Wireless Earphone

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.
Wireless Earphone  Detail of earphone case

**Power supply lines**
Load switch

**Battery management**

**External connector**

Criteria for device selection
- To improve energy-efficiency, a MOSFET with lower on-resistance is required.
- The circuit board area can be reduced by adopting a compact package product.
- Low-voltage operation suitable for battery operation is required.
- It is necessary to absorb ESD entering from external terminals and protect the circuit.

Proposals from Toshiba
- Small-signal MOSFET with low on-resistance and efficient heat dissipation
  Small-signal MOSFET
- TVS diode that realizes compact size and low capacitance
  TVS diode

※ Click on the number in the circuit diagram to jump to the detailed description page
Wireless Earphone  Detail of earphone

Battery management  Power supply circuit  Circuit protection

Criteria for device selection
- The circuit board area can be reduced by adopting a compact package product.
- To improve energy-efficiency, a MOSFET with lower on-resistance is required.
- In order to perform voltage conversion in a compact and efficient manner, an LDO regulator having a low dropout characteristic is required.
- A compact, standard capacitance type TVS diode is suitable for ESD protection.

Proposals from Toshiba
- Small-signal MOSFET with low on-resistance and efficient heat dissipation
  Small-signal MOSFET
- TVS diode that realizes compact size and low capacitance
  TVS diode
- Small LDO regulator capable of applying a large current
  Small surface mount LDO regulator

※ Click on the number in the circuit diagram to jump to the detailed description page
Recommended Devices
As described above, in the design of Wireless Earphone, “Miniaturization of circuit board”, “Low power consumption” and “High reliability” are important factors. Toshiba’s proposals are based on these three solution perspectives.
Device solutions to address customer needs

- Small-signal MOSFET
- TVS diode
- Small surface mount LDO regulator

- Small packaging
- High efficiency - Low loss
- Protection from Surge/ESD
Small-signal MOSFET
SSM6N56FE / SSM6N61NU / SSM3K56ACT

Contribute to miniaturization and low power consumption of the set by low on-resistance and 2in1 package.

1 Low on-resistance
Heat dissipation and power consumption can be reduced by low drain-source on-resistance.

2 Low voltage drive
Power consumption of the set can be reduced by low voltage drive.

3 Small size package
Wide variety of package lineups, including ES6 packages (2in1), are provided.

Value provided

Line up

<table>
<thead>
<tr>
<th>Part number</th>
<th>SSM6N56FE</th>
<th>SSM6N61NU</th>
<th>SSM3K56ACT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Package</td>
<td>ES6</td>
<td>UDFN6</td>
<td>CST3</td>
</tr>
<tr>
<td>Polarity</td>
<td>N-ch x 2</td>
<td>N-ch x 2</td>
<td>N-ch</td>
</tr>
<tr>
<td>$V_{DS}$ [V]</td>
<td>20</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>$I_{D}$ [A]</td>
<td>0.8</td>
<td>4</td>
<td>14</td>
</tr>
<tr>
<td>$R_{DS(ON)}$ [mΩ] @$V_{GS} = 4.5$ V</td>
<td>Typ. 186</td>
<td>25</td>
<td>186</td>
</tr>
<tr>
<td></td>
<td>Max 235</td>
<td>33</td>
<td>235</td>
</tr>
</tbody>
</table>

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TVS diode
DF2B6USL / DF2B7ASL / DF2S6P1CT

Value provided

Optimum to prevent malfunction of the circuit and device protection by absorbing static electricity (ESD) and surge from external terminals.

1. High ESD pulse absorption performance
   Improved ESD absorption compared to conventional products. (50% reduction in operating resistance)
   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>DF2B6USL</th>
<th>DF2B7ASL</th>
<th>DF2S6P1CT</th>
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<tbody>
<tr>
<td>Package</td>
<td>SL2</td>
<td>SL2</td>
<td>CST2</td>
</tr>
<tr>
<td>$V_{ESD}$ [kV]</td>
<td>±10</td>
<td>±30</td>
<td>±30</td>
</tr>
<tr>
<td>$V_{DRM}$ (Max) [V]</td>
<td>1.5</td>
<td>5.5</td>
<td>5.5</td>
</tr>
<tr>
<td>$C_t$ (Typ.) [pF]</td>
<td>1.5</td>
<td>8.5</td>
<td>90</td>
</tr>
<tr>
<td>$R_{DYN}$ (Typ.) [Ω]</td>
<td>0.25</td>
<td>0.2</td>
<td>0.23</td>
</tr>
<tr>
<td>Use</td>
<td>For signal lines</td>
<td>For signal / power supply line</td>
<td>For power supply lines</td>
</tr>
</tbody>
</table>

(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).
This LDO eliminates the switching noise generated in the power supply circuit and provides an ideal power supply with low output voltage fluctuation.

1. **High ripple rejection**
   
   Our LDO regulator has high ripple rejection characteristic. Stable power supply is realized by removing switching noise generated in the circuit.

2. **Low loss (low dropout)**
   
   The heat generated by the circuit can be minimized since our LDO regulator minimizes the losses generated by the circuit.

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

### Line up

<table>
<thead>
<tr>
<th>Part number</th>
<th>TCR5BM series</th>
<th>TCR3UG series</th>
<th>TCR2EN series</th>
</tr>
</thead>
<tbody>
<tr>
<td>Package</td>
<td>DFN5B</td>
<td>WCSP4F</td>
<td>SDFN4</td>
</tr>
<tr>
<td>$I_{OUT}$ [mA]</td>
<td>0.5</td>
<td>0.3</td>
<td>0.2</td>
</tr>
<tr>
<td>$V_{DO}$ [mV]</td>
<td>$@I_{OUT} = 100$</td>
<td>$@I_{OUT} = 140$</td>
<td>$@I_{OUT} = 160$</td>
</tr>
<tr>
<td>R.R. [dB]</td>
<td>98</td>
<td>70</td>
<td>73</td>
</tr>
<tr>
<td>$I_S$ [μA]</td>
<td>19</td>
<td>0.34</td>
<td>35</td>
</tr>
</tbody>
</table>

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