

SEMI MS7-0708

SPECIFICATION FOR MICROFLUIDIC INTERFACES TO ELECTRONIC DEVICE PACKAGES

This Standard was technically approved by the MEMS Global Technical Committee. This edition was approved for publication by the global Audits and Reviews Subcommittee on May 13, 2008. Available at www.semi.org in June 2008.

NOTICE: This Standard or Safety Guideline has an Inactive Status because the conditions to maintain Current Status have not been met. Inactive Standards or Safety Guidelines are available from SEMI and continue to be valid for use.

1 Purpose

1.1 This Document defines an industry-standard for fluidic interfaces with electronic devices. The Specification describes the connection attributes and specifies the interface dimensions required to design and build devices and systems that are compliant with this Standard. The goal is to enable devices from different vendors to interconnect via an open architecture. The Specification is intended as an enhanced capability to state-of-the-art electronic device technologies incorporating a combination of electronics and fluidics. It is intended to provide device users adequate room for product versatility and market differentiation without the burden of carrying obsolete interfaces, losing compatibility, and choice.

2 Scope

2.1 This Specification is primarily targeted toward die manufacturers, design engineers, packaging engineers, chemical engineers, packaging equipment suppliers, peripheral developers and system OEMs. This Specification can be used for developing new products and associated hardware.

NOTICE: SEMI Standards and Safety Guidelines do not purport to address all safety issues associated with their use. It is the responsibility of the users of the Documents to establish appropriate safety and health practices, and determine the applicability of regulatory or other limitations prior to use.

3 Limitations

3.1 This Specification does not address material-to-fluid compatibility, material-mechanical limitations, nor electromagnetic/fluid interactions.

4 Referenced Standards and Documents

4.1 SEMI Standards and Safety Guidelines

SEMI MS6 — Guide for Design and Materials for Interfacing Microfluidic Systems

4.2 ANSI/SBS Standard¹

ANSI SBS 4-2004 — Well Positions for Microplates

4.3 JEDEC Standard²

JEDEC MO-187 — Plastic Low/Thin/Very Thin Shrink Small Outline Package, 0.65 and 0.50 Pitch

NOTICE: Unless otherwise indicated, all documents cited shall be the latest published versions.

5 Terminology

5.1 Abbreviations and Acronyms

5.1.1 EFIC — electrofluidic integrated circuit

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² Joint Electron Device Engineering Council, 3103 North 10th Street, Suite 240-S, Arlington, VA 22201, USA; Telephone: +1.703.907.7560, Fax: +1.703.907.7583, <http://www.jedec.org>

5.1.2 IC — integrated circuit

5.2 Definitions

5.2.1 *electrofluidic integrated circuit (EFIC)* — the integration of semiconductor electronics and microfluidics on a common substrate.

5.2.2 *fluidic routing card* — a fluidic manifold used to interconnect the fluid flow between any multiple of EFIC's.

6 Architecture/System Considerations for a MEMS Fluidics System

NOTE 1: The purpose of this Document was initiated as a general reminder for MEMS Fluidic Interface designers that MEMS fluidics devices by themselves mostly provide certain localized functions. In order to fully explore the potential of MEMS fluidics devices some added functions and user-friendly interfaces to the outside world are required. These external functional providers could be well designed connected to or incorporated into the MEMS Fluidics interfaces. However in order not to provide these external functions as after thoughts, it is important to design them as an integrated parts of the whole MEMS Fluidics system at the beginning of the design, be at the system or subsystem architecture level. For convenience we will use the terminology of MEMS Fluidics System to include MEMS Fluidics subsystems. In order not to restrict creativity, it is not necessary to fix the actual architecture but to establish a set of guidelines that most of the practitioners in this field would agree. The following is set of such proposals.

6.1 *Definition* — A MEMS fluidics system consists of an integration of one or more MEMS fluidics components and related components to provide a new or replace an existing function with performance, cost, intelligence and footprints advantages.

6.2 A MEMS fluidics system should be easily adoptable to and interface to its environment with minimum requirements for existing environment modification.

6.3 A MEMS fluidics system is preferred to be 'intelligent' such that its output requires minimum data or information processing to be real time and cost effective. Software for data and information processing necessary to provided meaningful real time output to save time and effort could be either loaded into the system IC chip or imbedded in the device as firmware. Only system with useful intelligence is worthy of replacement and/or adoptive consideration.

6.4 A MEMS fluidics system may consists the following components:

6.4.1 A MEMS fluidics component which could be just a chamber or a more complex MEMS Fluidics device.

6.4.2 Fluidics interface to micro and/or macro interfaces preferably a smooth transition to present standard fluidics connectors/tubing.

6.4.3 Mechanical interface for positioning and equipment integration.

6.4.4 Electrical interface for power supply (if required) and signal input and output.

6.4.5 Optical interface for optoelectric and/or opto-bio interaction or measurements. This may require minimum one side of the fluidics chamber to be optically transparent.

6.4.6 Software for data and information processing necessary to provide meaningful real time output to save time and effort could be either loaded into the system IC chip or imbedded in the device as firmware. Only system with useful intelligence is worthy of replacement and/or adoptive consideration.

6.5 A representative integrated MEMS fluidics system architecture is shown in Figures 1 through 3, where the fluidics I/O interfaces are on both top ends, electrical/electronic interface at the bottom, and the middle portion space could be a convenient optical interface. The integration of all the components requires engineering design of material compatibility, reliable connections, and compactness of spacing. Of course the fluidics dynamics in various physical regions should be considered/simulated to provide necessary functions in the first place.

6.6 If the system is a throw away type bio-medical devices, the disposal of the system and its environment impact should be considered during the design stage

6.7 From the cost point of view the final test and the testing procedures of the system should be designed at the beginning of the design cycle to assure high yield; that is, low cost and easy to obtain reliability assurance data of the MEMS fluidics system.

7 Requirements

NOTE 2: Refer to layout for typical package shown below. The package outline is taken from JEDEC MO-187 (a variation of an SOP surface mount 8-pin electronic device) typical package. An open cavity has been added with an array of 8×8 fluidic ports. Compliance to the EFIC, micro to micro adapter, fluidic routing card, and macro adapter, design constraint requirements provides compatibility with this standard for parts A, B, C, and D. All dimensions are mean values where tolerances are dependent upon material selection and application requirements.

7.1 Part A — EFIC Fluidic I/O Design Constraints

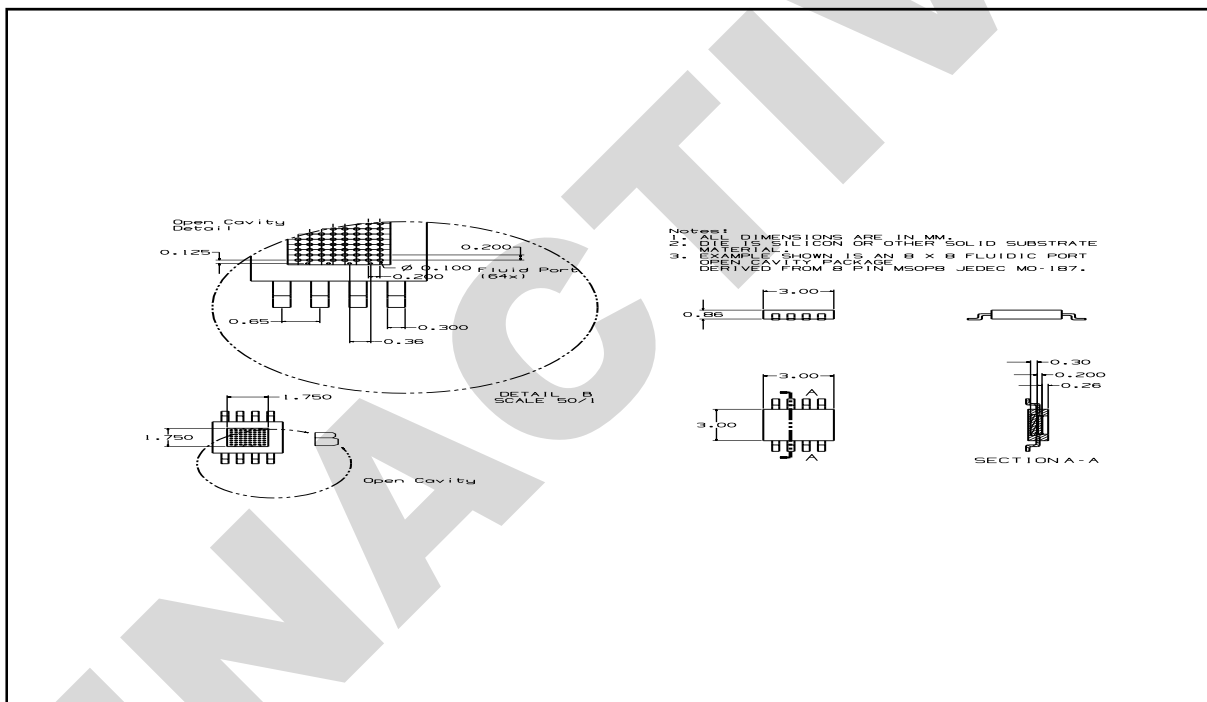
7.1.1 Fluidic interconnects shall not to be closer than 0.075 mm to electrical bond pads.

7.1.2 Port diameters shall be uniform and consisting of either 25, 50, 100, 200, or 400 microns with a pitch to port size ratio of 2.

7.1.3 Rectangular array sizes shall consist of 2^x ports.

7.1.4 Segregation of electronics and fluidics (not in mutual contact except where fluid sensing or flow control is required).

7.1.4.1 Fluidic distribution shall be at the top and flush with top of device package.



#1 An example of an open cavity JEDEC MO-187 package containing an EFIC.
Port dimensions are 0.100 mm diameter, a pitch of 0.200 mm, and a $2^6 = 8 \times 8$ array.

Figure 1
EFIC Package

7.2 Part B — In-package (Micro-to-Micro) Fluidic Adapter Design Constraints

7.2.1 In-package (micro-to-micro) fluidic adapters shall be used to interface a fluidic die to the same height as the package top surface.

7.2.2 The in-package fluidic adapter shall be the same port size and pitch as the EFIC.

7.2.3 The in-package fluidic adapter shall contain the same number of ports and pitch on both its top and bottom surfaces.

7.3 Part C — Fluidic Routing Card Constraints

7.3.1 A fluidic interface (or fluidic routing card) adapter shall be used to connect fluid I/O to the EFIC.

7.3.2 EFIC interface port diameters on the fluidic routing card shall be uniform and consisting of either 25, 50, 100, 200, or 400 microns with a pitch to port size ratio of 2.

7.3.3 On the fluidic routing card, rectangular array sizes shall consist of 2^x ports.

7.3.4 On the fluidic routing card, the fluidic routing card shall terminate to a mini-fluidic adapter.

7.3.5 On the fluidic routing card, the mini-fluidic adapter port diameters shall be uniform and consisting of 1 mm diameter ports.

7.3.6 On the fluidic routing card, the mini-fluidic adapter port pitch shall be $2.25 \text{ mm} \times 2.25 \text{ mm}$.

7.3.7 On the fluidic routing card, there shall be an equal number of EFIC ports and mini-fluidic adapter ports.

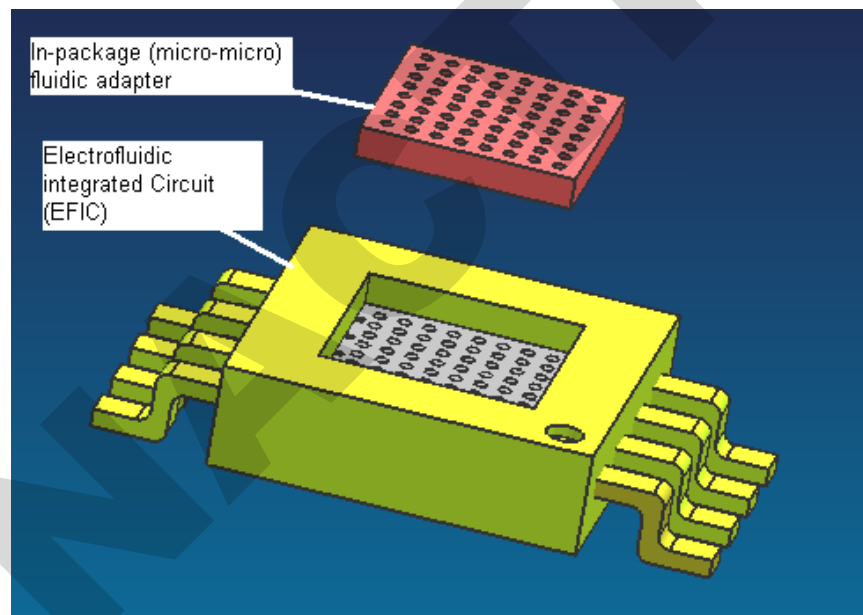
7.3.8 One side of the fluidic routing card shall be 25 mm in length where the other shall be any multiple of 25 mm.

7.4 Part D — Mini-Fluidic Adapter Constraints

7.4.1 The mini-fluidic adapter port diameters shall be uniform and consisting of 1 mm diameter ports.

7.4.2 The mini-fluidic adapter port pitch shall be $2.25 \text{ mm} \times 2.25 \text{ mm}$.

7.4.3 One side of the mini-fluidic adapter shall be 25 mm in length.



#1 Top — In-package (micro-to-micro) fluidic adapter and EFIC package.

Figure 2
Exploded 3D View of EFIC Package