Micromechatronics products
Cooling Solution

Active Cooling
- Motor - fan
  - Piezo Fan
    - ES: Now, MP: 2011/Q1~
  - Microblower
    - ES: Now, MP: 2010/Q3~

Passive Cooling

Natural Convection
Application of Micromechatronics Products

- Next Generation Energy System
  - Fuel Cell
- Air Pump application
  - Air Fresh
  - Toys/Game, etc
- Microblower
- DMFC
  (Direct methanol Fuel Cell)
- Microvalve
- Micropump
- Small/Mobile Equipment
  - Micro Projector
  - Security Camera
  - LED Lightning
- CPU
  - NETTOP PC
  - NETBOOK
- Piezo Fan

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Profile of Microblower

<Market trend and needs>
Thermal technology is increasing its importance, especially in small/compact electronic equipments. Customers are looking for a smaller cooling device than DC fan.

P/N: MZB1001T**

◆ Feature
- Small and thin (20 × 20 × 1.8mm)
- High output pressure (≥1kPa)
- Low power consumption

◆ Application
- Air cooler for compact equipments such as DVC, DSC, and UMPC, etc
- Air pump for Fuel Cell, Gas Sensor, Ionizer, Fragrance, etc.

Gas Sensor
(ex. Reflow Checker)

LED Cooling
(ex. Micro-projector)

PC Cooling
(ex. Net Top Book)
Air Cooling & Air pump

Microblower Technology
Feature of Microblower

<table>
<thead>
<tr>
<th>Item</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Driving Frequency</td>
<td>25KHz</td>
</tr>
<tr>
<td>Air flow</td>
<td>0.8l/min(@15Vpp)</td>
</tr>
<tr>
<td>Static pressure</td>
<td>1.5kPa</td>
</tr>
<tr>
<td>Size (Excl Nozzle Height)</td>
<td>20x20x1.85mm (Nozzle Height 1.6mm)</td>
</tr>
</tbody>
</table>

- 1.sucking in
- 2.ejecting

Air flow

Inlet

Outlet

intake channel

Ventura nozzle

top panel

pumping room

diaphragm
Principle of operation

Air flow with high velocity generates lower pressure to suck air around, which makes real net flow (Bernouilli’s theorem)

High velocity -> Low pressure -> Suck air around -> Push out to outlet
P-Q Characteristics

Micro blower PQ Characteristic

Pressure (kPa) vs. Flow rate (L/min)

- 10Vpp
- 15Vpp
- 20Vpp
Features

High Pressure: Air Pump, Cooling Narrow pitch Mounting

High Flow Rate: Local cooling, Diffusion

Flow rate: 20~30m/s
## Cooling methods

<table>
<thead>
<tr>
<th>Vertical</th>
<th>Horizontal -1</th>
<th>Horizontal -2</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="vertical_diagram.png" alt="Diagram" /></td>
<td><img src="horizontal1_diagram.png" alt="Diagram" /></td>
<td><img src="horizontal2_diagram.png" alt="Diagram" /></td>
</tr>
</tbody>
</table>
| - Minimizing mounting area  
- Certain distance is necessary to enhance cooling performance.  
(Cooling only by the amount of flowing from the blower if the distance is too close) | - Cooling effect is enhanced if there is some space above a material.  
- Effect of increasing Net amount of flowing.  
- Making thermal boundary thinner owing to flowing speed.  
- Not so adequate for low profile mounting. | - Cooling effect is enhanced if there is some space above a material.  
- Lower profile mounting is possible.  
- Attachment is necessary. |

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Application of Microblower

Current

Water Pipe
Suck up by capillary tube
(made with fiber)

Water supply is not stable
due to capillary effect

New Method w/ Microblower

Microblower

Water supply is stable and
quick start can be achieved.
Spot Cooling for PA/IC with Microblower

• Piezo Microblower

Microblower

IC or PA

Substrate

Condition

Heat Source: 2W

Temperature (Surface of heat source)

Time

T=4.8mm

T=9.5mm
Example of (Cooling Memory Module)

Example of the method to make flowing direction toward a substrate using minimum thickness of attachment.

Blower and attachment

Out flowing gate

Attachment (20 x 20 x 2.4)

Heat sink

Blower

Attachment (20 x 20 x 2.4)

Out flowing gate (0.8 x 0.8)

MicroBlower
**Test Result**

Power: 6.8W

We can see around 17k temp. lower in open space

Thermal temp. of surface of heat sink

(Before blower operation)

Thermal temp. of surface of heat sink

(Blower is under operation)

Rhs=6.3[K/W]

↓

Rhs=3.8[K/W]

40% lower

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Aspiration of hot air

Aspiration of hot air from deep area to cool down

Example: handmade attachment (Microblower + air pipe)
Appearance of Microblower
Test Result
MICROBLOWER Driver
MICROBLOWER's Driver Board

Control Board Type1
Can be controlled through DC supply

Control Board Type2 (USB Type)
Can be controlled easily through PC USB

P/N: MZBD001
Note: only for evaluation purpose
(we don’t have this product in mass-production.)
MICROBLOWER Sample (How to connect)

**Driver & Oscillator Circuit & DC Converter**

To PC’s USB Connector (5V)

DC Power Supply (+12~+22V)

20Vp-p
MICROBLOWER Sample (How to apply voltage)

P-Q特性(代表値)
P-Q characteristic (Typical value)

静圧(kPa)
Static pressure

流量(L/min)
Flow rate

DC Supply's Voltage
MICROBLOWER VOLTAGE (Vp-p)

Driver &
Oscillator Circuit

DC Power
Supply (12~22V)

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Driver Circuit (Type1)
<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>U2</td>
<td>Op Amp</td>
<td>LM7321MA</td>
<td>National Semiconductor</td>
<td>GBW=20MHz   RailtoRail IN/OUT</td>
</tr>
<tr>
<td>Q1</td>
<td>Transistor(PNF/NPN)</td>
<td>HN1 B04F</td>
<td>Toshiba Semiconductor</td>
<td>Ic=500mA</td>
</tr>
<tr>
<td>R3, R4</td>
<td>Chip Resistor 100kΩ</td>
<td>RK73B1 JTDD1 04J</td>
<td>KOA</td>
<td>0.1W</td>
</tr>
<tr>
<td>R5</td>
<td>Chip Resistor 1.5kΩ</td>
<td>RK73B1 JTDD1 52J</td>
<td>KOA</td>
<td>0.1W</td>
</tr>
<tr>
<td>R6</td>
<td>Chip Resistor 15Ω</td>
<td>RK73B1 JTDD1 50J</td>
<td>KOA</td>
<td>0.1W</td>
</tr>
<tr>
<td>R7</td>
<td>Chip Resistor 270KΩ</td>
<td>RK73B1 JTDD274J</td>
<td>KOA</td>
<td>0.1W</td>
</tr>
<tr>
<td>R8</td>
<td>Chip Resistor 100Ω</td>
<td>RK73B1 JTDD1 01J</td>
<td>KOA</td>
<td>0.1W</td>
</tr>
<tr>
<td>R9</td>
<td>Short Chip</td>
<td>RK73Z1 JTDD</td>
<td>KOA</td>
<td></td>
</tr>
<tr>
<td>C4, C5</td>
<td>Chip Capacitor 1 μF</td>
<td>GRM1 88R71 E1 05 KA12D</td>
<td>MURATA</td>
<td>25V X7R</td>
</tr>
<tr>
<td>C6</td>
<td>Chip Capacitor 100p</td>
<td>GRM1 882C1 H1 01 JA01 D</td>
<td>MURATA</td>
<td>50Vdc CH</td>
</tr>
<tr>
<td>J1</td>
<td>Connector</td>
<td>SM02B-SSR-H-TB</td>
<td>JST</td>
<td></td>
</tr>
<tr>
<td>J2</td>
<td>USB Connector</td>
<td>317A</td>
<td>Chant Sincere</td>
<td></td>
</tr>
</tbody>
</table>
Microblower Reliability Testing
On-going reliability

Amplitude ⇌ Apply Voltage

<table>
<thead>
<tr>
<th>試験項目</th>
<th>条件</th>
<th>結果</th>
<th>試験状態</th>
</tr>
</thead>
<tbody>
<tr>
<td>高温放置</td>
<td>85℃</td>
<td>6000hr/G</td>
<td>練続中</td>
</tr>
<tr>
<td>Dry heat (storage)</td>
<td>Continue</td>
<td></td>
<td></td>
</tr>
<tr>
<td>高温竜動 (CR内)</td>
<td>85℃20Vp-p</td>
<td>10000hr/G</td>
<td>練続中</td>
</tr>
<tr>
<td>Dry heat operating (in CR)</td>
<td>Continue</td>
<td></td>
<td></td>
</tr>
<tr>
<td>湿度放置</td>
<td>85℃85%</td>
<td>3000hr/G</td>
<td>5000時間で劣化 Degradation at 5000h</td>
</tr>
<tr>
<td>High temperature and humidity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>湿度置物</td>
<td>60℃93%20Vp-p</td>
<td>3000hr/G</td>
<td>完了 Finished</td>
</tr>
<tr>
<td>High temperature and humidity operating</td>
<td></td>
<td></td>
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<tr>
<td>HCT</td>
<td>-40℃〜85℃</td>
<td>6000cyc/G</td>
<td>練続中 Continue</td>
</tr>
<tr>
<td>Heat cycle test</td>
<td></td>
<td></td>
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<tr>
<td>低温放置</td>
<td>-40℃</td>
<td>7000hr/G</td>
<td>練続中 Continue</td>
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<tr>
<td>Low temperature</td>
<td></td>
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<tr>
<td>高圧負荷試験</td>
<td>85℃/20V</td>
<td>2000hr/G</td>
<td>完了 Finished</td>
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<tr>
<td>High temperature pressure driving test</td>
<td></td>
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<tr>
<td>落下試験</td>
<td>To 1.5m concrete 6directionx 3times</td>
<td>G</td>
<td>完了 Finished</td>
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<tr>
<td>Drop test</td>
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<tr>
<td>衝撃試験</td>
<td>1500G</td>
<td>G</td>
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<tr>
<td>Shock test</td>
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<tr>
<td>振動試験</td>
<td>98m/s2(10G)、max amplitude1.5mm 10～2KHz, Log sweep, 3dir-20min, 12cycles</td>
<td>G</td>
<td>完了 Finished</td>
</tr>
<tr>
<td>Vibration test</td>
<td></td>
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</tr>
</tbody>
</table>

Expected failure mode: Crack of piezo-element (Fatigue breakdown)
END