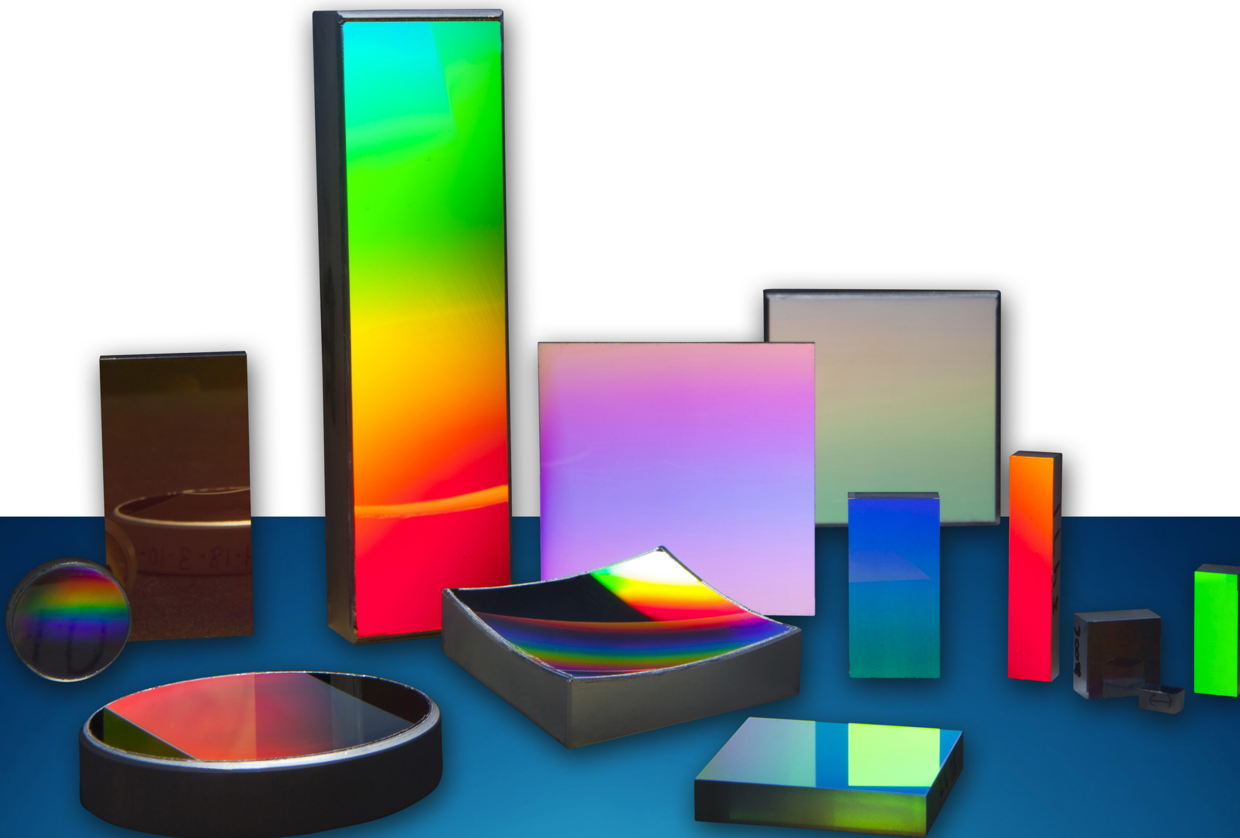
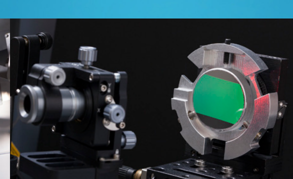
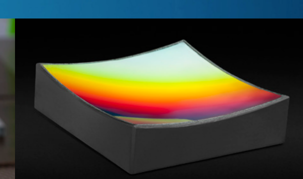
Diffraction Gratings Catalog

2021/2022

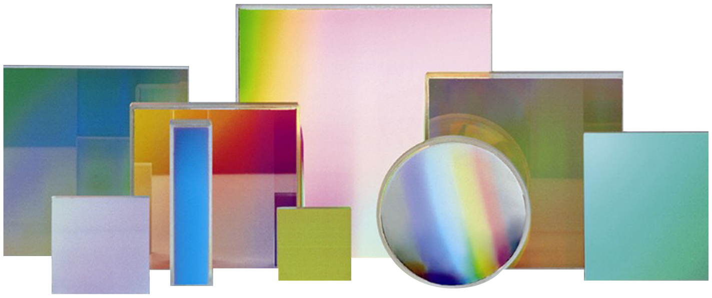








Richardson Gratings™ for OEM and Scientific Applications



Specializing in Diffraction Gratings for

- life science instrumentation
- analytical instrumentation
- optical systems manufacturers
- fiber-optic telecommunications
- lasers and tunable light sources
- scientific research

A Wide Variety of Diffraction Gratings

- plano & concave gratings
- ruled & holographic gratings
- reflection and transmission gratings
- echelle gratings
- aberration-reduced gratings
- blazed gratings
- dual-blaze gratings
- mosaic gratings
- grisms (grating prisms)

Product Consistency and Quality

- extensive optical metrology capabilities
- extensive use of SPC
- product certification and traceability
- quality system based on ISO 9001

Standard and Custom Capabilities

- custom mastering capabilities
- replication for high-volume production
- hundreds of master gratings
- plano, concave and convex gratings
- from 30 to 5880 grooves/mm
- from 2 x 2 mm to 320 x 420 mm
- several reflective coatings available
- various substrate materials
- grating and system design
- four ruling engines
- four holographic recording systems
- grating mounts and gratings masks
- Zemax and PCGrate simulations and optimizations
- precision grating saws

Flexible and Secure Delivery

- kanban arrangements
- blanket orders
- two production and testing facilities for risk mitigation
- off-site storage of critical tooling

Whether you need standard gratings or a customized solution, contact us today!

Founded in 1947, Richardson Gratings, a Newport™ Product Line, designs and manufactures standard and custom diffraction gratings for use in analytical instrumentation, lasers and tunable light sources, fiber optic telecommunications networks and photolithographic systems, as well as for researchers, astronomers and educators.

mks | Newport™

Table of Contents

The catalog number system

All standard Richardson gratings have a catalog number according to the following format:

AA BBB CC DD - EEE x

- The 1st and 2nd characters **AA** are numerals that indicate the type of grating (e.g., plano, concave, grism).
- The 3rd, 4th and 5th characters **BBB** are numerals that indicate the size of the grating substrate.
- The 6th and 7th characters **CC** are letters that indicate the substrate material.
- The 8th and 9th characters **DD** are numerals that indicate the type of coating (e.g., aluminium, gold).
- The 10th, 11th and 12th characters **EEE** serve to identify the groove frequency, blaze angle, and blaze wavelength (and, in the case of concave gratings, the substrate radius as well).
- The last character **x** indicates the type of grating: 'C' for concave holographic, 'D' for concave ruled, 'E' for echelle, 'H' for plane holographic and 'R' for plane ruled.

The type codes **AA** are given below:

33	**Diced**
43	**Wedged**
52	**Concave**
53	**Plano**
54	**Plano transmission**
63	**Score and Snap**
65	**Grism**

The substrate material codes **CC** are given below:

AL	**aluminum**
BF	**borosilicate float or equivalent**
BK	**BK-7 glass or equivalent**
CU	**copper**
FL	**float glass**
FS	**fused silica or equivalent**
LE	**low-expansion glass**
SP	**special glass (unspecified)**
TB	**BK-7, transmission grade**
TF	**fused silica, transmission grade**
UL	**Corning ULE® glass**
ZD	**Schott Zerodur®**

The coating material codes **DD** are given below:

01	**aluminum**
02	**gold**
03	**aluminum with MgF_2**
06	**protected silver**
07	**transmission**

Example **53004BK01–010R**

53 ‹	Plano grating
004 ‹	30 x 30 x 10 mm substrate dimensions, 26 x 26 mm ruled area
BK ‹	BK-7 substrate material
01 ‹	Aluminum coating
010 ‹	600 g/mm 5.2° blaze angle
R ‹	Ruled

Example **53015FS02–200H**

53 ‹	Plano grating
015 ‹	110 x 110 x 16 mm substrate dimensions, 102 x 102 mm ruled area
FS ‹	Fused silica substrate material
02 ‹	Gold coating
200 ‹	1200 g/mm blazed at 250 nm
H ‹	Holographic

Example **53028ZD06–414E**

53 ‹	Plano grating
028 ‹	165 x 220 x 35 mm substrate dimensions, 154 x 206 mm ruled area
ZD ‹	Schott Zerodur® substrate material
06 ‹	Protected silver
414 ‹	31.6 g/mm, 76° blaze angle
E ‹	Echelle

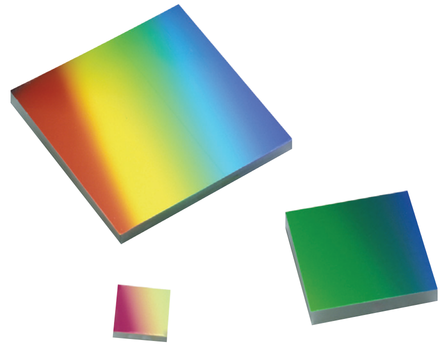
Example **52027BK03–010H**

52 ‹	Concave grating
027 ‹	32 x 32 mm substrate dimensions, 30 x 30 ruled area
BK ‹	BK-7 substrate material
03 ‹	Aluminium with MgF_2
010 ‹	1200g/mm, constant-deviation grating, blazed at 250nm
H ‹	Holographic

Custom coatings and substrates may be available upon request.

Organization of the product listings

Gratings are listed in the Catalog in fourteen (14) tables:



Plane Gratings

Table T1 Plane holographics reflection gratings

Table T2 Plane ruled reflection gratings

Table T3 Echelle gratings

Table T4 Plane transmission gratings

Concave Gratings

Table T6 Concave holographic reflection gratings for Flat-Field Spectrographs

Table T7 Concave holographic reflection gratings for Rowland Circle Spectrographs

Table T8 Concave holographic reflection gratings for Constant-Deviation Monochromators

Table T9 Concave ruled reflection gratings for Rowland Circle Spectrographs

By Application

Table A1 UV/Vis gratings

Table A2 Fiber optic telecommunication gratings

Table A3 Dye laser tuning gratings

Table A4 Molecular laser tuning gratings

Table A5 Large astronomical gratings

Table A6 Pulse compression gratings

Within each table, gratings are organized as follows:

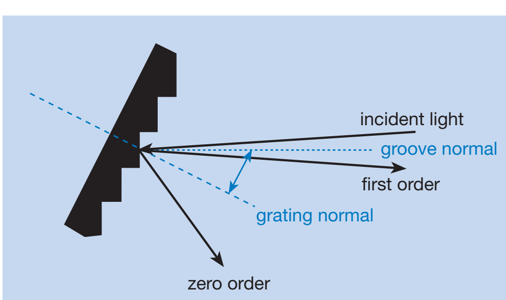
- Plane gratings are listed in order of groove frequency, with the lowest blaze angle listed first.
- Ruled concave gratings are listed in order of substrate radius, with the lowest blaze wavelength listed first.
- Concave holographic gratings are listed in order of groove frequency.

Catalog Number	Grooves per mm	Nominal Blaze Wavelength 1st Order (Littrow)	Nominal Blaze Angle	Maximum* Ruled Area (HxW, mm)
53-*-006	5880	138 nm	24.0°	30 x 45
53-*-911	4968	131 nm	19.0°	90 x 140

Catalog Number	Concave Radius (mm)	Grooves per mm	Nom First (Littr Blaz
52-04-*-440 (T)	115.0	600	427
52-02-*-410	390.0	600	180

Catalog Number	Grooves per mm	Substrate Radius (mm)	Imaging Range mĭ$_1$, mĭ$_2$ (nm)	RLD (nm/mm)
82-22-*-028H	200	152.4	290-1020	32.3
82-18-*-018H	233.9	131.53	190-400	33.0

In all cases except for concave holographic gratings, blaze wavelengths listed are for the first-order Littrow configuration. (The Littrow configuration is that in which the grating diffracts light back along the incident beam.)



Grating used in first order near Littrow.

Pro Tip

Dispersion is the phenomenon in which light is separated by wavelength in space. Gratings disperse light by directing different wavelengths into different directions according to the well-known grating equation.

Types of diffraction gratings

There are two fundamental types of grating masters: ruled and holographic.
Each can be on a flat (plane) or concave substrate. Each type of grating has its own advantages.

Ruled gratings can be blazed for specific wave lengths and generally have high efficiency. These gratings are often used in systems requiring high resolution.

Holographic gratings will often have lower scatter since they are generated optically. These gratings can be designed to minimize aberrations and can have high efficiency in a single plane of polarization.

Plane gratings

For a plane blazed grating, the groove spacing and blaze angle determine the distribution of energy. The blaze direction for most gratings is specified for first order Littrow use. In Littrow use, light is diffracted from the grating back toward the source. Gratings used in the Littrow configuration have the advantage of maximum efficiency, or blaze, at specific wavelengths.

Concave gratings

In analytical instrumentation, concave gratings are often used for the spectral region below 250 nm. Concave gratings are also used frequently between 120 and 400 nm, functioning as both the dispersing and focusing element for spectrographs as well as monochromators. Concave holographic gratings make possible short radii gratings with low $f/\#$ and flat-field imaging suitable for array spectrographs. An integral part of the system design, these gratings are frequently manufactured to specific requirements. Please see our Concave Grating Design Sheet in Appendix C for a list of standard design parameters.

Echelle gratings

Echelles are coarse, high-blaze angle gratings that are used in high diffraction orders. Providing very high dispersion and resolution echelles allow for compact system design. Some type of order separation is essential, with cross-dispersion provided by a prism or another grating. Echelle systems often focus an image on a flat plane compatible with CCD or CID detectors.

Large astronomical gratings

Large astronomical gratings have ruled areas from 128 x 254 mm to 304 x 406 mm. Individual gratings can be optically aligned and replicated onto a monolithic substrate to produce extremely large "mosaic" gratings.

Pro Tip

*A **blaze arrow** on a grating indicates its preferred orientation to maximize the intensity of light diffracted from it. See our Diffraction Grating Handbook for a detailed explanation.*

Holographic gratings

Holographic gratings normally have a sinusoidal groove shape, created by recording interference fringe fields in photoresist material. Since the grooves are symmetric, they do not have a preferred blaze direction. The range of useful diffraction efficiency is controlled by varying the modulation (the ratio of groove depth to groove spacing). The lower the modulation, the shorter the wavelength limit to which the grating can be used, but the peak efficiency may be lowered as well. We have found that three modulation levels are adequate for nearly all purposes. Additionally, holographic gratings contain no periodic errors or "ghosts" as they are generated optically.

Blazed holographic gratings

Sheridon gratings

In addition to sinusoidal grooves, it is possible to make asymmetric groove structures in photoresist by recording fringe fields inclined at a small angle with respect to the resist layer. This Sheridon method leads to blaze performance very similar to a ruled grating. However, these gratings are restricted to blaze peaks near 250 nm, and they have the same low stray light performance as gratings with sinusoidal grooves.

Ion-etched gratings

Gratings can also be blazed by bombarding their grooves with a beam of ions. This ion etching process changes the groove profile from sinusoidal to triangular, which can in certain cases increase the peak efficiency of the grating.

Laser tuning gratings

Diode and dye laser tuning gratings

Dye laser wavelength tuning, in the visible region of the spectrum, is done in two different modes. The classical one is with a grating in the autocollimating (Littrow) mount where the beam requires expansion to fill the grating in order to obtain adequate resolution. Telescope or prism optics fulfill this need. The alternative approach is to use the grating in a fixed grazing incidence mode together with a rotating reflecting tuning element in the form of either a mirror or a second grating.

Littrow tuning is done either with fine pitch, first order gratings (typically 1800 or 2400 g/mm frequency, either ruled or holographic) or a coarser grating used in higher orders. For the latter, a 600 g/mm, 54° blaze angle grating is particularly useful because it covers the visible spectrum in orders 3 to 7 with free spectral ranges that match the dyes and prevent overlap.

Grazing incidence tuning is done in first order only and 1800 g/mm, 2000 g/mm, and 2400 g/mm holographic gratings are preferred. The gratings have their ruled width filled by incidence angles of 80° to 88°.

Steep angle usage leads to special grating dimensions such as 16.5 x 58 x 10 mm.

Gratings for this application are listed in Table 8.

Pulse compression gratings

Gratings used for pulse compression of lasers generally require a diffracted wavefront free of aberrations as well as high diffraction efficiency. Several of our gratings, both ruled and holographic, can be used for pulse compression at wavelengths of 800 nm, 1.06 µm, 1.3 µm, 1.5 µm, etc. The groove frequencies most commonly used are 300 g/mm, 600 g/mm, 1200 g/mm and 1800 g/mm. Newport Corporation is continually developing new gratings, so please contact us if you have a question regarding the best grating for your particular application.

Molecular laser tuning gratings

Molecular lasers, operating both pulsed and continuous-wave (cw) in the infrared, typically have their output wavelength tuned by Littrow-mounted gratings. High efficiency is obtained by operating in the first order at diffraction angles >20°. This corresponds to λ/d ratios from 0.67 to 1.8 (where d is the groove spacing), which ensures that only the zero and first orders can diffract. The output will be polarized in the S-plane (i.e., with the electric vector perpendicular to the grooves) because the efficiency will be several times greater than in the P-plane (electric vector parallel to the grooves).

Dispersion is a function of the tangent of the diffraction angle β and is chosen from medium ($\beta \approx 20°$) to very high ($\beta > 50°$) as required. Note from Table 9, which summarizes gratings most suitable for this application, that high efficiency corresponds to diffraction angles that can be significantly greater than the groove or blaze angles. This is a consequence of the electromagnetic nature of diffraction from deep groove gratings. For maximum efficiency, any of these gratings can be supplied in the form of gold replicas.

Some molecular lasers operate at high power, capable of destroying gratings. In the case of pulsed lasers, extra thick replica films may be of help. In the case of cw lasers, replicas on metal substrates are superior to glass because of greater thermal conductivity; in some cases it is advisable to use water cooled substrates. In all cases, close attention to groove geometry maximizes reflection, minimizes absorption, and leads to improved grating performance.

The table at right serves as a guide to the typical power levels a grating can be expected to survive.

There are a number of masters available which are used to produce replicas with high S-plane efficiency for use with CO_2, CO, HF, or DF lasers (see Table A4). For this type of application, we suggest you advise us of the following specifications:

Spectral region of interest
Peak power
Pulse duration
Beam size

Transmission gratings

Transmission gratings (Tables T4 and T5) can be made from any low or medium blaze angle grating in the catalog. Special-quality substrates have anti-reflection coatings on the back face to reduce light loss and internal reflections. Geometrical optics considerations require relatively coarse spacings (no more than 600 g/mm). Finer grating pitches are possible, but at sharply reduced efficiencies.

For transmissions gratings, the blaze angle is defined to be the angle at which a normally incident beam at the blaze wavelength is diffracted. It is not equal to the groove angle (which is given in Tables T4 and T5).

Grisms (grating prisms)

Transmission gratings may be replicated onto the face of a prism (to form a *grism*), which produces a straight-through spectrum, undeviated at one central wavelength. In such cases the groove angle is often chosen to be approximately equal to the prism angle.

For a thorough treatment of grism equations, see W. A. Traub, *Journal of the Optical Society of America A*, Volume 7, September 1990, page 1779.

Grating damage thresholds

Since the applications in which gratings are used vary widely, we do not certify damage threshold figures. Instead, we offer the following general thresholds, which have been determined by independent researchers and published in the open literature:

Grating damage thresholds

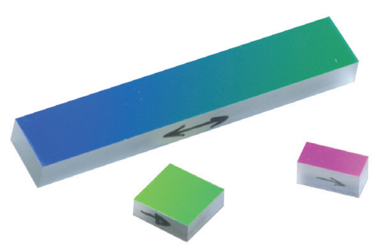
Pulsed lasers at 1.06 µm

Standard gold replica gratings can withstand 300 mJ/cm²
pulses of 100 ps duration.

Cw lasers at 10 µm

Standard gold replica on copper	100 W/cm²
Water-cooled gold replica on copper	200 W/cm²

For more information on gratings and their uses, request a hardcopy of the latest edition of our **Diffraction Grating Handbook** at **http://www.gratinglab.com**



Special requests

Newport is pleased to discuss special and unusual applications that are not addressed by our catalog items.

Special sizes and materials

In this catalog, we have listed the gratings and substrate sizes most frequently used, but you are not restricted to these sizes or materials. Gratings on special substrate sizes or materials are available upon request.

Special coatings

All reflection gratings listed in this catalog are priced to include a standard aluminum (Al) reflectance coating.

Gratings can also be replicated in gold (Au), or overcoated with magnesium fluoride (MgF_2) or silver (Ag), to enhance reflectivity in certain spectral regions.

Coating Material	Application
Gold (Au)	Offers higher reflectivity in the infrared.
Protected Silver (Ag)	Offers higher reflectivity in the visible and near infrared; silver is protected from tarnishing by a dielectric coating, which helps maintain reflection over time.
Magnesium Fluoride (MgF_2)	Used to prevent oxidation of aluminum (Al) coatings, which helps maintain high reflectivity in the ultraviolet over time.

Custom Master Gratings

In some instances, none of the hundreds of master gratings we have in stock meet specifications, so a new master may be required. Newport is capable of producing custom-designed ruled and holographic master gratings. Please contact us to discuss your application and specifications.

Our ruling engines and holographic recording chambers can produce master gratings to meet most any set of specifications. If you do not see a grating in this catalog that meets your requirements, please contact us to discuss a custom master grating.

Grating specifications

The information in the following paragraphs is provided to assist you in specifying your particular requirements for a special grating order. Please contact us with any questions or special requirements you may have.

Size

Grating size is usually dictated by the desired throughput, which is a function of the source and detector characteristics, the resolution of the optical system, and the required data-acquisition rate. This catalog lists the ruled area of each plane grating as the groove length followed by the ruled width (for example, 65 x 75 mm indicates a groove length of 65 mm and a ruled width of 75 mm).

The dimensions of the ruled area and the substrate may be altered from the regular catalog sizes at an additional cost. Special elongated grating shapes are available (e.g., for echelles and laser tuning gratings).

Substrate materials

The standard substrate material for small and medium-sized gratings is specially annealed borosilicate crown glass (BK-7). Low expansion material can be supplied on request. “Float” glass (plate glass) may be used for small, diced gratings. In addition, replicas may be furnished on metal substrates, such as copper or aluminum, for applications with extreme thermal conditions.

UV and IR enhancement

Aluminum (Al) is the standard reflection coating. Fast-fired aluminum with an over-coating of magnesium fluoride (MgF_2) can be used to enhance reflectivity in the region of 120-160 nm. For the extreme ultraviolet region, below 50 nm, gold (Au) replicas are recommended. Gold replicas also have higher reflectivity in the infrared spectrum.

Groove spacing

The angular dispersion of a grating for a given wavelength is a function of the angles of incidence and diffraction. Once these angles have been determined, the corresponding groove spacing becomes a function of the order in which the grating will operate. Most gratings are used in the first order, which reduces the effects of overlapping wavelengths and usually provides high efficiency over a wide range. Many systems, however, operate successfully in higher orders, although this usually requires order-sorting of some kind.

Blaze angle

The gratings in this catalog are listed with their blaze angles and corresponding first-order Littrow blaze wavelengths, even though a few high-blaze angle gratings are not intended for first-order use.

For practical reasons, blaze angles are usually chosen to favor the short end of the spectral region to be covered.

Grating efficiency

Efficiency behavior of diffraction gratings is one of the most important properties a user needs to know. Efficiency curves for most of the gratings in this catalog are available on-line at our web-site, www.gratinglab.com.

Efficiency of these gratings is represented as a function of wavelength with respect to a mirror. Separate data are obtained in both planes of polarized light in most cases. This is because efficiency behavior can vary significantly between light polarized with the electric vector perpendicular to the grooves (S-plane; solid lines) and that polarized parallel to the grooves (P-plane; dashed lines).

The differences in efficiency data for S- and P-plane incident light are due to electromagnetic interaction between light and a modulated metallic surface. If the incident light is completely unpolarized, the output efficiency is the arithmetic average of the S- and P-plane efficiencies. An example of our standard efficiency data is presented in Figure 1.

Grating efficiency is largely dependent on the blaze angle (if grooves are triangular) or of modulation depth (if they are sinusoidal in shape). Theoretical curves, which are conveniently plotted against a dimensionless ratio of wavelength to groove spacing (Ï/d), have been published in

E.G. Loewen *et al*., "Grating Efficiency Theory As It Applies To Blazed and Holographic Gratings," Applied Optics 16, 2711-2720 (1977).

A more complete variety of efficiency curves can be found in

Diffraction Gratings and Applications
E.G. Loewen and E. Popov
Marcel Dekker, Inc. (1997)
ISBN 0-8247-9923-2

Standard tolerances on gratings

The following standard tolerances apply to all gratings of thickness 10mm or greater:

1. Alignment of grooves to side of substrate (for rectangular substrates): ± 0.15º
2. Groove Spacing: < 0.05 %
3. Nominal Blaze Wavelength: ± 25 nm (first order, in Littrow) in most cases

In applications where the knowledge of the peak efficiency is critical, please contact us for a complete efficiency curve of the grating that interests you.

Standard tolerances on substrates

The following standard tolerances apply to all grating substrates:

1. Thickness of substrate: ± 0.5 mm
2. Length and width of substrate: ± 0.1 mm
3. Diameter of round substrate: ± 0.1 mm
4. Radius of concave gratings: ± 0.1%
5. Centering of ruled area on substrate: ± 1 mm

Please contact us if you require gratings whose specifications require tighter tolerances.

Pro Tip

Absolute efficiency *is defined as the ratio of light intensity diffracted into a given order at a given wavelength to the intensity of incident light at the same wavelength, whereas relative efficiency is the ratio of light intensity diffracted at a given wavelength into a given order to the light intensity reflected by a mirror coated with the same reflective material as the grating under test.*

Cleaning gratings

Contact with the ruled area of a grating will damage its groove structure. Dust should only be removed from the grating surface using filtered air. Fingerprints may occasionally be removed, but more often damage the groove structure.

Surface defects

Two types of surface defects may cause trouble and misunderstandings. One is inherent in the surface of the grating, the other is caused by handling.

The most common handling problem is careless removal or replacement of the plastic grating cover. If this is not done carefully, it is easy to scratch the soft, delicate aluminum film surface. It is important that all grating users carefully remove the tape that holds the edge of the cover in place and then slowly lift the cover. The cover should be replaced the same way.

Some gratings have visible surface defects. Many are cosmetic defects that can be seen with the naked eye, but do not adversely affect the performance of the grating. Also visible are occasional grooves on gratings that are ruled too lightly, known as ruling streaks. These ruling streaks do not affect the performance of the grating.

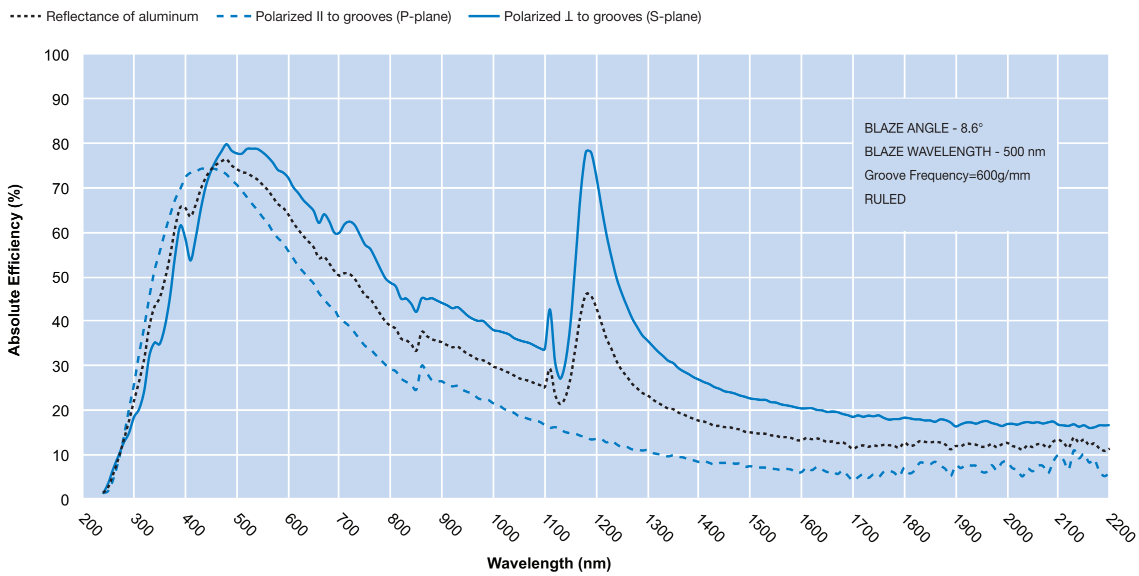
Pro Tip

Handling Gratings: *Never touch the optical surface of the grating, which can damage the surface beyond repair. When mounting the grating do not allow the clasps on the mount to contact the grating surface. Avoid breathing directly on or talking over the grooved surface, which can introduce cosmetic defects to the grating surface that may increase optical scatter.*

Grating Efficiency Curve

The following efficiency curve was measured from a plane aluminum coated replica grating with 8° between incident and diffracted beams (near-Littrow).

Figure 1



Efficiency curves for hundreds of Richardson Gratings can be viewed on-line at http://www.gratinglab.com

Pro Tip

Instrumental stray light*:* *Grating scatter is only one of the sources of instrument stray light in an optical system. See our Diffraction Grating Handbook for more information.*

Pro Tip

Holographic gratings *may have high average efficiency at a specific blaze wavelength or may have moderately high efficiency over a wider spectral range.*

Table T1 Plane Holographic Reflection Gratings

Catalog Number	**Grooves per mm**	**Recommended Spectral Region**	**Nominal Blaze Wavelength** (1st Order Littrow)	**Maximum Ruled Area** (Groove Length x Ruled Width, mm)
53-*-468H	4968	200 nm - 400 nm	370 nm	102 x 102
53-*-058H	4320	270 nm - 450 nm	350 nm	102 x 102
53-*-551H	4320	160 nm - 400 nm	275 nm	84 x 84
53-*-510H	3600	130 nm - 500 nm	200 nm	102 x 102
53-*-520H	3600	150 nm - 500 nm	250 nm	102 x 102
53-*-530H	3600	180 nm - 500 nm	300 nm	102 x 102
53-*-445H	2991	200 nm - 600 nm	270 nm	102 x 102
53-*-400H	2400	190 nm - 800 nm	250 nm	102 x 102
53-*-410H	2400	150 nm - 800 nm	250 nm	102 x 102
53-*-420H	2400	200 nm - 800 nm	270 nm	102 x 102
53-*-430H	2400	250 nm - 800 nm	300 nm	102 x 102
53-*-059H	2000	300 nm - 950 nm	475 nm	102 x 102
53-*-320H	1800	250 nm - 900 nm	450 nm	102 x 102
53-*-330H	1800	350 nm - 900 nm	500 nm	102 x 102
53-*-300H	1800	190 nm - 900 nm	250 nm	102 x 102
53-*-310H	1800	200 nm - 900 nm	300 nm	102 x 102
53-*-233H	1760	650 nm - 1.1 µm	550 nm	102 x 102
53-*-136H	1714	650 nm - 1.1 µm	550 nm	102 x 102
53-*-106H	1596	400 nm - 1.2 µm	770 nm	102 x 102
53-*-237H	1500	250 nm - 1.3 µm	510 nm	102 x 102
53-*-239H	1500	250 nm - 1.3 µm	600 nm	102 x 102
53-*-240H	1500	250 nm - 1.3 µm	460 nm	102 x 102
53-*-229H	1350	300 nm - 1.5 µm	650 nm	102 x 102
53-*-143H	1312	300 nm - 1.5 µm	650 nm	102 x 102
53-*-200H	1201.6	190 nm - 800 nm	250 nm	102 x 102
53-*-205H	1201.6	190 nm - 800 nm	210 nm	102 x 102
53-*-210H	1200	300 nm - 1.2 µm	450 nm	64 x 64
53-*-220H	1200	400 nm - 1.2 µm	700 nm	102 x 102
53-*-230H	1200	500 nm - 1.2 µm	800 nm	110 x 110
53-*-548H	1150	300 nm - 1.65 µm	620 nm	102 x 102
53-*-544H	1100	400 nm - 1.7 µm	900 nm	110 x 110
53-*-241H	1050	500 nm - 1.8 µm	600 nm	102 x 102
53-*-243H	1050	600 nm - 1.8 µm	800 nm	102 x 102
53-*-244H	1050	650 nm - 1.8 µm	900 nm	102 x 102
53-*-245H	1050	650 nm - 1.7 µm	1 µm	102 x 102
53-*-246H	1050	650 nm - 1.8 µm	1.1 µm	102 x 102
53-*-248H	1033	1.25 µm - 1.45 µm	1.45 µm	Φ70
53-*-253H	1033	1.25 µm - 1.45 µm	1.275 µm	Φ70
53-*-112H	1000	200 nm - 400 nm	230 nm	102 x 102
53-*-262H	950	500 nm - 1.75 µm	1 µm	102 x 102
53-*-268H	900	400 nm - 1.7 µm	800 nm	102 x 102
53-*-269H	900	400 nm - 1.7 µm	800 nm	102 x 102
53-*-175H	750	850 nm - 2.3 µm	1.2 µm	102 x 102
53-*-313H	600	200 nm - 700 nm	250 nm	102 x 102
53-*-302H	300	200 nm - 700 nm	230 nm	102 x 102
53-*-305H	150	200 nm - 700 nm	250 nm	62 x 62
53-*-471H	75	200 nm - 700 nm	270 nm	102 x 102
53-*-282H	30	200 nm - 700 nm	250 nm	102 x 102

Table T2 Plane Ruled Reflection Gratings

Catalog Number	Grooves per mm	Nominal Blaze Wavelength (1st Order Littrow)	Nominal Blaze Angle	Maximum Ruled Area (Groove Length x Ruled Width, mm)
53-*-006R	5880	138 nm	24°	30.5 x 45
53-*-911R	4968	131 nm	19°	90 x 140
53-*-115R	3600	104 nm	10.8°	52 x 52
53-*-160R	3600	130 nm	13.5°	102 x 102
53-*-170R	3600	240 nm	25.6°	64 x 64
53-*-021R	2700	259 nm	20°	102 x 34
53-*-196R	2400	29 nm	2°	26 x 26
53-*-190R	2400	150 nm	10.4°	102 x 102
53-*-150R	2400	240 nm	16.8°	102 x 102
53-*-240R	2400	300 nm	21°	102 x 102
53-*-151R	2200	226.2 nm	14.5°	54 x 54
53-*-102R	2160	173 nm	10.8°	64 x 64
53-*-140R	2160	200 nm	12.5°	102 x 102
53-*-040R	2160	300 nm	19°	102 x 128
53-*-300R	2160	500 nm	32.7°	128 x 154
53-*-195R	1800	180 nm	9.3°	52 x 52
53-*-061R	1800	250 nm	13°	52 x 52
53-*-289R	1800	400 nm	21.1°	102 x 102
53-*-290R	1800	500 nm	26.7°	102 x 102
53-*-128R	1714.3	650 nm	34°	102 x 102
53-*-285R	1700	530 nm	22.49°	102 x 102
53-*-164R	1649.5	375 nm	18°	102 x 102
53-*-118R	1600	200 nm	9.2°	102 x 30
53-*-070R	1500	250 nm	10.8°	52 x 52
53-*-176R	1350	675 nm	27.1°	75 x 96
53-*-188R	1201.6	250 nm	8.6°	102 x 102
53-*-101R	1200	29 nm	1°	50 x 52
53-*-034R	1200	43 nm	1.48°	30 x 50
53-*-130R	1200	120 nm	4.1°	65 x 76
53-*-120R	1200	150 nm	5.2°	154 x 206
53-*-020R	1200	200 nm	7°	154 x 206
53-*-060R	1200	250 nm	8.6°	154 x 206
53-*-030R	1200	300 nm	10.4°	154 x 206
53-*-330R	1200	400 nm	14°	102 x 128
53-*-254R	1200	450 nm	15.7°	155 x 208
53-*-047R	1200	450 nm	15.7°	102 x 102
53-*-280R	1200	500 nm	17.5°	154 x 206
53-*-340R	1200	600 nm	21°	204 x 306
53-*-360R	1200	750 nm	26.7°	154 x 206
53-*-361R	1200	850 nm	30.7°	102 x 102
53-*-067R	1200	900 nm	32.7°	154 x 206
53-*-530R	1200	1 µm	36.8°	154 x 206
53-*-531R	1200	1.1 µm	41.3°	156 x 206
53-*-546R	1200	1.1 µm	41.3°	70 x 79
53-*-540R	1200	1.2 µm	46°	154 x 206
53-*-105R	1000	250 nm	7.2°	102 x 102
53-*-701R	1000	900 nm	26.7°	102 x 102
53-*-148R	1000	1.31 µm	41°	102 x 102

Pro Tip

Ruled *gratings are chosen for high average efficiency at a specified blaze wavelength*

Table T2 Plane Ruled Reflection Gratings (continued)

Catalog Number	Grooves per mm	Nominal Blaze Wavelength (1st Order Littrow)	Nominal Blaze Angle	Maximum Ruled Area (Groove Length x Ruled Width, mm)
53-*-721R	984.6	140 nm	3.9°	52 x 52
53-*-462R	964	520 nm	14.6°	64 x 64
53-*-266R	900	550 nm	14.3°	154 x 206
53-*-155R	900	1.3 µm	35.8°	102 x 102
53-*-369R	830.77	900 nm	19.7°	156 x 206
53-*-035R	830	900 nm	21.4°	64 x 64
53-*-525R	830	1.2 µm	30°	154 x 206
53-*-274R	822.58	450 nm	10.7°	51 x 104
53-*-259R	768	425 nm	9.4°	102 x 104
53-*-252R	760	1.05 µm	23.5°	102 x 102
53-*-111R	720	2 µm	43.1°	156 x 206
53-*-051R	716.42	222 nm	4.7°	52 x 52
53-*-455R	700	530 nm	10.5°	104 x 102
53-*-727R	672	832 nm	16.1°	64 x 64
53-*-715R	664.3	3.6 µm	68.44°	64 x 64
53-*-720R	625	2.8 µm	61.2°	30 x 32
53-*-100R	600	120 nm	2°	102 x 102
53-*-110R	600	150 nm	2.6°	102 x 102
53-*-050R	600	250 nm	4.3°	102 x 128
53-*-010R	600	300 nm	5.2°	154 x 206
53-*-080R	600	400 nm	7°	154 x 206
53-*-260R	600	500 nm	8.6°	154 x 206
53-*-267R	600	650 nm	11.3°	154 x 206
53-*-350R	600	750 nm	13°	154 x 206
53-*-351R	600	800 nm	13.9°	154 x 206
53-*-520R	600	1 µm	17.5°	154 x 206
53-*-560R	600	1.2 µm	22°	154 x 206
53-*-550R	600	1.6 µm	28.7°	154 x 206
53-*-660R	600	1.85 µm	34°	154 x 206
53-*-132R	600	1.9 µm	34°	102 x 102
53-*-024R	600	2.16 µm	40.4°	102 x 102
53-*-258R	600	2.25 µm	42.5°	154 x 208
53-*-570R	600	2.5 µm	49°	154 x 206
53-*-466R	600	2.7 µm	54°	102 x 102
53-*-564R	590	240 nm	4°	102 x 102
53-*-264R	588	561 nm	9.5°	52 x 52
53-*-236R	534	2.75 µm	46.9°	35 x 45
53-*-069R	500	240 nm	3.4°	102 x 102
53-*-230R	500	330 nm	4.7°	102 x 102
53-*-246R	500	560 nm	8°	154 x 206
53-*-396R	500	770 nm	11.1°	102 x 102
53-*-055R	500	1.37 µm	20°	154 x 206
53-*-231R	497	2.25 µm	34°	102 x 102
53-*-341R	490.4	750 nm	10.6°	64 x 64
53-*-194R	450	1.8 µm	23.9°	102 x 102
53-*-168R	425.8	1.85 µm	23.2°	128 x 102
53-*-074R	424.2	2 µm	24°	104 x 102
53-*-676R	420	2.15 µm	26.7°	52 x 52

Table T2 Plane Ruled Reflection Gratings (continued)

Catalog Number	Grooves per mm	Nominal Blaze Wavelength (1st Order Littrow)	Nominal Blaze Angle	Maximum Ruled Area (Groove Length x Ruled Width, mm)
53-*-183R	400	250 nm	2.9°	104 x 102
53-*-586R	400	400 nm	4.5°	154 x 206
53-*-581R	400	550 nm	6.3°	102 x 128
53-*-580R	400	850 nm	9.7°	154 x 206
53-*-590R	400	1.2 µm	13.9°	154 x 206
53-*-600R	400	1.3 µm	15°	102 x 128
53-*-650R	400	1.6 µm	18.6°	154 x 206
53-*-162R	400	2.1 µm	24.8°	102 x 102
53-*-223R	384.6	520 nm	5.7°	102 x 102
53-*-222R	384.6	605 nm	6.7°	102 x 102
53-*-167R	361.2	2.35 µm	25.1°	130 x 102
53-*-496R	360	1 µm	10.4°	128 x 152
53-*-391R	360	1.74 µm	18.2°	64 x 64
53-*-775R	360	2 µm	21°	102 x 102
53-*-777R	360	2.9 µm	31.3°	64 x 64
53-*-778R	360	3.7 µm	42°	64 x 64
53-*-243R	345	3.6 µm	38.4°	102 x 102
53-*-321R	333	600 nm	5.7°	64 x 64
53-*-172R	300	280 nm	2.4°	104 x 102
53-*-090R	300	300 nm	2.5°	154 x 206
53-*-327R	300	325 nm	2.8°	102 x 102
53-*-091R	300	422 nm	3.6°	154 x 206
53-*-270R	300	500 nm	4.3°	154 x 206
53-*-204R	300	550 nm	4.7°	102 x 102
53-*-180R	300	760 nm	6.5°	102 x 128
53-*-220R	300	860 nm	7.4°	102 x 102
53-*-510R	300	1 µm	8.6°	204 x 306
53-*-640R	300	1.2 µm	10.4°	102 x 102
53-*-806R	300	1.7 µm	14.6°	102 x 128
53-*-770R	300	2 µm	17.5°	154 x 206
53-*-736R	300	2.5 µm	22°	102 x 102
53-*-039R	300	2.67 µm	23°	102 x 102
53-*-780R	300	3 µm	26.7°	154 x 206
53-*-800R	300	3.5 µm	31.6°	102 x 128
53-*-440R	300	4.3 µm	36.8°	154 x 206
53-*-013R	300	4.8 µm	46°	102 x 102
53-*-641R	293.53	1.3 µm	11.4°	64 x 64
53-*-166R	287.3	3.3 µm	28.1°	155 x 208
53-*-801R	287.2	1.9 µm	16.2°	64 x 64
53-*-154R	286.52	5 µm	46°	102 x 102
53-*-803R	285	3.8 µm	33.1°	102 x 102
53-*-169R	272.3	1.9 µm	15°	154 x 206
53-*-431R	260	2.7 µm	20.5°	64 x 64
53-*-126R	258	315 nm	2.4°	64 x 76
53-*-125R	250	1 µm	7.2°	64 x 64
53-*-203R	246.16	226 nm	1.6°	52 x 52
53-*-179R	245	4.85 µm	36.5°	158 x 208
53-*-107R	245	5 µm	38°	154 x 206

Table T2 Plane Ruled Reflection Gratings (continued)

Catalog Number	Grooves per mm	Nominal Blaze Wavelength (1st Order Littrow)	Nominal Blaze Angle	Maximum Ruled Area (Groove Length x Ruled Width, mm)
53-*-820R	240	3.75 µm	26.7°	90 x 102
53-*-825R	240	4.65 µm	34°	64 x 64
53-*-791R	236.8	1.35 µm	9.2°	52 x 52
53-*-789R	235.8	1.31 µm	9.25°	64 x 64
53-*-790R	235	750 nm	5.06°	64 x 64
53-*-796R	235	870 nm	5.9°	65 x 76
53-*-217R	223	2.45 µm	15.9°	212 x 410
53-*-001R	220	2.7 µm	17.5°	102 x 128
53-*-165R	219	4.4 µm	28.5°	129 x 104
53-*-866R	210	4.3 µm	26.7°	102 x 102
53-*-877R	210	5 µm	31.7°	154 x 190
53-*-346R	200	730 nm	4.2°	102 x 102
53-*-596R	200	1.05 µm	6°	102 x 102
53-*-633R	200	1.55 µm	8.95°	154 x 198
53-*-630R	200	1.7 µm	10°	102 x 102
53-*-636R	200	2.6 µm	15°	204 x 254
53-*-626R	200	3 µm	17.5°	52 x 52
53-*-103R	200	5 µm	29.8°	102 x 102
53-*-116R	180	150 nm	0.7°	52 x 52
53-*-870R	180	4.5 µm	23.9°	102 x 102
53-*-142R	175	7.6 µm	41.6°	154 x 206
53-*-104R	165	7.4 µm	37.9°	102 x 102
53-*-250R	158	400 nm	1.82°	134 x 178
53-*-400R	158	800 nm	3.6°	128 x 154
53-*-202R	150	300 nm	1.2°	102 x 102
53-*-201R	150	500 nm	2.2°	128 x 154
53-*-426R	150	800 nm	3.4°	154 x 206
53-*-501R	150	1.09 µm	4.7°	102 x 102
53-*-500R	150	1.25 µm	5.4°	154 x 206
53-*-349R	150	1.45 µm	6.2°	211 x 408
53-*-760R	150	2 µm	8.6°	154 x 206
53-*-810R	150	2.5 µm	10.8°	154 x 206
53-*-690R	150	3 µm	13°	154 x 206
53-*-860R	150	4 µm	17.5°	154 x 206
53-*-880R	150	6 µm	26.7°	154 x 206
53-*-890R	150	8 µm	36.8°	154 x 206
53-*-885R	135	7.4 µm	30°	64 x 64
53-*-616R	121.6	410 nm	1.44°	52 x 52
53-*-065R	120	330 nm	1.1°	102 x 102
53-*-625R	120	3.75 µm	13°	102 x 102
53-*-831R	120	7.5 µm	26.7°	65 x 76
53-*-746R	120	8.3 µm	30°	102 x 102
53-*-748R	120	13 µm	51.3°	64 x 64
53-*-019R	115	8.1 µm	27.8°	64 x 62
53-*-232R	115	10.4 µm	36.8°	154 x 206
53-*-138R	110.5	6.8 µm	22°	154 x 206
53-*-666R	110	253.8 nm	0.8°	102 x 102
53-*-876R	105	8.6 µm	26.7°	84 x 84

Pro Tip

Blaze Wavelength: *The blaze wavelength is generally defined as the wavelength for which the average diffraction efficiency in a given spectral order is a maximum.*

Table T2 Plane Ruled Reflection Gratings (continued)

Catalog Number	Grooves per mm	Nominal Blaze Wavelength (1st Order Littrow)	Nominal Blaze Angle	Maximum Ruled Area (Groove Length x Ruled Width, mm)
53-*-011R	100	780 nm	2.3°	102 x 102
53-*-108R	100	1.6 µm	4.6°	156 x 206
53-*-833R	100	2.5 µm	7.2°	102 x 102
53-*-886R	100	5.2 µm	15°	102 x 96
53-*-826R	100	6.5 µm	19°	64 x 64
53-*-830R	100	7.5 µm	22°	102 x 128
53-*-836R	100	8.1 µm	24°	44 x 50
53-*-970R	100	9 µm	26.7°	154 x 206
53-*-881R	97.5	4.2 µm	11.8°	102 x 102
53-*-829R	95.1	11.03 µm	32°	99 x 102
53-*-309R	90	1.9 µm	4.9°	212 x 408
53-*-686R	90	2.75 µm	7.1°	102 x 102
53-*-821R	90	6.7 µm	17.5°	64 x 64
53-*-036R	90	10 µm	26.7°	102 x 102
53-*-476R	86	950 nm	2.3°	65 x 76
53-*-754R	85	1.35 µm	3.2°	102 x 102
53-*-755R	85	2.14 µm	5.1°	84 x 84
53-*-480R	80	870 nm	2°	84 x 84
53-*-215R	80	4.25 µm	9.8°	204 x 408
53-*-005R	79.35	15 µm	35°	64 x 58
53-*-756R	75	1.7 µm	3.6°	102 x 102
53-*-750R	75	2 µm	4.3°	154 x 206
53-*-751R	75	2.5 µm	5.4°	154 x 206
53-*-740R	75	3 µm	6.5°	154 x 206
53-*-856R	75	4.65 µm	10°	102 x 102
53-*-950R	75	8 µm	17.5°	102 x 128
53-*-840R	75	10 µm	22°	154 x 206
53-*-960R	75	12 µm	26.7°	154 x 206
53-*-741R	70	3 µm	6°	64 x 64
53-*-064R	69.63	750 nm	1.49°	64 x 64
53-*-843R	61.97	10 µm	18.1°	84 x 84
53-*-129R	60	750 nm	1.26°	64 x 64
53-*-920R	60	16 µm	28.7°	154 x 206
53-*-921R	58	3.6 µm	6°	102 x 102
53-*-458R	56	19.45 µm	33°	204 x 410
53-*-235R	53	1.75 µm	2.7°	102 x 102
53-*-310R	50	600 nm	0.9°	128 x 206
53-*-850R	50	9 µm	13°	154 x 206
53-*-855R	50	11.5 µm	16.7°	91 x 102
53-*-937R	50	12 µm	17.5°	102 x 102
53-*-910R	50	18 µm	26.7°	154 x 206
53-*-946R	50	19.5 µm	29.2°	102 x 102
53-*-189R	46.1	19.6 µm	46.1°	102 x 87
53-*-131R	45	1.75 µm	2.22°	64 x 64
53-*-900R	45	20 µm	26.7°	52 x 52
53-*-457R	44.5	20.75 µm	27.5°	204 x 410
53-*-842R	41.85	10.6 µm	12.8°	84 x 84
53-*-811R	40.96	3.2 µm	3.7°	52 x 52

Table T2 Plane Ruled Reflection Gratings (continued)

Catalog Number	Grooves per mm	Nominal Blaze Wavelength (1st Order Littrow)	Nominal Blaze Angle	Maximum Ruled Area (Groove Length x Ruled Width, mm)
53-*-923R	40	4.8 µm	5.5°	154 x 190
53-*-932R	40	15 µm	17.5°	84 x 84
53-*-980R	40	22.5 µm	26.7°	154 x 206
53-*-904R	36.152	1.3 µm	1.4°	58 x 58
53-*-903R	36.152	3.25 µm	3.5°	58 x 58
53-*-902R	36.152	4.25 µm	4.5°	58 x 58
53-*-146R	36	10.1 µm	10.5°	154 x 206
53-*-906R	35	2.3 µm	2.3°	65 x 76
53-*-934R	35	9.2 µm	9.3°	64 x 64
53-*-033R	32	10 µm	9.21°	64 x 64
53-*-135R	31.7	6.8 µm	6.18°	154 x 206
53-*-922R	30.7	4.88 µm	4.3°	102 x 91
53-*-256R	30	800 nm	0.7°	102 x 102
53-*-606R	30	1.1 µm	1.2°	102 x 102
53-*-186R	30	2.1 µm	1.8°	102 x 102
53-*-933R	30	8 µm	6.9°	64 x 60
53-*-042R	30	9.53 µm	8.2°	64 x 64
53-*-931R	30	25 µm	20°	52 x 52
53-*-930R	30	30 µm	26.7°	102 x 128
53-*-936R	29.5	11.4 µm	9.7°	64 x 64
53-*-976R	25	36 µm	26.7°	52 x 52
53-*-123R	23.5	10 µm	6.75°	102 x 102
53-*-965R	22	25 µm	16°	102 x 102
53-*-841R	21.36	10.6 µm	6.5°	84 x 84
53-*-966R	21	28.6 µm	17.5°	64 x 64
53-*-956R	20	22.5 µm	13°	102 x 102
53-*-940R	20	45 µm	26.7°	102 x 102
53-*-944R	17.5	4.2 µm	2.1°	102 x 102
53-*-941R	14.3	4 µm	1.74°	52 x 52
53-*-942R	14.3	8 µm	3.33°	52 x 52
53-*-916R	12	6.8 µm	2.3°	65 x 76
53-*-156R	11.5	4 µm	1.3°	65 x 76
53-*-996R	7.9	112.5 µm	26.7°	154 x 206
53-*-145R	1.99	21.4 µm	1.2°	154 x 206

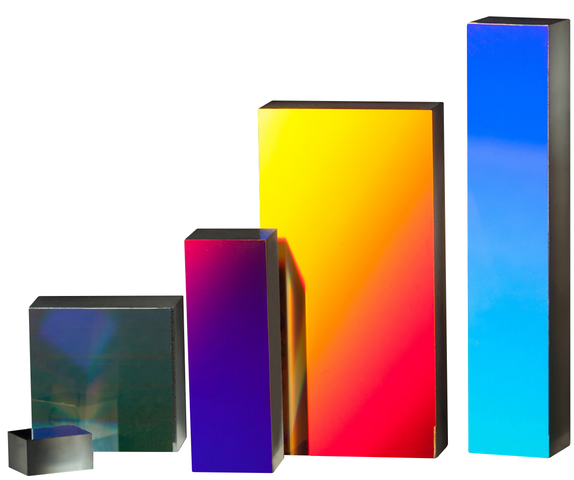


Table T3 Echelle Gratings

Catalog Number	Grooves per mm	Nominal Blaze Angle	Maximum Ruled Area (Groove Length x Ruled Width, mm)
53-*-182E	13.33	80.7°	198 x 412
53-*-412E	23.2	63°	154 x 306
53-*-419E	24.35	70°	97 x 102
53-*-413E	27	70°	64 x 153
53-*-411E	31.6	63.9°	204 x 408
53-*-453E	31.6	71°	308 x 408
53-*-414E	31.6	75°	154 x 313
53-*-303E	31.6	76°	310 x 413
53-*-174E	31.6	76°	200 x 400
53-*-428E	32.5	48.7°	102 x 102
53-*-425E	41.59	76°	204 x 410
53-*-418E	44.41	70°	101 x 103
53-*-407E	46.1	32°	102 x 102
53-*-275E	50.7	64.2°	154 x 306
53-*-422E	52.13	32°	102 x 102
53-*-415E	52.67	63.5°	128 x 254
53-*-424E	52.67	65°	204 x 410
53-*-417E	52.67	69°	204 x 408
53-*-053E	52.91	64°	102 x 102
53-*-416E	54.49	46°	102 x 102
53-*-153E	62	41.65°	154 x 184
53-*-454E	72	44°	95 x 90
53-*-408E	79	62°	210 x 411
53-*-401E	79	63°	204 x 408
53-*-402E	79	74°	128 x 254
53-*-406E	85.84	76°	128 x 254
53-*-127E	87	63°	308 x 413
53-*-291E	91.7	58.9°	154 x 208
53-*-488E	94.74	44°	104 x 104
53-*-304E	97.11	56°	102 x 102
53-*-403E	98.7	63°	154 x 206
53-*-002E	101.95	45°	100 x 100
53-*-121E	110	64°	310 x 413
53-*-071E	112.96	79°	128 x 258
53-*-084E	117.94	79°	128 x 258
53-*-187E	124.93	66°	154 x 206
53-*-141E	154.51	76°	128 x 260
53-*-404E	158	63°	127 x 203
53-*-405E	158	70°	128 x 256
53-*-420E	171.66	78°	102 x 102
53-*-149E	180	41.8°	154 x 206
53-*-451E	316	63°	204 x 408
53-*-452E	316	70°	128 x 256

Pro Tip

*Unlike conventional ruled gratings, **echelles** are coarse, high-blaze-angle gratings used in high diffraction orders. Echelles provide high diffraction efficiency in both polarization states. Providing very high dispersion and resolution, echelles enable compact system design.*

Table T4 Plane Transmission Gratings

Catalog Number	Grooves per mm	Nominal Blaze Wavelength (1st Order)	Nominal Groove Angle	Maximum Ruled Area (Groove Length x Ruled Width, mm)
54-*-111R	720	550 nm	43.1°	156 x 206
54-*-132R	600	540 nm	34°	102 x 102
54-*-550R	600	460 nm	28.7°	154 x 206
54-*-560R	600	400 nm	22°	154 x 206
54-*-660R	600	540 nm	34°	154 x 206
54-*-231R	497	650 nm	34°	102 x 102
54-*-676R	420	620 nm	26.7°	52 x 52
54-*-650R	400	460 nm	18.7°	154 x 206
54-*-391R	360	500 nm	18.2°	64 x 64
54-*-775R	360	580 nm	21°	102 x 102
54-*-770R	300	580 nm	17.45°	154 x 206
54-*-806R	300	490 nm	14.6°	102 x 128
54-*-736R	300	725 nm	22°	102 x 102
54-*-801R	287.2	560 nm	16.2°	64 x 64
54-*-630R	200	505 nm	10°	102 x 102
54-*-633R	200	450 nm	8.95°	154 x 206
54-*-760R	150	580 nm	8.6°	154 x 206
54-*-810R	150	725 nm	10.8°	154 x 206
54-*-108R	100	465 nm	4.6°	156 x 206
54-*-755R	85	610 nm	5.1°	102 x 102
54-*-756R	75	490 nm	3.65°	102 x 102
54-*-750R	75	580 nm	4.3°	154 x 206
54-*-751R	75	730 nm	5.43°	154 x 206
54-*-131R	45	500 nm	2.22°	64 x 64
54-*-906R	35	640 nm	2.2°	65 x 76
54-*-606R	30	405 nm	1.2°	102 x 102
54-*-596R	200	300 nm	6°	102 x 102
54-*-640R	300	350 nm	10.4°	102 x 102
54-*-560R	600	360 nm	22°	154 x 206
54-*-500R	150	365 nm	5.4°	154 x 206
54-*-600R	400	375 nm	15°	102 x 128
54-*-148R	1000	380 nm	41°	102 x 102
54-*-641R	293.53	390 nm	11.4°	64 x 64
54-*-791R	236.8	390 nm	9.2°	52 x 52
54-*-904R	36.152	390 nm	1.4°	135 x 168
54-*-789R	235.8	395 nm	9.25°	64 x 64
54-*-606R	30	405 nm	1.2°	102 x 102

Table T6 Concave Holographic Reflection Gratings for Flat-Field Spectrographs

Catalog Number	Grooves per mm	Imaging Range $m\lambda_1$, $m\lambda_2$ (nm)	RLD (nm/mm)	Entrance Slit r and α (mm, deg)	λ_1 focus r' and β (mm, deg)	λ_2 focus r' and β (mm, deg)	Input f/no	Ruled Area (Groove Length x Ruled Width, mm)	Substrate Size (mm)
52056BK-*-028C	200	290-1020	32.3	151, 5.0	153,2,-8.3	153,2,-17.0	3.5	ϕ44	ϕ50
52A16BK-*-307C	230	380-1080	31.2	137.4,- 5.73	138.3,10.8	134.5,20.4	2	ϕ68	ϕ70
52066BK-*-018C	233.9	190-400	33	148, 3.0	116-5.6	113,-8.4	2.5	ϕ60	ϕ63.5
52A15BK-*-224C	278.3	350-1050	30	88.0, 6.37	118.14, -12.02	111.13, -23.77	2.5	ϕ40	ϕ45
52067BK-*-040C†	282.7	190-545	14.5	235, -5.3	219, 8.4	228, 14.3	3.9	ϕ60	ϕ63.5
		545-900		252, 0.4			4.2		
52104BF-*-216C	310	470-680	33	100.9, -5.22	101, 13.7	101.7, 17.6	3.3	ϕ32	ϕ35
52A14BK-*-221C	367.43	200-800	25.7	88.00, 7.03	104.91, -11.29	97.90, -24.60	2.5	ϕ40	ϕ45
52A14BK-*-234C	367.43	200-850	25.7	88.00, 7.03	104.91, -11.29	97.90, -24.60	2.5	ϕ40	ϕ45
52A25BK-*-255C	400	380-730	83	30,-5.66	31.96, 14.52	34.19, 23	1.2	ϕ24	ϕ26
52097BK-*-207C	430	250-800	24.9	86.4, 6.0	88.6, -12.24	85.4, -26.6	2.9	ϕ35	ϕ37
52097BK-*-208C	430	450-850	24.9	86.4, 6.0	85.4, 17.3	83.6, 28.0	2.9	ϕ35	ϕ37
52097BK-*-209C	430	300-850	24.9	86.4, 6.0	86.1, 13.5	83.6, 28.0	2.9	ϕ35	ϕ37
52112BK-*-261C	432	190-840	26.15	86.4, 6.0	89.4, -10.7	85.4, -26.7	3.6	ϕ24	ϕ25
52107BK-*-214C	435.9	190-680	19.5	111.48, 5.5	111.64, -11.82	108.25, -22.45	2.2	ϕ51	ϕ55
52057BK-*-014C	435.9	190-400	19.5	109, -6.1	114, 10.9	113, 16.3	2.3	ϕ47	ϕ50.8
52066BK-*-001C	454.27	285-720	17	130, 11.3	130, -3.8	128, 7.36	2.2	ϕ58	ϕ63.5
52101BF-*-212C	477	200-850	31	86.9, -6.7	60.9, 12.2	70.3, 30.8	3.5	ϕ19	ϕ20
52101BK-*-211C	477	200-850	31	86.9, -6.7	60.9, 12.2	70.3, 30.8	3.5	ϕ19	ϕ20
52114BK-*-323C	489.87	200-800	24	77.36, 6.65	66.98, -12.35	78.0, -30.52	2.4	28 x 28	30 x 30
52099BK-*-317CL	580	340-800	16	98.2, 0.00	100.5, 11.37	100.8, 29.54	3.5	37 x 27	40 x 30
52129BK-*-358C	586.23	340-800	19.8	90.8, -10.78	74.9, 22.7	74.0, 41.0	3.2	28 x 28	37 x 37
52105BF-*-198C	660	340-805	10.1	112.5, 4.9	122.3, -18.0	133.7, -38.0	3	ϕ38	ϕ40
52034BK-*-004C	664	340-700	18	80, -13.3	80, 0.2	84, -13.6	2.7	ϕ29	ϕ32
52001BK-*-021C	792.8	380-780	4.5	231, 3.0	223, 14.4	258, 34.5	2.4	ϕ95	ϕ100
52140BK-*-279C	800	325-800	10.7	86.3, 0	85, 18.2	104.5, 43.82	2.7	28 x 28	30 x 30
52066BK-*-002C	813.5	380-705	9.5	130, 22.3	128, -4.0	129, 11.2	2.2	ϕ60	ϕ63.5
52049BK-*-012C	1300	340-650	7.8	94, -31.1	99, 4.3	97, -19.1	2.9	ϕ38	ϕ42
52064BK-*-008C	1803.8	753-784	1.2	345, 67.5	387, -25.8	394, -29.4	6.3	50 x 50	ϕ62.5
52071BK-*-007C	2197	277-313	1	575, 4.9	288, -43.9	296, -50.6	10.5	ϕ55	ϕ70

RLD - reciprocal linear dispersion

† This flat-field spectrograph grating is designed to produce two aberration-corrected spectra in the same place (using different entrance slit locations).

Pro Tip

Concave *holographic gratings function as both a dispersing and focusing element for monochromators and spectrographs. They can simplify instrumental design by eliminating the need for additional focusing elements. Concave holographic gratings can be designed to reduce aberrations over a wide spectral range to improve spectral resolution and instrumental light throughput*

Table T7 Concave Holographic Reflection Gratings for Rowland Circle Spectrographs

Catalog Number	Grooves per mm	Concave Radius (mm)	Recommended Spectral Region	Ruled Area (mm)	Substrate Size (mm)
52102BF-*-315C	390	350	300 nm-1 µm	⌀48	⌀50.8
52102BF-*-316C	390	350	300 nm-1 µm	⌀48	⌀50.8
52088BK-*-257C	678	83.7	200 nm-800 nm	⌀32	⌀38
52A02BF-*-356C	900	750	120 nm-500 nm	⌀75	⌀80
52011BK-*-003C	1200	498.1	300 nm-900 nm	⌀60	⌀63.5
52A02BF-*-556C	1500	750	120 nm-500 nm	⌀75	⌀80
52071BK-*-025C	1760	352	200 nm-1.1 µm	⌀65	⌀70
52017BK-*-009C	1800	750	250 nm-900 nm	⌀59	⌀63.5
52021BK-*-032C	2160	998.8	210 nm-350 nm	⌀59	⌀63.5
52017BK-*-247C	2400	750	200 nm-700 nm	⌀59	⌀63.5
52017BK-*-434C	2400	750	200 nm-700 nm	⌀60	⌀63.5
52017BK-*-482C	2400	750	150 nm-800 nm	⌀60	⌀63.5
52017BK-*-484C	2400	750	150 nm-800 nm	⌀60	⌀63.5
52A23BK-*-375C	2400	398.8	200 nm-700 nm	⌀33	⌀35
52017BK-*-520C	3600	750	150 nm-500 nm	⌀60	⌀63.5
52011BK-*-521C	3600	498.1	150 nm-500 nm	⌀60	⌀63.5
52011BK-*-530C	3600	498.1	180 nm-500 nm	⌀60	⌀63.5

Table T8 Concave Holographic Reflection Gratings for Constant-Deviation Monochromators

Catalog Number	Grooves per mm	Nominal Blaze Wavelength (1st Order Littrow)	Imaging Range $m\lambda_1$, $m\lambda_2$ (nm)	RLD (nm/mm)	Entrance Slit r (mm)	Exit Slit r' (mm)	Deviation angle 2K (deg)	Input f/no	Ruled Area (Groove Length x Ruled Width, mm)	Substrate Size (mm)
52073BK-*-037C	570	2 µm	1100-2500	10	203.9	184.1	38	2.4	⌀84	⌀90
52073BK-*-278C	1140	1 µm	550-1200	3	201	182.7	38	2.3	⌀84	⌀90
52094BK-*-096C	1198	300 nm	200-1000	7	105	100	34.7	2.5	38 x 38	42.4 x 42.4
52094BK-*-097C	1198	450 nm	350-1590	7	105	100	34.7	2.5	38 x 38	42.4 x 42.4
52094BK-*-098C	1198	375 nm	200-900	7	105	100	34.7	2.5	38 x 38	42.4 x 42.4
52105BK-*-226C	1200	250 nm	200-800	8.5	100	94	61.6	3.6	⌀36	⌀40
52111BK-*-228C	1200	350 nm	200-800	8.5	100	94	61.6	3.1	28 x 28	32 x 32
52085BF-*-246C	1200	250 nm	200-600	7	99.3	103.5	28	3.5	29 x 29	33 x 33
52085BF-*-251C	1200	250 nm	200-600	7	99.3	103.5	28	3.5	29 x 29	33 x 33
52085BF-*-364C	1200	225 nm	200-600	7	99.3	103.5	28	3.5	29 x 29	33 x 33
52085BF-*-433C	1200	225 nm	200-600	7	99.3	103.5	28	3.5	29 x 29	33 x 33
52027BK-*-006C	1200	200 nm	200-800	8.5	100	94	61.6	3.6	30 x 30	32 x 32
52057BK-*-020C	1200	450 nm	325-950	7	91.1	117.7	51.2	2.5	⌀47	⌀50.8
52057BK-*-022C	1200	350 nm	325-950	7	91.1	117.7	51.2	2.5	⌀47	⌀50.8
52057BK-*-238C	1200	275 nm	200-800	8.5	100	94	61.6	2.5	⌀45	⌀50.8
52052BF-*-023C	1350	250 nm	190-700	8	91.3	91.3	45	2.3	⌀40	⌀45
52093BK-*-095C	1500	250 nm	200-800	8	74.73	80	47.1	3.7	24 x 24	28 x 28

RLD - reciprocal linear dispersion

Table T9 Concave Ruled Reflection Gratings for Rowland Circle Spectrographs

Catalog Number	Grooves per mm	Concave Radius (mm)	Nominal Blaze Wavelength (1st Order Littrow)	Nominal Blaze Angle	Ruled Area (Groove Length x Ruled Width, mm)	Substrate Size (mm)
52000BK-*-800D (T)	2400	400.7	30 nm	2.2°	38 x 30	φ50.8
52000BK-*-700D	1281	400.7	70 nm	2.5°	38 x 30	φ50.8
52000BK-*-401D	600	400.7	80 nm	1.4°	38 x 30	φ50.8
52000BK-*-100D (T)	420	400.7	100 nm	1.2°	30 x 30	φ50.8
52000BK-*-400D (T)	600	400.7	100 nm	1.7°	38 x 30	φ50.8
52000BK-*-710D (B)	1200	400.7	103 nm	3.5°	38 x 30	φ50.8
52000BK-*-010D	75	400.7	120 nm	0.25°	32 x 30	φ50.8
52000BK-*-410D (T)	600	400.7	150 nm	2.5°	38 x 30	φ50.8
52000BK-*-720D	1200	400.7	206 nm	7.1°	38 x 30	φ50.8
52000BK-*-040D	133.6	400.7	546 nm	2.1°	38 x 30	φ50.8
52011BK-*-709D (T)	1200	498.1	70 nm	2.4°	50 x 30	φ63.5
52011BK-*-721D	2700	498.1	150 nm	11.7°	50 x 30	φ63.5
52011BK-*-411D (T)	600	498.1	150 nm	2.5°	50 x 30	φ63.5
52011BK-*-781D	1200	498.1	150 nm	5.2°	50 x 30	φ63.5
52011BK-*-761D	1200	498.1	200 nm	7°	50 x 30	φ63.5
52011BK-*-821D	2400	498.1	230 nm	16°	55 x 30	φ63.5
52011BK-*-725D	2700	498.1	230 nm	18.2°	50 x 30	φ63.5
52011BK-*-430D	600	498.1	350 nm	6°	46 x 35	φ63.5
52011BK-*-780D	1200	498.1	520 nm	18.2°	40 x 40	φ63.5
52011BK-*-041D	300	498.1	550 nm	4.7°	50 x 30	φ63.5
52011BK-*-441D	600	498.1	580 nm	10°	40 x 40	φ63.5
52011BK-*-750D	1200	498.1	600 nm	21.1°	50 x 30	φ63.5
52017BK-*-822D	2400	750	300 nm	21.1°	50 x 30	φ63.5
52017BK-*-645D	1071	750	483 nm	16°	45 x 35	φ63.5
52017BK-*-280D	1200	750	500 nm	17.5°	50 x 30	φ63.5
52015BK-*-652D	981.8	750	631 nm	18°	80 x 40	φ100
52015BK-*-680D (B)	85.6	750	3.17 µm	7.8°	46 x 60	φ100
52025BK-*-691D	1200	995.4	45 nm	1.5°	30 x 50	φ114.3
52025BK-*-702D (T)	1200	995.4	80 nm	2.7°	96 x 56	φ114.3
52025BK-*-812D	2400	995.4	80 nm	5.5°	60 x 60	φ114.3
52025BK-*-403D (T)	600	995.4	90 nm	1.5°	96 x 56	φ114.3
52025BK-*-784D	1200	995.4	120 nm	4.1°	96 x 56	φ114.3
52025BK-*-414D (T)	600	995.4	150 nm	2.5°	96 x 56	φ114.3
52025BK-*-706D	1200	995.4	150 nm	5.2°	96 x 56	φ114.3
52025BK-*-422D (B)	600	995.4	200 nm	3.4°	96 x 56	φ114.3
52025BK-*-763D	1200	995.4	250 nm	8.7°	96 x 56	φ114.3
52025BK-*-421D	600	995.4	300 nm	5.2°	96 x 56	φ114.3
52025BK-*-150D	300	995.4	700 nm	6°	96 x 56	φ114.3
52025BK-*-070D	300	995.4	1.5 µm	13°	96 x 56	φ114.3
52020BK-*-901D	3600	998.8	10 nm	1°	20 x 25	30 x 25
52020BK-*-801D	2160	998.8	16 nm	1°	20 x 25	30 x 25
52020BK-*-782D	1200	998.8	29 nm	1°	20 x 25	30 x 25
52020BK-*-810D	2160	998.8	48 nm	3°	20 x 25	30 x 25
52020BK-*-402D	600	998.8	58 nm	1°	20 x 20	30 x 25
52023BK-*-703D (T)	1200	998.8	60 nm	2°	50 x 40	φ100
52020BK-*-300D	576	998.8	61 nm	1°	24 x 20	25 x 30
52020BK-*-762D	1200	998.8	65 nm	2.3°	20 x 20	25 x 30
52021BK-*-802D	1440	998.8	75 nm	3.3°	50 x 30	φ63.5

(B) Bipartite Ruling (T) Tripartite Ruling

Table T9 Concave Ruled Reflection Gratings for Rowland Circle Spectrographs (continued)

Catalog Number	Grooves per mm	Concave Radius (mm)	Nominal Blaze Wavelength (1st Order Littrow)	Nominal Blaze Angle	Ruled Area (Groove Length x Ruled Width, mm)	Substrate Size (mm)
52021BK-*-811D	2400	998.8	80 nm	5.5°	50 x 30	φ63.5
52023BK-*-705D (T)	1200	998.8	80 nm	2.7°	80 x 40	φ100
52020BK-*-412D	600	998.8	120 nm	2°	20 x 25	30 x 25
52020BK-*-310D (T)	576	998.8	121 nm	2°	24 x 20	25 x 30
52020BK-*-320D	576.39	998.8	121 nm	2°	24 x 20	25 x 30
52021BK-*-783D	1200	998.8	150 nm	5.2°	50 x 30	φ63.5
52021BK-*-413D	600	998.8	160 nm	2.75°	50 x 30	φ63.5
52021BK-*-712D	2400	998.8	170 nm	11.8°	50 x 30	φ63.5
52023BK-*-178D	1200	998.8	170 nm	5.7°	80 x 40	φ100
52021BK-*-820D	2160	998.8	200 nm	12.5°	50 x 30	φ63.5
52058FS-*-825D	1440	998.8	200 nm	8.3°	40 x 24	φ50.8
52020BK-*-020D	300	998.8	233 nm	2°	20 x 25	30 x 25
52021BK-*-420D	600	998.8	276 nm	4.75°	50 x 30	φ63.5
52029BK-*-311D (T)	1110.9	998.8	280 nm	8.9°	80 x 36	45 x 90
52029BK-*-321D	1100.9	998.8	280 nm	8.9°	80 x 36	45 x 90
52058FS-*-930D	1666.7	998.8	347 nm	16.8°	50 x 30	φ100
52023BK-*-930D	1666.7	998.8	347 nm	16.8°	50 x 30	φ100
52021BK-*-830D	1440	998.8	400 nm	16.7°	64 x 64	φ63.5
52021BK-*-840D	1200	998.8	400 nm	14°	44 x 38	φ63.5
52020BK-*-442D	600	998.8	460 nm	7.9°	20 x 20	30 x 25
52020BK-*-041D	300	998.8	488 nm	4.2°	20 x 20	25 x 30
52021BK-*-651D	1080.7	998.8	500 nm	15.7°	50 x 30	φ63.5
52023BK-*-845D	1440	998.8	580 nm	25°	50 x 30	φ100
52029BK-*-880D (B)	2400	998.8	580 nm	44.2°	80 x 30	45 x 90
52058FS-*-650D	1080	998.8	600 nm	18.9°	40 x 24	φ50.8
52021BK-*-653D	1080	998.8	600 nm	18.9°	50 x 30	φ63.5
52021BK-*-850D	1440	998.8	700 nm	30.3°	50 x 30	φ63.5
52020BK-*-690D	1200	998.8	873 nm	30°	20 x 20	25 x 30
52020BK-*-091D	200	998.8	3.2 μm	18.5°	20 x 25	30 x 25
52029BK-*-180D	423	998.8	3.3 μm	44.2°	80 x 30	45 x 90
52029BK-*-281D	425.7	998.8	3.3 μm	44.2°	80 x 30	45 x 90
52030BK-*-404D	600	1188	90 nm	1.5°	45 x 48	58 x 55
52034BK-*-815D	1800	1200	657 nm	35°	50 x 30	φ63.5
52033BK-*-785D	1200	1500.5	180 nm	6.2°	80 x 40	φ100
52033BK-*-814D	1800	1500.5	180 nm	9.3°	50 x 50	φ100
52031BK-*-610D (A)	960	1500.5	200 nm	5.5°	50 x 32	φ63.5
52031BK-*-813D	1440	1500.5	200 nm	8.3°	52 x 35	φ63.5
52031BK-*-823D	1920	1500.5	280 nm	15.5°	52 x 35	φ63.5
52031BK-*-831D	1920	1500.5	300 nm	18.2°	52 x 35	φ63.5
52033BK-*-120D	415.5	1500.5	300 nm	3.5°	80 x 40	φ100
52031BK-*-620D	960	1500.5	300 nm	8.3°	50 x 32	φ63.5
52031BK-*-764D	1200	1500.5	300 nm	10.4°	52 x 32	φ63.5
52033BK-*-730D	1200	1500.5	300 nm	10.4°	78 x 42	φ100
52033BK-*-240D	450	1500.5	550 nm	7.2°	80 x 40	φ100
52033BK-*-550D	635.3	1500.5	600 nm	11°	80 x 40	φ100
52041BK-*-804D (T)	2400	1999.5	30 nm	2°	102 x 75	85 x 110
52038BK-*-707D	1200	1999.5	52 nm	1.8°	35 x 25	35 x 45
52038BK-*-803D	1440	1999.5	78 nm	3.2°	35 x 25	35 x 45

(A) Double Grating with Alignment Section (B) Bipartite Ruling (T) Tripartite Ruling

Table T9 Concave Ruled Reflection Gratings for Rowland Circle Spectrographs (continued)

Catalog Number	Grooves per mm	Concave Radius (mm)	Nominal Blaze Wavelength (1st Order Littrow)	Nominal Blaze Angle	Ruled Area (Groove Length x Ruled Width, mm)	Substrate Size (mm)
52038BK-*-405D	600	1999.5	89 nm	1.5°	35 x 25	35 x 45
52038BK-*-611D	960	1999.5	140 nm	3°	35 x 25	35 x 45
52043BK-*-786D	1200	1999.5	180 nm	6.2°	80 x 40	ϕ100
52038BK-*-423D	600	1999.5	200 nm	3.5°	35 x 25	35 x 45
52043BK-*-824D	1667	1999.5	230 nm	11°	80 x 40	ϕ100
52080BK-*-322D	600	1999.5	230 nm	4°	155 x 78	85 x 160
52043BK-*-832D	1440	1999.5	400 nm	16.7°	80 x 40	ϕ100
52043BK-*-835D	833.33	1999.5	460 nm	11°	80 x 40	ϕ100
52041BK-*-042D (T)	133.6	1999.5	546 nm	2°	102 x 75	85 x 110
52038BK-*-060D	300	1999.5	860 nm	7.4°	25 x 35	35 x 45
52047BK-*-801D	2400	2217.6	29 nm	2°	50 x 30	ϕ63.5
52047BK-*-708D	1200	2217.6	60 nm	2°	50 x 30	ϕ63.5
52047BK-*-406D	600	2217.6	87 nm	1.5°	50 x 30	ϕ63.5
52047BK-*-415D	600	2217.6	120 nm	2°	50 x 30	ϕ63.5
52047BK-*-021D	300	2217.6	240 nm	2°	52 x 30	ϕ63.5
52051BK-*-704D	1200	2998.3	30 nm	1°	50 x 32	ϕ63.5
52051BK-*-701D	1200	2998.3	60 nm	2°	50 x 32	ϕ63.5
52051BK-*-709D	1200	2998.3	75 nm	2.5°	50 x 32	ϕ63.5
52059BK-*-788D	1200	2998.3	140 nm	4.7°	150 x 65	76 x 160
52051BK-*-416D	600	2998.3	150 nm	2.5°	50 x 32	ϕ63.5
52053BK-*-787D	1200	2998.3	150 nm	5.2°	80 x 50	ϕ101.6
52053BK-*-520D	830.8	2998.3	250 nm	6°	80 x 50	ϕ101.6
52053BK-*-765D	1200	2998.3	300 nm	10.4°	80 x 50	ϕ101.6
52059BK-*-766D	1200	2998.3	300 nm	10.2°	150 x 65	76 x 160
52053BK-*-032D	300	2998.3	300 nm	2.2°	75 x 48	ϕ101.6
52051BK-*-030D	300	2998.3	300 nm	2.5°	32 x 50	ϕ63.5
52051BK-*-431D	600	2998.3	360 nm	6.2°	50 x 32	ϕ63.5
52053BK-*-460D	600	2998.3	550 nm	9.5°	80 x 50	ϕ101.6
52059BK-*-752D	1200	2998.3	600 nm	21°	150 x 65	76 x 160
52053BK-*-443D	600	2998.3	630 nm	11.2°	80 x 56	ϕ101.6
52014FS-*-900D (A)	3600	3997	30 nm	3°	120 x 120	130 x 140
52014FS-*-050D	200.32	3997	546 nm	3°	130 x 120	130 x 140
52086BK-*-753D	1200	10685	750 nm	26.7°	150 x 85	ϕ180

(A) Double Grating with Alignment Section (T) Tripartite Ruling

Table A1 UV/Vis Gratings

Catalog Number	Grooves per mm	Nominal Blaze Wavelength (1st Order Littrow)	Nominal Blaze Angle or Modulation	Maximum Ruled Area (Groove Length x Ruled Width, mm)
53-*-468H	4968	370 nm	high	102 x 102
53-*-058H	4320	350 nm	high	102 x 128
53-*-551H	4320	275 nm	high	84 x 84
53-*-510H	3600	200 nm	low	102 x 128
53-*-520H	3600	250 nm	medium	102 x 128
53-*-530H	3600	300 nm	high	84 x 84
53-*-445H	2991	270 nm	low	102 x 102
53-*-021R	2700	259 nm	20°	102 x 102
53-*-150R	2400	240 nm	16.8°	102 x 102
53-*-240R	2400	300 nm	21°	102 x 102
53-*-400H	2400	250 nm	blazed	102 x 102
53-*-410H	2400	200 nm	low	102 x 102
53-*-420H	2400	270 nm	medium	102 x 102
53-*-430H	2400	400 nm	high	102 x 102
53-*-300R	2160	500 nm	32.7°	128 x 154
53-*-059H	2000	475 nm	high	102 x 128
53-*-061R	1800	250 nm	13°	52 x 52
53-*-289R	1800	400 nm	21.1°	102 x 102
53-*-290R	1800	500 nm	26.7°	102 x 102
53-*-300H	1800	250 nm	blazed	102 x 102
53-*-310H	1800	300 nm	low	102 x 102
53-*-320H	1800	450 nm	medium	102 x 102
53-*-330H	1800	500 nm	high	102 x 128
53-*-233H	1760	550 nm	high	102 x 102
53-*-128R	1714.3	650 nm	34°	102 x 102
53-*-136H	1714	550 nm	high	102 x 102
53-*-285R	1700	530 nm	22.49°	102 x 102
53-*-331H	1700	550 nm	high	84 x 84
53-*-070R	1500	250 nm	10.8°	52 x 52
53-*-188R	1201.6	250 nm	8.6°	102 x 102
53-*-200H	1201.6	250 nm	blazed	102 x 102
53-*-210H	1200	450 nm	low	64 x 64
53-*-060R	1200	250 nm	8.6°	154 x 206
53-*-047R	1200	450 nm	15.7°	102 x 102
53-*-340R	1200	600 nm	21°	204 x 306
53-*-330R	1200	400 nm	14°	102 x 128
53-*-280R	1200	500 nm	17.5°	154 x 206
53-*-105R	1000	250 nm	7.2°	102 x 102
53-*-112H	1000	230 nm	blazed	110 x 110
53-*-462R	964	520 nm	14.6°	64 x 64
53-*-262H	950	1 µm	high	102 x 102
53-*-266R	900	550 nm	14.3°	154 x 206
53-*-274R	822.58	450 nm	10.7°	51 x 104
53-*-259R	768	425 nm	9.4°	102 x 104
53-*-455R	700	530 nm	10.5°	50 x 50
53-*-267R	600	650 nm	11.3°	154 x 206
53-*-313H	600	250 nm	4.3°	102 x 102
53-*-260R	600	500 nm	8.6°	154 x 206
53-*-010R	600	300 nm	5.2°	154 x 206
53-*-080R	600	400 nm	7°	154 x 206
53-*-264R	588	561 nm	9.5°	52 x 52
53-*-246R	500	560 nm	8°	154 x 206
53-*-230R	500	330 nm	4.7°	102 x 102
53-*-183R	400	250 nm	2.9	104 x 102
53-*-581R	400	550 nm	6.3°	102 x 128
53-*-586R	400	400 nm	4.5°	154 x 206
53-*-222R	384.6	605 nm	6.7°	102 x 102
53-*-321R	333	600 nm	5.7°	64 x 64
53-*-225R	316	550 nm	5°	154 x 206
53-*-204R	300	550 nm	4.7°	102 x 102
53-*-090R	300	300 nm	2.5°	154 x 206
53-*-091R	300	422 nm	3.6°	154 x 206
53-*-172R	300	280 nm	2.4	104 x 102
53-*-327R	300	325 nm	2.8°	102 x 102
53-*-302H	300	230 nm	2°	102 x 102
53-*-270R	300	500 nm	4.3°	154 x 206
53-*-272R	300	250 nm 590 nm	2.1° 5.1°	102 x 102
53-*-126R	258	315 nm	2.4°	64 x 76
53-*-346R	200	730 nm	4.2°	102 x 102
53-*-305H	150	250 nm	low	62 x 62
53-*-201R	150	500 nm	2.2°	128 x 154
53-*-202R	150	300 nm	1.2°	102 x 102
53-*-616R	121.6	410 nm	1.44°	52 x 52
53-*-065R	120	330 nm	1.1°	102 x 102
53-*-666R	110	253.8 nm	0.8°	102 x 102
53-*-471H	75	270 nm	low	102 x 102
53-*-310R	50	600 nm	0.8°	128 x 206
53-*-282H	30	250 nm	low	102 x 102

Table A2 Fiber Optic Telecommunication Gratings

Catalog Number	Grooves per mm	Working Diffraction Order	Equivalent Dispersion (grooves/mm)	Telecom Band	Characteristics
53-*-230H	1200	1	1200	S and C	High S-Plane diffraction efficiencies
53-*-544H	1100	1	1100	S, C and L	High S-Plane diffraction efficiencies
53-*-245H	1050	1	1050	S, C and L	High S-Plane diffraction efficiencies
53-*-248H	1033	1	1033	1250-1450 nm	High S-Plane diffraction efficiencies
53-*-253H	1033	1	1033	1250-1450 nm	High S-Plane diffraction efficiencies
53-*-148R	1000	1	1000	S, C and L	High S-Plane diffraction efficiencies
53-*-262H	950	1	950	S, C and L	High S-Plane diffraction efficiencies
53-*-269H	900	1	900	S, C and L	High S-Plane diffraction efficiencies
53-*-024R	600	2	1200	C	High diffraction efficiencies for S&P polarizations with low PDL
53-*-660R	600	1	600	C	High diffraction efficiencies for S&P polarizations with low PDL
53-*-013R	300	3	900	C	High diffraction efficiencies for S&P polarizations with low PDL
53-*-154R	286.52	3	859.5	L	High diffraction efficiencies for S&P polarizations with low PDL
53-*-415E	52.67	22	1158.7	C	High diffraction efficiencies for S&P polarizations with low PDL

Table A3 Dye Laser Tuning Gratings

Catalog Number	Grooves per mm	Maximum Ruled Area (Groove Length x Ruled Width, mm)	Nominal Blaze Angle
53-*-530H	3600	84 x 84	holographic
53-*-430H	2400	102 x 102	holographic
53-*-059H	2000	102 x 102	holographic
53-*-290R	1800	102 x 102	26.7°
53-*-330H	1800	102 x 102	holographic
53-*-466R	600	102 x 102	54.1°

(used in orders 3 through 8)

Table A4 Molecular Laser Tuning Gratings

Type	Wavelength Range	Catalog Number	Grooves per mm	Nominal Blaze Angle	Diffraction Angle	Maximum Ruled Area (Groove Length x Ruled Width, mm)
F_2	157.1 nm	53-*-141E	154.51	76	76.1	128 x 260
ArF	193.3 nm	53-*-071E	112.96	79	79	128 x 258
		53-*-406E	85.837	76	76.1	128 x 254
		53-*-141E	154.51	76	76.1	128 x 260
		53-*-084E	117.94	79	79	128 x 258
KrF	248.3 nm	53-*-402E	79.01	74	74	128 x 254
		53-*-071E	112.96	79	79	128 x 258
Parametric	1.4-2.1 µm	53-*-525R	830.8	30	39	154 x 206
		53-*-550R	600	28.7	29	154 x 206
HF	2.8-3 µm	53-*-676R	420	26.7	37.5	52 x 52
		53-*-736R	300	22	26	102 x 102
DF	3.5-4.1 µm	53-*-440R	300	36.8	31.7	154 x 206
		53-*-820R	240	26.7	24.8	90 x 102
		53-*-676R	420	26.7	47	52 x 52
HBr	4.1-4.8 µm	53-*-820R	240	28.7	32.3	90 x 102
		53-*-440R	300	36.8	41.9	154 x 206
CO, NO	4.8-6.2 µm	53-*-440R	300	36.8	51.1	154 x 206
		53-*-820R	240	26.7	42.2	90 x 102
		53-*-880R	150	26.7	24.8	154 x 206
CO_2, N_2O	9.6-11.3 µm	53-*-005R	79.35	35	24.8	64 x 58
		53-*-885R	135	30	45.7	64 x 64
		53-*-960R	75	26.7	23.4	154 x 206
		53-*-036R	90	26.7	28.5	102 x 102
		53-*-831R	120	26.7	39.5	65 x 76
		53-*-830R	100	22	32	102 x 128
		53-*-880R	150	26.7	52.6	154 x 206
CO_2 Isotope	16 nm	53-*-005R	79.35	35	39.4	64 x 58
		53-*-910R	50	26.7	23.5	154 x 206
		53-*-920R	60	28.7	28.7	154 x 206

Table A5 Large Astronomical Gratings

Catalog Number	Grooves per mm	Nominal Blaze Wavelength (1st Order Littrow)	Nominal Blaze Angle	Maximum Ruled Area (Groove Length x Ruled Width, mm)
53-*-109R	1000	460 nm	13.5°	230 x 260
53-*-147R	1000	330 nm	10.3°	230 x 260
53-*-461R	632	800 nm	14.7°	306 x 408
53-*-561R	632	1.2 µm	22.3°	306 x 408
53-*-571R	632	2.65 µm	57°	306 x 408
53-*-068R	600	620 nm	10.7°	308 x 408
53-*-083R	600	510 nm	9.5°	230 x 210
53-*-601R	452	1.14 µm	15°	209 x 310
53-*-584R	400	415 nm	4.76°	306 x 408
53-*-137R	316	870 nm	7.6°	308 x 414
53-*-181R	316	750 nm	6.8°	160 x 218
53-*-505R	316	1.2 µm	11°	300 x 370
53-*-273R	270	533 nm	4.13°	306 x 408
53-*-271R	250	600 nm	4.5°	306 x 408
53-*-179R	245	4.85 µm	36.5°	158 x 208
53-*-349R	150	1.45 µm	6.2°	211 x 408
53-*-187E	124.93	770 nm	66°	154 x 206
53-*-232R	115	10.4 µm	36.8°	154 x 206
53-*-291E	91.7	All	58.9°	154 x 208
53-*-309R	90	1.9 µm	4.9°	212 x 408
53-*-215R	80	4.25 µm	9.8°	204 x 408
53-*-856R	75	4.6 µm	10°	210 x 260
53-*-275E	50.7	All	64.2°	154 x 306

Table A6 Pulse Compression Gratings

Catalog Number	Grooves per mm	Nominal Blaze Wavelength (1st Order Littrow)	Nominal Blaze Angle (R) or Modulation Depth (H)	Maximum Ruled Area (Groove Length x Ruled Width, mm)
53-*-430H	2400	300 nm	high	102 x 102
53-*-059H	2000	750 nm	high	102 x 128
53-*-330H	1800	500 nm	high	102 x 128
53-*-233H	1760	550 nm	high	102 x 102
53-*-239H	1500	750 nm	high	102 x 102
53-*-230H	1200	800 nm	high	110 x 110
53-*-340R	1200	600 nm	21.1°	204 x 306
53-*-360R	1200	750 nm	26.7°	156 x 206
53-*-727R	672	832 nm	16.4°	64 x 64
53-*-351R	600	800 nm	13.9°	154 x 206

Appendix A Standard sizes for plane gratings

These tables indicate the set of standard size substrates for the plane gratings in Tables T1–T4 and A1–A6. The size code **BBB** for each standard size is given, along with the corresponding substrate dimensions (length x width x thickness) and the ruled area (groove length x ruled width), all in millimeters.

Gratings on plane substrates with non-standard sizes &/or substrate materials can be produced, but price &/or lead time may be affected - please contact us for more information.

For gratings in Tables **T1, T2, A1, A3, A4** and **A6**

BBB	Substrate Dimensions (mm)	Ruled Area (mm)
004	30 x 30 x 10	26 x 26
066	28.5 x 58 x 10	24 x 52
006	58 x 58 x 10	52 x 52
009	68.6 x 68.6 x 9.1	64 x 64
013*	90 x 90 x 16	84 x 84
015*	110 x 110 x 16	102 x 102
017	110 x 135 x 25	102 x 128
020	135 x 165 x 30	128 x 154
025	110 x 220 x 30	102 x 206
028	165 x 220 x 35	154 x 206

For gratings in Table **A5**

BBB	Substrate Dimensions (mm)	Ruled Area (mm)
032	135 x 265 x 45	128 x 254
036	220 x 265 x 45	204 x 254
044	165 x 320 x 50	154 x 306
040	220 x 320 x 50	204 x 306
047	300 x 320 x 70	290 x 306
049	320 x 380 x 74	306 x 360
045	320 x 420 x 74	306 x 408

For gratings in Table **T3**

BBB	Substrate Dimensions (mm)	Ruled Area (mm)
014	50 x 100 x 16	46 x 92
019	60 x 150 x 25	56 x 128
025	110 x 220 x 30	102 x 206
027	135 x 220 x 35	128 x 206
032	135 x 265 x 45	128 x 254
044	165 x 320 x 50	154 x 306

For gratings in Table **T4**

Table T4 gratings have a broadband anti-reflection (AR) coating.

BBB	Substrate Dimensions (mm)	Ruled Area (mm)
004	30 x 30 x 10	26 x 26
005	Ø50 x 10	30 x 32
006	58 x 58 x 10	52 x 52
008	Ø80 x 10	52 x 52
009	68.6 x 68.6 x 9.1	64 x 64
011	Ø110 x 16	65 x 76
013	90 x 90 x 12	84 x 84
015	110 x 110 x 12	102 x 102
025	110 x 220 x 30	102 x 206
028	165 x 220 x 35	154 x 206

*Please visit our website for a list of **gratings we currently have in-stock** available in a variety of standard sizes. www.newport.com/instock-gratings*

Appendix B Guidelines for specifying a diffraction grating

Proper technical specifications are needed to ensure that the part supplied by the manufacturer meets the requirements of the customer. This is especially true for diffraction gratings, whose complete performance features may not be fully recognized. Documents that provide guidance in the specification of optical components, such as the ISO 10110 series ("Optics and optical instruments: Preparation of drawings for optical elements and systems"), do not lend themselves to the specification of diffraction gratings. Guidelines are provided below for generating clear and complete technical specifications for gratings.

Specifications should meet the following criteria.

- They should refer to *measurable* properties of the grating.
- They should be as *objective* as possible (avoiding judgment or interpretation).
- They should be *quantitative* where possible.
- They should employ common *units* where applicable (metric is preferred).
- They should contain *tolerances*.

A properly written engineering print for a diffraction grating will be clear and understandable to both the customer and the manufacturer.

Required specifications

All grating prints should contain, at a minimum, the following specifications.

1. Free aperture The free aperture, also called the *clear aperture*, of a grating is the maximum area of the surface that will be illuminated. The free aperture is assumed to be centered within the *ruled area* (see below) unless otherwise indicated. For configurations in which the grating will rotate, such as in a monochromator, it is important to specify the free aperture as the maximum dimensions of the beam on the grating surface (i.e., when the grating is rotated most obliquely to the incident beam). Also, it is important to ensure that the free aperture specifies an area that is completely circumscribed by the ruled area, so that the illuminated area never includes part of the grating surface that does not have grooves.

The free aperture of the grating is that portion of the grating surface for which the optical specifications apply (e.g., *Diffraction efficiency, Wavefront flatness or curvature, Scattered light* – see below).

2. Ruled area The ruled area of a grating is the maximum area of the surface that will be covered by the groove pattern. The ruled area is assumed to be centered on the substrate face unless otherwise indicated. By convention, the ruled area of a rectangular grating is specified as "groove length by ruled width" – that is, the grooves are parallel to the first dimension; for example, a ruled area of 30 mm x 50 mm indicates that the grooves are 30 mm long.

Most rectangular gratings have their grooves parallel to the shorter substrate dimension. For gratings whose grooves are parallel to the longer dimension, it is helpful to specify "long lines" to ensure that the grooves are made parallel to the longer dimension.

3. Substrate dimensions The substrate dimensions (width, length, and thickness) should be called out, as should their tolerances. If the grating is designed to be front-mounted, the substrate specifications can be somewhat looser than if the grating surface will be positioned or oriented by the precise placement of the substrate. Front-mounting a grating generally reduces its cost and production time (see *Alignment* below).

A grating substrate should have bevels on its active face, so that it is easier to produce and to reduce chipping the edges while in use. Bevel dimensions should be specified explicitly and should be considered in matching the *Ruled area* (above) with the substrate dimensions. For custom (special-size) substrates, certain minimum bevel dimensions may be required to ensure that the grating is manufacturable – please contact us for advice.

4. Substrate material The particular substrate material should be specified. If the material choice is of little consequence, this can be left to the manufacturer, but especially for applications requiring substrates with low thermal expansion coefficients, or requiring gratings that can withstand high heat loads, the substrate material and its grade should be identified. For transmission gratings, the proper specification of the substrate material should include reference to the fact that the substrate will be used in transmission, and may additionally refer to specifications for inclusions, bubbles, striae, &c.

5. Nominal surface figure Plane (flat) gratings should be specified as being planar; concave gratings should have a radius specified, and the tolerance in the radius should be indicated in either millimeters or fringes of red HeNe light (λ = 632.8 nm) (a "wave" being a single wavelength, equaling 632.8 nm, and a "fringe" being a single half-wavelength, equaling 316.4 nm). Deviations from the nominal surface figure are specified separately as "wavefront flatness" or "wavefront curvature" (see below).

6. Wavefront flatness or curvature This specification refers to the allowable deviation of the optical surface from its *Nominal surface figure* (see above). Plane gratings should ideally diffract plane wavefronts when illuminated by collimated incident light. Concave gratings should ideally diffract spherical wavefronts that converge toward wavelength-specific foci. In both cases, the ideal radius of the diffracted wavefront should be specified (it is infinite for a plane grating) and maximum deviations from the ideal radius should also be called out (e.g., the tolerance in the radius, higher-power irregularity in the wavefront). It is important to specify that grating wavefront testing be done in the diffraction order of use if possible, not in zero order, since the latter technique does not measure the effect of the groove pattern on the diffracted wavefronts. Deviations from a perfect wavefront are most often specified in terms of waves or fringes of red HeNe light (λ = 632.8 nm). Generally, wavefront is specified as an allowable deviation from focus ("power") and allowable higher-order curvature ("irregularity").

7. Groove spacing or frequency The number of grooves per millimeter, or the spacing between adjacent grooves, should be specified, but not both (unless one is subjugated to the other by labeling it as "reference"). For a grating whose groove spacing varies across the surface (e.g., an aberration-corrected concave holographic grating), the groove spacing (or frequency) is specified at the center of the grating surface.

8. Groove alignment Alignment refers to the angle between the groove direction and an edge of the grating substrate. Sometimes this angular tolerance is specified as a linear tolerance by stating the maximum displacement of one end of a groove (to an edge) relative to the other end of the groove. Generally a tight alignment specification increases manufacturing cost; it is often recommended that alignment be allowed to be somewhat loose and that the grating substrate dimensions not be considered for precise alignment but that the grating surface be oriented and positioned optically instead of mechanically (see comments in *Substrate dimensions* above).

9. Diffraction efficiency Grating efficiency is generally specified as a minimum at a particular wavelength; often this is the *peak wavelength* (i.e., the wavelength of maximum efficiency). Occasionally efficiency specifications at more than one wavelength are called out.

Either relative or absolute diffraction efficiency should be specified.

- Relative efficiency is specified as the percentage of the power (or, more loosely, energy) at a given wavelength that would be reflected by a mirror (of the same coating as the grating) that is diffracted into a particular order by the grating (that is, efficiency relative to a mirror).
- Absolute efficiency is specified as the percentage of the power incident on the grating that is diffracted into a particular order by the grating.

In addition to the wavelength and the diffraction order, grating efficiency depends on the incidence and diffraction angles α and β (the "conditions of use"); if these angles are not explicitly stated, the standard configuration (namely the Littrow configuration, in which the incident and diffracted beams are coincident) will be assumed. Unless otherwise noted on the curves themselves, all standard efficiency curves are generated for the standard (Littrow) conditions of use: $\alpha = \beta$.

Generally diffraction gratings are polarizing elements, so that the efficiency in both polarizations should be considered:

P-plane: TE, light polarized parallel to the grooves

S-plane: TM, light polarized perpendicular to the grooves

For each wavelength that has an efficiency specification, the following should be indicated: the wavelength, the efficiency (in percent), whether the efficiency specification is relative or absolute, the diffraction order, the polarization of the light, and the conditions of use. In some cases, the bandwidth of the exit slit in the spectrometer used to measure the grating efficiency may need to be called out as well.

Supplemental specifications

Additional specifications are sometimes required based on the particular application in which the grating is to be used.

10. Blaze angle Although it is better to specify diffraction efficiency, which is a performance characteristic of the grating, sometimes the blaze angle is specified instead (or additionally). A blaze angle should be specified only if it is to be measured and verified (often done by measuring efficiency anyway), and a tolerance should be noted. In cases where both the diffraction efficiency and the blaze angle are specified, the efficiency specification shall be controlling and the blaze angle specification shall be for reference only.

11. Coating material Generally the *Diffraction efficiency* specifications will dictate the coating material, but sometimes a choice exists and a particular coating should be specified. Additionally, dielectric overcoatings may be called out that are not implied by the efficiency specifications.

Pro Tip

*The **nominal blaze angle (1st order Littrow)** is the diffraction angle of the blaze wavelength when the grating is used in the Littrow configuration in the first diffraction order.*

Appendix B **Guidelines for specifying a diffraction grating** (continued)

12. Scattered light Grating scattered light is usually specified by requiring that the fraction of monochromatic light power incident on the grating and measured a particular angle away from the diffracted order falls below a certain upper limit. Increasingly, this specification is provided in decibels. The proper specification of scattered light would call out the test configuration, the polarization and wavelength of the incident light, the incidence angle, the solid angle subtended by the detector aperture, and the dimensions of the exit slit. Grating scatter is measured using red HeNe light.

13. Cosmetics The cosmetic appearance of a diffraction grating does not correlate strongly with the performance of the grating, and for this reason specifications limiting the type, number and size of cosmetic defects are not recommended. Nevertheless, all Richardson gratings undergo a rigorous cosmetic inspection before shipment.

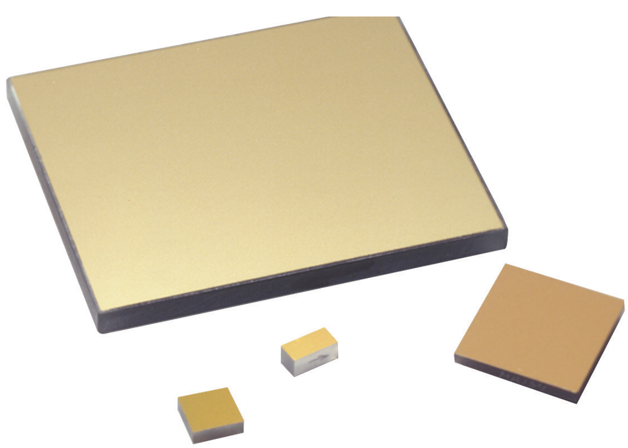
14. Imaging characteristics Concave holographic gratings may be aberration-corrected, in which case they can provide focusing without the use of auxiliary optics. In these cases, imaging characteristics should be specified, generally by calling out the *full width at half maximum intensity* (FWHM) of the images.

15. Damage threshold In some instances, such as pulsed laser applications, diffracted gratings are subjected to beams of high power density that may cause damage to the delicate grating surface, in which case the maximum power per unit area that the grating surface must withstand should be specified.

16. Other specifications Other specifications that relate to the functional performance of the grating should be called out in the print. For example, if the grating must perform in extreme environments (e.g., a satellite or space-borne rocket, high heat and/or humidity environments), this should be noted in the specifications.

Pro Tip

*There are two primary methods for **mounting a grating:** from the front and from the back. Front mounting is generally recommended, since it allows for accurate placement of the optical surface of the grating regardless of slight variations in grating substrate thickness or wedge. Care must be taken in front mounting to avoid occluding any of the grating surface that is illuminated.*



Richardson Gratings™ OEM Mounted Gratings and Masked Gratings

Newport's Richardson Gratings has been a trusted supplier of holographic and ruled diffraction gratings for over 70 years to companies that manufacture analytical instruments, lasers and fiber-optic telecommunications equipment. Our experienced technical team can design gratings mounts and masks to provide exceptional performance and ease of integration in many different applications.

GRATINGS MOUNTS

Gratings mounts are used to position diffraction gratings for a wide range of optical applications. Richardson Gratings mounts are engineered components that use a number of securing methods such as bar, ring, kinematic, or gimbal to safely hold the diffraction grating without risk of damage or unwanted movement. Grating mounts provide the means to position and orient the grating to improve instrument performance.

A wide selection of standard mounting options is available, along with the expertise to design a custom mount for any optical application.

The benefits of our mounted gratings are:

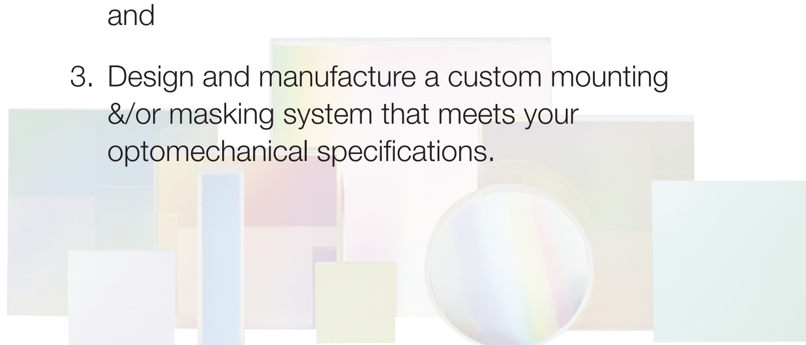
1. Our skilled optical technicians will carefully mount &/or mask your grating,
2. Our mounted & masked gratings are tested to ensure that they meet performance requirements,
3. Damage due to mishandling is reduced, and
4. Procurement is streamlined and parts inventory reduced.

MASKED GRATINGS

A grating mask is a frame applied to the perimeter of a diffraction grating to minimize damage due to handling and to reduce scattered light, helping to optimize system performance. Grating masks are applied to the grating by skilled technicians and are available in different configurations, including aluminum frames, additive polymer frames and precision-cut, pressure-sensitive adhesive masking materials.

Our optical experts can:

1. Select an appropriate mount &/or mask for your application from our wide range of existing mounts,
2. Manufacture a mount/mask based on your existing mechanical design (build-to-print), and
3. Design and manufacture a custom mounting &/or masking system that meets your optomechanical specifications.



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