

## Accessories

### Additional pipetting channels

The multi-dos can be extended by additional controller modules **PM1** (see right figure) and can then control up to eight (or more) micro-dosage heads simultaneously. All heads can be operated independently of each other, but also synchronously.

For OEM applications, the controller modules are also available without the multi-dos housing.

### Diluter

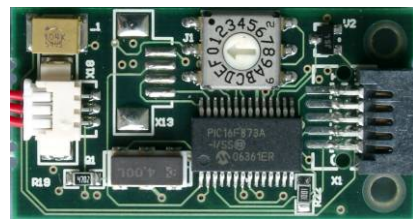
The micro-dosage heads can be filled manually using a syringe. For the automation of the liquid handling, we recommend to use a diluter system consisting of a computer-controlled syringe pump and a three-way valve. This adds the following features to the GeSiM dosage head:

- Flushing with system liquid (usually water)
- Automatic sample uptake through the nozzle or feeding of the sample from the back via the fluidic inlet

Please note that the diluter is controlled via a second serial interface (RS 232), in addition to the interface needed for the multi-dos. The syringe pump is controlled by an extra instruction set.

### Stroboscope system for droplet visualization

The stroboscope provides real-time views of the microdrops ejected from the dispense heads during different phases of their flight. Thus the optimization of dispensing parameters for a particular sample can be visually checked. It contains an integrated yellow illuminating diode, an integrated video camera, and a holder for an SPIP/PICPIP microdispenser. The stroboscope control module occupies a free slot in the multi-dos (which can be upgraded by GeSiM).



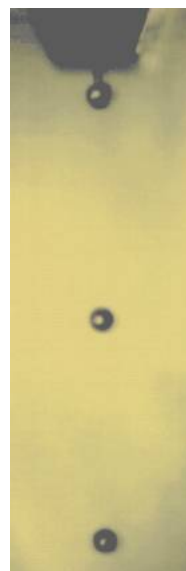
PM1 module (A020-303)



1-channel diluter (A072-102)



Heatable pipette (A010-300) in the stroboscope (A020-302); in the back multi-dos above temperature controller (A020-011). Bottom: stroboscopic picture of flying droplets.



### Fluids successfully dispensed using piezoelectric dispensers (selection)

Acetic anhydride, acetone, acetonitrile, betaine (*N,N,N*-trimethylglycine, < 1 M), chloroform, cyclohexanone, dextrane solutions, detergents (e.g. 2 % Triton X-100 or Tween-20), dichloromethane/trifluoroacetic acid (98:2), *N,N*-dimethylformamide (DMF), dimethylsulfoxide (DMSO), 1,4-dioxane, DNA (oligos or PCR product < 3 mg/ml, 4 kbp plasmid < 1 mg/ml), ethanol, ethylene glycol, *N*-FMOC-Ile (200 mM in DMF), glycerol (< 50 % in H<sub>2</sub>O), glues (Epoxy Technologies OG169, UVO-114, 301-2), iodine (in THF/pyridine/H<sub>2</sub>O 3:75:20:75), isopropanol, liquid crystals (Merck Licristal ZLI-2222 and MLC-6681 at 43 °C), MALDI matrix ( -cyano-4-hydroxycinnamic acid in NMP, 3-HPA in 20 % acetonitrile), methanol, 1-methyl-2-pyrrolidone (NMP), 1-methylimidazole (16 % in THF), NaCl (< 3 M), PDMS (< 30 % in -butyrolactone) phosphoramidite (T-CE in acetonitrile), polyethylene glycol 10000 (PEG, 5 %), polymers (P3OT 1 mg/ml in trichlorethylene or chlorobenzene, PEDOT: PSS 0.14/2.6 %), protein (< 10 mg/ml in PBS), silane (2-3 % in propanol), SSC (saline sodium citrate, 3x), tetrahydrofuran (THF), tetrazole (in acetonitrile), toluene, urea (< 7 M), water

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**GeSiM**

# Nanoliter Dosage



## With Piezoelectric Microdispensers

Our patented microdispensers are created from microstructured silicon and glass chips, tightly connected by anodic bonding. Different design and packaging allows the integration of these products into a whole range of customer-specific laboratory systems providing non-contact dispensing.

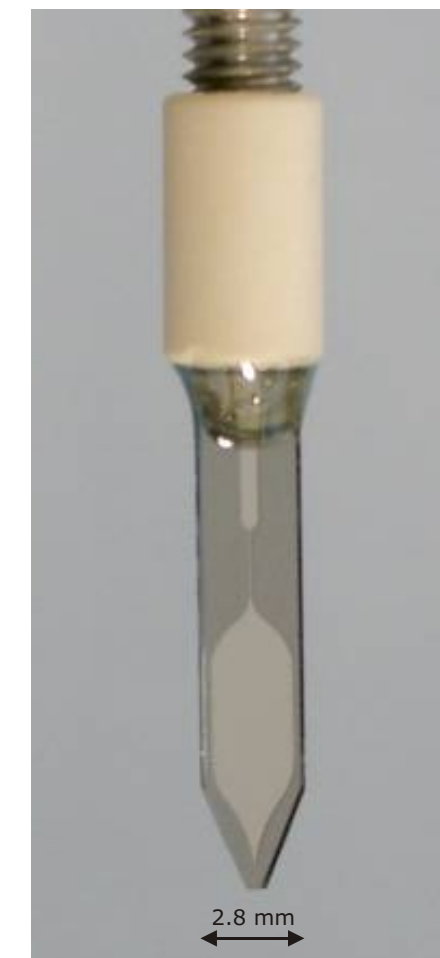
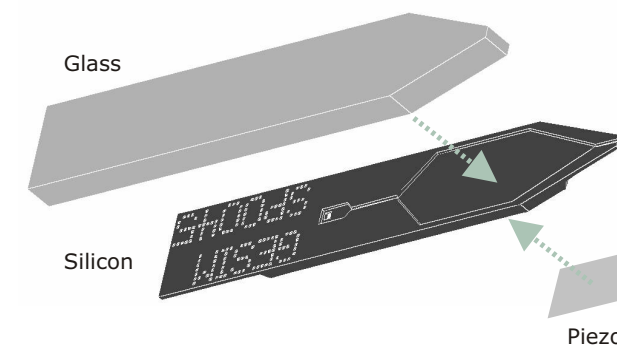
Our actuators are piezoelectric ceramics glued onto the outside of a thin silicon membrane. Upon application of a voltage, they go out of shape in a preferred direction. This deflection is transferred to a 0.8 µl pump chamber filled with fluid and results in the formation of a tiny droplet that is ejected from the nozzle at a speed of 1 - 5 meters per second. This process can be repeated indefinitely.

The dispensers adhere to the "Drop on Demand" principle; this means precise dosage, because each electrical pulse generates exactly one droplet. Bursts with a predefined number of drops at a certain frequency are freely selectable and can be used to dispense varying amounts of fluid or draw lines.

- Delivery of perfectly spherical droplets
- Two pipette types producing different droplet sizes: SPIP (~ 1 nanoliter) and PICPIP (~ 0.1 nanoliters)
- Defined bursts on mouse click or by hardware triggering
- Burst mode or continuous dosage (e.g., as a suction pump)
- Ready to use immediately after plugging the control device into the PC
- Special designs (multi-channel and heatable pipettes) available

Possible applications (not comprehensive):

- Fabrication of microarrays
- Drug delivery and application
- Toxicological tests
- High-throughput screening (HTS)
- Combinatorial chemistry
- Sample preparation
- Surface coating
- Generation of concentration gradients by varying the droplet number
- Aerosol production
- Usage as simple miniaturized pump in micro-



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## Product Overview Standard Micro-Dosage Heads (SPIP and PICPIP)

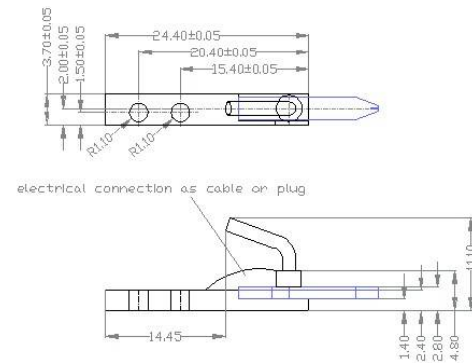
Both dispenser types are identical, except that their nozzle sizes are different and thus produce droplets of two different volume ranges:

- Materials in contact with liquid: glass/silicon, PEEK, stainless steel (where used)
- Driven by low-power piezoelectric actuators (~ 70 V, pulse duration ~ 100 µs)
- Valveless dispensing (i.e., no pressure difference between orifice and reservoir)
- Pump chamber volume approx. 0.8 µl
- Droplet volume is slightly dependent on piezo voltage: SPIP ~ 0.6 - 1.1 nl (100 - 130 µm diameter), PICPIP ~ 0.1 - 0.2 nl (as a special design down to 30 pl)
- Droplet frequency freely selectable (16 - 1000 Hz)
- Maximum volume flow approx. 70 µl/min (SPIP) or 12 µl/min (PICPIP)
- Maximum viscosity approx. 5 mPa·s (5 cP)
- Volume accuracy around 1 % upon dispensing of 1000 droplets

Both droplet size and dispensing performance

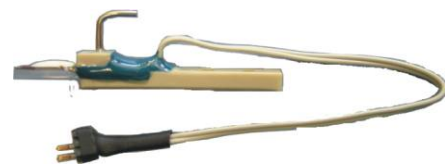
depend on viscosity, density, and surface tension of the sample. Higher viscosities may be handled by producing a burst of droplets at the resonance frequency of the pipette; another way would be the reduction of the viscosity of the liquid by heating the pipette, possibly aided by application of pressure (see right page). This way, glues, liquid crystals, and semiconducting polymers can be dispensed, up to a viscosity of 700 mPa·s. Please ask for further information.

Both dosage head types are available with a number of different inlet adapters, plus a mounting pad with two boreholes, or a cylindrical shaft.



A010-001 SPIP with stainless steel inlet  
A010-200 PICPIP with stainless steel inlet

- Stainless steel connection: OD 1.6 mm, ID 0.8 mm
- For flexible tubing with 1.1 mm inner diameter
- Contains mounting pad with two 2.2 mm holes



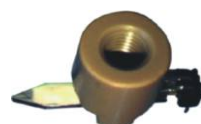
A010-002 SPIP with angled steel capillary  
A010-201 PICPIP with angled steel capillary

- Stainless steel connection for Teflon tubing with an inner diameter of 0.7-0.8 mm
- Contains mounting pad with two 2.2 mm holes



A010-003 SPIP with 1/16" PEEK capillary  
A010-005 PICPIP with 1/16" PEEK capillary

- For the dosage of aggressive liquids
- Liquid not in contact with metal
- Contains mounting pad with two 2.2 mm holes



A010-004 SPIP with 1/16" HPLC bushing, PEEK

- Connection via standard 1/16 inch HPLC bushing
- E.g., for fraction collection of HPLC runs



A-010-006 SPIP cylindrical housing

- Cylindrical housing with steel capillary
- Also available with PEEK housing/capillary
- Without mounting pad

## Application-Specific Design

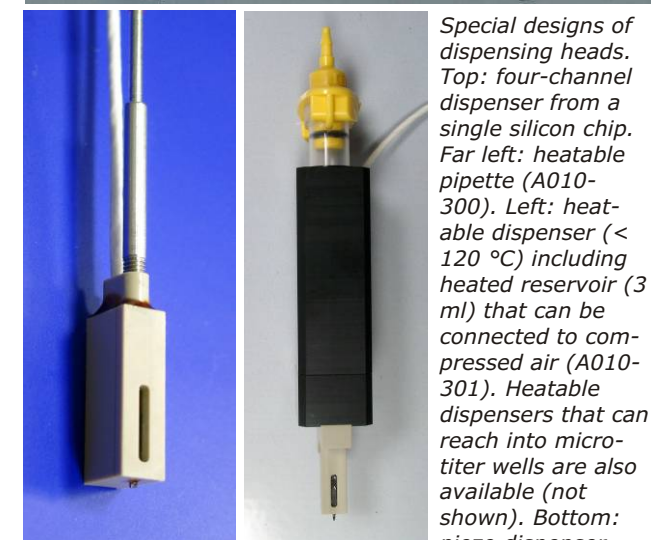
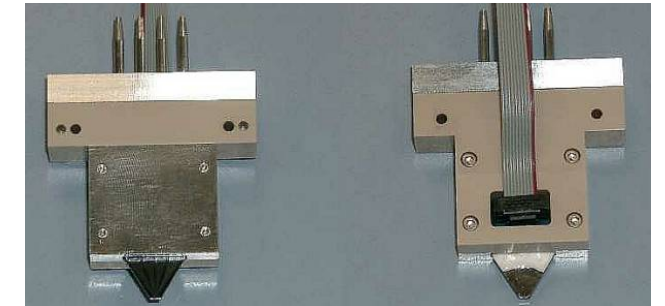
Silicon micromachining allows to substantially modify the design of our microdispensers. We can thus offer a special dosage head for practically every application (information on request):

- Mixing heads with a second inlet channel, such that the drops ejected from the pump chamber contain a mixture of two substances
- Heatable micro-dosage heads to reduce the viscosity of solutions: various heater designs exist (temperature controller necessary)
- Integration of several dosage units in a single silicon chip, e.g. to produce wider lines
- Dispensers with screwed-on glass capillary for the gentle uptake of cells and for the dispensing into small reaction chambers

In principle, these pipettes are also available as accessory to our robotic system "Nano-Plotter™" when they are equipped with an appropriate holder.



Liquid crystal spots

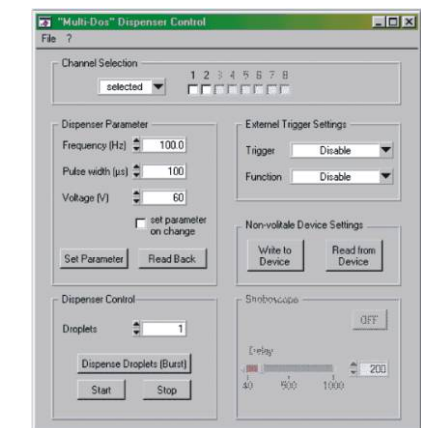


Special designs of dispensing heads.  
Top: four-channel dispenser from a single silicon chip.  
Far left: heatable pipette (A010-300). Left: heatable dispenser (< 120 °C) including heated reservoir (3 ml) that can be connected to compressed air (A010-301). Heatable dispensers that can reach into micro-titer wells are also available (not shown). Bottom: piezo dispenser with screwed-on glass capillary, disassembled.

## Control Unit multi-dos

The multi-dos houses pipette controller modules, i.e., microprocessor-based plug-in boards, which can control microfluidic components (mainly low-power piezo actuators) using the serial interface of your PC. The mds8 program independently accesses several controller modules and is well suited to drive GeSiM micro-dosage heads or the stroboscope.

The openly accessible application programming interface of the multi-dos ensures the convenient usage of GeSiM micro-dosage products in customized applications and instrument systems.



multi-dos (A020-001), four-channel version

## Items of shipment

- Controller for a single micro-dosage head
- Wide-range power adapter, serial cable to PC (RS 232), cable to microdispenser, trigger input
- Technology description
- Application programming interface for dosage control by string commands (built into multi-dos)
- Control software mds8 (requires Windows): adjustment of dispensing parameters (voltage/pulse width), start/stop or preset bursts (1 - 65535 drops); separately for each dispense head
- Dimensions: 192 x 136 x 45 mm