

| REVISIONS |  |          |          |
|-----------|--|----------|----------|
| REV       | DESCRIPTION  | DATE     | APPROVED |
| A         | Change cleaning procedure (priority of methods)                            | 3/13/98  | N.Jobe   |
| B         | ECO 3483: Update for HD1 special handling needs                            | 8/29/00  | C Cannon |
| C         | ECO 4297: Update cleaning procedures and remove HD1 special handling needs | 03-07-01 | G Labree |

## DMD Handling and Cleaning Specification

|                    |                |                       |                 |   |                       |          |
|--------------------|----------------|-----------------------|-----------------|---|-----------------------|----------|
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|                    |                | DWN/CHK<br>Nancy Jobe | Date<br>9-18-97 | <b>DMD Handling and Cleaning</b><br><br><b>Specification</b>  |                       |          |
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| <b>NHA</b>         | <b>USED ON</b> | QA<br>Mike Douglass   | 9-18-97         | SIZE<br><b>A</b>  | DRAWING NO<br>4144804 | <b>C</b> |
| <b>APPLICATION</b> |                | APVD<br>Carl Davis    | 9-18-97         | SCALE<br>NONE   | SHEET 1 OF 16         |          |

## DMD HANDLING AND CLEANING SPECIFICATION

### 1. PURPOSE

Define minimum precautions to protect DMD products from Electrostatic Discharge (ESD). Provide DMD handling guidelines and provide correct methods for cleaning the glass of the DMD.

### 2. SCOPE

This specification applies to all operations in which DMD products are used. Reference EIA-JESD 625A (Requirements for Handling Electrostatic Discharge- Sensitive ESD Devices) for additional information.

### 3. DEFINITIONS

**ANTI-STATIC MATERIAL:** Material that minimizes the generation of static charge when rubbed against itself, or when separated from itself or other similar materials.

**CONDUCTIVE MATERIAL:** Material having a surface resistivity of less than  $10 \times 10^5$  ohms per square.

**EARTH GROUND:** A metal pipe or metal rod inserted a minimum of 1 meter (3 feet) into the earth.

**ELECTROSTATIC DISCHARGE (ESD):** A transfer of electrostatic charge between bodies at different electrostatic potentials caused by direct contact or induced by an electrostatic field.

**ESD GROUND:** Either an earth ground or a third-wire ground.

**INSULATIVE MATERIAL:** Material having a surface resistivity equal to or greater than  $10 \times 10^{12}$  ohms per square.

**IONIZER:** Equipment that generates positive and negative ions, either by electrostatic means or by means of a radioactive energy source (such as polonium 210), and distributes a layer of ionized air over a work area to neutralize static charges.

**STATIC-DISSIPATIVE MATERIAL:** Material having surface resistivities between  $10 \times 10^5$  and  $10 \times 10^{12}$  ohms per square.

**SURFACE RESISTIVITY:** The resistance between two electrodes forming opposite sides of a square. It is measured in ohms-per-square, and the size of the square is immaterial. Other generally accepted terms for surface resistivity include sheet resistance or sheet resistivity.

**THIRD-WIRE GROUND:** The ground wire of a three-wire system with contact made only at the receptacle.

## 4. EQUIPMENT

### 4.1 General Requirements

4.1.1 All equipment, tools, fixtures and handling aids used for processing, handling, or storing of ESD-Sensitive (ESDS) products shall be made from conductive or static-dissipative material. Where conductive or static-dissipative material can not be used, antistatic solution can be used as a means to reduce static charge generation. During application of any antistatic solutions, the guidelines below must be followed:

- Use approved antistatic solutions only. They must be free of reactive elements (such as chlorine, phosphorus, sodium, etc...) Antistatic solutions must not contaminate ESDS devices.
- The solution must be re-applied to insure that the equipment, fixtures, tools, etc., generate less than +/-100V potential when rubbed vigorously with any insulative material (the frequency of once/day is recommended).
- Antistatic solutions should not be applied when devices are directly exposed to spray mists.

4.1.2 All flooring in the manufacturing area shall be conductive or static-dissipative.

4.1.3 All conductive or static-dissipative storage racks, fixtures, etc. shall be connected to ESD ground through a 1 megaohm +/- 10% resistor.

Note: Storage racks where any ESDS product is stored in compliance with section 5.6 do not require grounding.

4.1.4 All grounding for work surfaces, racks, equipment, etc. shall meet all local safety codes and/or requirements.

4.1.5 Any temporary connection used to ground any work surface, rack, equipment, etc. shall be of a snap or plug-and-socket type.

- 4.1.6 All electrical equipment used at the work station shall be hard grounded (third-wire grounded). Small hand tools such as tweezers, may be grounded via the operators.
- 4.1.7 Any electrical equipment located on the work surface shall be hard grounded (third-wire grounded) and shall also be isolated from the work surface.
- 4.1.8 It is strongly recommended that a qualified safety engineer perform a safety review of all new or modified ESD ground connections prior to their initial use.

## 4.2 Work Stations

- 4.2.1 Wrist straps shall be connected to ESD ground through a 1 megaohm +/- 10% resistor. A workstation monitor which constantly monitors the resistance of the workstation, operator, and wiring connections and alarms when connections are broken or missing (for example, the 3M Workstation Monitor model 720) is required at all work stations where ESDS materials are being handled. Static-dissipative work surfaces, and conductive or static-dissipative floor mats shall be connected to ESD ground through a 1 megaohm +/- 10% resistor.
- 4.2.2 An ionizer shall be used at each work station. There shall be no static-generating materials at the work station, and a conductive static-dissipative or antistatic smock shall be worn by the operator.  
A ceiling ionizer is sufficient for the work station provided that there is no obstruction between it and the work surface where ESD sensitive materials are being handled (such as under a hood).
- 4.2.3 Operators who are handling DMD devices shall wear a wrist strap in accordance with section 4.3 and heel straps in accordance with section 4.4.

## 4.3 Wrist Straps

- 4.3.1 Wrist Straps shall be connected to an ESD monitor for continuous monitoring.
- 4.3.2 When the wrist strap is connected to the static-dissipative mat:
  - a) it shall be connected to the same metallic button or the contactor used to ground the mat.
  - b) this may result in the wrist strap being 2 megaohms +/- 10% above ground, which is acceptable.

- 4.3.3 Wrist strap shall be worn snugly around the wrist to ensure continuous electrical contact with bare skin.
- 4.3.4 Wrist straps shall be checked daily to ensure that proper grounding is maintained.
- 4.4 Heel straps
  - 4.4.1 Two heel straps or conductive shoes shall be worn when handling ESDS products.
  - 4.4.2 Heel strap cups shall solidly contact conductive flooring. The tab (contact ribbon) shall be worn inside the sock, ensuring continuous electrical contact with bare skin.
  - 4.4.3 Heel straps or conductive shoes shall be checked daily to ensure that proper grounding is maintained.
- 4.5 Ionizers
  - 4.5.1 Forced-air, table-mounted ionizers shall be located so that devices are:
    - a) within a 1.3 meter (4-foot) arc measured by a vertical line from the face of the ionizer and 45 degrees on either side of this line, and
    - b) at least 0.3 meter (1-foot) away from the ionizer.
  - 4.5.2 All ionizing units shall be located in a position to limit charge-buildup in the device-handling area of the work station to +/- 100 volts.
  - 4.5.3 It is recommended that all ionizers be approved by a qualified safety engineer prior to implementation.
  - 4.5.4 Any ionizers with radioactive elements shall meet the conditions of Appendix A.
  - 4.5.5 The following checks on the ionizers (work station ionizers only) shall be performed:
    - a) On a monthly basis, check for proper operation of the ionizers with the 'quick check' procedure (or equivalent) described in appendix C.
    - b) On a semi-annual basis, check, as a minimum, for proper ionization output, ionization balance, and electrode cleanliness according to manufacturer's instructions. Record of the checks shall be maintained.

## 5. Specific Handling Requirements

- 5.1 All equipment, tools, etc. used shall meet the requirements of section 4.1.
- 5.2 Static free work station shall be used per section 4.2.
- 5.3 All manual processing or handling of ESDS products shall be performed at static-free work stations.
- 5.4 Before using a static-free work station, the operator shall:
  - a) check that the wrist strap is connected correctly.
  - b) if work station ionizer is used, check that it is switched on and properly positioned to aim at the devices and operator's hands.
- 5.5 An antistatic, static-dissipative, or conductive smock must be worn where ionizer is not present. Long-sleeved garments must be completely covered by the smock, except at the neck area.
- 5.6 ESDS products shall be stored and/or transported between static-free work stations in an enclosed conductive container. Do not transport the DMD device without such a container, even for short distances. The DMD container must keep the device stationary during transport. The container can only be opened at a static-free work station when the container is in contact with a properly grounded static-dissipative surface. The surface must be sturdy and as close to the process as possible.
  - 5.6.1 Never touch the inside of the DMD device container. Handle the lid gently. Do not allow the lid to flip open or slam shut.
  - 5.6.2 Always hold the device container with 2 hands at chest level, away from the body and with a firm grip. Handle the carrier gently and in such a way that the devices within do not make noise.
  - 5.6.3 Keep the device container closed and locked except when actively removing or replacing devices. This prevents particles from accumulating inside the container.
  - 5.6.4 Always ensure the container lid lock is in the locked position and is operating correctly before transporting the devices.
  - 5.6.5 Be aware of and avoid obstacles and other people while transferring device containers.
  - 5.6.6 It is recommended that only 2 DMD plastic totes be carried at a time to

reduce the risk of handling damage. If several containers must be transported,  
use an approved carrier cart.

- 5.6.7 Carriers must be stored in designated areas only.
- 5.6.8 Do not place anything inside the container with the devices except for approved packaging material.
- 5.6.9 Do not allow any object to come in contact with the glass of the DMD device.
- 5.6.10 Do not write on top of a device container full of devices.
- 5.6.11 Use clean device containers only.
- 5.7 Any operation performed on ESDS product at a static free work station should be such that the item:
  - a) remains in contact with the work surface as much as possible, and
  - b) does not touch any electrical equipment.
- 5.8 Clean antistatic or conductive gloves or finger cots must be worn at all times when handling DMD devices. Replace gloves and finger cots when they are dirty or damaged.
- 5.9 Extreme caution must be used when handling DMD devices to ensure that the glass area is not touched or scratched. Handle the DMD device by the package edges only.
- 5.10 Avoid any movement over the DMD device window. Do not lean over the DMD when the window portion of the DMD is facing up. When reaching for a DMD, avoid any movement over other DMDs in the carrier.
- 5.11 Remove the DMD device from the carrier gently. When putting the DMD into the carrier, use caution. Do not drop the DMDs into the carrier. Ensure that the DMDs are well seated in the carrier.
- 5.12 Touching of leads or contacts should be avoided, whenever possible, even though the operator is properly grounded. Cleaning the window of the DMD device should only be performed per approved procedures (see Appendix D), since the rubbing motion of the cleaning may generate ESD charges.
- 5.13 Clothing other than approved conductive or static-dissipative garments shall not be allowed within 150 mm (12 inches) of ESDS product which is not protected in an appropriate conductive container.

- 5.14 It is the responsibility of the operator and the area supervisor to ensure that the static-free work area is clear of unnecessary static hazards such as ESD generating plastic materials. All work-related items, including log book, tools, and device containers must be those approved for use at the static-free work station.

## 6. Identification

- 6.1 For static controlled areas, all entrances shall:

- a) clearly identify that the area is static controlled, and
- b) give warning that static can damage components.

- 6.2 Signs used shall be of consistent design and color.

Note: Suggested design for an entrance sign can be found in Figure 1, Appendix B. Other designs may be used as appropriate, provided the proper information is conveyed.

- 6.3 For isolated static-free work stations, each work station shall be adequately identified per paragraphs 6.1 and 6.2.

- 6.4 Each box of finished ESDS product and any other box in which these boxes are packed shall have a label attached to warn that the contents are static sensitive. The label shall clearly indicate by words and symbols that ESDS devices are inside the box and that the box cannot be opened except at a designated ESD protected area workstation.

or

Note: Suggested design for a label can be found in Figure 2, Appendix B. Suggested color choice is black symbols on a yellow background. Other designs may be used as appropriate, provided the proper information is conveyed. However, any customer requirements for ESDS identification have precedence over those of this specification.

## 7. Monitors

Compliance monitors shall be performed per the following minimum frequencies. Any deficiencies shall be corrected before processing any further products. Records of monitors shall be maintained.

- 7.1 On a weekly basis, all applicable manufacturing areas shall be monitored for the following:

- a) ESDS product only handled at approved work stations as per this specification.

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- b) visual inspection for correct use of wrist and heel straps.
- c) each wrist strap grounding connection is tested to a limit of 1 megaohm +/- 10 %.
- d) ionizers switched on and properly directed across the work surface.
- e) proper use of conductive or antistatic smocks, where applicable.
- f) no static generating materials in specified areas.
- g) check static voltage to limit of +/- 100v on operators, products, tools and materials at work stations.

7.2 On a monthly basis, all applicable manufacturing areas shall be monitored for the following:

- a) each static-dissipative work surface and static-dissipative floor mat connected to ESD ground through a 1 megaohm +/- 10% resistor per section 4.2.1.
- b) conductive floor mats connected to ESD ground, testing to a limit of 1 megaohm +/- 10 %.
- c) proper operation of ionizers with the 'quick check' procedure (or equivalent) described in Appendix C.

7.3 On a quarterly basis, all applicable manufacturing areas shall be monitored for the following:

- a) point-to-point resistance of 100 kohms to 2.0 megaohms for conductive floors.
- b) point-to-ground resistance of 100 kohms to 2.0 megaohms for conductive floors.

## 8. Training

All personnel who handle or process static sensitive products shall receive suitable training prior to such employment, and every 12 months thereafter. This training shall include the following as a minimum:

- a) ESD and DMD handling training
- b) Actual applications in the work area.

Training records shall be maintained. As a minimum, training records shall contain dates of training, length of training session, topics covered, and the name of the trainer.

## **Appendix A**

### **IONIZERS WITH RADIOACTIVE ELEMENTS**

A.1 The following instructions are recommendations only and shall not supersede any company policies, local or national laws or other regulations.

A.2 If ionizers using radioactive elements are used:

- a) they shall be handled in accordance with local laws and regulations.
- b) all caution and warning labels shall be heeded.
- c) the radiation safety office shall be notified before purchasing or leasing a radioactive unit.

A.3 A person within each operation or site, working with the site safety engineer, shall be appointed by the operation or site manager as having total responsibility and accountability for radioactive units.

- a) that person shall be responsible for fan-out communications regarding how the elements are to be treated and how to keep the radioactive source material isolated, attached to the element, and out of the room environment.
- b) the information shall be communicated to all new employees working in the facility, and shall be reviewed with all involved personnel annually thereafter.

A.4 The elements shall not be exposed to any chemicals to ensure that the bonding agents holding the elements together will not be degraded.

## Appendix B

### SAMPLE ESD SIGNS AND LABELS

Figure 1. ESD Sign

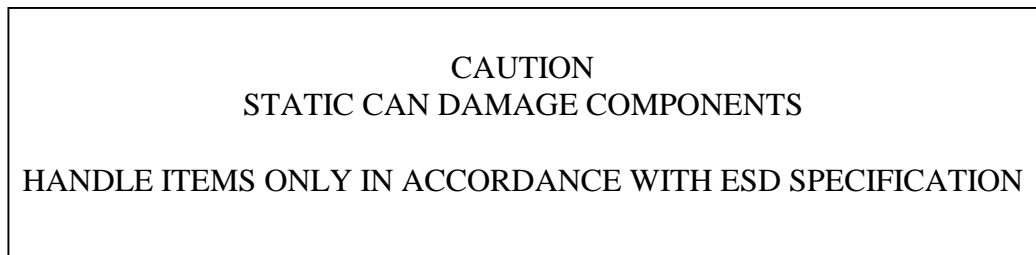
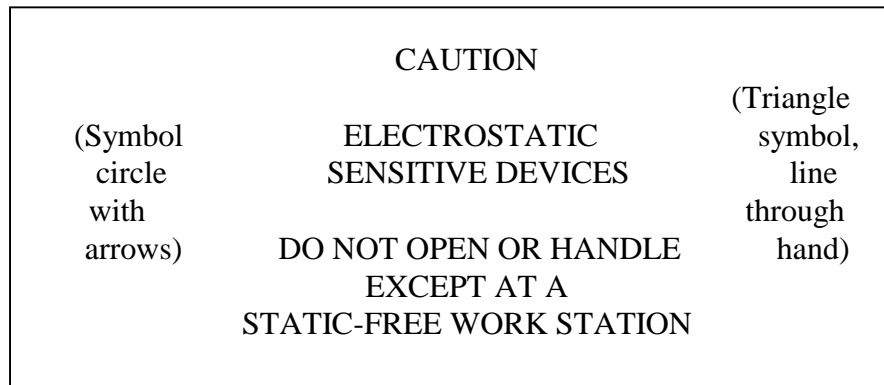


Figure 2. ESD Label



## Appendix C

### IONIZER 'QUICK CHECK'

#### C.1 Equipment / Materials

- a) electrostatic voltmeter
- b) sticky plastic tape (for example, transparent adhesive tape)

C.2 Assure that the ionizer to be checked is turned off and that all other ionizers in the area are either turned off or positioned so that they do not affect the ionizer being checked.

C.3 Prepare two (2) pieces of tape as follows:

- a) cut two pieces of tape approximately 10 cm (4 inches) in length.
- b) fold over each end of one piece of tape (sticky side to sticky side), approximately 1 cm (0.5 inch) to create pull tabs for step d.
- c) stick the two pieces of tape together (sticky side of tabbed tape to the non-sticky side of non-tabbed tape).
- d) separate the two pieces of tape using a fast, even pull, thereby creating one piece of tape charged to approximately +1000 to +2000 volts and the other charged to approximately -1000 to -2000 volts.

C.4 Place the positively charged piece of tape 0.3 - 0.5 meter (1 - 1.5 feet) directly in front of the ionizer to be checked. Turn on the ionizer for 30 - 35 seconds, then turn it off.

C.5 Measure the electrostatic charge on the tape. Acceptable voltage level is 0 +/- 50 volts.

C.6 Repeat the steps in paragraph C.4 through C.5, except use the negatively charged piece of tape.

## Appendix D

### DMD Window Cleaning Procedure

#### D.1 Purpose

To remove contaminants such as smudges, fingerprint oils, or foreign materials from the DMD window.

#### D.2 Materials

D.2.1 Forced Ionized Air ( regulated to 35 +/- 5 lbs and extremely clean.)

D.2.2 Antistatic or conductive finger cots or gloves

D.2.3 3X Magnification Lens

D.2.4 Microfiber Cleaning Cloth, examples include “ Mikros” from Crystal Optical, 11620 Trask Avenue, Garden Grove, CA, 92843, 1-800-766-8228), or “Anticon-100” from Controlled Environment Products Inc. 3605 N.E. Kimball Dr, Kansas City, Mo. 64161, phone 1-800243-7404 or equivalents

D.2.5 Texwipe, TX811 Optical Pad or equivalent, Texwipe Corp.

D.2.6 Acetone

D.2.7 High quality cotton swabs

D.2.8 High intensity light source or high florescent light source

#### D.3 Procedure

##### D.3.1 General Instructions

D.3.1.1 All cleaning of optical surfaces shall be performed with the appropriate cleaning method only. Exception to these methods must be approved in writing by Texas Instruments Production or Customer Engineering.

D.3.1.2 In all cases, the least aggressive cleaning method shall always be tried first. If the least aggressive cleaning method does not remove the contaminant then proceed to the next level of cleaning method.

### D.3.2 Specific Instructions

- D.3.2.1 All ESD handling precautions outlined in this document must be observed when cleaning the DMD.
- D.3.2.2 The DMD shall be placed glass-up on an ESD dissipating work surface and held firmly. After each cleaning attempt, inspect the DMD window under magnification in a work area with diffused fluorescent lighting to ensure it is clean. If it is not clean, repeat cleaning procedure as required.
- D 3.2.3 The least aggressive cleaning method is to use Forced Ionized Air. The Ionized Air used must be extremely clean. This will require in-line filters on the air hose. Gently blow off the glass surface of the DMD.
- D 3.2.4 If this does not remove the contaminant from the glass then proceed to the next cleaning level described in paragraph 3.2.5.
- D.3.2.5 With the Microfiber Cloth the recommended method is to start in the center of the DMD glass window, wipe lightly toward the outer edge with one continuous stroke. Rotate the DMD 180 degrees and obtain a clean area of the Microfiber Cleaning Cloth. Again, start in the center of the DMD and wipe toward the outer edge with one stroke. Inspect the glass and repeat if necessary.
- D.3.2.6 If contaminants remain on the glass after cleaning, proceed to next level of cleaning method described in paragraph 3.2.7. For applications where extremely stringent cleaning is required proceed to paragraph 3.2.8.
- D.3.2.7 The most aggressive cleaning method is a wet wash. This method uses a liquid such as Acetone or Alcohol with DI water. The alcohol with DI water comes prepackaged such as products from the Texwipe Co, TX-811 or equivalent. These optical pads are optic quality clothes that are soaked in alcohol with DI water. If Acetone is used it will require a high quality cotton swab or a wipe to apply the liquid to the glass surface. Care must also be taken to ensure the Acetone is clean and is in a dispenser that will not pick up moisture from the air. If Acetone is in an open air container then it must be discarded after one week because it will pick-up moisture from the air. The recommended method is always to start in the middle of the glass and wipe towards the outer edge of the DMD. Rotate the assembly 180 degrees and again start in the center of the DMD glass and wipe towards the outer edge of the device. On each wipe use an un-used area of the swab or optical pad for the wiping action.

D 3.2.8 For Acetone specific applications where extremely stringent cleaning is required the following steps are suggested as guidelines. For cleaning a DMD that is not installed in a system refer to paragraphs 3.2.8.1 through paragraphs 3.2.8.8.

D 3.2.8.1 Fold a wipe (i.e., Anticon-100) at least twice to have several layers. Dampen the wipe with acetone.

D 3.2.8.2 First wipe the pump to clean the lid, discard the wipe. The pump ought to be cleaned periodically during the day.

D 3.2.8.3 Obtain a new wipe, fold twice and dampen with acetone. With the DMD™ in the fixture wipe the gold portion of the DMD™ without letting the wipe touch the glass. This action removes potentially damaging abrasives. Discard the wipe.

D 3.2.8.4 Obtain a new wipe, fold twice and dampen with acetone. Slowly wipe the glass surface from the center out, at a rate such that the acetone evaporates within 1/8 inch of the wipe.

D 3.2.8.5 Fold the wipe over to expose a clean section of the wipe or obtain a new dampened wipe. Slowly wipe the other half of the glass surface from the center out, at a rate such that the acetone evaporates within 1/8 inch of the wipe. Discard the wipe and inspect the DMD™.

D 3.2.8.6 Obtain a new wipe, fold twice (do not dampen with acetone) and wipe the surface of the DMD™ from one end to the other, starting with the edge of the glass. Discard the wipe.

D 3.2.8.7 Inspect the DMD™ to ensure that it is clean. Repeat paragraphs 3.2.8.1 through 3.2.8.6 if necessary.

D.3.2.9 For Acetone specific applications where extremely stringent cleaning is required the following steps are suggested as guidelines. For cleaning a DMD that is installed in a system with an aperture refer to paragraphs 3.2.9.1 through paragraphs 3.2.9.7.

D 3.2.9.1 First try to blow the particle off using clean compressed ionized air or a ‘puff’ ball. Continue if this does not work.

D 3.2.9.2 Place the assembly onto a firm surface such that the DMD glass is facing up and no damage to the glass will result.

D 3.2.9.3 Dampen a clean cotton swab with acetone. Holding the swab near the tip and at a 90degree angle to the glass, quickly and firmly swipe back and forth many times across the glass from one edge of the aperture to the other covering the entire area. Discard the swab.

D 3.2.9.4 Obtain a second clean dry swab (do not dampen with acetone). Rotate the assembly 90 degrees. Hold the swab the same way and quickly and firmly swipe back and forth across the glass from one edge of the aperture to the other covering the entire area. Discard the swab.

D 3.2.9.5 Obtain a third clean dry swab (do not dampen with acetone). Rotate the assembly 90 degrees again. And repeat paragraph D3.2.9.4.

D 3.2.9.6 Using clean compressed ionized air, blow any particles and or cotton fibers off of the glass surface.

D 3.2.9.7 Inspect the assembly and repeat paragraphs if necessary.

D 3.2.10 Follow-up all wet cleanings with the microfiber cleaning cloth (per paragraph 3.2.5) except that described in paragraph 3.2.9 to ensure no residue is left on DMD glass. Inspect the glass and repeat if necessary.

### D.3.3 Quality

D.3.3.1 Cleaned optical surface shall be free of streaks, spots, fingerprints, and lint, when viewed under diffused fluorescent lighting with a 3X magnification lens.