



Screen Printing

With 3M™ 4-Colour Screen Printing UV Ink Series 9800

For 4-Colour Screen Printing

Product Replacement Note

3M™ Screen Printing UV Ink Series 9800 replaces 3M™ Screen Printing Ink Series 9700UV.

Recommended Types of Graphics and End Uses

Ink series 9800 is a high performance, ultraviolet-curable ink, formulated for use on selected 3M graphic films. Refer to the most current Product Bulletin 9800 for detailed information on applications, limitations and warranties.

Compatible Products for 3M™ MCS™ Warranted Graphics

Graphic Films

Ink series 9800 is compatible with most of 3M's Scotchcal, Controltac and Scotchlite branded graphic films that are designed for screen printing. Refer to the Product Bulletin for the base film being used for ink compatibility, intended applications, construction options and warranties.

Clears

- 3M™ Screen Printing Gloss Clear 9720UV
- 3M™ Screen Printing Low Gloss Clear 9730UV

Application Tapes

- 3M™ Premasking Tape SCPM-44X
- 3M™ Prespacing Tape SCPS-2
- 3M™ Prespacing Tape SCPS-55
(use on graphic films with 3M's Comply™ Adhesive)

Product Line

All information in this bulletin is subject to change. Be sure this is the most current Product Bulletin.

Process Colours			
9815P		Magenta	
9845P		Yellow	
9805P		Black	
9875P		Cyan	
Clears		Other Products	
9800CL	Gloss	9801	Thinner
		9810	Toner
		9800B	Halftone Base
		9800HBB	Heavy Body Halftone Base

Sheet Preparation

Conditioning

A change in humidity or temperature can affect the moisture content of the liner during storage and/or printing. These changes can affect the liner's dimensional stability and layflat characteristics, both of which can impact the ability to maintain tight tolerances and good print quality.

For the best results, follow these guidelines:

- Use films with polyethylene-coated liners.
- Keep the sheets of film wrapped in polyethylene.
- Do not condition the sheets of film by running them through the UV cure unit.
- Complete the printing as quickly as possible.
- Avoid stacking the sheets of film in an uncontrolled environment. The stacked sheets absorb moisture unevenly and develop wavy edges.

Cutting

The sheet size and the direction the sheet is cut from the roll can affect the liner stability due to humidity and temperature variations.

For the best results, follow these guidelines:

- Print a fewer number of graphics on a smaller sheet size instead of printing more graphics on a larger sheet.
- If possible, cut all sheets in the same direction and put the critical length parallel to the roll edge.

3M™ Scotchlite™ Reflective Film

Close colour matching of multi-sheet graphics is difficult on retroreflective materials because production lots may vary. Adjoining panels of reflective graphic films must be checked for both daytime and night-time appearance.

Ink and Clear Preparation

Coverage

Typically, the following coverage can be expected:

- One U.S. gallon (3.8 litre) of press ready ink series 9800 covers approx. 190 square metre/litre at 50% dot with a 150 threads per cm [tpc] plain weave mesh.
- One U.S. gallon (3.8 litres) of clear covers 59 to 83 square metre/litre with a 150 tpc plain weave mesh.

However, several elements affect the coverage:

- Screen mesh and type
- Hardness (durometer) of the squeegee
- Angle of the squeegee
- Emulsion thickness
- Average halftone-dot density

Mixing

- Return any ink adhered to the lid to its container.
- Thoroughly mix the ink before formulating colours or printing. This ensures an even distribution of the ink components.
- Use a high-speed power mixer with a blade that is 1/3 to 1/2 the diameter of the container. Put the blade 2/3 of the way into the liquid. Make sure to move it around in the entire container.

Ink

- Colour is supplied as a concentrate and must be let down to achieve the desired density. If the exact formula is not known start with;

	% Colour	% 9800B
Cyan	60	40
Magenta	80	20
Yellow	75	25
Black	30	70

- Print a test sample.
- If the density needs adjustment follow the directions under Colour Control on page 4.

- If the viscosity needs adjustment, replace all or part of the base 9800B with;
 - Toner 9810 or thinner 9801 to decrease the viscosity.
 - Heavy Body Half-tone base 9800HBB to increase the viscosity.

Clear

- Clear 9800CL is press ready. It should not be diluted with toner, thinner or base.

Printing

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

Note: The following instructions assume that the halftone positives are satisfactory

It is extremely important that the screen fabric be the same mesh size, manufacturer and tension as the screens used to print the colour standards supplied to the separator. Changes in the screen mesh, screen type, tension, squeegee geometry, stencil type, or stencil process may change the colour.

Frame

- Use a rigid, metal frame. Include a 15 to 25 cm well between the frame and the graphic design on all sides.
- Use a screen tension of at least 20 Newtons after the emulsion coat. High tensions produce a more uniform print with a minimum of printing problems. The emulsion coating lowers the tension.
- Tension the fabric the same amount in both directions and the same on all four screens. Uniform tension is absolutely critical for printing matched panels.

Fabric

Fabric selection is critical for printing four colour pictorials with ink series 9800. Choose a fabric that lays the thinnest ink deposit possible. Thick deposits (high dots) make it difficult or impossible to print the next colours successfully.

Inks and Clear 9800CL

- Use a polyester, monofilament, plain weave fabric.
- Use a thread count of 140 to 150 tpc
- Use a thread with a diameter of 31 to 34 microns.
- The thickness of the clear will be 10 to 15 microns depending on the fabric used.

Note: Calendered fabrics, twill weaves and thick threads affect the ink lay down and cause printing and curing problems.

Stencil

Choose a stencil system that produces a thin, uniform coating with a very smooth surface on the print side of the screen. Make all four stencils for a graphic before printing begins.

Indirect Emulsion (capillary films)

Use a film that is 15 microns or thinner.

Direct Emulsion

- Consistent and uniform emulsion thickness between screens is critical for making matched panels.
- Use a high quality emulsion, either diazo, photopolymer or diazo-photopolymer combination. To obtain a smooth surface on the print side of the screen, multiple coats are necessary.
- The emulsion thickness should not exceed 5 microns. A thicker emulsion produces higher dots that result in printing problems. With a sharp scoop coater, apply 2 to 3 wet coats on the print side and 2 coats on the well side of the screen. Experiment with various coating techniques to obtain the best results.
- Devices that measure the thickness of the dried emulsion coating are available. They are useful in establishing the proper stencil system.
- Expose the screen in a vacuum frame with the exposure lamp that is separated from the screen by a distance greater than the diagonal dimension of the area being exposed. Monitor each exposure using a transparent gray scale. Compare the exposure to previous ones that produced good results.
- Maintain a tight, uniform contact between the halftone positive and the stencil throughout the exposure. Poor contact in any area will make the screen unusable.
- Include a colour bar if the positive does not have one. A 2.54 cm² piece of opaque tape in the trim area of the positive creates an opening in the screen that prints a solid. Position the colour bar so that the colour bars for the other colours do not overlap it.

Squeegee

Multiple durometer squeegees (70/90, 65/95/65, 70/90/70, or 75/95/75) provide the best results. A sharp squeegee with an 80 durometer or harder plastic blade also will work.

Note: A softer squeegee increases the ink lay down and can make printing more difficult.

The squeegee should be large enough to overlap the design by at least 5 cm on each side.

The squeegee angle should be set at a position as near to vertical as possible. The angle should not be less than 80 degrees. The exact angle may vary because of press design.

Note: A lower angle may result in a heavy ink lay down. This may cause printing and curing problems.

Printing Order

Generally, the printing order is yellow, magenta, cyan and black. Other orders of colour can work, however, the order must be the same one used to prepare the colour standards provided to the separator.

Printing Method

1. Remove any dust or particles from the fabric, the stencil and the sheets by using a tack rag (a varnish-impregnated cloth). Make sure the cleaning cloth itself does not leave contaminants on the surface. Cleanliness and control of dust are important to getting good results.
2. Position the film on the press bed and hold the film in place with a vacuum. Good registration is critical to maintaining good visual colour balance.
3. Use the off-contact screen printing method to produce a uniform impression pass. Make a fill pass and then make the impression pass.
4. Cure the ink within 5 minutes of screen printing. Delaying the curing process may cause an undesirable surface appearance.
5. Perform all of the tests as outlined in the **Testing** section.

Colour Control

Producing a large number of multi-sheet, four colour graphics requires good colour control. Judging the colour and density visually is not adequate. The following quality control tools are essential to obtaining a satisfactory yield of high quality graphics.

- Establish good, stable, screening conditions.
- Use a reflection densitometer equipped with separation or graphic arts filter. Do not use Status A, M, T, or SPI colour filters.
- Use an approved proof from the colour separator with a colour bar or a series of printed, colour progressives accepted by the customer. The progressives should be made with the same ink and at the same gloss. Match the density readings from the print job to the colour bars on the proof or colour progressives.
- Use the density measurement from the approved proof or colour progressives as a target for the first colour. If neither of these is available, use the following suggested target densities.

Colour ¹	Target Density
Yellow	0.90
Magenta	1.35
Cyan	1.30
Black	1.60

¹ Assumes a print sequence of YMCK.

Note: Density values are relative to the substrate.

- Consider adjusting the density with halftone base 9800B if it differs from the target by more than 0.10 (0.05 compared to a progressive).
- The density of the first colour establishes the density targets for the rest of the colours. Adjust the original target density by an amount equal to the difference between the first colour and its target.

Example:

Colour Target	Target Density	Actual Measured	Difference	New Target Density
Yellow	0.90	0.81	-0.09	(actual)
Magenta	1.35	-	-0.09	1.26
Cyan	1.30	-	-0.09	1.21
Black	1.60	-	-0.09	1.51

Note: To preserve the colour balance, make every effort to screen to densities to within 0.03 of these new targets.

- Monitor the density of the colour bars and selected areas of halftone dots throughout the print run.
- A change in the densities indicates a potential problem that should be identified before the density drifts out of an acceptable range.
- For critical colour matches, take into consideration that gloss clear 9720UV has a yellow tint when cured in a focused-lamp cure unit. Make colour comparisons before printing the clear.

Screen Cleaning

Use a commercially-available screen cleaner. You also can use a blend of solvents such as xylol and methyl ethyl ketone. Screens that are not thoroughly clean may adversely affect the print quality of the screen when it is reused.

Non-solvent screen washes must be tested. They can cause the ink to gel in the screen or the reclaimed ink may contaminate unused ink.

Radiometers

The UV energy output of the cure unit must be accurately measured. We recommend the following;

(1) Kühnast Integrator (250 – 410 nm) which is available from Kühnast Stralungstechnik GmbH, Postra. 56, 633607 Wächtersbach, Germany

Web Site: www.uv-technology.de

or

(2) Uvicure™ Plus UVA/High Power (315 – 400 nm). Available from: EIT Corporation, 108 Carpenter Drive, Sterling, VA 20164, USA.

Web Site: www.eit.com

Calibrate your radiometer on a regular basis to ensure its readings are accurate.

Note: Other radiometers may not give the same readings.

Focused-lamp Cure Unit

Focused-lamp cure units use high concentrations of ultraviolet light to initiate polymerization. Ink series 9800 is formulated to cure when exposed to a focused, medium-pressure, mercury-vapour lamp at a belt speed necessary to achieve the required energy output. Ink series 9800 can be partially cured by stray light in and around a printing facility, such as skylights, windows and overhead lights.

Use bulbs that produce light with wavelengths of 260 to 360 nanometres. Ozone-free and doped bulbs may not produce the correct wavelengths to properly cure ink series 9800. Some quartz IR filters can also interfere with the curing of the ink.

Check to make sure that the energy levels are uniform across the entire web. When testing this uniformity, do not use belt speeds greater than 14 m/min. Energy levels could be significantly lower at the web edges. Do not print graphics that are wider than the width of the uniform output of the bulbs.

Cure Unit Operation

1. Measure the UV energy levels at the beginning of every working day and whenever adjustments are made to the unit.
2. Allow the lamps to heat-up for at least 10 minutes or until the indicators show that the lamps have stabilized.
3. Replace bulbs according to the bulb manufacturer's recommendations. Dirty lamps and reflectors or bent reflectors prevent the ink from curing properly.

- Adjust the lamp wattage and/or belt speed to get the specified energy level on the radiometer.

Products	UV Energy EIT in millijoules/cm ² (mJ/cm ²)	UV Energy Kühnast in millijoules/cm ² (mJ/cm ²)
Colours	200 to 275	190 to 230
Clear 9800CL	250 to 325	220 to 300
Clear 9720UV	300 to 350	320 to 370

Note: Radiometer measures in joules/cm². To convert, 0.045 joules/cm² equals 45 mJ/cm².

- Test the ink to make sure that it is properly cured. Test methods are outlined in the **Testing** section.
- Adjust the unit until the ink is correctly cured.

Testing

Maintain a testing log for future reference. Each print pass must be tested to determine if the ink or the clear is properly cured. Every print pass must pass these 3 tests.

- Appearance Test
- Abrasion Resistance Test
- Tape Snap Adhesion Test

Appearance Test

This test determines if the ink visually appears to be cured.

Frequency

Test before printing each colour and applying the clear.

Surface Characteristics

Properly cured ink series 9800 should have these surface characteristics:

- medium to high gloss for the inks; high gloss for clear
- smooth ink surface
- no wet or overly tacky areas

Abrasion Resistance Test

This test determines if the ink is undercured.

Frequency

Test in several areas on the sheet before printing each colour and applying the clear.

Procedure

- Make press adjustments to produce an acceptable wet (uncured) print.
- Print a production sheet of film and pass it through the UV curing unit.
- Using a RBA-1 Rivet Brush, firmly rub the surface of the cured samples a total of 10 times. The sample should exhibit good resistance to abrasion showing no softness or significant change in gloss. Some impression from the brush strokes is permissible.

If the ink scrapes off:

- Check to make sure the press conditions follow the recommendations.
 - Reduce the ink thickness.
 - Use a harder squeegee.
 - Set the squeegee angle closer to vertical.
 - Increase the energy level by slowing the belt speed slightly.
- Repeat steps 2 and 3 until the ink passes.

Tape Snap Adhesion Test

This test determines the cure of:

- each colour on the film if a clear will not be applied
- clear over each ink colour
- clear over bare film

Passing the sheet through the curing unit several times may change the surface characteristics of the ink and the film. Testing simulates the process and allows you to adjust the process and prevent graphic failures.

Frequency

Test in several areas on the sheet before printing each colour and applying the clear.

Procedure

At the beginning of the print run:

- Print and cure the first colour.
- Pass the sheet through the cure unit for the same number of times as there are colours left to print plus 2 more times. For example, if one colour remains, pass the sheet 3 times through the unit.
- Offset the sheet and then, reprint the ink so that it prints over the previously printed colour and on the bare film.

4. Cure the graphic with 4 passes at the ink energy level to simulate the clear.
5. Test the ink using steps 6 through 10.

At the beginning of each colour or clear pass:

6. Use the point of a sharp razor blade, a knife, or other suitable instrument to scratch a crosshatch pattern through the ink. Do not cut into the film. Be sure to scratch areas where the coating is over each printed ink layer and the film.
7. Use 3M™ Hand Applicator PA1-G Gold to firmly apply 1 inch wide Scotch™ Tape #610 over the crosshatched areas.
8. Remove the tape by pulling it back upon itself using a rapid, firm pull.
9. No separation should occur between the inks or between the inks and the film.
10. If the ink separates, increase the energy level by decreasing the belt speed slightly and retest.

Note: The ink must still pass the **Abrasion Resistance Test** and **Appearance Test** (page 6) after making any adjustments.

Special Applications

Use of Continuous Multi-Station Presses

A multi-station press automatically moves a sheet from one press and cure unit to another. Because sheets cannot easily be removed from between the presses, performing the standard tests is difficult or impossible.

If the printing will be finished after one pass through the equipment, perform the **Abrasion Resistance Test** (page) and the **Tape Snap Adhesion Test** (page) at the end of the pass. Test the sheet on the left, right, top and bottom edges, plus several places in the middle. Test all of these combinations of ink colours, clear and film:

- clear over each ink colour
- clear over bare film
- each colour over each film combination if a clear will not be applied

Shelf Life, Storage and Shipping

Ink Series 9800

Activity	Recommendation
Shelf life	<ul style="list-style-type: none"> • Use by the expiration date shown on the product packaging. A Use By date is on the ink container product label, as well as on the outer shipping carton. • Do not use ink that shows signs of gelling.
Storage conditions	<ul style="list-style-type: none"> • 15° to 32°C • Away from direct sunlight, mercury vapour lamps, quartz-halogen lamps, or arc lamps. • Original container or in other sealed, black, polyethylene containers. <i>Do not store the inks in glass or metal containers.</i>

Finished Graphics

Activity	Recommendation
Shelf life	<p>Total shelf life: 2 years Up to 2 years unprocessed, OR process within 1 year of film receipt and apply within 1 year of processing.</p>
Storage conditions	<ul style="list-style-type: none"> • 38°C maximum • Out of sunlight • Clean dry area
Shipping finished graphics	<ul style="list-style-type: none"> • Cure ink and clear coat before packaging. • Ship flat, or rolled printed side out on 6 inch (15 cm) or larger core to help prevent the liner and premasking tape from wrinkling or popping off. • Put a slip sheet, such as 3M™ Easy Release Liner #33, on the printed side(s) of graphics that are : <ul style="list-style-type: none"> - pre-mounted to panels - printed on the liner

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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