



Ceramic glass print with digital printer. General information, visual quality and allowed tolerances, installation and storage guidelines.

1. About this document:

This document establishes the general terms for determining the visual quality of ceramic glass print. It combines information gathered from experience, technical capabilities and restrictions, feedback from clients, as well as applicable information from European standards for other products. This document will serve as a guide to customers by providing the necessary information before purchasing ceramic printed glass and also as the source of information for solving visual quality claims.

2. What is digital ceramic glass print and how is it different from conventional printing on glass?

Ceramic ink can be laid on glass for the architecture mainly:

- with silkscreen printing
- by roller coating
- with digital printer for ceramic ink

The digital printer allows any type of multicolor images, as well as solid color images to be successfully printed on glass with high quality. The other two types are more suitable when it comes to printing multiple glasses with the same solid color or same pattern. Moreover, glasses for silkscreen printing must be of same or very close size. In this regards the digital printer is a much more flexible solution.

The main difference with the conventional ink printing comes from the strength of the coating after the printing process. With conventional inks there is no heat treatment of the glass after the printing and the strength of the coating is limited entirely by its adhesion to the glass and its integrity as a material. Upon contact with other objects conventional inks could get damaged or peel off.

After being printed with ceramic inks the glass must always be tempered. During the process of tempering the glass and the ink get heated up to more than 600 C°. During this process the surface of the glass and the ink literally fuse with each other creating an inseparable bond. Additionally, the ceramic structure of the ink ensures its durability and strength.

3. What is the technology for printing on glass with ceramic ink using a digital printer?

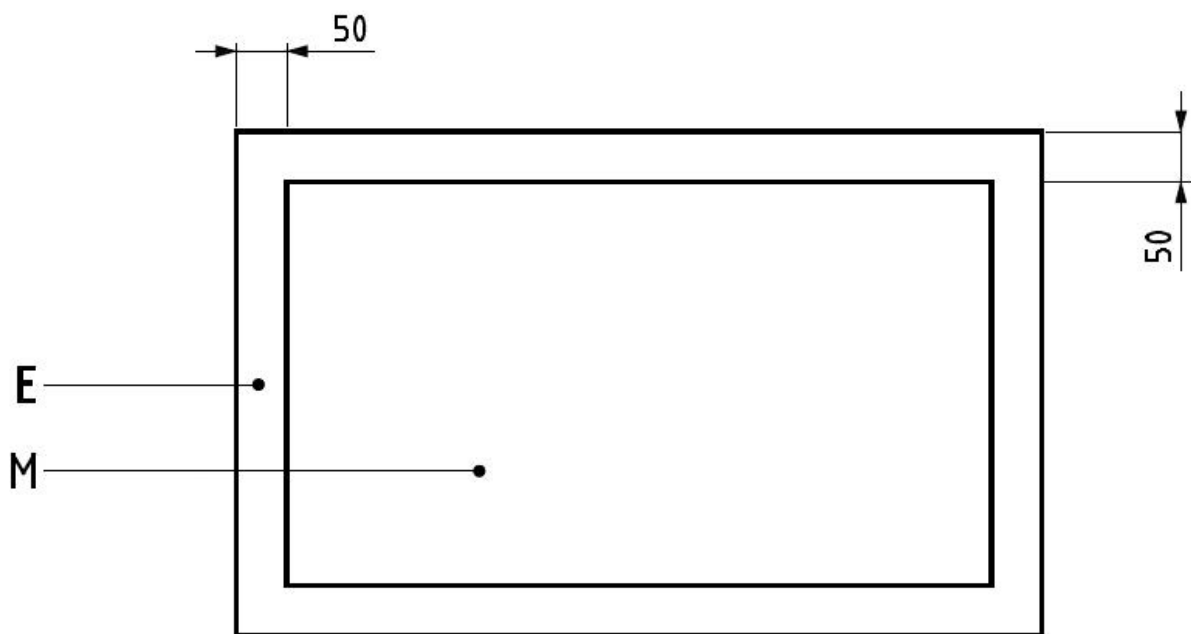
After the images have been digitally processed, a special software is used to send the files to the digital printer. Special printing heads are used to spray the ink on the glass. The layer of ink is extremely thin, which makes the coating susceptible to even minor impurities on the glass. Additionally the process must take place in an almost clinically clean environment with very strict climate conditions, for which heat and humidity control equipment is used.

4. What is the criteria for visual quality of the end product and what are the allowed tolerances?

At this time there is no dedicated European standard for ceramic printed glass. For that reason “Bul-It Glass” Ltd. establishes the following criteria and tolerances for determining the visual quality of this product:

4.1. General terms:

- 4.1.1. The distance from which a glass is evaluated (looked at) is no less than 1 meter.
- 4.1.2. The glass is always evaluated from the non-printed (clean) side, **without any direct light behind it**. The glass gets put at a distance of no more than 20 cm from a wall inside a room with natural light.
- 4.1.3. If any defects are spotted from a close distance, these must not get marked (circled) before evaluating from a distance.
- 4.1.4. Air bubbles inside the glass, which are a result of the glass production process are not subject to claim.
- 4.1.5. There are two general areas of the glass, as depicted on the following graph:



E – periphery zone with width of about 50 mm
M – main zone

4.2. Color match between image file and end product.

Digital ceramic print technology allows a rich variety of quality colors to be achieved on the glass. The inks’ structure however still cannot ensure a complete match between what one sees on the computer monitor and the end product. **Special attention must be paid to the magenta (pink-purple) and red colors.** It is absolutely necessary to always prepare a real color glass sample for client approval before producing an actual order. **If a client refuses such a sample due to lack of time or any other reason, any responsibility of Bul-It Glass for not meeting the client’s visual expectation is voided.**

4.3. Repeating the same color when printing over an interval of time.

There are few factors that can influence the end color when printing the same image file after a period of time. It is important that clients are aware of this occurrence and bring this information

to our attention in case new glass must be installed next to old glass, when for example a broken piece must be replaced or glass must be produced in phases over a period of time.

Despite all measures, it is still possible to have a color deviate from the original when printing in intervals of time. For that reason “Bul-It Glass” Ltd. Determines a tolerance of “5%” relative difference in color as a norm when the aforementioned situation takes place, **unless** there is an explicit request for matching a color of existing glass. When an existing color must be matched, **new samples must be prepared** and if needed new digital processing of the images too.



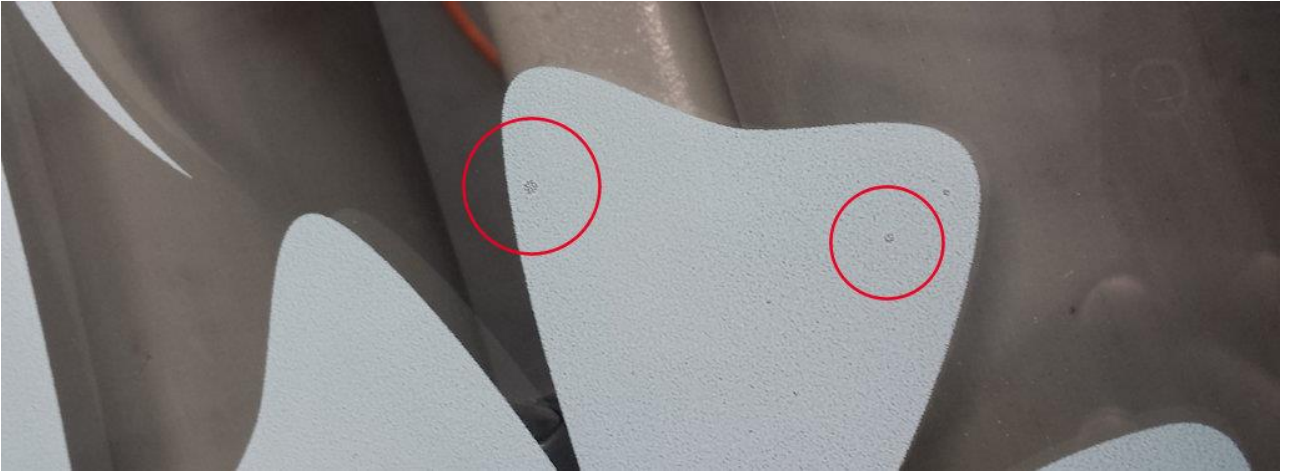
An example of blue color deviation when printing over a period of time.

Important:

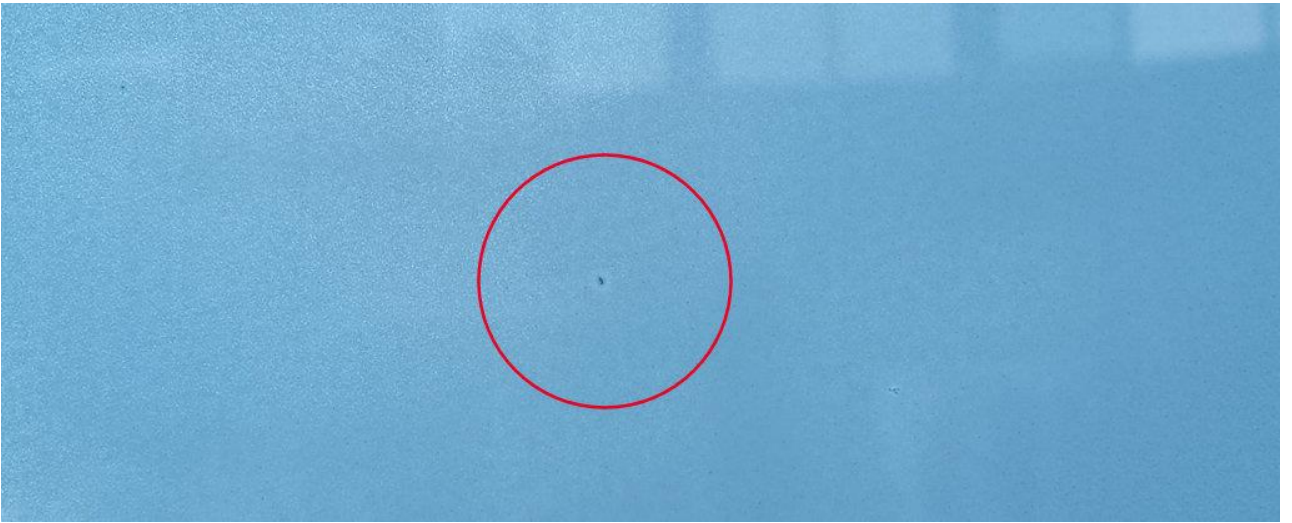
- The tint of the transparent float glass can influence the end result, based on iron oxide quantity in its mass. It is important to work with glass from the same manufacturer and even with glass that was produced in the same factory.
- The season of the year could influence the behavior of some inks, because it affects the humidity and temperature inside the printing room.
- The ceramic ink could have slight deviations based on its production batch.
- The period of technical maintenance of the digital printer can play a role. For example slight difference might take place if the same image is printed right after a maintenance or short before a scheduled maintenance
- **The glass thickness is a fundamental factor for the end result.** If the same image is printed on glasses with different thickness, the end result will be significantly different.

4.4. Spot defects, due to dust specs or impurities on the glass.

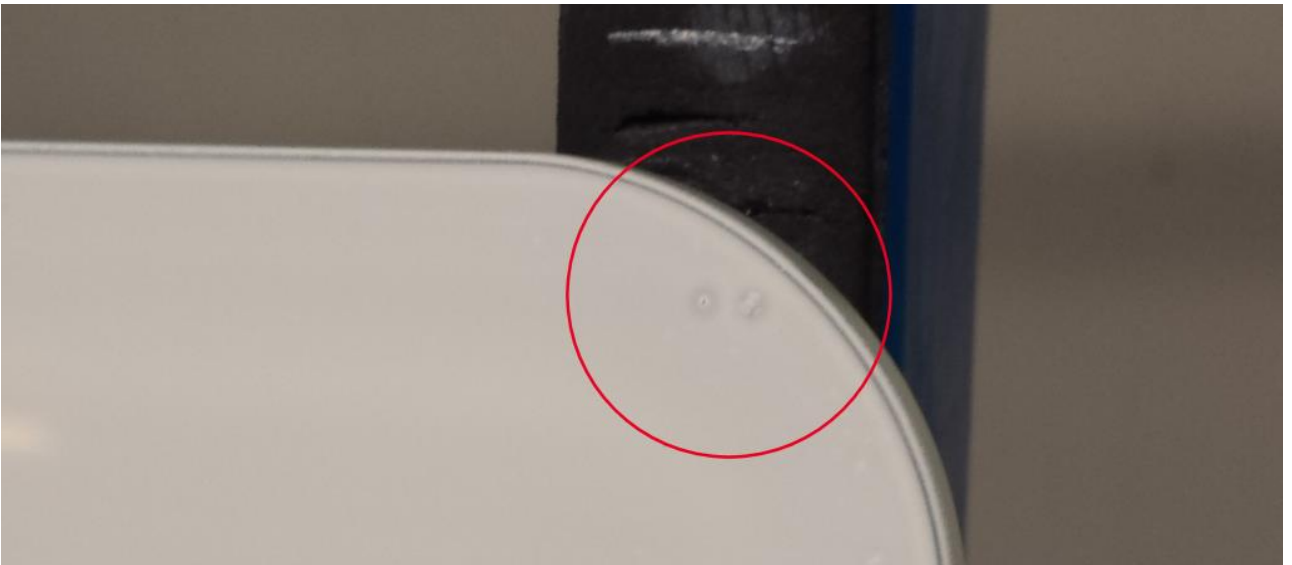
Despite the fact that all glass is washed and hand cleaned before printing plus the strict hygiene inside the printing room, achieving a 100% sterile environment is not possible in an industrial factory. This is the reason why in some cases after coating with one layer of ink, which as mentioned is very thin, there could be small areas where a small “dot” of non-homogeneous coating can be seen.



An example of non-homogeneous coating due to impurity of the glass.



An example of coating over a speck of dust.



An example of concentrated spot defects.

Spot defects **up to 3mm, visible under the conditions from point 4.1** are a subject to quality **evaluation** according to the table underneath. **Anything above 3mm, again visible under the same conditions is not allowed and is a subject to claim.**

Zone	Allowed spot defect count over a respective area
E	A concentration of up to 3 spot defects is allowed. 3 such concentrations are allowed, as long as they are more than 50 cm away from each other.
M	No concentrations of spot defects are allowed. Up to 3 single spot defects are allowed, as long as they are more than 80 cm away from each other.

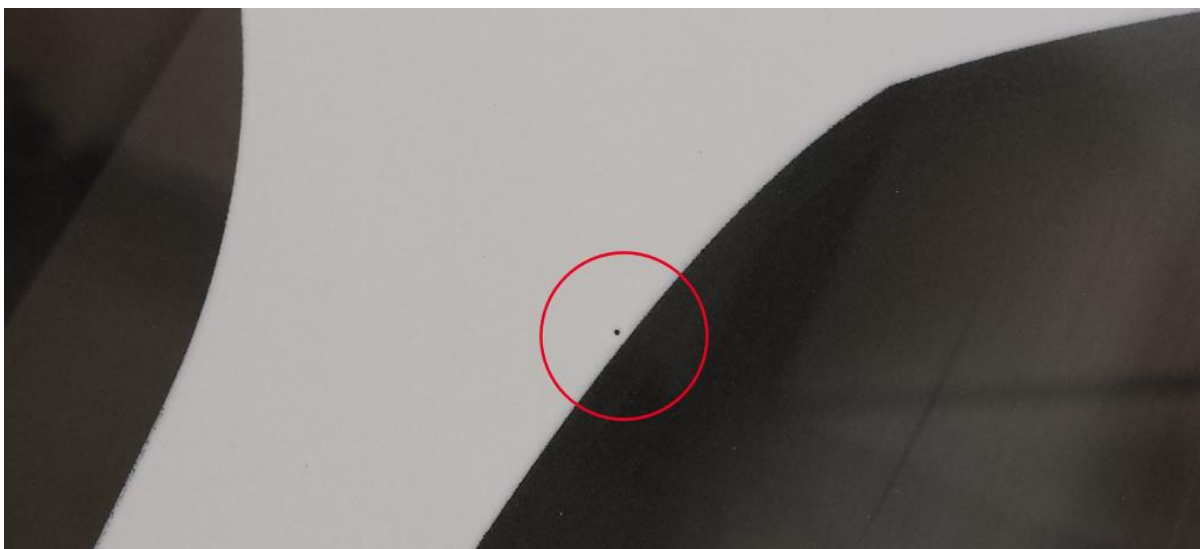
IMPORTANT:

The aforementioned criteria is valid when printing with one layer of ink. To avoid these defects it is necessary to lay 2 or 3 coatings, which will ensure enough coverage of the ink. When using more than one layer of ink, **only 1 spot defect is allowed in any area, visible under the conditions of point 4.1.** The necessary amount of additional layers to be used is related to the size of the glass and the details of the image to be printed.

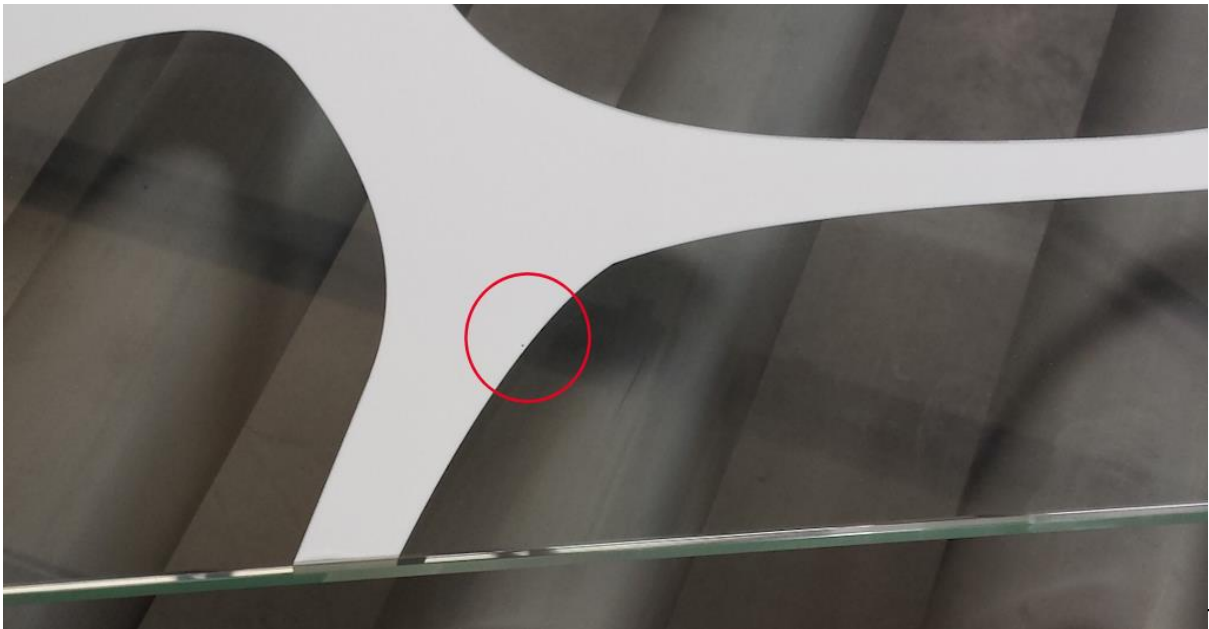
4.5. Spot defects due to lack of coverage.

The print heads use a set of miniature nozzles that deliver the ink to the glass. These droplets are also called “pixels”. The ink constantly circulates inside the print heads and at times it is possible that small clusters saturated ink passes over these nozzles as they print, preventing them from letting ink on the glass. This is mostly visible when direct light is applied on the back of the glass. A real world example of this occurrence could be a door between the living room and the hallway of a house. When the light in the hallway is on and the light in the living room is off, small specs of light can be seen on the door when looking at it from the dark room.

To avoid this occurrence, all glass that would be installed under such conditions must be printed with at least two layers of ink. In rare cases it is possible to have a slightly bigger dot of missing ink on the glass, such as the one in the picture below.



An example of a stop defect due to lack of ink, when looked from a distance of about 30-40 cm.



The

The same defect when looked from a distance of about 80-100 cm.

When such defects are present, they are evaluated using the criteria from point 4.4.

4.6. „Passes“

„Passes“ are linear marks from the printing heads. The printing technology works as multiple lines that are about 10mm wide, are being laid next to each other. It is normal when looking really close to spot these lines. However, if one can spot them at first glance from a distance, this could be due to bad digital processing of the image or a mechanical fault of the equipment. **If “passes” are visible when evaluated using the conditions from point 4.1, then we have a defective product which is subject to claim.**



An example of defective print when passes are highly visible.

5. Opacity of the coating.

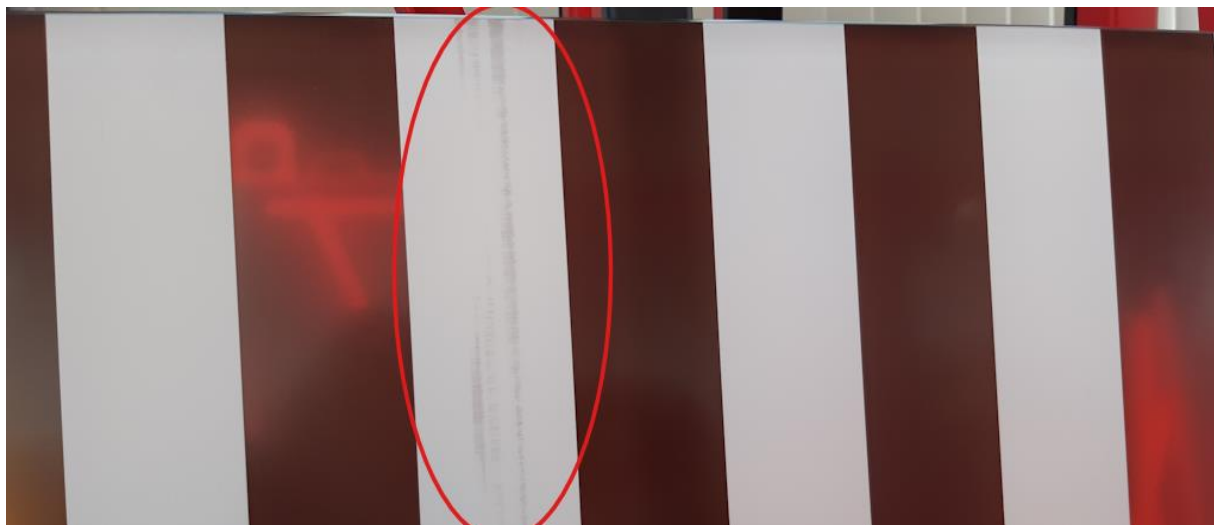
A single layer (default) of ink cannot achieve full opacity of the coating. This is not an issue for the end visual quality of the glass and is enough when the application of the products does not require them to be glued to other surfaces. If the opacity of the coating is to be higher, the client must explicitly request this in their inquiry so that the respective samples can be prepared. Higher opacity is usually achieved by applying second or third coating of ink. If the product must be visually equal on both sides, the image is printed multiple times. If the product is to be glued to other surfaces, the additional layer(s) can be pure white or black.

6. Gluing to other surfaces.

When the printed glass is to be glued to other surface (for kitchen counter back plates or construction column paneling for example) full opacity must be achieved in order to prevent the gluing material to become visible thru the coating. Full opacity is achieved by applying additional layers of pure white or black ink. It is important to use colorless gluing materials and it is highly advisable to install a sample piece with these materials first.

7. Storage before installation.

Ceramic coatings are hard to damage. However they do have a micro-relief which can hold dirt. It is advisable to avoid contact of the coating with any materials such as rubber, glue from separating pads or tape. Almost all dirt can be cleaning even with use of harder chemicals, but it is always preferable to avoid the need of such cleaning.



An example of rubber markings from a fastening bar of a glass A-rack. Although easy to clean, such contamination of the coating should be avoided.

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