

# Display technology fighting the sun

Codis TX series for vehicle  
operations

## Success factors for sunlight readability



Since many display products are used in bright ambient light conditions, typically outdoors in direct sunlight, additional technologies are required to reduce display reflectivity and to enhance display brightness and contrast. Inside military vehicles, intruding sunlight can completely wash out the display, and important, life-critical information can get lost in a reflected glare. If the reflected light is greater than the display's emitted light, the display will be washed out in sunlight. The display is still there, but the extrinsic contrast has dropped to zero, meaning the information has become unreadable.

The Esterline Codis TX display family features a third generation of rugged displays with light-emitting diode (LED) backlights. Esterline Codis's expertise in LED technology leads to maximum efficiency in terms of light output per power input and an unrivalled performance in terms of sunlight readability.



The Esterline Codis TX display



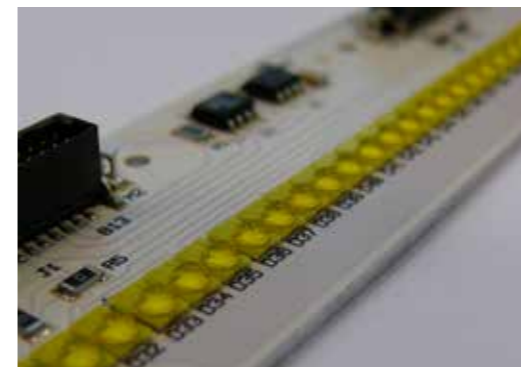
## High-efficiency LED backlighting

LED backlighting allows maximum daylight readability, extended dimming capability, an excellent white point, and night vision (NVIS) compliance without the use of filters. For its Codis TX displays, Esterline Codis developed a custom-made and highly efficient LED backlight technology with:

- High-efficiency White LEDs, in combination with state-of-the-art backlight optics, rendering a brightness level of 686 cd/m<sup>2</sup> (200fL) measured at the display
- White point color correction, using Blue LEDs in day mode for white point color compensation, which allows the use of commercial off-the-shelf LCD products originally designed for CCFL backlights

- Night Vision Goggle (NVG) compatibility without the use of night vision filters
- A dimming ratio at least 10 times greater than with CCFL backlights
- A stable light output over time and within a wide operational temperature range by means of feed-forward compensation

To achieve the overall display light output, Esterline Codis uses highly transparent commercial off-the-shelf LCD panels and replaces the original CCFL backlights with a more efficient LED light source. Esterline Codis specifically uses White LEDs for day mode, boasting a light output of at least 100 lm/W, as they are currently about twice as efficient as RGB LEDs.



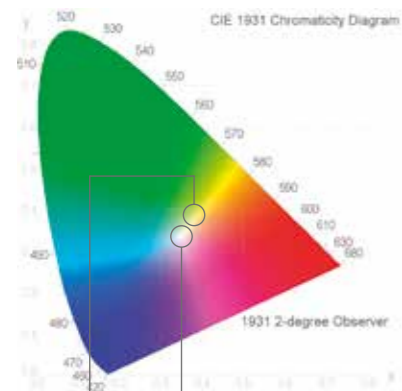
Esterline Codis' TX display series features an innovative LED backlight system



The Esterline Codis TX display family, with display sizes from 10" to 17"

Commercial off-the-shelf LCDs typically have color filters matched with CCFL backlights. Using LEDs will affect the color rendition. Esterline Codis adds Blue LEDs to solve this problem.

## Countering color shift



Color of 100 lm/W White LED

Color of 100 lm/W White LED  
+ Secondary optics (LCD color filter)  
-> Shift towards green

The spectral distribution of the 100 lm/W White LED does not match the spectral distribution of a CCFL, meaning it doesn't match the color filter of an LCD with traditional CCFL lamps. This results in a phenomenon called color shift, causing color changes in the image displayed (shift towards

green). To compensate for this color shift, Esterline Codis adds Blue LEDs to achieve a good and calibrated white point.



Commercial off-the-shelf LCD with White LED backlight can lead to a color shift

The efficiency of both LEDs and LCDs is affected by temperature and lifetime. The lumen output of LEDs changes with temperature (highest efficiency at cool

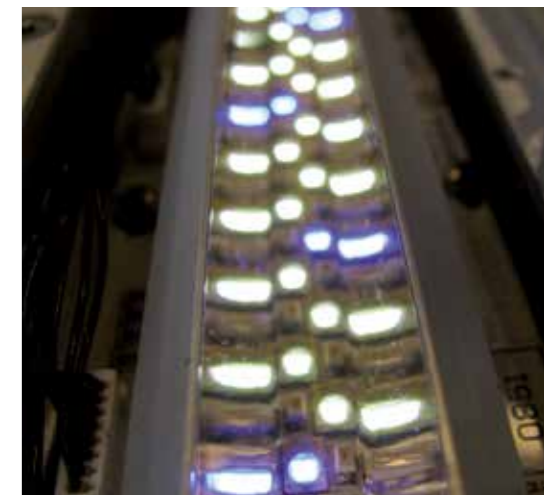
temperatures) and over time, while LCDs will be most efficient at room temperature and offer continuous stability over time.

## Feed-forward compensation

Despite the disparity between these two technologies, Esterline Codis manages to achieve a stable 686 cd/m<sup>2</sup> (200fL) light output over the full operational temperature envelope (-46°C up to +71°C) for 50,000 hours. First of all, the LED backlight is designed with sufficient headroom to minimize the effects of temperature and lifetime. Additionally,

Esterline Codis uses feed-forward compensation to ensure a stable light output. Esterline Codis' backlight control software will dynamically and automatically adjust the backlight brightness based on temperature sensor readings inside the display and empirical data of LED and LCD efficiency.

This method of compensation is called feed-forward, as the software receives no feedback of real-time light output measurements. Feedback requires more electronics, is more expensive and is of little added value in terms of light output stabilization.



Contrast performance in a high ambient light environment is primarily influenced by the light output and reflection characteristics of the optical system. To a lesser extent, it is also influenced by the intrinsic contrast of the LCD. The Esterline Codis TX displays

feature rugged, low-reflection analog-resistive touch screens bonded to the front of the LCD and EMI glass filter. The bonding material, and hence the absence of air between all parts of the optical stack, makes sure that reflections are heavily reduced.

## High contrast, low reflection

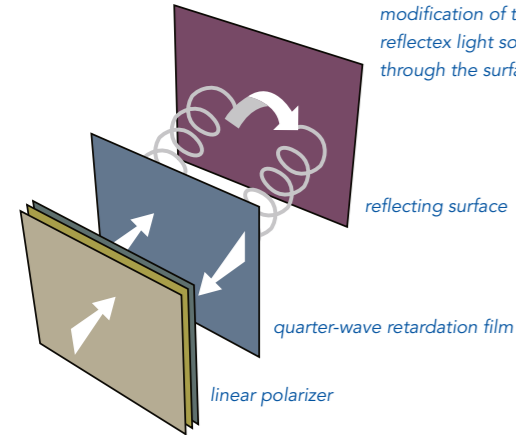


Implementing an analog-resistive touch screen into this optical system usually has dramatic effects on the reflection characteristics. Esterline Codis' TX displays integrate analog-resistive touch screens with circular polarization, resulting in a reflection percentage of less than 1% as opposed to conven-

tional analog-resistive touch screens with a reflection rate of more than 12%. Combined with a light output of 686cd/m<sup>2</sup>, the Codis TX display performance fully complies with the contrast requirements for sunlight readability.

Esterline Codis displays have a reflection rate of less than 1% due to an analog-resistive touch screen with circular polarization.

circular polarizer touch screen



principle: modification of the polarization of reflect light so it can't escape back through the surface of the LCD

circular polarizer is achieved by the combination of the linear polarizer and the quarter-wave retardation film

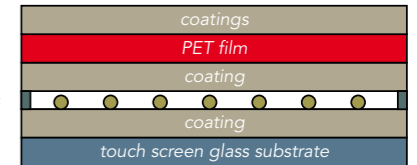
## Ruggedization

A conventional analog-resistive touch screen is constructed with a thin film over glass. The external layer is a polyester film that covers a conductive Indium-Tin Oxide (ITO) layer. The polyester material is hygroscopic

and naturally absorbs moisture. This means that in high-humidity, high-temperature environments, the top sheet will expand and eventually "pillow."

The Esterline Codis solution for the pillowing phenomenon is to add a 0.2 mm micro sheet outer layer of glass laminated to the touch screen. This seals the external surface of the touch screen. Thus, the complete construction of the Esterline Codis analog-resistive touch screen integrated into the Esterline Codis TX display consists of a glass layer, a film layer, the circular polarizer and another glass layer. This entire optical stack (LCD, filter glass and touch screen) has passed all environmental testing, including boot kick and wrench impact testing, meets all of the optical performance requirements, enables perfect cold start performance at temperatures as low as -46°C and offers EMI performance fully compliant with the military standard for emissions and susceptibility (MIL-STD-461F for ground army applications).

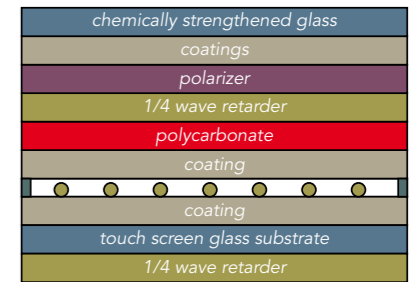
Air gap with spacer dots



A typical analog-resistive touch screen construction is not fit-for-use in combat vehicles

0.2 of 0.3 mm

Air gap with spacer dots



Esterline Codis adds several layers to its touch screens, providing boot kick and wrench impact resistance



- Some ruggedization tests:
- Vibration testing (1, 13)
  - Condensation testing (2)
  - Highly accelerated lifetime testing (3)
  - Electromagnetic compatibility testing (4)
  - Waterproof testing (5, 6, 12)
  - Drip proof testing (7, 8, 10, 11)
  - Hammer blow testing (9, 16)
  - Earthquake testing (14, 15)

1	2	3	4	5	6	7	8
				9	10	11	12
				13	14	15	16

# Esterline for defense

When conditions become extreme, only extreme technologies can offer operators the reliability and survivability they need. For the demanding environments of the utility vehicle, helicopter, or armored vehicle, Esterline has developed the Codis TX series of extremely rugged displays. Codis TX displays offer an ideal solution for battlefield management, fire control, driver's view enhancement, reconnaissance or local situational awareness inside today's rugged vehicles.

As no other visualization company, Esterline gives operators and decision-makers the power to see their high-resolution images in real-time, wherever they need them. Esterline has been serving the defense community for over 20 years, providing reliable and high-quality rugged displays, deployable workstations, advanced imaging platforms, and Common-Operational-Picture solutions.

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*The information and data given are typical for the equipment described. However any individual item is subject to change without any notice.*

*The latest version of this product sheet can be found on [www.esterline.com](http://www.esterline.com).*

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