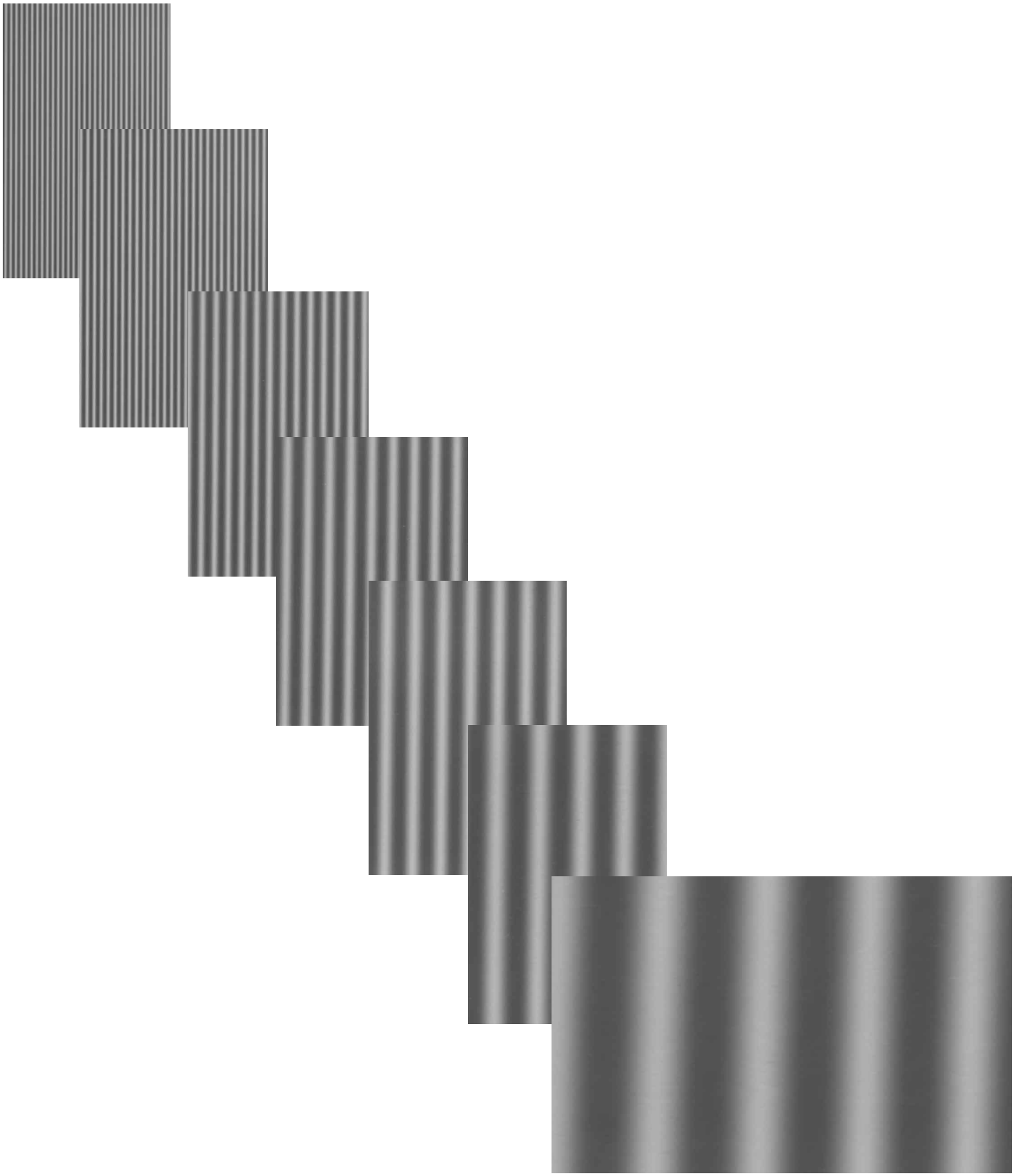


SINE PATTERNS®

The Sine Patterns Catalog

For more than fifteen years, Sine Patterns has supplied sinusoidal patterns as photographic images for a variety of applications; from moiré contouring to *reliable* MTF evaluation of materials, lenses, cameras, and electro-optical systems. To complement our line of continuous tone targets, Sine Patterns has added a selection of traditional resolution targets and a variety of current imaging standards. Sine Patterns is also your source for micro-lithographic images. We produce photo-chrome or emulsion on glass reticles or other replicas on any glass type, in any size. Contact us for any custom image.

Sine Patterns LLC

4/1999

SINUSOIDAL MTF TEST PATTERN ARRAYS

Each Sine Patterns Test Pattern Array contains a set of sinusoidal areas plus a gray scale that serves as a zero-frequency reference as described in our MTF Engineering Notes. Accompanying gray scales contain areas of the same density at the ends or corners that serve as a means for checking uniformity of illumination. These areas are matched to within 0.02 density.

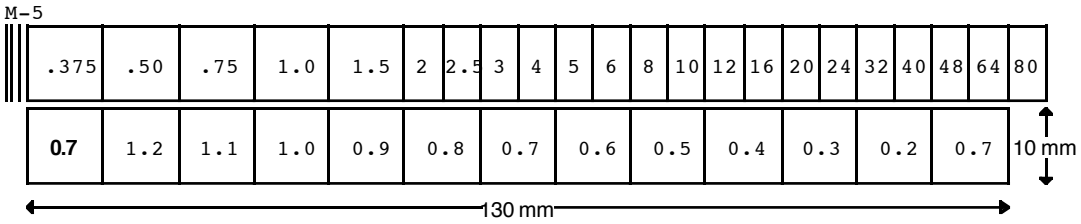
Transmission Sinusoidal Arrays

Our transmission type arrays are made on exceptionally high-resolution films. This makes it possible to achieve spatial frequencies as high as 256 cycles per mm. Most of our transmission pattern arrays are available with modulation (contrast) values of 35%, 60%, or 80%. Harmonic distortion of all of our patterns is generally less than 3%.

Transmission Array Selection Guide

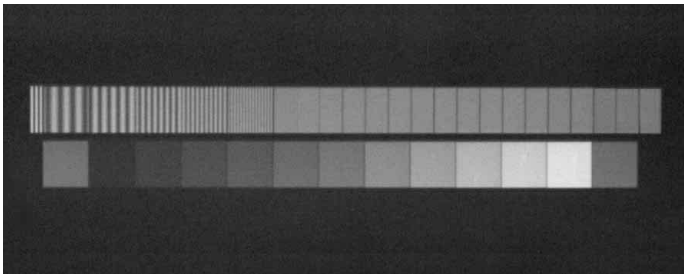
	M-5	M-6	M-7	M-14	M-19	SP-6
Size:	130 x 21 mm	70 x 46 mm	30 x 21.5 mm	15 x 12.6 mm	7.5 x 6.3 mm	20 x 15 mm
Frequency:	0.375 to 80 c/mm		0.75 to 128 c/mm	1 to 128 c/mm	2 to 256 c/mm	1 to 16 c/mm

Transmission Sinusoidal Test Pattern Array M-5



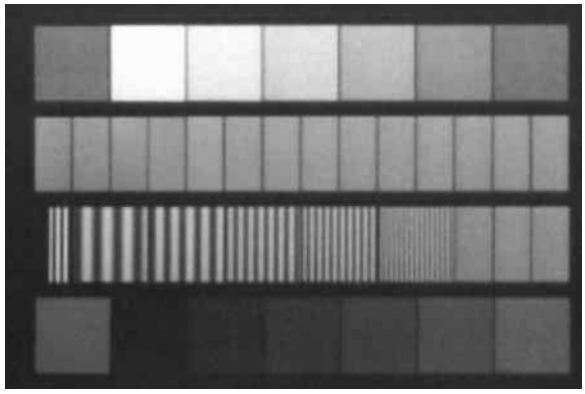
This pattern is made on a strip of 70 mm film about 8.5 inches (215 mm) long. The polyester film base is rather rigid, having a thickness of 7 mils (0.175 mm).

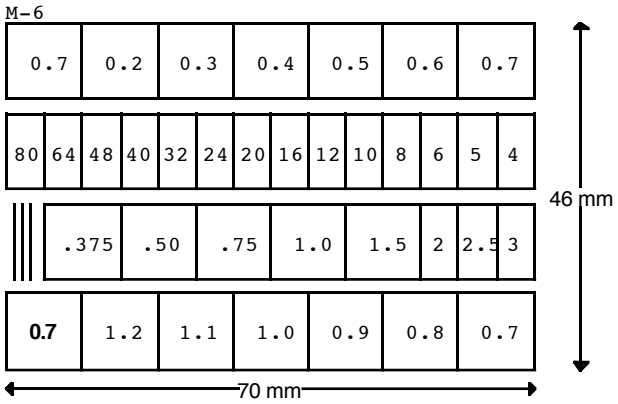
The upper row, as shown in the diagram, contains the sinusoidal areas with the spatial frequencies, in cycles per mm. All sinusoidal areas are carefully oriented with the others, and the lines at the left end of the array are for alignment purposes. The gray scale is in the lower row and the values show the approximate density values. (For the 80% modulation pattern it was necessary to increase the gray scale steps to approximately 0.12 in order that the scale exceeds the range of the sinusoidal areas.)



A digital microdensitometer scan is included with each test pattern.

Transmission Sinusoidal Test Pattern Array M-6



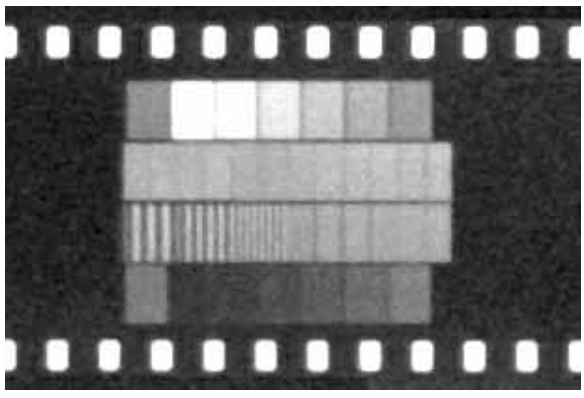


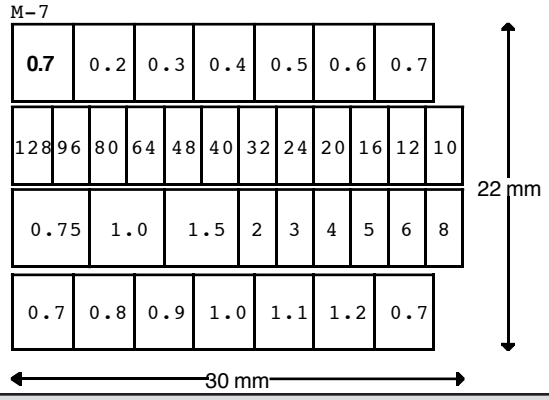
Test Pattern M-6 contains the same gray scale and sinusoidal areas as M-5 but is arranged in a shorter and wider format. The gray scale is in the outer rows. This makes it particularly useful when the complete array is to be imaged at one time.

The overall size of the array is 46 by 70 mm. It is approximately centered on an 8.5 inch strip of 70 mm film with a polyester base 7 mils (0.175 mm) thick. This pattern can be cemented between glass.

A digital microdensitometer scan is included with each pattern.

Transmission Sinusoidal Test Pattern Array M-7

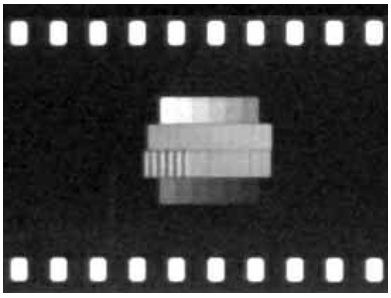


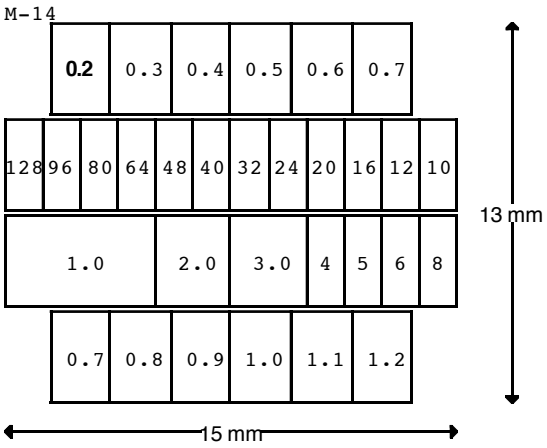


Test Pattern M-7 has an overall size of 21.5 by 30 mm which makes it small enough to fit into a standard 35 mm projection frame. The gray scale is contained in the outer rows. It is made on 35 mm perforated film with an acetate base 5 mil (0.127 mm) thick. It is also available on a wider film (with no perforations) cemented between glass.

A digital microdensitometer scan is included with each test pattern.

Transmission Sinusoidal Test Pattern Array M-14 and M-14H





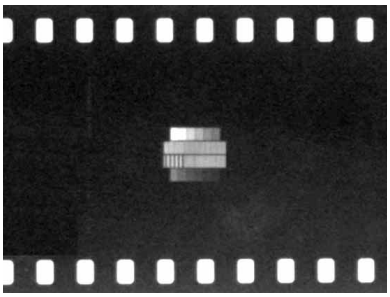
This test pattern was designed for various electro-optical applications, particularly where a small array is needed to fit into the frame. It can fit into an 18 mm diameter circle or into a standard 35 mm motion picture frame.

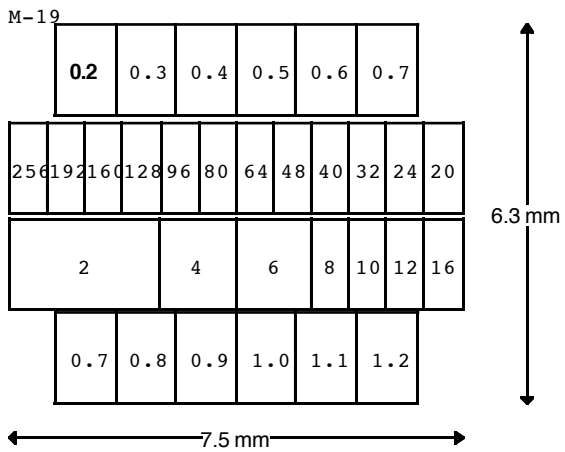
The gray scale is shown in the outer rows and the sinusoidal areas in the middle two rows. The approximate density values and spatial frequencies respectively, are shown in the diagram on the left.

The lines in the pattern M-14 lie perpendicular to the length of the film as pictured above. The lines in the M-14H are parallel to the length of the film. The pattern is also available on a wider film (with no perforations) cemented between glass.

A digital microdensitometer scan is included with each test pattern.

Transmission Sinusoidal Test Pattern Array M-19



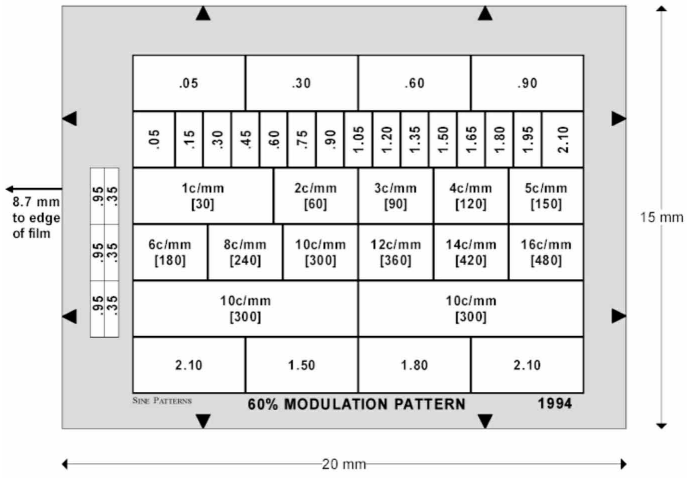


The M-19-80 is a remarkable new test pattern that achieves 256 cycles per mm while maintaining a significant modulation. It is designed for testing high resolution optical systems such as microscopes. Because its maximum width is 7.5 mm, it is small enough to fit easily onto a standard microscope slide. (Mounting on a 1" x 3" micro-slide with a cover slip is an available option.)

The layout of this pattern is similar to the M-14 except that it is exactly 1/2 its size and all frequencies are doubled. The array is made on perforated 35 mm film with lines running perpendicular to the length of the film.

A digital microdensitometer scan is included with each test pattern. Due to this pattern's higher spatial frequencies, scans are made with higher power optics than used for our other patterns. The scanning objective, having a numerical aperture of 0.40, is illuminated with a numerical aperture of 0.25.

Transmission Sinusoidal Test Pattern Array SP-6



The SP-6 Transmission Array is made on a direct reversal 35 mm motion picture film and is specifically designed for telecine systems. The pattern is within a gray surround as indicated in the figure above, and approximately centered on a 10 in. long strip of film.

The top two rows and the bottom row comprise a series of gray scale steps with density values as indicated. The remaining rows consist of sinusoidal areas whose spatial frequencies are shown in each box. Their equivalent number of TV lines are given in brackets.

The two columns on the left are density steps that are approximately equal to the maximum and minimum densities of the sinusoidal areas.

A digital microdensitometer scan is provided with each pattern.

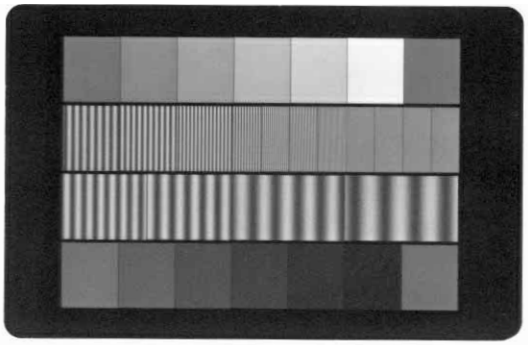
Reflection Sinusoidal Arrays

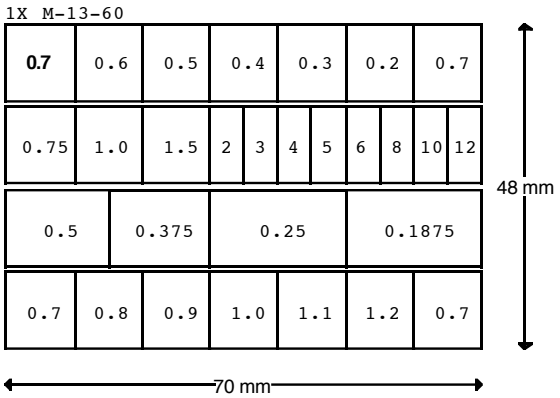
Reflection type arrays are made on photographic paper. These have proved to be very useful for MTF evaluation of various types of cameras and scanners. Because of the inherent limitations of photographic paper, the maximum spatial frequency of reflection patterns is limited to 20 cycles per mm.

Reflection Array Selection Guide

M-13-60	***Dimensions***	***Frequencies***
½X	35 x 24 mm	3/16 to 12 c/mm
1X	70 x 48 mm	3/16 to 12 c/mm
2X	140 x 96 mm	3/32 to 6 c/mm
4X	280 x 192 mm	3/64 to 3 c/mm
8X	560 x 384 mm	3/128 to 1.5 c/mm
M-15-60	70 x 48 mm	¼ to 20 c/mm
SP-6R	320 x 240 mm	1/16 to 1 c/mm

Reflection Sinusoidal Test Pattern Array M-13-60





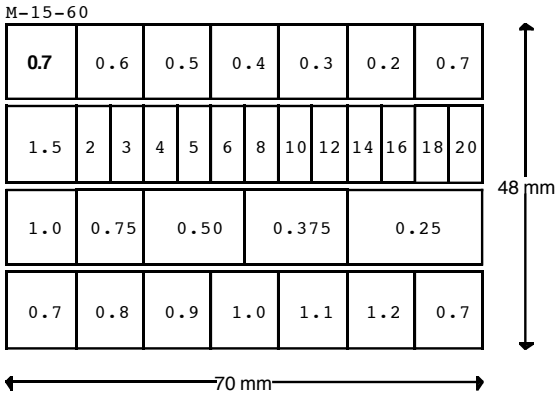
The M-13 pattern is designed to be used for evaluating systems that work in the reflection mode such as scanners, machine vision systems, cameras, and the like. It is supplied in five different sizes. A map of the 1X version is shown above. The fiX and 1X sizes incorporate the same spatial frequencies. Spatial frequencies for the 2X, 4X, and 8X versions are fi, ⁄, and ⅛ of these respectively.

Each test pattern is made on a single sheet of semi-matte photographic paper. The outer rows contain the gray scale and the numbers in the boxes indicate their approximate reflection density. The four corner areas are all within 0.02 density and are useful for checking uniformity of illumination. The inner rows contain the sinusoidal areas, having the indicated spatial frequencies. Nominal modulation of the sinusoidal areas is 60%.

Each pattern is supplied with a digital microdensitometer scan that lists the individual modulation values and density values of the gray scale. Modulation values are also given with compensation for the MTF of the microdensitometer.

The M-13-60 1X pattern is available in kit form with a 1.0 c/mm Ronchi ruling as specified by the Federal Bureau of Investigation (FBI) specification for performance testing of fingerprint scanners. Software is available for use of this patterns to evaluate scanners. There is no charge for this software as it is in the public domain. (See also, our FBI SIQT Scanner Test Chart.)

Reflection Sinusoidal Test Pattern Array M-15-60



The M-15-60 Reflection Sinusoidal Test Pattern is similar to the M-13-60 (1X Version) except that the range of spatial frequencies begins with 3/16 cycles per mm and extends to 20 cycles per mm.

The outer two rows contain the gray scale and the numbers in the boxes in the diagram indicate their nominal density values. The two inner rows contain the sinusoidal areas and the numbers indicate the spatial frequencies in cycles per mm.

A digital microdensitometer scan is included with each pattern. Modulation values are also given with compensation for the MTF of the microdensitometer.

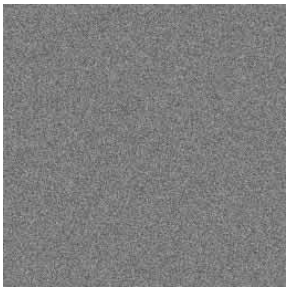
Reflection Sinusoidal Test Pattern Array SP-6R

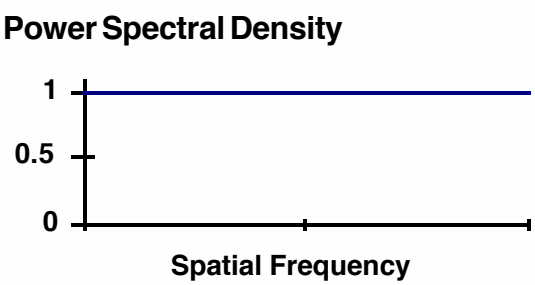
The SP-6R Reflection Array is a 16X enlargement of the SP-6 Transmission Array, onto photographic paper.

RANDOM MTF TEST PATTERNS

Random Test Patterns offer the ability to test the MTF of any detector array using a pseudo-natural test scene. The random aspect of the pattern improves the MTF test repeatability and accuracy by eliminating the effects of pattern registration on the rows and columns of the detector array. The random test pattern is available in two forms, as a reflective target or as a hologram, allowing the detector array to be tested with, or without, intervening optics.

Imaged Random Test Pattern

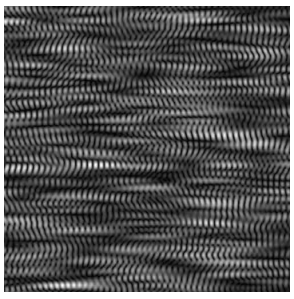


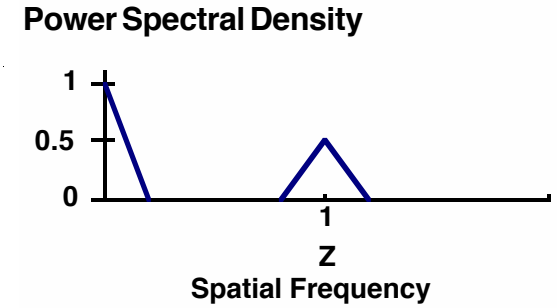


The Imaged Random Test Pattern is a reflective target, which is imaged onto the detector array. This pattern is available as a 15.2 cm square image on semi-matte photographic paper (as shown). Its spectral density (PSD) is 'white' and has equal power at all spatial frequencies. The MTF of the detector array is measured by transforming the captured image of the pattern into the frequency domain. Since the input PSD is uniform, the square root of the output PSD is equivalent to the MTF of the optical system.

This method allows the detector array to be tested with broad-band and narrow-band illumination. For example, a filter set (e.g. red, green, and blue) could be used to test the modulation response of a CCD array at crucial wavelengths.

Projected Random Test Pattern





In applications where the MTF of the detector array alone is required, the Projected Random Test Pattern can be projected directly onto the detector array. The pattern is produced by illuminating the supplied hologram with a low-power visible laser (~5 mw). (The hologram is mounted in a standard 35 mm projection slide having a 2" x 2" image.) The resulting test pattern is projected directly onto the detector array. Unlike the Imaged Random Test Pattern, the power spectral distribution of this pattern is narrow-band, and the distance from the hologram to the array determines the test frequency. Therefore simply translating the detector array along the optical axis of the projected pattern can generate any test frequency.

This method allows the detector array to be tested at different visible wavelengths. Since the hologram was created with a visible laser, a scaled version of the random pattern is generated when using different wavelength lasers. The scaling effect is easily countered by changing the detector array distance.

COMPOSITE SINUSOIDAL TEST PATTERN

This new type of pattern is used to determine a complete MTF from a single image. The Composite Pattern is ideal for applications where high speed analysis is required, such as quality assurance in routine production of optical components, or other applications where the image is sampled and analyzed digitally.

The Composite Pattern consists of seven (or more) superposed sinusoids with relative spatial frequencies of one through seven. Because the seven sine functions are phased in such a way as to provide a minimum overall variation of the envelope, the modulation values of the individual sinusoids is of the order of 30 to 35%.

This test pattern is supplied as a film and can be made with a wide range of basic spatial frequencies. Application Notes for this item are available on our website or by mail.

SINGLE FREQUENCY SINUSOIDAL GRATINGS

Our single frequency transmittance patterns have proved to be very useful for specialized MTF measurements as well as for such applications as moiré contouring. They are made on a heavy film base with a thickness of 7 mils (0.175 mm). This polyester material is somewhat birefringent.

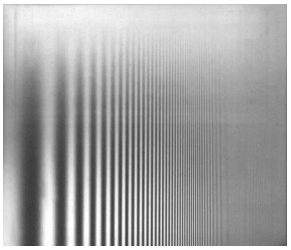
The modulation values for the harmonics are generally 2% or less. Minimum densities are approximately 0.2 and the average transmittance is about 30%.

A listing of stock spatial frequencies is given in the table on the right. These frequencies are also available as stock items, cemented between 2 inch (50 mm) square glass. Spatial frequencies not listed can be produced on a special order basis.

Reflection single frequency patterns can also be produced for lower spatial frequencies.

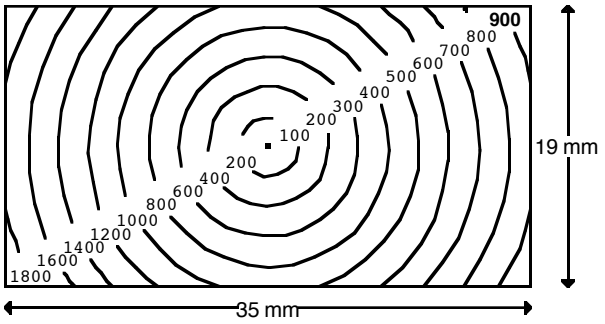
Pattern	Spatial Frequency	80%	90%	Approx. Size (mm)
SF-0.1	0.1 c/mm	Yes	Yes	100 x 100
SF-0.2	0.2 c/mm	Yes	Yes	100 x 100
SF-0.5	0.5 c/mm	Yes	Yes	100 x 100
SF-1.0	1.0 c/mm	Yes	Yes	100 x 100
SF-1.5	1.5 c/mm	Yes	Yes	100 x 100
SF-2.0	2.0 c/mm	Yes	Yes	100 x 100
SF-2.5	2.5 c/mm	Yes	Yes	100 x 100
SF-3.0	3.0 c/mm	Yes	Yes	100 x 100
SF-4.0	4.0 c/mm	Yes	Yes	100 x 100
SF-5.0	5.0 c/mm	Yes	Yes	80%: 100 x 100 90%: 82 x 100
SF-6.0	6.0 c/mm	Yes	-	100 x 100
SF-8.0	8.0 c/mm	Yes	-	75 x 100
SF-10.0	10.0 c/mm	Yes	-	60 x 100
SF-12.0	12.0 c/mm	Yes	-	50 x 100
SF-16.0	16.0 c/mm	Yes	-	39 x 75
SF-20.0	20.0 c/mm	Yes	-	31 x 50
SF-24.0	24.0 c/mm	Yes	-	27 x 45

VISUAL MTF DEMONSTRATION SLIDE



Test Pattern LSM-1 is a 35 mm projection slide designed to demonstrate the modulation transfer function (MTF) of the human eye. Its transmittance varies sinusoidally and increases in spatial frequency from 0.2 to 20 c/mm, following a logarithmic scale. The modulation increases linearly from top to bottom. One can see in the projected image, where visual contrast disappears as a contour that is the MTF of the eye. The slide is supplied as 2” x 2” cemented in glass.

SINUSOIDAL ZONE PLATES ZP-1 AND ZP-2



Zone Plates ZP-l and ZP-2 were designed as test patterns for high definition television. Each of these is circularly symmetrical and the spatial frequency increased linearly with distance from the center. These zone plates serve as a sensitive means for detecting frame jitter which appears as a moiré pattern.

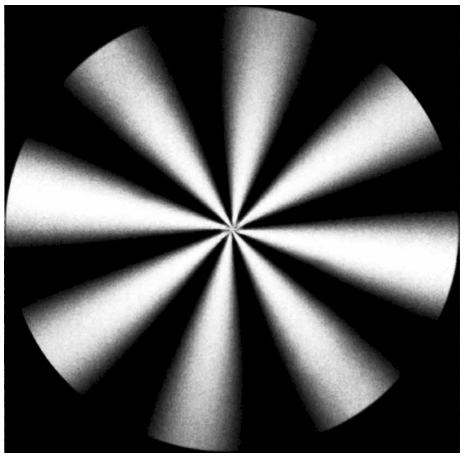
When ZP-2 is masked to a length-width ratio of 1.77:1, the spatial frequency at the top and bottom edges corresponds to 500 TV lines, as shown in the diagram.

ZP-l is similar to ZP-2 except that all spatial frequencies are doubled.

Each pattern contains a series of superposed black lines that designate each 100 TV line interval. The numbers to the upper right of the figure are for ZP-2 while those to the lower left are for the ZP-l. Modulation is approximately 60% over the complete area.

The pattern is on a piece of 7-mil unperforated film, but can also be placed in a 35 mm slide mount.

SINUSOIDAL STARBURST SB-1



The SB-l is an 8-sector "starburst" pattern that has a diameter of 103 mm (4 inches). It is made on a fine grained film which has a 7 mil (0.175 mm) base thickness. The modulation is approximately 80% with minimum and maximum densities of approximately 0.2 and 1.2 respectively. Modulations of the harmonics are of the order of 2% or less. (Measurements made toward the edge.)

This pattern can be very useful as a light beam modulator. Because of its high average transmission, the light throughput is about four times that obtained with crossed polarizers.

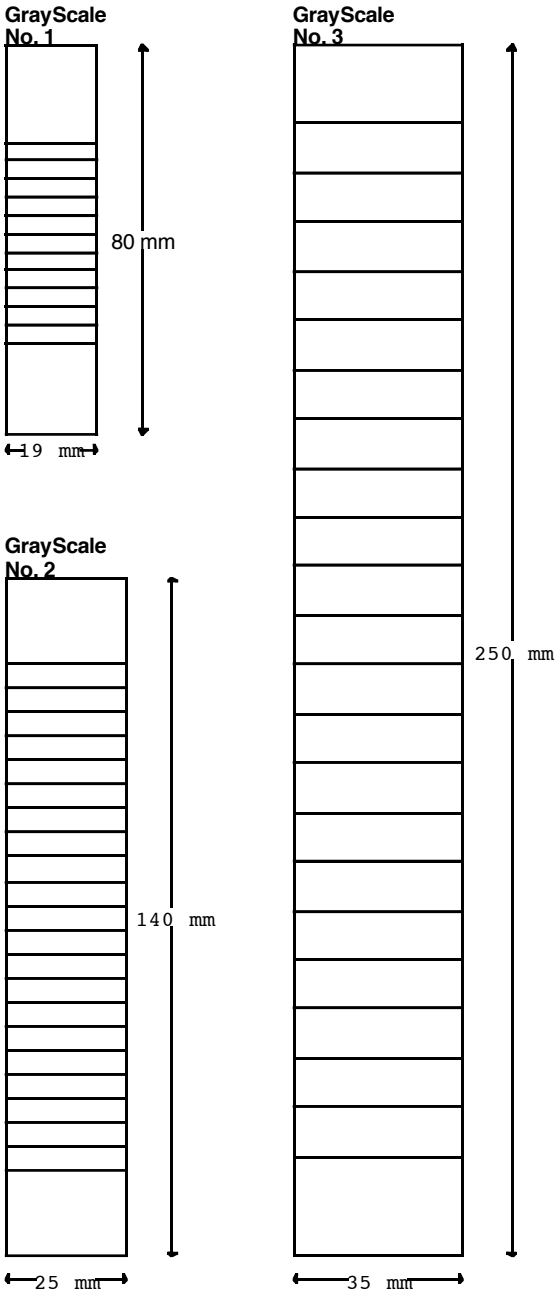
Starburst pattern with almost any number of sectors can be made on a special order basis.

DENSITY WEDGES, GAUSSIAN FILTERS, SPECIAL ORDERS

Because of our specialized facilities and extensive experience with photographic techniques, we are able to produce a wide variety of special order items. Continuous tone density wedges, for example, can be a low-cost alternative to metal on glass items.

We can also produce special masks such as gaussian filters. These are made photographically and are cemented between optical quality glass. Call us and we will be glad to discuss your special requirements.

GRAY SCALES



Transmission Gray Scales

Grays scales No. 1, No. 2, and No. 3 are transmission type; photographic silver on a thick base film (0.175 μm or 0.007 in. thick). They are available either calibrated or uncalibrated. Each gray scale ranges from 0.05 to 3.05 in density. Step widths and density increments are as follows:

	Step Width	Step Density Increment
No. 1	3.75 mm	0.30
No. 2	5.00 mm	0.15
No. 3	10.16 mm	0.15

Reflection Gray Scales

Gray Scale No. 4

0.70	0.10	0.15	0.20	0.25	0.30	0.35	0.40	0.70
0.45	0.50	0.55	0.60	0.65	0.70	0.75	0.80	0.85
0.90	0.95	1.00	1.05	1.10	1.15	1.20	1.25	1.30
0.70	1.35	1.40	1.45	1.50	1.55	1.60	0.10	0.70

40 mm

90 mm

Gray scale No. 4 is reflection type and is on semi-matte photographic paper. It is available either calibrated or uncalibrated. The four corner patches for the calibrated scales are within 0.02 density of one another. Each area is 10 mm square.

Custom Gray Scales

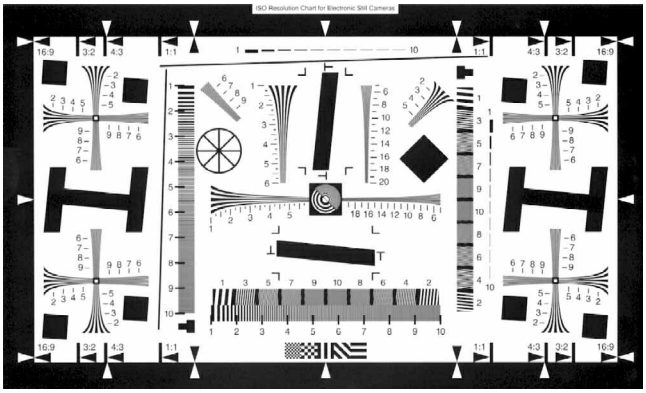
Custom transmission or reflection gray scales can be made to your requirements. Contact us to discuss your needs.

STANDARD TEST CHARTS

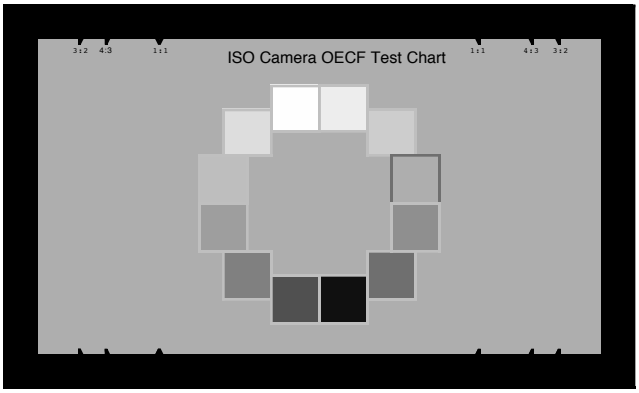
PIMA / ISO Camera Resolution Chart

Our PIMA Camera Chart conforms to ISO Final Draft International Standard 12233, "Photography-Electronic still picture cameras - Resolution measurements". This target's active area measures 20 cm high and has features of 0.1 mm. This target is available in the following sizes:

½X — 17.8 cm x 10 cm
1X — 35.6 cm x 20 cm
2X — 71.1 cm x 40 cm
4X — 142 cm x 80 cm



PIMA / ISO Camera Contrast Chart

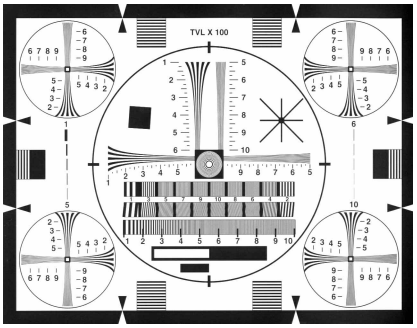


Our Camera Contrast Chart conforms to International Standard ISO 14524, "Photography-Electronic still picture cameras – Methods for measuring opto-electronic conversion functions (OECF's)". This target's area measures 35.6 cm wide by 20.0 cm high and has 12 gray levels on a durable photographic material. The densities range from 0.10 to 2.30.

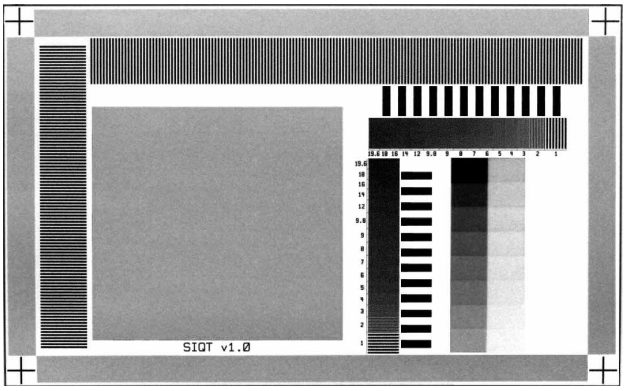
IEEE Resolution Chart

The IEEE Chart conforms to standard STD 208-1995, "Measurement of Resolution of Camera Systems". This standard is used to test frequency response characteristics, performance of the lens, camera, and display device. It replaces the EIA Resolution Chart.

This target measures 20.4 cm x 16.8 cm.

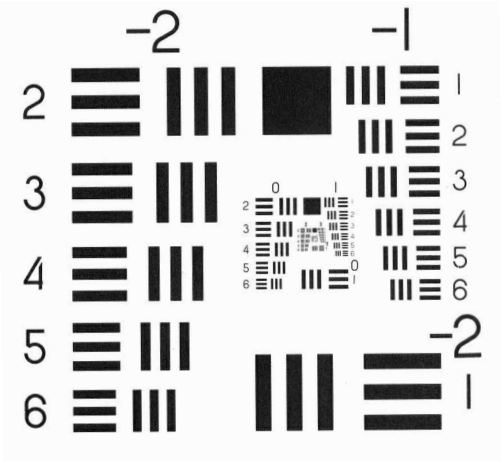


FBI SIQT Scanner Test Chart



The FBI designed this chart for gray level and resolution testing of the new Integrated Automated Fingerprint Identification System (IAFIS). The chart includes Ronchi areas with frequencies from 1 c/mm to 19.6 c/mm, and uniform gray areas having consistency better than ±0.02 OD. Target size is 20.0 cm x 12.5 cm on a high durability base. (See also our M-13 and M-15; FBI standards for fingerprint scanners.)

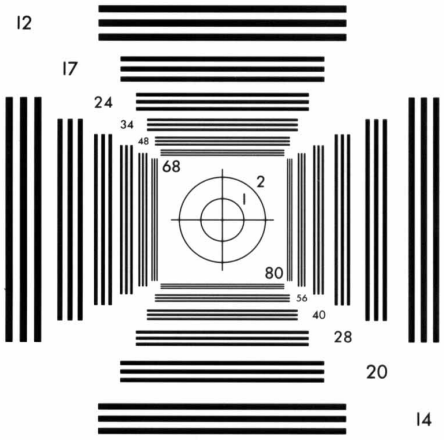
USAF 1951 Chart



The USAF Test Chart was developed for use with military specification Mil-Std-150A. It is one of the most commonly used resolution targets. Each test target comes with a chart that specifies the line pairs per mm for each group and element. A special box is provided for storage.

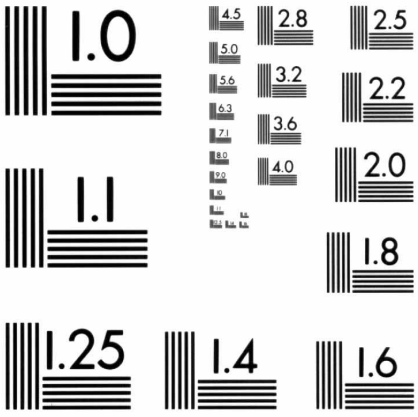
Available as black lines on white or as white lines on black. This target can be provided as chrome on glass or on a variety of photographic films or papers. Available sizes are 50 x 50 mm and 100 x 100 mm.

NBS 1952 Resolution Chart



This chart consists of bars that range from 1.5 to 10 cycles (or line pairs) per mm. Its image area is 25 mm x 25 mm and can be provided as chrome on glass or on a variety of photographic films or papers.

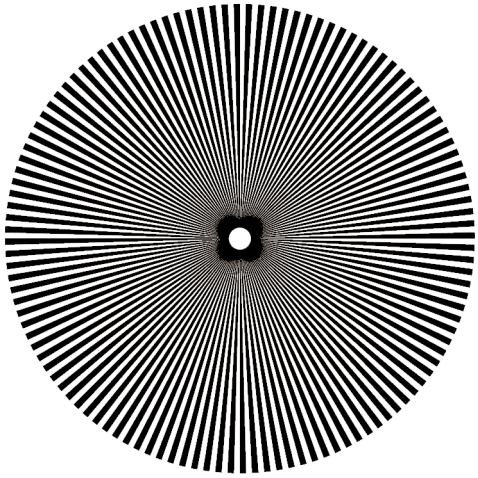
NBS 1963A Microscopy Chart



This Chart is also known as the NBS 1010A Microcopy Test Chart and the ANSI/ISO Test Chart #2. It consists of five bars of equal spatial frequency (equal lines and spaces) in the horizontal and vertical directions. There are a total of 26 groups that range from 1 to 18 cycles (or line pairs) per mm. The number adjacent to each group indicates the spatial frequency.

The Chart measures 75 mm x 75 mm and is provided with its own storage box. It can be provided as chrome on glass or on a variety of photographic films or papers.

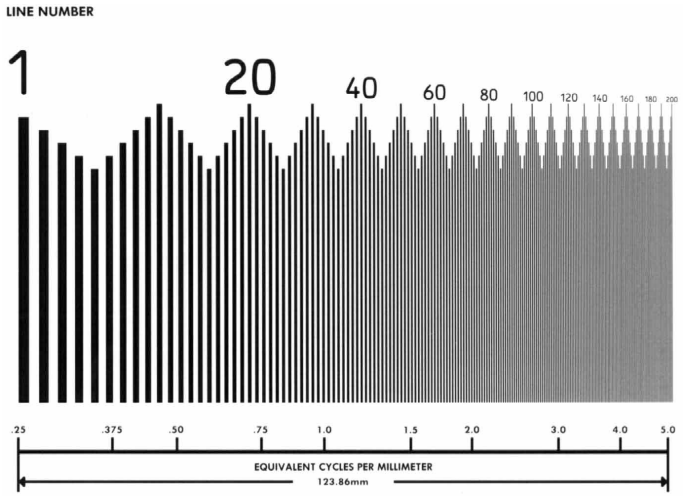
Sector Star Target



The Sector Star Target is designed to test for astigmatism. It consists of equally sized bar and space segments. This target is supplied on 4 inch substrate and available as chrome on glass or on a variety of photographic films or papers.

Sayce Logarithmic Chart

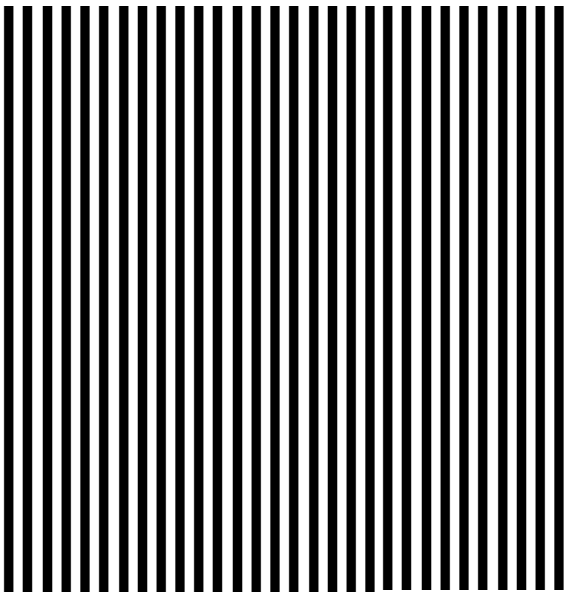
The Sayce Logarithmic Chart ranges in frequency from 0.25 c/mm to 5 c/mm with peaks every 10 cycles. Its image area is 3.75" x 5" and available as chrome on glass or on a variety of photographic films or papers.



RONCHI RULINGS

Sine Patterns Ronchi rulings are equal bar and space square wave targets, having very high contrast ratio and edge definition. They are available as chrome on glass or on a variety of photographic films or papers. Image sizes are 2" x 2" or 4" x 4".

Pattern Number	Line Pairs/mm
RR-1.0	1.0
RR-2.0	2.0
RR-2.5	2.5
RR-4.0	4.0
RR-5.0	5.0
RR-10	10.0
RR-12.5	12.5
RR-20	20.0
RR-25	25.0
RR-30	30.0
RR-50.0	50.0

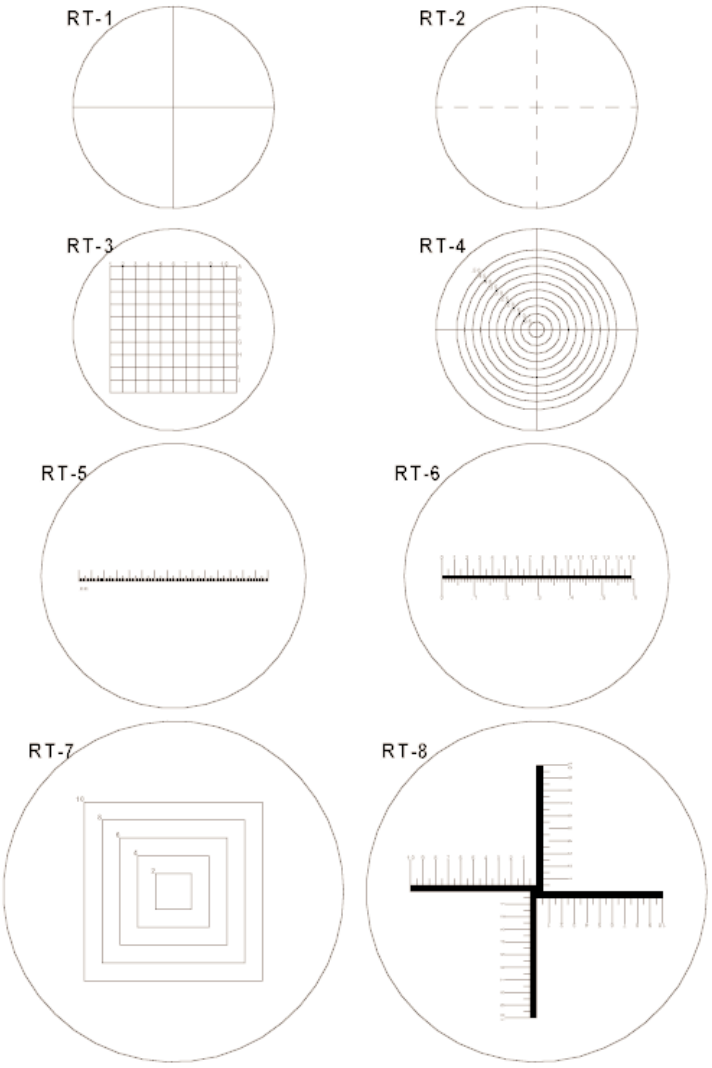


RETICLES & LITHOGRAPHY SERVICES

Please see our standard chrome reticles illustrated on the right and described below. In addition, Sine Patterns offers a wide range of lithographic services and products. Photo-emulsion glass reticles to chrome lithography, zinc selenide to UV grade quartz, in the size and shape you require. We manufacture precision encoders, masks, and apertures on glass. Our custom designed imaging devices will keep your tooling costs low. At quantities of one to thousands, we can meet your time lines and specifications. Contact us for your standard or custom lithography needs.

	Description
RT-1	Plain crosshair; centered
RT-2	Dashed crosshair; each dash and blank is 1 mm long
RT-3	Index squares; 1 mm or 0.05" each
RT-4	Concentric circles; 0.05 to 0.50" in 0.05" increments
RT-5	Metric line scale; 0 to 15 mm in 0.1 mm increments
RT-6	Inch / metric line scale; 0 to 15 mm and 0 to 0.06"
RT-7	Concentric squares; 2 to 10 mm in 2 mm increments
RT-8	Crossed scales; -10 mm to +10 mm

Reticles RT-1 through RT-4 are shown as 19 mm diameter. RT-5 and RT-6 are shown as 21 mm diameter, and RT-7 and RT-8 are shown in 27 mm diameter. Each reticle is available in 19 mm, 21 mm, or 27 mm diameter.



MICRODENSITOMETRY SERVICE

Since very few of our customers have access to a microdensitometer and a scan represents a basic calibration of a test pattern, we include scans with each sinusoidal test pattern. Sine Patterns also provides microdensitometer scanning on service basis.

Our microdensitometer has been specially equipped and programmed to perform a digital scan for each spatial frequency. Fourier analysis is used to determine modulation values for the fundamental, first and second harmonics, and peak to peak modulation. Modulation values are corrected for the MTF of the microdensitometer. Average density values are reported from scans made of the gray scale. All scans are calibrated in terms of diffuse density.

Scanning slit width is equivalent to 1 μm, using 0.25 N.A. microscope objective (0.2 N.A. substage) for transmission patterns. For reflection patterns, slit width is 10 μm using a 0.11 N.A objective.

Sine Patterns llc