Electronic Sphygmomanometer

Solution Proposal by Toshiba
Toshiba Electronic Devices & Storage Corporation provides comprehensive device solutions to customers developing new products by applying its thorough understanding of the systems acquired through the analysis of basic product designs.
Block Diagram
Electronic Sphygmomanometer

Overall block diagram

- Adapter
- Battery
- LDO
- LDO
- EEPROM
- MCU
- MOSFET
- MOSFET
- Pressure Sensor
- Pump Motor
- Air Release Valve
- Op-amp
- Power ON/OFF
- Battery Monitor
- Input Switch
- Switch
Electronic Sphygmomanometer

Detail of power supply circuits

**Surge voltage protection**

1. TVS

- The power line from the DC adapter must be protected against surge voltage.
- PSRR is a key feature of microcomputers.
- A backflow prevention measure is necessary between the battery and the AC adapter.

**Control MCU power supply**

2. LDO

- Static electricity (ESD) from external terminals is absorbed to prevent circuit malfunction and device breakdown. TVS diode
- Optimum power supply for environments with high power supply noise
- Low forward voltage / Strong against surge current

**Constant voltage supply circuit**

3. SBD

- Small surface mount LDO regulator
- Low forward voltage / Strong against surge current

* Click on the numbers in the circuit diagram to jump to the detailed descriptions page
**Motor protection**

- A small, low-on-resistance MOS FET is used to control the motors.
- Protection against flyback current by the motor is necessary.

**Motor control**

- Low forward voltage / Strong against surge current
  Schottky barrier diode
- Setting of low power consumption with low on-resistance
  U-MOS Series MOSFET (Trench Type)

* Click on the numbers in the circuit diagram to jump to the detailed descriptions page.
Electronic Sphygmomanometer    Detail of sensor signal detection circuit

Device selection points
- The voltage and current supplied are important for selecting the operational amplifier.
- The use of small packages reduces the board area.

Proposals from Toshiba
- **Amplify the detected small signal with low noise.**
  Low-noise operational amplifier

* Pressure sensor

* Click on the numbers in the circuit diagram to jump to the detailed descriptions page.
Recommended Devices
Device Solutions to address customer needs

As described above, in order to design Electronic Sphygmomanometer, "Miniaturization of circuit boards", "Low power consumption of sets" and "Robust operation" are important factors. Toshiba's proposals are based on these three solution perspectives.

- **Miniaturization of circuit boards**
  - Small size Package Supported

- **Lower power consumption of the set**
  - High efficiency 
  - Low loss

- **Robust operation**
  - Noise immunity
Device Solutions to address customer needs

- **TVS diode**: Small size package supported, noise immunity
- **Small surface mount LDO regulator**: Small size package supported, high efficiency, low loss
- **Schottky barrier diode**: Small size package supported, high efficiency, low loss
- **Small-signal MOSFET**: Small size package supported, high efficiency, low loss
- **Ultra-low noise operational amplifier**: Small size package supported, high efficiency, low loss, noise immunity
This absorbs static electricity (ESD) from external terminals, prevents circuit malfunction and protects devices.

1. Improved ESD absorption
Both low operating resistance and low capacitance are realized and ensures high signal protection performance and signal quality.

2. Reduce ESD energy by low clamp voltage
Steadily protect the connected circuits/devices using proprietary technology.

3. Optimal for high-density mounting
A variety of small size packages are available.

**Line up**

<table>
<thead>
<tr>
<th>Part number</th>
<th>DF2B7ASL</th>
<th>DF2B7AFU</th>
<th>DF2B20M4SL</th>
<th>DF2S14P2CTC</th>
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<tbody>
<tr>
<td>Package</td>
<td>SL2</td>
<td>USC</td>
<td>SL2</td>
<td>CST2</td>
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<tr>
<td>$V_{ESD}$ [kV]</td>
<td>±30</td>
<td>±30</td>
<td>±15</td>
<td>±30</td>
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<td>$V_{(Max.)}$ [V]</td>
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<td>$C_t$ (Typ.) [pF]</td>
<td>8.5</td>
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<td>270</td>
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<tr>
<td>$R_{DYN}$ (Typ.) [$\Omega$]</td>
<td>0.2</td>
<td>0.2</td>
<td>0.2</td>
<td>0.23</td>
</tr>
</tbody>
</table>

**Value provided**

1. **TVS diode**
   - DF2B7ASL / DF2B7AFU / DF2B20M4SL / DF2S14P2CTC

2. **Improved ESD absorption**
   - This absorbs static electricity (ESD) from external terminals, prevents circuit malfunction and protects devices.

3. **Reduce ESD energy by low clamp voltage**
   - Steadily protect the connected circuits/devices using proprietary technology.

4. **Optimal for high-density mounting**
   - A variety of small size packages are available.

**Part number**
- DF2B7ASL
- DF2B7AFU
- DF2B20M4SL
- DF2S14P2CTC

**Package**
- SL2
- USC
- SL2
- CST2

**$V_{ESD}$ [kV]**
- ±30 (DF2B7ASL, DF2B7AFU)
- ±15 (DF2B20M4SL)
- ±30 (DF2S14P2CTC)

**$V_{(Max.)}$ [V]**
- 5.5 (DF2B7ASL, DF2B7AFU)
- 18.5 (DF2B20M4SL)
- 13 (DF2S14P2CTC)

**$C_t$ (Typ.) [pF]**
- 8.5 (DF2B7ASL, DF2B7AFU)
- 0.2 (DF2B20M4SL)
- 270 (DF2S14P2CTC)

**$R_{DYN}$ (Typ.) [$\Omega$]**
- 0.2 (DF2B7ASL, DF2B7AFU, DF2B20M4SL)
- 0.23 (DF2S14P2CTC)

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*NOTE*: This product is an ESD protection diode and cannot be used for purposes other than ESD protection (including but not limited to voltage regulation diode applications).
Small size mount LDO regulator
TCR5BM / TCR3DF series

Variety of products that meet high performance requirements, from general-purpose package to ultra-small package type.

1 Low dropout voltage
New-generation process makes it possible to operate at low input voltages and achieve significant low power consumption.

2 High ripple compression
Realize stable power supply by eliminating switching noise generated in the power supply circuit.

3 Fast load transient response
Fast load transient response characteristic of our LDO regulator enables to supply a stable output voltage even for sudden current fluctuations.

Low dropout voltage

![Graph showing low dropout voltage comparison between conventional products and TCR5BM series.](image)

### Line up

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<tr>
<th>Part number</th>
<th>TCR5BM series</th>
<th>TCR3DF Series</th>
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<tr>
<td>Package</td>
<td>DFNS8</td>
<td>SMV</td>
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<td>$V_{IN}$ (Max) [V]</td>
<td>5.5</td>
<td>5.5</td>
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<td>$I_{OUT}$ (Max) [A]</td>
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<td>0.3</td>
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<td>$V_{OUT}$ [V]</td>
<td>0.8 to 3.6</td>
<td>1.0 to 4.5</td>
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<tr>
<td>R.R. (Typ.) [dB]</td>
<td>98</td>
<td>70</td>
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Low loss allows it to be applied to various applications, and greatly contributes to miniaturization.

1. **Low forward voltage**
   - It is suitable for Backflow prevention with low power loss by low forward voltage.

2. **Be resistant to reverse voltage**
   - The reverse voltage $V_R$ can be applied up to 40 V.

3. **Small package**
   - Small package is suitable for high-density mounting.

### CUS10S40 Characteristics Curves

#### Line up

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<tr>
<th>Part number</th>
<th>CUS10S40</th>
<th>CUHS15F40</th>
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<td>Package</td>
<td>USC</td>
<td>US2H</td>
<td>USC</td>
<td>ESC</td>
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<tr>
<td>$I_0$ (Max) [A]</td>
<td>1.0</td>
<td>1.5</td>
<td>1.0</td>
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<td>$V_E$ (Max) [V]</td>
<td>40</td>
<td>40</td>
<td>30</td>
<td>20</td>
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<td>$V_F$ (Typ.) [V]</td>
<td>0.45</td>
<td>0.49</td>
<td>0.43</td>
<td>0.42</td>
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Value provided

**Suitable for power management switches and greatly contributes to miniaturization.**

1. **Low voltage drive**
   
   Drive at $V_{GS} = 1.8$ V.

2. **Low on-resistance**
   
   Heat generation and power consumption can be kept low by keeping the on-resistance between the source and drain low.

3. **Small package**

   Package line-up for SOT-23F / VESM.

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### Line up

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<tr>
<th>Part number</th>
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<td>Package</td>
<td>SOT-23F</td>
<td>SOT-23F</td>
<td>VESM</td>
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<tr>
<td>Polarity</td>
<td>N-ch</td>
<td>N-ch</td>
<td>N-ch</td>
</tr>
<tr>
<td>$V_{DSS}$ [V]</td>
<td>30</td>
<td>30</td>
<td>20</td>
</tr>
<tr>
<td>$I_D$ [A]</td>
<td>3.5</td>
<td>4.0</td>
<td>0.25</td>
</tr>
<tr>
<td>$R_{DS(ON)}$ (Max) [$\Omega$] @$V_{GS} = 1.5$ V</td>
<td>0.289</td>
<td>0.109</td>
<td>3.1</td>
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</table>

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Ultra-low noise operational amplifier
TC75S67TU

Value provided

Very small signals detected by various sensors can be amplified with very low noise.

1. **Ultra-low noise**
   - \( V_{NI} \) (Typ.) = 6.0 [nV/√Hz]
   - @f = 1 kHz

   Very small signals detected by various sensors [Note 1] can be amplified with low noise using CMOS Op-amp by optimizing the processing. We achieved one of the industry's lowest [Note 2] input equivalent noise voltage.

2. **Small package**
   - This is a flat lead type compact package, which contributes to the miniaturization and lower height of the printed circuit board. Packaging size: 2.0 x 2.1 x 0.7 mm

3. **Low current consumption**
   - \( I_{DD} \) (Typ.) = 430 [μA]

   The adoption of the CMOS process achieves lower current-consumption characteristics than our bipolar process operational amplifier.

Ultra-low noise characteristic

(Company Comparison)

[Note 1] Various sensors: vibration detection sensors, shock sensors, acceleration sensors, pressure sensors, infrared sensors, and temperature sensors

[Note 2] Based on our survey (as of May 2017). [Note 3] Comparison with our bipolar process operational amplifier

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Line up

<table>
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<tr>
<th>Part number</th>
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<td>Package</td>
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<td>( V_{DD} ) (Max) [V]</td>
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<td>( V_{DD} ) (Min) [V]</td>
<td>±1.1</td>
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<td>( I_{DD} ) (Max) [μA]</td>
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<td>( V_{NI} ) (Typ.) [nV/√Hz] @f = 1 kHz</td>
<td>6</td>
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