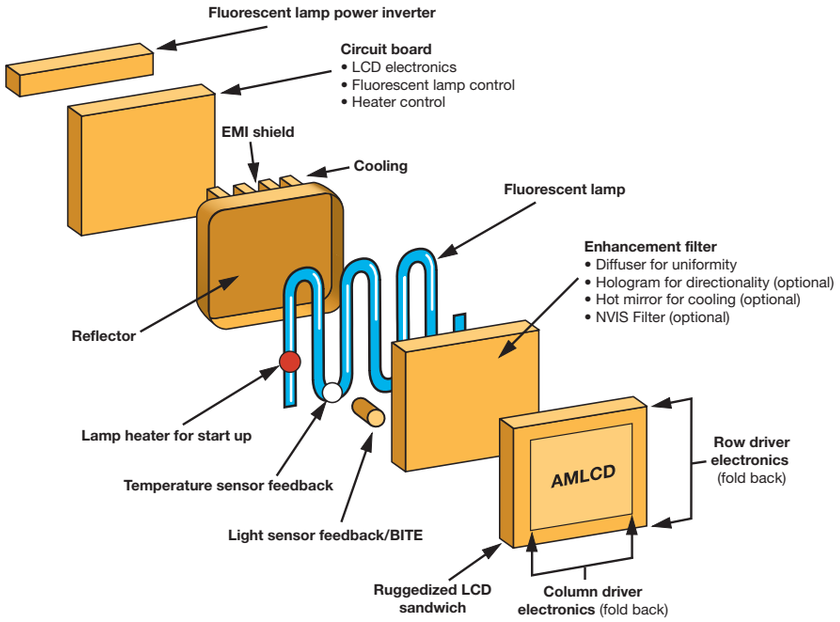

Figure 2: **High-performance avionics LCD**

the LCD. The key component is the LCD panel where the electrical signal of the image is converted into an optical effect. The optical effect is a change in birefringence due to a rotation of the liquid crystal material at each pixel, controlled electrically by the charge on the pixel. To see the contrast between the thousands of individual pixels that form the image, the LCD panel with polarizers must be illuminated from the rear.

The complete assembly is shown in Figure 2. An industry avionics infrastructure has emerged to custom build the backlight assembly. The backlight is designed to give the unique performance of wide dimming ratio, high brightness and night vision goggles compatibility needed in avionics. No other display technology has the brightness capability and dimming range of the avionics LCD.

The fluorescent lamp with the triband phosphor is uniquely suited to avionics applications with its high efficiency and red, green and blue spectral emission. Straight, bent and flat fluorescent lamps are used. The bent version is shown in Figure 2. The lamps are usually redundant for reliability purposes. Lamps with over 50,000 hours to half brightness are now available. The performance life characteristic of a fluorescent lamp is an exponential decay in luminance with operating time. The luminance decay can be compensated for electronically with feedback. To reduce cost and electromagnetic interference the avionics simulator industry is using LEDs as backlights, but their efficiency is much less than that of fluorescent lamps. The heat from the backlight becomes critical when packaged for the flight deck and operating at high luminance levels and a heat sink must be included in the box design.

The really good news is that the COTS LCD can be resized to fit the box or panel

The most important feature of LCDs in their application to avionics is their immunity to high ambient illumination. This is accomplished because of three factors:

• The display when off is truly black. The polarizers absorb all the light either from the back or front. The LCD is optimized to absorb all the light uniformly throughout the panel area and over a wide viewing angle. All CRTs suffer from the phosphors being white and the only way to make them dark and minimize refection is by filtering, but this absorbs the image light as well as the ambient light.

• The LCD reflects the image and is the only electronic display technology to do so. The ambient light passes through the pixels that are open – or turned on – to produce the image. The ambient light is then reflected and added to the backlight and passes through the pixels. Thus the ambient illumination adds to the image brightness.

• As with all avionics instrument glass, an antireflective coating is needed on the front surfaces.

There are three areas of concern about LCDs when applied to avionics:

• Off-axis image quality is poorer than in the normal axis. CRTs are lambertian emitters and have no variation in image quality off axis. However parallax problems exist with older mechanical instruments and CRTs.

• Speed of response is less than that of CRTs. LCDs can be refreshed at 60Hz with 20Hz image change to alleviate the slow response if necessary with no adverse effect.

• Temperature range is limited but most LCDs now exceed the required operating range for avionics. COTS LCDs are not tested for the avionics range so they need to be tested during qualification to confirm proper performance. Reliable ranges of between -40°C to 80°C and wider can be expected.

Summary

High-performance avionics LCDs can be made by ruggedizing COTS or resized COTS LCDs. The COTS LCD must be ruggedized in a sandwich and integrated with an avionics grade backlight. The complete assembly is normally designed, tested and qualified together just as with custom LCDs.

The really good news is that the COTS LCD can be resized to fit the box or panel. There are some limitations in resizing but there is a large range of COTS LCDs from which to choose. Resized COTS LCDs can be made at one-tenth the cost of custom LCDs. The evolution will be a revolution and LCDs will lead to a better flight deck at a lower cost with increased safety – the golden goal of avionics.

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1. D. Hogg, et al, "Development of a production process for COTS glass remanufacture for use in avionic displays"; in Proceedings of SPIE, 17-19 April 2001, Volume 4362, p. 278

2. L. E. Tannas, Jr., "AMLCD resizing". ibid, p. 288