CRL OPTO

Application Note —

Optical Basics and Microdisplays

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CONTENTS

FIGURES

1. Projection system overview

The purpose of the projection system is to illuminate the microdisplay, and collect the light reflected off the display into a projection lens. The projection lens creates a magnified real image of the display on a screen. A diagram showing a basic layout of a projection system for use with a reflective microdisplay is shown in figure 1.1. The elements shown in figure 1.1 will be considered individually.

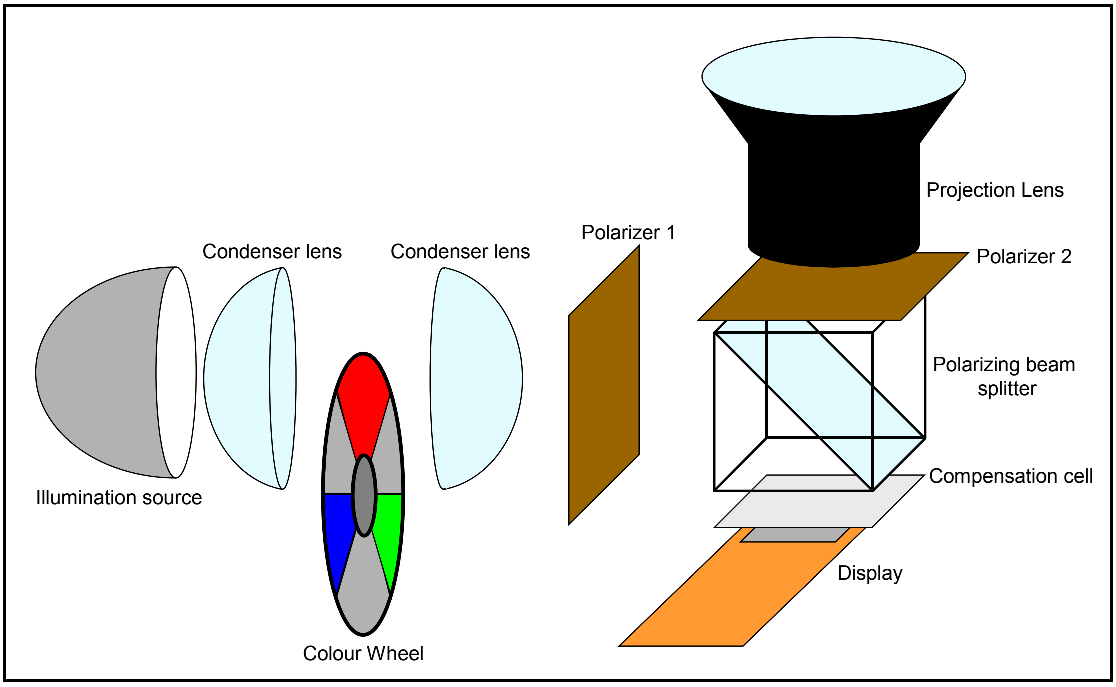

Figure 1.1: Projection system

1.1 Illumination source

Traditionally, arc lamps have been used for projection systems with microdisplays. The type of reflector that the lamp is supplied with will affect the subsequent condenser lens system. If the reflector is parabolic, the light output will be collimated. If the reflector is elliptical, the light will be convergent.
Another form of illumination becoming available is high brightness LEDs. The efficiencies of LEDs and their collection optics are continually improving, and they are now becoming a viable option for projection illumination.

1.2 Condenser Lenses

The purpose of the condenser lenses is to collect light from the illumination source and direct it onto the microdisplay. The condenser lenses do not necessarily need to collimate the light, and for some systems it is best if the light converges onto the display. This is because it is easier to collect the light into the projection lens after reflection of the microdisplay if it is converging.

The condenser lens system can be as simple as one or two lenses for a test system.

1.3 Polarising Beam Splitter

The polarizing beam splitter (PBS) reflects light in one orientation of polarization onto the display, with light in the orthogonal polarization state passing straight through the PBS. The PBS also analyses the light reflected off the display so that only light that has had its polarization state rotated to the orthogonal state can pass through to the projection lens. Note that it is possible to have the display at the other exit face of the PBS so that the "straight through" light is used. The choice of display position will depend on the particular PBS and its relative efficiencies of the two orientations.

1.4 Compensation Cell

The microdisplays work in the so-called 50:50 mode, in which positive and negative images are displayed alternately so as to maintain the DC balance of the liquid crystal. A compensation cell can be used to invert the polarization state of the light thus allowing the negative image to be shown as a positive image on the screen. In the type of projection system illustrated in figure 1.1 a compensation cell will allow the system to have a high optical efficiency, however the contrast ratio might be limited by the compensation cell. A system architecture that is more suited to the use of a compensation cell is an off-axis setup, as illustrated in figure 1.2. An off axis projector has the light impinging on the display at non-orthogonal incidence, which means that the light incident on and exiting from the display passes through different polarizing optics. This also means that the compensation cell can be used for a single pass rather than two passes in the architecture illustrated in figure 1.1. A single pass allows the compensation cell to be used more efficiently. While this architecture allows improved compensation cell performance and therefore improved contrast, the optics are necessarily more complex.

The CRL Opto reflective microdisplay technology is very suited to off axis use as the ferroelectric liquid crystal allows the displays to have a very large acceptance angle.

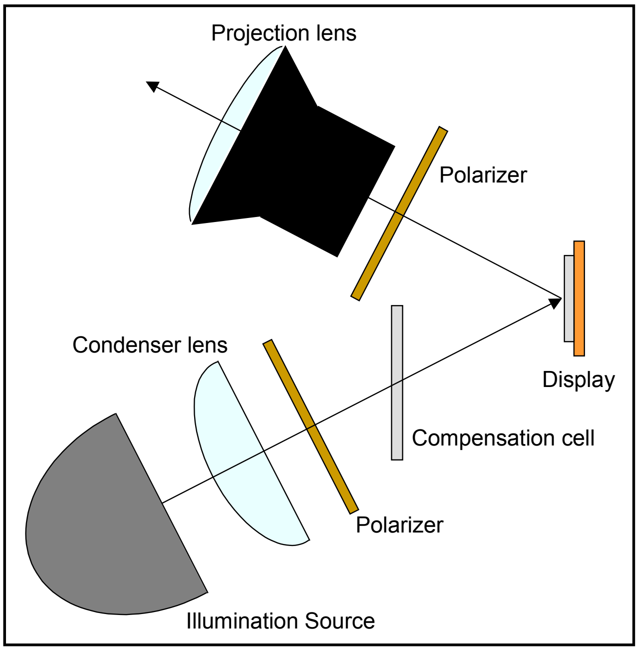

Figure 1.2: Off axis projection system

1.5 Colour Wheel

A colour wheel can be used if a colour image is required. A colour wheel is a set of rotating red, green and blue dichroic filters that are synchronized to the sequential red, green and blue images on the display. It is important that the condenser lenses are used to produce a small light spot on the colour wheel to produce the most efficient performance.

The colour wheel can also be used to block the light from the display during the negative image. This is done by using a wheel with a reflecting blank sector or sectors, as shown in figure 1.1, removing the requirement for a compensation cell and delivering very good contrast.

If red, green and blue LEDs are used as the illumination source, both the colour wheel and compensation cell are not required.

1.6 Projection Lens

The projection lens is used to create a magnified real image of the microdisplay on a screen. For a test system it can be as simple as one or two lenses, as long as the aperture is large enough to accept all the light that has reflected off the microdisplay.

1.7 Other Elements

The polarizers 1 and 2 shown in figure 1.1 are optional. A linear polarizer can be placed in one of these positions to “clean-up” the polarisation state of the light. This is may be required due to inefficiencies of the PBS, and has the effect of improving the contrast ratio of the system. It should be noted that if a polarizer is inserted in position 1, it should be suitable for high temperature use, as the light intensity could damage it otherwise.

Another element that can be used in the system is a light integrator, such as a fly eye lens or light pipe. This is used to give the light beam a more uniform intensity profile. It may not be necessary to use a light integrator in a simple test system. An integrator can also be used as part of a polarization conversion system which converts the polarization orientation that the PBS would have rejected into the orientation that is used.

2. Contacting CRL Opto

CRL Opto technical support may be contacted as shown below:

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