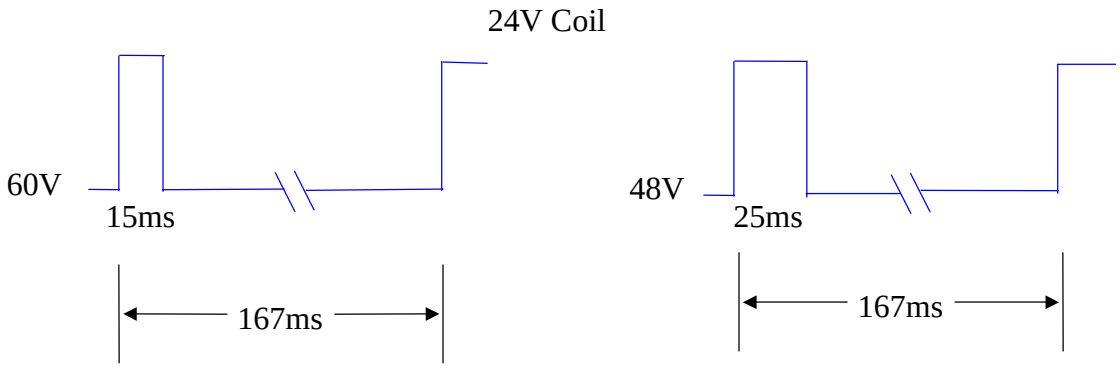
Electric Inker Operation

Inker Actuation

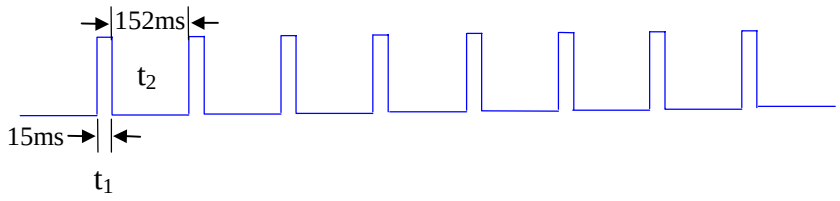
The Xandex Electric Inkers operate via an electronic pulse sent from the prober to actuate the solenoid. Upon actuation, the solenoid plunger drives the cartridge filament to the fully extended position, making slight contact with the wafer surface and depositing an ink droplet, forming a dot. The electronic pulse will vary depending on the coil drive voltage (48VDC minimum), as well as the pulse width and duty cycle. It is recommended that the drive voltage of the pulse is at least twice the solenoid coil voltage specification (i.e., 24VDC solenoid = 48VDC drive voltage). The pulse width will vary depending on the drive voltage, as shown below:



Pulse Width in milliseconds.

For voltages greater than 60VDC the on time of the cycle must be shortened. Maximum coil operating temperature must not exceed 100°C. The inker should not be operated more than 10 cycles without an ink cartridge installed (the cartridge can be empty) or damage to the solenoid may occur. 167ms is the minimum total cycle time. If faster inking is required, a **pneumatic inker** is recommended.

The duty cycle is a function of the time the solenoid is energized versus the total cycle time, as shown below where t_1 = time on and t_2 = time off. For example:



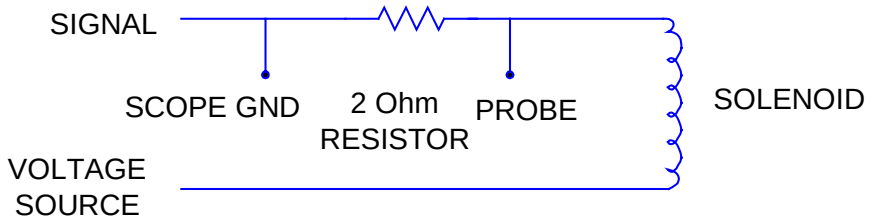
$$\text{Duty Cycle (as \%)} = \frac{t_1}{(t_1 + t_2)} \times 100 \quad \text{or} \quad \frac{15}{(15 + 152)} \times 100 = 8.9\%$$

A duty cycle of 20% is acceptable, <10% is optimal. If problems exist with the inker actuation, please refer to **Inker Drive Verification**, **Electric InkerTroubleshooting** or contact **Xandex Customer Service.**

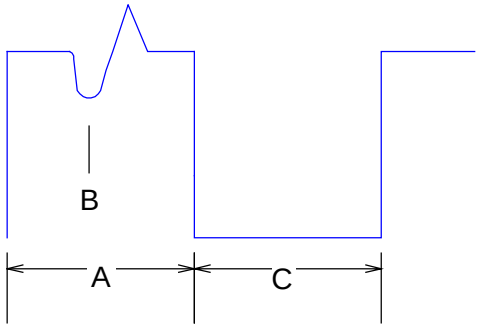
Inker Drive Verification

Xandex inkers operate nominally across all common prober circuits. If inker performance is not acceptable, it may be due to an incorrect inker drive. The coil used in the Xandex inker requires a signal that is a minimum of twice the coil voltage rating for consistent solenoid actuation. Verify that the inker drive output signal is ≥ twice the coil voltage rating by connecting an oscilloscope to the prober inker connection and actuating the inker several times. If the drive voltage is less than twice the coil voltage rating consult your prober manufacturer for prober inker drive voltage modification procedure. If the voltage is ≥ twice the coil voltage rating and acceptable results are still not achieved, the drive signal may be analyzed using the procedure below.

Referring to the prober manual, install a 2Ω 10 watt resistor in series with the inker solenoid as shown below:



Using an oscilloscope, connect a probe as shown above and measure the arrival time of the solenoid. Set the time scale to 5 ms per division and the voltage to 1 mV per division. Fire the inker several times and look for the following trace.



A = On time of inker pulse.
B = Solenoid arrival point. This indicates that the plunger has bottomed out in the coil.
C = Off time of inker cycle.

"B" is the critical component of this waveform. It is the visual indication that the plunger has traveled its full stroke. If the "kick" is not visible, or if it moves off the right side of the trace to a point beyond the falling edge, adjustment to the prober inker drive circuit is required.

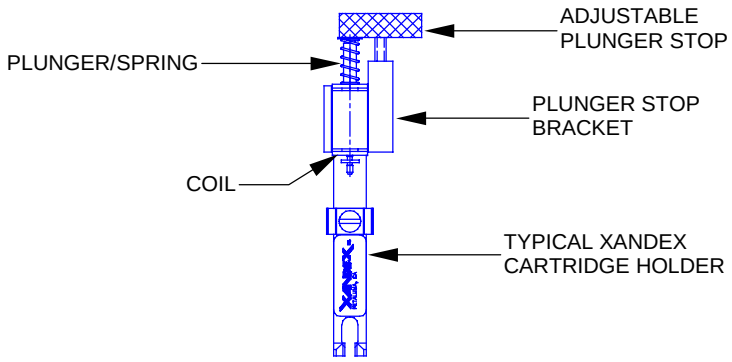
COIL DESCRIPTION	COIL RESISTANCE	MINIMUM DRIVE VOLTAGE	COLD ARRIVAL TIME	HOT ARRIVAL TIME
12 v Open Frame	60 Ω	24VDC	15-18 ms	20-24 ms
24 v Open Frame	290 Ω (±10Ω)	48 VDC	15-18 ms	20-24 ms
Ledex (Off Line)	209Ω	48VDC	9-10 ms	13-17 ms

To verify the inker drive circuitry, perform a minimum of 5 test cycles with each cycle consisting of 2 minutes of constant inking using "Typical Drive Voltage" with a 25 ms pulse width and a 30 second rest period between cycles. The "Cold Arrival" times are measured during the 1st cycle and the "Hot Arrival" times are measured during the 5th cycle.

If arrival times are acceptable, no further change is required. If the current configuration is inadequate, increase the drive pulse width to 30 ms. If this still does not provide acceptable operation, increase the inker drive voltage by 20% and decrease the pulse width by 25%.

If acceptable results are still not achieved, contact **Xandex Customer Service** for assistance.

Plunger Stop Bracket Assembly



This optional assembly is available for Xandex electric inker cartridge holders. 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.

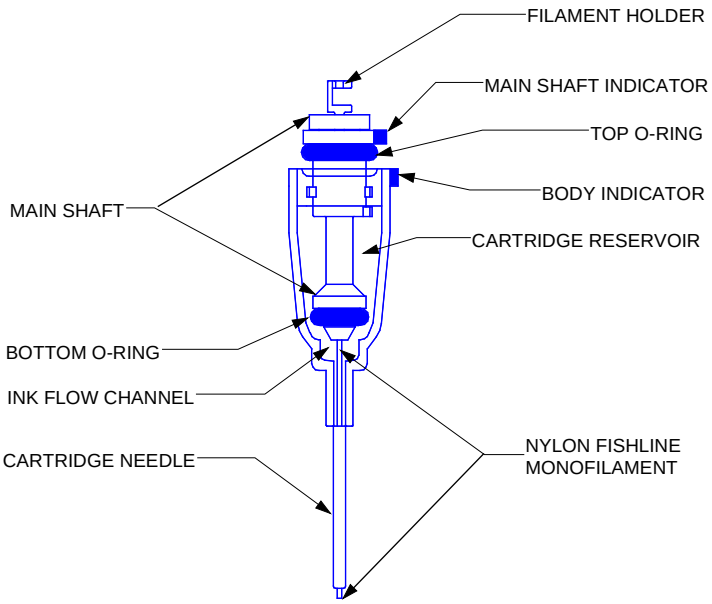
Order part number 210-0016, or contact **Xandex Customer Service** for assistance with your specific application.

Filament Ink 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 (±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 see **Filament Ink Cartridge Specifications**.

DM-1 Ink Cartridge Overview



- **Cartridge Description**

A cartridge is an ink reservoir sealed by two O-rings, top and bottom. A fishline filament passes through the cartridge main body and needle and is attached at the top to the filament holder.

- **Open Cartridge Description**

A cartridge is opened by 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. For detailed instructions see **cartridge opening, priming and installation.**

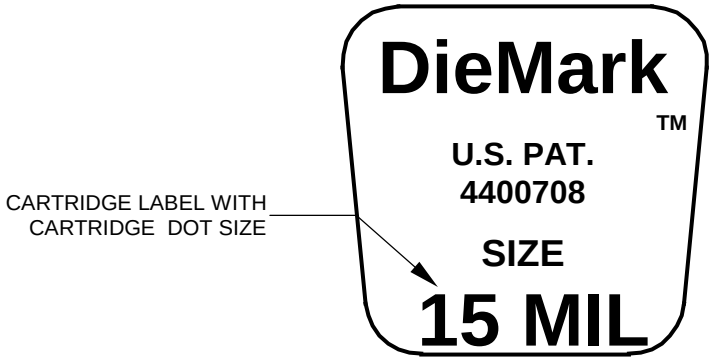
Ink Cartridge Labeling

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 dot size, (10mil, 15mil etc.).

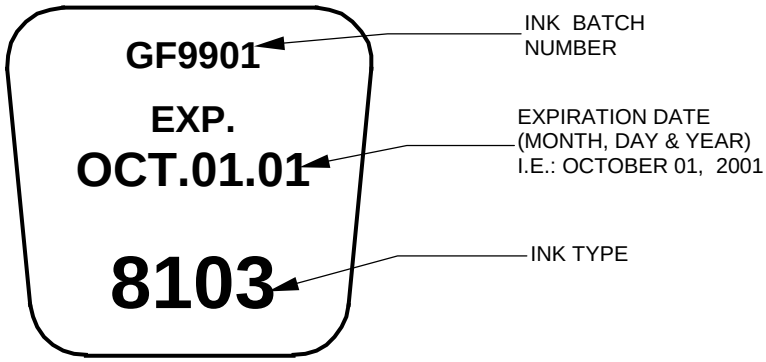


DieMark™ Cartridge Expiration Date Label

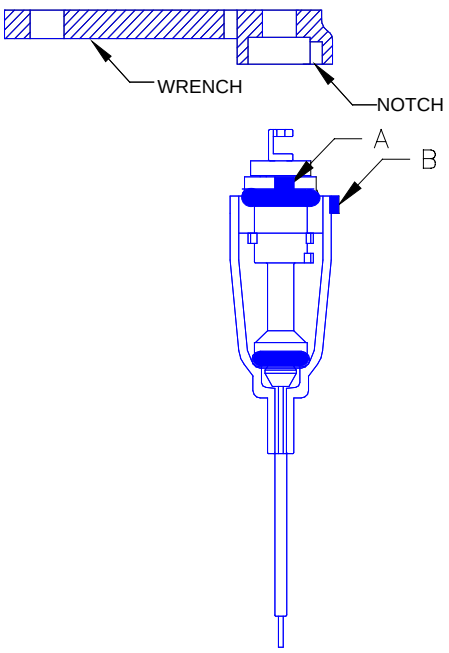
This label indicates the ink type, the batch number of the ink contained in the cartridge and the cartridge expiration date. Expiration dates shown are for *unopened* cartridges.

- Markem® 6990, 6993, 6997 and Xandex 8103 = Four (4) months.
- Xandex 7824 and 7824T = Two (2) 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 days for Xandex 8103.



Opening the Cartridge

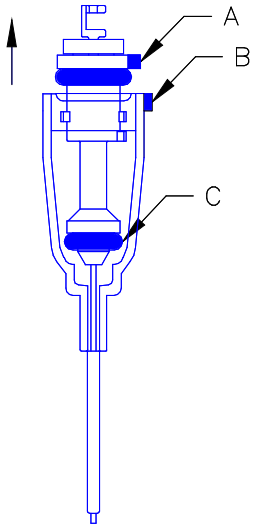


A plastic wrench is used to open and prime a cartridge. The wrench fits very tightly and has a shallow cup with a notch to fit over the top of the main shaft. The notch location is indicated by an alignment "bump" on the end of the wrench.

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).

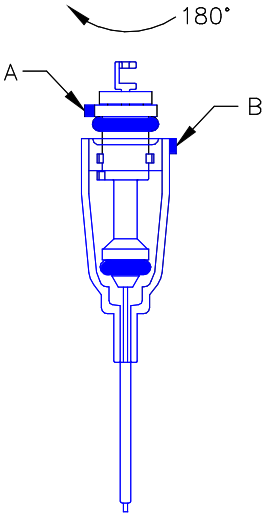
1. Align the *"main shaft indicator"* (A) with the notch in the wrench and fit the wrench over the top of the *main shaft*.



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

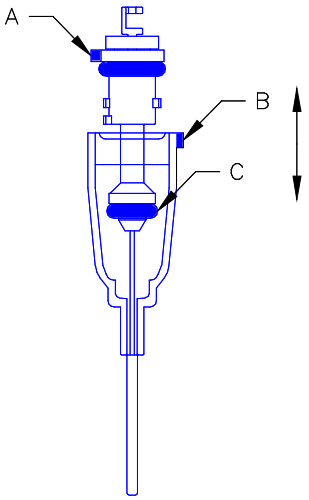
3. Hold the wrench at the cup section, between thumb and index finger, and pull up the *main shaft* with the wrench until it stops. The *bottom O-ring* (C) should be lifted from its sealed position, opening *the ink flow channels*. Visually inspect the *bottom O-ring* (C) and verify that it has lifted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

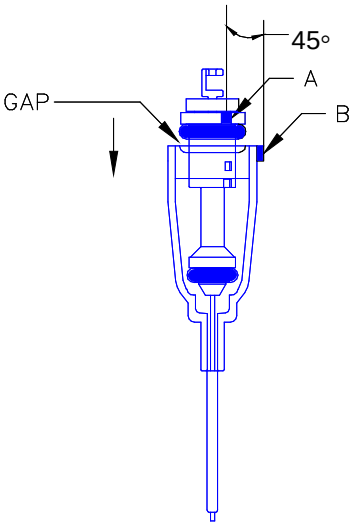


The purpose of priming the cartridge is to ensure that the lower reservoir and the *ink flow channels* below the *bottom O-ring* are completely filled with ink. This will ensure even, continuous ink flow. To prime the cartridge follow the steps below.

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 2/3 out of the reservoir.



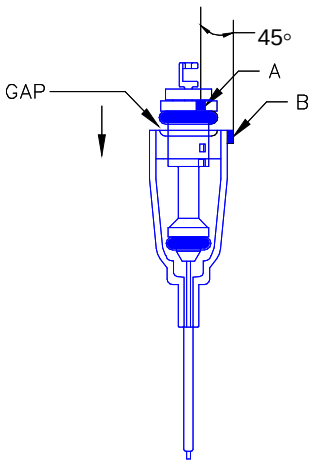
4. Lower the *main shaft* back to its original position while stirring the ink.

5. Repeat steps 1-4 two to three times until space below the *bottom O-ring* is completely filled with ink.

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 .

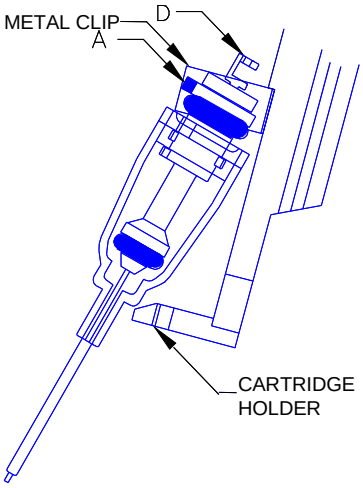
Cartridge Inspection



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

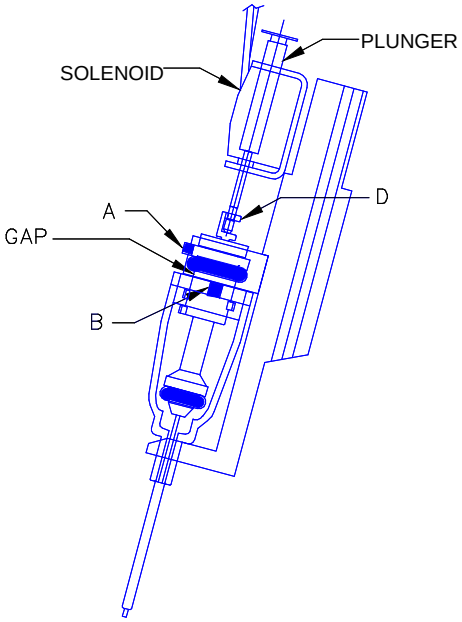
- The *bottom O-ring* is lifted and the *ink flow channels* under the bottom O-ring are completely filled with ink.
- The cartridge *alignment indicators* are 1/4 turn from each other. This way the *main shaft* cannot be pushed up or down.
- There is a *gap* between the *top O-ring* and the *cartridge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

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

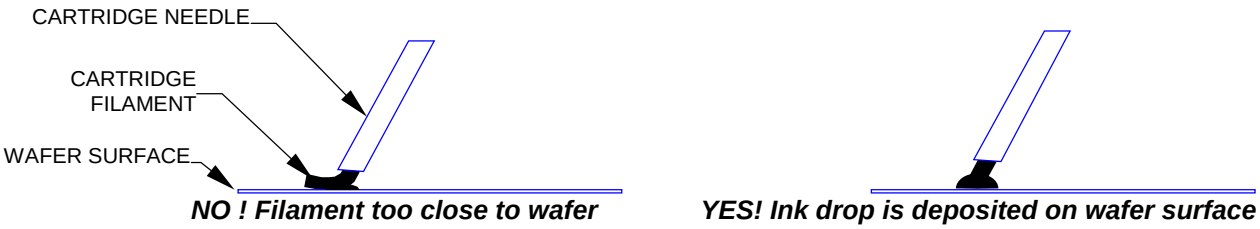
1. Prepare, prime and install and ink cartridge per the instructions.

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. Re-install the microscope and 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, 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.



***CAUTION* : Do not allow the cartridge needle 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.

Filament Ink Cartridge Specifications

Cartridge Model	Exposed Needle Length	Available Inks	Cartridge Type
DM-1	0.75"	Markem® 6990, 6993, 6997, Xandex 7824, 7824T, 8103	05 mil⌖ 08 mil 10 mil 15 mil 20 mil* ✓ 25 mil ✓ 28 mil** ✓ 30 mil*** ✓

Cartridge Model	Exposed Needle Length	Available Inks	Cartridge Type
DM-1.25	1.25"	Markem® 6990, 6993, 6997, Markem® 7224 Xandex 7824, 7824T	10 mil* 15 mil 20 mil* 25 mil

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

⌖*With tungsten filament *Not available in 7824, 7824T **Not available in 6990 *** Not available in 7824T black.* ✓*Not available in 8103*

Dot Size Parameters

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 cartridge open shelf life periods of 5 days maximum for Phenolic inks and 3 days maximum for Epoxy inks. Testing was performed under controlled, optimum laboratory conditions on unetched wafers. These figures are meant for use as guidelines and as such, cannot be guaranteed.

DieMark™ Filament Cartridge Average Minimum Dot Production

Cartridge Type	Average Number of Dots
5 mil	400,000 dots
8 mil	325,000 dots
10 mil	250,000 dots
15 mil	175,000 dots
20 mil	125,000 dots
25 mil	60,000 dots
28 mil	30,000 dots
30 mil	15,000 dots

Electric Inker/Cartridge Troubleshooting

This Troubleshooting section is divided into two parts. The first part covers the **Filament Ink Cartridge** and the second covers the Xandex **Electric Inker**.

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 phenolic inks travel all the way down the needle. Viscous epoxy 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 **Ink Curing**.
Runny, blobbing ink or skipping dots.	1. Check **ink** shelf life. Markem® 6990, 6993 & 6997 inks should be used within 4 months or 5 days of cartridge opening. Markem® 7224, Xandex 7824 and Xandex 7824T inks within 2 months or 3 days after cartridge opening. 2. Check for exposure to extreme temperatures. Cartridges should be stored **VERTICALLY** 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. Inker Z height may be adjusted too high. Ink can not wick off the filament and builds up, creating blobbing and skipping. Readjust inker Z height.

Problem		Solution
Small, inconsistent, skipping or no ink dots.		1. The ink flow channels may be blocked. It could be due to any one of the following: A. The bottom O-ring is not lifted at all. 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 **Opening the Cartridge**. 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 **Priming the Cartridge**. 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 as described in **Priming the Cartridge**. 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. 3. Chuck top or wafer surface not planar. Verify planarity of both.
Elongated instead of round dots.		1. Inker is set too close to the wafer, which results in a kinked fishline. The cartridge should be positioned so that the filament barely touches the wafer surface when it is fully exposed. See **Setup and Alignment** or refer to your specific inker manual.

Electric Inker Troubleshooting

Problem		Solution
The inker is working intermittently from the outset.		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. See **Inker Drive Verification**. 1. 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. 2. 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 **Priming the Cartridge.** 3. Faulty electrical connection somewhere on the line. Check the continuity of electrical supply connections to the inker and correct.
The inker works fine for a while (4-8 hours), then starts to skip badly.		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 as detailed in **Filament Ink Cartridge.** 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 as detailed in **Filament Ink Cartridge**. 2. 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. See **Inker Drive Verification** to check inker drive, pulse width, and cycle time.