FD4 Series Quad-Lens

for Philips Lumileds LUXEON[1] Rebel and Rebel ES LEDs

- **High efficiency**
- **Four LED capacity**
- **Compact enough for MR-16 sized applications**

The FD4 Quad-Lens offers a compact, 42mm diameter 4-up optic suitable for use in MR16 applications.

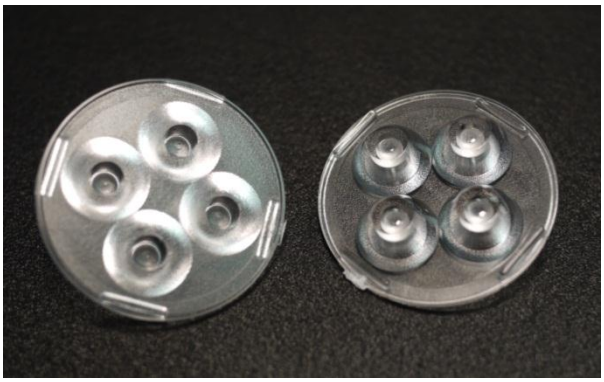
The FD4 Quad-Lens has been specifically designed to realize maximum performance and efficiencies when used with Philips Lumileds LUXEON Rebel and Rebel ES LEDs.

The software-optimized aspheric profile delivers a very efficient 15 degree (FWHM) Beam Angle[2] with a tight 30 degree Field Angle (FW10%), providing good on-axis intensity with useful spill light.

The FD4 Quad-Lens features an integrated flange with alignment and locating features. Both the lens and the flange are molded of optical grade PMMA.

Typical applications are:

- MR-16 LED lamps
- Reading Lamps
- Task Lighting
- Architectural lighting
- General illumination
- Applications requiring a compact light source with high on-axis intensity



(1) LUXEON® Rebel and Rebel ES are trademarks of Philips Lumileds. For technical specification on LEDs please refer to the LUXEON® Rebel and Rebel ES datasheet or visit www.philipslumileds.com

(2) Typical beam divergence may change with binning and color temperature of LEDs.

FRAEN Corporation OMG
80 Newcrossing Road
Reading MA 01867
USA
Phone: +1 781.205.5300
Fax: +1 781.942.2426

FRAEN Corporation Srl
Via delle Querce, 22
27020 Trivolzio (PV)
Italy
Phone: +39 0382 1933.1
Fax: +39 0382 1933.239

Inquiries: optics@fraen.com
Website: FraenOMG.com

For ordering or sales information in your region, please contact one of our offices listed above or visit www.FraenOMG.com/Contact.

General Characteristics

Materials

Lens Material	Optical Grade PMMA
Operating Temperature range	-40° C / + 80° C
Storage Temperature range	-40° C / + 80°C

Average transmittance in visible spectrum (400 – 700nm) >90%, as measured using 3mm thick Optical Grade PMMA.

Please note that flow lines and weld lines on the external surfaces of the lenses are acceptable if the optical performance of the tri-lens is within the specification described in the section "OPTICAL CHARACTERISTICS"

IMPORTANT NOTE – Lenses handling and cleaning*:*

- *Handling: Always use gloves to handle lenses and/or handle the lenses only by the flange. Never touch the outside surfaces of the lenses with fingers; finger oils and contamination will absorb or refract light.*
- *Cleaning: Clean lenses only if necessary. Use only soap and water to clean the surfaces and lenses. Never expose the lenses to solvents such as alcohol, as it will damage the plastic.*

Scope

This datasheet provides information about the FD4-M1-RE-0 Quad-lens for Philips Lumileds LUXEON Rebel and Rebel ES LEDs.

Optical Characteristics – On-axis Intensity[1], Beam Angle[2], Field Angle[3]

LED	Beam Shape	On-axis Intensity (peak)	Beam Angle (FWHM)	Field Angle (FW10%)
LUXEON Rebel Warm White	Medium	7.6 cd/lm	14.5°	30°
LUXEON Rebel Cool White	Medium	7.6 cd/lm	14.5°	30°
LUXEON Rebel ES Cool White	Medium	6.8 cd/lm	16°	33°

(1) To calculate the on-axis intensity (cd), multiply the on-axis value, above, of the lens (cd/lm) by the total flux (lm) of the LED used. See "Illumination Calculations" below. Luminous intensity depends on the flux binning and tolerances of the LEDs. Please refer to the LED datasheet for more details on flux binning.
(2) FWHM is the full angle where the beam intensity is half the on-axis peak intensity
(3) Field angle is the full angle where the beam intensity is 10% of the on-axis peak intensity

Example Calculations

To calculate intensity (cd): Find the central spot on-axis intensity (cd/lm) for the lens and then multiply this value by the luminous flux (lm) of the LED. Refer to the LED's datasheet for typical flux values; drive current versus flux ratios; color temperature and binning characteristics.

Example intensity calculations:

If a Fraen FD4 lens with an on-axis intensity of 7.6 candela per lumen (cd/lm) is used with an LED that produces 103 lumens of flux, the calculations are as follows:

On-axis intensity = (7.6 cd/lm) x (103 lumens) = 783 candela on-axis intensity (one LED).

With four LEDs used with an FD4, then the on-axis intensity = 4 LEDs x 783 candela (per LED)
= 3132 cd (on-axis – 4 LEDs)

An explanation of illuminance and the effect of distance

One candela at 1-meter distance produces 1 lux. In the above example, the four LEDs in a quad-lens produced 3132 candela. If that fixture is illuminating a surface one meter distant, then the *illuminance* on that surface is 3132 lux.

Illuminance decreases with the square of the distance. If you move the fixture so that it is two meters from the surface, then the illuminance falls to 3132 lux/ $(2m)^2$ or 783 lux. Moving the fixture three meters from the surface decreases the illuminance to 3132 lux/$(3m)^2$ or 348 lux.

Beam and Field Angles

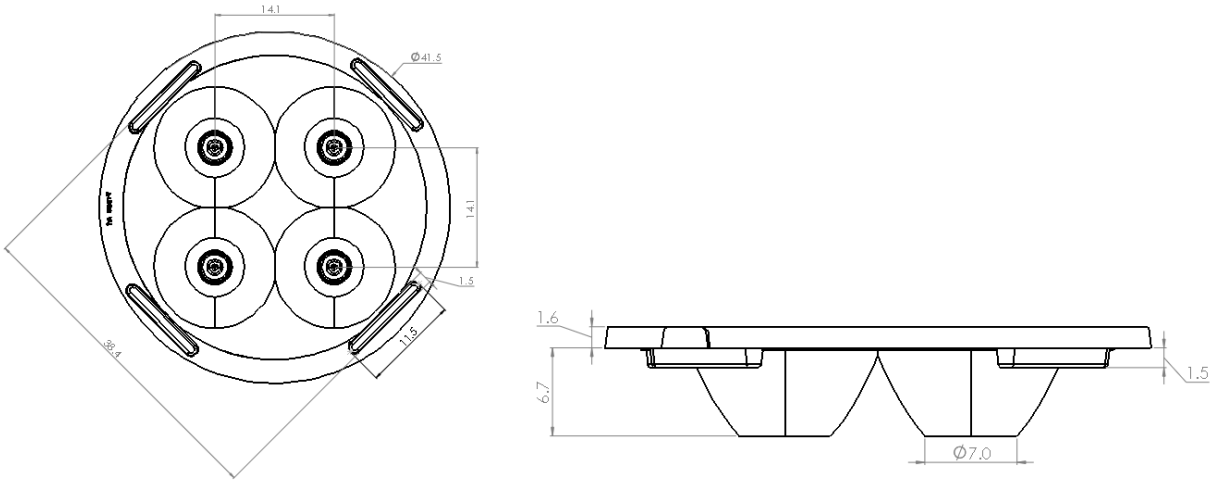
Beam and Field Angles are methods of describing the light distribution of a lens. The Beam Angle is expressed as a FWHM value (Full angular Width of the beam where it reaches Half the Maximum intensity). The Field Angle is a similar concept, sometimes expressed as FW10%, and represents the Full Width angle where the beam reaches 10% of maximum intensity.

The FD4 lens in our example, above, has a Beam Angle of 14.5° and an on-axis intensity of 3132 cd. At ± 7.25° (half of 14.5°) the intensity will drop to half of 3132 or 1566 cd. The Field Angle for the FD4 is 30°. At ± 15° (half of 30°) the intensity should be 10% of 3132 or 313 cd.

Most lenses have Beam and Field Angles that are rotationally symmetrical about the center axis of the lens. Lenses with an elliptical beam profile or optics with specifically shaped beam profiles are the exception.

Intensity, illuminance, Beam and Field Angle are all important factors to be considered in a fixture design. Some applications may require specific ratios between the Beam and Field Angle values.

Mechanical Characteristics



All dimensions in millimeters

Figure 1: FD4 layout and dimensions

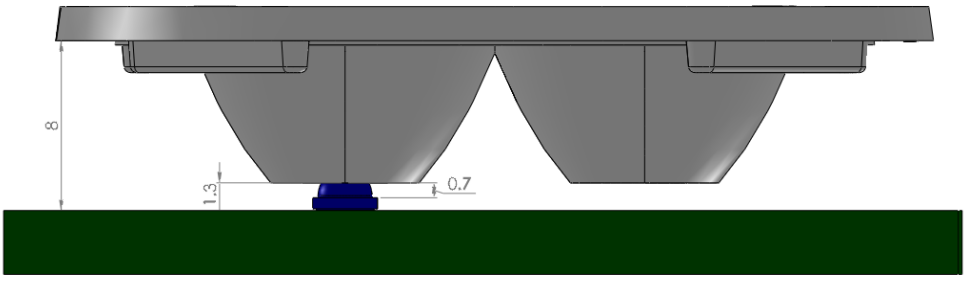


Figure 2: Optimal performance is realized when the FD4 is positioned 0.7mm above the LED package or 1.3mm (nominal) above the PCB plane.

Ordering Part Numbers

FD4-M1-RE-0 Medium Beam Quad-Lens