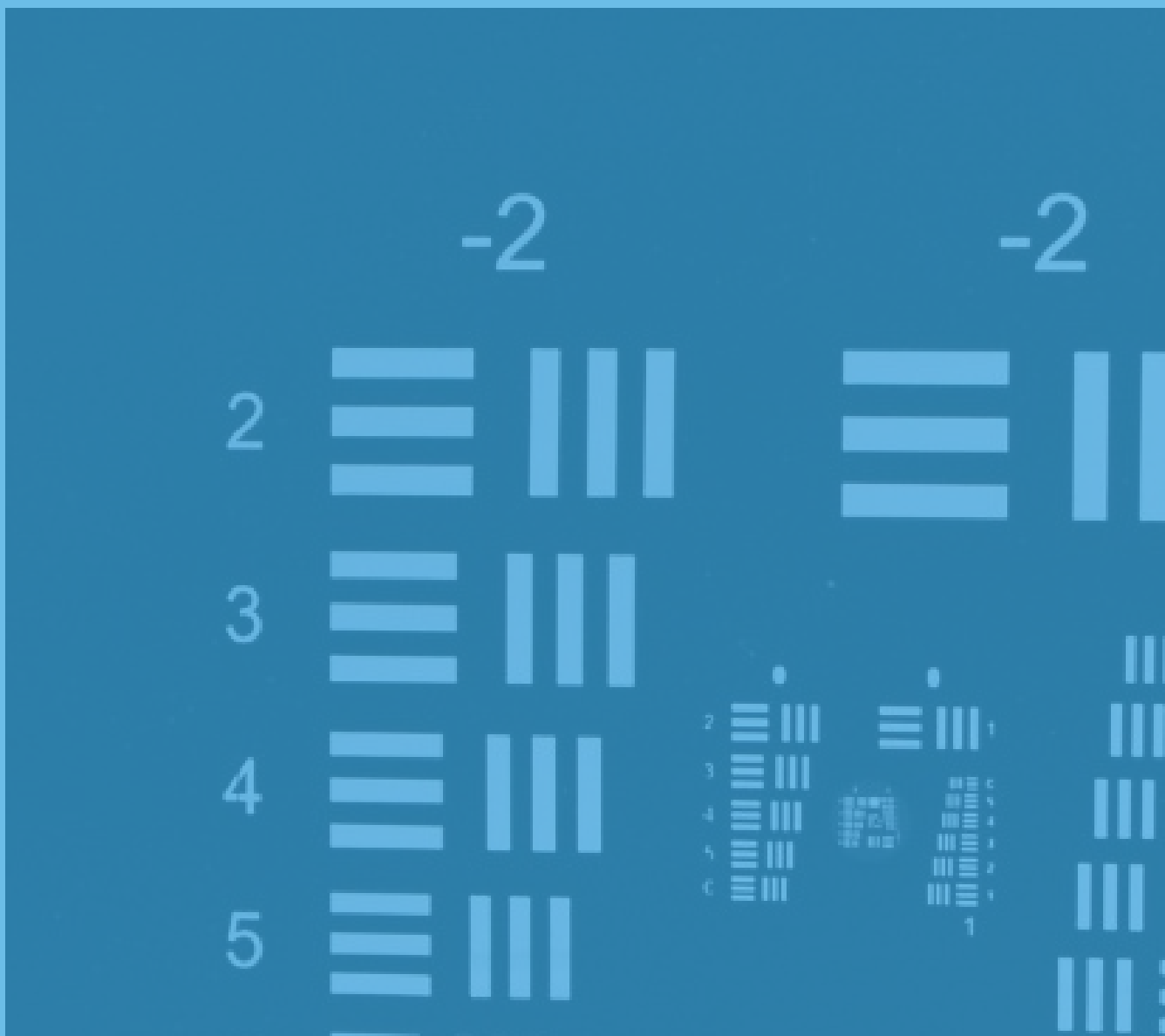


Resolution Charts and Gratings



Optical Resolution Charts, Ronchi Rulings and Grids

The optical resolution charts are used to test characteristics such as resolution, contrast, distortion and modulation transfer function (MTF) of lenses, cameras and optical systems.

Ronchi rulings and grids are used to create interference patterns, to measure distortion and for MTF measurements.

Graticules Optics manufactures a range of charts on glass and in metal foil. Customers often require special charts for specific applications and these can be made to your exact requirements.

In addition to these products, we also supply a specialist NPL/HSE test slide for checking the resolving power of phase contrast microscopes, the S84.

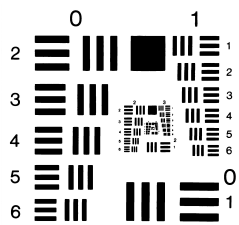
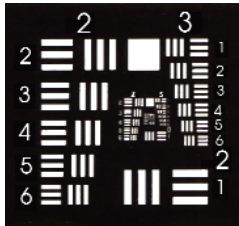
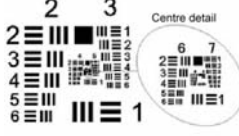
Special products are available for testing windscreens to various International standards. These are included here.

All products in this brochure are available on other materials to special order. If the product you require is not listed, then please contact us with your requirements.



USAF 1951 Test Chart

USAF resolution charts are recognised the world over as a universal standard for testing the vertical and horizontal resolution of imaging systems. Each element on the chart comprises three vertical bars and three horizontal bars, and the detail on these slides is as fine as 0.78microns (644 line-pairs per mm). The resolution of the imaging system is normally specified as the Group and Element of the finest bars that can be clearly defined - See further information on back page of brochure.

| Pattern | Description | Order Code | |
|---------|--|------------|---|
| R70 | USAF Test Chart, positive image. Group 0, element 1 to Group 7, element 6. B270 glass, size 50mm x 50mm | 06B01096 |  |
| R71 | USAF Test Chart, positive image. Group -2, element 1 to Group 7, element 6. B270 glass, size 75mm x 75mm | 06B01097 | |
| R75P | USAF Resolution Chart, positive version. Group 0, element 1 to group 9, element 3. Soda lime glass size 50mm x 50mm | 06B01102 |  |
| R75N | USAF Resolution Chart, negative version. Group 0, element 1 to group 9, element 3. Soda lime glass size 50mm x 50mm | 06B01103 | |
| PS75P | USAF Resolution Chart, positive version. Group 2, element 1 to Group 9, element 3. Soda lime glass mounted in stainless steel microscope slide, with engraved serial number for traceability, 76mm x 25mm. Supplied in polished wood case. | 05B01090 | |
| PS75N | USAF Resolution Chart, negative version. Group 2, element 1 to Group 9, element 3. Soda lime glass mounted in stainless steel microscope slide with engraved serial number for traceability, 76mm x 25mm. Supplied in polished wood case | 05B01091 |  |

We are also able to make custom versions of the USAF Test Chart which are often required for special applications, and can supply them with Internationally traceable certificates of calibration.

| USAF Resolution Chart, Number of Lines per mm | | | | | | | | | | | | |
|---|--------------|-------|------|------|------|------|-------|-------|-------|-----|-----|-----|
| Element Number | Group Number | | | | | | | | | | | |
| | -2 | -1 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 1 | 0.250 | 0.500 | 1.00 | 2.00 | 4.00 | 8.00 | 16.00 | 32.00 | 64.0 | 128 | 256 | 512 |
| 2 | 0.280 | 0.561 | 1.12 | 2.24 | 4.49 | 8.89 | 17.95 | 36.00 | 71.8 | 144 | 288 | 576 |
| 3 | 0.315 | 0.630 | 1.26 | 2.52 | 5.04 | 10.1 | 20.16 | 40.30 | 80.6 | 161 | 322 | 644 |
| 4 | 0.353 | 0.707 | 1.41 | 2.83 | 5.66 | 11.3 | 22.62 | 45.30 | 90.5 | 181 | 362 | |
| 5 | 0.397 | 0.793 | 1.59 | 3.17 | 6.35 | 12.7 | 25.39 | 50.80 | 102.0 | 203 | 406 | |
| 6 | 0.445 | 0.891 | 1.78 | 3.56 | 7.13 | 14.3 | 28.51 | 57.00 | 114.0 | 228 | 456 | |

| USAF Resolution Chart, Width of Bars in mm | | | | | | | | | | | | |
|--|--------------|------|-------|-------|-------|-------|-------|--------|--------|--------|--------|---------|
| Element Number | Group Number | | | | | | | | | | | |
| | -2 | -1 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 1 | 2.00 | 1.00 | 0.500 | 0.250 | 0.125 | 0.063 | 0.031 | 0.016 | 0.0078 | 0.0039 | 0.0020 | 0.00098 |
| 2 | 1.79 | 0.89 | 0.446 | 0.223 | 0.111 | 0.056 | 0.028 | 0.014 | 0.0070 | 0.0035 | 0.0017 | 0.00087 |
| 3 | 1.59 | 0.79 | 0.396 | 0.198 | 0.099 | 0.050 | 0.025 | 0.012 | 0.0062 | 0.0031 | 0.0016 | 0.00078 |
| 4 | 1.42 | 0.71 | 0.355 | 0.177 | 0.088 | 0.044 | 0.022 | 0.011 | 0.0055 | 0.0028 | 0.0014 | |
| 5 | 1.26 | 0.63 | 0.315 | 0.158 | 0.079 | 0.039 | 0.020 | 0.0098 | 0.0049 | 0.0025 | 0.0012 | |
| 6 | 1.12 | 0.56 | 0.281 | 0.140 | 0.070 | 0.035 | 0.018 | 0.0088 | 0.0044 | 0.0022 | 0.0011 | |

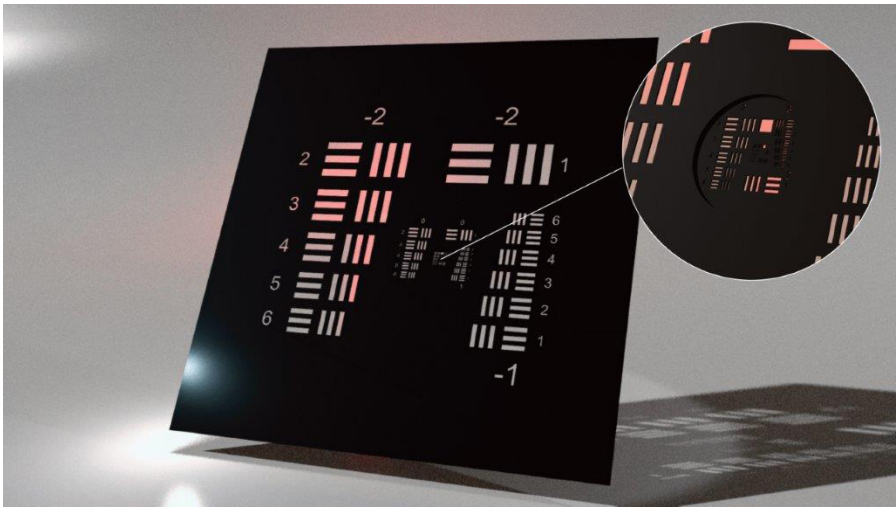
NEW R74 Thermal Imaging Test Chart

The R74 Thermal Imaging test chart, with improved dual material construction, provides a clear optical path USAF resolution pattern, from 0.25 lpmm (Group -2) to 28.51 lpmm (Group 4, element 6).

Suitable for resolution testing of Thermal, Far IR, UV and X-ray systems.

The front blackened 100mm square copper plate supports a finely patterned nickel central foil. The open apertures provide a clear air path pattern, to eliminate chromatic and absorption issues experienced with other solid substrate formats.

This latest version of our R74, improves on the long established original product and is complemented by our full range resolution products on the previous page.

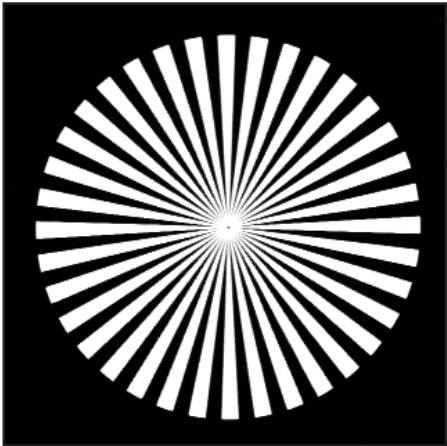


| Pattern | Description | Order Code |
|---------|---|------------|
| R74 | Thermal Imaging test chart. Group -2, element 1 to Group 4, element 6. Copper foil size 100mm x 100mm, blackened one side | 06A01101 |

Star Test Target

Also known as Siemens star or sunburst pattern. It is used qualitatively to demonstrate focussing effects, optical astigmatism and for rapid assessment of focal plane.

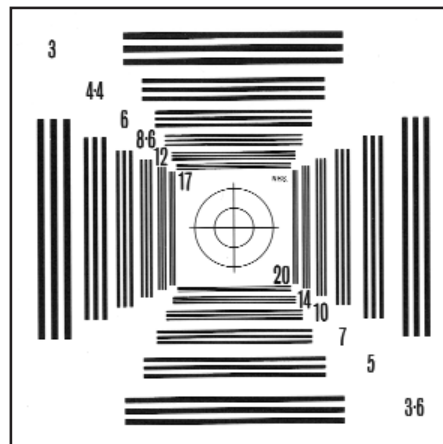
| Pattern | R65 | R66 |
|---------------------------|-------------------------|-------------------------|
| Sector pitch | 10° | 5° |
| Number of sectors | 36 | 72 |
| Outside diameter of image | 25mm | 25mm |
| Unresolved centre core | 0.2mm | 0.4mm |
| Normal substrate | B270 Glass | B270 Glass |
| Overall size | 50mm x 50mm | 50mm x 50mm |
| Image type | Vacuum deposited chrome | Vacuum deposited chrome |
| Order code | 06B01091 | 06B01092 |



NBS 25 Resolution Test Chart

A series of gratings diminishing in size as they go towards the central target. Lines range from 3 lines per mm to 20 lines per mm. Supplied as a positive high contrast chrome image on glass substrate 50mm x 50mm. Also available in low contrast and negative form.

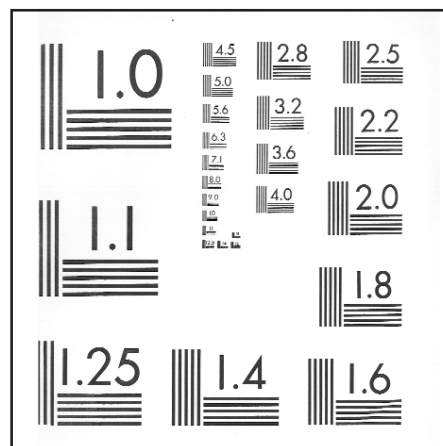
| Pattern | Description | OrderCode |
|---------|---|-----------|
| R60 | NBS 25 Test Chart, 3-20 lines per mm chrome surface image on B270 glass 50mm x 50mm | 06B01090 |



NBS 5 Bar Test Chart (BS4657)

This consists of elements of 5 bars ranging from 1 line per mm to 18 lines per mm, with adjacent numbers indicating the number of lines per mm. Produced as a vacuum deposited chrome image on 75mm x 75mm glass.

| Pattern | Description | Order Code |
|---------|---|------------|
| R67 | NBS 5 Bar Test Chart, 1-18 lines per mm, chrome surface image on B270 glass 75mm x 75mm | 06A01093 |

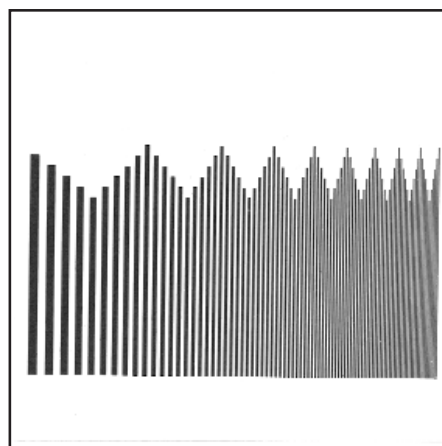


R72 Sayce Logarithmic Test Chart

The chart is ruled with 90 lines and spaces of gradually decreasing width. The width of lines and spaces are in logarithmic series, and their lengths are varied to assist counting. The charts have a base length of 100mm and are supplied on 0.175mm thick film.

Typically in use, the image is examined to determine the finest detail that can be distinguished. The finest resolved line is then counted to define the resolution of the device. Includes 6 charts, resolution table and instructions for use.

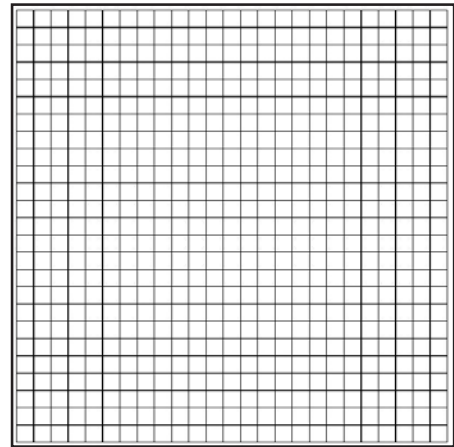
| Pattern | Description | Order Code |
|---------|--|------------|
| R72 | Sayce Test Chart photographic image on ester based film, 130mm x 85mm, 0.175mm thick | 06A01100 |



Grids

Vacuum deposited chrome on glass grid patterns in a variety of pitches. All supplied on 50mm x 50mm B270 glass, 1.5mm thick, ruled over the entire surface.

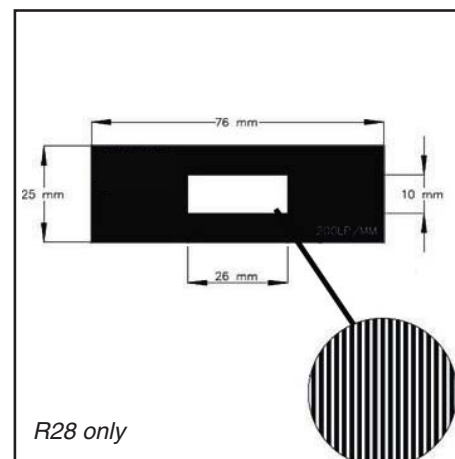
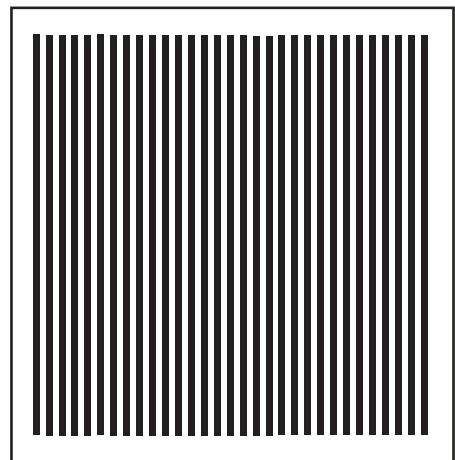
| Pattern | Description | Order Code |
|---------|--------------------------------|------------|
| R1 | Grid with line pitch of 2mm | 21B01250 |
| R2 | Grid with line pitch of 1mm | 21B01251 |
| R3 | Grid with line pitch of 0.5mm | 21B01252 |
| R4 | Grid with line pitch of 0.25mm | 21B01253 |
| R10 | Grid with line pitch of 0.1mm | 21B01254 |



Gratings – Ronchi Rulings

Vacuum deposited chrome gratings on glass substrate. Typically used for testing of resolution, field distortion and parfocal stability, but may be paired to provide interference patterns (fringe patterns) and as light gates.

| Pattern | Description | Order Code |
|---------|--|------------|
| R12 | Grating – Ronchi ruling 2 lines per mm. 50mm x 50mm B270 glass, 1.5mm thick, ruled over full area | 21B01270 |
| R15 | Grating – Ronchi ruling 8 lines per mm. 50mm x 50mm B270 glass, 1.5mm thick, ruled over full area | 21B01271 |
| R16 | Grating – Ronchi ruling 20 lines per mm. 50mm x 50mm B270 glass, 1.5mm thick, ruled over full area | 21B01272 |
| R17 | Grating – Ronchi ruling 40 lines per mm. 50mm x 50mm B270 glass, 1.5mm thick, ruled over full area | 21B01273 |
| R25 | Grating – Ronchi ruling 50 lines per mm. 50mm x 50mm B270 glass, 1.5mm thick, ruled over 30mm wide central strip | 21B01290 |
| R26 | Grating – Ronchi ruling 100 lines per mm. 50mm x 50mm B270 glass, 1.5mm thick, ruled over 30mm wide central strip | 21B01291 |
| R27 | Grating – Ronchi ruling 125 lines per mm. 50mm x 50mm B270 glass, 1.5mm thick, ruled over 30mm wide central strip 30 mm wide central strip | 21B01292 |
| R28 | Grating – Ronchi ruling 200 lines per mm. 26mm x 10mm soda lime glass grating mounted in anodised aluminium slide mount 76mm x 25mm. Supplied in a polished wooden box | 21B01293 |



Test Images for Analysis of Automotive Glass to BSI, DIN & ECE Standards

Graticules now offer a comprehensive range of image distortion test slides for the Automotive Glass industry.

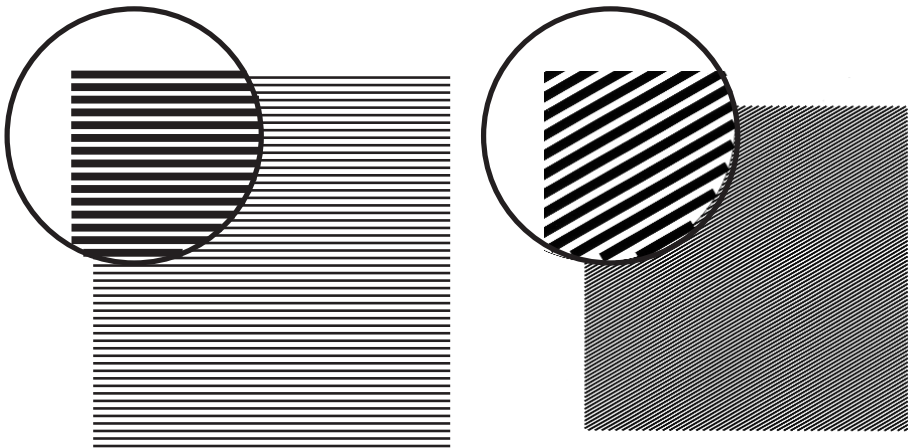
The testing of vehicle windscreens has been tightened-up in recent times with the introduction of BS, DIN & ECE standards. These standards specify optical testing methods for parameters such as angular deviation, refractive power and optical distortion. Compliance to these standards is essential for windscreen manufacturers.

All of the optical test methods utilise specialised patterned glass to give projected images, which are then analysed. The slides themselves are manufactured by Graticules on standard 50mm x 50mm B270 glass.

All standard slides are designed for use on projectors with a focal length of 90mm and a projector distance of 8 metres.

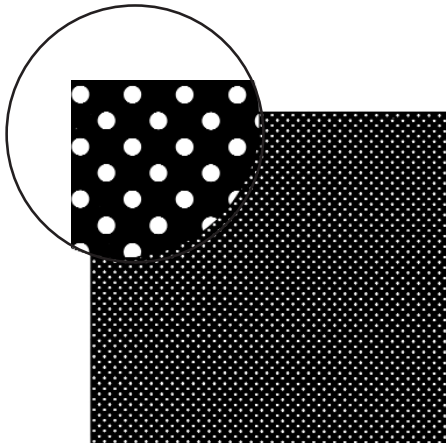
Grid Lines

Slides with inclined lines are used in both BS 857 & DIN 52305 standards for testing angular deviation. Horizontal lines are used to test for refractive power.



Circular Patterns

The test for optical distortion detailed in ECE Regulation 43 calls for a matrix of clear dots on an opaque background to simulate oncoming headlights. These can be produced to accomodate various focal lengths.



| Description | Order Code |
|---|------------|
| Dot matrix slide for testing to ECE Regulation 43 | 06B01200 |
| Horizontal 12mm lines for testing to DIN 52305 | 06B01201 |
| 30°12mm lines | 06B01202 |
| 45°12mm lines for testing to DIN 52305 | 06B01203 |
| 30°1.5mm lines for testing to BS857:1967 | 06B01204 |
| 30°2.5mm lines for testing to DIN 52305 | 06B01205 |

Definitions

Resolution: The ability of an optical device to clearly define a particular size or feature. Most commonly a grating is used to measure the resolution in line pairs per mm.

Distortion: The alteration of the optical image caused by imperfections or faults in the optical components. A percentage measurement is normally used.

Depth of Field: The distance between the front and back of an image that appears to be in focus. Optics will focus on one focal plane, but the depth of the image that is in focus will be greater to the naked eye. In general lower magnification devices have a larger depth of field than higher magnification devices.

Contrast: The measurement of the ability of an optical device to clearly separate the light and dark areas of an image. Normally expressed in terms of percentage.

Modulation Transfer Function (MTF): The resolution and performance of an optical system can be characterised by a quantity known as the modulation transfer function (MTF). This is a measurement of the optical systems ability to transfer contrast from the image to the sensor at a specific resolution. A Ronchi ruling is often used as the image object.

Ronch Ruling or Ronchi Grating: A series of lines and spaces of equal width used for resolution, distortion and contrast testing. Named after the Italian Physicist Vasco Ronchi, who invented the Ronchi test for telescopes.

Use of USAF Test Charts and similar test patterns

The USAF Test Chart comprises a series of blocks of bars and spaces arranged in groups and elements. As the group and element number increases, the width of the bars/spaces decreases. Each element block is made up of 3 horizontal gratings and 3 vertical gratings. Used for determining the resolution of optical devices.

The resolution of an optic or system is defined as the group and element where the difference between the black and white image of the grating can still be clearly determined. The resolution can be expressed as vertical or horizontal resolution due to the pattern arrangement on the USAF Test Chart.

The table below shows the line pairs per mm on the USAF Test Chart. As an example group 9 element 3 has 644 lines per mm which equates to a bar width of 0.78μ .

| USAF Resolution Chart, Number of Lines per mm | | | | | | | | | | | | |
|---|--------------|-------|------|------|------|------|-------|-------|-------|-----|-----|-----|
| Element Number | Group Number | | | | | | | | | | | |
| | -2 | -1 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 1 | 0.250 | 0.500 | 1.00 | 2.00 | 4.00 | 8.00 | 16.00 | 32.00 | 64.0 | 128 | 256 | 512 |
| 2 | 0.280 | 0.561 | 1.12 | 2.24 | 4.49 | 8.89 | 17.95 | 36.00 | 71.8 | 144 | 288 | 576 |
| 3 | 0.315 | 0.630 | 1.26 | 2.52 | 5.04 | 10.1 | 20.16 | 40.30 | 80.6 | 161 | 322 | 644 |
| 4 | 0.353 | 0.707 | 1.41 | 2.83 | 5.66 | 11.3 | 22.62 | 45.30 | 90.5 | 181 | 362 | |
| 5 | 0.397 | 0.793 | 1.59 | 3.17 | 6.35 | 12.7 | 25.39 | 50.80 | 102.0 | 203 | 406 | |
| 6 | 0.445 | 0.891 | 1.78 | 3.56 | 7.13 | 14.3 | 28.51 | 57.00 | 114.0 | 228 | 456 | |



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