



Screen Printing with

3M™ Screen Printing Ink Series 9700UV 4-Colour Inks

Description

The inks in four colour ink series 9700UV are high performance, ultraviolet radiation-curable inks formulated for use on selected 3M films and films. Refer to the most current Product Bulletin 9700 for detailed information on applications, limitations and warranties.

Clear 9720UV is formulated for use on selected 3M piezo inks. Refer to the Product Bulletin for the ink series for detailed information on applications, limitations and warranties. For processing information see Instruction Bulletin 3.4.

Product Line

The 9700 series UV 4-colour halftone inks are offered as part of a Matched Component System (MCS™) which consists of the following:

9700 series UV 4-colour half tone inks	
9710	Toner
9720	Overprint Clear (Gloss)
9730	Overprint Clear (Low Gloss)
9791	Magenta Concentrate
9792	Yellow Concentrate
9795	Black Concentrate
9796	Cyan Concentrate
9797NUV	Halftone Base

Clears, Films, Premask/Prespace Tape	
Overprint Clear	9720 (Gloss) 9730 (Low Gloss)
Film	Controltac <i>Plus</i> , Scotchcal <i>Plus</i> , Scotchcal Films
Premask/ Prespace	SCPM-44X

Packaging

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

Storage

Inks should be stored in the original container or in other sealed polyethylene containers. Do not store in metal or glass containers.

Inks should be stored away from heat sources at temperatures between 0–27°C (32–80°F) and used within one year of the date of purchase. Inks should be stored and used in areas away from direct sunlight, mercury vapour lamps, quartz–halogen lamps and arc lamps. Do not use ink which shows signs of gelling.

Coverage

The coverage of the inks and overprint clear, applied as recommended in this bulletin, will be approximately 70–85 sqm per litre when printed with 100% dot coverage. This coverage will vary depending on screen mesh and type, squeegee durometer and angle, and emulsion thickness.

Stock Preparation

Conditioning of Stock

For best results, sheets should be allowed to stabilise under shop humidity and temperature conditions before a run is started. Any significant variation between storage and shop area conditions or in shop conditions between start and finish of a printing run may cause sheets to curl or the printing to go out of register.

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.

Proper stock conditioning is especially important where hairline registry or multiple coloured markings are to be produced.

Sheet Cutting

If possible, all sheets which are to be screen printed should be cut from the roll in the same direction. Generally, a good rule to follow is to cut sheets with the longest dimension parallel to the printing on the liner.

If hairline registry is required in one direction, and where sheet size permits, sheets should be cut so that the critical dimension is parallel to the liner printing.

Screen Preparation

Note: The instructions, which follow, assume the availability of satisfactory halftone positives. If guidance is needed in obtaining satisfactory positives, refer to Instruction Bulletin 1.1.

It is strongly recommended that all four stencils for a graphic be prepared before printing begins. The fabric for the four stencils must have the same uniform tension.

Note: It is extremely important that the screens be the same mesh, manufacture, and tension as the ones used to print the colour standards provided to the colour separator. Changes in screen mesh, screen type, tension, stencil type or stencil process may render the stencils unusable.

Screen Fabric

Selection of the fabric is critical in being able to successfully print 4-colour pictorials using the 9700 Series UV 4-colour inks.

The objective is to choose a fabric which will allow the thinnest layer of ink deposit possible. Thick ink layers (high dots) make it difficult or impossible to print subsequent layers. The total fabric thickness should be less than 50 microns.

The recommended fabric for printing the halftone inks is a polyester, monofilament, plain weave fabric only.

Fabrics with a thread count of 150-165 and a thread diameter, which does not exceed 34 microns have been found to give satisfactory results.

The tension on the fabric should be as high as possible with a target of 20 Newtons after emulsion coat. High tension allows for a more uniform print with minimum printing problems.

Uniform tension between screens is absolutely critical for printing matched panels. Uniform tension in both directions on the screen frame is also critical for proper printing.

Screen Frame

Use a rigid frame, preferably metal, which is large enough to provide a 15 to 25 cm (6 to 10 inch) well between the frame and the open design area.

The fabric must be tightly and uniformly stretched and fastened onto the frame.

Stencil

Selection of a stencil system should be based on achieving a thin, uniform coating with a very smooth surface on the print side of the screen. Some systems, which have given good results, are:

Indirect Emulsion (Capillary Films) – Films of 15 microns or thinner are recommended.

Direct Emulsion – A high quality type emulsion either diazo, photopolymer or diazo-photopolymer combination is recommended. To achieve the proper coating with a smooth surface on the print side of the screen, multiple coats will be necessary.

The emulsion thickness should not exceed 5 microns or dot height can cause printing problems. It has been found that 2-3 wet coats on the print side of the screen and 2 coats on the well side of the screen with a sharp scoop coater has given good results. It will be necessary to experiment with coating techniques to obtain the optimum system.

Thickness measuring devices, which measure the dried emulsion coating, are available which are useful in establishing the proper stencil system. Consistent and uniform emulsion thickness between screens is critical for making matched panels.

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 the screen to be unusable.

If the final positives do not include the image of colour bars, they should be added. A piece of opaque tape in the trim area of the positive will create an opening in the screen, which will print a solid. These colour bars should be at least 1 square inch and be positioned so that the colours do not overlap.

Squeegee

The use of an 80 durometer blade is recommended. While the single durometer squeegee will work, multiple durometer squeegees provide the best results. 70/90, 65/95/65, 70/90/70 or 75/95/75 durometers have been used with good results.

Screen Printing Method

To get a uniform impression, the “off–contact” method of screen printing is recommended.

A fill pass, before the impression pass, is recommended. Position the film under the stencil and hold in place by vacuum.

Prior to screen printing, remove any dust or foreign matter from the fabric and stencil area, and from each piece of film with a “Tack Rag” (varnish impregnated cloth). Cleanliness and control of dust is important to obtaining good results.

Screen Wash-Up

Use a commercially available solvent based screen cleaner.



CAUTION: When using solvents for cleanup, it is essential that proper precautionary measures, as recommended by the solvent manufacturer for handling such materials, be observed. Consult container labels and MSDS's for health, safety and handling instructions.

Overprint Clear

Do all tests in the testing section before printing the overprint clear. Should the overprint clear have poor adhesion, stop production and call 3M Technical Service.

Do not print another layer of ink or overprint clear over a cured clear coat. Any printing done on a cured overprint clear will not adhere.

The overprint clear does have a slightly yellow tint. The higher the energy level used to cure the clear coat and/or the higher the amount of heat the graphic is exposed to; the greater the yellow tint will be. Exposing the graphic to outdoor, ultraviolet light will photo-bleach most of the colour within a few days. Fluorescent lights will also photo-bleach most of the colour, but it will take a longer period of time.

Overprint clear 9720 and 9730 can be mixed to obtain a custom gloss. Adding overprint clear 9730 to 9720 will reduce the durability of overprint clear 9720.

Printing Graphics with more than 4 colours

Graphics that have an overprint clear and more than 4 colours and must have 1910 toner printed over the entire graphic (film and ink) after the 4th colour has been printed. This allows to print up to 8 colours plus an overprint clear.

Graphics that have 9 or more 9700 series UV ink colours must have 1910 toner printed over the entire graphic after colour 4 and colour 8. The maximum number of colours that can be printed is 12.

If the graphic has more than 12 it should be produced using solvent inks or a combination of solvent and UV inks.

Graphics that DO NOT have an overprint clear and have more than 5 colours need 1910 toner printed over the entire graphic (film and ink) after colour 5 is printed. This allows the printing of up to 10 colours.

Using 1910 Toner

Toner 1910 is a colourless, solvent-based, screen printing ink. It can be used to promote intercoat adhesion to overcured 9700 series UV ink. For graphics with more than 4 colours, 1910 toner prevents ink adhesion failure to other 9700 series UV ink colours or the bare film.

Mix 1910 70% toner with 30% CGS-30 thinner by weight.

1. Print the thinned 1910 toner through a 90-150 tpc screen mesh. A coarser screen will prevent the 1910 toner from drying completely.

Note: If 1910 toner dries in the screen, then use the slower thinner CGS-50.

2. Dry the graphic properly. Any remaining solvent will cause a permanent, cloudy, matt finish on top of the surface.

Ink Preparation

It is important that, if possible, enough ink of each colour be prepared at one time to print the entire job. Even careful weighing and mixing will often not produce two lots of the same colour that print at the same density. These small density shifts which affect the grey balance can be avoided by mixing enough ink as one lot.

Note: If exact formulas are not available, colour strength should be gauged by ink room swatches or by screening from a small quantity with later mixing and blending of the total quantity needed. Extreme care should be taken to avoid mixing inks at too high a 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.

	Ink Concentrate	9797NUV Halftone Base	9710 Toner
9791 Magenta*	20	60	20
9792 Yellow	20	60	20
9795 Black	20	60	20
9796 Cyan	20	60	20

*More toner will make the final ink 'softer'. More halftone base will stiffen the mixture.

Mixing

It is recommended the ink concentrates be thoroughly mixed by hand using a stirring paddle or preferably mixed on a high speed power mixer prior to usage.

After combining ink concentrate, toner and halftone base, the prepared ink should be mixed on a high speed power mixer for 10 minutes.

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, adjustment methods are explained later in the section on colour control.

Additional toner may be added to adjust ink flow. All ink adjustments should be recorded for future reference.

Curing

The 9700 series UV inks must be cured within five minutes of screen printing. Placing the sheets in a drying rack or otherwise delaying the curing process may cause an undesirable surface appearance.

The 9700 series UV inks may be cured using the method described under "UV Curing using Focused Cure Unit".

Screenprinting

Printing Order

Generally, the printing order is yellow first, followed by magenta, cyan and black.

While it may be possible to obtain satisfactory results from other printing orders, the order must be the same as was used to prepare the ink tests provided to the separator. Refer to Instruction Bulletin 1.1.

Registration

Maintaining good registration is critical to good visual colour balance.

Colour Control Tools

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

1. A satisfactory proof or acceptable colour progressives of the same marking retained from a previous printing with the same inks. In either case, colour bars must be present for density measurements and the proofing or printing sequence must have been the same.
2. A reflection densitometer equipped with colour filters identified as "separation" or "graphic arts" filters. Colour filters identified as Status A, M, T or SPI response are not acceptable.

Colour Density Targets

A measurement of the density of the first-colour solid colour patch serves as the target density for printing the first colour. This measurement can be made on either of the items in step 1 above. If either of these is not available, the following is a list of

suggested target densities assuming a printing sequence of YMCK.

Colour	Suggested Target Density
Yellow (Y)	0.90
Magenta (M)	1.35
Cyan (C)	1.30
Black (K)	1.60

Note: All density values stated here are relative to the substrate. That is, the density of the substrate is read with the appropriate colour filter in place and that value is subtracted from the reading obtained from the colour bar. Or, alternatively, the densitometer is adjusted to read zero as the density for the substrate.

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 0.10 (0.05 if comparing to a progressive), an adjustment in density should be considered. For other than mechanical adjustments, refer to the table in paragraph "Ink Adjustment-Density."

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 examples will illustrate this.

Colour	Target	Actual	Difference	New Target
Yellow	0.90	0.81	-0.09	
Magenta	1.35		-0.09	1.26
Cyan	1.25		-0.09	1.16
Black	1.60		-0.09	1.51

Every attempt should be made to screen to densities within 0.03 of these new targets in order to preserve the colour balance.

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 toner which must be added to effect the desired result.

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 toner.

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.

UV Curing Using Focused Cure Unit

Chemistry

Focused cure units use high concentrations of ultraviolet light to initiate polymerization, resulting in a tough, flexible, chemical and abrasion resistant coating.



CAUTION: Please contact equipment manufacturer for information regarding safe operation of your particular equipment.

Focused Cure Unit Specifications

1. A curing unit with two lamps is recommended, each with an energy output of at least 200 watts per inch (wpi). One lamp with an output of two or three hundred wpi may be used if user determines there is not excessive heating of samples and slower belt speeds do not reduce production rates below acceptable levels.
2. Do not use "ozone free" bulbs. These bulbs may not produce the correct wavelength to properly cure 9700 series UV inks.
3. The UV energy output of the unit must be accurately measured to gauge energy levels specified for curing.

Use a Kuehnast or EIT radiometer with special 3M matched optics.

This unit may be purchased through 3M Commercial Graphics Division. Other radiometers may not give the same reading. All

radiometers must be compared to the 3M standard by 3M Technical Service.

- The energy levels across the entire web should be measured to ensure uniformity. Energy levels may be significantly lower at web edges.

Focused Cure Unit Operation

- UV energy levels should be measured at the beginning of every working day and whenever adjustments are made to the unit.
- Allow lamps to heat-up for at least 10 minutes or until indicators (if present) ensure lamps have stabilised.
- Adjust lamp wattage and belt speed, accordingly, to achieve specified energy level as measured by a Kuehnast or EIT radiometer.
- Replace bulbs according to the bulb manufacturers recommendations. Dirty lamps and reflectors will prevent the ink from curing properly.

Curing Energy Levels

Product	Required Curing Range	
	EIT [mJ/cm ²]	Kuehnast [mJ/cm ²]
9700 colours	150-200	180-220
9720 clear coat	300-350	320-370

The curing ranges specified above will ensure proper cure for most customer uses. However, if curing is attempted outside these ranges, care must be taken to ensure sufficient cure. Too low an energy level will result in a wet and tacky print. If the energy level is too high, intercoat adhesion failure may result.

⚠ CAUTION: Do not overprint the clear coat with another layer of overprint clear because intercoat adhesion failure may result.

Testing

Maintain a testing log for future reference. Each print pass must be tested to determine if the ink or the overprint clear is properly cured. Every print pass must pass all these tests.

- Appearance
- Abrasion Test
- Tape Snap Test

Appearance

The appearance should be checked before starting each colour and the overprint clear.

A properly cured print does not feel wet, is free of surface impressions, and passes the following tests.

Abrasion Resistance

- Using a RBA-1 rivet brush (available from 3M Commercial Graphics Division), firmly rub the surface of the cured sample a total of 10 times (one time includes forward and backward motion).
- The sample should exhibit good resistance to abrasion showing no softness or significant change in gloss. Some impression from the brush strokes is permissible.

Tape Snap Adhesion Test

- Using a sharp razor blade, knife, or other suitable instrument, scribe a crosshatch pattern through the ink layers. Do not cut through the film substrate.
- Using a PA-1 plastic applicator (available from 3M Commercial Graphics Division), firmly apply a strip of Scotch Tape #610 over the scribed area.
- Remove the tape by pulling it back upon itself using a rapid, firm pull.
- No separation of ink layers should occur.

Test for Intercoat Adhesion

The "Intercoat Adhesion Test" determines if the ink is overcured or if the film is overexposed. It tests the adhesion of the ink itself and the adhesion to the ink to the film. This test must be carried out before starting to print each colour and in several areas on the sheet.

Passing the sheet through the curing unit several times may change the surface characteristics of the ink and the film causing adhesion failure.

Testing only the first ink layer will not guarantee that the following ink layers are properly cured. For example, if the graphic has 4 colours and an overprint clear, the first colour will ultimately pass through the curing unit 5 times.

- Make press adjustments to produce an acceptable uncured print.
- Print an actual production sheet of the film that is to be used for the job, and pass through the curing unit at the recommended energy level. This sample sheet will be used for the entire test procedure.
- Test the sample sheet for proper curing using the "Abrasion Resistance Test", described earlier.

If sample passes - Continue to Step 4.

If sample fails -

- a) Recheck screen setup
- b) Raise energy level 5 millijoules and return to step 2.

4. The curing conditions are simulated by passing the sample sheet through the curing unit a number of times. The number of passes is determined by the following:

Count the number of inks that remain to be printed, including the clear coat. This figure, plus one, establishes the number of times the sample sheet is passed through the curing unit.

Example: Three colours and clear coat remain to be printed. Number of test passes = 3+1+1=5.

5. Pass the test sheet through the curing unit the number of times determined in step 4.
6. Overprint the sample sheet with another coat of ink or overprint clear and pass through the curing unit at the appropriate energy level.
7. Test intercoat adhesion of the sample using the "Tape Snap Adhesion Test", described earlier.

If sample passes - Continue to step 8.

If sample fails - Lower energy level 5 mJ and return to step 2.

8. Print the job at the lamp setting and belt speed determined above and record for future reference.

Premasking/Prespacing

After the markings are properly cured they should be premasked or prespaced with "Scotchcal" premask tape SCPM-44X. 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 38°C (100°F) or less. Markings may be stored up to one (1) year prior to use.

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 slipsheeting is necessary, use

Scotchcal Easy Release Liner Paper SCW-33. Markings applied on both sides of a substrate must have the shiny side of the slip sheet against each face of the marking.

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

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.

Purchasers and users of 3M products, and not 3M supplying companies, are always solely responsible for deciding on the suitability of the 3M product for their required or intended use.

Technical Assistance

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

Commercial Graphics Department
3M United Kingdom PLC
3M Centre, Cain Road, Bracknell
Berkshire, RG12 8HT
Tel: 01344 857850
Fax: 01344 857939
e-mail: commgraphics.uk@mmm.com
www.3m.com/uk/graphicsolutions
www.scotchprint.com/uk

Sales Assistance

Commercial Graphics Group
3M United Kingdom PLC
3M House, 28 Great Jackson Street
Manchester, M15 4PA

Tel: (0161) 237 6394
Free Fax: (0800) 378127
e-mail: commgraphics.uk@mmm.com
www.3m.com/uk/graphicsolutions
www.scotchprint.com/uk