Designing User Interface Technology for Use in Extreme Conditions

by Brian Coates, Technical Sales Manager, Lumex

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Creating LED and LCD Solutions Together™

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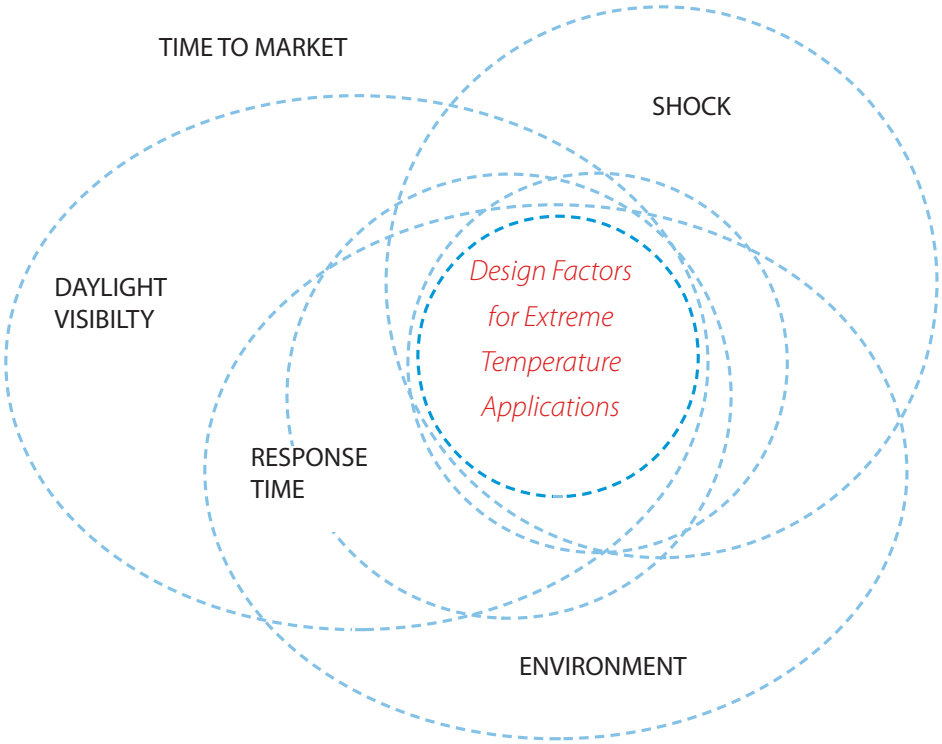
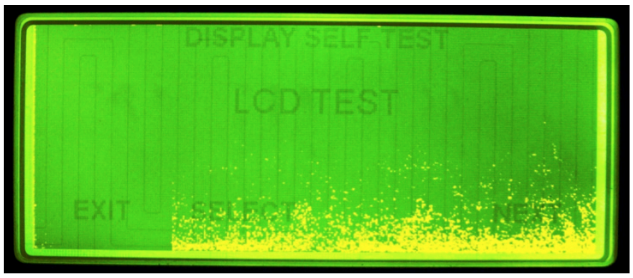
There is a growing global demand for user interface technology that can perform in extreme cold and extreme heat conditions. Applications as diverse as military, retail grocery freezers and utility meters require accurate displays able to perform consistently in even the most challenging of environments. There are a number of challenges that exists for LCDs in the world of AMR metering.

LCDs designed into these types of applications must meet a host of demanding challenges, such as UV exposure, shock and vibration, varying lighting conditions, the need for long term operation (10-20 years in the case of residential metering), exposure to the weather and extreme temperature changes.



Influence of Extreme Temp on LCDs

LCDs have a liquid crystal inside. As one would expect, the liquid doesn't behave the same at extremely high or extremely cold temperatures. The liquid crystal material in a standard LCD can be permanently damaged by extreme temperatures. The molecules within the LCD can form into solid crystals, and bubbles can form on the display. Additionally, some of the other materials used do not operate well at the extremes. Proper sealing of the enclosure will be enough to keep out the elements. The average operating life for an LCD is on the order of 5 years. That said, keeping the display turned off until needed extends the life of the product many years. High quality components also need to be used in order to survive the long life.



Extreme temperature affects visual performance. Standard LCDs tend to lighten up, bleach out or go dark in extreme temperatures.

Extreme conditions bring with them a unique set of engineering challenges. It can be hugely helpful to find a technology supplier who can not only provide the user interface component but also professional insights as to how to integrate this component into larger systems.

Lumex has been successful in breaking through the barriers faced by design engineers, helping them reach new heights in developing user interface solutions that provide cost-savings, superior reliability, and enhanced visual performance in even the most challenging of environments.

Technology Drivers

In order for a display to work instantly and consistently within a hostile environment, several technologies need to be brought together to work in parallel to get the best performance.

- Proprietary LCD fluid mixture, -40˚C ~ +85˚C
- Backlight available up to +100˚C
- Backlight brightness:
  - high bright for increased night visibility
  - not High Power LEDs (reduces thermal management requirement)
- Thin profile, low power integrated heater

These include the liquid crystal mixture itself, the operating heat threshold of the backlight which can be prone to fail at high temperatures, the size and power draw of the heater for extreme cold temperatures and ultimately the capability of any supplier to integrate all of these technologies seamlessly. Lumex is able to bring all of these technologies together into a single integrated solution with either standard or custom displays.

Lumex's extreme temperature displays have been rigourously tested in order to ensure instant and consistent performance in the field.

- Vibrated at 40G for six days
- Constant cycling between -40˚C ~ +100˚C for full duration
- 1 hour at max temp; 1 hour at min temp
- Temp transition from high to low over 7-12 minutes

The test was designed to exceed the operating environment and ensure that the design would provide best in class performance in the field.

Advantages of LCDs over VFDs

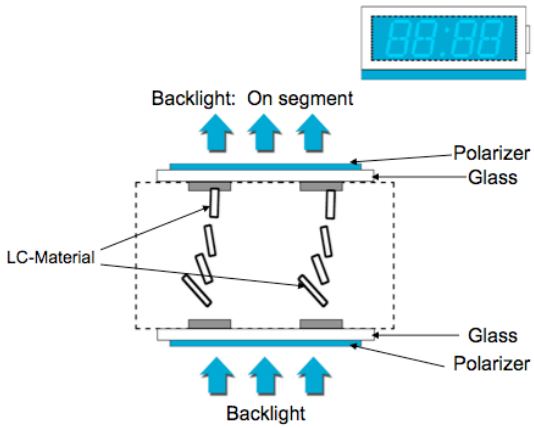
There are many reasons that most of the utility providers are implementing AMR meters that have LCD displays as their primary means to convey information, such as:

- More pleasing to the eye
- Space-saving
- More portable
- Easily programmable user-interface
- Typically more cost-effective
- More ecologically friendly / low power consumption

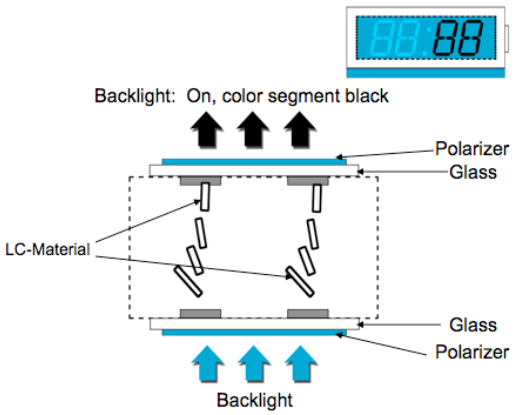
Major design factors include: readability, complex information, low energy draw and relatively low cost when compared to competing technologies, such as VFD or LED displays.

But what exactly is a Liquid Crystal Display or LCD, and what makes them so advantageous over other display technologies such as Vacuum Fluorescent Displays or VFD's? First, we need to understand the basic structure of an LCD and the term, Liquid Crystal.

The overall structure of an LCD is more than just a panel of liquid crystals. A basic LCD consists of two polarizers, two glass panels and liquid crystal fit in between them. The front layer of glass is etched on the inside surface to form a template for the artwork to be shown by the liquid crystal. Liquid crystal bends light in response to the electric field.

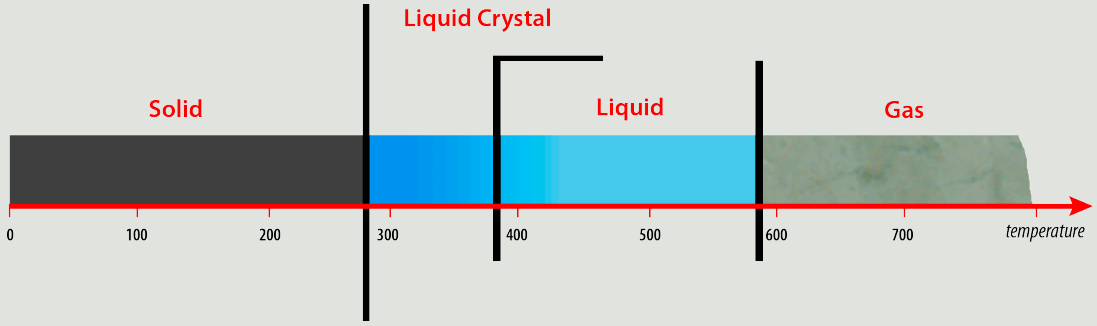


Basically each crystal acts like a shutter, either allowing light to pass through or block the light. The pattern of transparent and dark crystals form the images on the display.



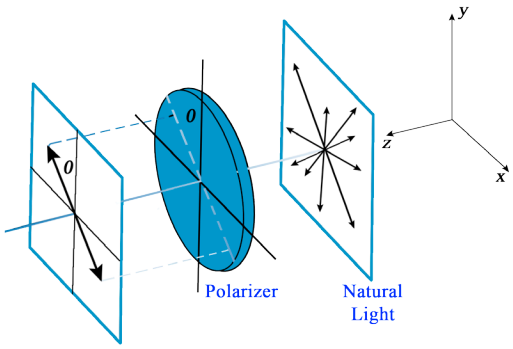
What is liquid crystal?

The name suggests that it is both solid and liquid. That isn't quite accurate. Liquid crystal is really in a state between both solid and liquid. Basically, the crystals in an LCD are able to maintain their orientation like a solid, but they can also move around to different positions, like a liquid.

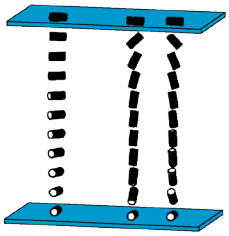


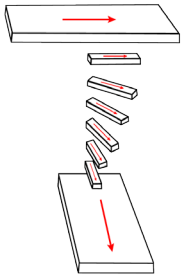
Polarizers

Polarizers are responsible for creating the image that is displayed on an LCD (see diagram below). The science of how light is polarized through the LCD can be a bit confusing. Simply stated, the light that is dispersed through the LCD is not actually created by the liquid crystals themselves. Ambient light is actually reflected off the relective rear polarizer back out the front of the LCD. The image that is seen with the naked eye is the light that is blocked by the front polarizer. Without these polarizers, the LCD would be completely transparent, with no image displayed.



To understand this better, we can look at an example that is easily seen. One could gather metal shavings, collect them together, and then expose them to a magnetic field. What you will see is that the shavings will align themselves in the direction of the magnetic field.



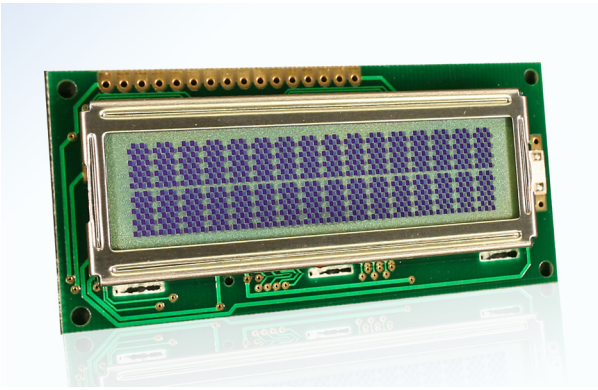


Resting state (no E-field applied): Molecules are twisted by a cetrain angle dependent on the liquid crystal material (i. e. 90°). The polarized light is de-polarized by reflecting off the crystal structure and passes through the linear front polarizer.

Active state (E-field applied): The molecules orientate towards the electric field. The polarized light does not reflect off the crystal structure and is blocked by the front front polarizer and an image is seen.

A similar phenomenon occurs when exposing liquid crystal to an electric field. The crystals will orient themselves in the same direction of the electric field. The visible pattern that you see in an LCD is limited by the etching on the glass, essentially limiting the movement of the crystals to create specific images.

There are many advantages in utilizing an LCD display technology versus other display technologies, such as VFD. LCDs are more aesthetically pleasing to the eye, as they can display just about any design. The sleek design of LCDs provides many space-saving advantages. They are also very light and are therefore more portable. The user-interface with an LCD is far superior when compared to VFD technology. And, LCDs are typically more cost-effective, not to mention more ecologically-friendly when it comes to power consumption. An average LCD's power consumption is in the area of 30 micro-watts when compared to an average VFD display which can be significantly higher.



Implementation of LCDs in AMR Metering

The implementation of an LCD display versus VFD allows the utility provider to communicate more information than simply usage to their customer base; which includes home owners, plant managers, building engineers and the utility provider's staff. This data can be simple usage statistics, such as kWh or gallons to more complex items such as peak usage rates and power optimization figures. This required level of versatility makes LCD displays the information display vehicle of choice.

Lumex can enhance any LCD product with a wide variety of design enhancements to achieve that unique point of difference and meet design engineer's needs and Lumex has a wide array of products that are capable of fulfilling this industry's needs. The most common application is in residential metering. These displays need to be very small, draw virtually no power and last 15 years or more. These displays are very customizable numeric displays with icons to show a wider variety of information such as kWh or total amount (in dollars) used month to date, etc… Other, more complex types of metering, such as in manufacturing plants or high rise buildings, may employ character or graphic LCD modules to show even more data to help optimize power usage.

Lumex has made many strides in creating robust products capable of meeting the demands and challenges that the AMR metering industry has put upon the technology. We use UV filers, the highest quality polarizers and a proprietary liquid crystal (the LC in LCD) to create some of the most robust products in the industry. In some cases,

we even employ solid state heating to increase response time in the extreme cold. Lumex has run these products through an exhaustive battery of tests. These tests include UV exposure life testing, thermal cycling, vibration testing, HAAS testing and life testing. The parts experience the least amount of discoloration to UV than any of the other parts tested. Lumex products experience very little discoloration at the temperature extremes as well as having very acceptable response times in cold weather situations. The Lumex products survive without exception during vibration, HAAS and life testing.

Lumex has been supporting the full range of Industrial Control companies throughout the world for the last 30 years. Our customers are the global leaders and technology innovators of their market segments. Industrial control companies rely on Lumex to be able to supply a full breadth of optoelectronics and displays as well as identify opportunities to create feature-rich, high value solutions.

Because use of optoelectronics is expanding rapidly in the industrial controls market, customers are also looking for a single supplier partner like Lumex to ease the burden of sourcing multiple vendors.

Lumex InfoVue™ Extreme Temp LCDs

P/N's
LCR-U01602DSF/AWH
LCR-U01602DSF/DWH
LCR-U02002DSF-WH
LCR-U02004DSF-WH
LCR-U12864GSF-WH

Product Brochure