



Screen Printing with 3M™ 4-Colour Screen Printing Ink Series 1900 (Halftone Inks)

Description

Four colour screen printing is the reproduction of a full colour original subject as a halftone. The three primaries (yellow, magenta and cyan) plus black are printed sequentially in close register to form the image.

The processing of 4-colour screen printed markings requires careful preparation and execution. Please be aware the pigments in the 1900 Series 4-colour ink may be slightly different than those in the 9700 Series 4-colour ink. Adjustments may need to be made in the colour separations.

Four colour reproduction on 3M Controltac Plus, Scotchcal films and Scotchlite reflective sheetings allows the production of durable exterior pictorial graphics.

Product Line

The 3M 4 colour halftone ink series 1900 are offered as a part of the Matched Component System (MCS™) which consists of the following:

4-colour half tone ink Series 1900	
1990	Yellow Halftone Ink Concentrate
1991	Magenta Halftone Ink Concentrate
1995	Black Halftone Ink Concentrate
1996	Cyan Halftone Ink Concentrate
1997	Standard Halftone Base
1998	Retarder Halftone Base

Clears, Thinners, Premask and Prespace Tapes	
Overprint Clear	1920DR high gloss 1930 matt
Thinners for inks & clears	CGS-30 CGS-50 CGS-80
Premasking	SCPM-19
Prespacing	SCPS-100

Petrol resistant clear	1955 ABC See IB3.12.2
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Note: The higher the CGS number, the slower the evaporation rate. Matt overprint clear 1930 and petrol restart overprint clear 1955 ABC cannot be used for 3M™ Controltac™ Plus Graphic Marking System for Curtain Sided Vehicles Series 190 and 3M™ Scotchcal™ Contour Film Series 1100.

Packaging

The ink halftone concentrates, halftone bases, overprint clears and thinners are sold in one US gallon (3.8 litres) containers. The halftone bases are also sold in five US gallon containers.

Storage

Inks should be stored between 21°C and 32°C (70-90°F) and be used within one year of the date of purchase.

Ink Coverage

Ink Coverage 4-Colour Inks

The coverage of a halftone ink will be affected by many factors, primarily the screen mesh, the average halftone dot density. Under typical conditions, with a 120T mesh screen, one litre of press ready ink will cover 45 sqm with 100% dot coverage. Ink coverage on the finished graphics (un-clearcoated) must not exceed 280%. This can be accomplished by a chromatic colour removal by the colour separator. If more than 280% ink coverage is used, the finished graphics may have unacceptable flexibility after application.

Overprint Clear Coverage

One litre of unthinned overprint clear will cover approximately 60 sqm when thinned to print viscosity, and printed through a 90T screen. Use of less than recommended usage of overprint clear can result in shortened durability.

Ordering Quantities

After the required ink halftone concentrate quantities have been determined, other required items can be estimated as follows:

Halftone base 1997 or 1998: 4 gallons for each gallon of ink halftone concentrate.

Thinner for inks are CGS-30/50/80. These thinners can be added up to 15% of the total ink to adjust viscosity and drying rates.

These thinners are also used for the overprint clear and can be added up to 30% by weight.

Since the two halftone bases can be mixed, experience with a given printing situation will determine a "best" combination. It is recommended to start with the retarder halftone base 1998. Experience with a given printing situation will also determine a "best" combination of thinners.

The ink halftone concentrates have been formulated in such a way that 20% ink halftone concentrate and 80% halftone base reach target densities when printed through a 120T fabric.

The amount of halftone concentrate should be from 15 to 25% of the total press-ready ink. You should never use less than 10% halftone concentrate as this can cause a decrease in durability. You should never use more than 35% halftone concentrate.

Stock Preparation

Sheet Cutting

To avoid registration problems during fabrication, all sheets should be cut from the roll in the same direction. Generally this can be done by cutting sheets with the longest dimension parallel to the liner printing.

Conditioning of Stock

Stacking of cut sheets should be avoided even when shop humidity is controlled because stack pressure causes uneven humidity absorption or loss with resultant waving or curling of the sheets' edges.

Racking of the sheets individually, liner side up or face to face, overnight in the shop will tend to stabilise them.

It is important during this conditioning that the sheets be supported and kept flat over their entire length and width.

Some screen printers find it advantageous to run the unprinted sheets through the conveyor dryer once immediately before printing.

Screens

Screen Preparation

Screen mesh recommended is a 120T fabric.

Note: The following procedures and recommendations assume the availability of a satisfactory halftone positive. If guidance is needed in obtaining a satisfactory positive, refer to Instruction Bulletin 1.1.

It is strongly recommended that all four stencils for a graphic be prepared before printing begins. Screen frames should be rigid and large enough to provide at least 15cm (6 inch) well between the frame and the open stencil area.

To reduce the possibility of moire effect, it is recommended that the separations be pre-angled at 7 degrees relative to the screen frame. The fabric for the four stencils must have the same uniform tension.

Screen Exposure

Screens should be exposed in a vacuum frame or with a direct projection camera system.

When working with a vacuum frame the exposure lamp should be separated from the screen plane by a distance greater than the diagonal dimension of the area to be exposed. Each exposure should be monitored by the inclusion of a transparent grey scale and controlled by an exposure integrator.

Tight uniform contact between the halftone positive and the stencil must be maintained throughout the exposure. Poor contact in any area will cause a loss of dot percentage.

If the final positive does not include the image of colours bars, they should be added. A piece of opaque tape in the rim area of the positive will create an opening in the screen which will print a solid colour.

Squeegee

The use of a 75 to 80 durometer blade is recommended. The squeegee should be long enough to cover the image area and extend 5cm (2 inch) or more at each end. The blade must be sharp and free of scratches and nicks.

Ink Preparation

It is important that enough ink be matched for the entire job in one batch. Even the most careful weighing and mixing may not produce two lots of the same colour which print at the same density.

These small density shifts which affect the grey balance can be avoided by mixing enough ink in one lot.

 **CAUTION:** If exact formulas are not available, colour strength should be gauged by ink room swatches or by screening from a small test quantity. Extreme care should be taken to avoid mixing inks at a too high colour strength as the halftone base additions to correct them will result in large volume increases.

The following table gives suggested mixes by weight percentage which have been found to give good results.

Table 1

	Suggested	Allowed Range
Ink halftone concentrate	20%	10-35%
Halftone base (equal parts 1997 and 1998)	80%	65-90%

Up to 15% thinner CGS-30/50/80 may be added to reduce the viscosity. Addition of more than 15% thinner is normally not necessary and will adversely affect the dot gain.

Printing of large images or very small halftone dots or with long mesh open times may require a higher proportion of retarder halftone base 1998 and/or thinner CGS-80. This should be undertaken with caution as slow-drying problems may result as the system is retarded. A shift toward higher proportions of halftone base 1997 will increase the drying speed but may lead to drying in the screen.

Note: Except as specified in this instruction bulletin, the printing of the 1900 Series 4-colour ink at reduced strength, use in colour formulations for line copy, or any modification of colour hue is not recommended or warranted.

Mixing

It is recommended that inks be mixed on a high speed power mixer for 10 minutes. If it is necessary to add ink halftone concentrate, halftone base or thinner to adjust density or printability, the ink should be mixed for an additional 15 minutes.

Due to the thixotropic characteristic of these inks, they will become more liquid when stirred. On standing they return to a more viscous condition. The proper consistency will be "thicker" than most screen printers are accustomed to handling. Thinning to a normally used consistency will result in unsatisfactory results (flooding of negative printing dots and smearing of positive printing dots).

Ink Adjustment

When first mixed or as a result of the first screen impressions, it may be necessary to adjust the printing density or printability of the ink. Because accurate density adjustment requires the use of a densitometer or a visual standard, adjustment methods are explained later in the section on colour control.

Additional thinner may be added to adjust ink flow but the total thinner addition, including thinner added at initial mixing, should not exceed 15% of the weight of ink halftone concentrate and the halftone base. All ink adjustments should be kept as small as possible and should be recorded for future reference.

Printing Order

The printing order of the colours is not critical but should be the same as the order used in proofing.

Drying Conditions

The 1900 series 4-colour inks should be conveyor dried.

 **CAUTION:** Printing onto Controltac *Plus* 190 *Plus* film requires conveyor drying. Listed below are some suggestions for obtaining properly dried markings. Times and temperatures given will vary with equipment, amount of thinner or retarder, ambient temperature, humidity and air flow.

Primaries and Black

Should be conveyor dried at 60-70°C (120-160°F) with 25-30 seconds dwell time.

Note: Insufficient drying can result in blocking, sticking or severe surface impressions. Excessive drying may cause sheet dimension change resulting in registration problems.

It is essential that sufficient residual thinner be removed from the marking before the premask tape

is applied. If there is any question as to sufficient dryness, a dryness test should be performed.

Dryness Test

This test is used to determine if adequate drying has taken place.

- a. Take several printed sheets and place them under a 30cm (12 inch) stack of film or under a weight of 135 g/cm².

Note: Sheets must not be stacked face to face.

- b. After 10 minutes, remove the sheets and check for blocking (sticking together) or surface impression.
- c. If blocking or severe surface impression is noted, additional drying is required. If conveyor drying, either the temperature should be increased or the belt speed decreased.

Registration

Maintaining good registration is critical to good visual colour balance. The single most important factor affecting the ability to maintain registration is drying temperature. It is important to the entire process that drying temperatures be only as high as is absolutely necessary.

Colour Control Tools

Production of a large number of multi-sheet 4-colour markings requires a high degree of colour control. Visual judgment of colour and density are not satisfactory. Listed below are two quality control tools which are essential to high yield of quality markings.

1. A satisfactory proof or acceptable colour progressive of the same marking retained from a previous printing with the same inks. In either case, colour bars must be present for solid tone measurements.
2. A reflection densitometer equipped with colour filters identified as “separation” or “graphic arts” filters (narrow band). Colour filters identified as Status A, M, T or SPI are not acceptable.

Colour Density Targets

A measurement of the density of the first colour colour-bar of the proof serves as the target density for printing the first colour. This measurement can be made on either of the items in #1 above.

If either of these is not available, the density that one obtains for a marking will depend on the model of densitometer used and its conditions from length

of use, age of bulb in densitometer, age and condition of filters, and so on.

Density readings should not be quoted and transferred from one densitometer to another. Printed colour bars, either litho or screen printed should be used for reference.

Table 2 lists, as an example, some densities of the Y, M, C, K that one might obtain.

Table 2

Colour	Suggested Target Density
Yellow (Y)	1.00
Magenta (M)	1.30
Cyan (C)	1.30
Black (K)	1.50

Note: Prior to measuring the densities of the proof, make sure the densitometer has been zeroed to the white of the substrate before measuring the densities of the printed 1900 series inks.

Colour Control – First Colour

Once good screening conditions have been established, the density of a colour bar should be measured and compared to the target value. If this density differs from the target by more than 0.03 the inks will need to be adjusted. For other than mechanical adjustments, refer to Table 3 for guidance.

Colour Control – Other Colours

The commitment to a density for the first colour establishes the density targets for the subsequent colours. Each of the original target densities should be adjusted by an amount equal to the difference between the first colour and its target.

The following example will illustrate this.

Colour	Target	Actual	Difference	New Target
Yellow	1.00	0.91	-0.09	
Magenta	1.30		-0.09	1.21
Cyan	1.30		-0.09	1.21
Black	1.50		-0.09	1.41

Every attempt should be made to screen to densities within 0.05 of these targets.

As printing progresses, the densities of the colour bars and selected areas of halftone dots should be monitored. Any change in the densities indicates a potential problem which should be addressed before a density drifts out of an acceptable range.

Ink Adjustment – Density

If it is necessary to increase or decrease the printing density of the ink as originally mixed, the following table may be used to estimate the quantities of ink concentrate or halftone base and thinner which must be added to effect the desired result.

Table 3

Desired density change	Percentage of original to add
0.05	12%
0.10	26%
0.15	41%
0.20	58%
0.25	78%
0.30	100%

Thus, to increase the density by 0.15, an addition of 41% of the original weight of ink concentrate is required. A decrease in density by 0.10 will require an addition of 26% of the original weight of halftone base and thinner.

Note: If the ink has been reclaimed from the screen, original weights must be reduced based on the reclaimed weight before the additions are calculated.

Overprint Clear

1. May be conveyor dried at 60–70°C (120–160°F) with 25–30 seconds dwell time.
2. Air drying is not recommended.

In order to obtain the stated durability of the Overprint Clear thickness after drying, there must be a minimum of 0.006 mm on the printed areas.

Test for thickness as follows using a micrometric gauge.

1. Apply pressure-sensitive masking tape down the entire length of the film in the centre. Apply overprint clear, remove tape and dry thoroughly.
2. Measure thickness of overprint clear by reading calliper at point (1) adjacent to taped area and then at taped area, point (2) on base material.
3. The difference between these two readings will be the dry thickness of the overprint clear coating.

It is likely that this thickness can also be obtained by one of the following methods:

1. Screening the overprint clear through a 90T screen fabric or coarser.
2. Roll coating, thinning the clear not more than 30% by weight with thinner.

Most screen printing shops do not possess reliable means to measure the dry overprint clear thickness. It can be assumed that sufficient clear has been applied if shop documents verify overprint clear usage (discounting waste) of at least one litre for each 60 sqm coated.

The same variables that affect drying of the ink also apply to the overprint clear. Insufficient drying will result in blocking or severe surface impressions.

Check for sufficient dryness of the clear using the test for dryness outlined under Ink Drying Test. If markings are to be premasked, several sheets should be premasked and tested using the test for dryness outlined under Ink Drying Conditions Dryness Test.



CAUTION: Graphics are not warranted without clear coat. Matt overprint clear 1930 is neither intended nor warranted for use onto Controltac *Plus* 190 film.

Screen Wash-Up

Use a commercially available solvent based screen cleaner.

Cleanup of ink and clear from screens and equipment can also be accomplished with CGS-50, CGS-80 thinner or MEK (methyl ethyl ketone).



CAUTION: When using solvents, follow all manufacturer's instructions and review and follow all health and safety information. Refer to container labels and MSDS's for health, safety and handling instructions.

Premasking/Prespacing

After the markings are thoroughly dry they should be premasked with Scotchcal Premask Tape SCPM-19 and prespaced with SCPS-100. Refer to Instruction Bulletin 4.3 for detailed information.

Storage of Printed Film

Fabricated markings must be stored flat or on a core with a diameter of at least 13 cm (5 inch), wound film—side out and in a clean area free from excessive moisture and direct sunlight, with ambient temperatures of 30°C (85°F) or less. Markings may be stored up to one (1) year prior to use.

Packaging

Finished markings must be substantially free of residual thinner prior to packaging. Premasked markings need not be slip sheeted unless the protective liner has been imprinted or the marking has been premounted and the premask removed.

When slip—sheeting is necessary, use Scotchcal Easy Release Liner Paper SCW—33.

For more specific storage and packaging instructions, refer to Instruction Bulletin 6.5.

Related 3M Literature

Listed below is related 3M technical literature which may be of interest.

Subject	Product	Instruction Bulletin(s)
Design of Markings		2.1
Preparation for 4—colour printing		1.1
Screen Printing Ink series 1900	1900	3.12
3M Scotchcal overprint clear & Edge Sealer Series 1955 ABC		3.12.2
Scoring and Cutting		4.1
Premasking and Prespacing		4.3
Surface Preparation		5.1, 5.12
Storage		6.5
3M Graphics Warranties matrix		—

Health & Safety

Refer to the package label and the Material Safety Data Sheet for health, safety, and handling information on the products referenced in this bulletin. For 3M products, if necessary, you may contact our Toxicology/Product Responsibility Department on 01344 858000.

Important Notice to Purchaser

The 3M products described in this publication are covered by a 3M warranty and limitation of liability.

3M's warranty provides that if 3M finds that goods are defective in material or workmanship they will be replaced or the price refunded at 3M's option but note that 3M does not accept liability for other direct losses (except for personal injury or death) or consequential losses relating to defective products or from information supplied by 3M.

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For help on specific questions relating to 3M Commercial Graphics Division Products, contact your local Technical Service Representative.

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