



# Screen Printing with 3M™ Screen Printing Ink Series 9700UV

For line colour printing and clear coating of Piezo ink jet print graphics

## Description

Ink series 9700UV are high performance, ultraviolet radiation-curable inks formulated for use on selected 3M films. Screen print clear 9720UV may be used to protect selected piezo ink jet printed graphics. Refer to the base film's Product Bulletin for detailed information on intended uses, limitations and warranties.

The 9700 series UV inks were developed for use on films to give superior exterior performance on difficult application surfaces, including corrugated and riveted surfaces. In order to obtain these superior properties, the 9700 series UV inks may be cured in a focused lamp curing unit. Scotchcal 9700 series UV inks are not recommended for markings used on concrete transport trucks or other vehicles frequently washed with concentrated strong acids.

## Printer Training Requirement

All printers must receive training from 3M on handling and processing 3M™ Screen Printing Ink Series 9700UV before their graphics will be warranted by the worldwide 3M™ MCS™ Warranty.

## Product Line

The 9700 series inks are offered as part of a matched Component System (MCS™) which consists of the following:

9700 series UV screen printing inks	
9700	Flow agent
9701	Thinner
9703	White
9704	High Opacity White <sup>2</sup>
9705	Black
9710	Toner/Reducer
9713	Red Shade Orange
9714	Transparent Dark Green
9715	Red
9716	Transparent Green Shade Blue
9720	Overprint Clear (Gloss)
9723	Yellow Shade Orange
9724	Transparent Light Green
9725	Transparent Scarlet Red
9727	Transparent Blue-Violet
9730	Overprint Clear (Low Gloss)
9732	Green Shade Yellow
9735	Transparent Real Red
9737	Transparent Red-Violet
9752	Transparent Medium Yellow
9753	Transparent Orange
9757	Transparent Violet
9767	Transparent Magenta
9770	Transparent Red Shade Blue
9771	Deep Red
9772	Transparent Lemon Yellow

**Note:** 9702, 9712 and 9733 have been replaced with lead-free alternative inks. These are not one-to-one replacements, but can be used to colour match the lead containing inks with the follow approximate formulations.

## Packaging

The line inks, thinner and overprint clears are sold in one US gallon (3.8 litres) 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, applied as recommended in this bulletin, will be approximately 70–85 sqm for the line inks and the overprint clear. 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

### Screen Fabric

The recommended screen fabric for inks and clear is a polyester fabric with a mesh count of 150–165 tpc. The tension of the fabric should be as high as possible with a target of 16–18 Newtons after emulsion coat. High tension allows for a more uniform print with minimum printing problems.

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

Any photographic or hand–cut water soluble material may be used. The stencil material must be able to resist ketones and strong lacquer solvents.

### Squeegee

Use a sharp, medium to hard (80 durometer or harder) plastic blade. The squeegee should be large enough to overlap the design at least 5cm (2 inch) on each side.

**Note:** Softer durometer squeegees will increase ink lay down and can make it more difficult to cure inks. Multiple durometer squeegees can work well but each screen printer will have to test them in their own situation.

A lower squeegee angle may result in excessive ink lay down leading to a rough surface cured ink. The recommendation of a specific angle is difficult because of variations in press design.

However, the squeegee angle should be set at a position as nearly vertical as practical dependent on the press involved.

### 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.

## Compatible Inks and Films

### Screen Printing Inks

- 3M™ Screen Printing Ink Series 1900
- 3M™ Screen Printing Ink Series 2900

### Piezo Ink Jet Inks

- 3M™ Piezo Ink Jet Ink Series 1500
- 3M™ Piezo Ink Jet Ink Series 2500UV
- 3M™ Piezo Ink Jet Ink Series 4600
- 3M™ Piezo Ink Jet Ink Series 5500
- 3M™ Piezo Ink Jet Ink Series 6000
- 3M™ Piezo Ink Jet Ink Series 6800

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

Graphics that have 9 or more 9700 series 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

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

1. Mix 70% 1910 toner with 30% CGS-30 thinner by weight.
2. Print the thinned 1910 toner through a 90-150 tpc screen mesh. A coarser screen will prevent the toner 1910 from drying completely.  
**Note:** If 1910 toner dries in the screen, then use the slower thinner CGS-50.
3. Dry the graphic properly. Any remaining solvent will cause a permanent, cloudy, matt finish on top of the surface.

## Ink Preparation

### Mixing

To achieve an even distribution of all ink components, it is important to mix the ink before formulating the colours or printing.

It is recommended that the inks be thoroughly mixed on a high speed mixer, or paint shaker, for 10 minutes prior to use.

### Colour Matching

With critical colour matches of light colours, take into consideration that overprint clear has a yellow tint.

### Tinting

Inks may be tinted by adding 9703 White, up to 95% by weight to all colours, except for the following inks where no more than 75% by weight of 9703 may be added.

9727	Blue-Violet
9737	Red-Violet

## Toning

Inks may be toned by adding 9710 Toner up to 50% by weight. Do not use 9720 overprint clear to tone colours.

## Viscosity Reduction

Viscosity reduction can be achieved through the use of 9701 Thinner - Add up to a maximum of 10% by weight.



**CAUTION:** Do not add 9701 Thinner or 9710 Toner/Reducer to 9720 overprint clear.

## Viscosity Increase

An increase in viscosity for the 9700 inks can be achieved with 9797NUV Halftone Base. This may be necessary for printing fine lines, copy, or a halftone pattern. Adding approximately 5% by weight to the ink can increase the viscosity by 500 Centipoise. Test each application before use. Do not add more than 50% by weight of halftone base 9797NUV.

## Foaming

When printing at a rate of 1000-1500 impressions/hour or greater, foaming may occur which creates a poor flow-out appearance of the inks. If foaming occurs, proper flow-out of the inks can be achieved by adding up to 10% 9701 and 0.5% 9700 Flow Agent by weight.

## 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".

## 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 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 3M standard by 3M Technical Service.

4. 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

1. UV energy levels should be measured at the beginning of every working day and whenever adjustments are made to the unit.
2. Allow lamps to heat-up for at least 10 minutes or until indicators (if present) ensure lamps have stabilised.
3. Adjust lamp wattage and belt speed, accordingly, to achieve specified energy level as measured by a Kuehnast or EIT radiometer.
4. 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 <sup>2</sup> ]	Kühnast [mJ/cm <sup>2</sup> ]
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

1. 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).
2. 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

1. 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.
2. Using a PA-1 plastic applicator (available from 3M Commercial Graphics Division), firmly apply a strip of Scotch Tape #610 over the scribed area.
3. Remove the tape by pulling it back upon itself using a rapid, firm pull.
4. 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.

1. Make press adjustments to produce an acceptable uncured print.
2. 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.
3. 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

Premask/Prespace	SCPM-44X, SCPS-55
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## 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 slip sheeting 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.

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