

Specification of Diffraction Orders and Efficiencies for Grating Regions

Abstract



For the simulation of AR & MR devices Virtual ab Fusion offers the Light Guide component. Grating regions can be defined on the surfaces of the light guide for coupling purposes. These regions are very flexible in their configuration: the shape of the region, its channels, the parameters of the grating and how many grating orders are to be traced through the system, as well as the method used to simulate the interaction of light with the grating, can all be adjusted at will by the user. In this use case we focus on the configuration of gratingrelated aspects: selecting which grating orders to simulate and the different mechanisms to determine their efficiencies (idealized or rigorous).

Modeling Task



- How to specify which diffraction orders generated by a given grating region are to be traced through the system in the simulation?
- How to employ the different methods available (idealized or rigorously modeled with FMM) to characterize the efficiencies of the grating orders?



System Construction



Region Definition



Initialization

- For illustration purposes, we work with a single plane interface, i.e., we just consider one surface of the light guide.
- Create a rectangular region on the plane interface by clicking on Add Region.
- Define a rectangular region with a size of 4×4 mm.



Selection of Grating Orders and Simulation

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Grating order definition

- Define an ideal linear grating with period of 1 µm (five propagating diffraction orders for 532 nm wavelength in fused silica).
- Under the tab Order Selection, follow default setting with All Orders at first.

• Run Rays in System and Field Tracing simulations.



Selection of Grating Orders and Simulation

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Shape Region Channels Grating	Graung order demnition
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Selection of Grating Orders and Simulation

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Add Order Remove Order To	Add Order Remove Order Tools 🖓 - Add Order Remove Current Order Del Reset OK Cancel Help
Vore useful tools are available for order settings.	Define Order Range Sort
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Grating order definition

- Next, select All but Specified Orders, here we also give e.g., the 0th and 1st transmission orders.
- Run *Rays in System* and *Field Tracing* simulations, then all orders except for the specified ones will be propagated.



Efficiency Settings for Idealized and Real Gratings

Idealized Grating Efficiency Settings

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© Constant Overall Transmission From Front Side Order Drag the slider to adjust the overall transmission- reflection efficiency, or type in the values. Validity: ●	 Run Rays in System and Field Tracing simulations. If "Cames Detector" (#80) site: "Waveguide" (#) (0) (Field Tacing) Commute Fields Set

Idealized Grating Efficiency Settings

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From Front Side Direction Order Number T (+/+) -1 R (+/-) +1 All orders will be traced in this simulation, but only these two	Edit Grating Region Shape Region Channels Grating ID-Periodic (Lamellar) 0 2D-Periodic Grating Period 1 µm Orientation (Rotation about z-Axis) 0° Order Selection Efficiencies Image: Constant Programmable Overall Transmission 80 % From Front Side From Back Side	• Efficiencies of u	tion in the set of th	nly distributed.
orders have specified efficiencies. Check this technol for more info	Order Efficiency T.1 75 % R+1 19 % E.g., h T(+1) Similar ogy whitepaper	Efficiency ord ere, $T(-1) = 75\%$, then = $(80\% - 75\%)/4$, and s by, $R(+1) = (20\% - 19\%)$	ers 19: "Camera Detector" (# 602) after "Wavechide" (# 1) (R) (Field Tracing) Chromatic Fields Set Data for Wavelength of 532 nm [(Data for Wavelength of 532 nm [(0 On)/2 Reflection orders	V/m) ²] +1 0.553 0.276 0.276 -1E-05

Programmable Efficiencies

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	<pre>44</pre>	orma
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Validity: 🗸	48 returnValue.Add(new Grating1DChannelInformation(orderNumber: new Vector(0, 0), e
	50 return returnValue;	
	51 #endregion 52 }	
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- The *Programmable* option for the efficiencies uses the same assumption as the *Constant* option (see previous slides) in order to establish the vectorial behavior on the basis of the efficiency values.
- However, the *Programmable* mode gives the user more flexibility to assign an efficiency value which can depend on other system parameters, like the wavelength, the incident plane-wave direction, and other user-defined global parameters.
- The *Edit* button opens the *Source Code Editor* to enter the corresponding snippet of code. It also comes with a validity indicator and other tabs where, for instance, additional parameters (in several data formats) can be declared for subsequent use in the code.

Real Grating Efficiency Settings

 It is also possible to define the real structure of the grating, so that the (vectorial) interaction of the light with the grating is rigorously calculated using the Fourier Modal Method (FMM), with the *From Real Gratings* option.

The orientation of the grating structure can also be selected. In case *On Back Side of Base Surface* is chosen, its coordinate system coincides with that of the interface.

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- After the simulation has been run once with the real grating, the calculated information of how that grating transforms the incoming field is automatically stored in a *Lookup Table* (LUT), so that the same (potentially numerically costly) simulation does not have to be repeated superfluously again.
- If any system parameters which can affect the grating response are modified (wavelength, plane-wave directions) the new information is added to the LUT when the simulation is run again.
- The calculated lookup table can be saved for later use in the same or in a different system where the same grating and configuration are employed.



Configuration of Real Grating Structure

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Grating definition

- Set up the default Sawtooth Grating with 1 µm modulation depth.
- Following the same mechanism, we also independently set up a *Sinusoidal Grating* with the same period and modulation depth, for comparison.



Field Tracing Simulation



Sawtooth grating shows asymmetry in diffraction efficiencies

Sinusoidal grating provides symmetric efficiencies around zeroth order

title	Specification of Diffraction Orders and Efficiencies for Grating Regions
document code	LIG.0003
version	1.0
VL version used for simulations	VirtualLab Fusion Advanced 2021.1 (Build 1.180)
category	Feature Use Case
further reading	 Flexible Region Definition Configuration of Grating Structures by Using Special Media Configuration of Grating Structures by Using Interfaces