



Screen Printing

With 3M™ Screen Printing UV Ink Series 9800

For 4-Color Screen Printing Only

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2. Recommended Types of Graphics and End Uses

UV ink series 9800 is a high performance, ultraviolet-curable ink formulated for use on any 3M brand graphic film designed for screen printing. This Bulletin covers how to use 4-color UV ink series 9800. Refer to the most current Product Bulletin 9800 for detailed information on applications, limitations and warranties.

3. Compatible Products

A. Graphic Films

Refer to the Product Bulletin for the base film being used for ink compatibility, intended applications, construction options and warranties.

B. Clears

- 3M™ Screen Printing UV Gloss Clear 9800CL
- 3M™ Screen Printing UV Gloss Clear 9740i
- 3M™ Screen Printing Low Gloss Clear 9730UV

C. Application Tapes

- 3M™ Premasking Tape SCPM-44X
- 3M™ Prespacing Tape SCPS-53X
- 3M™ Prespacing Tape SCPS-55

4. Product Line

All information in this Product Bulletin is subject to change. Be sure this is the most current Product Bulletin. See the 3M Related Literature section for a list of all Bulletins you may need in order to use this product properly.

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

Note: Custom blended colors are available. Contact a 3M Commercial Graphics sales representative or customer service representative for more information.

5. Health and Safety



CAUTION

When handling any chemical products, read the manufacturers' container labels and the Material Safety Data Sheets (MSDS) for important health, safety and environmental information. To obtain MSDS sheets for 3M products go to 3M.com/MSDS, or by mail or in case of an emergency, call 1-800-364-3577 or 1-651-737-6501.

When using any equipment, always follow the manufacturers' instructions for safe operation.



WARNING

Observe safe operating procedures when using ink series 9800. Provide adequate ventilation and wear appropriate gloves and other protective clothing to avoid all skin contact. Refer to the Material Safety Data Sheet (MSDS) for details.

A. Air Quality Regulations

State Volatile Organic Compound (VOC) regulations may prohibit the use of certain cleaning chemicals with VOC's in graphic arts coatings and printing operations. For example, the California South Coast Air Quality Management District prohibits use of certain solvent-based solutions without a permit and other California AQMD's prohibit use of certain solutions without a permit or a regulatory exemption. Check with your State environmental authorities to determine whether use of this solution may be restricted or prohibited.

6. Sheet Preparation

A. 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 lay-flat characteristics, as well as graphics that have tight tolerances or multiple colors.

For the best results, heed the following guidelines.

(1) 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.

B. 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.

C. 3M™ Scotchlite™ Reflective Graphic Film

Close color 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.

Follow the recommendations in [Instruction Bulletin 2.1](#) to minimize within-lot and crossweb variation. Reflective films 680CM-10 and 680CRCM-10 are available already color matched.

(1) Methods for Printing Liners

The graphic manufacturer is responsible for testing and approving any printing on the liner. Follow the ink manufacturers' processing instructions.

- **Screen printing:** use a fast drying screen printing ink for paper. Rack the sheets individually until they are dry at least 30 minutes.
- **Printing on a press:** use a fast-drying, process black ink. Stack the sheets.

Note: Make sure the ink used on the liner does not transfer to the film or ink series 9800 later during processing. Slip sheets may be necessary.

7. Ink and Clear Preparation

A. Coverage

Press Ready Ink: Typically, one U.S. gallon (3.8 liter) covers 8000 square feet (193.6 square meter/liter) at 50% dot with a PE390 (150 threads per cm [tpc]) plain weave mesh.

Clear: Typically, one U.S. gallon (3.8 liter) covers 2500 to 3500 square feet (59 to 83 square meter/liter) with a PE390 (150 threads per cm [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

B. Mixing

- Return any ink adhered to the lid to its container.
- Thoroughly mix the ink before formulating colors 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.

C. Ink Preparation

Color is supplied as a concentrate and must be reduced to achieve the desired density. If an existing formula for ink series 9800 is not known, use the suggested percentages in the following table. The results are based on 3M testing and equipment using a plain weave 380 mesh. Your press conditions will influence your results.

1. Print a test sample.
2. *To adjust density, see Color Control, page 5.*
3. *To adjust viscosity:*
 - a. Replace all or part of base 9800B with Toner 9810 or Thinner 9801 to decrease viscosity.
 - b. Replace all or part of base 9800B with Halftone base 9800HBB to increase viscosity.

(1) Typical Color Densities

| Ink | 100% Ink | 75% Ink 25% HTB | 62.5% Ink 37.5% HTB | 50% Ink 50% HTB |
|---------|----------|--------------------|------------------------|--------------------|
| Cyan | 1.68 | 1.44 | 1.28 | 1.07 |
| Magenta | 1.74 | 1.57 | 1.42 | 1.25 |
| Yellow | 1.00 | 0.92 | 0.84 | 0.76 |

D. Clear Preparation

(1) Color Matching with Clear 9740i

Clear 9800CL is press ready. Do not dilute with toner, thinner or base.

With critical color matches of light colors, take into consideration that clear 9740i has a yellow tint when cured in a focused-lamp cure unit. See [Product & Instruction Bulletin UV Clears](#) for more information about yellow tints.

(2) About Using Ink Series 9800 on 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 colors.
- Print the ink formulation and view it under night time conditions to determine if the retro-reflectivity is adequate.
- To maximize the night time retroreflectivity, you may need to add toner to full strength blends of transparent inks.

8. Printing

A. Frame

- Use a rigid, metal frame. Include a 6 to 10 inch (15 to 25 cm) well between the frame and the graphic design on all sides.
- Use a screen tension of 137 pounds force/foot (20 newtons/cm) or higher 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.

B. Fabric

- Use a polyester, monofilament, plain weave fabric.
- Use a thread count of PE355 to PE390 (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.

C. 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.

(1) Indirect Emulsion Capillary Films

Use a film that is 15 microns or thinner.

(2) 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 color bar if the positive does not have one. An 1 inch square (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 color bar so that the color bars for the other colors do not overlap it.

D. 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. 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 2 inches (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. A lower angle may result in a heavy ink lay down. This may cause printing and curing problems.

E. Printing Order

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

F. 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.
5. Perform all of the tests as outlined in the Testing section.

G. Color Control

Producing a large number of multi-sheet, four color graphics requires good color control. Judging the color 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 color filters.
- Use an approved proof from the color separator with a color bar or a series of printed, color 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 color bars on the proof or color progressives.
- Use the density measurement from the approved proof or color progressives as a target for the first color. If neither of these is available, use the following suggested target densities.

| Color 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. The density of the substrate is read with the appropriate color filter in place and that value is subtracted from the reading obtained from the color bar. Adjust the densitometer to read "0" as the density for 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 color establishes the density targets for the rest of the colors. Adjust the original target density by an amount equal to the difference between the first color and its target.

(1) Example

| Color 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 |

Continued on the next page.

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

- Monitor the density of the color 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 color matches, take into consideration that gloss clear 9740i has a yellow tint when cured in a focused-lamp cure unit. Make color comparisons before printing the clear.

H. 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.

9. Curing

A. Radiometer

The UV energy output of the cure unit must be accurately measured. Use an Uvicure™ Plus UVA/High Power model. This radiometer is available from: EIT Corporation, 108 Carpenter Drive, Sterling, VA 20164, Phone: 703-478-0700.

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

Note: Other radiometers may not give the same readings.

B. 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 nanometers. 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 45 ft/min (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.

(1) 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.
4. Adjust the lamp wattage and/or belt speed to get the specified energy level on the radiometer.

| Products | UV Energy millijoules/cm ² (mJ/cm ²) | UV Peak milliwatts/cm ² (mW/cm ²) |
|--------------|--|---|
| Colors | 200 to 275 | 600 |
| Clear 9800CL | 250 to 325 | 600 |

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

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

10. 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

A. Appearance Test

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

(1) Frequency

Test before printing each color and applying the clear.

(2) 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

B. Abrasion Resistance Test

This test determines if the ink is undercured.

(1) Frequency

Test in several areas on the sheet before printing each color and applying the screen print clear.

(2) 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. Try to smear the ink by twisting your thumb on the surface of the graphic. Be sure to wear protective gloves to protect your skin from any uncured ink and prevent your skin oil from influencing the outcome.

If impressions are made on the ink surface:

- 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.

C. Tape Snap Adhesion Test

This test determines the cure of:

- Each color and trap on the film if a clear will not be applied
- Clear over each ink color
- Clear over bare film
- Clear over color 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.

(1) Frequency

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

(2) Procedure

a. At the beginning of the print run

1. Print and cure the first color.
2. Pass the sheet through the cure unit for the same number of times as there are colors left to print plus 2 more times. For example, if one color 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 color 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.

b. At the beginning of each color or clear pass

6. Use the point of 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.

Note: Applicator PA1-G is available from 3M Commercial Graphics. Tape 610 is available through most film or tape distributors.

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, decrease the energy level by increasing the belt speed slightly and retest.

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

11. Special Applications

A. 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 7) 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 colors, clear and film:

- Clear over each ink color
- Clear over bare film
- Clear over color traps
- Each color 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.

B. Roller Coating

Although our UV clear coats are designed for screen printing, they can be roll coated. The process must produce the 3M recommended coating thickness of 6-12 microns in all areas of the graphic, with a gloss and an appearance that is acceptable to the end user. Achieving the correct thickness is critical. If the coating is too thin, it will not have the expected durability; if too thick, the coating will reduce the film's ability to stretch and conform.

3M UV clears are high viscosity solutions that require appropriate handling equipment, and may require adjustments to flow properly. Do not thin the clear coat or add any components (such as flow agents) that have not been approved by 3M.

3M does not recommend or endorse a specific roll coater, nor does 3M make specific recommendations on how to make 3M UV clears more suitable for roll coating.

12. Shelf Life, Storage and Shipping

A. Shelf Life

- Use by the expiration date shown on the product packaging. A Use By Date, such as 01Jan2014, is on the ink container product label, as well as the outer shipping carton.
- Do not use ink that shows signs of gelling.

B. Storage Conditions

- 60° to 90°F (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. *Do not store the inks in glass or metal containers.*

C. Shipping Finished Graphics

Refer to the base film's Product Bulletin.

- Cure ink and clear coat before packaging.
- Put a slip sheet, such as 3M™ Easy Release Liner #33, on the printed side(s) of graphics that are:
 - pre-mounted to panels
 - printed on the liner

13. Warranty and Limited Remedy

The information contained and techniques described herein are believed to be reliable, but 3M makes no warranties, express or implied, including but not limited to any implied warranty of merchantability or fitness for a particular purpose.

The [3M Commercial Graphics Warranty Brochure](#) at 3Mgraphics.com, along with the applicable film Product Bulletins, provide the details to any warranty offered for the 3M graphics products described in this bulletin.

14. Limitation of Liability

Except where prohibited by law, 3M SHALL NOT UNDER ANY CIRCUMSTANCES BE LIABLE TO PURCHASER OR USER FOR ANY DIRECT, INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES (INCLUDING, BUT NOT LIMITED TO, LABOR, NON-3M MATERIAL CHARGES, LOSS OF PROFITS, REVENUE, BUSINESS, OPPORTUNITY, OR GOODWILL) RESULTING FROM OR IN ANY WAY RELATED TO SELLER'S PRODUCTS, SERVICES OR THIS BULLETIN. This limitation of liability applies regardless of the legal or equitable theory under which such losses or damages are sought including breach of contract, breach of warranty, negligence, strict liability, or any other legal or equitable theory.

15. 3M Related Literature

Before starting any job, be sure you have the most current Product and Instruction Bulletins.

The information in 3M Product and Instruction Bulletins is subject to change. Current Bulletins are available at 3Mgraphics.com. The techniques described in these Bulletins are required when applying a 3M warranted graphic, but are also practical recommendations when using promotional materials for non-warranted graphics. Additional Bulletins may be needed as indicated in the 3M Related Literature section of other 3M components you use.

Bulletin types: PB = Product Bulletin; PB-IB = Product & Instruction Bulletin; IB = Instruction Bulletin

| Subject | Type | Bulletin No. |
|--|--|--------------|
| 3M™ Screen Print UV Gloss Clear 9740i | PB-IB | UV Clears |
| 3M™ Screen Printing UV Ink Series 9800 | PB | 9800 |
| - Screen printing with UV ink series 9800 - line color | IB | 3.20 |
| - Screen printing with UV ink series 9800 4-color | IB | 3.21 |
| 3M Commercial Graphics Warranty Brochure | Go to www.3Mgraphics.com/Warranties | |
| Sample Color Deck for Ink Series 9800 <i>Contact your 3M sales representative to order.</i> | 75-5100-2446-8 | |

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16. Bulletin Change Summary

New and modified content is marked with a black bar in the margin. Clear 9740i is a direct replacement for 3M™ Screen Print Gloss Clear 9720UV and 3M™ Screen Print UV Gloss Clear 9720i. Corrected the instructions on adjusting the energy level for the Tape Snap Adhesion Test if the ink separates from the film. Updated contact information for EMD Chemicals.



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