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LCD Resources:

Temperature Consideration for Displays

Temperature Considerations for Displays

This note will discuss the operating and storage temperatures for LCDs. Each LCD has a specified operating and storage temperature listed in the specification sheet of the display and its controller. Typically, this temperature is specified as -20°C to 70°C for the operating temperature and -30°C to 80°C for the storage temperature. Considerations should be made when operating or storing the display near the maximum and minimum temperatures.

For applications where the display must operate in extreme temperature environments, measures can be taken to avoid damaging the display and the embedded display controller. This resource will discuss the precautions and preventions of operating and storing a display at the maximum and minimum temperatures specified.

The environment a display is operated and stored in can have effects on things such as: voltage, contrast, signal integrity, and system performance. The effects of temperature on the display become more significant at the two extremes. Common display temperature ranges can be found as three common sets. Below are the three most common temperature ranges for LCDs. The temperature ranges can be confirmed in the datasheet of the display and its controller.

Wide Temperature Range	
Operating Temperature	-20˚C - 70˚C
Storage Temperature	-30˚C - 80˚C

Super Wide Temperature Range	
Operating Temperature	-30˚C - 80˚C
Storage Temperature	-40˚C - 90˚C

Standard Temperature Range	
Operating Temperature	0˚C - 50˚C
Storage Temperature	-20˚C - 60˚C

High Temperatures

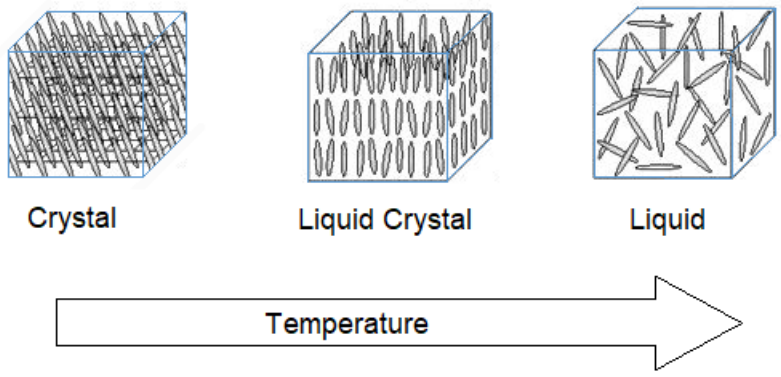
At very high temperatures, the effects can be seen on the electronic components and the liquid crystal of the display. The effects from an environment that is too hot will cause a darkening of the display, decreased/limited visibility, unreliable communications, and potential damage to the IC due to increased conductivity. The liquid crystal in the display will begin to degrade at very high temperatures. Overheating the display can cause dark spots to appear or result in a fully dark screen.

Both internal and external heat should be taken into consideration when operating the display. The environmental heat can contribute to overheating the device internally. The most common source of internal heat generation is from the backlight. The backlights can operate at high voltages and current

consumptions to supply power to the backlight LEDs. This internal heat generation should be considered in high temperature environments.

To prevent internal and external overheating, fans and vents can be incorporated into the system to keep the display within the specified operating conditions. Precautions to avoid moisture entering the system should be taken when including vents. Moisture can cause electrical shorting, especially at high operating temperatures.

Contrast can be affected when a display is operated in ultra-high temperatures. Higher temperatures result in an increase in conductivity. This means that less voltage is required to provide the same contrast to the pixels. These effects can become more prominent when using graphic or character LCDs. Undesired effects such as a black screen can occur if the operating environment is above the specified temperature range.



The liquid crystal that is used in the display can get disoriented at very high temperatures. At these temperatures, the liquid crystal molecules can become unaligned and light will not pass through as desired. This disorientation of the liquid crystal molecules can result in a dim or partially dim image on the display. The viscosity of the liquid crystal decreases at high temperatures. The causes unreliable control of the pixels, feedback on the display, and deeper colored images.

Operating and storing a display at temperatures higher than the specified ranges can cause permanent damage to the device. Melting of display properties can occur if operating or storing the display at temperatures that exceed the limits.

Low Temperatures

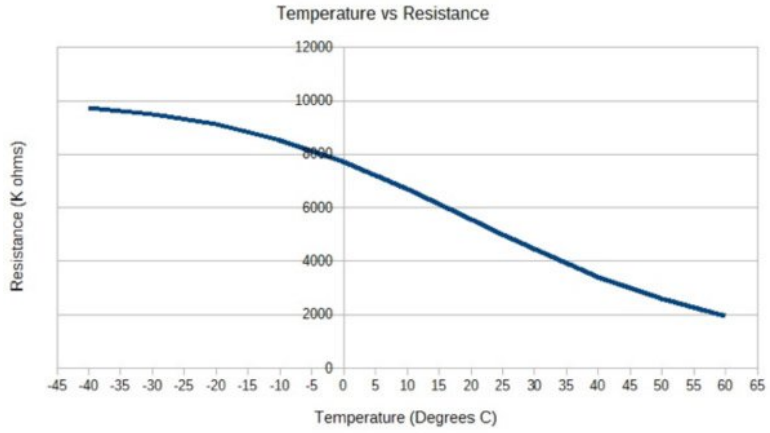
A display that is operated or stored at very low temperatures will have the opposite effects in comparison to high temperatures. The effects of cold temperatures can be seen as a slowed response time, increased power consumption, reduced contrast, and a non-operational display. Storing and operating a display in low temperatures will have fewer permanent effects than at high temperatures.

At low temperatures, the liquid crystal in the display will begin to freeze. This causes reduced mobility of the liquid crystal molecules and light cannot pass through as intended. This can cause reduced visibility

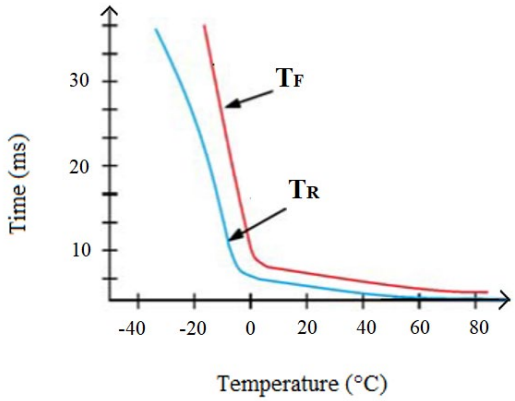
and reduced color depth of the displayed image. Opposite to a very hot environment, the contrast will be reduced at low temperatures.

The effects of extremely low temperatures on a display are less likely to be permanent than in hot temperatures. The likely outcome of operating a display below the recommended range is that the display will not turn on. This removes the opportunity for internal circuits to short. Once the display is returned to a temperature within the specified range, the liquid crystal will typically return to normal behavior.

Different liquid crystal fluid has different temperature properties. Extreme temperature liquid crystal exists for certain applications but can be more expensive. Twisted nematic (TN) LCD's have the temperature ranges listed in this note.



Semiconductors operating in very low temperatures will have decreased conductivity due to increased resistance. The LCD controller, often incorporated on the glass of the LCD, will operate at lower speeds in very cold environments.



Response times can also slow in displays that are operated in very cold environments. The semiconductor will react less quickly due to the higher viscosity and power consumption. The voltage required by the system will increase to compensate for the increased resistance. This applies to signal voltages and backlight voltages of the display.

Compensations to adjust for cold environments can include heaters, voltage regulators and thermistors to adjust power determined by temperature. Temperature compensating IC's can be included in the applications on both ranges of the temperature spectrum.

It is strongly recommended to operate and store the display within the specified temperature ranges to avoid damaging the display. Operating the display at temperatures that exceed the specified range can cause the display to malfunction, become unreliable and cause permanent damage to the device. Precautions can be taken to compensate for the environment and to avoid exceeding the specified ranges.

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