Effects of direct sun-light exposure to Touchscreen equipped Liquid Crystal Display monitors and mitigation techniques

Introduction

Liquid crystal, at room temperature, is neither a liquid nor a solid. This state allows liquid crystal to be usable as a light controlling device – i.e.: Liquid Crystal Display (LCD). However, liquid crystal can be adversely affected by temperature changes causing undesirable results. Low temperature environments can cause the crystal to transition more to a solid thus causing the crystal to be less responsive to changes needed to properly control light. In a LCD this can be observed as slow transition time from frame to frame (choppy video or memory of previous image). Higher temperature environments cause the liquid crystal to transition more to a liquid state, again causing the crystal to not perform correctly when controlling light. This effect can be seen in an LCD as a lowering of contrast ratio (darkening) or in extreme heat conditions melting the crystal resulting in a completely dark LCD image. Direct sun-light exposure typically does not cause LCD to internally heat enough to reach the liquid crystal's melting point. However, touch monitors have a glass overlay and air barrier on top of the LCD. This can cause a greenhouse effect causing the air temperature between the touch sensor and LCD to become much hotter than the ambient temperature.

Preventive measures

- Orientation: The easiest way to prevent thermal heating by the sun is of course to not expose the LCD to direct sunlight. In many cases simply orienting the face of the LCD monitor in an East/West position will prevent the greenhouse effect and darkening of the LCD.

- Covering or awning: If orientation cannot be controlled and the design allows for it, a simple shade can be employed to block direct sun light. The shade can be a protective awning overhead, or a cover that lies over the screen prompting the user to open or remove the covering to use the device.

- Touch Technology choices: Touch sensor design varies based on the given technology. Technologies such as APR and SAW are based on glass only technologies. Resistive and Capacitive technologies have coatings which block some light transmission in both directions. In theory, touch sensors with coatings would slow the greenhouse effect by blocking a percentage of entering light thus slowing the LCD darkening. Touch sensors such as Infra-Red and Optical have no boundaries on the substrates; thus films, coatings or substraight material itself can be adjusted to block additional light.

- Films and Coatings: Films designed to block light can be applied to some touchscreen technologies to slow the greenhouse effect. APR, resistive, capacitive, Infra-Red, and Optical all would be candidates for addition of films. The below experiment shows the results of three APR screens with various films and no film applied.

Testing was performed on three Elo ESY15B1-APR products, outdoors in direct sunlight for 4-hours. A white background was displayed and a burn-in was test running to load the processor.

The Elo product with *[Nushield](), NU204GA Anti-Glare film applied, looked very dim before testing and was difficult to read after 4-hours but the pixels did not melt.

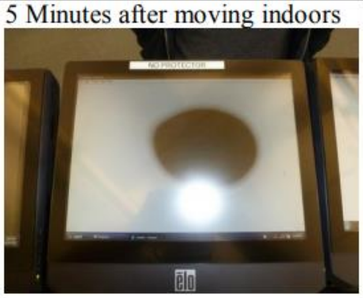
After 4-hours, the one with no film applied entered its isotropic state and was completely black except around the very outside edges.

The Elo product with NU405RA DAYVUE film applied looked best of all three every time and was readable after 4-hours.

- Note: This product also appeared clearer in normal conditions than the one without a film applied, however the touchscreen was a little more difficult to activate with the shield verses without the shield.

PROTECTOR=	NU204GA	**NONE**	NU405RA - DAYVIEW
LUMINANCE	489	604	672
TEMP/Degrees	79	114	80
TIME	9:30	9:30	9:30
READABLE?	YES	YES	YES
LUMINANCE	250	465	388
TEMP/Degrees	103	114	115
TIME	10:30	10:30	10:30
READABLE?	BARELY	DIM	YES
LUMINANCE	124	111	146
TEMP/Degrees	125	134	133
TIME	1:30	1:30	1:30
READABLE?	NO/VERY DARK	NO/BLACK	YES/DARK

5 Minutes after moving indoors



10 Minutes after moving indoors

- Note: The beginning luminance readings of the product with NU405RA film applied were higher than the no film control. This may explain the appearance of a brighter screen with film applied.

**Elo Touch Solutions is not affiliated with Nushield or any other film providers. Elo Touch Solutions offers no warranty, implied or expressed, as to the products or techniques described in this white paper. Information was collected and assembled for edification purposes only, and individual results may vary.*