Stencil Making Guide

Introduction

This step-by-step Guide has been produced to offer useful advice on all aspects of stencil making. It includes helpful tips for the production of high quality and durable stencils for all screen printing applications.

1. Frame Selection

There are three main types of frames - Wood, Aluminium and Steel. All are suitable for screen printing, but consideration should be given to the following key factors when choosing a frame.

Wood Frames

Advantages	Disadvantages
Inexpensive Good surface for adhesion	Tend to warp Distort under high tension Limited life

Aluminium Frames

Advantages	Disadvantages
Lightweight Retain good tension Good resistance to distortion Rust resistant	Need scurfing to assist mesh adhesion Larger frames need heavy sections

Steel Frames

Advantages	Disadvantages
Excellent resistance to distortion Retain good tension	Heavy Tend to rust if not coated Expensive

Most printers choose aluminium frames with the appropriate section for the frame size. LoFlex Pro aluminium frames are available for high tension mesh.

2. Mesh Selection

The majority of printers use monofilament polyester mesh for its ability to maintain tension. Nylon is used by some bottle printers where its elasticity helps overcome printing onto uneven surfaces. The choice of mesh count, weave and thread diameter will depend on a wide variety of considerations.

Mesh Count

Print Design

Coarse mesh will give higher ink deposits and provide high opacity.

Finer mesh is used to avoid saw-toothing on fine lines and moiré problems with halftones.

Ink Type

Solvent-based Inks require a mesh range of between 77 and 140 threads per cm, depending on the required deposit.

Ultra-violet Curing Inks require a thinner ink deposit to assist in ink curing and therefore require a mesh range of between 140 and 180 threads per cm.

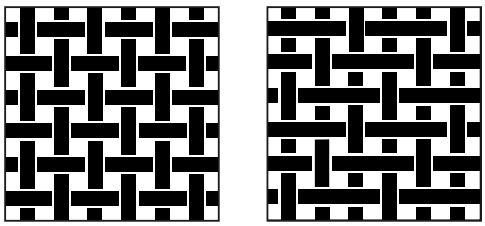
Water-based Jet Dryable inks require a mesh range between 110 and 150 threads per cm. The fine end of this mesh range is to avoid paper distortion when printing with water-based ink.

Textile Inks require a mesh range between 34 to 120 threads per cm for plastisols and 49 to 62 threads per cm for water-based inks.

Mesh Weave

The most common types of weave used by screen printers are twill weave (one thread over two) or plain weave (one thread over one).

Diagram 1



Plain Weave **Twill Weave 2/1**

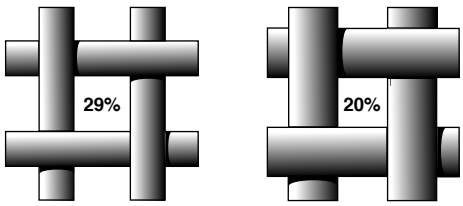
Plain weave mesh provides a thinner mesh fabric and this is helpful in producing low ink deposits, required when using UV or water-based inks.

Thread Diameter

Mesh suppliers usually offer a choice of thread diameter, as a given measurement of the mesh weave eg 34 microns.

In general screen printers use a thread diameter which maintains an open area sufficient to allow the ink to flow through cleanly (Diagram 2). Thicker diameter threads are used with coarser mesh and for more demanding applications such as providing mechanical resistance to abrasive inks or pastes.

Diagram 2



120.34 (305) **120.40 (305)**

Stencil Making Guide

Dyed Mesh

To reduce the amount of light scatter and problems with edge definition, caused by white filaments reflecting light during stencil exposure, most printers use mesh that has been dyed orange or yellow. However, coloured mesh would not generally be recommended for projection exposure applications (see the Sericol 'Direct Projection Emulsions Guide'.
Dyed mesh absorbs light and although this will lengthen exposure times, it will give greater exposure latitude, which helps when reproducing fine stencil detail.

3. Adhesion of mesh to the frame

It is essential to achieve a good bond between the mesh and frame to avoid loss of tension or complete slippage.

The following is a guide of Do's and Don'ts to optimise the performance of Serifix and Screenfix Mesh Adhesives.

Do's

- Roughen (scurf) aluminium frames to provide a good surface for adhesion.
- Ensure frames are clean, dry and grease free.
- Shake both base and catalyst before mixing - they settle in their containers.
- Accurately mix Serifix/Screenfix base and catalyst by weight, 10 parts base to 1 part catalyst.
- Use a stirring stick to mix base and catalyst thoroughly.
- Ensure good contact between frame and mesh.
- Apply Serifix/Screenfix with a short haired stiff brush to penetrate the mesh.
- Allow a minimum drying time of 15 minutes before cut out - double time for coarse or high tension mesh.
- Allow to fully cure for 24 hours before exposure to strong solvents or high temperatures.

Don'ts

- Over-catalyse - This lengthens the reaction time and adversely affects both drying time and solvent resistance.
- Leave base or catalyst containers open - they will absorb moisture and go off.
- Adhere mesh in damp or cold conditions - this affects the adhesion of Serifix/Screenfix.
- Use brushes that have been cleaned in thinner without thoroughly drying.
- Spread the adhesive too thickly - thicker coats take longer to dry.

4. Mesh Preparation

Mesh Preparation - for new screens.
New polyester mesh has a very smooth surface which impairs the adhesion of emulsions. Xtend Prep 101 mesh preparation paste will lightly abrade this surface and promote better adhesion of stencil emulsion to mesh.

Mesh Degreasing - for all screens, new or used, before emulsion coating. The use of Xtend Prep 102 for manual degreasing will:

- Thoroughly degrease mesh to avoid fisheyes.
- Removes surface dust particles that cause pinholes.
- Impart anti-static properties to the mesh to avoid dust attraction.
- Assist the flow characteristics of emulsion.
- Prolong stencil life.

Prep 300 Degreasing Concentrate will give all the above properties and is designed for large format spray application or automatic machines.

5. Emulsion Selection

Before choosing a stencil emulsion it is necessary to understand the performance characteristics of the three main emulsion technologies.

Diazo Emulsions

Advantages	Disadvantages
Durable stencils. Resistant to solvent. Resistant to water. Good exposure latitude. Easy to calculate correct exposure via colour change.	Shrink back on drying. Need intermediate drying/coating to produce high quality. Two pack system. Requires degassing once sensitised. Not resistant to combination of water and solvent. Unreacted Diazo stains mesh.

Diazo Photopolymer (dual cure)

Advantages	Disadvantages
High quality with wet on wet coating. Combined water and solvent resistance. Good exposure latitude. Easy to calculate correct exposure via colour change.	Two pack system. Unreacted Diazo stains mesh. Requires degassing once sensitised.

Photopolymer

Advantages	Disadvantages
One Pack Pre-sensitised No Mixing No degassing Fast exposure No Diazo stains High quality with wet on wet coating	Limited exposure latitude Not resistant to combination of water and solvent

When choosing a stencil emulsion, the following considerations should be made.

a. ***Ink system*** (solvent-based, UV curing, water-based graphic, water-based textile).

b. ***Exposure speed*** required (dependent on light source power and distance from screen.

c. ***Image requirements*** (fine lines, halftone, block areas etc)

The following chart gives general guidelines on the correct selection of Dirasol® Photostencil Emulsion.

Stencil Making Guide

Light Sources

There is a wide variety of ultra violet emitting light sources, but the most commonly used for stencil production are Metal Halide lamps.

Metal Halide lamps are available in various power ratings from 800 to 8,000 Watt.

Exposure Tips

- Use a single point light source - to minimise undercutting and help when reproducing fine detail.
- Use a lamp with correct power rating - to avoid long exposure times use a 5 or 6 kw lamp.
- Use a set distance between lamp and print down frame for continuity - the minimum distance for the lamp will be the diagonal measurement of the exposure frame glass.
- Ensure the print down frame achieves good contact - good contact during exposure avoids light under-cutting. You can improve vacuum pressure to the stencil area by using rubber tubing from the inside of the screen to the edge of the print down frame.
- Light integrator - the use of a light integrator will measure exactly how much light is received by the stencil and automatically adjust exposure times for repeatable results.
- Change lamps regularly - old lamps may look bright but they lose their ultra violet output.
- Use exposure calculator regularly to ensure optimum exposure..

9. Developing

Develop exposed stencils using a firm water spray or a high pressure gun at a minimum distance of one metre.

Wet both sides of the stencil and wash mainly from the substrate side with occasional washes on the squeegee side.

Wash until all open areas are clear and then give a final rinse to both sides of the stencil.

Dry stencil thoroughly to ensure maximum durability during a print run, especially when using water-based inks.

10. Stencil Treatments

a) **Water Proofing**
Dirasol stencils can be made waterproof by the application of Sericure (stencil waterproofing agent). For the best results, use Sericure with a water resistant emulsion to extend its durability. Stencils treated with Sericure are much more difficult to decoat.

b) **Post Hardening**
Dirasol stencils can be post hardened by using Dirasol Super Hardener (2 pack post hardening system). Post hardening will improve the water, solvent and mechanical resistance of any emulsion. Stencils treated with Dirasol Super Hardener cannot be decoated.

Tips for waterproofing and post hardening

- Apply to both sides of dried stencil with a sponge or brush.
- Allow solution to penetrate right through the emulsion coating.
- For maximum durability allow treated stencil to stand over-night or leave to stand for 1 hour and then place in front of hot fans (40-50°C) for a further hour.

11. Spotting Out

For Resistance to Solvent-based Inks
Dried stencils can be spotted out with emulsion or a solvent resistant screen filler.

For Resistance to Water-based Inks
Dried stencils can be spotted out with a sensitised water resistant emulsion and then re-exposed, or spotted with a water resistant screen filler.

12. Decoating

Dirasol stencil emulsions are formulated to be easily decoated using the Xtend Strip range of stencil decoating concentrates.

Xtend Strip Powder
Xtend Strip Powder is an easily diluted powder concentrate for manual stencil decoating, using mains pressure or, as is now more common, a high pressure water-gun.

Xtend Strip Liquid
Xtend Strip Liquid is a highly concentrated stencil decoating liquid designed to be used manually or with automatic stencil decoating machines. The dilution ratio of Xtend Strip liquid can be varied to suit different machine manufacture designs and dwell times, i.e., 1 ltr Xtend Strip Liquid to 20 or 30 ltrs of water.

Stencil Decoating Tips

- Under-exposed stencils can be more difficult to decoat. If the emulsion has not completely cross linked it may fuse together at the decoating stage.
- Do not allow decoating solution to dry on the stencil. This will also fuse the emulsion and make it difficult to decoat.
- Remove all ink residues with Xtend Screen Cleaner before decoating. This allows the decoating agent to get into the stencil.
- Apply decoating solution to both sides of the stencil and allow at least 2 minutes to react.

Automatic Screen Cleaning Machines

The use of automatic screen cleaning machines is becoming more common. These machines usually have two separate compartments, one for removing ink residues and the other to decoat stencils. Most screen cleaning machines rely on spray jets for their cleaning action and therefore require special products, such as Xtend Screen Cleaner AM (active screen cleaner) and Xtend Strip Liquid (Stencil decoating concentrate). Some machines have the facility to degrease as well and this will require a concentrated degreasing solution, such as Xtend Prep 300.

Stencil Making Guide

13. Ghost Image Removal

There are two types of stain left on screens after the stencil has been decoated. These stains are caused by ink and diazo residues and are often referred to as ghost images.

Diazo Stain Removal

All diazo emulsions will leave diazo stains on the mesh and these will be much worse where stencils are constantly under exposed. Diazo stains discolour the mesh in the stencil areas and, if allowed to build up, they can cause under exposure of future stencils, by restricting the passage of light during exposure.

Diazo stains can be quickly and easily removed by the application of Xtend Antistain.

Ink Stain Removal

However well a screen is cleaned prior to stencil decoating, there will always be an ink residue to deal with. Ink residues are worse after long print runs where ink gets trapped between the knuckles of the mesh. If these ink stains are not removed they can cause problems in future print runs by restricting the passage of ink or bleeding into lighter colours.

The use of caustic pastes, such as Antistain Paste, in conjunction with an Xtend Screen Cleaner will quickly remove ink stains from screens. Care should be taken not to exceed dwell times with caustic pastes to avoid damaging the mesh. Caustic pastes can also be a hazard to the operative so the correct protective clothing should be worn.

The use of caustic free products, such as Antistain Cream, can be just as effective in safely removing ink stains, but dwell times will be longer.

The best recommendation for removing stains/ghost images, without risk to mesh or operator is to use Antistain in conjunction with Antistain Cream.

14. Health and Safety

It is recommended that protective clothing, i.e. gloves, goggles, aprons etc, be worn when handling screen making products.

Screen reclaiming areas should be fitted with effective extraction systems.

Floor areas should have good drainage and non slip flooring.

To minimise the risk of damage to containers and accidental spillage, do not store screen making products on high shelves.

Screens should be rinsed before using high pressure guns to avoid atomising screen making chemicals.

15. Environmental Considerations

Most screen making products will end up being washed down the drain to the main sewage system. Authorities will usually measure the following parameters to assess your consent limits.

a. Chemical Oxygen Demand (C.O.D.)
b. Settleable Solids
c. pH

Tips for minimising environmental impact of Screen Making Products.

C.O.D. Level Reduction

Solvents are one of the main causes of high C.O.D. readings. So by changing your application methods and keeping solvents out of waste water they can be greatly reduced.

- Use a separate dedicated solvent wash booth.
- Re-circulate solvent within booth.
- Allow solvent to drain from screen or squeegee off before transferring to water washing.
- Minimise the use of screen filler, which often have a high C.O.D. reading.

Minimising settleable solids

Settleable solids are caused mainly by ink and stencil residues, but they can be dealt with by:

- Reducing the amount of ink left on screens before reclaiming
- Use a settling tank or weir system to allow solids to settle out of waste water
- Simple flocculation and filtering processing

Flocculation is a process of combining very small particles so they accumulate and can be separated, usually by filtration.

Balancing pH

The pH of Sericol stencil products vary from 1 (very acidic) to 14 (very alkaline). In most circumstances when using these products and collecting waste water in holding tanks the pH reading will balance out between 6 and 9, which is acceptable to most water authorities.

Making these simple changes in your working practices will have a dramatic effect on the quality of your waste water readings and will help you meet the current requirements and consent limits. They will also help you reduce costs by minimising the waste of products.

Stencil Making Guide

Recommended Applications	Photopolymer		Diazo Photopolymer				Diazo		
	Dirasol 132	Dirasol 125/135	Dirasol 902	Dirasol 916	Dirasol 917	Dirasol SuperTex	Dirasol Rapid	Dirasol 22	Dirasol 25
Graphic									
General Graphic Printing	•••	–	•••	•••	•••	–	••	••	–
Posters	•••	–	•••	•••	•••	–	••	••	–
Fine Halftones - Graphic	•••	–	•••	•••	•••	–	••	••	–
PVC and Other Stickers/Decals	•••	–	•••	•••	•••	–	••	••	–
Textile									
Textile: Plastisols (Direct and Transfer)	•••	•••	•••	•••	•••	•••	••	•	•••
Textile: Water-based Colours	–	•••S	–	•••S	–	•••S	–	–	•••S
Textile: Reel to Reel Flat Screen Machinery	–	••S	–	•••S	–	•••S	–	–	••S
Specialist									
Rub Removable Lottery Tickets	••	–	••	••	••	–	•••	•	–
Nameplate and Control Panels	•••	–	•••	•••	•••	–	••	••	–
Touch Contact Switches & Instrument Displays	•••	–	•••	•••	•••	–	••	••	–
Printed Circuits	•••	–	•••	•••	•••	–	•	••	–
Compact Discs	••	–	••	•••	•••	–	–	–	–
Bottles and Containers	•••	–	•••	•••	•••	–	•••	••	–
Ceramic Tiles	–	–	–	–	•••S	–	•••S	–	–
Ceramic Transfers	•••	–	•••	•••	•••	–	••	••	–
Ink Resistance									
Solvent and UV Ink	•••	•	•••	•••	•••	••	•••	••	•
Water-based UV Ink	–	–	–	•••	–	–	–	–	–
Water/Solvent Ink	–	–	–	•••	–	–	–	–	–
Water-based Ink	–	•••S	–	•••S	–	•••S	–	–	•••S
Properties									
Definition Resolution	•••	••	•••	•••	•••	•••	••	••	••
Humidity Resistance	••	••	•	•••	••	••	••	••	••
Through-cure Exposure Speed in Seconds* (5Kw Metal Halide at 1.2m)	42 0n 120 U	15 on 62 W	85 on 120 U	70 on 120 U	65 on 120 U	70 on 120	85 on 120 U	135 on 120 U	150 on 62 W

Key to ratings: ••• = Excellent •• = Good • = Fair – = Not Recommended S = Sericured/Super Hardened
* Based on 2+2 Coating Technique, U = Orange Mesh, W = White Mesh.

6. Coating

There are many techniques used to coat direct stencil emulsions and these will vary from one stencil maker to another.

The basic aim of a good emulsion coating is to produce an even coating that encapsulates the mesh and produces a repeatable stencil build on the substrate side of the screen.

The most common method of achieving this is to coat the substrate side of the screen first, followed by further coats on the squeegee side. The screen must be dried in the printing position (squeegee side up) to maintain this emulsion build.

What is Stencil Build?

Stencil build is the amount of dried emulsion proud of the mesh on the substrate side of the screen.

A good stencil build will enable good printed edge definition.

Repeatable stencil builds maintain constant ink deposits to control colour variations from stencil to stencil; especially important should a screen have to be re-made half way through a print run.

Calculating Stencil Build

Stencil build is calculated by measuring (with an electronic thickness gauge) the total thickness of the stencil in microns and then deducting the thickness of the mesh.

The following is a guide to stencil builds required for printing various ink systems:

Stencil Making Guide

Ink System	Mesh	% of ink deposit lost through evaporation	Stencil Build required		Comments
			Halftone	Line	
Solvent-based Jet Drying	120.34 U	50-80%	8-10 Microns	8-10 Microns	Solvent based jet drying inks require higher build stencils to ensure good printed edge definition. Stencil build of 8-10 microns will maintain ink finish, opacity and light fastness.
UV Curing	150.34	0%	3-4 Microns	3-4 Microns	No ink deposit is lost through evaporation, therefore fine mesh and low stencil builds are required to avoid heavy ink deposits.
Water-based UV Curing	150.34	25-45%	3-4 Microns	3-4 Microns	Water-based UV curing inks give excellent printed edge definition from lower stencil builds. Using a 3-4 micron build stencil will maximise on ink coverage and ensure rapid ink curing speeds.
Water-based Jet Drying	120.34 or 150.34	50-60%	120.34 : 8-10 Microns 150.34: 3-4 Microns	120.34: 8-10 Microns 150.34: 3-4 Microns	Water-based jet drying inks provide excellent printed edge definition using the recommended mesh and stencil combination for the relevant application and ink.

Coating Tips

- Coat screens in subdued or yellow lighting to avoid fogging.
- Avoid dusty areas; dust causes pinholes.
- Use a purpose made trough with a uniform edge for even coats.
- After sensitising allow Diazo or Diazo Photopolymer emulsion to de-gas (overnight if possible) to avoid bubbles.
- Coat slowly to avoid trapping air bubbles.
- Keep troughs topped up with emulsion - different levels in the trough will affect build.

Coating Machines

Many stencil makers use a machine to coat screens and these can give the following advantages:

- Even coatings - coating machines can use a 1+1 simultaneous coating which helps eliminate any slack in the mesh.
- Repeatable coating builds - coating pressures can be set and techniques programmed.
- Large format screens can be coated quickly and without effort.

7. Drying

Thorough drying of the finished emulsion coating is essential for maintaining the photographic speed of the emulsion and producing tough durable stencils, especially when using water-based inks.

Drying Tips

- Use a drying cabinet - this will limit dust and exclude stray daylight to avoid fogging.
- Dry at temperatures not exceeding 35°C - higher temperatures will cause the diazo to react and could fog screens.
- Use good ventilation or a dehumidifier to avoid moisture build up - this will produce drier coatings and speed up the drying process.
- Dry in printing position (squeegee side up) to maintain stencil build.

8. Exposure

The correct exposure time is very important for producing durable stencils with good edge definition and the resolving of fine detail.

- **Durability** - the emulsion coating should be exposed right through; under exposure will cause poor adhesion of emulsion to the mesh and early stencil breakdown.
- **Edge Definition** - good edge definition allows straight lines to be printed without any saw- toothing caused by interference from the mesh.

Correct stencil build will produce good edge definition, but unless the coating is exposed right through it will remain soft and could distort. Under exposed stencils are vulnerable to solvent attack during printing, which can break down edge definition.

- **Resolution** - stencil emulsions have the ability to resolve very fine lines or dots, even when fully exposed. When reproducing fine detail on stencils, use an emulsion with the correct resolving abilities and do not be tempted to under expose.

Stencil Making Guide

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