Optics for Uncooled Detectors

PRECISION-OPTICAL ENGINEERING

OSE 002

Application Note

Introduction

The development of room temperature staring array sensors operating over the 8 to 14 micron range offers the potential for lightweight, low cost thermal imagers. This requires optical systems that give good performance with the minimum amount of elements. A typical lens system would consist of two germanium elements, the front one being an asphere in a Petzval-type arrangement. Unfortunately, this type of lens maintains acceptable optical performance over a range of only a few degrees Celsius around the ambient, yet the lens may be required to perform over -20 to +40 degrees. The solution is to use hybrid diffractive/reflective athermalised lens systems. The principle of athermalisation is discussed in Technical Data Sheet OSE003.

Using diffractive optics to correct aberrations

With a positive refractive lens (Figure 1) blue light is refracted short and red light is refracted long, however, with a positive diffractive surface the reverse is true (Figure 2).

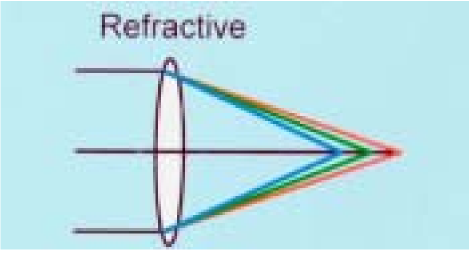

Figure 1

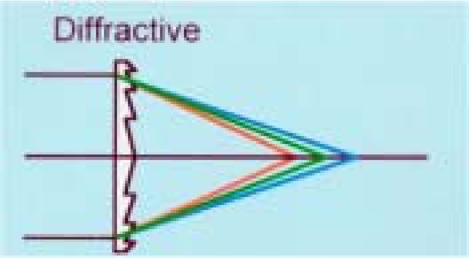

Figure 2

The two can be combined to produce a colour corrected lens, as shown in Figure 3.

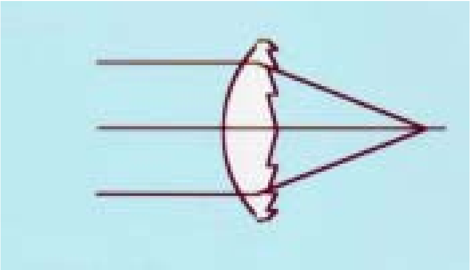

Figure 3

Lenses can have aspheric profiles to correct other aberrations such as spherical aberration and the diffractive can be applied over the top of this to form a hybrid element. Such hybrids bring lower material costs, lower mass as well allowing the dispersive properties of the diffractive to balance those of the refractive.

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Optics for Uncooled Detectors

Uncooled detector optics

Precision-Optical Engineering has been involved in the design and development of numerous lens systems for optical designs which incorporate uncooled detectors. Many are used in aerial applications and therefore cost and weight considerations are of paramount importance. The example shown below was more complex than the simple system discussed above and was designed for airborne use with a second generation uncooled detector which has an active array area of 15.36 mm x 11.52 mm. High image quality is required, with blur spots of 20 to 40.0 microns or less This particular system was used for a wide field of view application with a focal length of 21 mm. It operates in the 8-13 micron waveband at a F/1.0.

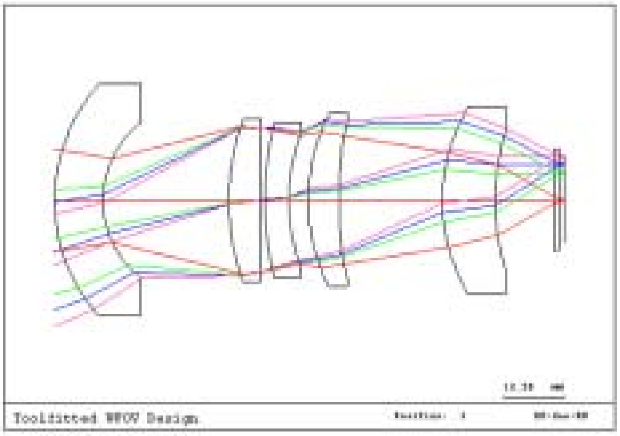

Figure 4

Figure 4 shows the five element lens design.

Five elements are needed to cope with the very large field of view (± 27.3 degrees diagonal). The materials used are, from left to right, Zinc Selenide / Germanium / Zinc Selenide /Germanium.

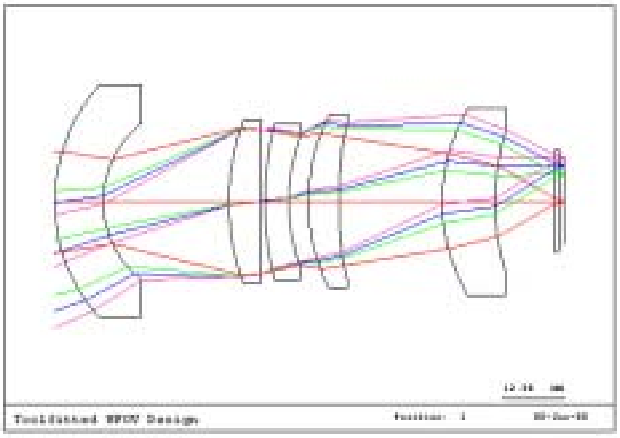

Figure 5

Figure 5 shows the axial modulation transfer function against temperature.

Performance is excellent and satisfies the MTF requirements of the detector (spot sizes are in the range 20 to 40 microns). In addition, performance is held from below –10 to +50 degrees C.

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