

Technical News Bulletin



FleXinspect™ B Application Notes

May 2018

Section 1 Overview

The FleXinspect B (also known as FleX B) is a configurable multi-station, servo-controlled inspection system that combines contact (belt handler) and a non-contact inspection to provide a comprehensive suite of vision inspections for glass containers.

Combined standard and optional inspections can capture and correlate up to 6 individual views of the

sealing surface, base, base stress, vision plug, wire edge, vision dip, and mold reading. The FleX B comes equipped with SCOUT technology software, where everything is based on defect classifications, automatic learned variations and predefined defect limits.

The FleX B is designed to inspect round and non-round glass containers at speeds of up to 600 containers per minute (bpm).

NOTE: *Actual maximum speed and inspection capabilities of the FleX B can vary depending on container size and characteristics, as well as inspection setup.*



Standard Inspections –

- **Sealing Surface** – Image acquisition is performed using two super bright LED light sources with a 1396 x 1024 pixel resolution, area matrix camera.

Common defects detected: chips, lineovers, finish blisters, seeds, and overpress.

- **Base Inspection** – Image acquisition is performed using a super bright LED light source with a 1396 x 1024 pixel resolution, area matrix camera.

Common defects detected: blisters, seeds, fused glass, plunger pulls, dirt, deep or damaged baffles, tramp glass, and birdswings contacting the lower heel or base.

Optional Inspections –

- **Base Stress** – Image acquisition is performed using the same light source that is used for base inspection, but with a cross-polarizing filter and dedicated 1396 x 1024 pixel resolution, area matrix camera.

Common defects detected: seeds, stones, viscous knots and other stress causing defects that may be impossible to detect with conventional base inspection.

- **Vision Plug Gauge** – Image acquisition is performed using a super bright LED light source with a 1396 x 1024 pixel resolution, area matrix camera.

Common defects detected: choked neck, oval neck, spike, and birdswings contacting the neck or appearing in the field of view.

- **Vision Plug with Wire Edge** – Image acquisition is performed using vision plug gauging optics with an additional light source to illuminate the wire edge defects.

Common defects detected: wire edge, overpress, run-in finishes, and chipped finish.

- **Vision Dip Gauge** – Image acquisition is performed using four super bright LED light sources with a 1396 x 1024 pixel resolution, area matrix camera. The chart below provides additional information on kits available for various finish sizes.

Max. Finish Size	Lens
75 mm	12 mm
50 mm	16 mm lens with high resolution insert
150 mm **	12 mm
150 mm **	16 mm lens with high resolution insert

** Special for wide mouth jars and large containers larger than 120mm diameter

Common defects detected: Dipped finish and saddle finish.

Mold Number Reading

Mold number reading, enables mold-defect correlation for all inspections in the FleX B. The standard mold number reading capability is provided at the base inspection station and uses the base inspection image. This mold number reader may be effective with both heel dot, and base codes, but only if the codes can be seen clearly in the base inspection image with enough contrast to determine the mold code. This built in feature of mold reading in the base inspection image is not intended to be used for mold/cavity sorting of defective containers. For more efficient mold reading capabilities, the FleX B can be equipped with dedicated vision mold number readers, which provide mold number reading using dedicated cameras and light sources that enable image optimization specifically for mold number reading.

Optional Mold Number Readers

- **Universal Vision Mold Number Reader (U-VMNR)** – Image acquisition is performed using a super bright LED light source with 1396 x 1024 pixel resolution, area matrix camera positioned under the base of the container imaging the code off of a set of parabolic reflective mirrors. The U-VMNR supports the following types of heel codes:
 - 9 dot heel
 - 10 dot heel
 - Extended 9 dot heel
 - Owens 8 dot heel
 - Owens 9 dot heel
- **Dedicated Top- Down Vision Mold Number Reader** – Image acquisition is performed using a super bright LED light source optimized to illuminate the bottom codes on a glass container with a 1396 x 1024 pixel resolution, area matrix camera positioned over the finish looking at the bottom plate of the container.
 - 6 dot mini
 - 10 dot round bottom
 - 8 dot peanut
 - 7 dot bottom
 - Owens 8 dot bottom
 - MSC numeric

Section 2 Ware Range

The FleX B is designed to inspect round and non-round containers

Standard Ware Range:

Body Diameter:	16 to170 mm [0.625-to 6.7 in.]
Height:	38 to 381 mm [1.5-15.0 in.]
Finish Inner Diameter:	4.5 mm [0.177 in.]
Finish Outer Diameter:	144 mm [5.67 in.]

Round containers include almost all cylindrical round shapes and most tapers within the machine's ware range.

Non-round containers include most non-round shapes; however some non-round containers that are rectangular in shape may need to be oriented prior to entering the FleX B. Certain shapes with rounded bottoms such as ampoules, light bulbs, etc. are excluded.

Some containers may cause handling problems and should be tested by Emhart Glass. Examples of these containers include:

- Containers with extreme tapers
- Containers with offset necks or finishes.

CAUTION: **Misshapen and structurally weak containers may break during handling in the FleX B. This may cause unscheduled down time and/or damage to handling components. The installation of a squeeze tester or freak detection device upstream of the FleX B is strongly recommended.**

Tapered containers and containers with different diameters usually can be inspected in the FleX B. The upper and lower belt handler arms can be adjusted independently to permit handling of many different container shapes.

Section 3 Machine Speed

The FleX B is designed to acquire images at a maximum speed of 600 bpm (approximately 1200 mm/sec. [47.2 in. /sec.] linear conveyor speed). The actual maximum speed is based on container diameter, container spacing, and conveying speed. The machine's integrated bottle spacing belts can be configured to provide a spacing of two bottle diameters or can be setup to minimize space to reduce the linear speed. The following formula can be used to calculate the maximum inspection speed of the FleX B for any container diameter within the machine's ware range:

$$BPM = \text{Conveyor speed per minute} \div (\text{max. bottle diameter} + \text{spacing})$$

Example:

- Max. Conveyor speed = 72,000 mm/min. (1200mm/sec)

Section 4 Inspection Notes – Base & Sealing Surface Inspections

Sealing Surface. Sealing surface inspection is accomplished by illuminating the container finish with two separate light sources.

- *Axial illumination* is performed with a beam splitter. This provides light along the optical axis and illuminates the surface of the container that is perpendicular to the camera.
- *Diffuse illumination* is accomplished using a parabolic reflective bowl light. This provides light along the beveled edges of the sealing surface that are not perpendicular to the optical axis.

When properly illuminated, the sealing surface and the beveled edges of the container reflect the same amount of light into the camera. This gives the system a uniform gray scale image to inspect. Defects that occur on the finish will appear darker or lighter than the rest of the finish. This change in appearance is what the system will look for in detecting defects.

Base Inspection. Base inspection is accomplished by illuminating the container base with diffused back lighting. The camera then looks through the opening in the neck and is focused on the base of the container. Setting the light intensity and camera lens aperture to get the proper gray level is important. Defects that occur in the base will appear darker or lighter than the rest of the base image.

Base Stress. Inspection of the base for stress defects is accomplished by illuminating the base with diffused back lighting through a set of polarized filters. These filters cross polarize the light, canceling out all of the light being received by the camera. When a stress-causing defect is present in the base, it changes the orientation of the light allowing the camera to see visible light.

Vision Plug. Inspection for plugged or choked necks is accomplished by illuminating the part with diffused back lighting. The camera looks through a field lens creating a telecentric view of the part. This telecentric view gives the camera a focal depth of 140 mm [5.5 in.] into the container.

Wire Edge Inspection. Inspection for wire edge defects, as well as many defects that occur on the inner finish of the container, is accomplished using the optics of the vision plug gauging option with an additional on-axis light source that illuminates the inside finish area of the container. The resulting image provides a black ring where a wire edge defect occurs. When a defect is seen, the black area reflects light into the camera, which appears as a bright white ring (or partial ring).

Vision Dip. Inspection for vision dip is accomplished by illuminating the finish with four separate light sources. Each light source provides a diffused backlit reflection of the finish on four separate mirror surfaces. The camera lens is then focused on these mirrored surfaces, and inspects 120° of the finish in each view, by fitting an ellipse to the images. Once an ellipse is created, it calculates the difference between the edge of the part and the ellipse to determine if a defect is present.

Vision Mold Number Reading. The Flex B mold number readers (both standard and optional top-down, and universal vision mold number reader) are capable of reading most mold codes used throughout the glass container industry.

NOTE: *The mold reading capability of the FleX B is limited to mold codes that are cut correctly, according to specification, and can be seen in the acquired image.*

For all vision mold number readers, the mold codes must be within specification and also have clearance from other container markings to allow proper sensing. Specifications for the engraving the various mold codes read by the FleX B mold number readers are described in the following documents available from Emhart Glass:

16049A, *Code Specifications for Emhart Glass MNR*

22444A, *Bottom and Heel Code Specifications for VMNR.*

Heel code specifications from document 22444A:

Dot shapes and proper dot-to-dot spacings are crucial to the long-term capability of the U-VMNR to recover the mold codes at high rates of reliability. Dot size and spacing is dictated by the optical characteristics of the vision system, thus it is important that they are held within the following specifications for a standard dot:

Dot Diameter: 0.055" +/- 0.005" or 1.40mm +/-0.13mm

Dot to Dot Spacing*: 0.120" or 3.00mm (see note on page A.29)

*(Referred to throughout this specification as "T")

To calculate dot position on container surface in degrees:

Degrees =(Radians x 180°) ÷π

Where Radians = Arc Length ÷ Radius

Where π = 3.14

Where Arc Length = .120"

And, where Radius is measured from the container's central axis at the elevation of the code

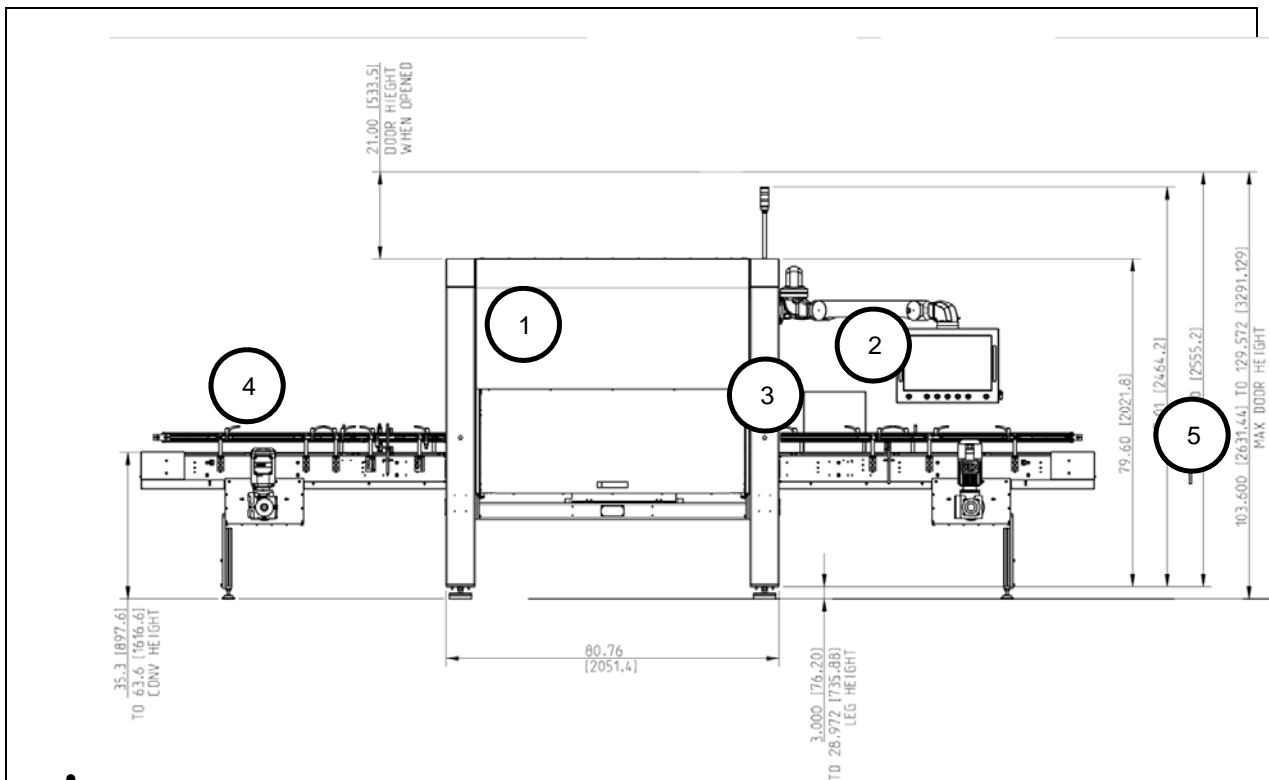
Dot Radius of Curvature: 0.039" or 1.0 mm

Dot Height on container: 0.012" +0.006"/-0.000" or 0.30 mm +0.15 mm/-0.00 mm

These Dimensions apply **after** forming.

Section 6 Site Preparation and Installation Requirements

NOTE: Machine clearances for the Flex B are shown in Figure 1.



1.Flex B machine

2.User Interface

3.Cullet Chute (customer supplied)

4.Ware Backlog (prime) sensor

5. Ware Backup sensor

Area Preparation. The area where the Flex B will be located must be:

- A straight, level area that is free of legs and under-conveyor obstructions (minimum conveyor height is 914 mm [36 in.]). The Flex B and its conveyor cannot be installed on an incline or decline.
- A break in the conveyor approximately 4.3 meters [approximately 14.2 feet].
- A clear height of at least 2225 mm [87.6 in.] above the top of the conveyor.
- A minimum of approximately 3.6 meters [12 feet] upstream and downstream of the Flex B (measured from the infeed and outfeed sides of the machine).

Conveyor Control System Integration. The FleX B is designed to interface with most plant conveyor control systems. However, ***Emhart Glass cannot be responsible for the modification or performance of a conveyor control system. Our responsibility is limited to the supply and performance of the FleX B and its integrated Emhart Glass conveyor system.*** Any conveyor/machine control issues must be reviewed and resolved during machine specification. Emhart Glass will work with customers and/or their conveyor supplier(s) to meet specific line requirements; however, the customer has the ultimate responsibility for any changes that must be made to the conveyor control to enable interface with the FleX B machine and conveyor.

Conveyor Control Considerations. When the FleX B is interfaced with a plant conveyor control system, the speed of the FleX B must be set in such a way that speed of the machine and the conveyor retain the same ratio.

There are two ways to achieve this machine-conveyor speed ratio goal:

- Configure the conveyor to follow the FleX B and set the amount of time it takes for the conveyor to accelerate (ramp up) to its new speed to be as short as possible.
- Configure the FleX B to follow the conveyor and set the time that it takes for the conveyor to accelerate to be longer than the time it takes for the machine to accelerate to the new speed.

NOTE: *If either of the above two goals is not achieved, ware can accumulate between the FleX B and other machines on the line. If the accumulation of ware exceeds the capacity of the conveyor between machines, containers can fall over or back up into an upstream machine.*

The best way to achieve either of the machine-conveyor speed control goals is to control the speed of the FleX BC using a 0-10 VDC analog speed reference signal from the plant line control system to the FleX B.

The line control system then must be configured as follows:

1. The line control system sends a speed control signal to the FleX B.
2. Allow adequate time for the FleX B to change its speed and provide a feedback speed reference signal to the conveyor controller telling the controller how fast the FleX B is now running.
3. Set the conveyor controller to follow the speed of the FleX B as closely as possible.

When the above procedure is followed, the FleX B and its conveyors can maintain the correct speed ratio and the conveyor control system can respond to a speed change demand as quickly as possible, thereby reducing ware flow problems upstream or downstream of the FleX B.

Air and Power Requirements

NOTE: ***It is the customer's responsibility to provide a stable, clean power supply to the FleX B. Power fluctuations (high or low voltage conditions) can cause the FleX B to shut down and/or stop unexpectedly, as well as damage electronic components in the machine.***

Power: 380 to 480 VAC, 3 phase, 25 amps (max. consumption: 30 amps at 460 VAC)

Air: 3.5 bar [50 psi] nominal (consumption 0.8 to 0.85 m³/minute [105.9 cfm].

Section 7 Operating Environment

Enclosures: All electrical/electronic enclosures used in the FleX B should be considered rated for NEMA 12 and IP20.

The FleX B is equipped with a closed-loop air conditioning system designed to maintain the FleX B internal temperature at or below 50°C [122°F]. The temperature is constantly monitored and the user interface will display the following conditions when temperatures inside the electronic cabinet exceed set points.

Fault Message	Description	Machine State
Over temperature warning	The temperature inside of the electronics cabinet has exceeded the user set warning.	<ul style="list-style-type: none"> Counters reset Machine status icon is yellow.
Over temperature fault	The temperature inside of the electronics cabinet has exceeded 50 C.	<ul style="list-style-type: none"> Machine stopped Red stop button is illuminated Counters reset icon flashing. Machine status icon is red.
Air conditioner fault.	The electronics cabinet air conditioner has stopped.	<p>Note: Machine will not restart until the condition that caused the alarm is resolved and cabinet temperature is below 50 C.</p>

Operating Temperatures: The FleX B is controlled by electronic equipment that is designed to operate in the majority of glass plant environments without modification. However, since conditions can vary from one installation to another, the following operating conditions must be observed. Failure to maintain these requirements will affect the applicable warranties covering the Emhart Glass hardware and software associated with the FleX B. If the proper operating conditions are not maintained, the electronic hardware will not function as designed.

The maximum allowable temperature inside the machine is 50°C [122°F]. Although control components can operate at this upper temperature, life expectancy of the electronic components will be reduced. The lowest recommended operating temperature is 5°C [41°F]. Maximum relative humidity is 95%, non-condensing.

CAUTION! **Components within the electronic consoles must be kept clean. The life expectancy of electronic components will be substantially reduced if they are contaminated with plant dirt (swab oil, dust, etc.). The accumulation of these substances on electronic components causes the actual temperature of these components to be much higher than the temperature of air within the control cabinet.**

Container Temperature: The machine handling equipment is rated for 60°C [140°F] maximum container temperature at machine infeed. Containers hotter than this can cause damage to handling equipment and can cause the internal machine temperature to rise above acceptable limits as outlined above.

Section 8 Conformity Statement

The FleX B conforms to the provisions of the following European CE directives and standards:

- Directive 73/23/EEC and amendments (Low Voltage Directive)
- Directive 89/336/EEC and amendments (EMC Directive)
- Directive 89/392/EEC and amendments (Machine Safety Directive)
- EN292 Parts 1 and 2
- EN50081-2 Part 2
- EN50082-2 Part 2
- EN60204 Part 1
- CEN TC151 WG13 PrEN13042 Part 6: Specific Safety Requirements for Hollow Glass – Part 6: Multi-Station Multi-Inspection Machines

Section 9 Specifications Required for Order Entry

The following items are configurable and require specification when ordering:

- Machine hand
- Plant voltage
- Conveyor height
- Options
- Line layout drawings

Section 10 Spare Parts

Spare parts kits are available for the base machine, as well as for the optional inspections. Although the FleX B is covered by a one-year parts and labor warranty, spare parts kits are strongly recommended. If an adequate supply of spare parts is maintained, critical parts, when needed, will be available if they fail or wear out prematurely. An adequate spare parts inventory also helps reduce downtime or extended unsatisfactory machine operation caused by occasional out-of-stock conditions and time required to order and ship required parts. Parts failing within the specified warranty period will be replaced free of charge when returned to Emhart Glass under a Return Authorization number provided by Emhart Glass.

Spare parts have been organized in the following manner.

Basic Kit PN 12603DSP1 – This kit contains parts that are the recommended required parts for the base machine.

Advanced Spares Kit PN 12603DSP2 – This kit contains both the basic spare parts, as well as parts to cover almost all failure conditions, including major vision system components (computer, optics, and light sources for base and sealing surface inspections).

Wear Parts Kit PN 12603DSP – This kit contains parts to be considered consumables, these are parts that need to be replaced over time. Items like belts and protective windows are included in this kit.

Section 11 Training

Setup operation and maintenance training by Emhart Glass personnel is mandatory for optimum machine operation and extended life. A machine-specific service program also is available for the FleX B. Training programs, offered at Emhart Glass training centers in St Petersburg, FL (USA), or Leipzig, Germany or at your plant, provide plant personnel with hands-on experience in all aspects of machine job change, maintenance, troubleshooting, and operation. We recommend training for all lead maintenance and setup personnel (at least one per shift). This helps facilitate optimum, 24-hour-a-day machine operation and can virtually eliminate costly machine maintenance and service calls.

Revisions

Rev.	Date	Description
	6 March 2014	Preliminary release for review.
A	03/03/2017	Changed picture, added Scout, removed dip part numbers, changed spare part numbers
B	05/18/2018	Added universal vision mold number reader (U-VMNR)