# Application Note —

# MOXTEK ProFlux™ Polarizer use with LCOS displays

**Customer support information:**

**CRL Opto Limited, Dawley Road, Hayes, Middlesex, UB3 1HH. United Kingdom.**
**Tel: +44 (0) 20 8848 6400 Fax: +44 (0)20 8848 6653**
**e-mail:tech-support@crlopto.com**
**http://www.crlopto.com**

**a scipher company**

# CONTENTS



# Tables



# Figures

# 1. Introduction

MOXTEK ProFlux™ polarizers are metal-on-glass polarizers. These polarizers are becoming increasingly recognized as a good replacement for traditional polarizers in LCD applications.

## 1.1 Scope

This document has been produced to help engineers in their choice of polarizers and design of optical systems incorporating LCOS microdisplays.

The document is intended to supplement the data sheets and application notes that can be obtained from the MOXTEK ProFlux™ website: www.profluxpolarizer.com. The MOXTEK data quoted in this document is available in documents on the MOXTEK website.

Information on polarizer handling and cleaning techniques are not discussed in this document and can be found at the ProFlux™ website.

# 2. Comparison of ProFlux™ with traditional polarizers

It is important to consider whether it is appropriate to use ProFlux™ polarizers in a relevant application. To aid this decision, a comparison between ProFlux™ polarizers and traditional polarizers is given.

## 2.1 Polarizing Beam Splitters

In a reflective LCD optical system, a polarizing beam splitter (PBS) is often used to direct light onto the display and then to analyse the output. This has traditionally been done using a MacNeille PBS, which is a glass cube with an internal surface (with thin film coating) at 45° to the faces.

The main problem in using a MacNeille PBS with a CRL Opto FLCOS display is that the illumination f/# is limited to about f/3. For f/#s below this, the skew rays lead to reduced contrast. Constraining an optical system to f/3 limits the total light throughput due to Etendue, and as higher output is continually demanded for projection systems this can be a problem. This problem is of particular importance with the CRL Opto display, as it has a very large acceptance angle compared to many rival technologies, with illumination cones down to f/2 being possible. The ProFlux™ PBS is more suited to the display in this regard, as it works to f/1.8 thus allowing greater throughput without a trade-off with contrast.

It is possible to use the PBS with the display in two different positions, as illustrated in figures 2.1(a) and (b). The choice for a MacNeille PBS system is determined by the relative efficiencies of the two systems for the specific PBS. For a ProFlux™ PBS, the display can again be placed in the two locations, but the choice now becomes related to image quality rather than contrast. For the system in figure 2.1(a), the image will have astigmatism introduced due to the light passing through an angled plate in the output path. The MacNeille PBS does not suffer from this problem as the light only hits glass surfaces that are normal to the display.

For the system in figure 2.1(b) the critical feature is the flatness of the surface. To improve performance in this orientation, MOXTEK has introduced an optically flat PBS, with flatness $<3\lambda$/inch, this flatness is sufficient for most applications. However, $<3\lambda$/inch may not be flat enough for some applications, in which case a MacNeille PBS may be more appropriate, with surface flatness as good as ($\lambda$/4)/inch possible, but this would of course limit the f/#.

Another problem that can occur with the MacNeille PBS is that in high flux applications the cube can heat up leading to stress birefringence. To help avoid this, the cubes are usually made from glasses that reduce this problem, but this generally leads to an increased cost of the product. If the ProFlux™ PBS is used correctly (as discussed in section 3), the effect of any stress birefringence can be minimized or even eliminated.

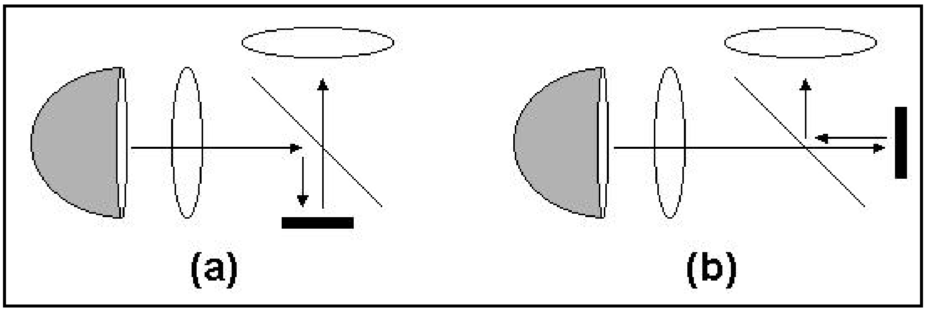


**Figure 2.1: PBS use - (a) reflection before display, (b) reflection after display**

## 2.2 Normal incidence polarizers

In projection systems, one of the main problems associated with traditional dye-type absorbing polarizers is their inability to survive high light flux. The ProFlux™ range of normal incidence polarizers are able to cope well with high flux applications as they reflect rather than absorb the orientation of light that is to be rejected. MOXTEK has shown that their polarizers can survive 7 Megalux for 1000 hours or more, which compares favourably to dye-type polarizers, which were found to survive only 10 minutes or less. Further environmental parameters are available at the ProFlux™ website.

Another advantage of ProFlux™ polarizers over traditional dye-type polarizers is that dye-type polarizers can depolarise light that is already well polarized. This is due to poor alignment of the molecules. The ProFlux™ polarizers have much better alignment leading to less or no depolarisation.

One case where a traditional absorptive polarizer would be more suitable than a reflective one is for head mounted displays where a clean-up polarizer is in front of the eye. If a reflective ProFlux™ polarizer were used in this situation there would be considerable reflection of ambient light back into the eye thus degrading the contrast. Also, for very cost sensitive products, where performance is not critical, a cheap dye-type polarizer might be more cost effective.

# 3. Design Considerations

One of the most important things to consider when building a system with ProFlux™ polarizers is their orientation. It is important that the metal side of the polarizer is facing towards the display, as illustrated in figure 3.1. This means that any birefringence in the glass will not critically affect the polarization state, e.g. before the light reflecting off the display has been analysed.

Another design consideration for normal incidence polarizers is the reflection of the rejected polarization (section 2.2). In most projection systems, the polarizer is in a location where the light beam is converging so the reflected polarization is diverging. The divergent reflection usually causes few difficulties within the projection system. It is possible to control the reflected polarization by rotating the ProFlux™ polarizer, so the rejected light is redirected to another location in the system. For best results rotate the ProFlux™ polarizer about an axis perpendicular to the transmission axis.

As mentioned in section 2.1, it is possible to use the PBS such that light reflects off it before or after the display. If the optically flat PBS is used so that the reflection is after the display (figure 3.1), a clean up polarizer should be used after the PBS. This is necessary due to contrast of the PBS being limited in reflection due to Fresnel reflection off the glass substrate.

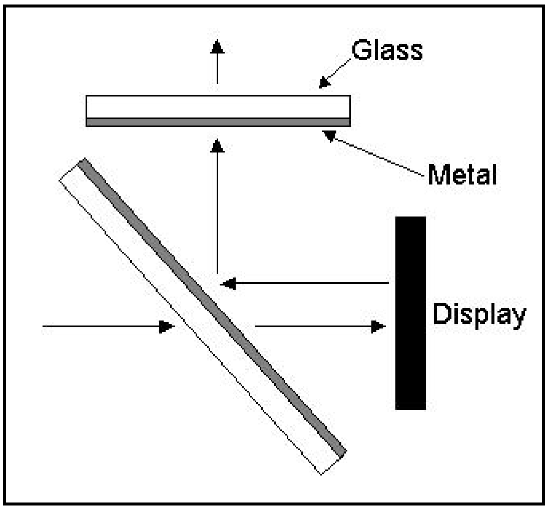


**Figure 3.1: PBS with reflection after display (Polarizer Choice)**

The choice of PBS, as discussed in section 2.1, is to have an optically flat beam splitter for reflection after the display, or a standard PBS for reflection before the display. Other than for mechanical design reasons, the choice of PBS will depend on the required optical quality of the system. If the system is to be low cost and can accommodate some astigmatism then the standard PBS might be suitable. However, if no extra astigmatism can be tolerated then the more expensive optically flat PBS would be a more suitable option.

There is a range of normal incidence polarizers. These are listed in table 3.1, with typical applications.

| Polarizer type | Application |
|---|---|
| High Transmission | Pre-polarization and clean up |
| Very High Transmission | Polarization, pre-polarization, and polarization recovery systems |
| General | Systems where both “s” and “p” polarisations are of equal importance |
| High Contrast | Off-axis systems, Transmissive LCD (HTPS) systems, and where the highest possible contrast is necessary. |

**Table 3.1: Polarizer types and applications**

# 4. Contacting CRL Opto

CRL Opto technical support may be contacted as shown below:

Telephone: +44 (0) 208 848 6400

Facsimile: +44 (0) 208 848 6653

E-mail: tech-support@crlopto.com

Website: http://www.crlopto.com

Address: CRL Opto Limited
Dawley Road
Hayes
Middlesex
UB3 1HH
United Kingdom

# 5. Contacting MOXTEK

MOXTEK and their Asian representatives Polatechnco Co., Ltd. may be contacted as shown below:

Telephone: 1-801-225-0930

Facsimile: 1-801-765-1050

E-mail: sales@moxtek.com

Website: http://www.moxtek.com

Address MOXTEK Inc.

452 West 1260 North
Orem, UT 84057
USA

Telephone: 03-5828-6195

Facsimile: 03-5828-6190

E-mail: overseas@mail.polatechno.co.jp

Website: http://www.polatechno.co.jp

Address: Polatechno Co., Ltd.
Toshin Ueno Bldg. 4F
6-2-1 Higashiueno
Taito-ku, Tokyo 110-0015
Japan

**Application Note: MOXTEK ProFlux™ Polarizers**

**Document no.: 915/0277/01A dated 29/01/03. Document release no. SC 132**