

Filter, reflect, and split light  
**White Paper**



Coated glass for use  
in trade, industry and science.  
For measuring, displaying, hardening  
and illuminating.

## Special glass to solve filter and light-bending problems

The ability to influence natural and artificial light radiation through optical filters depends on physical laws.

When using optical phenomena, the feasibility and accuracy of filtering, reflecting and splitting light are the result of glass-coating technology – perfected through many years of development work by PRINZ OPTICS.

The transparency of glass can thus be controlled in a targeted manner in the required wave-length region specific to the application. The region affected generally lies between 250 and 1600 nanometres.



Washing and drying system

Flat glass from 1.1 to 6.5 mm thickness in 1080 x 800 mm format (borosilicate glass, float glass) and smaller formats (silica glass, thin glass) can be coated by PRINZ OPTICS in a dip-coating procedure. This also applies to glass tubes with diameters from 30 to 300 mm and lengths of up to 750 mm.

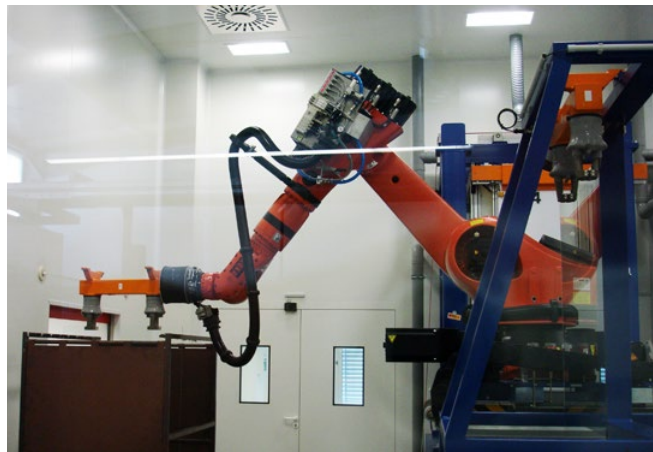
For delivery at short notice, standard products are available for standard applications that use filter technology. These filters are held in stock in stock dimensions of 1080 x 800 mm and cut to the required final format when ordered.



Charging the drawing chambers

Individual solutions are developed for special customer requirements. Both standard software for filter designs and our own calculation tools developed in-house are used for this. Even unusual projects can be managed in this way.

In dip coating, substrate glass is evenly coated by dipping and controlled withdrawal from sol dip baths (sol-gel dip procedure). Metal alcohol solutions are used for coating. During the subsequent thermal process, they are converted into highly adhesive metal-oxide layers and burned into the surface of the glass.



Charging the furnace bodies

PRINZ OPTICS has been using this nano-technological procedure to produce special dichroic glass for more than two decades, and during this time it has continually optimised the dip-coating procedure, developing it for numerous applications and problem solutions.

The wide range of possibilities offered by the vacuum-coating procedure supplement this special expertise of sol-gel dip coating.

## Areas of use in industry and science

### **In laser, measurement and control technology for**

- anti-reflection coatings on cover glass, primarily in laser applications from UV to NIR, such as in 3D printers,
- broadband anti-reflective coatings on display cases and inspection glasses,
- the filtering of excitation radiation for curing adhesives, varnishes and plastics, such as the material for dental prostheses.

### **In medical technology,**

- heat-absorbing filters are used to reduce the heat load in illuminated zones and
- conversion filters are required to achieve defined light properties in operating-theatre lights and illumination for microscopes and endoscopes.

### **In radiation technology,**

UV-blocking and UV-reflecting filters are used.

### **In showrooms,**

conversion filters are used for the optimal presentation of goods.

# 1. Filtering light radiation

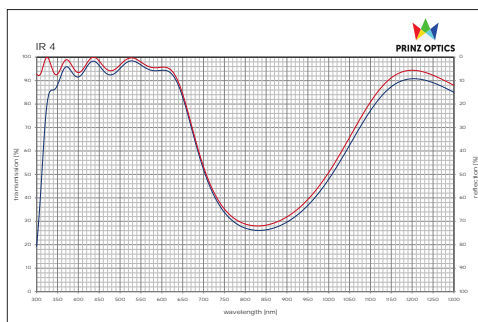
## 1.1 Heat-reflecting filters

Unwanted radiation frequencies of intensive light sources that lead to the heating of illuminated objects can be “switched off”. IR filters based on BOROFLOAT substrate remove radiation in the near infra-red region (NIR) from the spectrum.

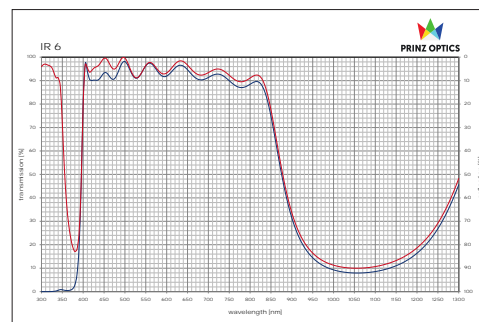
Suitable filter types are available for different light applications in the relevant position of the spectral transmission region.

To simulate the solar spectrum and standardised light when testing material ageing and stability, as well as to adjust measuring instruments:

Filter type **IR 4**

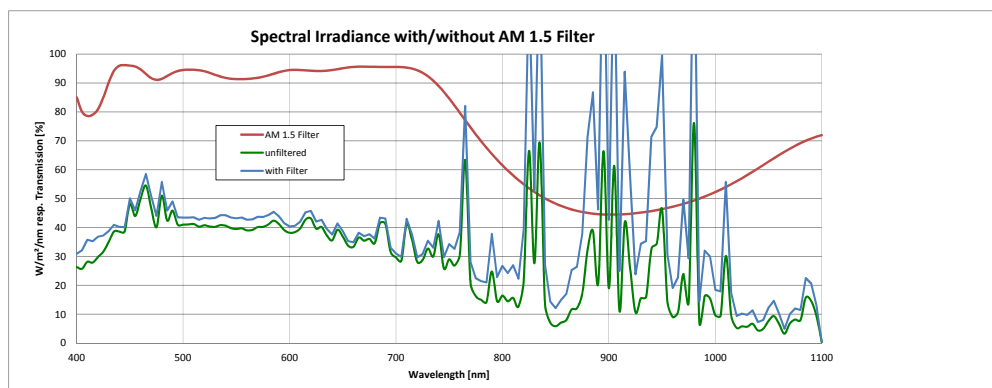


Filter type **IR 6**



## 1.2 The AM 1.5 filter

When measuring the efficiency of modules for photovoltaic systems, a spectrum that is almost equivalent to sunlight at a zenith angle of 48.2° is generated from xenon or HMI light sources:



	Setpoint	Actual	Deviation	IEC Class	Compensated	Residual Deviation	IEC Class
	IEC 60904	without Filter	Factor	without Filter	with AM 1.5 Filter	Factor	with Filter
400 - 500 nm	18,4	15,52	0,84	A	19,17	1,04	A+
500 - 600 nm	19,9	15,61	0,78	A	19,75	0,99	A+
600 - 700 nm	18,4	14,27	0,78	A	18,46	1,00	A+
700 - 800 nm	14,9	12,27	0,82	A	14,03	0,94	A+
800 - 900 nm	12,5	17,61	1,41	C	11,86	0,95	A+
900 - 1100 nm	15,9	24,71	1,55	C	16,72	1,05	A+

Example: AM 1.5 correction filter for the simulation of the solar spectrum, as used in materials testing or the quality testing of solar cells.



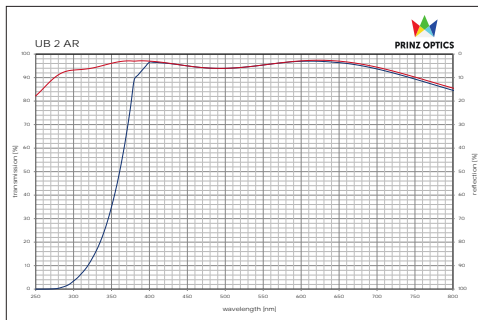
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### 1.3 UV blockers

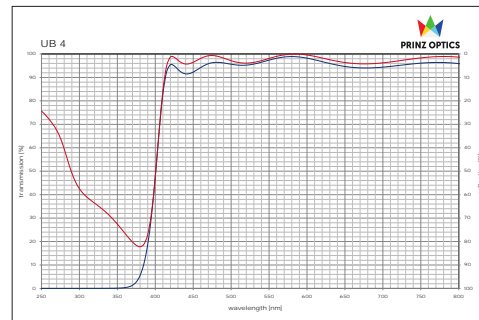
Light can cause damage: Varnishes and paints may fade. Plastics become brittle; paintings, drawings and prints suffer under the UV region of the spectrum.

UV radiation can be reliably blocked using

**UB2-AR**



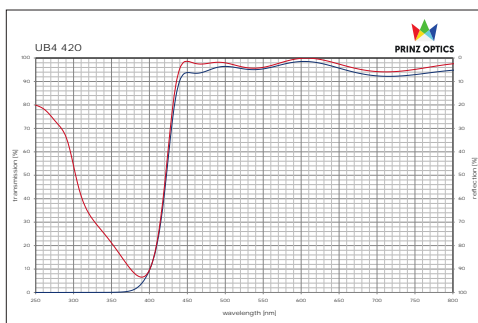
**UB4**



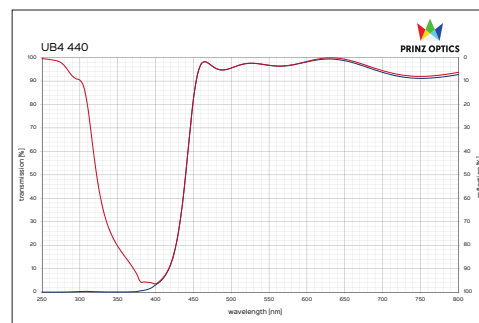
Particularly in discharge lamps with a high proportion of UV and blue light, filters with significant blue-light suppression prevent insects being irresistibly attracted by night-time lighting.

Suitable filters:

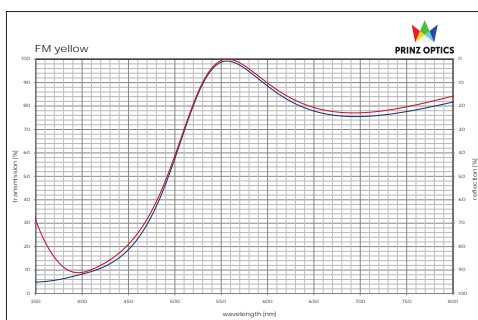
**UB4-420**



**UB4-440**



**FM yellow**

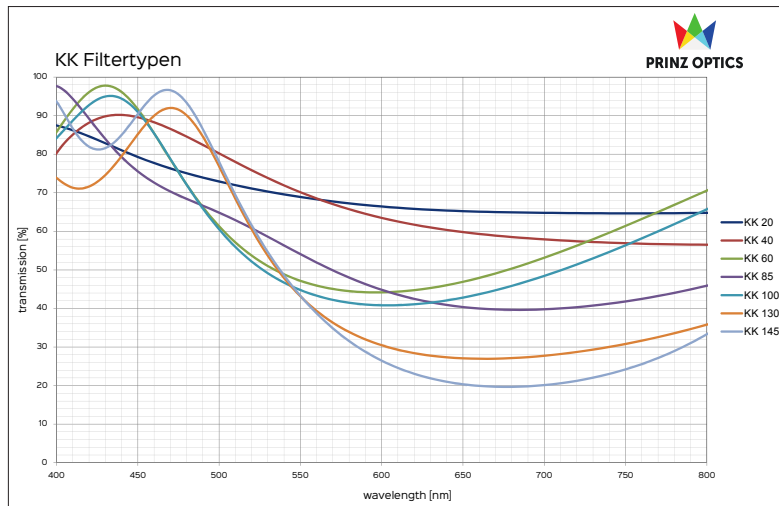




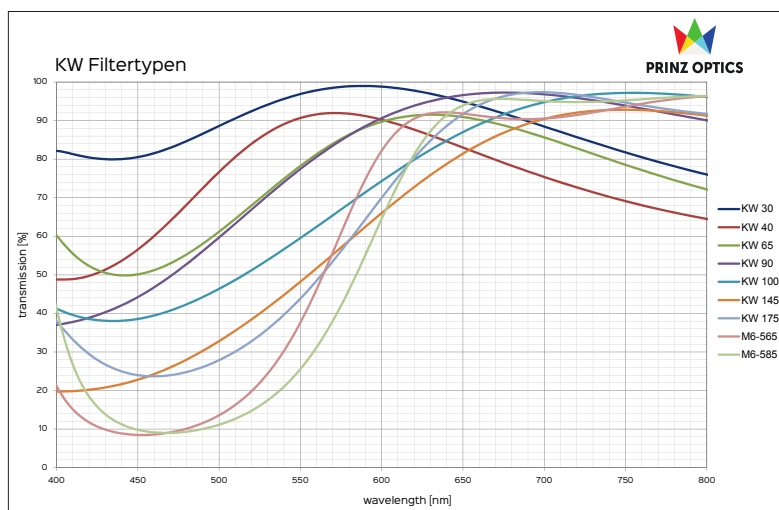
## 1.4 The conversion filters

Filter glass with a special distribution of the degree of transmission in the visible spectral range changes light properties by increasing or reducing the colour temperature of light sources. Using our KW filter types, it can be moved to lower values (warmer light colour, warm tone), and using KK types to higher values (bluish light colour, cold tone). In this way, defined light properties can be achieved, as required in operating-theatre lights as well as in illumination facilities in microscopy and endoscopy.

In showrooms, placing the goods in the “right light” may lead to a sale. Tailor-made correction filters are available for the presentation of goods in different product groups. Conversion filters provide the required colour temperature, particularly in the case of LED lighting, but also in the case of CDM-T, SDW-T and HMI light sources.



Example: conversion filters of the KK series



Example: conversion filters of the KW series



As there should not be any visible variance from colour neutrality caused by filtering when compared to an ideal light source with the required colour temperature, the lighting used (halogen spot lights, discharge lamps, LEDs) must be taken into account when designing the right filter.

**FE Pink**



**FE Green-3**



**M3-400**



**KW 90**



### **1.5 Colour-effect filters (FS, FE and FM filter types)**

only let through specific spectral regions of the incoming light; the rest is reflected back to the light source.

## 1.6 Anti-reflection coatings (AR-coatings)

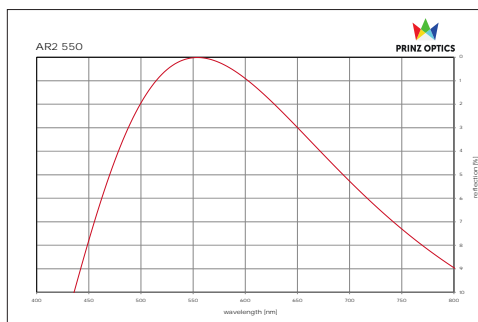
Anti-reflection coatings are used when the reflection prevents transparency of inspection glasses or displays, or impairs analysis in optical measuring systems. It often also depends on the losslessness when passing through cover glass, such as in projectors or in light sources and laser windows.

By mutually cancelling wave regions, the reflection that would otherwise occur without a coating, equaling approximately 4% per glass surface, is reduced to a harmless amount. As this anti-reflection coating can physically only work in a limited wave-length region, relevant standard types are used to reduce the reflection of the required wave regions: e.g. AR4 to reduce the reflection of the visible spectrum from 380 to 780 nm or AR2-1064 to reduce the reflection of protective glass for NdYAG lasers.

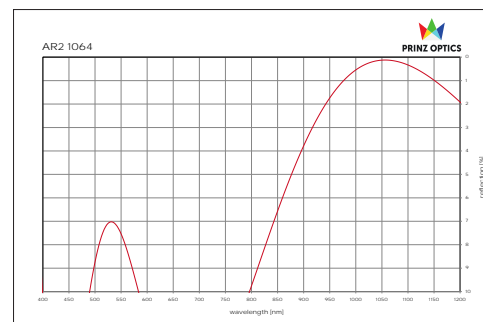
Anti-reflection coating systems can be applied to flat glass and glass tubes.

Filter type and reflexion:

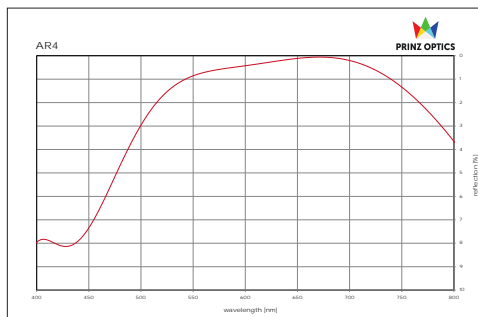
**AR2-550 < 0,5 % at 550 nmF**



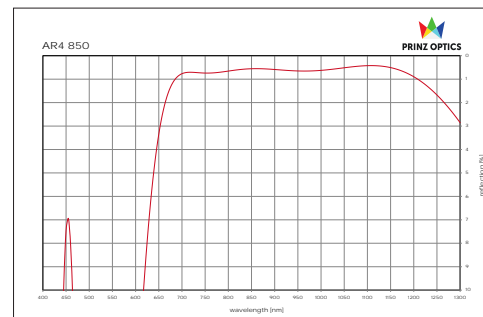
**AR2-1064 < 0,5 %**  
at the required 1064 nm wavelength



**AR4 < 1 % for  $\lambda = 450 \text{ nm} - 650 \text{ nm}$**



**AR4-850 < 1 % for  $\lambda = 650 \text{ nm} - 950 \text{ nm}$**

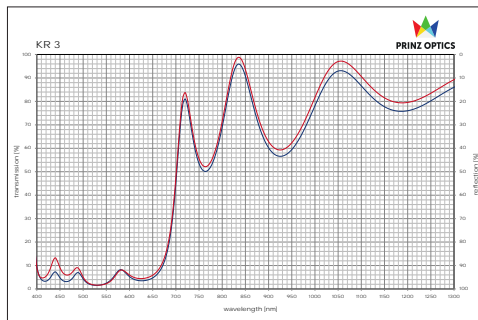


## 2. Reflecting light radiation

### 2.1 Cold light filter

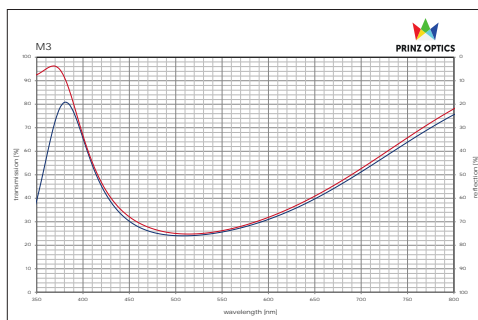
Reflecting visible light (VIS) while letting through thermal radiation (IR) reduces the temperature rise on the illuminated object. In the lighting arrangement, only the reflected portion is used and the transmitted portion remains in the lamp housing. Three versions of coated filters are available for separating the IR radiation:

**KR3**  $R_{\max} \geq 90\%$  at 420 – 650 nm

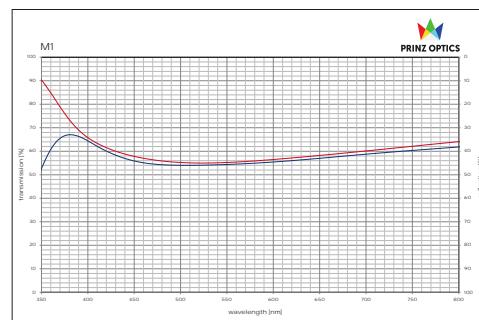


The filter versions with lower reflection/partial reflection or neutral reflection in the VIS range are also suitable for decorative purposes:

**M3**  $R_{\max} \geq 70\%$  at 450 – 600 nm



**M1**  $R_{\max} \geq 40\%$  at 400 – 650 nm





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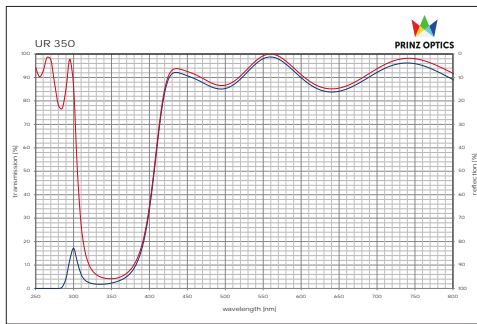
## 2.2 UV mirror

UV mirrors can be used to protect UV-sensitive materials. They are mainly indispensable, however, for accelerating curing and drying processes in adhesives and paints as well as in dentistry.

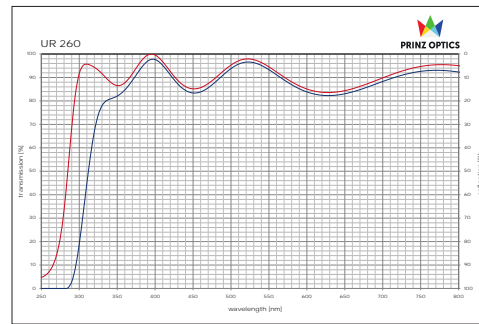
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Three filter versions are available:

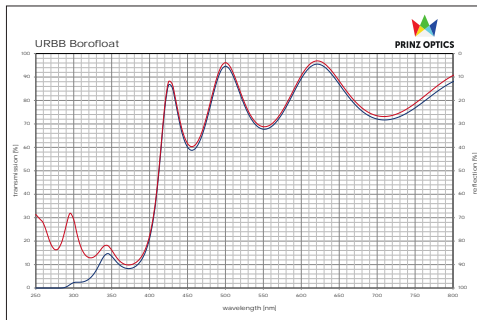
**UR 350-0**



**UR 260-0**



**URBB**



### 3. Splitting light radiation

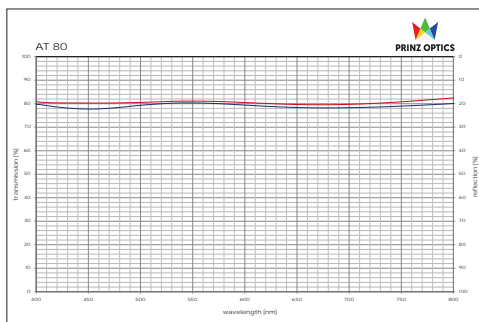
#### Splitter mirror/beam splitter

Splitter mirrors are mainly used for teleprompters, 3D filming and in metrology. They are also suitable for illumination purposes if the light output is to be reduced without colour distortion from dimming.

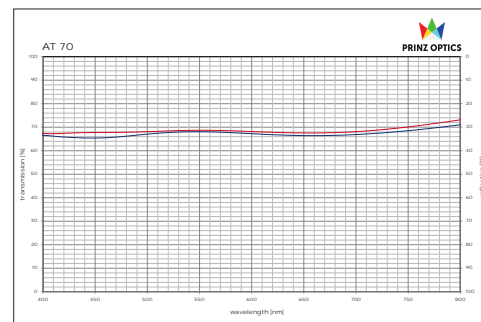
In the case of splitter mirrors, a colour-neutral part at 50, 60, 70 or 80 percent of the incoming light is transmitted in the visible wave-length region and the remainder is reflected. As the mirrors are generally fitted at below 45 degrees to the angle of incidence, splitter mirrors have an anti-reflective coating on the rear. This prevents ghost images in the reflection.

The available splitter mirrors differ in their respective ratio of transmitted to reflected radiation:

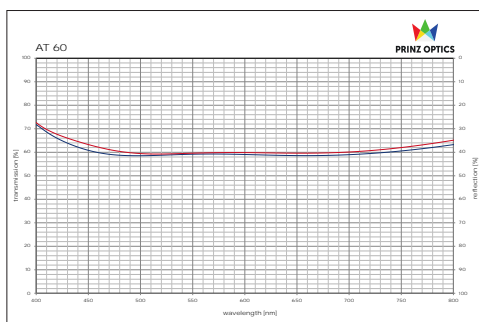
**AT80**



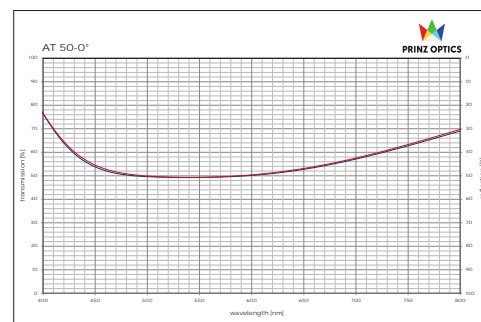
**AT70**



**AT60**



**AT50**





## Consultancy and services

In the case of questions on how to use coated glass and how to realise relevant projects, PRINZ OPTICS provides appropriate services: from photometric advice, optical measurements, the construction of models, and custom products to project management.



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