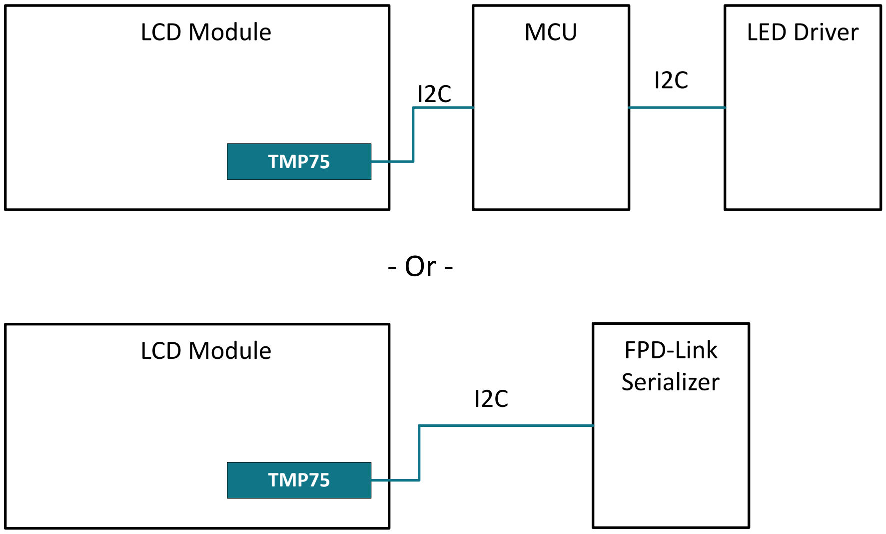

Figure 4. Using Digital Temperature ICs for Display Temperature Sensing

The TMP1075, TMP75-Q1, and TMP102-Q1 are very accurate I2C temperature sensors that are used often in displays for their very low drift and high levels of integration. Another option could be the very small TMP114 which can have up to 16 daisy-chained sensors to reduce the amount of routing.

Sensor Type #4: Remote Temperature ICs

What if you need to sense temperature in multiple locations? You could have various point-to-point traces with thermistors or analog temperature ICs going back to the ADC pins, but what if you run out of inputs on your MCU? A much cleaner design that could solve this problem is to use a digital remote temperature IC. This type of sensor measures temperature locally and also has multiple inputs that can connect to thermal diodes or bipolar junction transistors (BJT) you place throughout your LED array to measure various temperature hotspots. From there, you can connect to your I2C bus on the MCU and be reading temperatures from all the thermal diodes and the sensor at the same time, as shown in Figure 5.

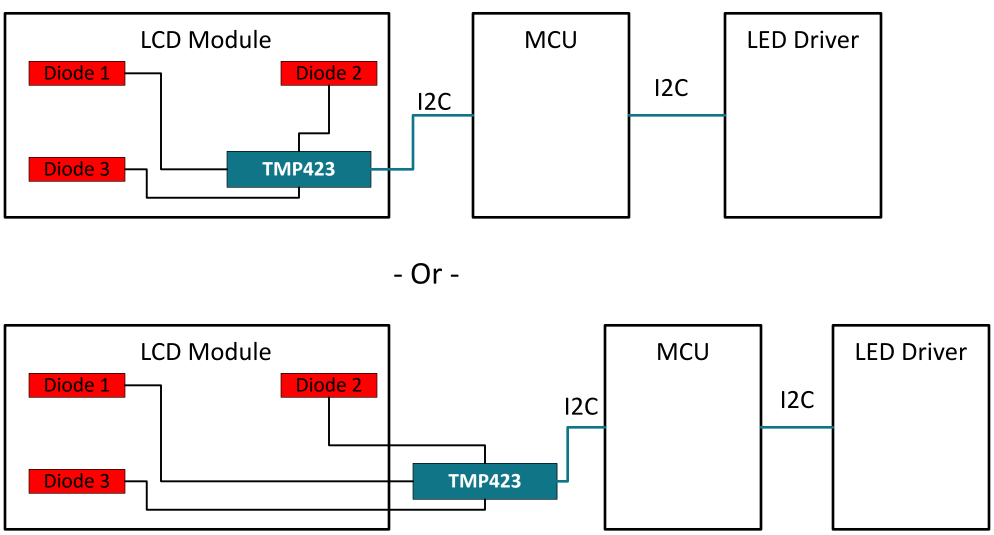

Figure 5. Using Remote Temperature ICs for Display Temperature Sensing

This is a great way to measure panel temperature because the remote diodes can either be embedded into the glass or placed behind the panel. To learn more about how to use a remote temperature IC like the TMP423-Q1 in displays, see the *Optical Sense Backlight Reference Design with Temperature Sensing Reference Design*.

Conclusion

Whether designing a TV or automotive displays, always consider component and circuit cost, accuracy, repeatability, low drift over time, and general reliability to meet design requirements. Choosing the right sensors can not only run your displays more efficiently, but also protect them from undesirable temperatures.

Solution Type	Use When...	Resource
Linear Thermistor	Cost is the # 1 priority	TMP61 + LP8867 Application Report
Analog Temperature IC	More integration than a thermistor is needed, but not at the cost of a digital temperature sensor	TIDA-020001: Local dimming backlight reference design
Digital Temperature IC	There are no ADC inputs available or you need high accuracy	TMP114 TMP75-Q1
Remote Temperature IC	Temperature must be measured at multiple locations	TIDA-01008: Backlight reference design

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