



Screen Printing

With 3M™ Screen Printing UV Ink Series 9800

For line colour printing

Product Replacement Note

3M™ Screen Printing UV Ink Series 9800 replaces the coloured inks in 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.

Opaque Colours	Transparent Colours
9802 Opaque Black	9825 Blue Shade Red
9803 Mixing Black	9828 Yellow Shade Red
9806 Mixing White	9831 Orange
9808 Opaque White	9840 Medium Yellow
9812 Magenta	9848 Yellow
9813 Red Violet	9864 Blue Shade Green
9826 Brick Red	9882 Red Shade Blue
9827 Red	
9830 Orange	
9837 Red Shade Yellow	
9843 Medium Yellow	
9849 Lemon Yellow	
9861 Light Green	
9879 Green Shade Blue	
9891 Blue Violet	
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 size and layflat characteristics, as well as graphics that have tight tolerances or multiple colours.

For the best results, follow these guidelines:

All liners

- 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.

Kraft paper liner only

- Stabilize the sheets of film under the normal humidity and temperature conditions of the shop.
- Condition the sheets of film overnight by racking them individually, or placing two sheets face-to-face.

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 Graphic 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 nighttime appearance.

Ink and Clear Preparation

Coverage

Typically, one U.S. gallon (3.8 litre) of ink series 9800 covers 59 to 83 square metre/litre.

However, several elements affect the ink coverage:

- Screen mesh and type
- Hardness (durometer) of the squeegee
- Angle of the squeegee
- Emulsion thickness

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.

Colour Matching with Clear 9720UV

With critical colour matches of light colours, take into consideration that clear 9720UV has a yellow tint when cured in a focused-lamp cure unit.

Tinting and Toning

- Use ink 9806 to tint colours.
- Do not use ink 9808 to tint colours; this ink is a block-out colour only.
- Use less than 95% by weight of ink 9806. Using more may affect the durability of the colour.
- Use only toner 9810 to tone colours.
- Do not tone or thin the clear.
- Use less than 50% by weight of any combination of thinner 9801, toner 9810 and halftone base 9800B. Using more may affect the durability of the colour.

Scotchlite Reflective Graphic Film

- Ink series 9800 is compatible with reflective graphic films. However, not all of the inks are transparent. Using a formulation containing an opaque ink prevents the film from properly retroreflecting in the printed area. White and black are opaque colours.
- Print the ink formulation and view it under nighttime conditions to determine if the retroreflectivity is adequate.
- To maximize the nighttime retroreflectivity, you may need to add toner to full strength blends of transparent inks.

Reducing the Viscosity

- Thin the inks with thinner 9801.
- Use less than 10% by weight of thinner 9801.
- Do not add toner 9810 to the clear; this will reduce the clear's durability and gloss.
- Test the formulation for printability.

Increasing the Viscosity

- Use halftone base 9800B to thicken the ink. This may be necessary for printing fine lines, copy or a halftone pattern.
- To increase the viscosity by 500 centipoise, add about 1 to 5% by weight of halftone base 9800B to the ink.
- Do not add more than 50% by weight of halftone base 9800B to an ink formula.
- Do not add halftone base 9800B to the clear; this will reduce the clear's durability and gloss.
- Test the formulation for printability.

Foaming

Foaming may occur when the print rate is greater than 1000 to 1500 impressions per hour. Foaming creates entrapped air bubbles that give a poor flow-out and appearance. Add less than 10% by weight of thinner 9801 to reduce foaming.

Printing

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 20 newtons/cm or higher.

Fabric

- 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

Use direct emulsions and thin capillary films that yield a thin ink deposit and are water soluble, resistant to ketones and strong lacquer solvents, and are compatible with UV inks.

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 will also 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 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.
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.

- Perform all of the tests as outlined in the **Testing** section.

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 when the screen 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.

Curing

Radiometer

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

(1) Kühnast Integrator (250 - 410nm) which is available from Kühnast Strahlungstechnik 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-vapor 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

- Measure the UV energy levels at the beginning of every working day and whenever adjustments are made to the unit.
- Allow the lamps to heat-up for at least 10 minutes or until the indicators show that the lamps have stabilized.
- 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 test log for future reference. Each print pass must be tested to determine if the ink or the screen print clear is properly cured. Every print pass must pass these 3 tests.

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

Note: The ink must pass the **Abrasion Resistance Test** and **Appearance Test** after making any adjustments.

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 screen print clear.

Procedure

1. Make press adjustments to produce an acceptable wet (uncured) print.
2. Print a production sheet of film and pass it through the UV curing unit.
3. 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:

- a. Check to make sure the press conditions follow the recommendations.
- b. Reduce the ink thickness.
- c. Use a harder squeegee.
- d. Set the squeegee angle closer to vertical.
- e. Increase the energy level by slowing the belt speed slightly.

4. Repeat steps 2 and 3 until the ink passes.

Tape Snap Adhesion Test

This test determines the cure of:

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

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 before applying the clear.

Procedure

At the beginning of the print run:

1. Print and cure the first colour.
2. 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.
3. 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 sharp knife 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 PA-1 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.

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** and the **Tape Snap Adhesion Test** (page 6) 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

If more than one pass through the multi-station press is required to process the sheets, call Technical Service for guidance.

Metallic and Pearlescent Inks

Producing graphics with ink that contains metallic and pearlescent flakes requires careful attention to produce consistent, high quality graphics. Even small changes in components and processing conditions affect the print quality.

Warranted Metallic Flakes

The recommended aluminum flakes are a “non-leafing” type and are dispersed in mineral oil. Their disk shape provides a specular-like appearance and has a “whiter” look than other flakes that have a cornflake-like shape.

Do not use larger flakes, which are difficult to screen print and may not produce graphics with a consistent appearance.

Use only the recommended flakes. Other flakes may not be outdoor durable.

Specifically request COATED flakes as both coated and uncoated flakes have the same part number. The aluminum in metallic flakes can catalyze UV-cured inks, causing the ink to thicken rapidly, affect colour consistency and reduce pot life.

Flake Size	Sparkle Silvex™ Aluminum Flakes
Small	SSP-950-20-C
Medium	SSP-910-20-C or SSP-404AR

Note: Sparkle Silvex is available from: Silberline Manufacturing Company, Inc., 130 Lincoln Drive, P.O. Box B, Tamaqua, PA 18252-0420
Telephone: 800-348-4824 FAX: 717-668-0197

Flake Deterioration Issues

Important Note

Metallic flakes require special handling. Exposure to air causes them to deteriorate and agglomerate. This will cause printing problems. We recommend buying only what can be used in a short period of time.

To ensure good, consistent print quality, special handling of the flakes is required. The recommended flakes have an unopened shelf life of one year from date of manufacture. However, each time you open the container, the flakes are exposed to oxygen and moisture, which degrades the flakes and shortens the shelf life. As the flakes oxidize, they agglomerate. Agglomerated flakes appear darker, have less hiding power and have less specularly than non-agglomerated flakes. The screens used in the printing process tend to filter out the agglomerations. These factors result in reduced ink lay down and a change in flake concentration, causing colour changes throughout the print run.

How to Determine if Flakes are Deteriorating

1. Upon receipt of the flakes, prepare a known concentration: 5% or 10% of flakes in toner 9810.
2. Print this mixture on a clear substrate such as 3M™ Controltac™ Plus Graphic Film 180-114. Apply this to a piece of glass. This is your standard.
3. Each time you use flakes from the same container (in the same concentration), compare the standard to the new prints. Look for a change in hiding power and colour consistency. It is up to the operator to determine an acceptable quality level.

How to Protect the Flakes

Limiting exposure of the flakes to air and moisture is the best defense against deterioration. This is what you can do to protect the flakes:

1. Order a smaller container of flakes.

2. Repackage the flakes into quantities you typically use for one print run. Use packaging similar to the original packaging containers.
3. Tightly reseal the container immediately after removing the flakes.
4. Store at temperatures between 10° to 27°C.
5. Avoid high shear mixing which can also cause the flakes to agglomerate.

Warranted Pearlescent Flakes

Pearlescent flakes are a stable, multi-layer, metal oxide. Compared to aluminum flakes, the pearlescent flakes have a subtle specularly and they do not muddy the colour of ink series 9800. Although there is some sparkle to pearlescent flakes, it is usually only seen in sunlight.

Pearlescent flakes come in a variety of colours from white pearl to red, violet, bronze, yellow, blue or green. Coloured inks are used with the pearlescent flakes to get the colour. Although they come in colours, not all flakes have good outdoor durability.

Do not use large flakes, which are difficult to screen print and may not produce graphics with a consistent appearance.

Use only the following pearlescent flakes.

Flake Size	EMD Chemicals Part No.	Effect
Small	9111WR Rutile fine satin	Luster
	9121WR Rutile luster satin	Luster
Medium	9103WR Sterling silver	Similar to small to medium aluminum flake, except they have no opacity or hiding power

Note: These pearlescent flakes are available from:
EMD Chemicals, Inc., Division of E. Merck,
7 Skyline Dr., Hawthorne, NY 10532
Telephone: 914-592-4660 FAX: 914-592-9469

Mixing

1. Follow these concentration recommendations:

Type	Maximum Concentration by % weight	Typical Concentration by % weight
Metallic flakes	12	5 to 10
Pearlescent flakes	12	10 to 15

Mixtures of metallic and pearlescent flakes	12	5 to 10
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2. Use a power mixer. Do not use a cowls blade dissolver or any other high shear mixer. These can cause the flakes to break or agglomerate.
3. Gradually add the flakes to the liquid and mix until the flakes are evenly blended.
4. Inks must be mixed frequently to keep the flakes from settling.
 - Increasing the flake concentration increases the viscosity. To decrease the viscosity, add less than 10% by weight of thinner 9801.
 - Adding 5 to 10% by weight of halftone base 9800B gives the ink body and slows the rate that the flakes settle. Reducing the settling helps maintain more consistent colour throughout the print run.
 - If there is any coloured ink in the formula, limit the combined amount of thinner 9801 and toner 9810 to 80% by weight.
 - If there is no coloured ink in the formula, there is no limitation for the amount of thinner 9801 and toner 9810.
 - Adding more than 10% to 15% by weight of opaque ink prevents the ink from curing correctly. There is a trade-off between the amount of flake and the amount of opaque ink that allows the formulation to cure properly.
 - Using opaque inks increases the opacity, but decreases the specularly of the ink and the perception of depth.

Printing

- Use the same screen printing method for metallic and pearlescent ink as regular ink series 9800.
- Mesh size is critical. Too small an opening does not allow all the flakes to go through causing the colour to shift. Too large a mesh opening does put down too thick an ink deposit and interfere with cure. The theoretical ink volume should be less than 13.5 cm³/m².

- Follow these mesh size recommendations.

Type	Flake Size	Median Flake Size <i>microns</i>	Mesh Size
Metallic flake	Small	19	34 micron or larger 140 to 150 tpc plain weave
	Medium	22	34 micron or larger 120 tpc plain weave
Pearlescent flake	Small	< 20	34 micron or larger 140 to 150 tpc plain weave
	Medium	10 to 40	34 micron or larger 120 tpc plain weave

- Inks must be mixed frequently to keep the flakes from settling.
- The ink must be mixed before adding it to the screen and then thoroughly mixed with the ink already in the screen.
- Both types of flakes increase the wear on the squeegee and the screen mesh.

Curing

- Curing metallic inks from ink series 9800 may be more difficult if flake concentrations are greater than 15% by weight. To cure properly, the inks may need a higher energy level than the recommended 140 mJ/cm² target. When using higher energy, the **Tape Snap Adhesion Test** is even more critical.
- Cured ink is initially softer and tackier than ink without flakes. Gradually increase the energy level until the ink does not easily scrape off of the film. The ink hardens in about 2 hours.
- Increasing the flake concentration more than 12% to 15% by weight increases the softness of the ink.

Pot life

- After adding the metallic flakes, the pot life of metallic ink is 1 to 2 days after which time the ink begins to gel. How fast the inks gel depends on the flake concentration, the storage temperature, the formula and the mixing conditions.
- Pearlescent flakes do not cause the ink to gel. However, the flakes do settle more rapidly than metallic flakes.

Testing

- Refer to the **Testing** section for the test procedures.
- The appearance will not be as glossy because of the surface texture.
- The initial softness of the inks may cause the ink to be more easily scraped off during the **Abrasion Resistance Test**.
- The clear option must be used for the **Tape Snap Adhesion Test**.
- Ink formulations that have a high flake concentration may split within the ink layer during the **Tape Snap Adhesion Test**. If this happens, reduce the flake concentration.

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 vapor lamps, quartz-halogen lamps, or arc lamps. • Store in 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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