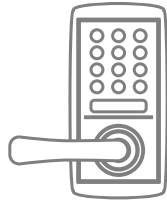
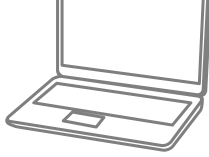


# Wireless Earbuds

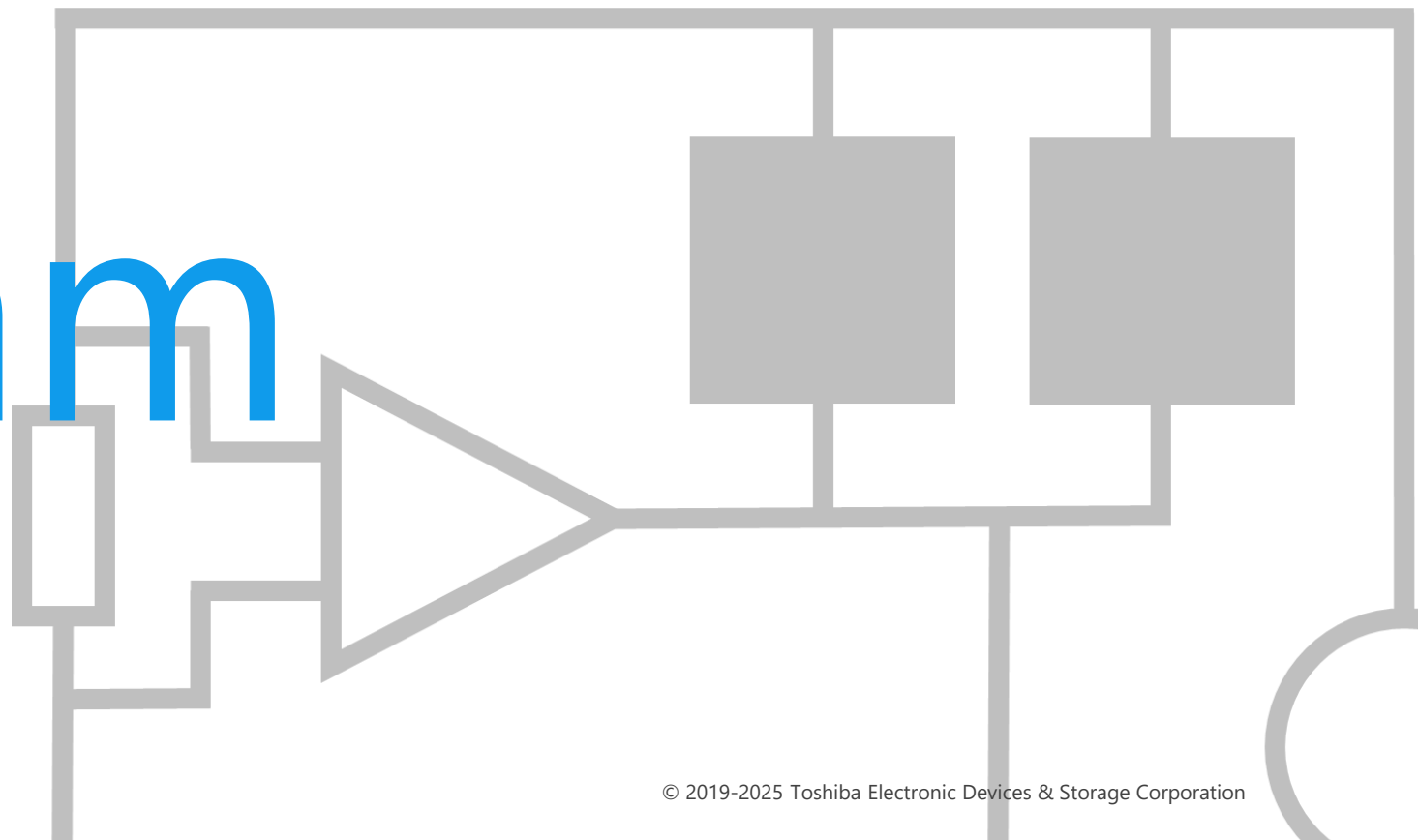
Solution Proposal by Toshiba



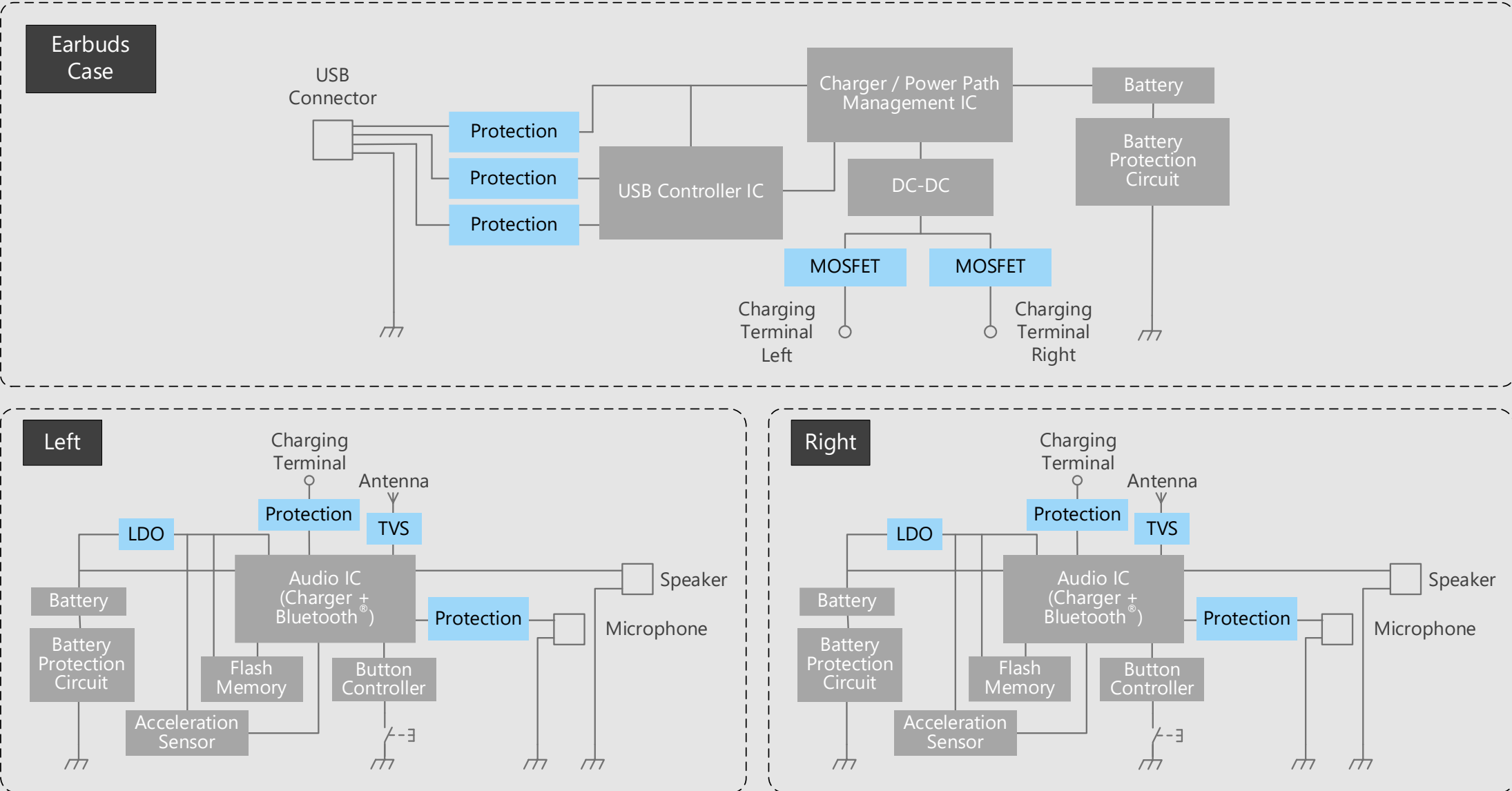


Toshiba Electronic Devices & Storage Corporation provides comprehensive device solutions to customers developing new products by applying its thorough understanding of the systems acquired through the analysis of basic product designs.

# Block Diagram



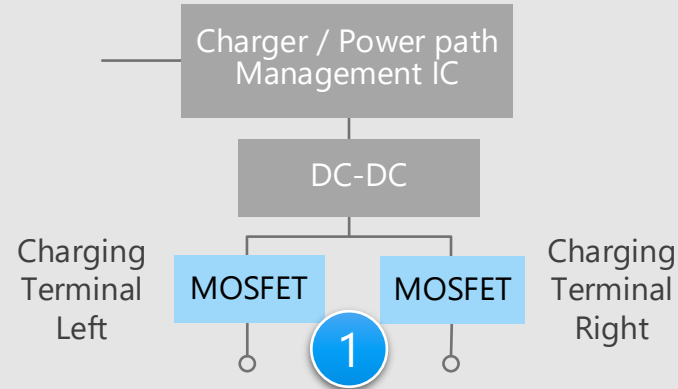
# Wireless Earbuds    Overall block diagram



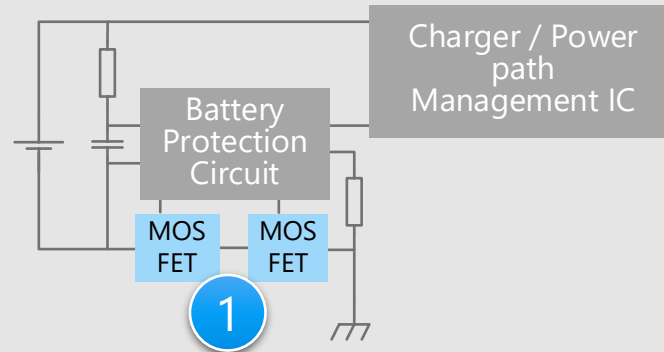
# Wireless Earbuds    Detail of earbuds case

## Power supply lines

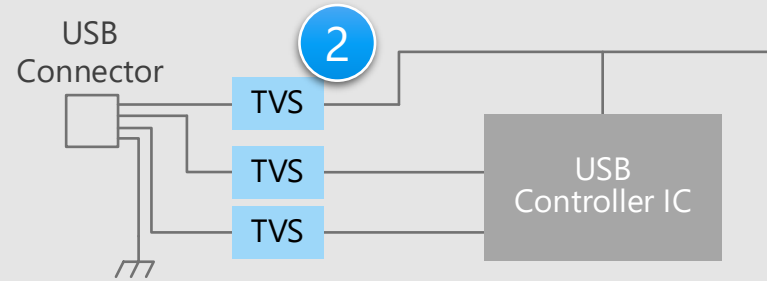
Load switch



## Battery management



## External connector



## Criteria for device selection

- Low voltage driven MOSFET with low on-resistance is suitable for load switch.
- A compact TVS diode is suitable for ESD (Electrostatic Discharge) protection.

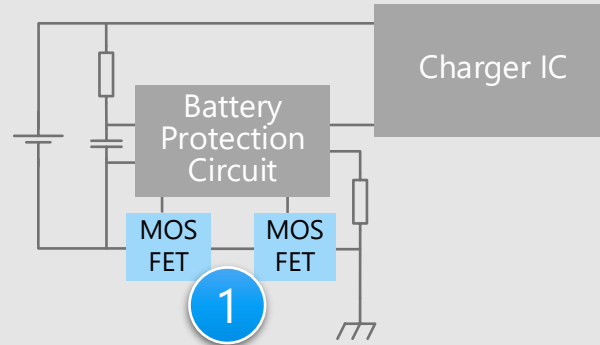
## Proposals from Toshiba

- **Realize a set with low power consumption by low voltage drive and low on-resistance**  
Small signal MOSFET 1
- **Absorb ESD from external terminals to prevent circuit malfunction and device breakdown**  
TVS diode 2

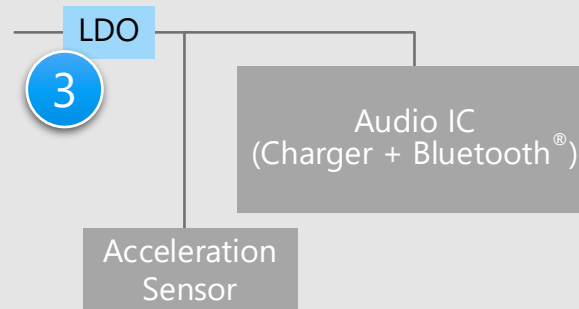
\* Click on the number in the circuit diagram to jump to the detailed description page

# Wireless Earbuds    Detail of earbuds

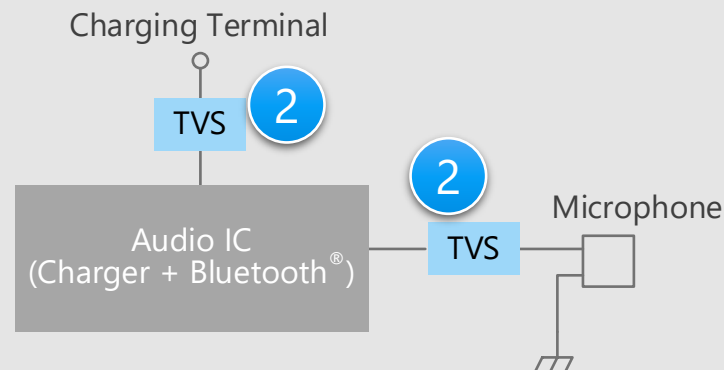
## Battery management



## Power supply circuit



## Circuit protection



## Criteria for device selection

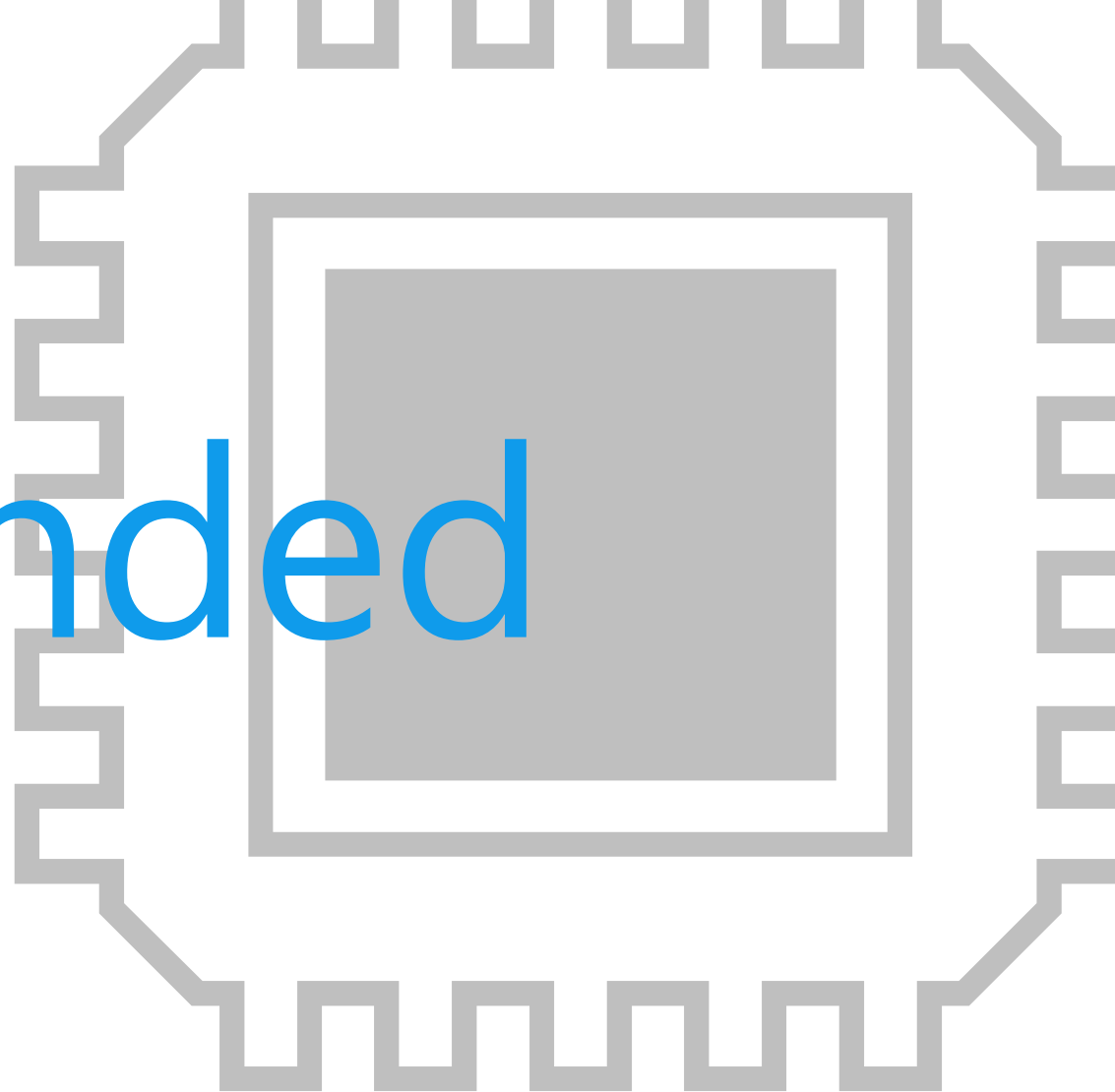
- Low voltage driven MOSFET with low on-resistance is suitable for battery management.
- PSRR (Power Supply Rejection Ratio) of LDO regulator is an important parameter for wireless system.
- A compact TVS diode is suitable for ESD protection.

## Proposals from Toshiba

- **Realize a set with low power consumption by low voltage drive and low on resistance**  
Small signal MOSFET 1
- **Absorb ESD from external terminals to prevent circuit malfunction and device breakdown**  
TVS diode 2
- **Supply the power with low noise**  
Small surface mount LDO regulator 3

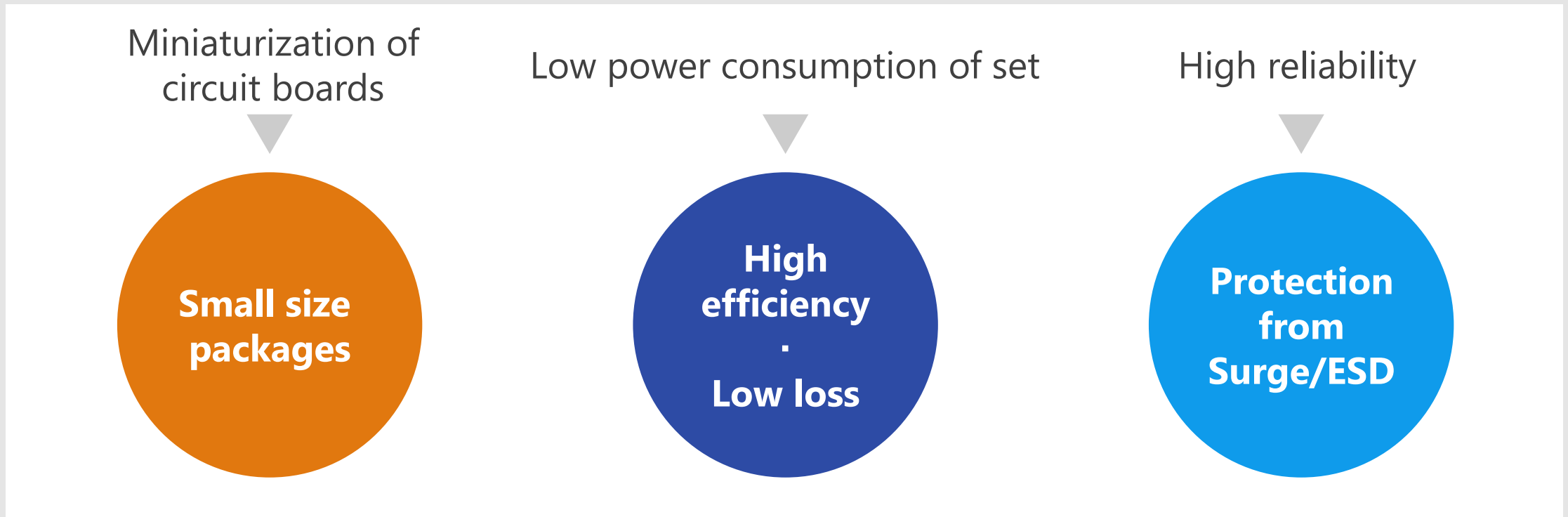
\* Click on the number in the circuit diagram to jump to the detailed description page

# Recommended Devices



# Device solutions to address customer needs

As described above, in the design of wireless earbuds, “**Miniaturization of circuit boards**”, “**Low power consumption of set**” and “**High reliability**” are important factors. Toshiba’s proposals are based on these three solution perspectives.





# Device solutions to address customer needs

|                                     | Small size packages | High efficiency<br>·<br>Low loss | Protection from<br>Surge/ESD |
|-------------------------------------|---------------------|----------------------------------|------------------------------|
| 1 Small signal MOSFET               | ●                   | ●                                |                              |
| 2 TVS diode                         | ●                   |                                  | ●                            |
| 3 Small surface mount LDO regulator | ●                   | ●                                |                              |

Value provided

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

## 1 Low on-resistance

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

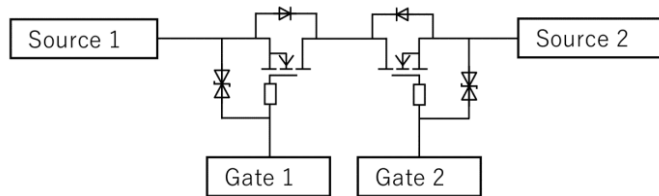
## 2 Low voltage drive

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

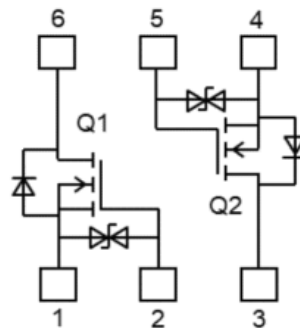
## 3 Small size package

Various packages, including ES6 packages (2in1), are available.





SSM6N951L internal circuit



SSM6N61NU internal circuit



Lineup

| Part number  | SSM6N951L   | SSM6N56FE   | SSM6N61NU   | SSM3K56ACT   |
|--|---|---|---|--|
| Package  | TCSP6A-172101  | ES6  | UDFN6  | CST3  |
| Polarity   | N-ch x 2 (Drain Common)   | N-ch x 2  | N-ch x 2  | N-ch   |
| $V_{DS}, / V_{SS}$ [V]                               | 12  | 20  | 20  | 20   |
| $I_D / I_S$ [A]                                      | 8   | 0.8   | 4   | 1.4  |
| $R_{DS(ON)} / R_{SS(ON)}$ [mΩ]<br>@ $V_{GS} = 2.5$ V | Typ.  | 5.5   | 230   | 31   |
|  | Max   | 10  | 300   | 45   |

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Value provided

**Absorbs static electricity (ESD) from external terminals, prevents circuit malfunction and protects devices.**

## 1 Improved ESD absorption

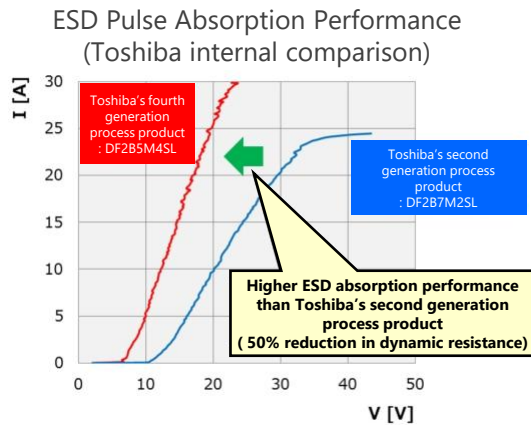
Improved ESD absorption compared to Toshiba's existing products. (50 % reduction in operating resistance)  
For some products, both low operating resistance and low capacitance are realized and ensure high signal protection performance and signal quality.

## 2 Suppress ESD energy by low clamp voltage

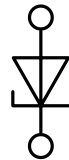
Protect the connected circuits and devices using Toshiba own technology.

## 3 Suitable for high density mounting

A variety of compact packages are available.



Unidirectional




Suitable for paths such as logic signals. There are lineups of 1in1, 2in1, 4in1, 5in1, 7in1.

Bidirectional



Suitable for paths with both polar signals such as audio signals.

### Lineup

| Part number                   | DF2B6USL  | DF2B6M4BSL       | DF2B7BSL                        |
|-------------------------------|---|------------------|---------------------------------|
| Package                       | SL2  |                  |                                 |
| $V_{ESD}$ [kV]                | ±10   | ±8               | ±30                             |
| $V_{RWM}$ (Max) [V]           | 5.5   | 5.5              | 5.5                             |
| $C_t$ (Typ.) [pF]             | 1.5   | 0.12             | 12                              |
| $R_{DYN}$ (Typ.) [ $\Omega$ ] | 0.25  | 1.05             | 0.2                             |
| Purpose                       | For signal lines  | For signal lines | For signal / power supply lines |

[◆Return to Block Diagram TOP](#)

(Note) This product is an ESD protection diode and cannot be used for purposes other than ESD protection.

# 3 Small surface mount LDO regulator

TCR5BM Series / TCR5RG Series / TCR3UG Series / TCR2EN Series



Value provided

**LDO regulator capable of low power and long operation time with low output voltage fluctuation by eliminating switching noise.**

## 1 High PSRR

High PSRR (Power Supply Rejection Ratio) characteristic realizes stable power supply by eliminating switching noise generated in the power supply circuit.

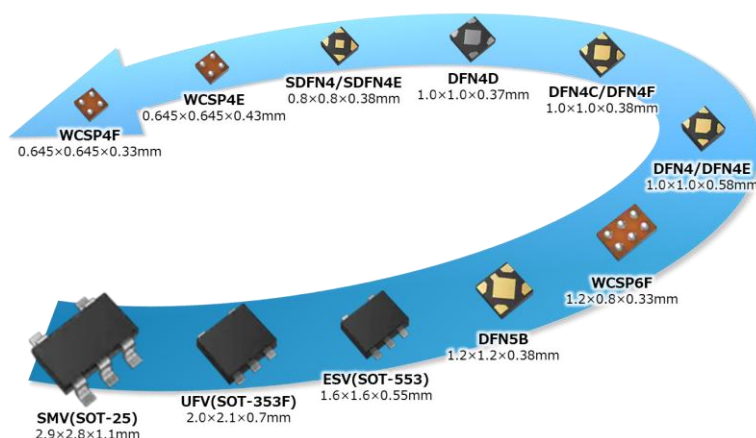
## 2 Low dropout voltage

The originally developed process realized the low dropout voltage characteristics.

## 3 Suitable for high density mounting

Various packages are available.

### Rich package lineup



### Lineup

| Part number                       | TCR5BM Series  | TCR5RG Series   | TCR3UG Series               | TCR2EN Series  |
|-----------------------------------|--|---|-----------------------------|--|
| Package                           | DFN5B  | WCSP4F  |                             | SDFN4  |
| $I_{OUT}$ (Max) [A]               | 0.5  | 0.5   | 0.3                         | 0.2  |
| $V_{DO}$ (Typ.) [mV]              | 100<br>@ $I_{OUT}$ = 500 mA  | 150<br>@ $I_{OUT}$ = 500 mA   | 140<br>@ $I_{OUT}$ = 300 mA | 160<br>@ $I_{OUT}$ = 150 mA  |
| PSRR (Typ.) [dB]<br>@ $f$ = 1 kHz | 98   | 100   | 70                          | 73   |
| $I_B$ (Typ.) [ $\mu$ A]           | 19   | 7   | 0.34                        | 35   |

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If you are interested in these products and have questions or comments about any of them, please do not hesitate to contact us below:

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