Mon, December 14, 2009 - 12:01 PM

Designing Portable Medical Devices

Critical Considerations when Designing the User Interface for Portable Medical Devices

As health care and treatment move outside the walls of traditional medical institutions, medical devices have increasing requirements for both performance and features. With the rapid expansion and deployment of at home and self care, ruggedized medical devices with integrated user interfaces are becoming the center of focus for the medical industry and increasingly are being viewed as equipment designed to operate in a hostile environment. For portable, hand held and disposable medical devices, there is a growing need for electronic user interfaces that communicate more information using a solution that can withstand a wide range of environments. User interface technology, including LCDs and LEDs, that can meet or exceed the continuously increasing demands of portable medical devices is of paramount importance.

Rugged Design

For portable medical devices, one of the primary considerations when designing products from the at-home digital automated blood pressure devices to emergency respiratory care devices is the ruggedness and durability of the LED and/or LCD user interface. In most cases, the portable device is going to be exposed to wide temperature variations, shock and vibration, and varying light conditions. Emergency respiratory devices, for example, are regularly used in medical transportation which is one of the harshest operating environments in health care. The equipment will be exposed to climates ranging from Fairbanks, Alaska to Tucson, Arizona. The new temperature range for numeric, graphic and character LCDs in portable devices for hostile operating environments is -40°C to +85°C. This can be achieved by using a proprietary fluid mixture and high temperature back light along with a heater and special polarizers. In many cases, there are standard sizes available including 8x1 up to 4x40 for character modules and 122x32 up to 320x240 in graphic modules. Having this operating range for the device's LCD will ensure full functionality of the user interface at cold start or after exposure to long durations at high temperature which is essential at any time during critical care.

Highly Accelerated Life Testing (HALT) should not only include temperature cycling between -40°C to +85°C but also vibration testing. In order to identify potential weaknesses early, the LCD display should be able to withstand up to and including 5 days of constant vibration at 40G. This type of testing will help to ensure a minimum of 3 years of field service under the most stressful vibration environments, whether airborne or terrestrial.

Finally, a consideration for both LED and LCD displays for the user interface is the varying light conditions. Both medical professionals and patients self administering or

monitoring need instantaneous detailed information regardless of whether they are in full daylight, complete darkness or in an environment with multiple competing or shifting light sources. High intensity LED displays and LED backlights as well as high contrast LCDs offer solutions to all of these challenges. Ensuring that the LED display on a medical device has high bright RED 636nm or pure green 525nm that enables it both daylight and night time visible. For an LCD, having a high contrast level along with a high bright (but not necessarily high power) LED backlight is critical. Using Super Twisted Nematic (STN) fluid will give a high level of contrast at a wide viewing angle and will not get washed out by a high brightness backlight. For maximum visibility, a white backlight with a minimum intensity of 4000 nits will enhance daylight viewing in direct sunlight as well as in shifting or competing light conditions, as in a moving vehicle.

Ultimately, the display that makes up the user interface, regardless of whether it is an LED or LCD display has to be able to withstand some of the most stringent requirements for operation. That envelop will continue to be pushed and finding the right technology to meet the expanding performance demands is critical.

Engineered Solution

Another chief consideration when incorporating a user interface is the features and options. For many medical device companies, standard LED and LCD display offerings can be the simple solution to what is often the greatest challenge to the most visible and important part of the product. Increasingly, however, design engineers are finding that many standard, off-the-shelf display technologies do not meet all of their needs, and recognize that a total engineered solution will offer the best result for more complex design needs and enriched feature options.

Many of the features and options in a portable medical device are designed to communicate information to the user easily and quickly. Information communication can include a whole range of user interface products like LEDs, light bars, LED arrays, indicators, LCDs and icons. Ultimately, in order to provide product differentiation and the most feature rich devices, integration of some or all of these components may be necessary. If this is the case, then color and intensity matching or “binning” for any LED products become an important part of design consideration. There are advantages to having a single supplier who is able to take all the LED components and integrate them into a single solution, because the binning is all done and tested before the device manufacturer ever sees the product. In addition, custom LED colors can be incorporated to create product differentiation and to communicate optional information. While green (574nm), amber (610nm) and red (636nm) are the most common colors used in portable medical devices, some devices now include unique LED colors like turquoise and even pink.

In combination with LED components, custom LCD options also can communicate more information and offer more uniqueness than a standard product. Custom sized monochromatic LCDs can often be offered to ensure that the primary user interface is

using only as much space and power as required for the application. Custom Backlights with custom colors or brightness add distinctiveness in a highly competitive market. Custom LCDs can be part of an integrated solution with LEDs, switches, IC, connectors in a single module. Custom icons give the display additional functionality without substantial additional cost or programming. For example, an at-home automatic electronic blood pressure device can include a monochromatic LCD with a custom heart icon to indicate heart rate and a custom mmHg icon to indicate pressure. It includes a light sensor to activate the white LED backlight only when the ambient light drops so that it does not drain the battery. It also includes a turquoise LED to backlight one of the switches and both green and amber LEDs to indicate the beginning and end of a test cycle. This is the very definition of an integrated user interface solution.

In any medical device, a wide range of information can be communicated in challenging conditions. In the leading medical devices, engineers are always taking into consideration the ruggedness of the design for extreme conditions and the ease of communicating critical information with distinctive and integrated solutions.