



DIEMARK™ FILAMENT AND PNEUMATIC INK CARTRIDGE OPERATION AND TROUBLESHOOTING MANUAL

820-0013 Revision M
July, 2016



**DM-2
Pneumatic
Cartridge**

**DM-1
Filament
Cartridge**



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SAFETY INFORMATION

Safety and Hazard identification symbols used in this document are intended to be compliant with ANSI/NEMA Z 535.6 2006. The table below lists the symbols used in this document along with a description of each type of safety hazard. Failure to observe identified safety risks may result in serious injury or death.

Safety and Hazard Identification Symbols

SYMBOL	DESCRIPTION
 DANGER	DANGER = Indicates a hazardous situation which, if not avoided, will result in death or serious injury
 WARNING	WARNING = Indicates a hazardous situation which, if not avoided, could result in death or serious injury.
 CAUTION	CAUTION = Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.
 NOTICE	NOTICE = Indicates a practice that is not related to personal injury, but may cause damage to equipment or property.

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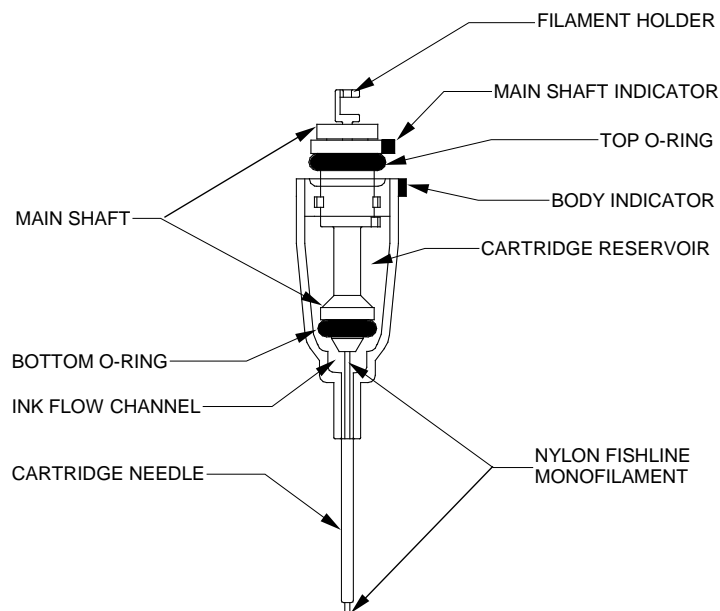
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Section 1. Filament Cartridge Operation

General Information

The DM-1 and DM-1.25 filament ink cartridges have a polypropylene reservoir and monofilament fishline encased in a stainless steel needle. The DM-1 differs from the DM-1.25 in that the overall needle length of the DM-1.25 is 0.50 inches ($\pm 0.005''$) longer than the DM-1. Both the DM-1 and DM-1.25 cartridges contain approximately 0.60 grams of ink in the reservoir. After opening and priming, the monofilament fishline wicks the ink to the filament tip each time the inker solenoid fires. For dot production figures and related information see **Section 3 “Ink”** and **“Filament Ink Cartridge Specifications”** in **Section 5**.

DM-1 Ink Cartridge Overview



• Cartridge Description

A cartridge is an ink reservoir sealed by two O-rings, top and bottom. A monofilament "fish line" passes through the cartridge main body and needle and is attached at the top to the filament holder. A cartridge is opened by turning the top of the main shaft to open position and pulling the main shaft up to lift the bottom O-ring and open up the ink flow channels.

• Cartridge Priming

Priming is necessary to establish continuous ink flow into the cartridge needle. The cartridge is primed by lifting the main shaft (and bottom O-ring) to fill the reservoir under the bottom O-ring with ink and actuating the filament, coating it with ink all the way to the needle tip. The cartridge is ready for use when the ink flow channels are open (i.e., bottom O-ring is raised and the space below the bottom O-ring is full of ink), the filament is coated with ink to the needle tip and the main shaft is locked in position so that it cannot move up or down. Detailed cartridge opening, priming and installation instructions appear later in this section.

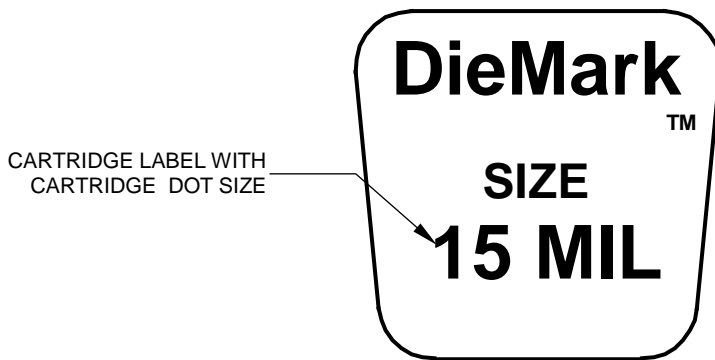
Ink Cartridge Labeling

DieMark™ ink cartridges are individually labeled with two distinct labels. One label shows the cartridge dot size and the other label indicates the ink batch number, ink type and expiration date of the cartridge.

Do not remove the labels from the cartridges as this can cause cartridge type and ink types to be confused at cartridge installation, resulting in improper performance. Removal of cartridge labels will also void the cartridge warranty.

DieMark™ Cartridge Size Label

This label contains the cartridge dot size, (10mil, 15mil etc.).

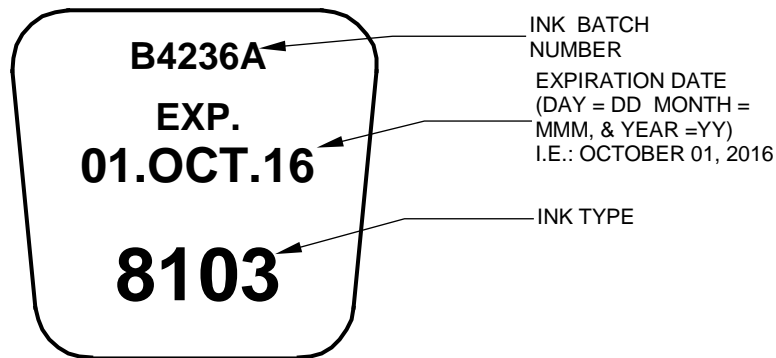


DieMark™ Cartridge Expiration Date Label

This label indicates the ink type, the batch number of the ink contained in the cartridge and the cartridge expiration date. Expiration dates shown are for *unopened* cartridges.

- ◆ Markem® 6990, 6993, 6997 = Four (4) months.
- ◆ Xandex 8103, 8104 and Xandex 7824, 7824T = Four (4) months.

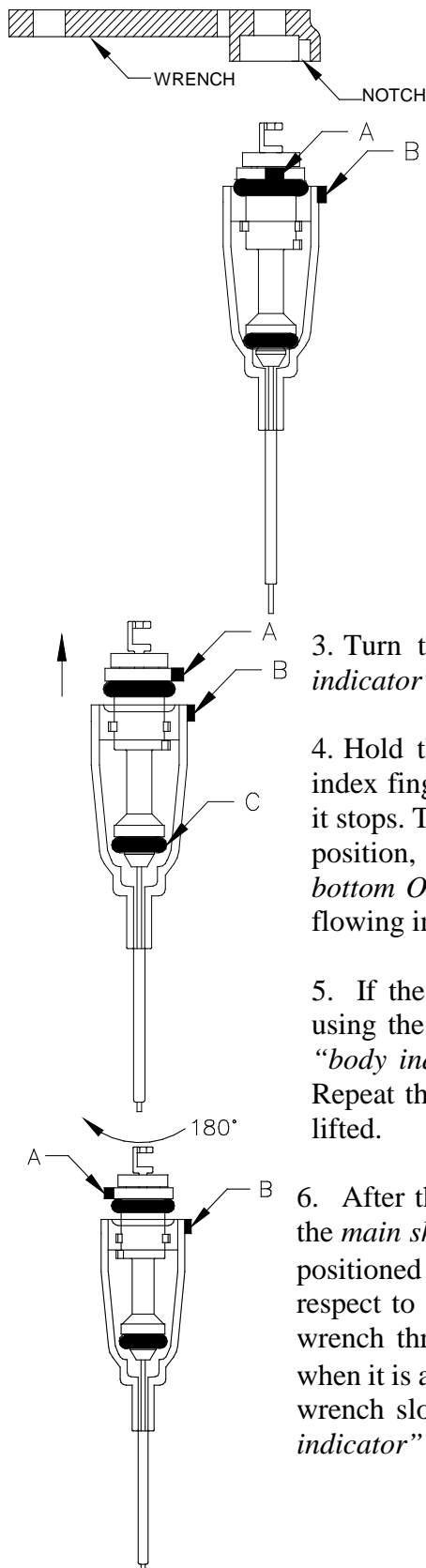
After the cartridge is opened, consistent ink flow can only be expected for up to five (5) days for Markem® 6990, 6993 and 6997, three (3) days for Xandex 7824 and 7824T and two (2) days for Xandex 8103 and 8104.



Cartridge Label Color Coding

5 / 8 / 10 / 15 / 25 / 30 MIL FILAMENT CARTRIDGE LABELS	
LABEL	DESCRIPTION
	5 MIL IS SILVER
	8 MIL IS RED
	10 MIL IS BLUE
	15 MIL IS GREEN
	25 MIL IS YELLOW
	30 MIL IS PURPLE

Opening the cartridge



A plastic wrench is used to open and prime a cartridge. The wrench fits very tightly and has a shallow cup with a notch to fit over the top of the main shaft. The notch location is indicated by an alignment "bump" on the end of the wrench.

1. Two reference points on the ink cartridge are used in opening and priming the cartridge.

- An alignment "bump" at the top of main shaft called the "*main shaft indicator*" (A).
- An alignment "bump" on the cartridge body near the top called the "*body indicator*" (B).

2. Align the "*main shaft indicator*" (A) with the notch in the wrench and fit the wrench over the top of the *main shaft*.

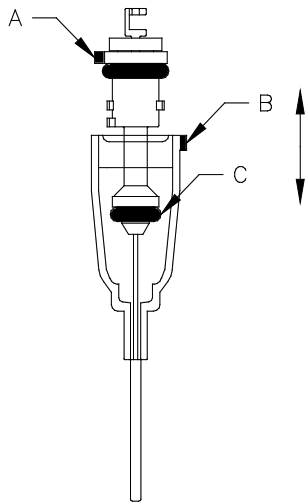
3. Turn the "*main shaft indicator*" (A) towards the "*body indicator*" (B) on the cartridge until they are aligned.

4. Hold the wrench at the cup section, between thumb and index finger, and pull up the *main shaft* with the wrench until it stops. The *bottom O-ring* (C) should be lifted from its sealed position, opening the *ink flow channels*. Visually inspect the *bottom O-ring* (C) and verify that it has lifted and the ink is flowing into the channels.

5. If the *bottom O-ring* is not lifted, close the cartridge by using the wrench to re-align the "*main shaft indicator*" and "*body indicator*". Push the *main shaft* down to re-seat it. Repeat this procedure if necessary until the *bottom O-ring* is lifted.

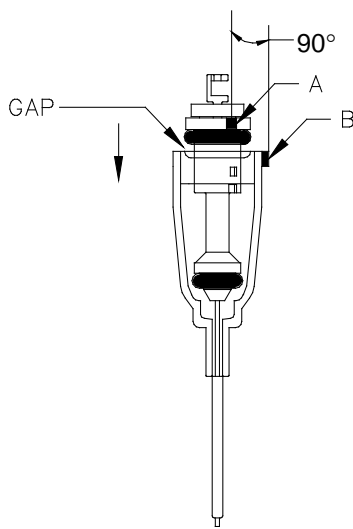
6. After the *main shaft* and the *bottom O-ring* are lifted, turn the *main shaft* with the wrench until the *indicators* (A & B) are positioned exactly at opposite sides of the cartridge (at 180° with respect to each other). There is a small hole at the top of the wrench through which the "*body indicator*" (B) can be seen when it is at 180° from the "*main shaft indicator*" (A). Turn the wrench slowly while looking through this hole for the "*body indicator*" (B).

Priming the cartridge



The purpose of priming the cartridge is to ensure that the lower reservoir and the *ink flow channels* below the *bottom O-ring* are completely filled with ink. This will ensure even, continuous ink flow. To prime the cartridge, follow the steps below.

1. Hold the cartridge steady in one hand and the wrench at the cup area (top of the *main shaft*) with the other.
2. Keeping the indicators at 180° from each other, pull up very gradually and lift the *main shaft* while wiggling the wrench slightly from side to side.
3. Stop lifting the *main shaft* when it is ½ way out of the reservoir.

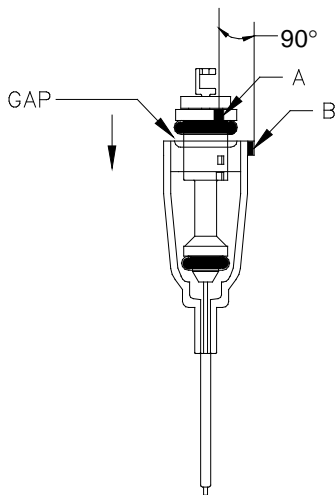


4. Lower the *main shaft* back to its original position while gently stirring the ink. Take care not to bend the filament.

5. Repeat steps 1-4 as many times as necessary until space below the *bottom O-ring* is completely filled with ink.

Notice: Avoid over priming! No more than 60 seconds should be required for steps 1-5

6. Lower the *main shaft* the final time, as far down as it will go (until it stops). The *indicators* should still be 180° from each other and the *main shaft* back down to the pre-prime position.



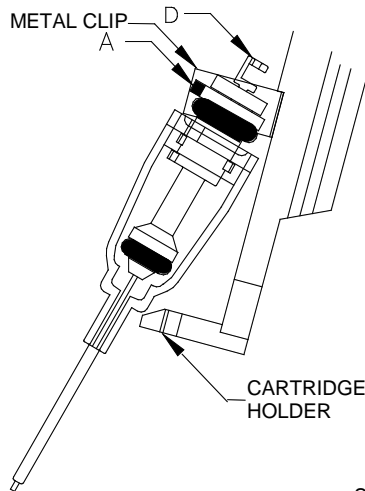
7. Turn the *main shaft* 1/4 turn in either direction. This locks the *main shaft* in position so that it cannot be moved up or down. There should be a gap between the *top O-ring* and the *cartridge body*. Push the *filament holder* down and remove the wrench. The cartridge is now primed and ready for installation.

Cartridge Inspection

Visually inspect the primed cartridge before installing it on the inker and verify that the following conditions exist;

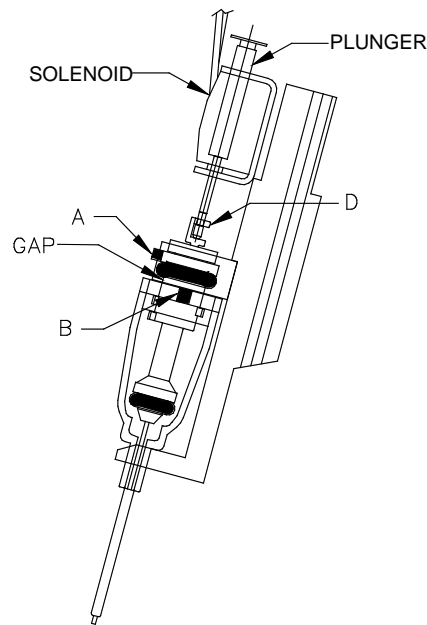
- The *bottom O-ring* is lifted and the *ink flow channels* under the bottom O-ring are completely filled with ink.
- The cartridge *alignment indicators* are 1/4 turn from each other. This way the *main shaft* cannot be pushed up or down.
- There is a *gap* between the *top O-ring* and the *cartridge body* indicating that the cartridge has not been inadvertently closed.

Cartridge Installation



1. Verify that the *filament holder* (D) has been pushed down.

2. Push the *main shaft* section into the *metal clip* on the *cartridge holder*. Make sure the “*main shaft indicator*” (A) is pointing outwards. Press the *cartridge body* until it snaps into place. Verify that the *gap* has not closed and the *indicators* are still 1/4 turn from each other. If these conditions are NOT satisfactory, remove the cartridge from the clip and review the priming procedure.



3. Align the *solenoid plunger* with the *filament holder* (D) and push the *plunger* until it snaps into the *filament holder*. In this position the *plunger* should move up and down freely. Manually depress the *plunger* a number of times to verify operation, occasionally rotating the *plunger* to ensure free movement.

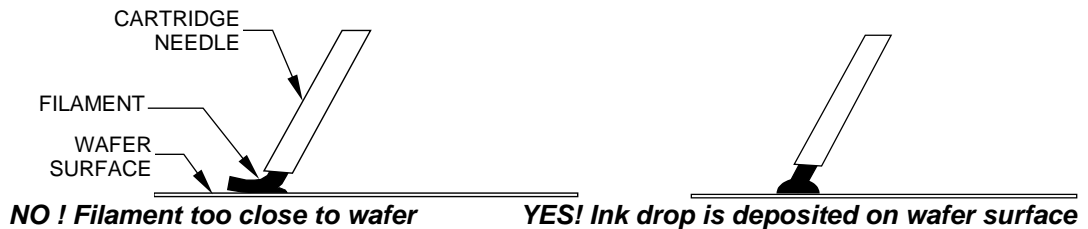
4. Exercise the *plunger* manually or electrically until

ink flow is established in the *stainless steel needle* and the *monofilament* is coated with ink. A standard DM-1 cartridge requires a minimum of 30-40 *plunger* strokes to properly establish ink flow. When the *filament* is completely coated with ink, check the *needle tip* for excess ink and wipe with a clean, lint free cloth if necessary.

Setup and Adjustments

The following instructions are generic and may not apply to your inker. Please refer to your inker manual for instructions for your specific inker.

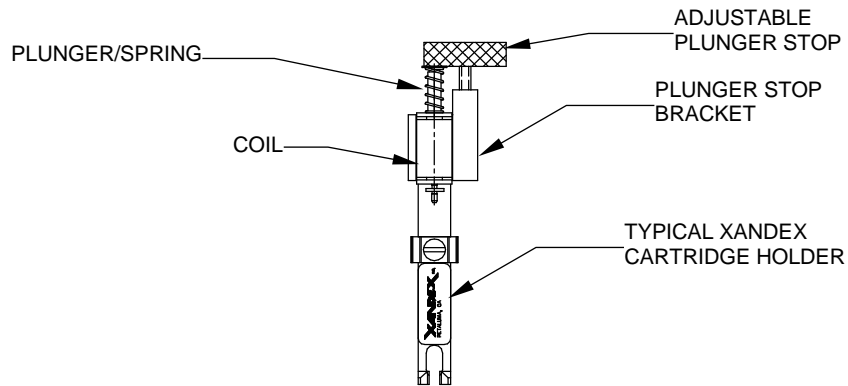
1. Prepare, prime and install an ink cartridge per the instructions in this section (1).
2. With the chuck still in a safe position out from under the probe card, verify the inker Z height is set to full Z up (full counterclockwise *Z adjust knob* adjustment) position before lowering the inker arm or installing inker in the test head.
3. Using the microscope or camera, focus on the *cartridge tip*.
4. Place a sample or scrap wafer on the chuck and move directly under the cartridge tip. Raise the chuck height to normal Z inking position.
5. While monitoring the cartridge/wafer surface through the microscope or camera, fire the inker a few times and inspect the results. Slowly turn the *Z adjust knob* clockwise while firing the inker until dots begin to appear on the wafer surface. The cartridge *filament* should barely contact the wafer surface.



NOTICE

Do not allow the cartridge tip to contact the wafer surface while performing Z Height adjustment. Damage to the filament and/or wafer surface may occur.

6. Adjust Z height with *Z adjust knob* until dots are round and of proper size. The cartridge *filament* should barely contact the *wafer surface* only close enough so the ink droplet wicks off onto the wafer surface.
7. Remove the sample/scrap wafer and replace with a production wafer. Move chuck under the inker and perform X & Y adjustment to desired die position.

Plunger Stop Assembly

This optional assembly, available for Xandex electric ink cartridge holders, is necessary when the 5 mil tungsten filament DM-1 ink cartridge is used. The assembly consists of an adjustable plunger stop, which is attached to the solenoid/cartridge holder with a bracket. Limiting plunger travel via the adjustable plunger stop provides higher control and therefore consistency of dot sizes in applications where small dots (5 mil) are required. The assembly is required for use of DieMark™ 5 mil tungsten filament cartridges.

Order part number 210-0016, or contact Xandex Customer Service for assistance with your specific application.

Filament Cartridge Tips**Tips to avoid common problems with Filament Ink Cartridges.**

DO NOT attempt to refill Xandex DieMark Ink Cartridges. Cartridges are disposable and designed for single use only. Using a refilled cartridge will have an adverse effect on functionality and performance. Please note; Xandex does not warranty refilled cartridges.

Handling Tips:

Handle cartridges with care to avoid damaging the exposed filament.

When removing the cartridges from the clamshell package, lift the cartridge straight up to avoid bending the needle or damaging the filament.

Allow the cartridge to reach optimal temperature of 18-25C (65-78F) before priming the cartridge. Never attempt to prime and use cartridges that are not at optimal temperature.

Priming Tips:

DO NOT over-prime the cartridge during Step 2 of the priming process. Twenty or thirty (20-30) up and down movements of the main shaft should be enough to remove the large bubbles and get a continuous flow of ink into the needle.

NEVER perform Step 2 of the priming process with the plastic tabs on the cartridge body and main shaft lined up. The tabs must be 180 degrees apart from each other so that the main shaft can be lifted all the way out of the cartridge body.

Wipe off any excess ink on the outside of the needle using a lint free cloth or swab before use.

NEVER re-close the cartridge. The cartridge should be left in the open position as described in Step 5 of the priming instructions, until the cartridge is ready to be discarded (cartridge is either empty or expired).

DO NOT use the cartridges beyond the recommended open time for the ink type in the cartridge. Recommended open time is two (2) days for 8103 and 8104, three (3) days for 7824 and 7824T and five (5) days for 6990, 6993, and 6997.

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Section 2. Pneumatic Cartridge Operation

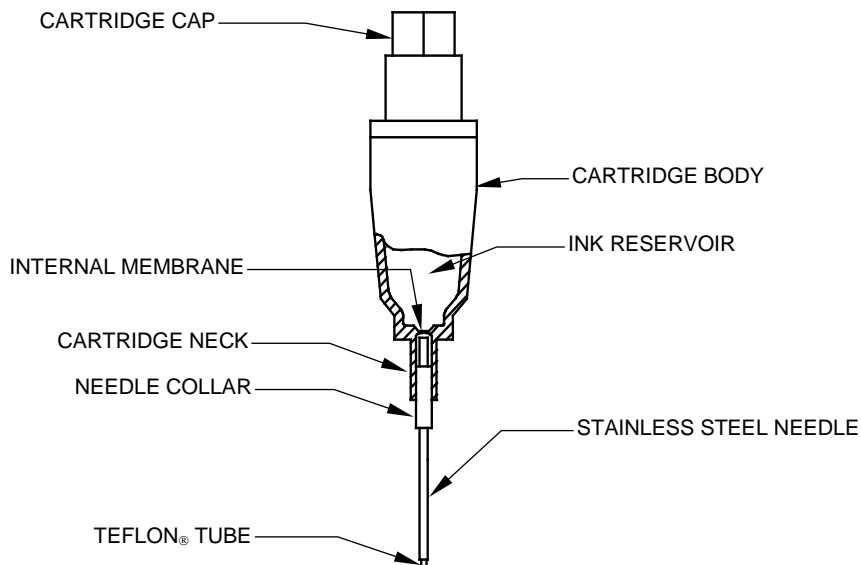
General Information

The two DieMark™ pneumatic ink cartridges used with Xandex Pneumatic Inkers are the DM-2, and the DM-2.3. The DM-2.3 differs from the DM-2 in that the overall needle length of the DM-2.3 is 0.20 inches ($\pm 0.005''$) shorter than the DM-2. They are both available in A5, A6, and A8 (designating 0.005'', 0.006'', and 0.008'' Teflon® tube I.D., respectively). DM-2 and DM-2.3 cartridges have a polypropylene reservoir which is sealed at the bottom by a thin membrane, and a small Teflon® tube encased in a stainless steel needle. When the cartridge is opened, the needle punctures the membrane to provide ink flow through the Teflon® tube.

Each cartridge holds 1.0 grams minimum of ink and can produce a wide range of dot sizes. Dot size is controlled by changing the duration of the air pulse into the cartridge reservoir, which determines how much ink is forced through the Teflon® tube to create the ink drop at the needle tip. A5 and A6 cartridge types will produce an average of 30,000 dots*, while the A8 averages 10,000 dots*. For more information see **Section 3 “Ink”** and **“Pneumatic Ink Cartridge Specifications”** in **Section 5**.

** Averages exclude 8104 ink type. Dot production figures are averages and as such, are not guaranteed. Testing is performed at ambient temperature of 70 degrees F, relative humidity of 50% on polished, unetched silicon wafers (no passivation) and based on pneumatic controller operating at "MIDDLE" dot size setting (standard controller = dot size knob centered between "MIN" and "MAX": Auto-Z/Motor-Z Controller = dot size thumbwheel setting of 50). Dot production figures represent an average of results for multiple ink types. Your yield may be higher or lower depending on the ink type and dot size setting you use. Average figures are based on complete cartridge use within **cartridge open shelf life periods** (5 days maximum or 3 days maximum) as stated for each specific ink type.*

Cartridge Overview



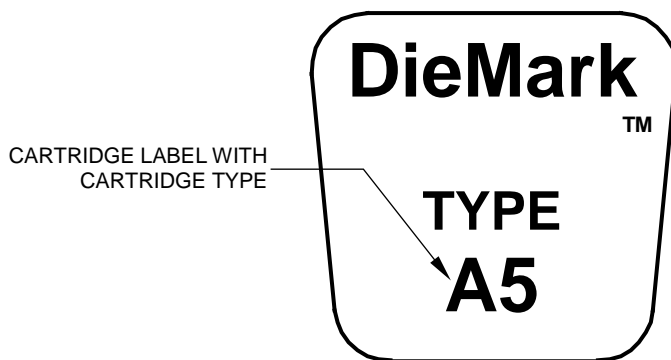
Ink Cartridge Labeling

DieMark™ ink cartridges are individually labeled with two distinct labels. One label shows the cartridge type and the other label indicates the ink batch number, ink type and expiration date of the cartridge.

Do not remove the labels from the cartridges as this can cause cartridge type and ink types to be confused at cartridge installation, resulting in improper performance. Removal of cartridge labels will also void the cartridge warranty.

DieMark™ Cartridge Type Label

This label contains the cartridge type, (either **A5**, **A6** or **A8**).

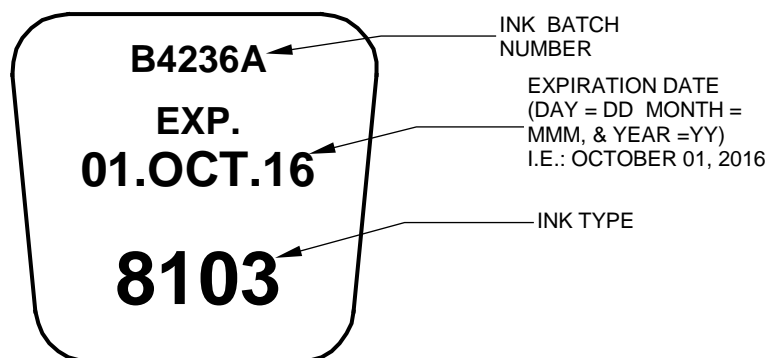


DieMark™ Cartridge Expiration Date Label




This label indicates the ink type and batch number of the ink contained in the cartridge and the cartridge expiration date. Expiration dates shown are for *unopened* cartridges.

- ◆ Markem® 6990, 6993, 6997 = Four (4) months.
- ◆ Xandex 8103, 8104 and Xandex 7824, 7824T = Four (4) months.

After the cartridge is opened, consistent ink flow can only be expected for up to five (5) days for Markem® 6990, 6993, 6997 and three (3) days for Xandex 7824, 7824T, 8103 and 8104.



Cartridge Label Color Coding

DM-2 & DM-2.3 PNEUMATIC CARTRIDGE LABELS	
LABEL	DESCRIPTION
	A5 IS RED
	A6 IS BLUE
	A8 IS YELLOW

Pneumatic Ink Cartridge Tips

Tips to avoid common problems with Pneumatic Ink Cartridges

DO NOT attempt to refill Xandex DieMark Ink Cartridges. Cartridges are disposable and designed for single use only. Using a refilled cartridge will have an adverse effect on functionality and performance. Please note, Xandex does not warranty refilled cartridges.

Handling Tips:

Handle cartridges with care to avoid damaging the exposed Teflon tube at the tip of the needle

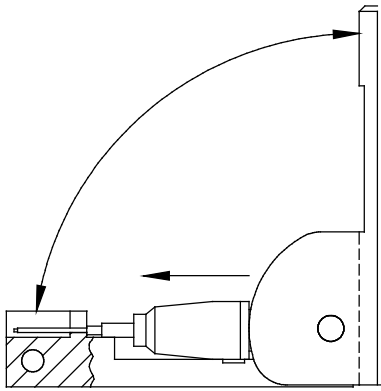
When removing the cartridges from the clamshell package, lift the cartridge straight up to avoid bending the needle or damaging the Teflon tube.

Allow the cartridge to reach optimal temperature of 18-25C (65-78F) before priming the cartridge. Never attempt to prime and use cartridges that are not at optimal temperature.

Priming Tips:

Wipe off any excess ink on the outside of the needle using a lint free cloth or swab before use.

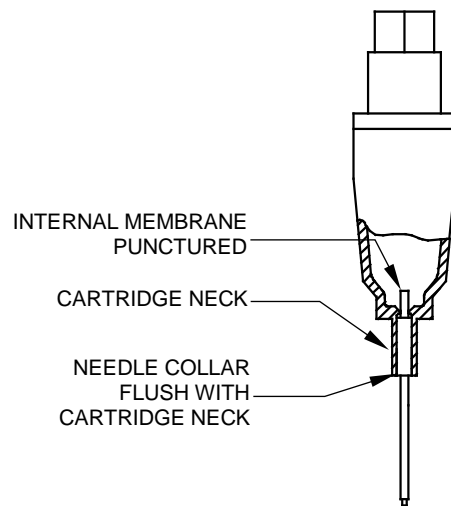
DO NOT use the cartridges beyond the recommended open time for the ink type in the cartridge. Recommended open time is three (3) days for 7824, 7824T, 8103 and 8104 and five (5) days for 6990, 6993, and 6997 in pneumatic ink cartridges.

Cartridge Preparation

1. Place the cartridge into the cartridge preparation tool (Xandex Part No. 200-0001) as shown, exercising care to avoid damaging the Teflon® tip. The cartridge cap should be seated in the tool hinge with the needle resting in the slot.

2. Firmly squeeze the tool fully closed with a smooth, quick motion. This will push the cartridge body forward, causing the needle to puncture the internal membrane.

3. Open tool and remove cartridge. The needle should be straight and the needle collar flush with the cartridge neck.

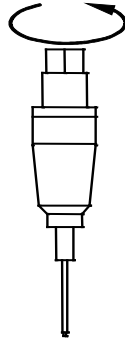


Note: Do not shake the cartridge at any time, as air bubbles may be introduced into the reservoir and restrict the flow of ink. If mixing of the ink in the reservoir is desired, roll the cartridge between thumb and forefinger (or between palms) for 1-2 minutes prior to installation.

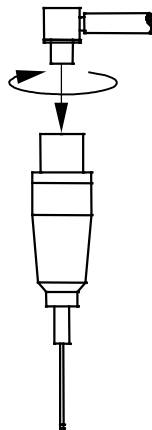
Cartridge Installation

The following instructions are generic and may not apply to your inker. Please refer to your inker manual for specific instructions for your inker.

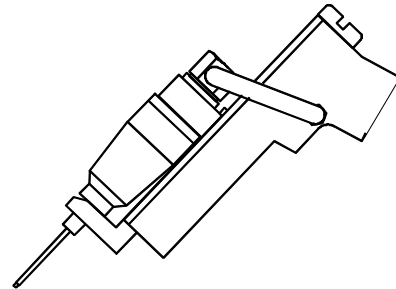
1. Use the slotted section of the cartridge preparation tool and a *counter-clockwise* motion to remove the cartridge cap.



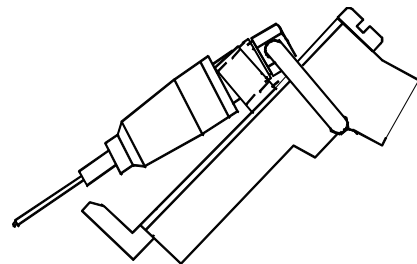
2. Thread the cartridge onto the brass air fitting of the RED AIR HOSE, turning the cartridge *clockwise* until snug.



3. Press top of cartridge into shuttle spring clip.



4. Press cartridge body into shuttle forks until the neck fully snaps into place.




5. Cartridge is now ready for priming.

Changing the Cartridge

The following instructions are generic and may not apply to your inker. Please refer to your inker manual for specific instructions for your inker.

1. Place thumb and forefinger on each side of the cartridge and gently pull out to remove cartridge from clips.
2. Unthread the cartridge from the air fitting and discard in the proper manner.
3. Inspect the air fitting and hose for ink contamination and clean or replace as necessary.
4. Install a new cartridge per installation instructions.

Cartridge Priming

	<p><i>Always wear protective eyeglasses when handling an active pneumatic inking system!</i></p>
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The following instructions are generic and may not apply to your inker. Please refer to your inker manual for specific instructions for your inker.

1. Prepare a cartridge per the “Cartridge Preparation” section of this manual.
2. Install a prepared cartridge on the inker.
3. Move the controller switch to “RUN”.

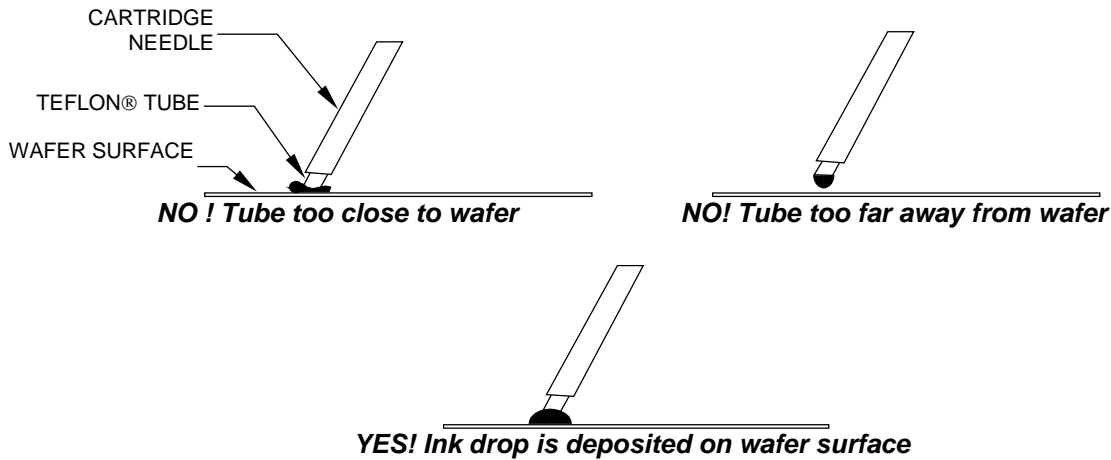
Note: *When the “RESET” button is initially pushed the “INK ON” LED will not be lit and the “STATUS” LED will begin to flash. At the end of 3 seconds both the “INK ON” and “STATUS” LED will light continuously and the air valve will begin to pulse, priming the cartridge.*

4. Push the “RESET” button on the controller for at least 3 seconds and hold down until ink appears at the needle tip.
5. Once priming is completed, clean excess ink from the needle tip with a clean, lint free cloth. The cartridge is now ready for operation.

<p>NOTICE</p>	<p><i>Always use the RESET button to pulse the cartridge valve when priming a cartridge with the inker swing arm in the up position. The RESET button fires only the inker's cartridge valve. If the shuttle valve is fired with the swing arm in the up position, (by using the prober's test inker function for example) ink may be forced into the cartridge air fitting and air hose, contaminating both.</i></p>
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Cartridge Alignment

Cartridge alignment in relation to the wafer surface is very important in obtaining the best performance from a pneumatic inking system. Please refer to your inker manual for specific setup and alignment procedures for your inker. After your inker is aligned, the Teflon® tube will be 1-2 mil from the wafer surface when the dot is deposited. The Teflon® tube should never come into contact with the wafer surface.



NOTICE

Do not let the Teflon® cartridge tube contact the wafer surface. This may crush the tip preventing ink flow and damaging the cartridge or the wafer!

Section 3. Ink

Ink Overview

Semiconductor manufacturers use the vision system of automatic pick and place equipment during the assembly process to detect damaged and/or rejected die. This is done by shining a combination of different lights on the wafer surface to create a “white” background. Ink dots and defects like chipped corners are easily recognizable against this background.

Xandex 8103, 8104, 7824, 7824T and Markem® 6993 inks are opaque and easily recognizable under all lighting conditions. Xandex Glycol Free 8103 ink is thick in viscosity and delivers opaque dots ranging from 6 to 40 mils. Xandex 8104 is not as viscous as 8103 and provides thinner dots with excellent geometry and adhesion in a larger dot range up to 86 mils. Markem® 6990 and 6997 are less opaque and may not offer sufficient contrast under all lighting conditions.

Xandex 8103 ink is certified to contain less than 10 ppm of Sodium (Na) and Chloride (Cl). Xandex 8104 ink is certified to contain less than 20 ppm of Sodium (Na) and Chloride (Cl). Both 8103 and 8104 premium inks are free of glycol ethers, which are identified reproductive hazards and carcinogens. Xandex 7824 and 7824T inks are certified by Xandex to contain less than 10 ppm of Na and Cl. Markem® 6990 is certified by Markem® to contain less than 25 ppm of Na and Cl. Analysis reports are available upon request from Xandex Customer Service.

Although Markem® 6993 and 6997 are not contaminant controlled, periodic test data indicates that these inks typically contain less than 100 ppm of Sodium (Na) and 400 ppm of Chloride (Cl). These levels are not certified or guaranteed by Markem or by Xandex¹.

Xandex Glycol Free 8103 and 8104 inks have a 4 month shelf life, rapidly air dry at ambient conditions and will give consistent flow for 2-3 days after cartridge opening. Markem® 6990, 6993 and 6997 inks have a 4 month shelf life, require heat curing to be permanent, and will give consistent flow for 5 days after cartridge opening. Xandex 7824 and Xandex 7824T inks have a 4 month shelf life and will give consistent flow for 3 days after cartridge opening. Xandex 7824 and 7824T can be air or “heat set” cured.

Xandex Glycol Free 8103 and 8104 inks are thermally stable at temperatures up to 150° C and can be used in hot chuck or oven drying applications without cracking or loss of adhesion. Use of either Markem® 6990, 6993 and 6997 or Xandex 7824 and 7824T inks in hot chuck applications is not recommended as the elevated ambient temperature in the probing area can reduce cartridge life and cause inconsistent ink flow. However, use of a hot chuck to heat set dots during offline inking has reportedly been successful when employed by some customers. All of the inks offered by Xandex are non-magnetic.

Material Safety Data Sheets (MSDS) are available for all inks offered by Xandex. To obtain MSDS or information about choosing the appropriate ink for your application please contact your local distributor or Xandex Customer Service. ¹ Test measurements are dependant on test method used.

Ink Curing

The procedure for curing will depend on the type of ink used. Markem® 6990, 6993, and 6997 should be cured/baked within 2 hours of inking due to the evaporation of solvents in the ink over time. If a wafer (or boat of wafers) is left uncured for an extended period of time, the dots may crack and/or flake after the baking process.

Markem® 6990, 6993, and 6997 inks, which are air-dried, will not smear when touched. They are not permanent, however, and will not withstand most post-probe handling or processes. Conversely, Xandex 7824 and 7824T inks air cure within 2.5 hours (≤20 mil, up to 8 hours for >20 mil dots). Xandex 7824 and 7824T may also be “heat set” at 120°C for 10 minutes.

Xandex 8103 and 8104 Glycol Free inks hard cure under ambient conditions in the least time of any of the inks offered by Xandex. Ink dots of ≤25 mil air dry to a hard cure in 45 minutes. Dot sizes >25 mil may require significantly longer to cure. An ambient cure time of up to 6 hours may be needed for larger dot sizes. Continuous air flow across the wafer surface will reduce the amount of time required for curing. The following table provides specifics for each type of ink:

INK CURING			
CURE TYPE	TEMPERATURE	CURE TIME	RESULT
Markem® 6990, 6993, and 6997			
Soft Cure	100-150°C	5-15 minutes	Ink is semi-permanent and will not withstand wash of alcohol, acetone, or photoresist removers
Hard Cure	150-185°C	30-60 minutes	Ink is permanent and resistant to wash process
Xandex 7824, 7824T			
Hard Cure	Air dry, ambient conditions	2.5 hours ± 0.25 hrs for ≤20 mil, up to 8 hrs >20 mil.	Ink is permanent and may only be removed with great difficulty
Hard Cure	150 watt heat lamp at 5-6 inches OR oven at 110-120°C	5-10 minutes	Ink is permanent and may only be removed with great difficulty
Xandex 8103 and 8104 Glycol Free			
Hard Cure	Air dry, ambient conditions	5-15 minutes for 5-15 mil 15-45 minutes for 15-25 mil 45 min-6 hours for 25-40 mil	Ink is permanent and may only be removed with great difficulty

Note: Longer drying times are required for larger dot sizes.

Note: Markem® is a registered trademark of Markem Corporation, Keene, NH

Ink Removal Information

A rinse with isopropyl alcohol or acetone generally removes ink completely if the wafer is washed shortly after inking (within 5 minutes). An ultrasonic bath is recommended to ensure complete removal of ink residue. Ink dots that have been air dried or hard cured, require the application of an ink remover.

Xandex DieMark Remover 8000

Xandex has developed DieMark Remover 8000 specifically for the semi-conductor industry. DieMark Remover 8000 thoroughly removes all inks supplied by Xandex, including oven baked ink dots. DieMark Remover 8000 has very low levels of organic and inorganic contaminants and is an efficient and thorough ink remover when used in simple bench top cleaning methods. Due to its high flash point, DieMark Remover 8000 is also safe and effective when used in ultrasonic, temperature/pressure cycling under vacuum and deep bath heating and agitation ink removal processes.

DieMark Remover 8000 is carcinogen and teratogen free (NTP, OSHA) and all ingredients used are TSCA listed. For an MSDS or more information on using DieMark Remover 8000 in your specific ink removal process, contact Xandex Customer Service.

Ink Removal Procedure

The following is the recommended bench top procedure for removing ink from wafers using DieMark Remover 8000. *



All procedures should be performed under a laboratory hood, following proper safety precautions (protective goggles, gloves and clothing).

1. Apply sparingly with an eyedropper to a localized area of the wafer.
2. Allow 2-3 minutes for the DieMark Remover 8000 to begin solvating. Time required will vary depending on the degree that the ink was cured.
3. For highly cured ink dots, use longer soak times, then wipe gently with a clean lint-free cloth to facilitate removal. If necessary, repeat steps 1 and 2.
4. For large areas or removal of ink from entire wafer, soak a clean lint-free cloth with DieMark Remover 8000, then lay the wet cloth over the entire surface and allow time to soak/solvate ink, then remove wet cloth. Repeat as necessary.
5. After dots are removed, clean wafer via standard procedures, such as vapor degreasing, and/or rinse with a clean solvent (Isopropyl Alcohol) followed by a bake cycle at 65° C to dry.

* The following ink removers may be substituted for DieMark Remover 8000, however, Xandex does not guarantee that satisfactory results will be obtained. None of the following solvents or ink removers are available from Xandex.

- ◆ Aptek 6515 Ink Remover
- ◆ Markem® 540
- ◆ P-300 Resist Remover
- ◆ 712-D Resist Remover
- ◆ Uresolve Resist Remover
- ◆ Methyl Ethyl Ketone (MEK)
- ◆ N-Methyl-2-Pyrrolidone (M-Pyrrol)

Section 4. Troubleshooting

This Troubleshooting section is divided into two parts. The first part covers the filament ink cartridge. The second part covers the pneumatic ink cartridge. More troubleshooting information is available in the “Support” section at <http://www.xandexsemi.com/>.

Filament Ink Cartridge Troubleshooting

Problem	Solution
The lower O-ring does not lift when opening a cartridge.	This happens sometimes when some ink dries around the lower O-ring. Push the main shaft down, keeping the indicators aligned, then pull up the shaft while slanting it to one side as much as possible.
The cartridge is opened per instructions and the fishline comes out smoothly, but the ink does not flow down the needle.	It usually takes 30 to 40 strokes before the ink travels all the way down the needle. Viscous and air dry inks may require longer. After priming and installation manually activate the inker plunger 30 to 40 strokes until ink appears at the needle tip.
Some ink dots tend to crack after baking using Xandex recommended cure cycles.	This occurrence is related to the ink surface tension, wafer surface conditions and too long a delay time between inking and curing. To remedy this situation, the curing cycle has to be modified (reduce time and temperature). See Section 3 “Ink Curing.”
Runny, blobbing ink or skipping dots.	<ol style="list-style-type: none"> <li>1. Check ink shelf life. Filament cartridges containing Markem® 6990, 6993 and 6997 should be used within 4 months or 5 days of cartridge opening. Xandex 8103 and 8104 glycol free air dry inks should be used within 4 months or 2 days of cartridge opening. Xandex 7824 and 7824T inks within 4 months or 3 days after cartridge opening. <li>2. Check for exposure to extreme temperatures. Cartridges should be stored at 25°C. DO NOT refrigerate the cartridges. Occasionally, ink is subjected to much higher temperatures (40-50° C) for an extended time during transport. This could break down the ink such that its viscosity and surface tension are altered permanently.

Problem	Solution
Runny, blobbing ink or skipping dots (continued)	<p>3. Inker Z height may be adjusted too high. Ink can not wick off the filament and builds up, creating blobbing and skipping. Re-adjust inker Z height and alignment as detailed in your inker manual.</p>
Small, inconsistent, skipping or no ink dots.	<p>1. The ink flow channels may be blocked. It could be due to any one of the following:</p> <p>A. The bottom O-ring is not lifted. In this case, when the cartridge is primed only a small amount of the ink flows into the space below the O-ring. This is enough to start inking, but the inker quickly uses up that ink (i.e., on two or three wafers) and will start to skip. To eliminate the problem, close the cartridge, re-open and prime again. See Section 1 "Opening the Cartridge."</p> <p>B. The cartridge is opened and primed correctly but is closed inadvertently before it is mounted on the holder. The main shaft is pushed down all the way, leaving no gap and the fishline appears to be too long. To correct this problem, pull up the main shaft until it stops, then turn it 1/4 of a turn in either direction. See Section 1 "Priming the Cartridge."</p> <p>C. During priming, an air bubble may have become trapped under the bottom O-ring. This inhibits the full flow of ink. To eliminate air bubbles, reseal the cartridge and repeat the priming procedure in Section 1.</p>

Problem	Solution
<p>Small, inconsistent, skipping or no ink dots (continued)</p>	<ol style="list-style-type: none"> <li>2. Verify that coil and cartridge are in line, visually check the straightness of plunger and check for possible damage to the plunger spring. The plunger should travel smoothly and freely when actuated manually from any position. If there is any binding replace the plunger and/or spring. <li>3. Chuck top or wafer surface not planar. Verify planarity of both.
<p>Elongated instead of round dots.</p>	<ol style="list-style-type: none"> <li>1. Inker is set too close to the wafer, which results in a kinked monofilament. The cartridge should be positioned so that the filament barely touches the wafer surface when it is fully exposed. See Setup and Alignment procedure as detailed in your inker manual.

Electric Inker Troubleshooting

Problem	Solution
<p>The inker is working intermittently from the outset.</p>	<ol style="list-style-type: none"> 1. Incorrect inker drive, in which case the plunger will travel very sluggishly. The 290Ω coil requires an inker drive signal of 48 volts with a 25 ms pulse duration. Contact Xandex Customer Service for more information. 2. The plunger might be bent. This can happen when pushing the plunger through the coil. Manually actuate the plunger a few times, rotate 1/4 turn and repeat. The plunger should travel freely. Replace if necessary. 3. During opening of the cartridge, the fishline monofilament has been kinked because the main shaft was lowered quickly or incorrectly. Replace the cartridge and review Section 1 “Priming the Cartridge.” 4. Faulty electrical connection somewhere on the line. Check the continuity of electrical supply connections to the inker and correct.
<p>The inker works fine for a while (4-8 hours), then starts to skip badly.</p>	<ol style="list-style-type: none"> 1. Ink flow channels are blocked by the lower O-ring. If the bottom O-ring is not lifted during opening and priming, a small amount of ink below will be used up after a few rows, while the remainder is trapped in the reservoir. Remove the cartridge, close and repeat opening and priming procedure in Section 1. 2. When the cartridge is installed on the holder, the indicators are left aligned and the main shaft has been pushed closed. The indicators should be moved 1/4 turn into locking position. Remove the cartridge and repeat opening and priming procedure in Section 1.

Problem	Solution
<p>The inker works fine for a while (4-8 hours), then starts to skip badly (continued)</p>	<p>3. Wrong inker drive being used. Sometimes the coil problem does not appear from the outset. If the actuation pulse is marginally acceptable the plunger will travel less than a full stroke as the solenoid heats up. This causes the inker to miss badly. Contact Xandex Customer Service for more information.</p>

Pneumatic Ink Cartridge Troubleshooting

This Troubleshooting section for the Pneumatic Inkers is divided into three parts. The first part covers ink and the DM-2/DM2.3 ink cartridge. The second part covers the Inker Assembly, and the third part covers the Pneumatic Controller.

Problem	Solution
Some ink dots tend to crack after baking using Xandex recommended cure cycles.	This occurrence is related to the ink surface tension, the wafer surface conditions and too long a delay time between inking and curing. To remedy this situation, the curing cycle has to be modified (reduce time and temperature). See Section 3 “ Ink Curing.”
Runny, blobbing ink or skipping dots.	<ol style="list-style-type: none"> 1. Check ink shelf life. Pneumatic cartridges containing Markem® 6990, 6993 and 6997 should be used within 4 months or 5 days of cartridge opening. Xandex 8103 and 8104 glycol free air dry inks should be used within 4 months or 3 days of cartridge opening. Xandex 7824 and 7824T inks within 4 months or 3 days after cartridge opening. 2. Check for exposure to extreme temperatures. Cartridges should be stored at 25°C. DO NOT refrigerate the cartridges. Occasionally, ink is subjected to much higher temperatures (40-50° C) for an extended time during transport. This could break down the ink such that its viscosity and surface tension are altered permanently. 3. Improper Z Height set-up. Re-adjust Z Height as detailed in your inker manual. 4. Chuck top or wafer surface not planar. Verify planarity of both.
After changing the controller dot size settings, the dots are too small or the ink blobs at the tip of the needle.	<ol style="list-style-type: none"> 1. The cartridge tip may be damaged. Examine cartridge and replace if necessary. 2. Whenever dot size is changed there may be minor inker Z height adjustments required. The inker should be set so that just the bottom of the ink drop touches the wafer.

Problem	Solution
<p>Small, inconsistent or no ink dots.</p>	<ol style="list-style-type: none"> 1. Soft Teflon® tip of the cartridge tube is clogged or damaged. Change cartridge. 2. The controller dot size setting may be too low. Increase dot size setting. 3. Wrong cartridge type (A5, A6, A8). Change cartridge type. 4. Air pressure too low. Verify that regulator setting is 70 ± 10 PSI for all inkers <i>except</i> for the X4X10 Motorized Z inkers which require 80 ± 5 PSI. 5. Z height adjustment is incorrect. Adjust Z Height. 6. Verify that the inker swing arm is all the way down and locked in position. 7. Shuttle mechanism may be binding. Perform shuttle maintenance as detailed in your inker operation manual.

Pneumatic Inker Troubleshooting

Problem	Solution
Dots too large.	<ol style="list-style-type: none"> 1. Dot size setting too high. Decrease dot size setting. 2. Main Air pressure too high, verify setting at 70 ± 10 PSI, 80 PSI for Motorized Z inkers. 3. Wrong cartridge type. Change cartridge type. 4. Controller dot size potentiometer defective. Run controller diagnostics test as detailed in your inker manual.
Cartridge tip does not reach wafer surface.	<ol style="list-style-type: none"> 1. Check Z height by switching the controller into "SETUP" mode, which will extend the shuttle downward into the "inking position". 2. Adjust inker Z height as directed in your inker manual.
Unit functions normally, no dots, no shuttle movement.	<ol style="list-style-type: none"> 1. Verify that the Controller-Shuttle air hose connector is plugged into the controller. 2. Verify that the Controller-shuttle air hose is not kinked, clogged or pinched closed. 3. Check Main Air pressure setting (verify 70 ± 10 PSI air input, 80 PSI for Motorized Z inkers).
Inker produces dots during "puff pulse" or ink flows out of cartridge with toggle switch in "SETUP".	<ol style="list-style-type: none"> 1. Verify that the air hoses from the controller to the inker are connected properly: <ul style="list-style-type: none"> ◆ RED AIR HOSE (air in) connects to the ink cartridge. ◆ BLUE AIR HOSE (exhaust) connects to the shuttle connection on the shuttle mechanism.

Problem	Solution
<p>Unit functions normally, shuttle moves, no dots.</p>	<ol style="list-style-type: none"> 1. Check red air hose to top of cartridge to be sure it is connected and not kinked, clogged or pinched. 2. Verify cartridge preparation, insuring Needle Collar is flush with the Cartridge Neck and the internal membrane is broken. See Section 2 “Pneumatic Ink Cartridge.” 3. Check the Teflon® tip of cartridge tube to confirm that it is not clogged or damaged. 4. Verify that the rubber washer on the cartridge air hose connector is installed.
<p>Cartridge air hose and connector contaminated with ink.</p>	<p>Always use the RESET button to pulse the cartridge valve when priming a cartridge with the inker swing arm in the up position. This also applies to remote adjust inkers when the cartridge is being primed and the inker is not oriented in vertical (operating) position.</p> <p>The RESET button fires only the inker's <i>cartridge</i> valve. If the shuttle valve is fired with the cartridge in a horizontal orientation, (by using the prober's test inker function for example) ink may be forced into the cartridge air fitting and air hose, contaminating both.</p>

Pneumatic Controller Troubleshooting

Problem	Solution
The controller is plugged in but the "POWER" LED is off.	<ol style="list-style-type: none"> 1. Make sure that the AC outlet has power. The requirement is 100-240 VAC @ 47-63Hz. 2. Verify that the power supply is connected to the 24V input on the back of the controller and that the ON/OFF switch on the controller is in the ON position.
Controller powers up okay but will not respond to prober signal.	<ol style="list-style-type: none"> 1. Verify input cable is plugged into the prober input on the controller. 2. Verify input cable is plugged into inker jack on prober. 3. Check continuity of cable. 4. Perform Pneumatic Controller diagnostics tests as detailed in your inker manual to verify controller operation.
Controller powers up okay, responds to prober input but the shuttle does not move.	<ol style="list-style-type: none"> 1. Check that shuttle toggle switch on the front of the controller is in the RUN position. 2. Check that the air hose "quick disconnects" are correctly oriented. 3. Perform Shuttle Valve diagnostic test as detailed in your inker manual to verify operation.
Dot size does not change or does not change sufficiently with adjustment of Dot Size Knob	<ol style="list-style-type: none"> 1. Verify that the air hoses from the controller to the inker are connected properly: Reference the drawings in your specific inker manual. 2. Run Dot Size Potentiometer diagnostic Test as detailed in your inker manual. If test results are not within parameters, consult Xandex Customer Service. 3. Cartridge tip is damaged. Replace ink cartridge.

	<p>4. Wrong ink cartridge type. Replace ink cartridge with larger (or smaller) type dot size rating. See “Dot Size Parameters” table in Section 4. “Operation.”</p>
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Section 5. System Specifications

Filament Cartridge Specifications

Cartridge Model	Available Inks	Cartridge Type
DM-1	Markem®	05 mil [†]
	6990	08 mil
	6993	10 mil
	6997	15 mil
	Xandex	25 mil
	7824	30 mil
	7824T	
8103		

Cartridge Model	Available Inks	Cartridge Type
DM-1.25	Markem®	10 mil*/**
	6990	15 mil**
	6993	25 mil
	6997	
	Xandex	
	7824 7824T	

[†] Also available with tungsten filament in most configurations * Not available in 7824

** Not available in 7824T

Cartridge Model	Needle Type	Available Inks	Cartridge Type
DM-S	S-Curved	Markem®	10 mil
		6990	15 mil
		6993	
		6997	

Filament Cartridge Dot Production

Cartridge dot production and dot size are influenced by many factors, including inker drive, coil voltage, ambient temperature and ink type. The following figures are average dot quantities for the cartridge types listed and are based on complete use within DM-1, DM-1.25 and DM-S cartridge open shelf life periods of 5 days maximum for Markem® 6990, 6993 and 6997 inks, 3 days maximum for Xandex 7824 and 7824T and two days maximum for Xandex 8103 and 8104 glycol free inks. Testing was performed under controlled, optimum laboratory conditions on unetched wafers with no passivation. These figures are meant for use as guidelines and as such, cannot be guaranteed.

Filament DieMark™ Cartridge Average Minimum Dot Production			
Type	# of Dots	Type	# of Dots
5 mil	400,000 dots	20 mil	125,000 dots
8 mil	325,000 dots	25 mil	60,000 dots
10 mil	250,000 dots	28 mil	30,000 dots
15 mil	175,000 dots	30 mil	15,000 dots

DM-2 Cartridge Specifications

Models:	DM-2, Type A5, A6, A8
Total Needle Length:	0.845" (± 0.005")
Teflon Tube I.D.:	A5 - 0.005" / A6 - 0.006" / A8 - 0.008"
Reservoir Capacity:	1.0 grams minimum
Available Inks:	6990, 6993, 6997, 7824, 7824T, 8103, 8104
Dot Sizes:	Dot sizes (± 10%) consistent for speeds of 12 dots/second to 1 dot/2 minutes

DM-2.3 Cartridge Specifications

Models:	DM-2.3, Type A5, A6, A8
Total Needle Length:	0.645" (± 0.005")
Teflon Tube I.D.:	A5 - 0.005" / A6 - 0.006" / A8 - 0.008"
Reservoir Capacity:	1.0 grams minimum
Available Inks:	6990, 6993, 6997, 7824, 7824T, 8103, 8104
Dot Sizes:	Dot sizes (± 10%) consistent for speeds of 12 dots/second to 1 dot/2 minutes

Pneumatic Ink Cartridge Dot Size Parameters

Cartridge dot production and dot size are influenced by many factors, including regulator pressure setting, ambient temperature and ink type. The following figures are average dot quantities for the cartridge types listed and are based on complete use within *cartridge open* shelf life periods 5 days maximum for Markem® 6990, 6993 and 6997 inks and 3 days maximum for Xandex 7824 and 7824T air dry inks and Xandex 8103 and 8104 glycol free air dry inks. Testing was performed under controlled, optimum laboratory conditions on unetched wafers with no passivation. These figures are meant for use as guidelines and as such, cannot be guaranteed.

Dot size is also determined by the internal diameter of the Teflon® tube in the cartridge type being used (A5, A6 or A8) and by adjustment of the pneumatic controller DOT SIZE KNOB or DOT SIZE THUMBWHEELS. The table on the next page gives average minimum and maximum dot size setting parameters for DM-2 and DM-2.3 cartridges. For more information on the controller DOT SIZE adjustment refer to the appropriate sections of your inker manual.

DM-2 and DM-2.3 Dot Size Table

Note: 1 mil (0.001 inch) = 25.4 microns (µm)

Cartridge Type	X1000 & X4000 Series 3 ft. air hose DM-2		X2000, X3000 X901 & X1101 5 ft. air hose DM-2		X5000 Series 5 ft. air hose DM-2.3		Motorized-Z 5 ft. air hose DM-2		
	8103							Small Dot Mode	Large Dot Mode
A5	Min.	14 mil	Min.	14 mil	Min.	14 mil	Min.	6 mil*	12 mil
	Max.	23 mil	Max.	23 mil	Max.	25 mil	Max.	10 mil	25 mil
A6	Min.	18 mil	Min.	17 mil	Min.	19 mil	Min.	7mil	15 mil
	Max.	28 mil	Max.	28 mil	Max.	29 mil	Max.	13 mil	31 mil
A8	Min.	26 mil	Min.	22 mil	Min.	25 mil	Min.	11 mil	26 mil
	Max.	41 mil	Max.	39 mil	Max.	39 mil	Max.	22 mil	42 mil
8104							Small Dot Mode	Large Dot Mode	
A5	Min.	26 mil	Min.	24 mil	Min.	24 mil	Min.	11 mil	21 mil
	Max.	48 mil	Max.	41 mil	Max.	46 mil	Max.	18 mil	46 mil
A6	Min.	37 mil	Min.	35 mil	Min.	36 mil	Min.	14 mil	27 mil
	Max.	60 mil	Max.	62 mil	Max.	60 mil	Max.	22 mil	51 mil
A8	Min.	56 mil	Min.	56 mil	Min.	59 mil	Min.	26 mil	47 mil
	Max.	86 mil	Max.	79 mil	Max.	83 mil	Max.	42 mil	83 mil
7824 / 7824T							Small Dot Mode	Large Dot Mode	
A5	Min.	17 mil	Min.	19 mil	Min.	19 mil	Min.	7 mil	17 mil
	Max.	32 mil	Max.	32 mil	Max.	33 mil	Max.	15 mil	33 mil
A6	Min.	24 mil	Min.	21 mil	Min.	24 mil	Min.	8 mil	20 mil
	Max.	39 mil	Max.	43 mil	Max.	40 mil	Max.	19 mil	38 mil
A8	Min.	31 mil	Min.	32 mil	Min.	30 mil	Min.	16 mil	31 mil
	Max.	58 mil	Max.	58 mil	Max.	60 mil	Max.	27 mil	57 mil
6990 / 6993 / 6997							Small Dot Mode	Large Dot Mode	
A5	Min.	15 mil	Min.	19 mil	Min.	18 mil	Min.	8 mil	16 mil
	Max.	29 mil	Max.	29 mil	Max.	30 mil	Max.	14 mil	32 mil
A6	Min.	19 mil	Min.	20 mil	Min.	20 mil	Min.	9 mil	18 mil
	Max.	33 mil	Max.	33 mil	Max.	32 mil	Max.	16 mil	35 mil
A8	Min.	32 mil	Min.	29 mil	Min.	30 mil	Min.	14 mil	29 mil
	Max.	52 mil	Max.	50 mil	Max.	51 mil	Max.	25 mil	54 mil

* Dot sizes as small as 6 mil have been achieved using the Xandex Motorized Z pneumatic inker and Xandex 8103 ink.

Ink and Cartridge Availability

The following table illustrates ink and cartridge configurations. Configurations designated with a 0 are available as a Customer Specific Product (CSP) but have not been tested by Xandex and are subject to limited warranty conditions. The information in this table is accurate as of the time of publication but is subject to change without notice.

Ink Type	Pneumatic Cartridge Types						Filament Cartridge Types						DM-1.25			DM-S	
	DM-2			DM-2.3			DM-1						10 mil	15 mil	25 mil	10 mil	15 mil
Markem Inks	A5	A6	A8	A5	A6	A8	5 mil	8 mil	10 mil	15 mil	25 mil	30 mil	10 mil	15 mil	25 mil	10 mil	15 mil
6990 Black	+	+	+	+	+	+	T,F	+	+	+	+	+	+	+	+	+	+
6993 Black	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
6993 Red	+	+	+	+	+	+	T,F	+	+	+	+	+	+	+	+	+	+
6997 Black	+	+	+	+	+	+	T,F	+	+	+	+	+	+	+	+	+	+
Empty (no ink)	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Xandex Inks																	
7824 Black	+	+	+	+	+	+	T,F	+	+	+	+	+	0	+	+	0	0
7824T Black	+	+	+	+	+	+	T	+	+	+	+	+	0	0	+	0	0
8103 Black	+	+	+	+	+	+	T	+	+	+	+	+	0	0	0	0	0
8103 Red	+	+	+	+	+	0	T	+	+	+	+	+	0	0	0	0	0
8103 White	+	+	+	+	+	+	T	+	+	+	+	+	0	0	0	0	+
8104 Black	+	+	+	+	+	+	X	X	X	X	X	X	X	X	X	X	X

- + = Available standard cartridge and ink configuration.
- 0 = Not yet qualified by Xandex. Available as a special order, subject to limited warranty conditions.
- T = with Tungsten filament
- F = with Mono-Filament
- X = Not available in filament cartridge configurations.

Ink Cartridge Warranty

Seller warrants as follows:

All material supplied will conform to the description stated. All products will be free of defects in materials and workmanship under normal use for the following periods:

Stated shelf life of DM-1, DM-1.25, DM-S Ink Cartridges:

- ◆ Markem® 6990, 6993, 6997 = Four (4) months. Five (5) days after cartridge opening
- ◆ Xandex 8103 and 8104 = Four (4) months. Two (2) days after cartridge opening.
- ◆ Xandex 7824 and 7824T = Four (4) months. Three (3) days after cartridge opening.

Stated shelf life of DM-2, DM-2.3 Ink Cartridges:

- ◆ Markem® 6990, 6993, 6997 = Four (4) months. Five (5) days after cartridge opening
- ◆ Xandex 8103 and 8104 = Four (4) months. Three (3) days after cartridge opening.
- ◆ Xandex 7824 and 7824T = Four (4) months. Three (3) days after cartridge opening.

Xandex makes no other warranty, express or implied, including without limitation any warranty of merchantability or of fitness for a particular purpose. Customer, OEM or Distributor's exclusive warranty shall be, at Xandex's option, to have defective product repaired or replaced, or to receive a refund of purchase price.

Xandex may, upon request, furnish to buyer such technical advice, as it may be able to supply with reference to the use by buyer of any materials delivered. Xandex assumes no liability for the advice given or results obtained. Buyer expressly agrees that it will implement any advice thus given at its own risk and agrees to indemnify and hold Xandex harmless against any liabilities, costs or expense resulting therefrom.

Xandex makes no warranty for performance, service or support of any products unless they are purchased directly from Xandex or through an authorized Xandex Distributor.

Exclusions: This warranty shall not apply to defects or damage resulting from;

- Improper or inadequate maintenance by customer, including failure to perform preventive maintenance per manufacturer's specified schedule
- Misuse or unauthorized modification
- Operation outside the environmental specifications for the product
- Improper site preparation and maintenance

Some states and provinces do not allow limitations on how long an implied warranty lasts, so the limitation or exclusion contained in this warranty may not apply to you. However, any implied warranty of merchantability or fitness is limited to the duration period of this written warranty.

If you have any questions or need further assistance please contact your authorized Xandex distributor or contact our Customer Service Group.



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